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(54) Titre : DERIVES HETEROCYCLIQUES SPIROCYCLIQUES ET LEURS METHODES D'UTILISATION
(54) Title: SPIROCYCLIC HETEROCYCLIC DERIVATIVES AND METHODS OF THEIR USE

(57) Abrégé/Abstract:
Spirocyclic heterocyclic derivatives, pharmaceutical compositions containing these compounds, and methods for their pharmaceutical use are disclosed. In certain embodiments, the spirocyclic heterocyclic derivatives are ligands of the δ opioid receptor and may be useful, inter alia, for treating and/or preventing pain, anxiety, gastrointestinal disorders, and other δ opioid receptor-mediated conditions.

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(57) Abstract: Spirocyclic heterocyclic derivatives, pharmaceutical compositions containing these compounds, and methods for their pharmaceutical use are disclosed. In certain embodiments, the spirocyclic heterocyclic derivatives are ligands of the δ opioid receptor and may be useful, *inter alia*, for treating and/or preventing pain, anxiety, gastrointestinal disorders, and other δ opioid receptor-mediated conditions.

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CECI EST LE TOME 1 DE 2
CONTENANT LES PAGES 1 À 403

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THIS SECTION OF THE APPLICATION/PATENT CONTAINS MORE THAN ONE VOLUME

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SPIROCYCLIC HETEROCYCLIC DERIVATIVES AND METHODS OF THEIR USE

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. Provisional Application Serial No. 60/507,864, filed October 1, 2003, the entire disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The invention relates to spirocyclic heterocyclic derivatives (including derivatives of spiro(*2H*-1-benzopyran-2,4'-piperidines), pharmaceutical compositions containing these compounds, and methods for their pharmaceutical use. In certain embodiments, the spirocyclic heterocyclic derivatives are ligands of the δ opioid receptor and are useful, *inter alia*, for treating and/or preventing pain, anxiety, gastrointestinal disorders, and other δ opioid receptor-mediated conditions.

BACKGROUND OF THE INVENTION

There are at least three different opioid receptors (μ, δ and κ) that are present in both central and peripheral nervous systems of many species, including humans. Lord, J.A.H., *et al.*, *Nature,* **1977**, 267, 495. Activation of the δ opioid receptors induces analgesia in various animal models. Moulin, *et al., Pain*, **1985**, 23, 213. Some work suggests that the analgesics working at δ opioid receptors do not have the attendant side effects associated with μ and κ opioid receptor activation. Galligan, *et al., J. Pharm. Exp. Ther.*, **1985**, 229, 641. The δ opioid receptor has also been identified as having a role in circulatory systems. Ligands for the δ receptor have also been shown to possess immunomodulatory activities. Dondio, *et al., Exp. Opin. Ther. Patents*, **1997**, 10, 1075. Further, selective δ opioid receptor agonists have been shown to promote organ and cell survival. Su, T-P, *Journal of Biomedical Science*, **2000**, 9(3), 195-199. Ligands for the δ opioid receptor may therefore find potential use as analgesics, as antihypertensive agents, as immunomodulatory agents, and/or agents.

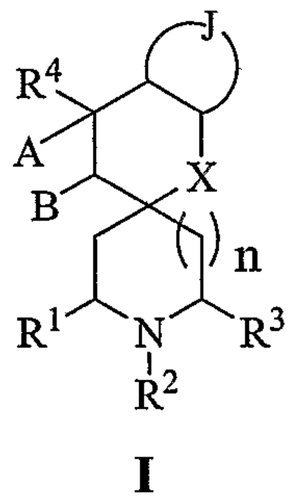
Numerous selective δ opioid ligands are peptidic in nature and thus are unsuitable for administration by systemic routes. Several non-peptidic δ opioid receptor ligands have been

developed. See, for example, E. J. Bilsky, *et al.*, *Journal of Pharmacology and Experimental Therapeutics*, **1995**, 273(1), 359-366; WO 93/15062, WO 95/04734, WO 95/31464, WO 96/22276, WO 97/10216, WO 01/46192, WO 02/094794, WO 02/094810, WO 02/094811, WO 02/094812, WO 02/48122, WO 03/029215, WO 03/033486, JP-4275288, EP-A-0,864,559, US-A-5,354,863, US-B-6,200,978, US-B-6,436,959 and US 2003/0069241.

While there are a large number of non-peptidic δ opioid receptor modulators, there is still an unfulfilled need for compounds with selective δ opioid receptor activity that may be used in methods to provide beneficial pharmaceutical characteristics while minimizing undesirable side effects. The present invention is directed to these, as well as other important ends.

SUMMARY OF THE INVENTION

In one aspect, the invention is directed to compounds of formula I:



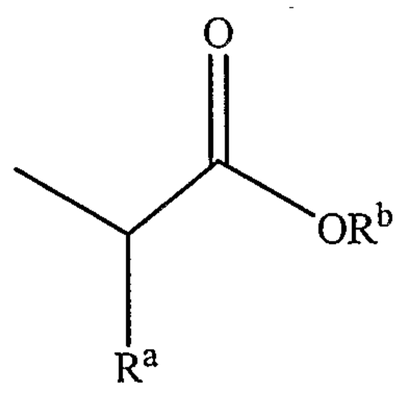
I

wherein:

R^1 and R^3 are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^1 and R^3 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

R^2 is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^1 and R^2 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^2 and R^3 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

provided that R^2 is not



each R^a is independently H or alkyl;

each R^b is independently H, alkyl, or aryl;

n is the integer 0, 1, 2 or 3;

A and B are each independently H, fluoro, or alkyl, or together form a double bond between the carbon atoms to which they are attached;

R^4 is –Y-W;

Y is a single bond, $C(R^a)(R^b)$, $C(R^a)(R^b)C(R^a)(R^b)$, or $C(R^a)(R^b)C(R^a)(R^b)C(R^a)(R^b)$;

W is aryl or heteroaryl;

X is $-CH_2-$, -O-, -S-, -SO, $-SO_2$, or $-N(R^5)-$;

R^5 is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-COR^b$, or $-SO_2R^b$; and

J forms a 6-membered aryl or a 5- or 6-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

$-S-C_{1-4}$ alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl or 2,2-difluoro-1,3-benzodioxazolyl,

$-NH_2$,

$-N(C_{1-4}$ alkyl$)_2$, and

pyrrolyl;

n is 1,

R^1 and R^3 are each H,

A and B together form a double bond between the carbon atoms to which they are attached,

Y is a single bond; and

X is –O-;

then R^2 is other than H or methyl; and

provided that when:

(b) J taken together with the carbon atoms to which it is attached forms a phenyl ring,

W is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

$-S-C_{1-4}$ alkyl,

n is 1,

R^1 and R^3 are each H,

A and B together form a double bond between the carbon atoms to which they are attached,

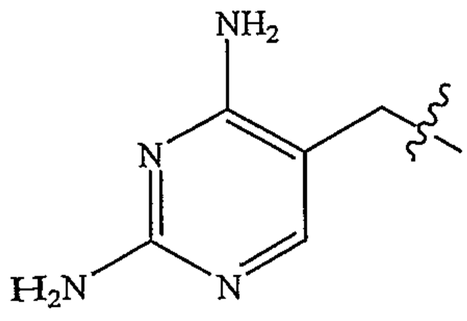
Y is a single bond; and

X is –O-;

then R^2 is other than H or benzyl; and

provided that when:

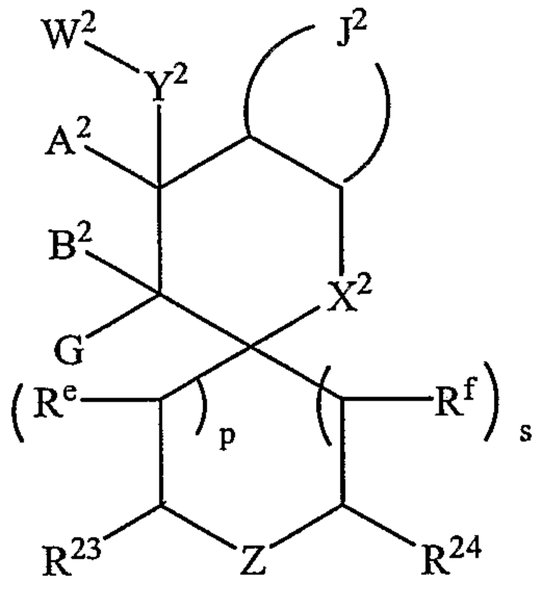
(c) J forms a 6-membered aryl ring, it is not substituted with:



;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In other aspects, the invention is related to compounds of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)- or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

$-C(=O)-H$

$-S-C_{1-4}$ alkyl,

$-NHS(=O)_2-C_{1-4}$ alkyl,

$-NHS(=O)_2-H$,

$-N(C_{1-4}$ alkyl$)S(=O)_2-H$,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

$-NH_2$,

-N=C(aryl)$_2$,

-N(H)C_{1-4} alkyl,

-N(C_{1-4} alkyl)$_2$,

-OS(=O)$_2$-C_{1-4} alkyl optionally substituted with one or more halogens,

-OS(=O)$_2$-C_{6-12} aryl optionally substituted with C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-N(C_{1-4} alkyl)S(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H, and

-N(C_{1-4} alkyl)S(=O)$_2$-H;

p and s are each 1,

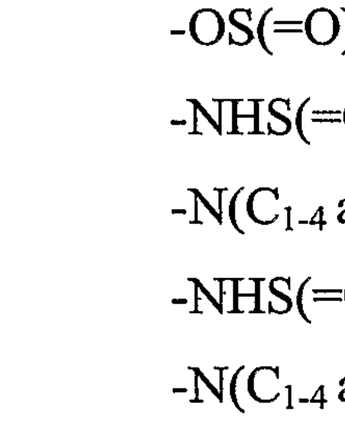
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



, wherein t is an integer from 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-S-C_{1-4} alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

-NH_2,

-N(C_{1-4} alkyl)$_2$, and

pyrrolyl;

p and s are each 1,

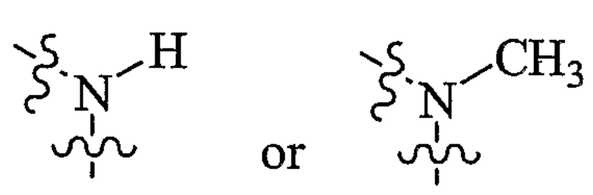
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached forms unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

-S-C_{1-4} alkyl,

p and s are each 1,

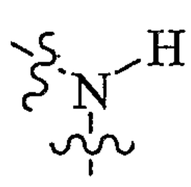
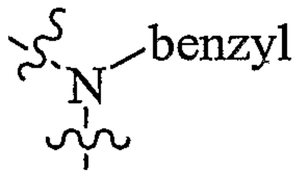
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

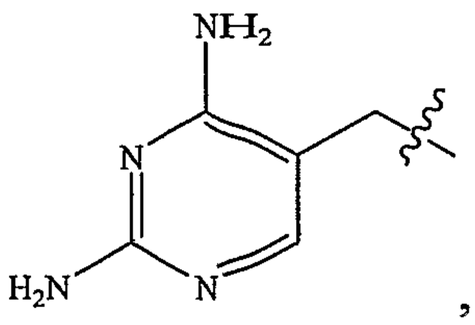
X^2 is –O-;

then Z is other than:

 or  ; and

provided that when:

(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:

 , then Z is other than –N(R^{25})- or -CH(NH_2)-;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to pharmaceutical compositions comprising a pharmaceutically acceptable carrier and an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII. In certain embodiments, the pharmaceutical composition further comprises an effective amount of at least one opioid.

In yet another aspect, the invention is directed to methods of binding opioid receptors, preferably δ opioid receptors, in a patient in need thereof, comprising the step of administering to said patient an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII. In preferred embodiments, the binding modulates the activity of the receptor. In certain other preferred embodiments, the binding agonizes the activity of said opioid receptors.

In other aspects, the invention is directed to methods of preventing or treating pain, comprising the step of administering to a patient in need thereof an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating gastrointestinal dysfunction, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating ileus, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating a urogenital tract disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods of preventing or treating an immunomodulatory disorder, comprising the step of administering to a patient in need thereof an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods of preventing or treating an inflammatory disorder, comprising the step of administering to a patient in need thereof an

effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods of preventing or treating a respiratory function disorder, comprising the step of administering to a patient in need thereof an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating anxiety, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating a mood disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating a stress-related disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating attention deficit hyperactivity disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating sympathetic nervous system disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating tussis, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating a motor disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for treating a traumatic injury to the central nervous system, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating stroke, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating cardiac arrhythmia, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating glaucoma, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for preventing or treating sexual dysfunction, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for treating a condition selected from the group consisting of shock, brain edema, cerebral ischemia, cerebral deficits subsequent to cardiac bypass surgery and grafting, systemic lupus erythematosus, Hodgkin's disease, Sjogren's disease, epilepsy, and rejection in organ transplants and skin grafts, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for treating substance addiction, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for improving organ and cell survival, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for providing cardioprotection following myocardial infarction, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods for reducing the need for anesthesia, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

In another aspect, the invention is directed to methods of producing or maintaining an anaesthetic state, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII. Preferably, the compound of the invention including, for example, a compound of formula I, II, III, IV, V, VI, VII, VIII, IX,

X, XI, XII, and/or XIII is co-administered with an anaesthetic agent selected from the group consisting of an inhaled anaesthetic, a hypnotic, an anxiolytic, a neuromuscular blocker and an opioid.

In certain aspects, the invention is directed to the radiolabeled derivatives and the isotopically labeled derivatives of compounds of the invention including, for example, radiolabeled and isotopically labeled derivatives of compounds of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII.

These and other aspects of the invention will become more apparent from the following detailed description.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The invention relates to spirocyclic heterocyclic derivatives, pharmaceutical compositions containing these compounds, and methods for their pharmaceutical use. In certain embodiments, the spirocyclic heterocyclic derivatives are ligands of the δ opioid receptor and may be useful, *inter alia*, in methods for treating and/or preventing diseases and conditions that may be mediated or modulated by the δ opioid receptor including, for example, pain, gastrointestinal disorders, urogenital tract disorders including incontinence and overactive bladder, immunomodulatory disorders, inflammatory disorders, respiratory function disorders, anxiety, mood disorders, stress-related disorders, attention deficit hyperactivity disorders, sympathetic nervous system disorders, depression, tussis, motor disorders, traumatic injuries, especially to the central nervous system, stroke, cardiac arrhythmias, glaucoma, sexual dysfunctions, shock, brain edema, cerebral ischemia, cerebral deficits subsequent to cardiac bypass surgery and grafting, systemic lupus erythematosus, Hodgkin's disease, Sjogren's disease, epilepsy, rejections in organ transplants and skin grafts, and substance addiction. In certain other embodiments, the spirocyclic heterocyclic derivatives are ligands of the δ opioid receptor and may be useful in, *inter alia*, methods for improving organ and cell survival, methods for providing cardioprotection following myocardial infarction, methods for reducing the need for anesthesia, methods for producing and/or maintaining an anaesthetic state, and methods of detecting, imaging or monitoring degeneration or dysfunction of opioid receptors in a patient.

As employed above and throughout the disclosure, the following terms, unless otherwise indicated, shall be understood to have the following meanings.

"Alkyl" refers to an optionally substituted, saturated straight, branched, or cyclic hydrocarbon having from about 1 to about 20 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), with from about 1 to about 8 carbon atoms, herein referred to as "lower alkyl," being preferred. Alkyl groups include, but are not limited to, methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, t-butyl, n-pentyl, cyclopentyl, isopentyl, neopentyl, n-hexyl, isohexyl, 3-methylpentyl, 2,2-dimethylbutyl, and 2,3-dimethylbutyl.

"Cycloalkyl" refers to an optionally substituted alkyl group having one or more rings in their structures and having from about 3 to about 20 carbon atoms (and all combinations and

subcombinations of ranges and specific numbers of carbon atoms therein), with from about 3 to about 10 carbon atoms being preferred. Multi-ring structures may be bridged or fused ring structures. Cycloalkyl groups include, but are not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cyclooctyl, 2-[4-isopropyl-1-methyl-7-oxa-bicyclo[2.2.1]heptanyl], 2-[1,2,3,4-tetrahydro-naphthalenyl], and adamantyl.

"Alkylcycloalkyl" refers to an optionally substituted ring system comprising a cycloalkyl group having one or more alkyl substituents, wherein cycloalkyl and alkyl are each as previously defined. Exemplary alkylcycloalkyl groups include, for example, 2-methylcyclohexyl, 3,3-dimethylcyclopentyl, trans-2,3-dimethylcyclooctyl, and 4-methyldecahydronaphthalenyl.

"Heterocycloalkyl" refers to an optionally substituted ring system composed of a cycloalkyl radical wherein in at least one of the rings, one or more of the carbon atom ring members is independently replaced by a heteroatom group selected from the group consisting of O, S, N, and NH, wherein cycloalkyl is as previously defined. Heterocycloalkyl ring systems having a total of from about 5 to about 14 carbon atom ring members and heteroatom ring members (and all combinations and subcombinations of ranges and specific numbers of carbon and heteroatom ring members) are preferred. In other preferred embodiments, the heterocyclic groups may be fused to one or more aromatic rings. Exemplary heterocycloalkyl groups include, but are not limited to, tetrahydrofuranyl, tetrahydrothienyl, piperidinyl, pyrrolidinyl, isoxazolidinyl, isothiazolidinyl, pyrazolidinyl, oxazolidinyl, thiazolidinyl, piperazinyl, morpholinyl, piperadinyl, decahydroquinolyl, octahydrochromenyl, octahydro-cyclopenta[c]pyranyl, 1,2,3,4,-tetrahydroquinolyl, octahydro-[2]pyrindinyl, decahydro-cycloocta[c]furanyl, tetrahydroquinolyl, and imidazolidinyl.

"Alkylheterocycloalkyl" refers to an optionally substituted ring system comprising a heterocycloalkyl group having one or more alkyl substituents, wherein heterocycloalkyl and alkyl are each as previously defined. Exemplary alkylheterocycloalkyl groups include, for example, 2-methylpiperidinyl, 3,3-dimethylpyrrolidinyl, *trans*-2,3-dimethylmorpholinyl, and 4-methyldecahydroquinolinyl.

"Alkenyl" refers to an optionally substituted alkyl group having from about 2 to about 10 carbon atoms and one or more double bonds (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), wherein alkyl is as previously defined.

"Alkynyl" refers to an optionally substituted alkyl group having from about 2 to about 10 carbon atoms and one or more triple bonds (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), wherein alkyl is as previously defined.

"Aryl" refers to an optionally substituted, mono-, di-, tri-, or other multicyclic aromatic ring system having from about 5 to about 50 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), with from about 6 to about 10 carbons being preferred. Non-limiting examples include, for example, phenyl, naphthyl, anthracenyl, and phenanthrenyl.

"Aralkyl" refers to an optionally substituted moiety composed of an alkyl radical bearing an aryl substituent and having from about 6 to about 50 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), with from about 6 to about 10 carbon atoms being preferred. Non-limiting examples include, for example, benzyl, diphenylmethyl, triphenylmethyl, phenylethyl, and diphenylethyl.

"Halo" refers to a fluoro, chloro, bromo, or iodo moiety.

"Heteroaryl" refers to an optionally substituted aryl ring system wherein in at least one of the rings, one or more of the carbon atom ring members is independently replaced by a heteroatom group selected from the group consisting of S, O, N, and NH, wherein aryl is as previously defined. Heteroaryl groups having a total of from about 5 to about 14 carbon atom ring members and heteroatom ring members (and all combinations and subcombinations of ranges and specific numbers of carbon and heteroatom ring members) are preferred. Exemplary heteroaryl groups include, but are not limited to, pyrryl, furyl, pyridyl, 1,2,4-thiadiazolyl, pyrimidyl, thienyl, isothiazolyl, imidazolyl, tetrazolyl, pyrazinyl, pyrimidyl, quinolyl, isoquinolyl, thiophenyl, benzothienyl, isobenzofuryl, pyrazolyl, indolyl, purinyl, carbazolyl, benzimidazolyl, and isoxazolyl. Heteroaryl may be attached via a carbon or a heteroatom to the rest of the molecule.

"Heteroarylalkyl" and "heteroaralkyl" each refers to an optionally substituted, heteroaryl substituted alkyl radical where heteroaryl and alkyl are as previously defined Non-limiting

examples include, for example, 2-(1H-pyrrol-3-yl)ethyl, 3-pyridylmethyl, 5-(*2H*-tetrazolyl)methyl, and 3-(pyrimidin-2-yl)-2-methylcyclopentanyl.

"Perhaloalkyl" refers to an alkyl group, wherein two or more hydrogen atoms are replaced by halo (F, Cl, Br, I) atoms, and alkyl is as previously defined. Exemplary perhaloalkyl groups include, for example, perhalomethyl, such as perfluoromethyl and difluoromethyl.

"Alkoxy" and "alkoxyl" refer to an optionally substituted alkyl-O- group wherein alkyl is as previously defined. Exemplary alkoxy and alkoxyl groups include, for example, methoxy, ethoxy, n-propoxy, i-propoxy, n-butoxy, and heptoxy.

"Alkenyloxy" refers to an optionally substituted alkenyl-O- group wherein alkenyl is as previously defined. Exemplary alkenyloxy and alkenyloxyl groups include, for example, allyloxy, butenyloxy, heptenyloxy, 2-methyl-3-buten-1-yloxy, and 2,2-dimethylallyloxy.

"Alkynyloxy" refers to an optionally substituted alkynyl-O- group wherein alkynyl is as previously defined. Exemplary alkynyloxy and alkynyloxyl groups include, for example, propargyloxy, butynyloxy, heptynyloxy, 2-methyl-3-butyn-1-yloxy, and 2,2-dimethylpropargyloxy.

"Aryloxy" and "aryloxyl" refer to an optionally substituted aryl-O- group wherein aryl is as previously defined. Exemplary aryloxy and aryloxyl groups include, for example, phenoxy and naphthoxy.

"Aralkoxy" and "aralkoxyl" refer to an optionally substituted aralkyl-O- group wherein aralkyl is as previously defined. Exemplary aralkoxy and aralkoxyl groups include, for example, benzyloxy, 1-phenylethoxy, 2-phenylethoxy, and 3-naphthylheptoxy.

"Cycloalkoxy" refers to an optionally substituted cycloalkyl-O- group wherein cycloalkyl is as previously defined. Exemplary cycloalkoxy groups include, for example, cyclopropanoxy, cyclobutanoxy, cyclopentanoxy, cyclohexanoxy, and cycloheptanoxy.

"Heteroaryloxy" refers to an optionally substituted heteroaryl-O- group wherein heteroaryl is as previously defined. Exemplary heteroaryloxy groups include, but are not limited

to, pyrryloxy, furyloxyl, pyridyloxy, 1,2,4-thiadiazolyloxy, pyrimidyloxy, thienyloxy, isothiazolyloxy, imidazolyloxy, tetrazolyloxy, pyrazinyloxy, pyrimidyloxy, quinolyloxy, isoquinolyloxy, thiophenyloxy, benzothienyloxy, isobenzofuryloxy, pyrazolyloxy, indolyloxy, purinyloxy, carbazolyloxy, benzimidazolyloxy, and isoxazolyloxy.

"Heteroaralkoxy" refers to an optionally substituted heteroarylalkyl-O- group wherein heteroarylalkyl is as previously defined. Exemplary heteroaralkoxy groups include, but are not limited to, pyrrylethyloxy, furylethyloxy, pyridylmethyloxy, 1,2,4-thiadiazolylpropyloxy, pyrimidylmethyloxy, thienylethyloxy, isothiazolylbutyloxy, and imidazolyl-2-methylpropyloxy.

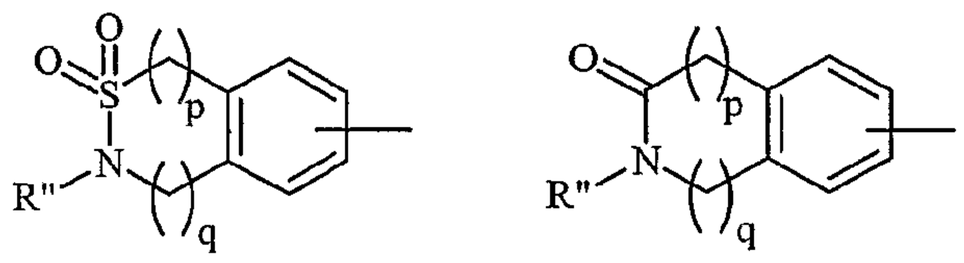
"Heterocycloalkylaryl" refers to an optionally substituted ring system composed of an aryl radical bearing a heterocycloalkyl substituent wherein heterocycloalkyl and aryl are as previously defined. Exemplary heterocycloalkylaryl groups include, but are not limited to, morpholinylphenyl, piperidinylnaphthyl, piperidinylphenyl, tetrahydrofuranylphenyl, and pyrrolidinylphenyl.

"Alkylheteroaryl" refers to an optionally substituted ring system composed of a heteroaryl radical bearing an alkyl substituent wherein heteroaryl and alkyl are as previously defined. Exemplary alkylheteroaryl groups include, but are not limited to, methylpyrryl, ethylfuryl, 2,3-dimethylpyridyl, N-methyl-1,2,4-thiadiazolyl, propylpyrimidyl, 2-butylthienyl, methylisothiazolyl, 2-ethylimidazolyl, butyltetrazolyl, 5-ethylbenzothienyl, and N-methylindolyl. Alkyheteroaryl groups may be attached via a carbon or a heteroatom to the rest of the molecule.

"Heteroarylaryl" refers to an optionally substituted ring system composed of an aryl radical bearing a heteroaryl substituent wherein heteroaryl and aryl are as previously defined. Exemplary heteroarylaryl groups include, but are not limited to, pyrrylphenyl, furylnaphthyl, pyridylphenyl, 1,2,4-thiadiazolylnaphthyl, pyrimidylphenyl, thienylphenyl, isothiazolylnaphthyl, imidazolylphenyl, tetrazolylphenyl, pyrazinylnaphthyl, pyrimidylphenyl, quinolylphenyl, isoquinolylnaphthyl, thiophenylphenyl, benzothienylphenyl, isobenzofurylnaphthyl, pyrazolylphenyl, indolylnaphthyl, purinylphenyl, carbazolylnaphthyl, benzimidazolylphenyl, and isoxazolylphenyl. Heteroarylaryl may be attached via a carbon or a heteroatom to the rest of the molecule.

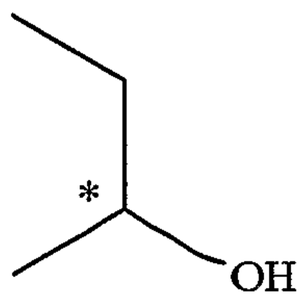
"Alkylheteroarylaryl" refers to an optionally substituted ring system composed of an aryl radical bearing an alkylheteroaryl substituent and have from about 12 to about 50 carbon atoms (and all combinations and subcombinations of ranges and specific numbers of carbon atoms therein), with from about 12 to about 30 carbon atoms being preferred wherein aryl and alkylheteroaryl are as previously defined. Exemplary heteroarylaryl groups include, but are not limited to, methylpyrrylphenyl, ethylfurylnaphthyl, methylethylpyridylphenyl, dimethylethylpyrimidylphenyl, and dimethylthienylphenyl.

Typically, substituted chemical moieties include one or more substituents that replace hydrogen. Exemplary substituents include, for example, halo (*e.g.*, F, Cl, Br, I), alkyl, cycloalkyl, alkylcycloalkyl, alkenyl, alkynyl, aralkyl, aryl, heteroaryl, heteroaralkyl, spiroalkyl, heterocycloalkyl, hydroxyl (-OH), oxo (=O), alkoxyl, aryloxyl, aralkoxyl, nitro ($-NO_2$), cyano (-CN), amino ($-NH_2$), -N-substituted amino (-NHR"), -N,N-disubstituted amino (-N(R")R"), carboxyl (-COOH), -C(=O)R", -OR", -C(=O)OR", $-C(=O)NHSO_2R$", -NHC(=O)R", aminocarbonyl ($-C(=O)NH_2$), -N-substituted aminocarbonyl (-C(=O)NHR"), -N,N-disubstituted aminocarbonyl (-C(=O)N(R")R"), thiol, thiolato (SR"), sulfonic acid and its esters (SO_3R"), phosphonic acid and its mono-esters (P(=O)OR"OH) and di-esters (P(=O)OR"OR"), $S(=O)_2R$", $S(=O)_2NH_2$, $S(=O)_2NHR$", $S(=O)_2NR"R$", $SO_2NHC(=O)R$", $NHS(=O)_2R$", $NR"S(=O)_2R$", CF_3, CF_2CF_3, NHC(=O)NHR", NHC(=O)NR"R", NR"C(=O)NHR", NR"C(=O)NR"R", NR"C(=O)R", NR"C(=N-CN)NR"R", and the like. Aryl substituents may also include $(CH_2)_pSO_2NR"(CH_2)_q$ and $(CH_2)_pCO_2NR"(CH_2)_q$, where p and q are independently integers from 0 to 3, where the methylene units are attached in a 1,2 arrangement yielding substituted aryls of the type:



In relation to the aforementioned substituents, each moiety R" can be, independently, any of H, alkyl, cycloalkyl, alkenyl, aryl, aralkyl, heteroaryl, or heterocycloalkyl, or when (R"(R")) is attached to a nitrogen atom, R" and R" can be taken together to form a 4- to 8-membered nitrogen heterocycloalkyl ring, wherein said heterocycloalkyl ring is optionally interrupted by one or more additional –O-, -S-, -SO, $-SO_2-$, -NH-, -N(alkyl)-, or –N(aryl)- groups, for example.

As used herein, an "*" denotes the presence of a chiral center in a molecule, wherein one stereoisomeric form (R or S) predominates, more preferably is substantially enriched, and even more preferably is enantiomerically pure at a specific center in the molecule, but the absolute configuration at this center has not been conclusively established. This can be expressed, for example in a compound's identification number such as **4***, and indicates that the stereochemical configuration of at least one chiral center of the identified compound has not been established . The specific center is identified within a structure by placing the "*" adjacent the chiral center in question, such as, for example, in the structure below.



In some compounds, several chiral centers may be present. The presence of two asterisks "*" in a single structure indicates that two racemic pairs may be present, but that each pair is diastereomeric relative to the other pair. As such, the first pair of enantiomers having two chiral centers may have the configurations, for example, (R, R) and (S, S). The second pair then have configurations, for example, (R, S) and (S, R). For example, compounds **37A** and **37B** are diastereomeric with respect to one another, but each is a racemic mixture of its two possible enantiomers. Their absolute stereochemistry has not been conclusively established.

"Ligand" or "modulator" refers to a compound that binds to a receptor to form a complex, and includes, agonists, partial agonists, antagonists and inverse agonists.

"Agonist" refers to a compound that may bind to a receptor to form a complex that may elicit a full pharmacological response, which is typically peculiar to the nature of the receptor involved and which may alter the equilibrium between inactive and active receptor.

"Partial agonist" refers to a compound that may bind to a receptor to form a complex that may elicit only a proportion of the full pharmacological response, typically peculiar to the nature of the receptor involved, even if a high proportion of the receptors are occupied by the compound.

"Antagonist" refers to a compound that may bind to a receptor to form a complex that may not elicit any response, typically in the same manner as an unoccupied receptor, and which preferably does not alter the equilibrium between inactive and active receptor.

"Inverse agonist" refers to a compound that may bind to a receptor to form a complex that may preferentially stabilize the inactive conformation of the receptor.

"Prodrug" refers to compounds specifically designed to maximize the amount of active species that reaches the desired site of reaction that are themselves typically inactive or minimally active for the activity desired, but through biotransformation are converted into biologically active metabolites.

"Stereoisomers" refers to compounds that have identical chemical constitution, but differ as regards the arrangement of the atoms or groups in space.

"N-oxide" refers to compounds wherein the basic nitrogen atom of either a heteroaromatic ring or tertiary amine is oxidized to give a quaternary nitrogen bearing a positive formal charge and an attached oxygen atom bearing a negative formal charge.

"Hydrate" refers to a compound of the present invention which is associated with water in the molecular form, i.e., in which the H-OH bond is not split, and may be represented, for example, by the formula $R \cdot H_2O$, where R is a compound of the invention. A given compound may form more than one hydrate including, for example, monohydrates ($R \cdot H_2O$), dihydrates ($R \cdot 2H_2O$), trihydrates ($R \cdot 3H_2O$), and the like.

"Pharmaceutically acceptable salts" refer to derivatives of the disclosed compounds wherein the parent compound is modified by making acid or base salts thereof. Examples of pharmaceutically acceptable salts include, but are not limited to, mineral or organic acid salts of basic residues such as amines; alkali or organic salts of acidic residues such as carboxylic acids; and the like. The pharmaceutically acceptable salts include the conventional non-toxic salts or the quaternary ammonium salts of the parent compound formed, for example, from non-toxic inorganic or organic acids. For example, such conventional non-toxic salts include those derived from inorganic acids such as hydrochloric, hydrobromic, sulfuric, sulfamic, phosphoric, nitric

glycolic, stearic, lactic, malic, tartaric, citric, ascorbic, pamoic, maleic, hydroxymaleic, phenylacetic, glutamic, benzoic, salicylic, sulfanilic, 2-acetoxybenzoic, fumaric, toluenesulfonic, methanesulfonic, ethane disulfonic, oxalic, isethionic, and the like. These physiologically acceptable salts are prepared by methods known in the art, *e.g.*, by dissolving the free amine bases with an excess of the acid in aqueous alcohol, or neutralizing a free carboxylic acid with an alkali metal base such as a hydroxide, or with an amine.

Compounds described herein throughout can be used or prepared in alternate forms. For example, many amino-containing compounds can be used or prepared as an acid addition salt. Often such salts improve isolation and handling properties of the compound. For example, depending on the reagents, reaction conditions and the like, compounds as described herein can be used or prepared, for example, as their hydrochloride or tosylate salts. Isomorphic crystalline forms, all chiral and racemic forms, N-oxide, hydrates, solvates, and acid salt hydrates, are also contemplated to be within the scope of the present invention.

Certain acidic or basic compounds of the present invention may exist as zwitterions. All forms of the compounds, including free acid, free base and zwitterions, are contemplated to be within the scope of the present invention. It is well known in the art that compounds containing both basic nitrogen atom and acidic groups often exist in equilibrium with their zwitterionic forms. Thus, any of the compounds described herein throughout that contain, for example, both basic nitrogen and acidic groups, also include reference to their corresponding zwitterions.

"Effective amount" refers to an amount of a compound as described herein that may be therapeutically effective to inhibit, prevent or treat the symptoms of particular disease, disorder, condition, or side effect. Such diseases, disorders, conditions, and side effects include, but are not limited to, those pathological conditions associated with the binding of δ opioid receptor (for example, in connection with the treatment and/or prevention of pain), wherein the treatment or prevention comprises, for example, agonizing the activity thereof by contacting cells, tissues or receptors with compounds of the present invention. Thus, for example, the term "effective amount," when used in connection with compounds of the invention, opioids, or opioid replacements, for example, for the treatment of pain, refers to the treatment and/or prevention of the painful condition. The term "effective amount," when used in connection with compounds active against gastrointestinal dysfunction, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with gastrointestinal

dysfunction. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of urogenital tract disorders, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with urogenital tract disorders and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of immunomodulatory disorders, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with immunomodulatory disorders and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of inflammatory disorders, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with inflammatory disorders and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of respiratory function disorders, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with respiratory function disorders and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of anxiety, mood disorders, stress-related disorders, and attention deficit hyperactivity disorder, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with anxiety, mood disorders, stress-related disorders, attention deficit hyperactivity disorder and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of sympathetic nervous system disorders, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with sympathetic nervous system disorders and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of tussis, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with tussis and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of motor disorders, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with motor disorders and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment of traumatic injuries of the central nervous system, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with the central nervous system and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of stroke, cardiac arrhythmia or glaucoma, refers to the treatment and/or prevention of symptoms, diseases,

disorders, and conditions typically associated with stroke, cardiac arrhythmia, glaucoma and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of sexual dysfunction, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with sexual dysfunction and other related conditions. The term "effective amount," when used in connection with compounds useful in improving organ and cell survival, refers to refers to the maintenance and/or improvement of a minimally-acceptable level of organ or cell survival, including organ preservation. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of myocardial infarction, refers to the minimum level of compound necessary to provide cardioprotection after myocardial infarction. The term "effective amount," when used in connection with compounds useful in the treatment and/or prevention of shock, brain edema, cerebral ischemia, cerebral deficits subsequent to cardiac bypass surgery and grafting, systemic lupus erythematosus, Hodgkin's disease, Sjogren's disease, epilepsy, and rejection in organ transplants and skin grafts, refers to the treatment and/or prevention of symptoms, diseases, disorders, and conditions typically associated with shock, brain edema, cerebral ischemia, cerebral deficits subsequent to cardiac bypass surgery and grafting, systemic lupus erythematosus, Hodgkin's disease, Sjogren's disease, epilepsy, and rejection in organ transplants and skin grafts and other related conditions. The term "effective amount," when used in connection with compounds useful in the treatment of substance addiction, refers to the treatment of symptoms, diseases, disorders, and conditions typically associated with substance addiction and other related conditions. The term "effective amount," when used in connection with compounds useful in reducing the need for anesthia or producing and/or maintaining an anaesthetic state, refers to the production and/or maintenance of a minimally-acceptable anaesthetic state.

"Pharmaceutically acceptable" refers to those compounds, materials, compositions, and/or dosage forms that are, within the scope of sound medical judgment, suitable for contact with the tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problems or complications commensurate with a reasonable benefit/risk ratio. The term specifically encompasses veterinary uses.

"In combination with," "combination therapy," and "combination products" refer, in certain embodiments, to the concurrent administration to a patient of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X,

XI, XII, and/or XIII, and one or more additional agents including, for example, an opioid, an anaesthetic agent (such as for example, an inhaled anesthetic, hypnotic, anxiolytic, neuromuscular blocker and opioid), an antiParkinson's agent (for example, in the case of treating or preventing a motor disorder, particularly Parkinson's disease), an antidepressant (for example, in the case of treating or preventing a mood disorder, particularly depression), an agent for the treatment of incontinence (for example, in the case of treating or preventing a urogenital tract disorder), an agent for the treatment of pain, including neuralgias or neuropathic pain, and/or other optional ingredients (including, for example, antibiotics, antivirals, antifungals, anti-inflammatories, anesthetics and mixtures thereof). When administered in combination, each component may be administered at the same time or sequentially in any order at different points in time. Thus, each component may be administered separately but sufficiently closely in time so as to provide the desired therapeutic effect.

"Dosage unit" refers to physically discrete units suited as unitary dosages for the particular individual to be treated. Each unit may contain a predetermined quantity of active compound(s) calculated to produce the desired therapeutic effect(s) in association with the required pharmaceutical carrier. The specification for the dosage unit forms of the invention may be dictated by (a) the unique characteristics of the active compound(s) and the particular therapeutic effect(s) to be achieved, and (b) the limitations inherent in the art of compounding such active compound(s).

"Pain" refers to the perception or condition of unpleasant sensory or emotional experience, associated with actual or potential tissue damage or described in terms of such damage. "Pain" includes, but is not limited to, two broad categories of pain: acute and chronic pain (Buschmann, H.; Christoph, T; Friderichs, E.; Maul, C.; Sundermann, B; eds.; *Analgesics*, Wiley-VCH, Verlag GMbH & Co. KgaA, Weinheim; **2002**; Jain, K. K. "A Guide to Drug Evaluation for Chronic Pain"; *Emerging Drugs,* 5(2), 241-257(2000)). Non-limiting examples of pain include, for example, nociceptive pain, inflammatory pain, visceral pain, somatic pain, neuralgias, neuropathic pain, AIDS pain, cancer pain, phantom pain, and psychogenic pain, and pain resulting from hyperalgesia, pain caused by rheumatoid arthritis, migraine, allodynia and the like.

"Gastrointestinal dysfunction" refers collectively to maladies of the stomach, small and large intestine. Non-limiting examples of gastrointestinal dysfunction include, for example,

diarrhea, nausea, emesis, post-operative emesis, opioid-induced emesis, irritable bowel syndrome, opioid-bowel dysfunction, inflammatory bowel disease, colitis, increased gastric motility, increased gastric emptying, stimulation of small intestinal propulsion, stimulation of large intestinal propulsion, decreased amplitude of non-propulsive segmental contractions, disorders associated with sphincter of Oddi, disorders associated with anal sphincter tone, impaired reflex relaxation with rectal distention, disorders associated with gastric, biliary, pancreatic or intestinal secretions, changes to the absorption of water from bowel contents, gastro-esophageal reflux, gastroparesis, cramping, bloating, distension, abdominal or epigastric pain and discomfort, non-ulcerogenic dyspepsia, gastritis, or changes to the absorption of orally administered medications or nutritive substances.

"Urogenital tract disorders" refers collectively to maladies of the urinary and genital apparati. Non-limiting examples of urogenital tract disorders include incontinence (i.e., involuntary loss of urine) such as stress urinary incontinence, urge urinary incontinence and benign prostatic hyperplasia, overactive bladder disorder, urinary retention, renal colic, glomerulonephritis, and interstitial cystitis.

"Overactive bladder disorder" refers to a condition with symptoms of urgency with or without incontinence, and is typically associated with increased urinary frequency and nocturia. Overactive bladder disorders are typically associated with urodynamic finding of involuntary bladder contractions, generally referred to as bladder instability.

"Immunomodulatory disorders" refers collectively to maladies characterized by a compromised or over-stimulated immune system. Non-limiting examples of immunomodulatory disorders include autoimmune diseases (such as arthritis, autoimmune disorders associated with skin grafts, autoimmune disorders associated with organ transplants, and autoimmune disorders associated with surgery), collagen diseases, allergies, side effects associated with the administration of an anti-tumor agent, side effects associated with the administration of an antiviral agent, multiple sclerosis and Guillain-Barre syndrome.

"Inflammatory disorders" refers collectively to maladies characterized by cellular events in injured tissues. Non-limiting examples of inflammatory diseases include arthritis, psoriasis, asthma, and inflammatory bowel disease.

"Respiratory function disorders" refers to conditions in which breathing and/or airflow into the lung is compromised. Non-limiting examples of respiratory function disorders include asthma, apnea, tussis,chronic obstruction pulmonary disease, and lung edema.

"Lung edema" refers to the presence of abnormally large amounts of fluid in the intercellular tissue spaces of the lungs.

"Anxiety" refers to the unpleasant emotional state consisting of psychophysiological responses to anticipation of real, unreal or imagined danger, ostensibly resulting from unrecognized intrapsychic conflict.

"Mood disorders" refers to disorders that have a disturbance in mood as their predominant feature, including depression, bipolar manic-depression, borderline personality disorder, and seasonal affective disorder.

"Depression" refers to a mental state of depressed mood characterized by feelings of sadness, despair and discouragement, including the blues, dysthymia, and major depression.

"Stress-related disorders" refer collectively to maladies characterized by a state of hyper- or hypoarousal with hyper- and hypovigilance. Non-limiting examples of stress-related disorders include post-traumatic stress disorder, panic disorder, generalized anxiety disorder, social phobia, and obsessive-compulsive disorder.

"Attention deficit hyperactivity disorder" refers to a condition characterized by an inability to control behavior due to difficulty in processing neural stimuli.

"Sympathetic nervous system disorders" refer collectively to maladies characterized by disturbances of the autonomic nervous system. Non-limiting examples of sympathetic nervous system disorders include hypertension, and the like.

"Tussis" refers to a coughing condition, and "antitussive" agents refer to those materials that modulate the coughing response.

"Motor disorders" refers to involuntary manifestations of hyper or hypo muscle activity and coordination Non-limiting examples of motor disorders include tremors, Parkinson's disease, tourette syndrome, parasomnias (sleep disorders) including restless leg syndrome, postoperative shivering and dyskinesia.

"Traumatic injury of the central nervous system" refers to a physical wound or injury to the spinal cord or brain.

"Stroke" refers to a condition due to the lack of oxygen to the brain.

"Cardiac arrhythmia" refers to a condition characterized by a disturbance in the electrical activity of the heart that manifests as an abnormality in heart rate or heart rhythm. Patients with a cardiac arrhythmia may experience a wide variety of symptoms ranging from palpitations to fainting.

"Glaucoma" refers collectively to eye diseases characterized by an increase in intraocular pressure that causes pathological changes in the optic disk and typical defects in the field of vision.

"Sexual dysfunction" refers collectively to disturbances, impairments or abnormalities of the functioning of the male or female sexual organs, including, but not limited to premature ejaculation and erectile dysfunction.

"Cardioprotection" refers to conditions or agents that protect or restore the heart from dysfunction, heart failure and reperfusion injury.

"Myocardial infarction" refers to irreversible injury to heart muscle caused by a local lack of oxygen.

"Addiction" refers to a pattern of compulsive substance abuse (alcohol, nicotine, or drug) characterized by a continued craving for the substance and, in some cases, the need to use the substance for effects other than its prescribed or legal use.

"Anaesthetic state" refers to the state of the loss of feeling or sensation, including not only the loss of tactile sensibility or of any of the other senses, but also to the loss of sensation of pain, as it is induced to permit performance of surgery or other painful procedures, and specifically including amnesia, analgesia, muscle relaxation and sedation.

"Improving organ and cell survival" refers to the maintenance and/or improvement of a minimally-acceptable level of organ or cell survival.

"Patient" refers to animals, including mammals, preferably humans.

"Side effect" refers to a consequence other than the one(s) for which an agent or measure is used, as the adverse effects produced by a drug, especially on a tissue or organ system other then the one sought to be benefited by its administration. In the case, for example, of opioids, the term "side effect" may refer to such conditions as, for example, constipation, nausea, vomiting, dyspnea and pruritus.

When any variable occurs more than one time in any constituent or in any formula, its definition in each occurrence is independent of its definition at every other occurrence. Combinations of substituents and/or variables are permissible only if such combinations result in stable compounds.

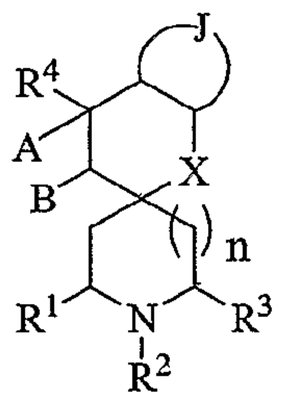
It is believed the chemical formulas and names used herein correctly and accurately reflect the underlying chemical compounds. However, the nature and value of the present invention does not depend upon the theoretical correctness of these formulae, in whole or in part. Thus it is understood that the formulas used herein, as well as the chemical names attributed to the correspondingly indicated compounds, are not intended to limit the invention in any way, including restricting it to any specific tautomeric form or to any specific optical or geometric isomer, except where such stereochemistry is clearly defined.

In certain preferred embodiments, the compounds, pharmaceutical compositions and methods of the present invention may involve a peripheral δ opioid modulator compound. The term "peripheral" designates that the compound acts primarily on physiological systems and components external to the central nervous system. In preferred form, the peripheral δ opioid modulator compounds employed in the methods of the present invention exhibit high levels of

activity with respect to peripheral tissue, such as, gastrointestinal tissue, while exhibiting reduced, and preferably substantially no, CNS activity. The phrase "substantially no CNS activity," as used herein, means that less than about 50% of the pharmacological activity of the compounds employed in the present methods is exhibited in the CNS, preferably less than about 25%, more preferably less than about 10%, even more preferably less than about 5% and most preferably 0% of the pharmacological activity of the compounds employed in the present methods is exhibited in the CNS.

Furthermore, it is preferred in certain embodiments of the invention that the δ opioid modulator compound does not substantially cross the blood-brain barrier. The phrase "does not substantially cross," as used herein, means that less than about 20% by weight of the compound employed in the present methods crosses the blood-brain barrier, preferably less than about 15% by weight, more preferably less than about 10% by weight, even more preferably less than about 5% by weight and most preferably 0% by weight of the compound crosses the blood-brain barrier. Selected compounds can be evaluated for CNS penetration, for example, by determining plasma and brain levels following i.v. administration.

Accordingly, in one embodiment, the invention provides compounds of formula I:



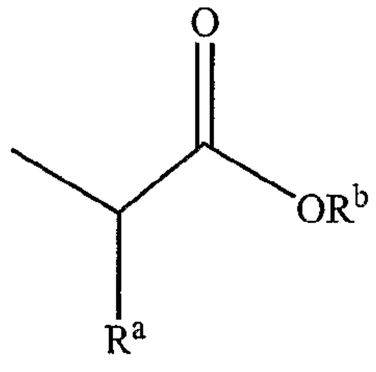
I

wherein:

R^1 and R^3 are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^1 and R^3 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

R^2 is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^1 and R^2 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^2 and R^3 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

provided that R^2 is not



each R^a is independently H or alkyl;

each R^b is independently H, alkyl, or aryl;

n is the integer 0, 1, 2 or 3;

A and B are each independently H, fluoro, or alkyl, or together form a double bond between the carbon atoms to which they are attached;

R^4 is –Y-W;

Y is a single bond, $C(R^a)(R^b)$, $C(R^a)(R^b)C(R^a)(R^b)$, or $C(R^a)(R^b)C(R^a)(R^b)C(R^a)(R^b)$;

W is aryl or heteroaryl;

X is $-CH_2-$, -O-, -S-, -SO, $-SO_2$, or $-N(R^5)-$;

R^5 is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-COR^b$, or $-SO_2R^b$; and

J forms a 6-membered aryl or a 5- or 6-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

$-S-C_{1-4}$ alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl,

$-NH_2$,

$-N(C_{1-4}$ alkyl$)_2$, and

pyrrolyl;

n is 1,

R^1 and R^3 are each H,

A and B together form a double bond between the carbon atoms to which they are attached,

Y is a single bond; and

X is –O-;

then R^2 is other than H or methyl; and

provided that when:

(b) J taken together with the carbon atoms to which it is attached forms a phenyl ring,

W is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

$-S-C_{1-4}$ alkyl,

n is 1,

R^1 and R^3 are each H,

A and B together form a double bond between the carbon atoms to which they are attached,

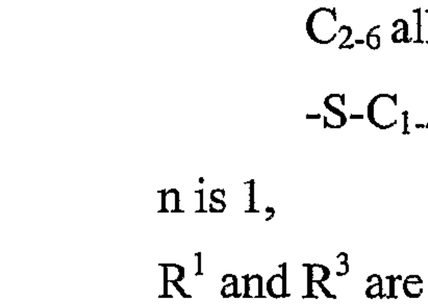
Y is a single bond; and

X is –O-;

then R^2 is other than H or benzyl; and

provided that when:

(c) J forms a 6-membered aryl ring, it is not substituted with:



;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In certain preferred embodiments of formula I compounds, J is -C-D-E- or -C-D-E-F-; wherein C, D, E and F are each independently -O-, -S-, -SO-, $-SO_2-$, =N-, =CH- or -NH-; wherein the latter two moieties are each independently optionally substituted;
provided that each -O- ring atom within J is directly attached only to carbon or nitrogen atoms;

provided that each -S- ring atom within J is directly attached only to carbon or nitrogen atoms; and

provided that when J is -C-D-E-F-, at least one of C, D, E and F is =CH-.

In certain preferred embodiments of formula I compounds, X is $-CH_2-$, -O-, -S-, -SO, or $-SO_2$, more preferably $-CH_2-$ or -O-, still more preferably -O-.

In other preferred embodiments of formula I compounds, J, taken together with the carbon atoms to which it is attached, forms an optionally substituted 6-membered aryl ring, preferably, optionally substituted phenyl, or an optionally substituted 5- or 6-membered heteroaryl ring. Preferably, J is optionally substituted, including fully substituted, phenyl, 3-pyridinyl, 4-pyridinyl, 5-pyridinyl, 6-pyridinyl, thienyl, oxazolyl, 1,2,5-oxadiazolyl, imidazolyl, N-methylimidazolyl or indolyl.

In certain preferred embodiments of formula I compounds, at least one of R^1 and R^3 is H. In other preferred embodiments of formula I, R^1 and R^3 are each independently H, alkyl, alkenyl, or alkynyl; more preferably R^1 and R^3 are each independently H, C_1-C_3 alkyl, C_2-C_3 alkenyl, or C_2-C_3 alkynyl; even more preferably R^1 and R^3 are each independently H, C_1-C_3 alkyl, or C_2-C_3 alkenyl.

In certain preferred embodiments of formula I compounds, R^2 is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, more preferably H or alkyl, more preferably alkyl, even more preferably lower alkyl.

In certain preferred embodiments of formula I compounds, n is the integer 1.

In certain preferred embodiments of formula I compounds, A and B are taken together from a double bond between the carbon atoms to which they are attached. More preferably, A and B are taken together to form a double bond between the carbon atoms to which they are attached and n is the integer 1. Even more preferably, A and B are taken together to form a double bond between the carbon atoms to which they are attached, n is the integer 1 and at least one of R^1 and R^3 is H.

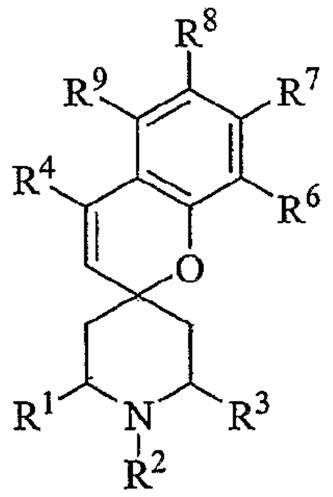
In certain preferred embodiments of formula I compounds, A and B are each H. More preferably, A and B are each H and n is the integer 1. Even more preferably, A and B are each H, n is the integer 1 and at least one of R^1 and R^3 is H.

In certain preferred embodiments of formula I compounds, R^4 is aryl substituted with -$C(=O)NR^{11}R^{12}$, wherein:

R^{11} is H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, heteroarylalkyl, or COR^{12};

R^{12} is H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, or heteroarylalkyl, or R^{11} and R^{12} are taken together with the nitrogen atom to which they are attached to form a 4- to 8-membered heterocycloalkyl ring, wherein 1 or 2 of the heterocycloalkyl ring carbon atoms independently may be optionally replaced by -O-, -S-, -SO-, $-SO_2-$, –NH-, -N(alkyl)-, or –N(aryl)- groups.

In other embodiments, the invention provides compounds of formula **II**:



II

wherein:

R^6, R^7, R^8 and R^9 are each independently H or $-(CH_2)_mR^{10}$;

m is the integer 0, 1, 2, 3, or 4;

each R^{10} is independently alkyl, halo, perhaloalkyl, $-OR^5$, $-OCF_2H$, $-OCF_3$, -CN, $-CO_2R^5$, $-C(=O)NR^{11}R^{12}$, $-S(=O)_2R^{13}$, $-S(=O)_2NR^{11}R^{12}$, $-NR^{11}R^{12}$, $-NR^{14}C(=O)R^{15}$, $-NR^{14}S(=O)_2R^{15}$, aryl, or heteroaryl;

each R^{11} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, heteroarylalkyl, or COR^{12};

each R^{12} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, or heteroarylalkyl, or R^{11} and R^{12} taken together with the nitrogen atom to which they are attached form a 4- to 8-membered heterocycloalkyl ring, wherein 1 or 2 of the heterocycloalkyl ring carbon atoms independently may be optionally replaced by -O-, -S-, -SO-, $-SO_2$-, –NH-, -N(alkyl)-, or –N(aryl)- groups;

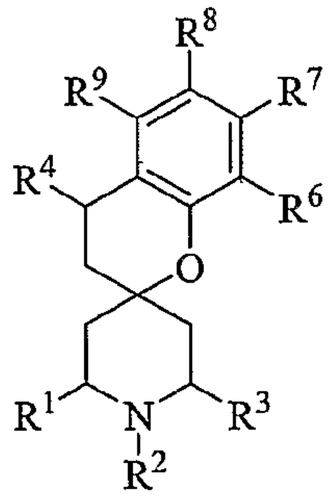
each R^{13} is independently -OH, alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, or alkylcycloalkyl;

each R^{14} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, aryl, heteroaryl, alkylheterocycloalkyl, aralkyl, or heteroarylalkyl; and

each R^{15} is independently alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, alkylcycloalkyl, heterocycloalkyl, or alkylheterocycloalkyl.

In certain preferred embodiments of formula II compounds, R^1 and R^3 are each H. In certain preferred embodiments of formula II, R^4 is aryl substituted with $-C(=O)NR^{11}R^{12}$.

In yet other embodiments of formula I compounds, the invention provides compounds of formula III:



III

wherein:

R^6, R^7, R^8 and R^9 are each independently H or $-(CH_2)_mR^{10}$;

m is the integer 0, 1, 2, 3 or 4;

each R^{10} is independently alkyl, halo, perhaloalkyl, $-OR^5$, $-OCF_2H$, $-OCF_3$, -CN, $-CO_2R^5$, $-C(=O)NR^{11}R^{12}$, $-S(=O)_2R^{13}$, $-S(=O)_2NR^{11}R^{12}$, $-NR^{11}R^{12}$, $-NR^{14}C(=O)R^{15}$, $-NR^{14}S(=O)_2R^{15}$, aryl, or heteroaryl;

each R^{11} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, heteroarylalkyl, or COR^{12};

each R^{12} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, or heteroarylalkyl, or R^{11} and R^{12} taken together with the nitrogen atom to which they are attached form a 4- to 8-membered heterocycloalkyl ring, wherein 1 or 2 of the heterocycloalkyl ring carbon atoms independently may be optionally replaced by -O-, -S-, -SO-, $-SO_2-$, –NH-, –N(alkyl)-, or –N(aryl)- groups;

each R^{13} is independently -OH, alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, or alkylcycloalkyl;

each R^{14} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, aryl, heteroaryl, alkylheterocycloalkyl, aralkyl, or heteroarylalkyl; and

each R^{15} is independently alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, alkylcycloalkyl, heterocycloalkyl, or alkylheterocycloalkyl.

In certain preferred embodiments of formula II compounds, R^1 and R^3 are each H.

In certain preferred embodiments of formula II compounds, R^4 is aryl substituted with $-C(=O)NR^{11}R^{12}$.

In certain preferred embodiments of the invention, the compound is selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-6-fluoro-spiro[2H,1-benzopyran-2,4'-piperidine] hydrochloride;

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-6-hydroxyspiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-3,4-dihydrospiro[2H,1-benzopyran-2,4'-piperidine] hydrochloride;

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-*N*-methyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*-ethylaminocarbonyl)phenyl]spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*-propyl-*N*-cyclopropylmethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(isoindolineaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(4-carboxypiperidineaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(2*H*-tetrazolyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(4-carboxypropyl-tetrazol-2-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

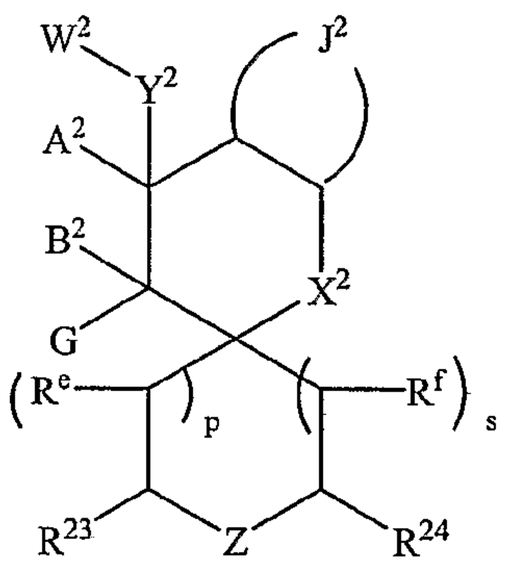
4-(3-pyridyl)-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(methanesulfonyl)-phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]spiro[2H,1-benzopyran-2,4'-nortropine]; or

a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof..

In other aspects, the invention is related to compounds of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4– to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{28} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

-C(=O)-H

$-S-C_{1-4}$ alkyl,

$-NHS(=O)_2-C_{1-4}$ alkyl,

$-NHS(=O)_2-H$,

$-N(C_{1-4}$ alkyl)$S(=O)_2-H$,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

$-NH_2$,

-N=C(aryl)$_2$,

-N(H)C_{1-4} alkyl,

-N(C_{1-4} alkyl)$_2$,

-OS(=O)$_2$-C_{1-4} alkyl optionally substituted with one or more halogens,

-OS(=O)$_2$-C_{6-12} aryl optionally substituted with C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-N(C_{1-4} alkyl)S(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H, and

-N(C_{1-4} alkyl)S(=O)$_2$-H;

p and s are each 1,

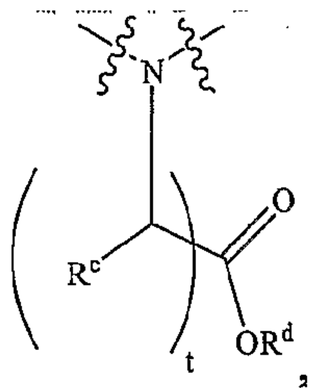
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:


, wherein t is an integer from 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-S-C_{1-4} alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

-NH_2,

-N(C_{1-4} alkyl)$_2$, and

pyrrolyl;

p and s are each 1,

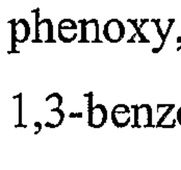
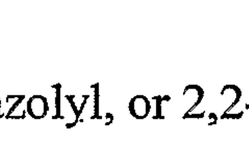
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:


or

; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached forms unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

-S-C_{1-4} alkyl,

p and s are each 1,

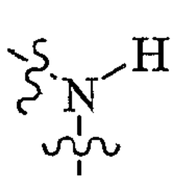
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

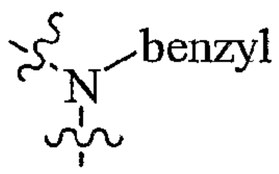
Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



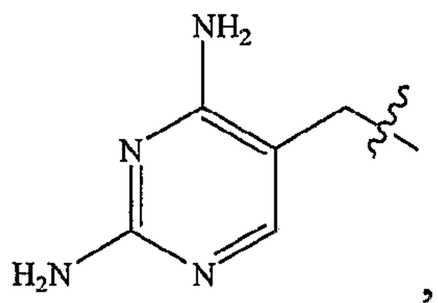
or



; and

provided that when:

(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:



, then Z is other than –N(R^{25})- or -CH(NH_2)-;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In certain preferred embodiments of compounds of formula IV, Y^2 is a single bond.

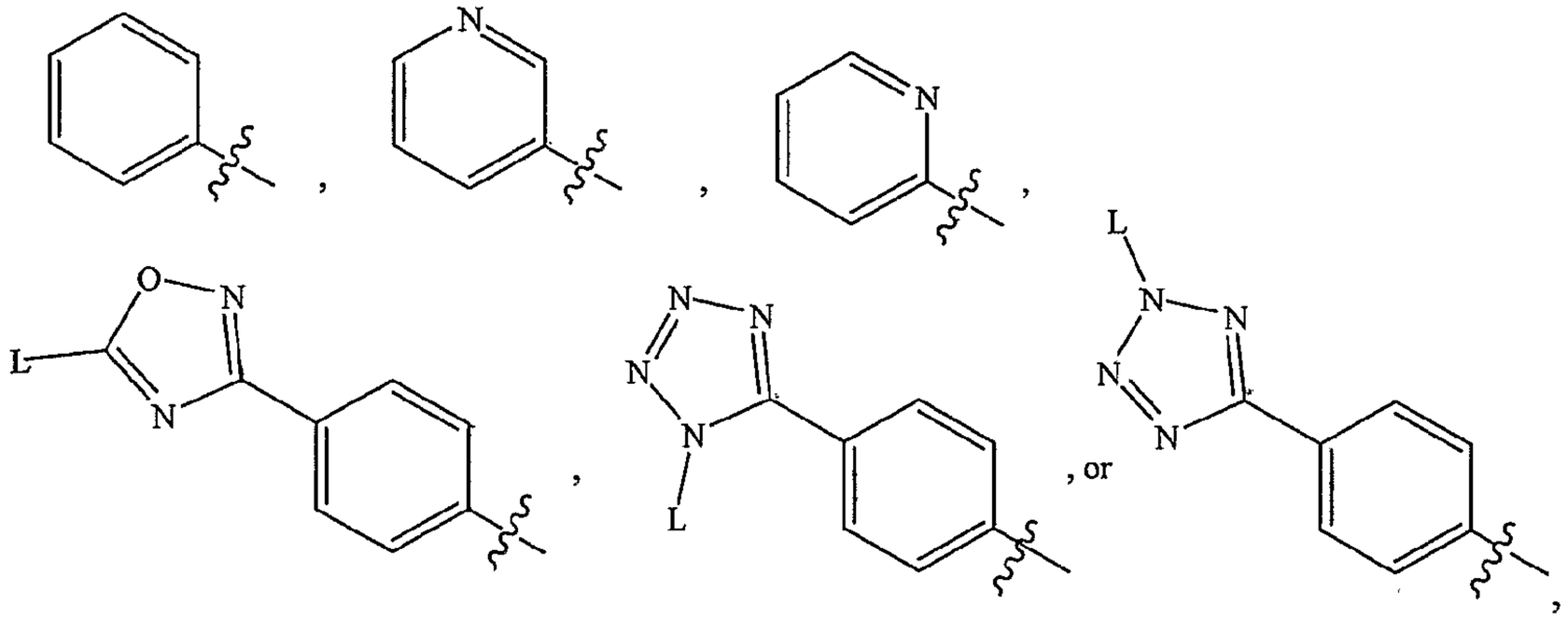
In some preferred embodiments of compounds of formula IV, R^c, R^e, and R^f are each independently H or lower alkyl; more preferably H or C_1-C_3 alkyl; more preferably still H or

methyl; yet more preferably, each is H. In some alternative preferred embodiments, at least one of R^c, R^e, and R^f is H.

In other preferred embodiments of compounds of formula IV, each R^d is independently H, alkyl, or phenyl, the later two optionally substituted; more preferably H, alkyl, or unsubstituted phenyl; yet more preferably H or alkyl; still more preferably H or methyl; most preferably H.

In certain preferred embodiments of compounds of formula IV, W^2 is aryl, alkaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl, each of which is optionally substituted. More preferably W^2 is aryl, alkaryl, heteroaryl, or heteroarylaryl, each of which is optionally substituted. Even more preferably, W^2 is phenyl, pyridyl, tetrazolylphenyl, benzothienyl, benzofuranyl, thienyl, furanyl, indolyl, thiazolyl, pyrimidinyl, or diazolyl, each of which is optionally substituted; with optionally substituted phenyl or optionally substituted pyridyl being still more preferred.

As noted above, the ring systems in W^2 are optionally substituted. In preferred embodiments, the ring systems in W^2 are optionally substituted with at least one of alkyl, aryl, hydroxyl, carboxyl, *N*,*N*-dialkylaminocarbonyl, -S(=O)$_2$-N(alkyl)$_2$, -N(H)S(=O)$_2$-alkyl, and -N(alkyl)C(=O)-alkyl. In particularly preferred embodiments, W^2 is:



wherein W^2 is optionally substituted with at least one of alkyl, aryl, hydroxyl, carboxyl, *N*,*N*-dialkylaminocarbonyl, -S(=O)$_2$-N(alkyl)$_2$, -N(H)S(=O)$_2$-alkyl, and –N(alkyl)C(=O)-alkyl; and L is H or alkyl.

In other preferred embodiments of compounds of formula IV, R^{23} and R^{24} are each independently H or alkyl, alkenyl, alkynyl, or aryl, each of the latter four groups being optionally

substituted. More preferably, R^{23} and R^{24} are each independently H, alkyl, alkenyl, or alkynyl; with H or alkyl being yet more preferred and H or methyl being still more preferred. In particularly preferred embodiments, R^{23} and R^{24} are H. In alternate preferred embodiments of compounds of formula IV, R^{23} and R^{24} are each independently H, alkyl, alkenyl, or alkynyl; more preferably R^{23} and R^{24} are each independently H, C_1-C_3 alkyl, C_2-C_3 alkenyl, or C_2-C_3 alkynyl; more preferably still R^{23} and R^{24} are each independently H, C_1-C_3 alkyl, or C_2-C_3 alkenyl. In still other preferred embodiments, at least one of R^{23} and R^{24} is H.

In certain preferred embodiments of compounds of formula IV, Z is -N(R^{25})-, -CH(N(R^c)(R^d))-, or –O-; more preferably –N(R^{25})- or –O-; yet more preferably –N(R^{25})-. In other preferred embodiments of compounds of formula IV, Z is –N(R^{25})-, -CH(OH)-, or -CH(N(R^c)(R^d)).

In preferred embodiments of compounds of formula IV, R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, each of the latter seven groups being optionally substituted. More preferably, R^{25} is H, alkyl, or aralkyl, still more preferably H or alkyl, even more preferably H or lower alkyl, yet more preferably H or methyl, most preferably H.

In certain preferred embodiments of compounds of formula IV, k is 1.

In certain preferred embodiments of compounds of formula IV, p is 0, 1 or 2, with 1 or 2 being more preferred, and 1 being even more preferred.

In certain preferred embodiments of compounds of formula IV, s is 0, 1, or 2, with 1 or 2 being more preferred, and 1 being even more preferred.

In preferred embodiments of compounds of formula IV, the sum of p and s is 2 or 3, with 2 being more preferred.

In some preferred embodiments of compounds of formula IV, A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond; more preferably each is independently H or alkyl, or together they form a double bond; still more preferably each is independently H or lower alkyl, or together they form a double bond; yet more preferably H or

methyl, or together they form a double bond; even more preferably together they form a double bond. In other preferred embodiments of compounds of formula IV, A^2 and B^2 are each independently H, fluoro, or alkyl. Alternatively, A^2 and B^2 together form $-CH_2-$.

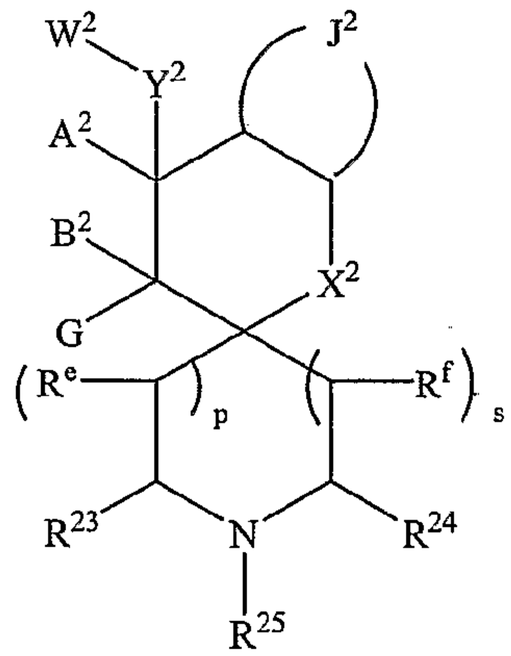
In other preferred embodiments of compounds of formula IV, G is H or lower alkyl; more preferably H or methyl; still more preferably G is H.

In certain preferred embodiments of compounds of formula IV, X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, or $-N(R^{26})-$; more preferably $-C(R^c)(R^d)-$, -O-, or $-S(=O)_2-$; yet more preferably $-C(R^c)(R^d)-$ or -O-; still more preferably -O-.

In some preferred embodiments of compounds of formula IV, R^{26} is H or alkyl; more preferably H or lower alkyl; more preferably still H or methyl; yet more preferably H.

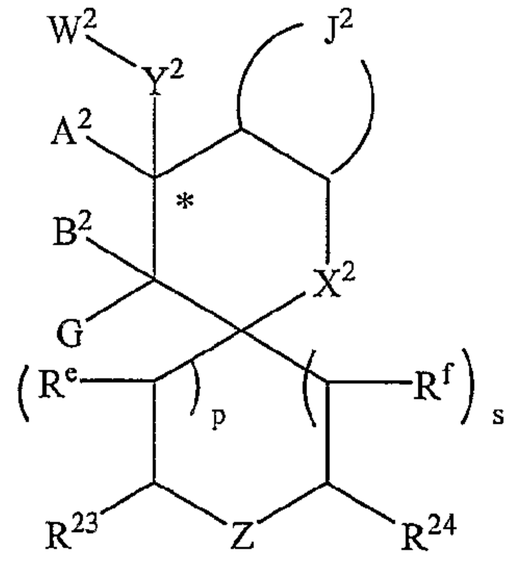
In preferred embodiments of compounds of formula IV, J^2 forms a 6- to 10-membered optionally substituted aryl ring when taken together with the carbon atoms to which it is attached; more preferably optionally substituted phenyl or optionally substituted naphthyl; still more preferably optionally substituted phenyl.

In certain preferred embodiments, the compounds of formula IV have the structure according to formula V:



V

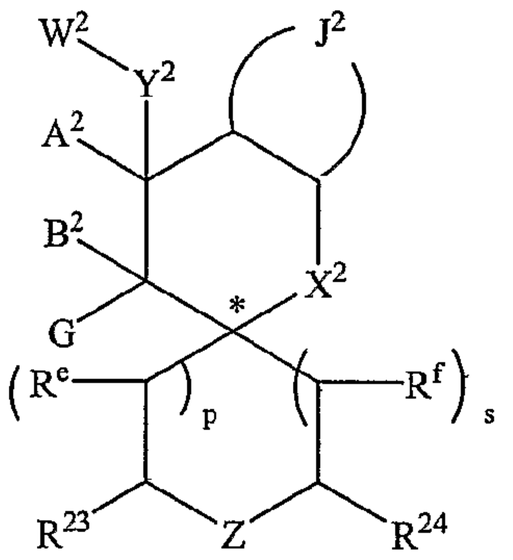
In certain preferred embodiments, the compounds of formula IV have the structure according to formula VI:



VI

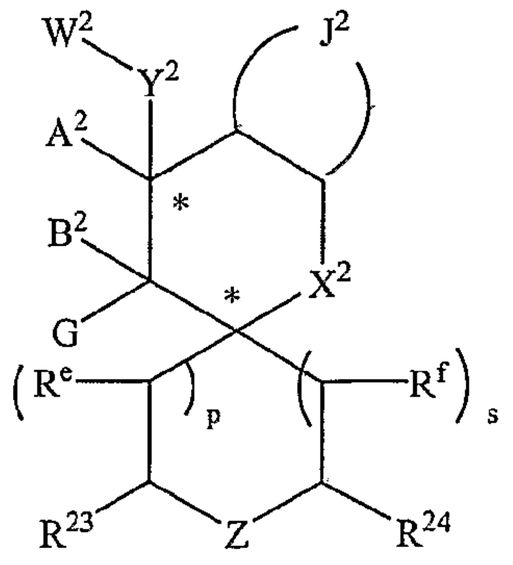
wherein A^2 and B^2 are each independently H, fluoro or alkyl.

In certain preferred embodiments, the compounds of formula IV have the structure according to formula VII:



VII

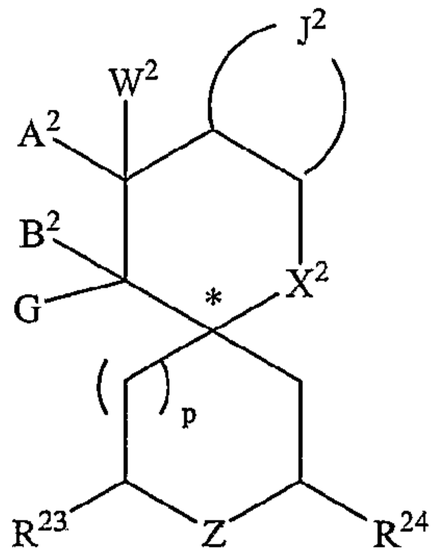
In certain preferred embodiments, the compounds of formula IV have the structure according to formula VIII:



VIII

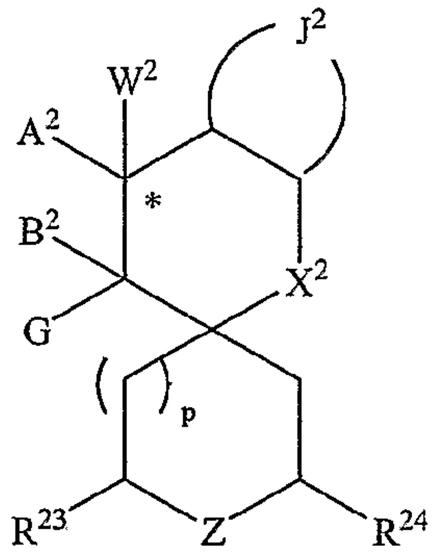
wherein A^{2} and B^{2} are each independently H, fluoro or alkyl.

In certain preferred embodiments, the compounds of formula IV have the structure according to formula IX:



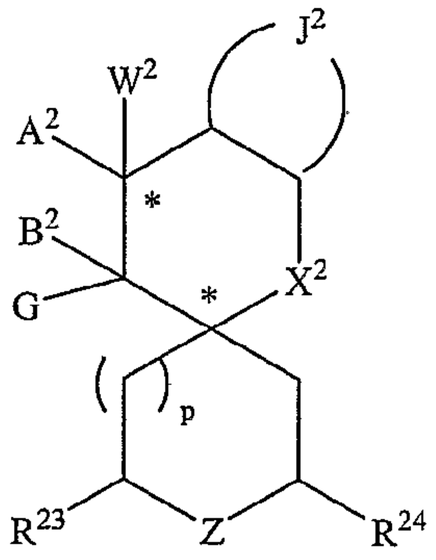
IX

In certain preferred embodiments, the compounds of formula IV have the structure according to formula X:



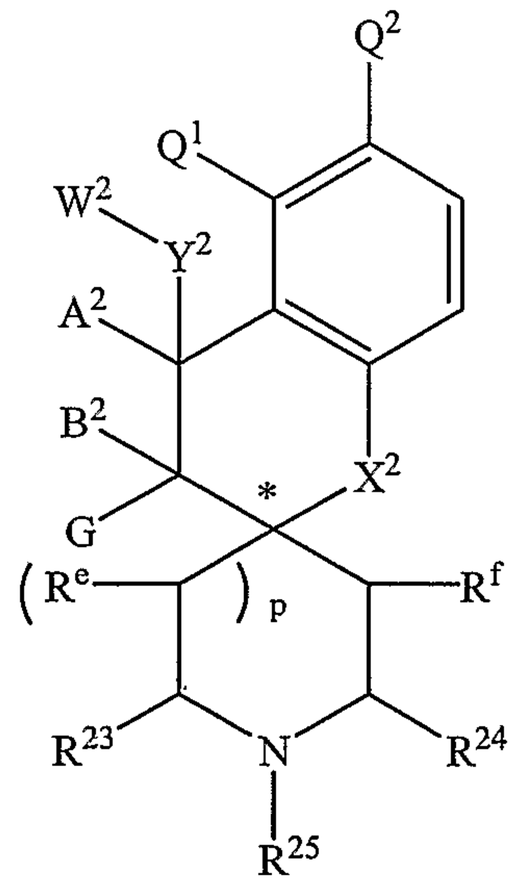
X

In certain preferred embodiments, the compounds of formula X have the structure according to formula XI:



XI

In certain preferred embodiments, the compounds of formula X have the structure according to formula XII:

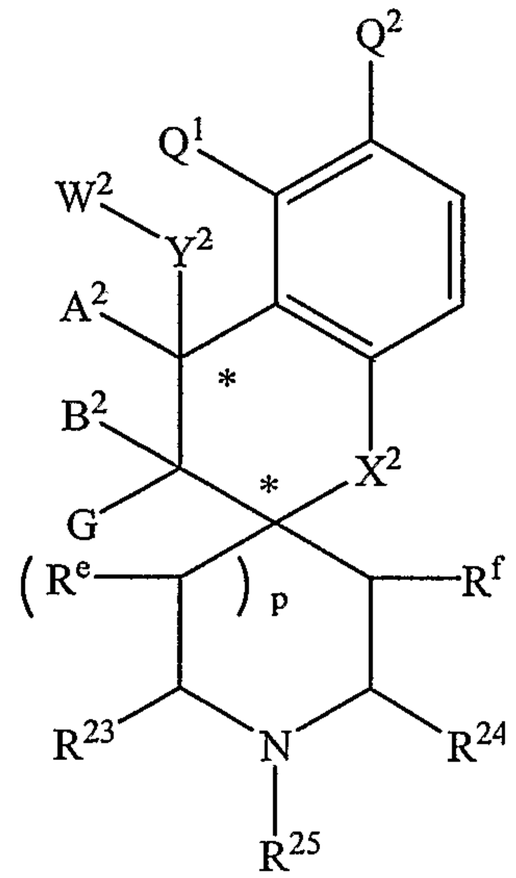


XII ;

wherein:

Q^1 and Q^2 are each independently H, halo, alkyl, hydroxyl, alkoxyl, cycloalkyl substituted alkoxyl, aminocarbonyl, -S(=O)$_2$-alkyl, -S(=O)$_2$-N(H)alkyl, -S(=O)$_2$-N(H)cycloalkylalkyl, or -N(H)S(=O)$_2$-alkyl.

In certain other more preferred embodiments, the compounds of formula XII have the structure according to formula XIII:



XIII

In certain preferred embodiments of compounds of formula IV, the compound is selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[5-methoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-hydroxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[1,2-dihydronaphthalene-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-2-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-3-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-3-methyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[-6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-aminocarbonyl-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-propylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(5-*N*,*N*-diisopropylaminocarbonyl)pyrid-2-yl]-spiro[2H,1-benzopyran-2,4'-piperidine

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-ethylsulfonylamino-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-methylsulfonylamino-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-methyl-2H,1-benzopyran-2,4'-piperidine];

4-[4-(2*H*-tetrazol-5-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(2-methyl-tetrazol-5-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[3-(2-(3-carboxyprop-1-yl)-tetrazol-5-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(5-Methyl-[1,2,4]oxadiazol-3-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-(1'-methyl-piperidine)];

4-[(4-*N*,*N*-diethylaminosulfonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

4-[(4-(*N*-methyl-*N*-(3-methylbutanoyl)-amino)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, and N-oxide thereof.

In certain preferred embodiments of compounds of formula IV, the compound is selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[5-methoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-hydroxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[1,2-dihydronaphthalene-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-2-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-3-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-3-methyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[-6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-aminocarbonyl-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-propylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-3,4-dihydro-2H,1-benzopyran-2,4'-piperidine]; and

4-[(5-*N*,*N*-diisopropylaminocarbonyl)pyrid-2-yl]-spiro[2H,1-benzopyran-2,4'-piperidine];

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, and N-oxide thereof.

In certain preferred embodiments of compounds of formula IV, the compound is selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[5-methoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-hydroxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[1,2-dihydronaphthalene-2,4'-piperidine];

4-[(2-N,N-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-cyclopropyylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-N,N-diethylaminocarbonyl)phenyl]-spiro[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl-2-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

4-[(4-*N*,*N*-diethylaminocarbonyl-3-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; or

a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, and N-oxide thereof.

In certain preferred embodiments of compounds of formula IV, the compound is selected from the group consisting of:

4*-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine]; and

4*-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

or a partial stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, and N-oxide thereof.

In certain preferred embodiments of compounds of formula IV, the compound is selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[6-propylaminosulfonyl-2H,1-benzopyran-2,4'-azepane]; and

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

or a partial stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, and N-oxide thereof.

In an alternate preferred embodiment, the present invention is directed to compounds selected from the group consisting of:

4-[(4-methoxyphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-methylphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-phenyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(3-methoxyphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

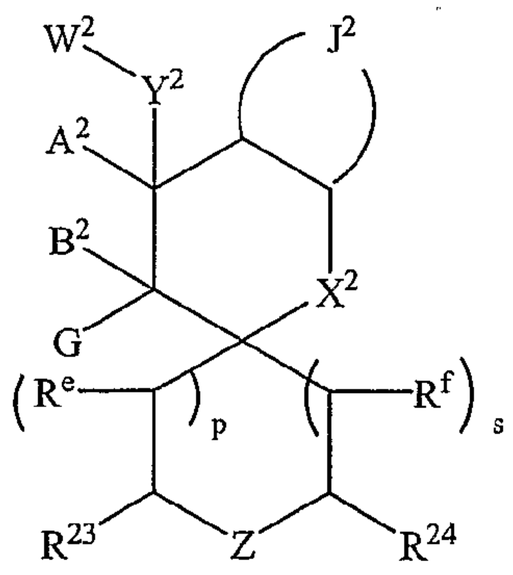
4-[(2-methoxyphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, and N-oxide thereof.

In another aspect, the invention is directed to pharmaceutical compositions, comprising:

a pharmaceutically acceptable carrier; and an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain embodiments, the pharmaceutical composition further comprises an effective amount of at least one opioid.

In some preferred aspects, the invention is directed to pharmaceutical compositions comprising a pharmaceutically acceptable carrier; and a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

-C(=O)-H

-S-C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H,

-N(C_{1-4} alkyl)S(=O)$_2$-H,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

-NH_2,

-N=C(aryl)$_2$,

-N(H)C_{1-4} alkyl,

-N(C_{1-4} alkyl)$_2$,

-OS(=O)$_2$-C_{1-4} alkyl optionally substituted with one or more halogens,

-OS(=O)$_2$-C_{6-12} aryl optionally substituted with C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-N(C_{1-4} alkyl)S(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H, and

-N(C_{1-4} alkyl)S(=O)$_2$-H;

p and s are each 1,

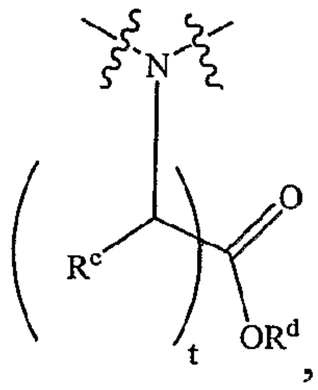
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



, wherein t is an integer from 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-S-C_{1-4} alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

$-NH_2$,

$-N(C_{1-4}\text{ alkyl})_2$, and

pyrrolyl;

p and s are each 1,

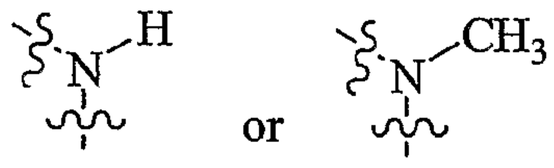
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached forms unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

$-S-C_{1-4}$ alkyl,

p and s are each 1,

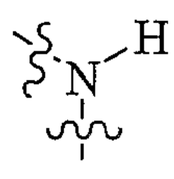
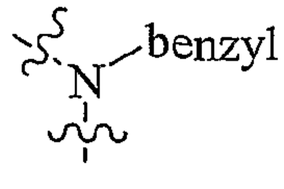
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

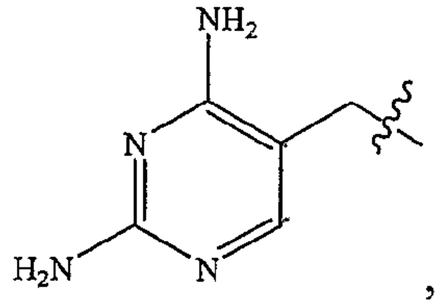
X^2 is –O-;

then Z is other than:

 or  ; and

provided that when:

(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:

 , then Z is other than $-N(R^{25})-$ or $-CH(NH_2)-$;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

Compounds of the invention may be useful as analgesic agents for use during general anesthesia and monitored anesthesia care. Combinations of agents with different properties are often used to achieve a balance of effects needed to maintain the anaesthetic state (*e.g.*, amnesia, analgesia, muscle relaxation and sedation). Included in this combination are inhaled anesthetics, hypnotics, anxiolytics, neuromuscular blockers and opioids.

In any of the above teachings, a compound of the invention may be either a compound of one of the formulae herein described, or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, N-oxide or isomorphic crystalline form thereof.

The compounds employed in the methods and compositions of the present invention may exist in prodrug form. As used herein, "prodrug" is intended to include any covalently bonded carriers which release the active parent drug, for example, as according to formula I or other formulas or compounds as described herein, *in vivo* when such prodrug is administered to a mammalian subject. Since prodrugs are known to enhance numerous desirable qualities of pharmaceuticals (*e.g.*, solubility, bioavailability, manufacturing, etc.), the compounds described herein may, if desired, be delivered in prodrug form. Thus, the present invention contemplates compositions and methods involving prodrugs. Prodrugs of the compounds employed in the present invention, for example formula I, may be prepared by modifying functional groups

present in the compound in such a way that the modifications are cleaved, either in routine manipulation or *in vivo*, to the parent compound.

Accordingly, prodrugs include, for example, compounds described herein in which a hydroxy, amino, or carboxy group is bonded to any group that, when the prodrug is administered to a mammalian subject, cleaves to form a free hydroxyl, free amino, or carboxylic acid, respectively. Examples include, but are not limited to, acetate, formate and benzoate derivatives of alcohol and amine functional groups; and alkyl, carbocyclic, aryl, and alkylaryl esters such as methyl, ethyl, propyl, iso-propyl, butyl, isobutyl, sec-butyl, tert-butyl, cyclopropyl, phenyl, benzyl, and phenethyl esters, and the like.

Compounds described herein may contain one or more asymmetrically substituted carbon atoms, and may be isolated in optically active or racemic forms. Thus, all chiral, diastereomeric, racemic forms and all geometric isomeric forms of a structure are intended, unless the specific stereochemistry or isomeric form is specifically indicated. It is well known in the art how to prepare and isolate such optically active forms. For example, mixtures of stereoisomers may be separated by standard techniques including, but not limited to, resolution of racemic forms, normal, reverse-phase, and chiral chromatography, preferential salt formation, recrystallization, and the like, or by chiral synthesis either from chiral starting materials or by deliberate synthesis of target chiral centers.

The compounds of the present invention may be prepared in a number of ways well known to those skilled in the art. The compounds can be synthesized, for example, by the methods described below, or variations thereon as appreciated by the skilled artisan. All processes disclosed in association with the present invention are contemplated to be practiced on any scale, including milligram, gram, multigram, kilogram, multikilogram or commercial industrial scale.

As will be readily understood, functional groups present may contain protecting groups during the course of synthesis. Protecting groups are known *per se* as chemical functional groups that can be selectively appended to and removed from functionalities, such as hydroxyl groups and carboxyl groups. These groups are present in a chemical compound to render such functionality inert to chemical reaction conditions to which the compound is exposed. Any of a variety of protecting groups may be employed with the present invention. Preferred protecting

groups include the benzyloxycarbonyl group and the tert-butyloxycarbonyl group. Other preferred protecting groups that may be employed in accordance with the present invention may be described in Greene, T.W. and Wuts, P.G.M., *Protective Groups in Organic Synthesis* 2d. Ed., Wiley & Sons, 1991, the disclosures of which are hereby incorporated herein by reference, in their entirety.

The δ agonist compounds of the present invention may be administered by any means that results in the contact of the active agent with the agent's site of action in the body of a patient. The compounds may be administered by any conventional means available for use in conjunction with pharmaceuticals, either as individual therapeutic agents or in a combination of therapeutic agents. For example, they may be administered as the sole active agent in a pharmaceutical composition, or they can be used in combination with other therapeutically active ingredients including, for example, opioid analgesic agents. In such combinations, selected compounds of the invention may provide equivalent or even enhanced therapeutic activity such as, for example, pain amelioration, while providing reduced adverse side effects associated with opioids, such as addiction or pruritus, by lowering the amount of opioid required to achieve a therapeutic effect.

The compounds are preferably combined with a pharmaceutical carrier selected on the basis of the chosen route of administration and standard pharmaceutical practice as described, for example, in *Remington's Pharmaceutical Sciences* (Mack Publishing Co., Easton, PA, 1980), the disclosures of which are hereby incorporated herein by reference, in their entirety.

In addition to the pharmaceutical carrier, the compounds of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII may be co-administered with at least one opioid, preferably a μ opioid receptor modulator compound. In certain embodiments, the combination of the compounds of formula I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII with at least one opioid, preferably a μ opioid receptor modulator compound, provides a synergistic analgesic effect. The utility of the instant combination product may be determined by those skilled in the art using established animal models. Suitable opioids include, without limitation, alfentanil, allylprodine, alphaprodine, anileridine, benzyl-morphine, bezitramide, buprenorphine, butorphanol, clonitazene, codeine, cyclazocine, desomorphine, dextromoramide, dezocine, diampromide, diamorphone, dihydrocodeine, dihydromorphine, dimenoxadol, dimepheptanol, dimethylthiambutene, dioaphetylbutyrate, dipipanone, eptazocine, ethoheptazine,

ethylmethylthiambutene, ethylmorphine, etonitazene, fentanyl, heroin, hydrocodone, hydromorphone, hydroxypethidine, isomethadone, ketobemidone, levallorphan, levorphanol, levophenacylmorphan, lofentanil, loperamide, meperidine (pethidine), meptazinol, metazocine, methadone, metopon, morphine, myrophine, nalbuphine, narceine, nicomorphine, norlevorphanol, normethadone, nalorphine, normorphine, norpinanone, opium, oxycodone, oxymorphone, papaveretum, pentazocine, phenadoxone, phenomorphan, phanazocine, phenoperidine, piminodine, piritramide, propheptazine, promedol, properidine, propiram, propoxyphene, sulfentanil, tilidine, tramadol, diastereoisomers thereof, pharmaceutically acceptable salts thereof, complexes thereof; and mixtures thereof.

The pain ameliorating and/or opioid combination products of the present compositions may further include one or more other active ingredients that may be conventionally employed in analgesic and/or cough-cold-antitussive combination products. Such conventional ingredients include, for example, aspirin, acetaminophen, phenylpropanolamine, phenylephrine, chlorpheniramine, caffeine, and/or guaifenesin. Typical or conventional ingredients that may be included in the opioid component are described, for example, in the *Physicians' Desk Reference*, 1999, the disclosure of which is hereby incorporated herein by reference, in its entirety.

In addition, the opioid component may further include one or more compounds that may be designed to enhance the analgesic potency of the opioid and/or to reduce analgesic tolerance development. Such compounds include, for example, dextromethorphan or other NMDA antagonists (Mao, M. J. *et al., Pain* **1996**, *67*, 361), L-364,718 and other CCK antagonists (Dourish, C.T. *et al., Eur J Pharmacol* **1988**, *147*, 469), NOS inhibitors (Bhargava, H.N. *et al., Neuropeptides* **1996**, *30*, 219), PKC inhibitors (Bilsky, E.J. *et al., J Pharmacol Exp Ther* **1996**, *277*, 484), and dynorphin antagonists or antisera (Nichols, M.L. *et al., Pain* **1997**, *69*, 317). The disclosures of each of the foregoing documents are hereby incorporated herein by reference, in their entireties.

Other opioids, optional conventional opioid components, and optional compounds for enhancing the analgesic potency of the opioid and/or for reducing analgesic tolerance development, that may be employed in the methods and compositions of the present invention, in addition to those exemplified above, would be readily apparent to one of ordinary skill in the art, once armed with the teachings of the present disclosure.

Compounds of the present invention can be administered to a mammalian host in a variety of forms adapted to the chosen route of administration, *e.g.*, orally or parenterally. Parenteral administration in this respect includes administration by the following routes: intravenous, intramuscular, subcutaneous, rectal, intraocular, intrasynovial, transepithelial including transdermal, ophthalmic, sublingual and buccal; topically including ophthalmic, dermal, ocular, rectal, and nasal inhalation via insufflation aerosol.

The active compound may be orally administered, for example, with an inert diluent or with an assimilable edible carrier, or it may be enclosed in hard or soft shell gelatin capsules, or it may be compressed into tablets, or it may be incorporated directly with the food of the diet. For oral therapeutic administration, the active compound may be incorporated with excipient and used in the form of ingestible tablets, buccal tablets, troches, capsules, elixirs, suspensions, syrups, wafers, and the like. Such compositions and preparations should preferably contain at least 0.1% of active compound. The percentage of the compositions and preparations may, of course, be varied and may conveniently be, for example, from about 2 to about 6% of the weight of the unit. The amount of active compound in such therapeutically useful compositions is preferably such that a suitable dosage will be obtained. Preferred compositions or preparations according to the present invention may be prepared so that an oral dosage unit form contains from about 0.1 to about 1000 mg of active compound.

The tablets, troches, pills, capsules and the like may also contain one or more of the following: a binder, such as gum tragacanth, acacia, corn starch or gelatin; an excipient, such as dicalcium phosphate; a disintegrating agent, such as corn starch, potato starch, alginic acid and the like; a lubricant, such as magnesium stearate; a sweetening agent such as sucrose, lactose or saccharin; or a flavoring agent, such as peppermint, oil of wintergreen or cherry flavoring. When the dosage unit form is a capsule, it may contain, in addition to materials of the above type, a liquid carrier. Various other materials may be present as coatings or to otherwise modify the physical form of the dosage unit. For instance, tablets, pills, or capsules may be coated with shellac, sugar or both. A syrup or elixir may contain the active compound, sucrose as a sweetening agent, methyl and propylparabens as preservatives, a dye and flavoring, such as cherry or orange flavor. Of course, any material used in preparing any dosage unit form is preferably pharmaceutically pure and substantially non-toxic in the amounts employed. In addition, the active compound may be incorporated into sustained-release preparations and formulations.

The active compound may also be administered parenterally or intraperitoneally. Solutions of the active compound as a free base or a pharmacologically acceptable salt can be prepared in water suitably mixed with a surfactant, such as hydroxypropylcellulose. A dispersion can also be prepared in glycerol, liquid polyethylene glycols and mixtures thereof and in oils. Under ordinary conditions of storage and use, these preparations may contain a preservative to prevent the growth of microorganisms.

The pharmaceutical forms suitable for injectable use include, for example, sterile aqueous solutions or dispersions and sterile powders for the extemporaneous preparation of sterile injectable solutions or dispersions. In all cases, the form is preferably sterile and fluid to provide easy syringability. It is preferably stable under the conditions of manufacture and storage and is preferably preserved against the contaminating action of microorganisms such as bacteria and fungi. The carrier may be a solvent or dispersion medium containing, for example, water, ethanol, polyol (for example, glycerol, propylene glycol, liquid polyethylene glycol and the like), suitable mixtures thereof, and vegetable oils. The proper fluidity can be maintained, for example, by the use of a coating, such as lecithin, by the maintenance of the required particle size in the case of a dispersion, and by the use of surfactants. The prevention of the action of microorganisms may be achieved by various antibacterial and antifungal agents, for example, parabens, chlorobutanol, phenol, sorbic acid, thimerosal and the like. In many cases, it will be preferable to include isotonic agents, for example, sugars or sodium chloride. Prolonged absorption of the injectable compositions may be achieved by the use of agents delaying absorption, for example, aluminum monostearate and gelatin.

Sterile injectable solutions may be prepared by incorporating the active compound in the required amount, in the appropriate solvent, with various of the other ingredients enumerated above, as required, followed by filtered sterilization. Generally, dispersions may be prepared by incorporating the sterilized active ingredient into a sterile vehicle that contains the basic dispersion medium and the required other ingredients from those enumerated above. In the case of sterile powders for the preparation of sterile injectable solutions, the preferred methods of preparation may include vacuum drying and the freeze-drying technique that yield a powder of the active ingredient, plus any additional desired ingredient from the previously sterile-filtered solution thereof.

The therapeutic compounds of this invention may be administered to a patient alone or in combination with a pharmaceutically acceptable carrier. As noted above, the relative proportions of active ingredient and carrier may be determined, for example, by the solubility and chemical nature of the compound, chosen route of administration and standard pharmaceutical practice.

The dosage of the compounds of the present invention that will be most suitable for prophylaxis or treatment will vary with the form of administration, the particular compound chosen and the physiological characteristics of the particular patient under treatment. Generally, small dosages may be used initially and, if necessary, increased by small increments until the desired effect under the circumstances is reached. The therapeutic human dosage, based on physiological studies using rats, may generally range from about 0.01 mg to about 100 mg/kg of body weight per day, and all combinations and subcombinations of ranges and specific dosages therein. Alternatively, the therapeutic human dosage may be from about 0.4 mg to about 10 g or higher, and may be administered in several different dosage units from once to several times a day. Generally speaking, oral administration may require higher dosages.

It will be further appreciated that the amount of the compound, or an active salt or derivative thereof, required for use in treatment will vary not only with the particular salt selected but also with the route of administration, the nature of the condition being treated and the age and condition of the patient and will be ultimately at the discretion of the attendant physician or clinician.

The desired dose may conveniently be presented in a single dose or as divided doses administered at appropriate intervals, for example, as two, three, four or more sub-doses per day. The sub-dose itself may be further divided, *e.g.,* into a number of discrete loosely spaced administrations; such as multiple inhalations from an insufflator or by application of a plurality of drops into the eye.

The dose may also be provided by controlled release of the compound, by techniques well known to those in the art.

The compounds of the invention may also be formulated with other optional active ingredients, in addition to or instead of the optional opioids, and in addition to the optional pharmaceutical-acceptable carriers. Other active ingredients include, but are not limited to,

antibiotics, antivirals, antifungals, anti-inflammatories, including steroidal and non-steroidal anti-inflammatories, anesthetics and mixtures thereof. Such additional ingredients include any of the following:

a. Antibacterial agents

Aminoglycosides, such as Amikacin, Apramycin, Arbekacin, Bambermycins, Butirosin, Dibekacin, Dihydrostreptomycin, Fortimicin(s), Fradiomycin, Gentamicin, Ispamicin, Kanamycin, Micronomicin, Neomycin, Neomycin Undecylenate, Netilmicin, Paromomycin, Ribostamycin, Sisomicin, Spectinomycin, Streptomycin, Streptonicozid and Tobramycin;

Amphenicols, such as Azidamfenicol, Chloramphenicol, Chloramphenicol Palmirate, Chloramphenicol Pantothenate, Florfenicol, Thiamphenicol;

Ansamycins, such as Rifamide, Rifampin, Rifamycin and Rifaximin;

β-Lactams;

Carbapenems, such as Imipenem;

Cephalosporins, such as 1-Carba (dethia) Cephalosporin, Cefactor, Cefadroxil, Cefamandole, Cefatrizine, Cefazedone, Cefazolin, Cefixime, Cefmenoxime, Cefodizime, Cefonicid, Cefoperazone, Ceforanide, Cefotaxime, Cefotiam, Cefpimizole, Cefpirimide, Cefpodoxime Proxetil, Cefroxadine, Cefsulodin, Ceftazidime, Cefteram, Ceftezole, Ceftibuten, Ceftizoxime, Ceftriaxone, Cefuroxime, Cefuzonam, Cephacetrile Sodium, Cephalexin, Cephaloglycin, Cephaloridine, Cephalosporin, Cephalothin, Cephapirin Sodium, Cephradine and Pivcefalexin;

Cephamycins such as Cefbuperazone, Cefmetazole, Cefminox, Cefetan and Cefoxitin;

Monobactams such as Aztreonam, Carumonam and Tigemonan;

Oxacephems such as Flomoxef and Moxolactam;

Penicillins such as Amidinocillin, Amdinocillin, Pivoxil, Amoxicillin, Ampicillan, Apalcillin, Aspoxicillin, Azidocillan, Azlocillan, Bacampicillin, Benzylpenicillinic Acid, Benzylpenicillin, Carbenicillin, Carfecillin, Carindacillin, Clometocillin, Cloxacillin, Cyclacillin, Dicloxacillin, Diphenicillin, Epicillin, Fenbenicillin, Floxicillin, Hetacillin, Lenampicillin, Metampicillin, Methicillin, Mezlocillin, Nafcillin, Oxacillin, Penamecillin,, Penethamate Hydriodide, Penicillin G Benethamine, Penicillin G Benzathine, Penicillin G Benzhydrylamine, Penicillin G Calcium, Penicillin G Hydragamine, Penicillin G Potassium, Penicillin G. Procaine, Penicillin N, Penicillin O, Penicillin V, Penicillin V Benzathine, Penicillin V Hydrabamine,

Penimepicycline, Phenethicillin, Piperacillin, Pivapicillin, Propicillin, Quinacillin, Sulbenicillin, Talampicillin, Temocillin and Ticarcillin;

Lincosumides such as Clindamycin and Lincomycin;

Macrolides such as Azithromycin, Carbomycin, Clarithromycin, Erythromycin(s) and Derivatives, Josamycin, Leucomycins, Midecamycins, Miokamycin, Oleandomycin, Primycin, Rokitamycin, Rosaramicin, Roxithromycin, Spiramycin and Troleandomycin;

Polypeptides such as Amphomycin, Bacitracin, Capreomycin, Colistin, Enduracidin, Enviomycin, Fusafungine, Gramicidin(s), Gramicidin S, Mikamycin, Polymyxin, Polymyxin β-Methanesulfonic Acid, Pristinamycin, Ristocetin, Teicoplanin, Thiostrepton, Tuberactinomycin, Tyrocidine, Tyrothricin, Vancomycin, Viomycin(s), Virginiamycin and Zinc Bacitracin;

Tetracyclines such as Spicycline, Chlortetracycline, Clomocycline, Demeclocycline, Doxycycline, Guamecycline, Lymecycline, Meclocycline, Methacycline, Minocycline, Oxytetracycline, Penimepicycline, Pipacycline, Rolitetracycline, Sancycline, Senociclin and Tetracycline; and

others such as Cycloserine, Mupirocin, Tuberin.

b. Synthetic Antibacterials

2,4-Diaminopyrimidines such as Brodimoprim, Tetroxoprim and Trimethoprim;

Nitrofurans such as Furaltadone, Furazolium, Nifuradene, Nifuratel, Nifurfoline, Nifurpirinol, Nifurprazine, Nifurtoinol and Nitrofurantoin;

Quinolones and analogs thereof, such as Amifloxacin, Cinoxacin, Ciprofloxacin, Difloxacin, Enoxacin, Fleroxacin, Flumequine, Lomefloxacin, Miloxacin, Nalidixic Acid, Norfloxacin, Ofloxacin, Oxolinic Acid, Perfloxacin, Pipemidic Acid, Piromidic Acid, Rosoxacin, Temafloxacin and Tosufloxacin;

Sulfonamides such as Acetyl Sulfamethoxypyrazine, Acetyl Sulfisoxazole, Azosulfamide, Benzylsulfamide, Chloramine-β, Chloramine-T, Dichloramine-T, Formosulfathiazole, N.sup.2 -Formyl-sulfisomidine, N.sup.4 -β-D-Glucosylsulfanilamide, Mafenide, 4'-(Methyl-sulfamoyl)sulfanilanilide, p-Nitrosulfathiazole, Noprylsulfamide, Phthalylsulfacetamide, Phthalylsulfathiazole, Salazosulfadimidine, Succinylsulfathiazole, Sulfabenzamide, Sulfacetamide, Sulfachlorpyridazine, Sulfachrysoidine, Sulfacytine, Sulfadiazine, Sulfadicramide, Sulfadimethoxine, Sulfadoxine, Sulfaethidole, Sulfaguanidine, Sulfaguanol, Sulfalene, Sulfaloxic Acid, Sulfamerazine, Sulfameter, Sulfamethazine, Sulfamethizole, Sulfamethomidine, Sulfamethoxazole, Sulfamethoxypyridazine, Sulfametrole,

sulfamidochrysoidine, Sulfamoxole, Sulfanilamide, Sulfanilamidomethanesulfonic Acid Triethanolamine Salt, 4-Sulfanilamidosalicyclic Acid, N^4 -Sulfanilylsulfanilamide, Sulfanilylurea, N-Sulfanilyl-3,4-xylamide, Sulfanitran, Sulfaperine, Sulfaphenazole, Sulfaproxyline, Sulfapyrazine, Sulfapyridine, Sulfasomizole, Sulfasymazine, Sulfathiazole, Sulfathiourea, Sulfatolamide, Sulfisomidine and Sulfisoxazole;

Sulfones, such as Acedapsone, Acediasulfone, Acetosulfone, Dapsone, Diathymosulfone, Glucosulfone, Solasulfone, Succisulfone, Sulfanilic Acid, p-Sulfanilylbenzylamine, p,p'-sulfonyldianiline-N,N'-digalactoside, Sulfoxone and Thiazolsulfone;

Others such as Clofoctol, Hexedine, Magainins, Methenamine, Methenamine Anhydromethylene-citrate, Methenamine Hippurate, Methenamine Mandelate, Methenamine Sulfosalicylate, Nitroxoline, Squalamine and Xibomol.

c. Antifungal (antibiotics)

Polyenes such as Amphotericin-B, Candicidin, Dermostatin, Filipin, Fungichromin, Hachimycin, Hamycin, Lucensomycin, Mepartricin, Natamycin, Nystatin, Pecilocin, Perimycin; and others, such as Azaserine, Griseofulvin, Oligomycins, Pyrrolnitrin, Siccanin, Tubercidin and Viridin.

d. Antifungal (synthetic)

Allylamines such as Naftifine and terbinafine;

Imidazoles such as Bifonazole, Butoconazole, Chlordantoin, Chlormidazole, Cloconazole, Clotrimazole, Econazole, Enilconazole, Finticonazole, Isoconazole, Ketoconazole, Miconazole, Omoconazole, Oxiconazole Nitrate, Sulconazole and Tioconazole;

Triazoles such as Fluconazole, Itraconazole, Terconazole;

Others such as Acrisorcin, Amorolfine, Biphenamine, Bromosalicylchloranilide, Buclosamide, Chlophenesin, Ciclopirox, Cloxyquin, Coparaffinate, Diamthazole, Dihydrochloride, Exalamide, Flucytosine, Halethazole, Hexetidine, Loflucarban, Nifuratel, Potassium Iodide, Propionic Acid, Pyrithione, Salicylanilide, Sulbentine, Tenonitrozole, Tolciclate, Tolindate, Tolnaftate, Tricetin, Ujothion, and Undecylenic Acid.

e. Antiglaucoma agents

Antiglaucoma agents, such as Dapiprazoke, Dichlorphenamide, Dipivefrin and Pilocarpine.

f. Anti-inflammatory agents

Corticosteroids, aminoarylcarboxylic Acid Derivatives such as Etofenamate, Meclofenamic Acid, Mefanamic Acid, Niflumic Acid;

Arylacetic Acid Derivatives such as Acemetacin, Amfenac Cinmetacin, Clopirac, Diclofenac, Fenclofenac, Fenclorac, Fenclozic Acid, Fentiazac, Glucametacin, Isozepac, Lonazolac, Metiazinic Acid, Oxametacine, Proglumetacin, Sulindac, Tiaramide and Tolmetin;

Arylbutyric Acid Derivatives such as Butibufen and Fenbufen;

Arylcarboxylic Acids such as Clidanac, Ketorolac and Tinoridine;

Arylpropionic Acid Derivatives such as Bucloxic Acid, Carprofen, Fenoprofen, Flunoxaprofen, Ibuprofen, Ibuproxam, Oxaprozin, Piketoprofen, Pirprofen, Pranoprofen, Protizinic Acid and Tiaprofenic Add;

Pyrazoles such as Mepirizole;

Pyrazolones such as Clofezone, Feprazone, Mofebutazone, Oxyphenbutazone, Phenylbutazone, Phenyl Pyrazolidininones, Suxibuzone and Thiazolinobutazone;

Salicylic Acid Derivatives such as Bromosaligenin, Fendosal, Glycol Salicylate, Mesalamine, 1-Naphthyl Salicylate, Olsalazine and Sulfasalazine;

Thiazinecarboxamides such as Droxicam, Isoxicam and Piroxicam;

Others such as e-Acetamidocaproic Acid, S-Adenosylmethionine, 3-Amino-4-hydroxybutyric Acid, Amixetrine, Bendazac, Bucolome, Carbazones, Difenpiramide, Ditazol, Guaiazulene, Heterocyclic Aminoalkyl Esters of Mycophenolic Acid and Derivatives, Nabumetone, Nimesulide, Orgotein, Oxaceprol, Oxazole Derivatives, Paranyline, Pifoxime, 2-substituted-4,6-di-tertiary-butyl-s-hydroxy-1,3-pyrimidines, Proquazone and Tenidap.

g. Antiseptics

Guanidines such as Alexidine, Ambazone, Chlorhexidine and Picloxydine;

Halogens/Halogen Compounds such as Bomyl Chloride, Calcium Iodate, Iodine, Iodine Monochloride, Iodine Trichloride, Iodoform, Povidone-Iodine, Sodium Hypochlorite, Sodium Iodate, Symclosene, Thymol Iodide, Triclocarban, Triclosan and Troclosene Potassium;

Nitrofurans such as Furazolidone, 2-(Methoxymethyl)-5-Nitrofuran, Nidroxyzone, Nifuroxime, Nifurzide and Nitrofurazone;

Phenols such as Acetomeroctol, Chloroxylenol, Hexachlorophene, 1-Naphthyl Salicylate, 2,4,6-Tribromo-m-cresol and 3',4',5-Trichlorosalicylanilide;

Quinolines such as Aminoquinuride, Chloroxine, Chlorquinaldol, Cloxyquin, Ethylhydrocupreine, Halquinol, Hydrastine, 8-Hydroxyquinoline and Sulfate; and

others, such as Boric Acid, Chloroazodin, m-Cresyl Acetate, Cupric sulfate and Ichthammol.

h. Antivirals

Purines/Pyrimidinones, such as 2-Acetyl-Pyridine 5-((2-pyridylamino)thiocarbonyl) Thiocarbonohydrazone, Acyclovir, Dideoxyadenosine, Dideoxycytidine, Dideoxyinosine, Edoxudine, Floxuridine, Ganciclovir, Idoxuridine, MADU, Pyridinone, Trifluridine, Vidrarbine and Zidovudline;

others such as Acetylleucine Monoethanolamine, Acridinamine, Alkylisooxazoles, Amantadine, Amidinomycin, Cuminaldehyde Thiosemicarbzone, Foscamet Sodium, Kethoxal, Lysozyme, Methisazone, Moroxydine, Podophyllotoxin, Ribavirin, Rimantadine, Stallimycin, Statolon, Thymosins, Tromantadine and Xenazoic Acid.

i. Agents for Neuralgia/Neuropathic Pain

Mild OTC (over the counter) analgesics, such as aspirin, acetaminophen, and ibuprophen.
Narcotic analgesics, such as codeine.
Anti seizure medications, such as carbamazepine, gabapentin, lamotrigine and phenytoin.
Anti-depressants, such as amitryptiline.

j. Agents for the Treatment of Depression

Selective serotonin re-uptake inhibitors (SSRIs), such as Fluoxetine, Paroxetine, Fluvoxamine, Citaprolam, and Sertraline.

Tricyclics, such as Imipramine, Amitriptyline, Desipramine, Nortriptyline Protriptyline, Trimipramine, Doxepin, Amoxapine, and Clomipramine.

Monoamine Oxidase Inhibitors (MAOIs), such as Tranylcypromine, Phenelzine, and Isocarboxazid.

Heterocyclics, such as Amoxipine, Maprotiline and Trazodone.

others such as Venlafaxine, Nefazodone and Mirtazapine.

k. Agents for the treatment of Incontinence

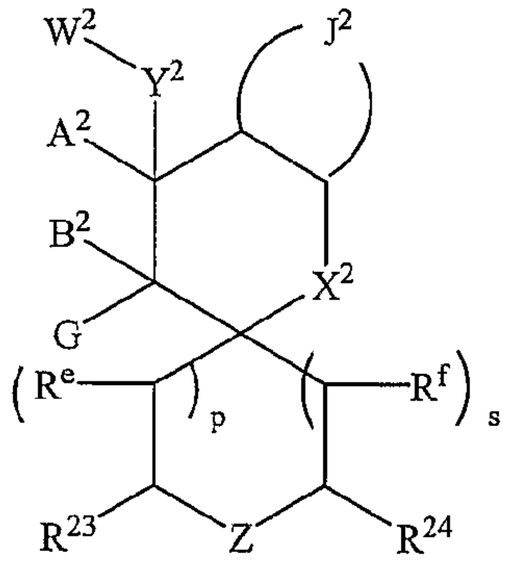
Anticholinergic agents such as propantheline.
Antispasmodic medications such as oxybutynin, tolterodine, and flavoxate.
Tricyclic antidepressants such as imipramine, and doxepin.
Calcium channel blockers such as tolterodine.
Beta agonists such as terbutaline.

l. AntiParkinson's Agents

Deprenyl, Amantadine, Levodopa, and Carbidopa.

In yet another aspect, the invention is directed to methods of binding opioid receptors, preferably δ opioid receptors, in a patient in need thereof, comprising the step of administering to said patient an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. The δ opioid receptors may be located in the central nervous system or located peripherally to the central nervous system. In certain preferred embodiments, the binding of the present compounds modulates the activity, preferably as an agonist, of said opioid receptors. In certain preferred embodiments, the compound of formula I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII does not substantially cross the blood-brain barrier. Preferably, the compounds of the present invention are peripherally selective.

In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

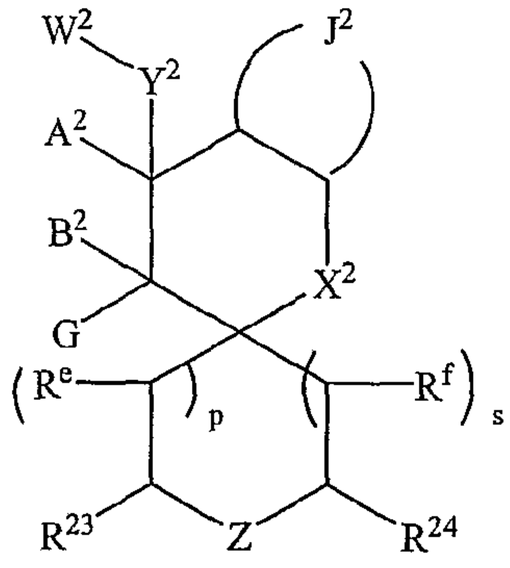
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

The spirocyclic heterocyclic derivatives of the present invention and pharmaceutical compositions containing these compounds may be utilized in a number of ways. In certain embodiments, the spirocyclic heterocyclic derivatives are ligands of the δ opioid receptor and are useful, *inter alia*, in methods for treating and/or preventing pain, gastrointestinal disorders, urogenital tract disorders including incontinence, for example, stress urinary incontinence, urge urinary incontinence and benigh prostatic hyperplasia, and overactive bladder disorder (*see, e.g.*, R. B. Moreland et al., *Perspectives in Pharmacology*, Vol. 308(3), pp. 797-804 (2004) and M.O. Fraser, *Annual Reports in Medicinal Chemistry*, Chapter 6, pp. 51-60 (2003), the disclosures of which are hereby incorporated herein by reference, in their entireties), immunomodulatory disorders, inflammatory disorders, respiratory function disorders, depression, anxiety, mood disorders, stress-related disorders, sympathetic nervous system disorder, tussis, motor disorder, traumatic injury, stroke, cardiac arrhythmia, glaucoma, sexual dysfunction, shock, brain edema, cerebral ischemia, cerebral deficits subsequent to cardiac bypass surgery and grafting, systemic lupus erythematosus, Hodgkin's disease, Sjogren's disease, epilepsy, and rejection in organ transplants and skin grafts, and substance addiction. In certain other embodiments, the spirocyclic heterocyclic derivatives are ligands of the δ opioid receptor and are useful, *inter alia*, in methods for providing cardioprotection following myocardial infarction, in methods for providing and maintaining an anaesthetic state, and in methods of detecting, imaging or monitoring degeneration or dysfunction of opioid receptors in a patient.

Thus, in accordance with preferred aspects of the invention, there are provided methods of preventing or treating pain, comprising the step of administering to said patient an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII and/or XIII. More preferably, there are provided methods of preventing or treating pain, comprising the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

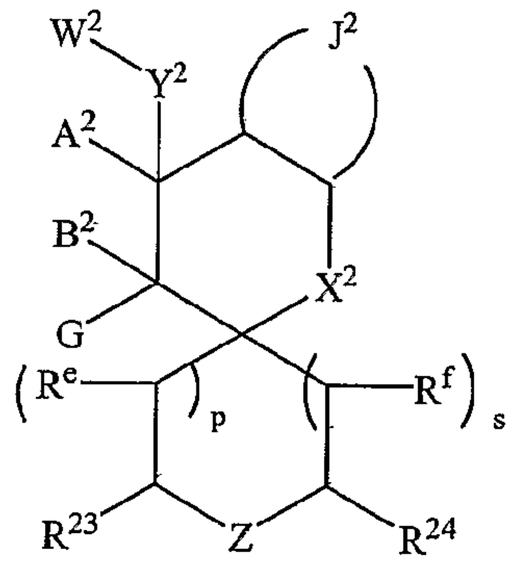
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In certain preferred embodiments, the present methods of preventing or treating pain may further comprise the administration to a patient of an effective amount of an agent for the treatment of neuralgia and/or neuropathic pain.

In another aspect, the invention is directed to methods for preventing or treating gastrointestinal dysfunction, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they

are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $–CH_2$-;

G is H or alkyl;

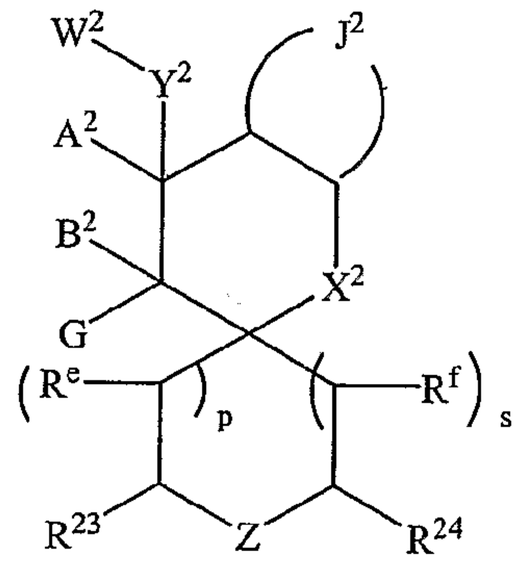
X^2 is $–C(R^c)(R^d)$-, -O-, -S-, -S(=O)-, $-S(=O)_2$-, -C(=O)-, -CH(OH)-or $–N(R^{26})$-;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating a urogenital tract disorder, such as incontinence (including, for example, stress urinary incontinence and urge urinary incontinence, and overactive bladder), comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

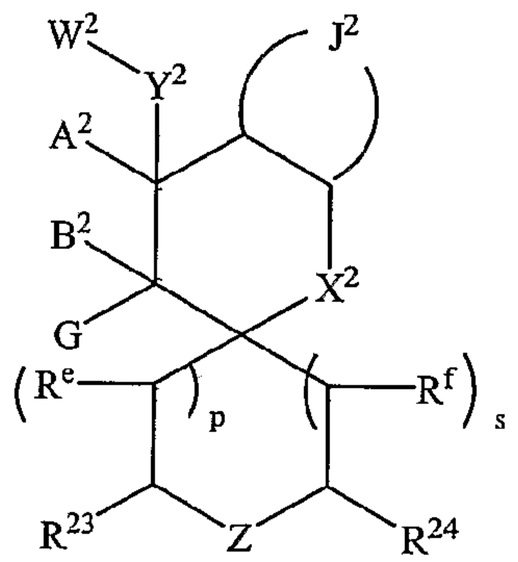
J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In certain preferred embodiments, the present methods of preventing or treating a urogenital tract disorder may further comprise the administration to a patient of an effective amount of an agent for the treatment of incontinence.

In another aspect, the invention is directed to methods of preventing or treating an immunomodulatory disorder, comprising the step of administering to a patient in need thereof an

effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. Immunomodulatory disorders include, but are not limited to, autoimmune diseases, collagen diseases, allergies, side effects associated with the administration of an anti-tumor agent, and side effects associated with the administration of an antiviral agent. Autoimmune diseases include, but are not limited to, arthritis, autoimmune disorders associated with skin grafts, autoimmune disorders associated with organ transplants, and autoimmune disorders associated with surgery. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV

,

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $–CH_2$-;

G is H or alkyl;

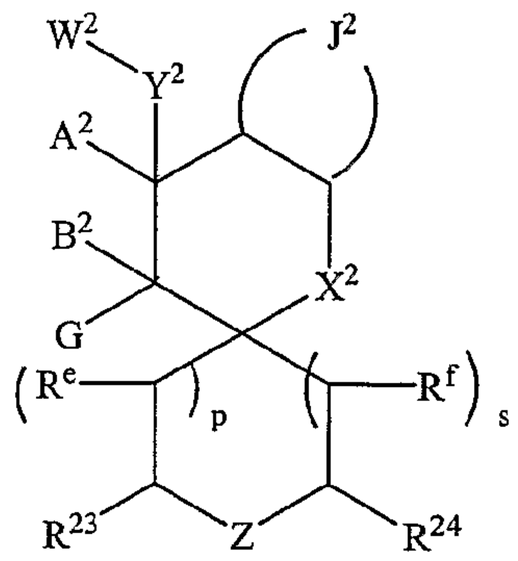
X^2 is $–C(R^c)(R^d)$-, -O-, -S-, $-S(=O)$-, $-S(=O)_2$-, $-C(=O)$-, -CH(OH)-or $–N(R^{26})$-;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods of preventing or treating an inflammatory disorder, comprising the step of administering to a patient in need thereof an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. Inflammatory disorders include, but are not limited to, arthritis, psoriasis, asthma, or inflammatory bowel disease. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $–[C(R^c)(R^d)]_k$-;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

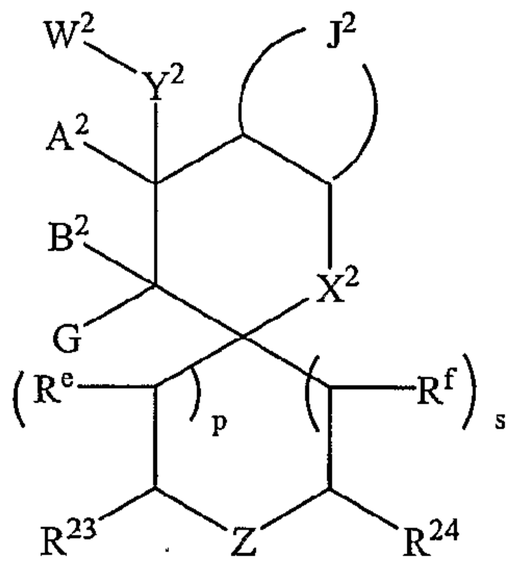
X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods of preventing or treating a respiratory function disorder, comprising the step of administering to a patient in need thereof an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. Respiratory function disorders include but are not limited to asthma or lung edemal. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

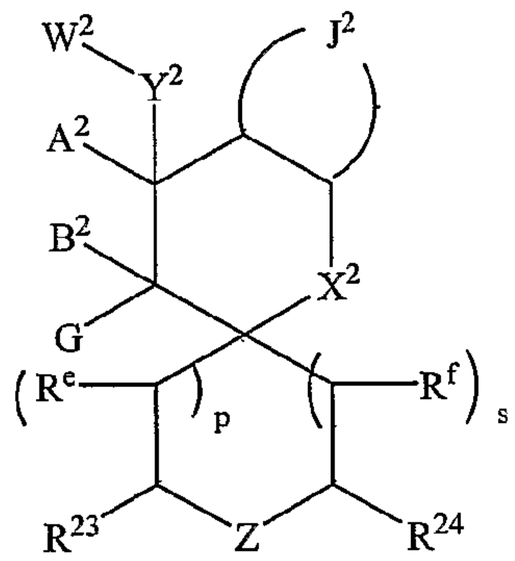
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating anxiety, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

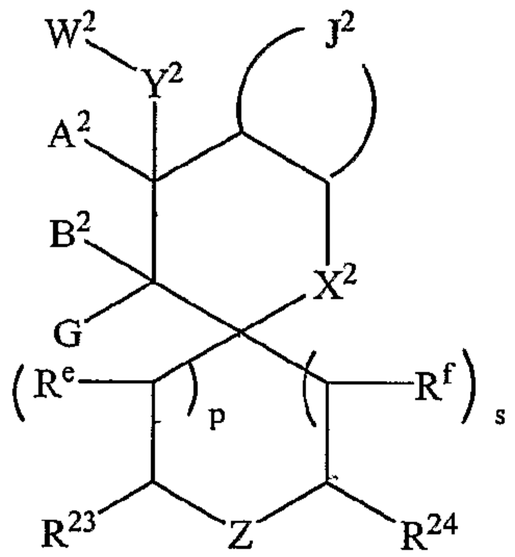
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating a mood disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and XIII. Mood disorders include but are not limited to depression, bipolar manic-depression, and seasonal affective disorder. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

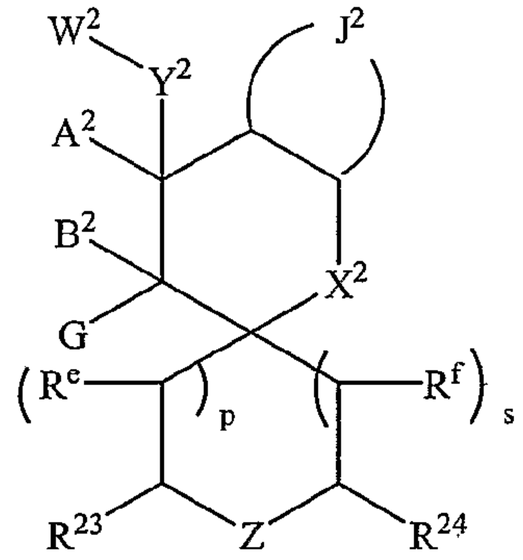
J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In certain preferred embodiments, the present methods of preventing or treating a mood disorder may further comprise the administration to a patient of an effective amount of an agent for the treatment of depression.

In another aspect, the invention is directed to methods for preventing or treating a stress-related disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. Stress-related disorders include, but are not limited to, post-traumatic stress disorder, panic disorder, generalized anxiety disorder, social phobia, and obsessive compulsive disorder. In certain preferred aspects, the

methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

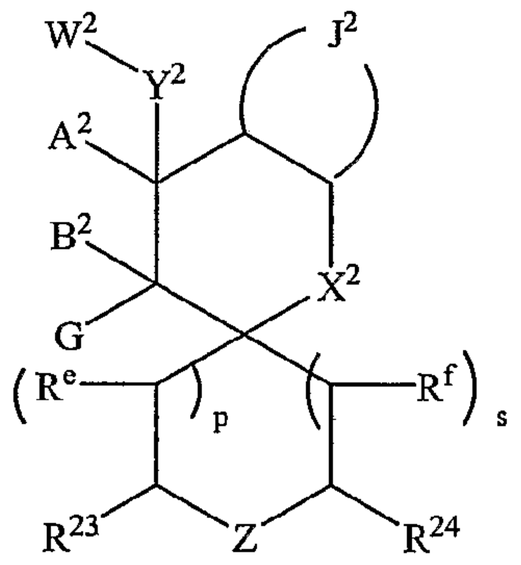
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, -(CH_2)-alkenyl, -(CH_2)-alkynyl, aryl, -$C(=O)R^d$, or -$S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating attention deficit hyperactivity disorder, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k$-;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})$-, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))$-, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they

are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $–CH_2$-;

G is H or alkyl;

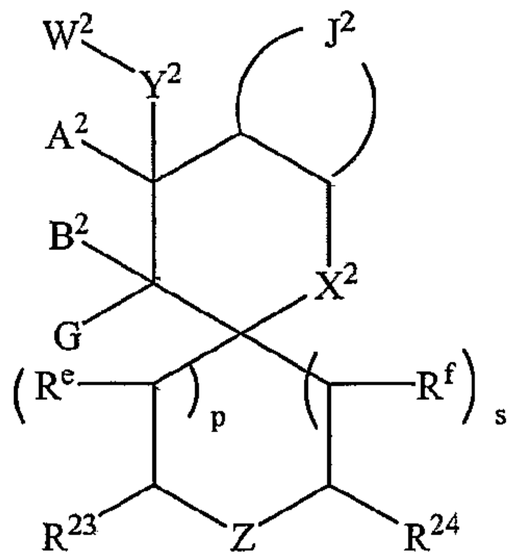
X^2 is $–C(R^c)(R^d)$-, -O-, -S-, -S(=O)-, $-S(=O)_2$-, -C(=O)-, -CH(OH)-or $–N(R^{26})$-;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating sympathetic nervous system disorders, including hypertension, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $–[C(R^c)(R^d)]_k$-;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

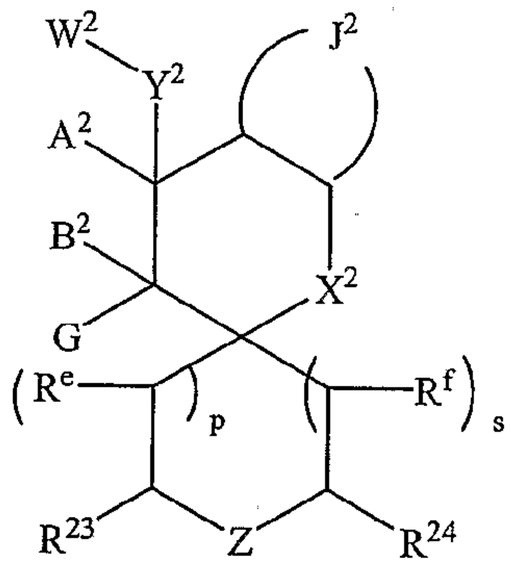
X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)-$alkenyl, $-(CH_2)-$alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating tussis, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

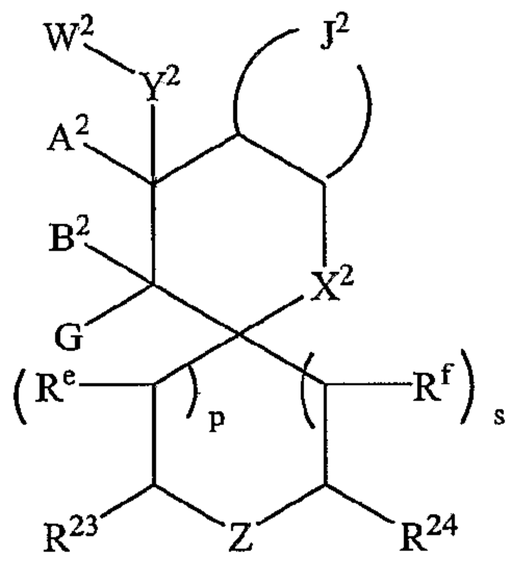
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating a motor disorder, including tremors, Parkinson's disease, Tourette's syndrome and dyskenesia, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k$-;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})$-, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))$-, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $–CH_2$-;

G is H or alkyl;

X^2 is $–C(R^c)(R^d)$-, -O-, -S-, -S(=O)-, $-S(=O)_2$-, -C(=O)-, -CH(OH)-or $–N(R^{26})$-;

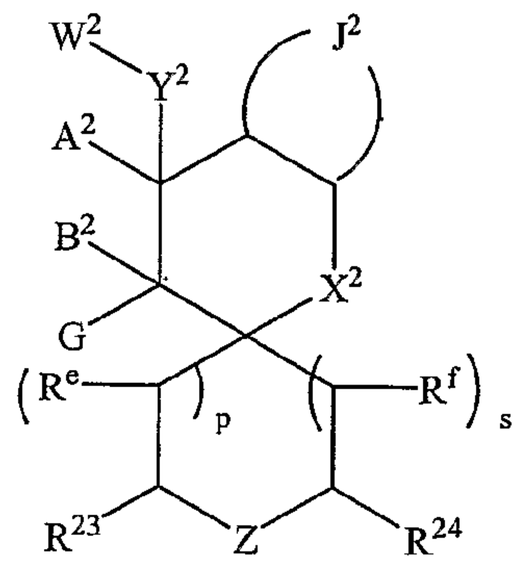
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In certain preferred embodiments, the present methods of preventing or treating a motor disorder may further comprise the administration to a patient of an effective amount of an agent for the treatment of Parkinson's disease.

In another aspect, the invention is directed to methods for treating a traumatic injury to the central nervous system, including the spinal cord or brain, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $–[C(R^c)(R^d)]_k$-;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

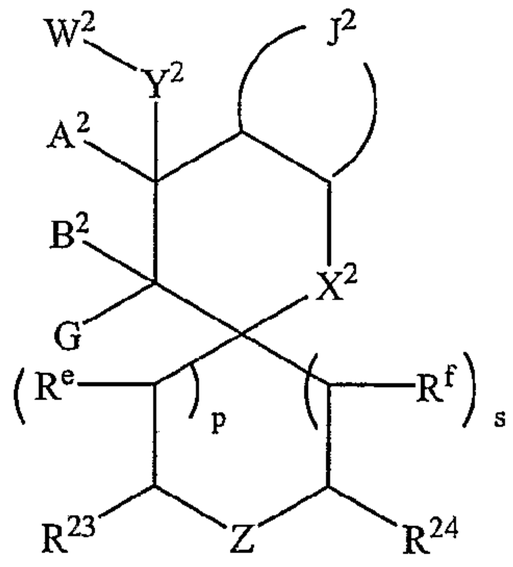
X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating stroke, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

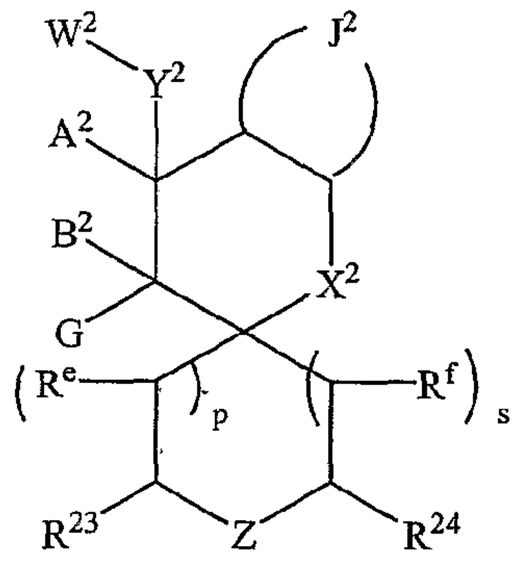
X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating cardiac arrhythmia, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

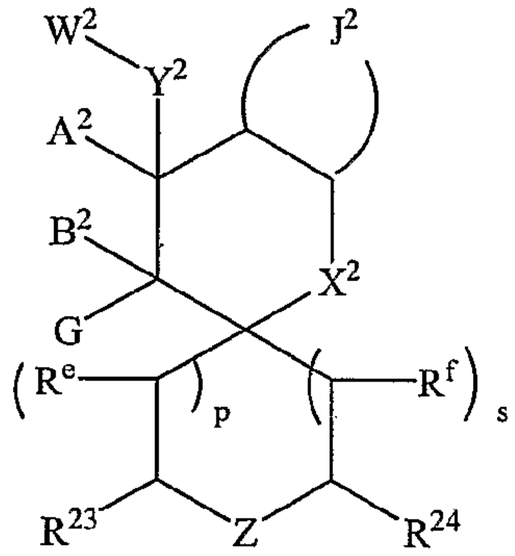
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating glaucoma, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

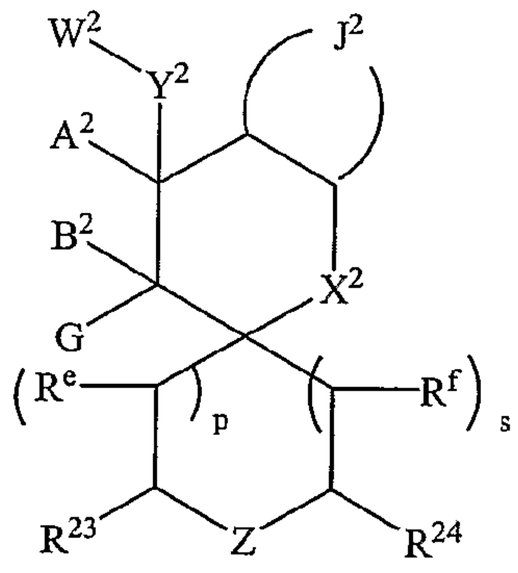
X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for preventing or treating sexual dysfunction, including premature ejaculation, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

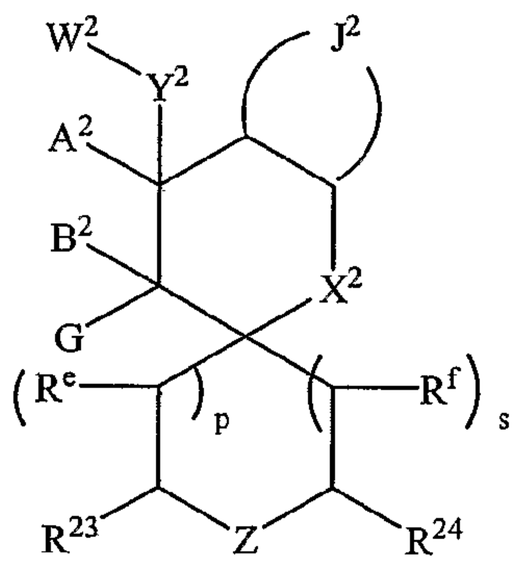
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for treating a condition selected from the group consisting of shock, brain edema, cerebral ischemia, cerebral deficits subsequent to cardiac bypass surgery and grafting, systemic lupus erythematosus, Hodgkin's disease, Sjogren's disease, epilepsy, and rejection in organ transplants and skin grafts, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken

together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

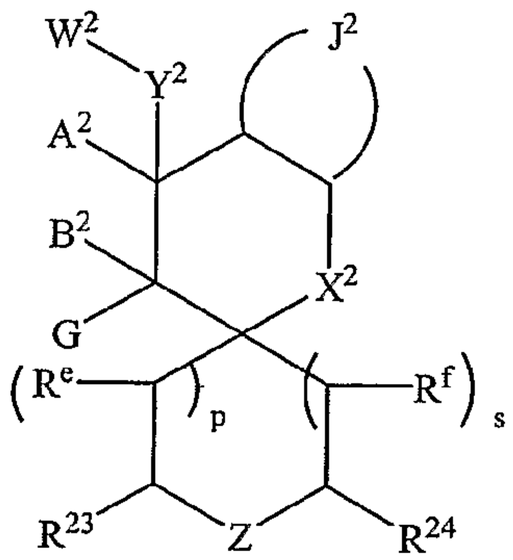
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for treating substance addiction, including addictions to alcohol, nicotine or drugs such as opioids, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $–CH_2–$;

G is H or alkyl;

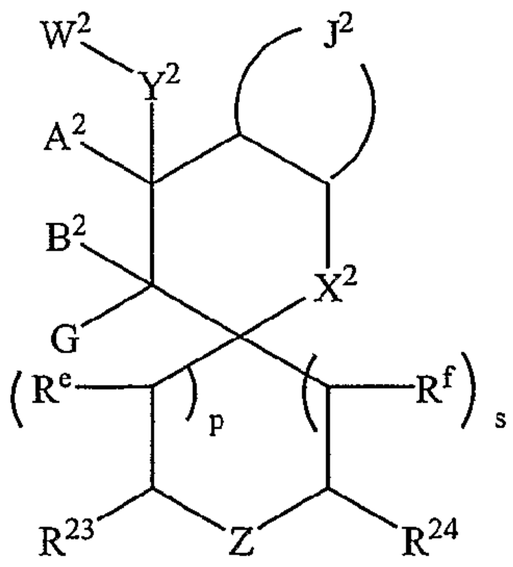
X^2 is $—C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $–N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for improving organ and cell survival, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

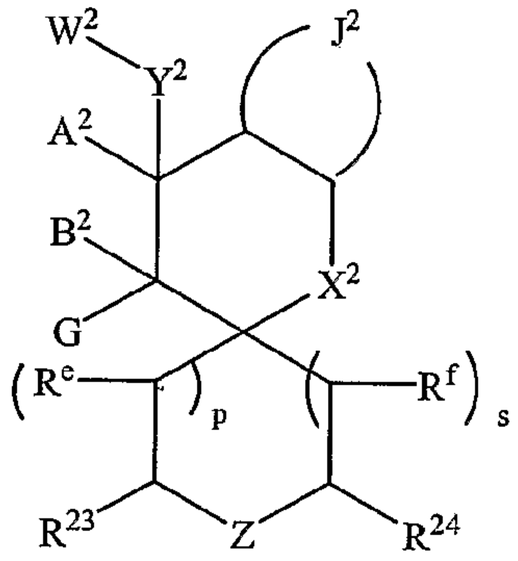
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

Techniques for evaluating and/or employing the present compounds in methods for improving organ and cell survival and organ preservation are described, for example, in C.V. Borlongan et al., *Frontiers in Bioscience* (2004), 9(Suppl.), 3392-3398, Su, *Journal of Biomedical Science* (Basel) (2000), 7(3), 195-199, and U.S. Patent No. 5,656,420, the disclosures of each of which are hereby incorporated herein by reference in their entireties.

In another aspect, the invention is directed to methods for providing cardioprotection following myocardial infarction, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

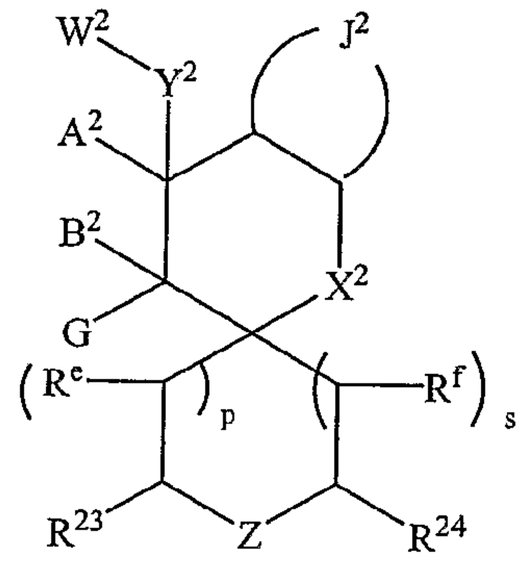
X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods for reducing the need for anesthesia, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

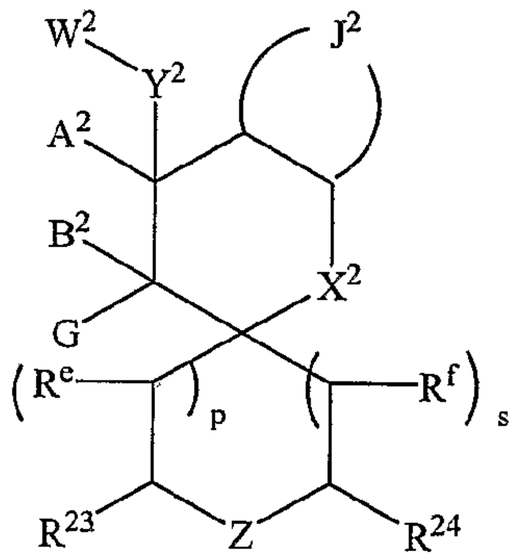
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

In another aspect, the invention is directed to methods of producing or maintaining an anesthetic state, comprising the step of administering to a patient in need of such treatment an effective amount of a compound of the invention including, for example, a compound of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. The method may further comprise the step of administering to said patient an anesthetic agent, which may be co-

administered with compound(s) of the invention. Suitable anesthetic agents include, for example, an inhaled anaesthetic, a hypnotic, an anxiolytic, a neuromuscular blocker and an opioid. Thus, in the present embodiment, compounds of the invention may be useful as analgesic agents for use during general anesthesia and monitored anesthesia care. Combinations of agents with different properties may be used to achieve a balance of effects needed to maintain the anaesthetic state. In certain preferred aspects, the methods comprise the step of administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

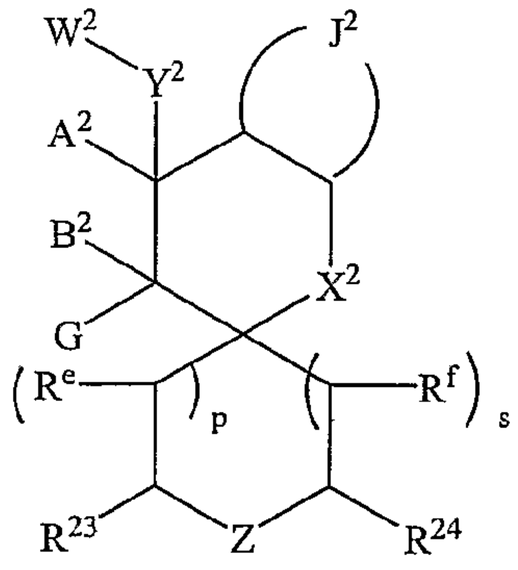
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

Additional diseases and/or disorders which may be treated and/or prevented with the compounds and pharmaceutical compositions of the present invention include those described, for example, in WO2004/062562 A2, WO 2004/063157 A1, WO 2004/063193 A1, WO 2004/041801 A1, WO 2004/041784 A1, WO 2004/041800 A1, WO 2004/060321 A2, WO 2004/035541 A1, WO 2004/035574 A2, WO 2004041802 A1, US 2004082612 A1, WO 2004026819 A2, WO 2003057223 A1, WO 2003037342 A1, WO 2002094812 A1, WO 2002094810 A1, WO 2002094794 A1, WO 2002094786 A1, WO 2002094785 A1, WO 2002094784 A1, WO 2002094782 A1, WO 2002094783 A1, WO 2002094811 A1, the disclosures of each of which are hereby incorporated herein by reference in their entireties.

In certain aspects, the present invention is directed to radiolabeled derivatives and isotopically labeled derivatives of compounds of the invention including, for example, compounds of formulas I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, and/or XIII. Suitable labels include, for example, ^{2}H, ^{3}H, ^{11}C, ^{13}C, ^{13}N, ^{15}N, ^{15}O, ^{18}O, ^{18}F and ^{34}S. Such labeled derivatives may be useful for biological studies, for example, using positron emission tomography, for metabolite identification studies and the like. Such diagnostic imaging methods may comprise, for example, administering to a patient a radiolabeled derivative or isotopically labeled derivative of a compound of the invention, and imaging the patient, for example, by application of suitable energy, such as in positron emission tomography. Isotopically- and radio-labeled derivatives may be prepared utilizing techniques well known to the ordinarily skilled artisan. In certain preferred aspects, the radiolabeled derivatives and the isotopically labeled derivatives of the invention are compounds of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

-C(=O)-H

-S-C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H,

-N(C_{1-4} alkyl)S(=O)$_2$-H,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

$-NH_2$,

$-N=C(aryl)_2$,

$-N(H)C_{1-4}$ alkyl,

$-N(C_{1-4}$ alkyl$)_2$,

$-OS(=O)_2-C_{1-4}$ alkyl optionally substituted with one or more halogens,

$-OS(=O)_2-C_{6-12}$ aryl optionally substituted with C_{1-4} alkyl,

$-NHS(=O)_2-C_{1-4}$ alkyl,

$-N(C_{1-4}$ alkyl$)S(=O)_2-C_{1-4}$ alkyl,

$-NHS(=O)_2-H$, and

$-N(C_{1-4}$ alkyl$)S(=O)_2-H$;

p and s are each 1,

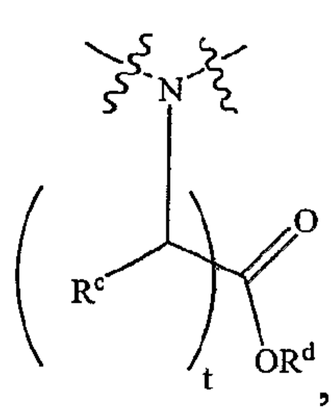
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



, wherein t is an integer from 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

$-S-C_{1-4}$ alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

$-NH_2$,

$-N(C_{1-4}$ alkyl$)_2$, and

pyrrolyl;

p and s are each 1,

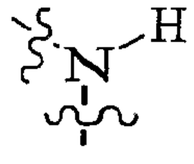
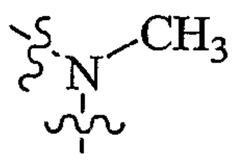
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:

; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached forms unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

$-S-C_{1-4}$ alkyl,

p and s are each 1,

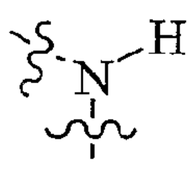
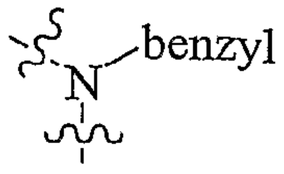
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

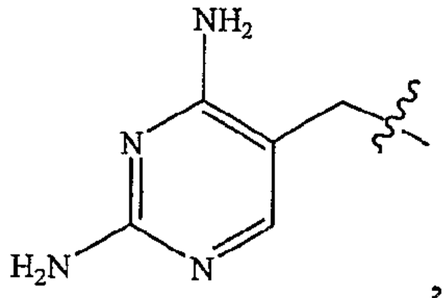
X^2 is –O-;

" then Z is other than:


or

; and

provided that when:

(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:


, then Z is other than $-N(R^{25})-$ or $-CH(NH_2)-$;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

The present invention will now be illustrated by reference to the following specific, non-limiting examples. Those skilled in the art of organic synthesis may be aware of still other synthetic routes to the invention compounds. The reagents and intermediates used herein are commercially available or may be prepared according to standard literature procedures.

Methods Of Preparation

The examples listed in Table 1 were prepared according to Schemes 1-37. The synthesis of compounds **1A–1U** is outlined in Scheme 1. The 2'-hydroxyacetophenone derivatives **1.1a-1.1m** were condensed with 1-Boc-4-piperidone **1.2** in neat pyrrolidine (method 1A) at room temperature or in refluxing methanol in the presence of pyrrolidine (method 1B) to provide *N*-Boc-spiro[2*H*-1-benzopyran-2,4'-piperidine]-4(3*H*)-one derivatives **1.3**. Conversion of the ketones **1.3** to the enol triflate derivatives **1.5** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivatives **1.5** with either 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** (commercially available from Combi-Blocks Inc.) or 2-(*N*,*N*-diethylaminocarbonyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxoborolan-2-yl)pyridine **1.7** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0) (method 1C) or palladium, 10 wt.% (dry basis) on activated carbon (method 1D), lithium chloride, and an aqueous solution of sodium carbonate afforded compounds **1.8** which were converted to the final products (compounds **1A-1T**) under acidic conditions (method 1E: anhydrous HCl, diethyl ether, room temperature or method 1F: neat trifluoroacetic acid, room temperature). Demethylation of compound **1G** using boron tribromide provided the corresponding phenolic derivative (compound **1U**). The boronate derivative **1.7** was prepared in 4 steps from 2,5-dibromopyridine **1.9**. Treatment of 2,5-dibromopyridine with *n*-butyllithium provided the corresponding lithiated derivative, which reacted with carbon dioxide to provide 5-bromopyridine-2-carboxylic acid **1.10**. Treatment of the carboxylic acid derivative **1.10** with oxalyl chloride furnished the acyl chloride **1.11**, which reacted with diethylamine **1.12** to provide 5-bromo-2-(*N*,*N*-diethylaminocarbonyl)-pyridine **1.13**. Conversion of the aryl bromide **1.13** to the corresponding boron derivative **1.7** was achieved using 4,4,5,5-tetramethyl-2-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1,3,2-dioxaborolane **1.14** and dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II) dichloromethane adduct, abbreviated as [$Pd(dppf)Cl_2 \cdot CH_2Cl_2$].

The synthesis of compounds **2A-2F** is outlined in Scheme 2. The 2'-5'-dihydroxyacetophenone derivative **2.1** was condensed with 1-Boc-4-piperidone **1.2** in refluxing methanol in the presence of pyrrolidine to provide *N*-Boc-spiro[2*H*-1-benzopyran-2,4'-piperidine]-4(3*H*)-one derivative **2.2** which was converted to the silyl ether derivative **2.4** using *tert*-butyldimethylsilyl chloride **2.3**. Conversion of the ketone **2.4** to the enol triflate derivative **2.5** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **2.5** with either 4-(*N*,*N*-diethylaminocarbonyl)-phenyl boronic acid **1.6** or 2-(*N*,*N*-diethylaminocarbonyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxoborolan-2-yl)pyridine **1.7** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0) (method 1C) or palladium, 10 wt.% (dry basis) on activated carbon (method 1D), lithium chloride, and an aqueous solution of sodium carbonate afforded compounds **2.6**. Removal of the silyl protecting group of **2.6** using a solution of tetrabutylammonium fluoride (TBAF) in tetrahydrofuran gave the phenolic derivatives **2.7** which were converted to the final products compounds **2A** and **2B** under acidic conditions. Preparation of each of the ether derivatives **2.9** from the phenols **2.7** was achieved by alkylation reaction using the appropriate alkyl bromide (**2.8a**, **2.8b**) (method 2A) or alkyl iodide (**2.8c**) reagent (method 2C). In some instances, the ether derivatives **2.9** were also obtained from the phenols **2.7** using the Mitsunobu conditions, i.e., condensation of the phenols **2.7** with the appropriate alcohol (**2.8d**, **2.8e**) in the presence of triphenylphosphine and diisopropyl azodicarboxylate (DIAD) (method 2B). Treatment of the Boc derivatives **2.9** with hydrochloric acid provided the final compounds **2C-F**.

The synthesis of compounds **3A-AC** is outlined in Scheme 3. Conversion of the phenols **2.7** to the triflate derivatives **3.1** was achieved using the triflating reagent *N*-phenylbis(trifluoromethanesulphonimide) **1.4**. Palladium catalyzed carbonylation of **3.1**, conducted in methanol or in a mixture dimethylsulfoxide/methanol using palladium (II) acetate, 1,1'-bis(diphenylphosphino)ferrocene (dppf) and carbon monoxide, provided the methyl esters **3.2** which were hydrolyzed under basic conditions to give the carboxylic acid derivatives **3.3**. Coupling of the carboxylic acids **3.3** with various amines (**3.4a-3.4q**) using *O*-benzotriazol-1-yl-*N*,*N*,*N'*,*N'*-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the primary,

secondary, and tertiary amides **3.5**. Treatment of the Boc derivatives **3.2**, **3.3** and **3.5** with hydrochloric acid provided the final compounds **3A-3Y**. Suzuki type coupling of the triflate derivative **3.1a** (X = CH) with various organoboron reagents (**3.6a-3.6d**) in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), and/or dichloro[1,1'-bis(diphenylphosphino) ferrocene]palladium(II)dichloromethane, [Pd(dppf)Cl_2 CH_2Cl_2], lithium chloride, and an aqueous solution of sodium carbonate afforded compounds **3.7** which were converted to the final products (compounds **3Z-3AC**) under acidic conditions.

The synthesis of compounds **4A-4I** is outlined in Scheme 4. Treatment of compound **1A** with trifluoroacetic anhydride in tetrahydrofuran in the presence of triethylamine provided the trifluoroacetamide derivative **4.2** which was converted to the sulfonyl chloride **4.4** using sulfur trioxide *N*,*N*-dimethylformamide complex (**4.3**) as sulfating agent. Condensation of **4.4** with various primary and secondary amines (**3.4**, **4.5**) afforded the sulfonamide derivatives **4.6** which were converted to the compounds **4A-4G** under basic conditions. Treatment of the sulfonyl chloride **4.4** with ammonium hydroxide in acetonitrile provided the sulfonamide compound **4H**, which was further protected as its *tert*-butyloxycarbonyl (Boc) derivative **4.8** buy treatment with *tert*-butyloxycarbonyl anhydride (**4.7**). Acetylation of **4.8** using acetic anhydride (**4.9**) gave the acetylsulfonamide derivative **4.10** which was converted to compound **4I** by treatment with iodotrimethylsilane.

The synthesis of compound **5A** is described in Scheme 5. Condensation of hydrazine hydrate (**5.1**) with the sulfonyl chloride derivative **4.4** provided the sulfonyl hydrazide **5.2**, which was converted to the sulfone **5.3** by treatment with methyl iodide (**2.8c**) in the presence of sodium acetate. Deprotection of the trifluoroacetamide protecting group of **5.3** under basic conditions (potassium carbonate, methanol/tetrahydrofuran/water) provided the final compound **5A**.

The synthesis of compounds **6A-6E** is described in Scheme 6. Nitration of the trifluoroacetamide **4.2** using nitronium tetrafluoroborate complex (**6.1**) as nitrating reagent provided predominantly the *mono*-nitro isomer **6.2**. Reduction of the nitro functionality of **6.2** using tin(II) chloride dihydrate (**6.3**) gave the aniline derivative

6.4, which reacted with the sulfonyl chloride derivatives **6.5** or with acetyl chloride (**6.7**) to provide the sulfonamides **6.6** or the acetamide **6.8**, respectively. Deprotection of the trifluoroacetamide protecting group of **6.2**, **6.4**, **6.6** and **6.8** under basic conditions (potassium carbonate, methanol/tetrahydrofuran/water) provided the final compounds (compounds **6A-6E**).

The synthesis of compounds **7A-7C** is described in Scheme 7. Buchwald type coupling of the triflate derivative **3.1a** with diphenylmethanimine (**7.1**) in toluene in the presence of tris(dibenzylideneacetone)dipalladium (0) [$Pd_2(dba)_3$], 1,1'-bis(diphenylphosphino)ferrocene (dppf) and sodium *tert*-butoxide afforded the benzophenone imine derivative **7.2**, which was converted to the aniline **7.3** by treatment with hydroxylamine hydrochloride in the presence of sodium acetate. Treatment of **7.3** with methanesulfonyl chloride (**7.4**) in dichloromethane in the presence of triethylamine provided the *bis*-methanesulfonamide **7.5**, which was hydrolyzed to the *mono* methanesulfonamide derivative **7.6** under basic conditions. Deprotection of the *tert*-butyloxycarbonyl protecting group of **7.6** under acidic conditions provided the final compound **7A**. Compound **7B** was obtained in two steps from **7.6**. Alkylation of **7.6** with methyl iodide (**2.8c**) in tetrahydrofuran in the presence of sodium hydride provided the *N*-methylsulfonamide **7.7**, which was converted to compound **7B** under acidic conditions. Treatment of the aniline derivative **6.4** with methanesulfonyl chloride (**7.4**) in dichloromethane in the presence of triethylamine provided the *bis*-methanesulfonamide **7.8**, which was hydrolyzed to the *mono*-methanesulfonamide derivative compound **7A** under basic conditions. During the course of this reaction, the *N*-methyl piperidine derivative compound **7C** was identified as a side product. The separation of the mixture containing compounds **7A** and **7C** was achieved by first treating the mixture of compounds **7A/7C** with *tert*-butyloxycarbonyl anhydride (**4.7**) which provided the Boc derivative **7.6** and unreacted compound **7C**, followed by purification of compound **7C** using flash colum chromatography.

The synthesis of compounds **8A-8F** is outlined in Scheme 8. The 2'-3'-dihydroxyacetophenone derivative **8.1** was condensed with 1-Boc-4-piperidone **1.2** in

refluxing methanol in the presence of pyrrolidine to provide the *N*-Boc-spiro[2*H*-1-benzopyran-2,4'-piperidine]-4(3*H*)-one derivative **8.2** which was converted to the silyl ether derivative **8.3** using *tert*-butyldimethylsilyl chloride **2.3**. The ketone **8.3** was converted to the enol triflate derivative **8.4** using the triflating reagent *N*-phenylbis(trifluoromethanesulphonimide) **1.4**. Suzuki type coupling of the enol triflate derivative **8.4** with either 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** or 2-(*N*,*N*-diethylaminocarbonyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxoborolan-2-yl)pyridine **1.7** in ethylene glycol dimethyl ether in the presence of palladium, 10 wt.% (dry basis) on activated carbon, lithium chloride, and an aqueous solution of sodium carbonate afforded compounds **8.5**. Removal of the silyl protecting group of **8.5** using a solution of tetrabutylammonium fluoride (TBAF) in tetrahydrofuran gave the phenolic derivatives **8.6** which were converted to the final products (compounds **8A** and **8B**) under acidic conditions. Preparation of the ether derivatives **8.7** from the phenols **8.6** was achieved by alkylation using the appropriate alkyl bromide (**2.8a**) or methyl iodide (**2.8c**) reagent. Treatment of the Boc derivatives **8.7** with hydrochloric acid provided the final compounds **8C-8F**.

The synthesis of compounds **9A-9B** is outlined in Scheme 9. The 2'-4'-dihydroxyacetophenone derivative **9.1** was condensed with 1-Boc-4-piperidone **1.2** in refluxing methanol in the presence of pyrrolidine to provide the *N*-Boc-spiro[2*H*-1-benzopyran-2,4'-piperidine]-4(3*H*)-one derivative **9.2** which was converted to the silyl ether derivative **9.3** using *tert*-butyldimethylsilyl chloride **2.3**. Conversion of the ketone **9.3** to the enol triflate derivative **9.4** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **9.4** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the phenolic derivative **9.5** (simultaneous removal of the silyl protecting group occurred under the Suzuki coupling conditions). Alkylation of the phenol **9.5** with (bromomethyl)cyclopropane (**2.8a**) in acetone in the presence of potassium carbonate provided the ether derivative **9.6** which was converted to compound **9A** under acidic conditions. Treatment of the phenol **9.5** with methyl chlorodifluoroacetate (**9.7**) in *N*,*N*-dimethylformamide in the presence of cesium

carbonate provided the ether derivative **9.8** which was converted to compound **9B** under acidic conditions.

The synthesis of compounds **10A-10J** is outlined in Scheme 10. Conversion of the phenol **9.5** to the triflate derivative **10.1** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Palladium catalyzed carbonylation of **10.1**, conducted in a mixture *N,N*-dimethylformamide/methanol using palladium (II) acetate, 1,1'-bis(diphenylphosphino)ferrocene (dppf), and carbon monoxide, provided the methyl ester **10.2** which was hydrolyzed under basic conditions to give the carboxylic acid derivative **10.3**. Coupling of the carboxylic acid **10.3** with various amines (**3.4a,c,j,k,p**; **1.12**) using either *O*-(7-azabenzotriazol-1-yl)-*N,N,N',N'*-tetramethyluronium hexafluorophosphate (HATU) (method 10B) or *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (TBTU) (method 10A) as coupling agents afforded the primary, secondary, and tertiary amides **10.4**. The dimethylamide derivative **10.4b** (R_1 = H, R_2 = CH_3) was obtained by heating a mixture of the ester **10.2** with methylamine (**3.4b**) in methanol in a sealed tube. Treatment of the Boc derivatives **10.2, 10.3** and **10.4** with hydrochloric acid provided the final compounds **10A-10I**. Treatment of the ester **10.2** with lithium borohydride in tetrahydrofuran provided the primary alcohol **10.5** which was converted to the compound **10J** under acidic conditions.

The synthesis of compounds **11A-11F** is outlined in Scheme 11. The 2'-6'-dihydroxyacetophenone derivative **11.1** was condensed with 1-Boc-4-piperidone **1.2** in refluxing methanol in the presence of pyrrolidine to provide the *N*-Boc-spiro[2*H*-1-benzopyran-2,4'-piperidine]-4(3*H*)-one derivative **11.2** which was converted to the methoxymethyl (MOM) ether derivative **11.4** using chloro(methoxy)methane (**11.3**). Conversion of the ketone **11.4** to the enol triflate derivative **11.5** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **11.5** with either 4-(*N,N*-diethylaminocarbonyl)phenyl boronic acid **1.6** or 2-(*N,N*-diethylaminocarbonyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxoborolan-2-yl)pyridine **1.7** in

ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded compounds **11.6**. Removal of the MOM and the Boc protecting groups of **11.6** in methanol at room temperature in the presence of hydrochloric acid (anhydrous solution in dioxane) afforded the phenolic compounds **11A** and **11B** which were converted to the corresponding Boc derivatives **11.7** by treatment with *tert*-butyloxycarbonyl anhydride (**4.7**). Preparation of the ether derivatives **11.9a** [X=CH; R = $CH_2c(C_3H_5)$], **11.9b** [X=N; R = $CH_2c(C_3H_5)$] and **11.9d** [X=N; R = $c(C_5H_9)$] from the corresponding phenols **11.7a** [X=CH] or **11.7b** [X=N] was achieved using the Mitsunobu conditions, i.e., condensation of the phenols **11.7a** or **11.7b** with cyclopropylmethanol (**2.8e**) or cyclopentanol (**11.10**) in dichloromethane in the presence of triphenylphosphine and diethyl azodicarboxylate (DEAD). The cyclobutyl ether **11.9c** [X=CH; R = $c(C_4H_7)$] was obtained by alkylation of the corresponding phenol **11.7a** [X=CH] with bromocyclobutane in acetone in the presence of potassium carbonate. Treatment of the Boc derivatives **11.9** with hydrochloric acid provided the final compounds **11C-11F**.

The synthesis of compounds **12A-12L** is outlined in Scheme 12. Conversion of the phenol **11.2** to the triflate derivative **12.1** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Palladium catalyzed Negishi-type coupling of **12.1** with methylzinc chloride (**12.2a**), propylzinc bromide (**12.2b**), or butylzinc bromide (**12.2c**), conducted in tetrahydrofuran using tetrakis triphenylphosphine palladium (0) as catalyst, provided the ketones **12.3**. Conversion of the ketones **12.3** to the enol triflate derivatives **12.4** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **12.4** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** or 2-(*N*,*N*-diethylaminocarbonyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxoborolan-2-yl)pyridine **1.7** using either method 1C (tetrakis triphenylphosphine palladium (0), lithium chloride, aqueous solution of sodium carbonate, ethylene glycol dimethyl ether) or method 12A (tetrakis triphenylphosphine palladium (0), potassium bromide, potassium phosphate, dioxane) afforded compounds **12.5**. Removal of the Boc protecting group of **12.5** in dichloromethane at room temperature

in the presence of hydrochloric acid (anhydrous solution in diethyl ether) afforded compounds **12A** and **12H-12L**. Palladium catalyzed carbonylation of **12.1**, conducted in a mixture *N*,*N*-dimethylformamide/methanol using palladium (II) acetate, 1,3-bis(diphenylphosphino)propane (dppp) and carbon monoxide, provided the methyl ester **12.6** which was hydrolyzed under basic conditions (lithium hydroxide, methanol/tetrahydrofuran) to give the carboxylic acid derivative **12.7**. Coupling of the carboxylic acid **12.7** with dimethylamine (**3.4j**) using *O*-benzotriazol-1-yl-*N*,*N*,*N*',*N*'-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the dimethylaminocarbonyl derivative **12.8**. Conversion of **12.8** to the enol triflate derivative **12.9** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **12.9** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded compound **12.10**. Removal of the Boc protecting group of **12.10** in dichloromethane at room temperature in the presence of hydrochloric acid (anhydrous solution in diethyl ether) afforded compound **12G** ($R_1 = R_2 = CH_3$). Conversion of **12.6** to the enol triflate derivative **12.11** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **12.11** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the ester **12.12** which was hydrolyzed under basic conditions (potassium *tert*-butoxide, diethyl ether, water) to give the carboxylic acid **12.13**. Coupling of the carboxylic acid **12.13** with various amines (**12.15** or **3.4b-3.4d**) using *O*-benzotriazol-1-yl-*N*,*N*,*N*',*N*'-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the primary and secondary aminocarbonyl derivatives **12.14**. Treatment of the Boc derivatives **12.13** and **12.14** with hydrochloric acid provided the final compounds **12B-12F**.

The synthesis of compounds **13A-13S** is outlined in Scheme 13. The 2'-hydroxyacetophenone derivative **1.1a** was condensed with 1-Boc-4-piperidone **1.2** in refluxing methanol in the presence of pyrrolidine to provide *N*-Boc-spiro[2*H*-1-

benzopyran-2,4'-piperidine]-4(3*H*)-one **1.3a**. Conversion of **1.3a** to the enol triflate derivative **1.5a** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **1.5a** with 4-(methoxycarbonyl)phenylboronic acid (**13.1**) in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the ester **13.2** which was hydrolyzed under basic conditions (lithium hydroxide, methanol/tetrahydrofuran/water) to give the carboxylic acid **13.3**. Coupling of the carboxylic acid **13.3** with various amines (**3.4a-3.4c, 3.4e, 3.4j-3.4k, 3.4o-3.4q**; **13.4a-13.4h**) using *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the primary, secondary, and tertiary aminocarbonyl derivatives **13.5**. Treatment of the Boc derivatives **13.3** and **13.5** with hydrochloric acid provided the final compounds **13A-13R**. Hydrolysis of compound **13O** under basic conditions (sodium hydroxide, ethanol/tetrahydrofuran) provided the carboxylic acid compound **13S**.

The synthesis of compounds **14A-14C** is outlined in Scheme 14. Suzuki type coupling of the enol triflate derivative **1.5a** with 4-cyanophenylboronic acid (**14.1**) in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the cyanide **14.2** which was converted to the tetrazole **14.4** using sodium azide (**14.3**) and zinc bromide in a solution isopropanol/water. Alkylation of **14.4** with methyl iodide (**2.8c**) in N,N-dimethylformamide in the presence of triethylamine afforded the two regioisomers **14.5** (major isomer) and **14.6** (minor isomer) separated by silica gel column chromatography. The Boc protecting group of **14.4**, **14.5**, and **14.6** was removed using hydrochloric acid to generate the compounds **14A-14C.** Alternatively, the Boc protecting group of **14.4** was also removed using trifluoroacetic acid to give **14A.**

The synthesis of compounds **15A-15N** is outlined in Scheme 15. Alkylation of **14.4** with the alkyl bromide derivatives **15.1a-15.1e** in *N,N*-dimethylformamide in the presence of triethylamine afforded the regioisomers **15.2** (major isomers) and **15.3** (minor isomers) separated by silica gel column chromatography. The Boc protecting group of **15.2** and **15.3** was removed using hydrochloric acid to generate the

compounds **15A-15J.** Hydrolysis of compounds **15A** or **15C-15E** under basic conditions (sodium hydroxide, methanol (or ethanol) /tetrahydrofuran/water) provided the corresponding carboxylic acids compounds **15K-15N**, respectively. In some instances, compounds **15K-15N** were also obtained in two steps from **15.2**, i.e. by basic hydrolysis of the ester functionality of **15.2** followed by deprotection of the Boc derivatives **15.4** under acidic conditions.

The synthesis of compounds **16A-16C** is outlined in Scheme 16. Suzuki type coupling of the enol triflate derivative **1.5a** with 3-cyanophenylboronic acid (**16.1**) in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the cyanide **16.2** which was converted to the tetrazole **16.3** using sodium azide (**14.3**) and zinc bromide in a solution isopropanol/water. Alkylation of **16.3** with methyl iodide (**2.8c**) in *N,N*-dimethylformamide in the presence of triethylamine afforded the two regioisomers **16.4** (major isomer) and **16.5** (minor isomer) separated by silica gel column chromatography. The Boc protecting group of **16.3**, **16.4**, and **16.5** was removed using hydrochloric acid to generate the compounds **16A-16C.**

The synthesis of compounds **17A-17F** is outlined in Scheme 17. Alkylation of **16.3** with the alkyl bromide derivatives **15.1a** or **15.1c** in *N,N*-dimethylformamide in the presence of triethylamine afforded the regioisomers **17.1** (major isomers) and **17.2** (minor isomers) separated by silica gel column chromatography. Alkylation of **16.3** with 4-(2-bromoethyl)morpholine (**17.3**) in *N,N*-dimethylformamide in the presence of triethylamine afforded the isomer **17.4**. The Boc protecting group of **17.1**, **17.2**, and **17.4** was removed using hydrochloric acid to generate the compounds **17A-17D.** Hydrolysis of compounds **17A** and **17B** under basic conditions (sodium hydroxide, methanol/ tetrahydrofuran/water) provided the corresponding carboxylic acids compound **17E** and compound **17F**, respectively. In some instances compounds **17E** and **17F** could also be obtained in two steps from **17.1**, i.e. by basic hydrolysis of the ester functionality of **17.1** followed by deprotection of the Boc derivatives **17.5** under acidic conditions.

The synthesis of compounds **18A-18C** is outlined in Scheme 18. Coupling of the carboxylic acid **13.3** with ammonium chloride (**3.4a**) in acetonitrile in the presence of diisopropylethylamine using *O*-benzotriazol-1-yl-*N*,*N*,*N*',*N*'-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the primary aminocarbonyl derivative **13.5a** which was converted to the thioamide **18.2** using the Lawesson's reagent (**18.1**) [2,4-bis(4-methoxyphenyl)-1,3-dithia-2,4-diphosphetane-2,4-disulfide]. Condensation of the thioamide **18.2** with 1-bromo-3,3-dimethylbutan-2-one (**18.3a**) or
2-bromo-1-phenylethanone (**18.3b**) afforded the thiazole derivatives **18.4** which were converted to the final compounds (compounds **18A** and **18B**) under acidic conditions. Condensation of the nitrile derivative **14.2** with hydroxylamine hydrochloride (**18.5**) in ethanol in the presence of triethylamine afforded the *N*-hydroxybenzamidine derivative **18.6** which reacted with acetyl chloride (**6.7**) in refluxing pyridine to give the 1,2,4-oxadiazole derivative **18.7**. Deprotection of the Boc functionality of **18.7** under acidic conditions afforded compound **18C**.

The synthesis of compound **19A-19D** is outlined in Scheme 19. The 2'-hydroxyacetophenone **1.1a** was condensed with benzyl 4-oxopiperidine-1-carboxylate (**19.1**) in refluxing methanol in the presence of pyrrolidine to provide *N*-Cbz-spiro[2*H*-1-benzopyran-2,4'-piperidine]-4(3*H*)-one (**19.2**). Conversion of the ketone **19.2** to the enol triflate derivative **19.3** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Conversion of the enol triflate **19.3** to the corresponding boron derivative **19.4** was achieved using 4,4,5,5-tetramethyl-2-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1,3,2-dioxaborolane **1.14** and dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II) dichloromethane adduct, abbreviated as [Pd(dppf)Cl_2•CH_2Cl_2]. Suzuki type coupling of the boronate derivative **19.4** with *tert*-butyl 4-bromophenylcarbamate **19.5** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the *tert*-butyloxycarbonyl (Boc) protected aniline derivative **19.6**. Acidic hydrolysis of **19.6** provided the aniline derivative **19.7** which reacted with acyl chlorides **19.8a**, **19.8b**, *iso*propylsulfonyl chloride (**6.5b**) or ethyl isocyanate (**19.11**) to give the corresponding amide derivatives **19.9**, sulfonamide derivative **19.10** or urea derivative

19.12, respectively. The derivatives **19.9**, **19.10** and **19.12** were converted to compounds **19A-19D** by treatment with iodotrimethylsilane.

The synthesis of compounds **20A-20R** is outlined in Scheme 20. The tertiary amine derivatives compounds **20A-20R** were obtained from the secondary amines of general formula **20I**, by reductive amination methods (methods 20A or 20B) using the aldehydes **20.1a-20.1d** and sodium cyanoborohydride as reducing agent or by alkylation method (method 20C) using the bromides **2.8a**, **20.2a-e** as the alkylating reagent.

The synthesis of compounds **21A-21F** is outlined in Scheme 21. Condensation of 1-Boc-4-piperidone **1.2** with ethyl diazoacetate (**21.1**) in the presence of boron trifluoride diethyl etherate provided 1-*tert*-butyl 4-ethyl 3-oxoazepane-1,4-dicarboxylate in equilibrium with its enol form (**21.2**). Ester hydrolysis followed by decarboxylation of **21.2** under acidic conditions provided the azepan-3-one (**21.3**), which was protected as its Boc derivative **21.4** by treatment with *tert*-butyloxycarbonyl anhydride (**4.7**). The 2'-hydroxyacetophenone **1.1a** was condensed with **21.4** in refluxing methanol in the presence of pyrrolidine to provide the racemic ketone **21.5**. Conversion of **21.5** to the enol triflate derivative **21.6** was achieved using the triflating reagent *N*-phenylbis(trifluoromethanesulphonimide) **1.4**. Suzuki type coupling of the enol triflate derivative **21.6** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid (**1.6**) in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the racemic derivative **21.7**, which was hydrolyzed under acidic conditions to give the compound **21A** (racemic mixture). The two enantiomers derived from **21.7**, i.e. compounds **21.7a** and **21.7b**, were separated by chiral HPLC. The pure enantiomers **21.7a** and **21.7b** were converted to compounds **21B** and **21C**, respectively under acidic conditions. Palladium catalyzed hydrogenation of compounds **21B** and **21C** afforded compounds **21D** (diastereoisomeric mixture) and **21E** (diastereoisomeric mixture), respectively. Treatment of compound **21A** with benzyl chloroformate (**21.8**) in dichloromethane in the presence of triethylamine provided the Cbz-protected derivative **21.9**, which was converted to the sulfonyl chloride **21.10** using sulfur trioxide *N*,*N*-dimethylformamide

complex (**4.3**) as sulfating agent. Condensation of **21.10** with ethylamine (**3.4c**) in dichloromethane in the presence of triethylamine, afforded the ethyl sulfonamide derivative **21.11** which was converted to compound **21F** by treatment with iodotrimethylsilane.

The synthesis of compounds **22A-22E** is outlined in Scheme 22. Treatment of compound **21B** (most active enantiomer) with trifluoroacetic anhydride (**4.1**) in tetrahydrofuran in the presence of triethylamine provided the trifluoroacetamide derivative **22.1** which was converted to the sulfonyl chloride **22.2** using sulfur trioxide *N*,*N*-dimethylformamide complex (**4.3**) as sulfating agent. Condensation of **22.2** with various primary amines (**3.4b, 3.4c, 3.4d, 3.4g**) afforded the sulfonamide derivatives **22.3** which were converted to compounds **22A-22D** under basic conditions. Condensation of hydrazine hydrate (**5.1**) with the sulfonyl chloride derivative **22.2** provided the sulfonyl hydrazide **22.4**, which was converted to the sulfone **22.5** by treatment with methyl iodide (**2.8c**) in the presence of sodium acetate. Deprotection of the trifluoroacetamide protecting group of **22.5** under basic conditions (potassium carbonate, methanol/tetrahydrofuran/water) provided the methyl sulfonyl analog (compound **22E**).

The synthesis of compounds **23A-23C** is outlined in Scheme 23. The 2'-hydroxyacetophenone **1.1a** was condensed with *tert*-butyl 3-oxopyrrolidine-1-carboxylate (**23.1a**) or *tert*-butyl 3-oxopiperidine-1-carboxylate (**23.1b**) in refluxing methanol in the presence of pyrrolidine to provide the racemic ketones **23.2a** (n=0) and **23.2b** (n=1), respectively. Conversion of the ketones **23.2** to the enol triflate derivatives **23.3** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivatives **23.3** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the Boc derivatives **23.4** which were converted to the final products compounds **23A** and **23B** (racemic mixtures) under acidic conditions. The 2'-hydroxyacetophenone **1.1a** was also condensed with 1-Boc-4-nortropinone (**23.5**) in refluxing methanol in the presence of pyrrolidine to provide the ketone **23.6**. Conversion of the ketone **23.6** to the enol triflate derivative

23.7 was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **23.7** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the Boc derivative **23.8** which was converted to the final product compound **23C** under acidic conditions.

The synthesis of compounds **24A-24G** is outlined in Scheme 24. The 2'-hydroxyacetophenone **1.1a** was condensed with 1,4-cyclohexanedione *mono*-ethylene ketal (**24.1**) in refluxing methanol in the presence of pyrrolidine to provide the ketone **24.2**. Conversion of the ketone **24.2** to the enol triflate derivative **24.3** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **24.3** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the derivative **24.4** which was converted to the ketone compound **24A** under acidic conditions. The reduction of the ketone compound **24A**, conducted in tetrahydrofuran in the presence of sodium borohydride, provided the corresponding alcohol derivatives compounds **24B** and **24C**. Treatment of the ketone compound **24A** with propylamine (**3.4d**) or dimethylamine (**3.4j**) under reductive amination conditions using sodium cyanoborohydride as reducing agent, provided the amines compounds **24D-24G**.

The synthesis of compound **25A** is outlined in Scheme 25. The 2'-hydroxyacetophenone **1.1a** was also condensed with tetrahydropyran-4-one (**25.1**) in refluxing methanol in the presence of pyrrolidine to provide the ketone **25.2**. Conversion of the ketone **25.2** to the enol triflate derivative **25.3** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **25.3** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded compound **25A**.

The synthesis of compounds **26A-26B** is outlined in Scheme 26. Palladium catalyzed Negishi-type coupling of **1.5a** with 4-cyanobenzylzinc bromide (**26.1**) conducted in tetrahydrofuran using tetrakis triphenylphosphine palladium (0) as catalyst, provided the nitrile **26.2**. Acidic hydroysis of the nitrile **26.2** provided the carboxylic acid derivatives **26.3a** and **26.3b** (compounds **26.3a** and **26.3b** were separated by column chromatography; however, the following step was conducted using the mixture **26.3a / 26.3b**). Treatment of the mixture **26.3a / 26.3b** with methanol in the presence of hydrochloric acid afforded the piperidine esters **26.4a / 26.4b** which were converted to the corresponding Boc derivatives **26.5a / 26.5b** by treatment with *tert*-butyloxycarbonyl anhydride (**4.7**). Hydrolysis of the esters **26.5a / 26.5b** in basic conditions gave the carboxylic acid derivatives **26.6a / 26.6b**. Coupling of the carboxylic acid derivatives **26.6a / 26.6b** with diethylamine (**1.12**) using *O*-benzotriazol-1-yl-*N*,*N*,*N'*,*N'*-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the dimethylaminocarbonyl derivatives **26.7a / 26.7b**. Removal of the Boc protecting group of **26.7a / 26.7b** in dichloromethane at room temperature in the presence of hydrochloric acid (anhydrous solution in dioxane) afforded compounds **26A** and **26.8** which were separated by column chromatography. Palladium catalyzed hydrogenation of compound **26.8** afforded compound **26B.**

The synthesis of compounds **27A-27W** is outlined in Scheme 27. The saturated derivatives (compounds **27A, 27D, 27G, 27H, 27K, 27N,** and **27W**, as their racemic mixtures) were obtained by hydrogenation of the unsaturated analogs (compounds **1A, 1D, 2C, 1N, 1O, 1S,** and **1E**), respectively, in methanol in the presence of palladium, 10 wt.% (dry basis) on activated carbon (method 27A) or palladium hydroxide, 20 wt.% Pd (dry basis) on carbon (Pearlman's catalyst (method 27B)). Hydrogenation of **11.6a** in methanol in the presence of palladium hydroxide, 20 wt.% Pd (dry basis) on carbon (Pearlman's catalyst) provided the saturated derivative **27.1.** Acidic hydrolysis of **27.1** provided compound **27T**. Hydrolysis of **2.7a** in methanol in the presence of palladium, 10 wt.% (dry basis) on activated carbon, provided the saturated derivative **27.6**. Acidic hydrolysis of **27.6** provided the compound **27Q**. Chiral separation of the enantiomers derived from **27.1** provided compounds **27.4** and **27.5**. The enantiomers **27.4** and **27.5** were converted to compounds **27U** and **27V**, respectively under acidic conditions. Chiral separation of

the enantiomers derived from each of the racemic compounds (compounds **27A, 27 D, 27G, 27H, 27K, 27N, 27Q** and **27W**) provided compounds **27B, 27E, 27I, 27L, 27O, 27R** (pure enantiomer) and compounds **27C, 27F, 27J, 27M, 27P, 27S** (pure enantiomer). Condensation of compound **27B** with (1*S*)-(+)-10-camphorsulfonyl chloride (**27.2**) (used as chiral resolving agent) in dichloromethane in the presence of triethylamine provided the chiral sulfonamide derivative **27.3**. The absolute configuration of **27.3** was determined by X-ray crystallography, therefore establishing the absolute configuration of compound **27B**, and therefore by inference, its enantiomer, compound **29C**.

The synthesis of compounds **28A-28E** is outlined in Scheme 28. Condensation of benzyl 4-oxopiperidine-1-carboxylate (**19.1**) with ethyl cyanoacetate (**28.1**) in the presence of acetic acid and ammonium acetate gave the unsaturated ester **28.2**. Compound **28.2** was subjected to conjugate addition by reaction with organo cuprate reagents derived from benzyl or methoxybenzyl magnesium chloride (**28.3a** and **28.3b**, respectively) and copper (I) cyanide to yield the cyano esters **28.4**. Treatment of the conjugate addition product **28.4a** (R^v =H) with concentrated sulfuric acid at 90 °C provided the amino ketone **28.5**. Treatment of **28.5** with benzyl chloroformate (**21.8**) in dichloromethane in the presence of triethylamine provided the corresponding Cbz-protected derivative **28.6a** (R^v =H). Decarboxylation of **28.4b** (R^v =OCH_3) by treatment with sodium chloride in dimethylsulfoxide containing small amount of water at 160°C afforded the nitrile **28.9**. Hydrolysis of the nitrile functionality of **28.9** to the methyl ester group by treatment with methanol in the presence of sulfuric acid provided the corresponding piperidine derivative (Cleavage of the Cbz protecting group of **28.9** occured during the course of the hydrolysis). Treatment of the piperidine derivative with benzyl chloroformate afforded the compound **28.10**. The ester **28.10** was hydrolyzed with lithium hydroxide to furnish the carboxylic acid **28.11**. Treatment of the acid **28.11** with oxalyl chloride followed by reaction of the resulting acyl chloride with aluminum chloride yielded the corresponding spiro piperidine derivative which was further protected as its CBz derivative **28.6b** (R^v =OCH_3) by treatment with benzylchloroformate. Conversion of the ketones **28.6** to the enol triflate derivatives **28.7** was achieved using *N*-

phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivatives **28.7** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the derivatives **28.8** which were converted to the compounds **28A** and **28B** by treatment with iodotrimethylsilane. The compounds **28C** and **28D** (racemic mixtures) were obtained by hydrogenation of unsaturated derivatives **28.8** in methanol in the presence of palladium, 10 wt.% (dry basis) on activated carbon. Suzuki type coupling of the enol triflate derivative **28.7a** (R^V =H) with 2-(*N*,*N*-diethylaminocarbonyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxoborolan-2-yl)pyridine **1.7** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the derivative **28.12** which was converted to the compound **28E** by treatment with iodotrimethylsilane.

The synthesis of compounds **29A-29D** is outlined in Scheme 29. The Negishi coupling of the enol triflate **28.7a** with 4-(ethoxycarbonyl)phenylzinc iodide (**29.1**) in tetrahydrofuran in the presence of tetrakis triphenylphosphine palladium (0) gave the ester **29.2**, which was hydrolyzed with lithium hydroxide to afford the carboxylic acid **29.3**. Coupling of the carboxylic acid **29.3** with *iso*propylamine (**3.4h**) or 1-ethylpropylamine (**29.4**) using 2-chloro-1-methylpyridinium iodide (Mukaiyama acylating reagent) as coupling agent afforded the secondary aminocarbonyl derivatives **29.5**, which were converted to the compounds **29A** and **29B** by treatment with iodotrimethylsilane. Curtius rearrangement of the carboxylic acid **29.3** by reaction with diphenylphosphoryl azide (**29.6**) in the presence of *tert*-butyl alcohol provided the *tert*-butyloxycarbonyl (Boc) protected aniline derivative **29.7**. Acidic hydrolysis of **29.7** provided the aniline derivative **29.8** which reacted with propionyl chloride **29.9** or methanesulfonyl chloride (**7.4**) to give the corresponding amide derivative **29.10** or sulfonamide derivative **29.11**, respectively. The derivatives **29.10** and **29.11** were converted to compounds **29C** and **29D**, respectively, by treatment with iodotrimethylsilane.

The synthesis of compound **30A** is outlined in Scheme 30. Wittig type condensation of 1-benzoyl-4-piperidone (**30.1**) with methyl(triphenylphosphoranylidene)acetate (**30.2**) in toluene gave the unsaturated ester **30.3**. Compound **30.3** was subjected to conjugate addition by reaction with benzenethiol (**30.4**) to yield the thioether **30.5**. Treatment of the conjugate addition product **30.5** with concentrated sulfuric acid provided the cyclized product **30.6**, which was converted to the sulfone **30.7** by oxidation using a solution of hydrogen peroxide in glacial acetic acid. Acidic hydrolysis of **30.7** provided the amine **30.8**, which was treated with *tert*-butyloxycarbonyl anhydride (**4.7**) to give the Boc protected derivative **30.9**. Conversion of the ketone **30.9** to the enol triflate derivative **30.10** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **30.10** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the derivative **30.11** which was converted to compound **30A** under acidic conditions.

The synthesis of compounds **31A-31AA** is outlined in Scheme 31. Suzuki type coupling of the enol triflate derivative **1.5a** with the commercially available boronic acid derivatives **13.1**, **14.1**, **16.1** or **31.1a-31.1u** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded compounds **13.2**, **14.2**, **16.2** and **31.2**, respectively. Compounds **13.2**, **14.2**, **16.2** and **31.2** were converted to the final products compounds **31A-31X** under acidic conditions (method 1E: anhydrous HCl, diethyl ether, room temperature or method 1F: neat trifluoroacetic acid (with optional dichloromethane), room temperature or method 31A: anhydrous HCl, methanol, dioxane, reflux). Treatment of the nitrile **16.2** with lithium aluminum hydride in tetrahydrofuran provided the diamine compound **31Y**, which reacted with acetyl chloride (**6.7**) or methanesulfonyl chloride (**7.4**) to give the corresponding amide derivative compounds **31Z** or the sulfonamide derivative compound **31AA**, respectively.

The synthesis of compounds **32A-32Z** is outlined in Scheme 32. Conversion of the enol triflate **1.5a** to the corresponding boron derivative **32.1** was achieved using 4,4,5,5-tetramethyl-2-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1,3,2-dioxaborolane **1.14** and dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II) dichloromethane adduct, abbreviated as [Pd(dppf)Cl_2•CH_2Cl_2]. Suzuki type coupling of the boronate derivative **32.1** with various aryl bromide derivatives **32.2** under different conditions [method 1C: ethylene glycol dimethyl ether, tetrakis triphenylphosphine palladium (0), lithium chloride, aqueous solution of sodium carbonate; method 1D: ethylene glycol dimethyl ether, palladium, 10 wt.% (dry basis) on activated carbon, lithium chloride, aqueous solution of sodium carbonate; method 12A: tetrakis triphenylphosphine palladium (0), potassium bromide, potassium phosphate, dioxane] afforded the derivatives **32.3**, which were converted to compounds **32A-32I** or **32K-32Z** under acidic conditions. The *tert*-butyl sulfonamide derivative compound **32.3b** was converted to the sulfonamide compound **32J** by treatment with trifluoroacetic acid. The derivatives **32.2** used in the Suzuki coupling step were prepared as follows. Coupling of the carboxylic acid **32.4** with diethylamine (**1.12**) using 2-chloro-1-methylpyridinium iodide (Mukaiyama acylating reagent) as coupling agent afforded 2-(4-bromophenyl)-*N*,*N*-diethylacetamide (**32.2a**). The sulfone derivatives **32.2j-32.2p** were obtained in two steps from 4-bromobenzenethiol (**32.7**). Alkylation of **32.7** with the alkyl bromide derivatives **20.2**, **2.8** or **32.8** in acetonitrile in the presence of triethylamine (method 32A) or in *N*,*N*-dimethylformamide in the presence of sodium hydride (method 32B) provided the thioether derivatives **32.9**, which were oxidized to the sulfone derivatives **32.2j-32.2p** in glacial acetic acid in the presence of an aqueous solution of hydrogen peroxide. Coupling of 4-bromobenzene-1-sulfonyl chloride (**32.5**) with various amines (**3.4**, **1.12**, **13.4** or **32.6**) in tetrahydrofuran in the presence of triethylamine provided the sulfonamides **32.2b-32.2i**. Acylation of *N*-methyl-4-bromoaniline (**32.10**) with various acyl chloride derivatives (**19.8**, **32.11** or **6.7**) in dichloromethane in the presence of triethylamine provided the amides **32.2q-32.2u**, **32.2x**, **32.2y**. The aryl bromides **32.2v** and **32.2w** are commercially available.

The synthesis of compounds **33A-33L** is outlined in Scheme 33. Suzuki type coupling of the boronate derivative **32.1** with various aryl bromide derivatives **33.1**

under different conditions [method 1C: ethylene glycol dimethyl ether, tetrakis triphenylphosphine palladium (0), lithium chloride, aqueous solution of sodium carbonate; method 1D: ethylene glycol dimethyl ether, palladium, 10 wt.% (dry basis) on activated carbon, lithium chloride, aqueous solution of sodium carbonate; method 33A: ethylene glycol dimethyl ether, dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II) dichloromethane adduct, abbreviated as [$Pd(dppf)Cl_2 \cdot CH_2Cl_2$], lithium chloride, potassium phosphate] afforded the derivatives **33.2**, which were converted to compounds **33A-33K** under acidic conditions. The derivatives **33.1** used in the Suzuki coupling step were either obtained from commercial sources (**33.1 a-e**) or prepared as follows. Coupling of 5-bromopyridine-3-carboxylic acid (**33.3**) or 6-bromopyridine-2-carboxylic acid (**33.4**) with diethylamine (**1.12**) using *O*-benzotriazol-1-yl-*N*,*N*,*N*',*N*'-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the diethylaminocarbonyl derivative derivatives **33.1f** and **33.1**g, respectively. Treatment of 2,5-dibromopyridine (**1.9**) with *n*-butyllithium provided the corresponding lithiated derivative, which reacted with carbon dioxide to provide 5-bromopyridine-2-carboxylic acid **1.10**. The carboxylic acid **1.10** was also obtained by acidic hydrolysis of commercially available 5-bromopyridine-2-carbonitrile (**33.1e**). Treatment of the carboxylic acid derivative **1.10** with oxalyl chloride furnished the acyl chloride **1.11**, which reacted with dimethylamine (**3.4j**), ethylamine (**3.4c**) or methylamine (**3.4b**) to provide the corresponding aminocarbonyl derivatives **33.1h**, **33.1i** and **33.1j**, respectively. Treatment of commercially available 5-bromo-2-iodopyrimidine (**33.5**) with *n*-butyllithium provided the corresponding lithiated derivative, which reacted with carbon dioxide to provide 5-bromopyrimidine-2-carboxylic acid (**33.6**). Treatment of the carboxylic acid derivative **33.6** with oxalyl chloride furnished the acyl chloride **33.7**, which reacted with diethylamine **1.12** to provide 5-bromo-2-(*N*,*N*-diethylaminoarbonyl)-pyrimidine **33.1k**.

Hydrolysis of the nitrile derivative **33.2a** under acidic conditions provided the carboxylic acid derivative compound **33E** and compound **33L**. Compound **33E** and compound **33L** were readily separated by column chromatography.

The synthesis of compounds **34A-34P** is outlined in Scheme 34. Suzuki type coupling of the boronate derivative **32.1** with various aryl bromide derivatives **34.1** in

ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded compounds **34.2** which were converted to the final products compounds **34A-34P** under acidic conditions. The derivatives **34.1** used in the Suzuki coupling step were prepared as follow. Coupling of 6-bromopyridine-3-carboxylic acid (**34.3**), 5-bromothiophene-2-carboxylic acid (**34.4**), 4-bromothiophene-2-carboxylic acid (**34.7**) or 5-bromofuran-2-carboxylic acid (**34.6**) with diethylamine (**1.12**) or diisopropylamine (**3.4o**) using *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the diethylaminocarbonyl derivatives **34.1 a-d, f-i**. Coupling of 5-bromothiophene-2-sulfonyl chloride (**34.5**) with diethylamine (**1.12**) in acetonitrile in the presence of triethylamine provided the sulfonamide **34.1e**. Coupling of the commercially available carboxylic acid derivatives **34.8a-34.8f** and **34.9** with diethylamine (**1.12**) using *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the corresponding diethylaminocarbonyl derivatives **34.1j-34.1 o** and **34.1p**.

The synthesis of compounds **35A** and **35B** is outlined in Scheme 35. Iodination of 3-hydroxybenzoic acid (**35.1**) afforded 3-hydroxy-4-iodobenzoic acid (**35.2**), which was converted to the methyl ester **35.3** under standard esterification conditions. Alkylation of the phenolic derivative **35.3** with methyl iodide (**2.8c**) in acetone in the presence of potassium carbonate afforded the methyl ether **35.4**, which was converted to the carboxylic acid **35.5** in the presence of lithium hydroxide. Coupling of the carboxylic acid derivatives **35.5** with diethylamine (**1.12**) using *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (TBTU) as coupling agent afforded the corresponding diethylaminocarbonyl derivative **35.6**. Demethylation of **35.6** using boron tribromide afforded the phenolic derivative **35.7** which was converted to the methyloxymethyl (MOM) ether derivative **35.8** using chloro(methoxy)methane **11.3**. Suzuki type coupling of the boronate derivative **32.1** with **35.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded compound **35.9** which was converted to the final product compound **35A** under acidic conditions. Suzuki type coupling of the boronate derivative **32.1** with **35.8** in ethylene glycol dimethyl ether in the presence of

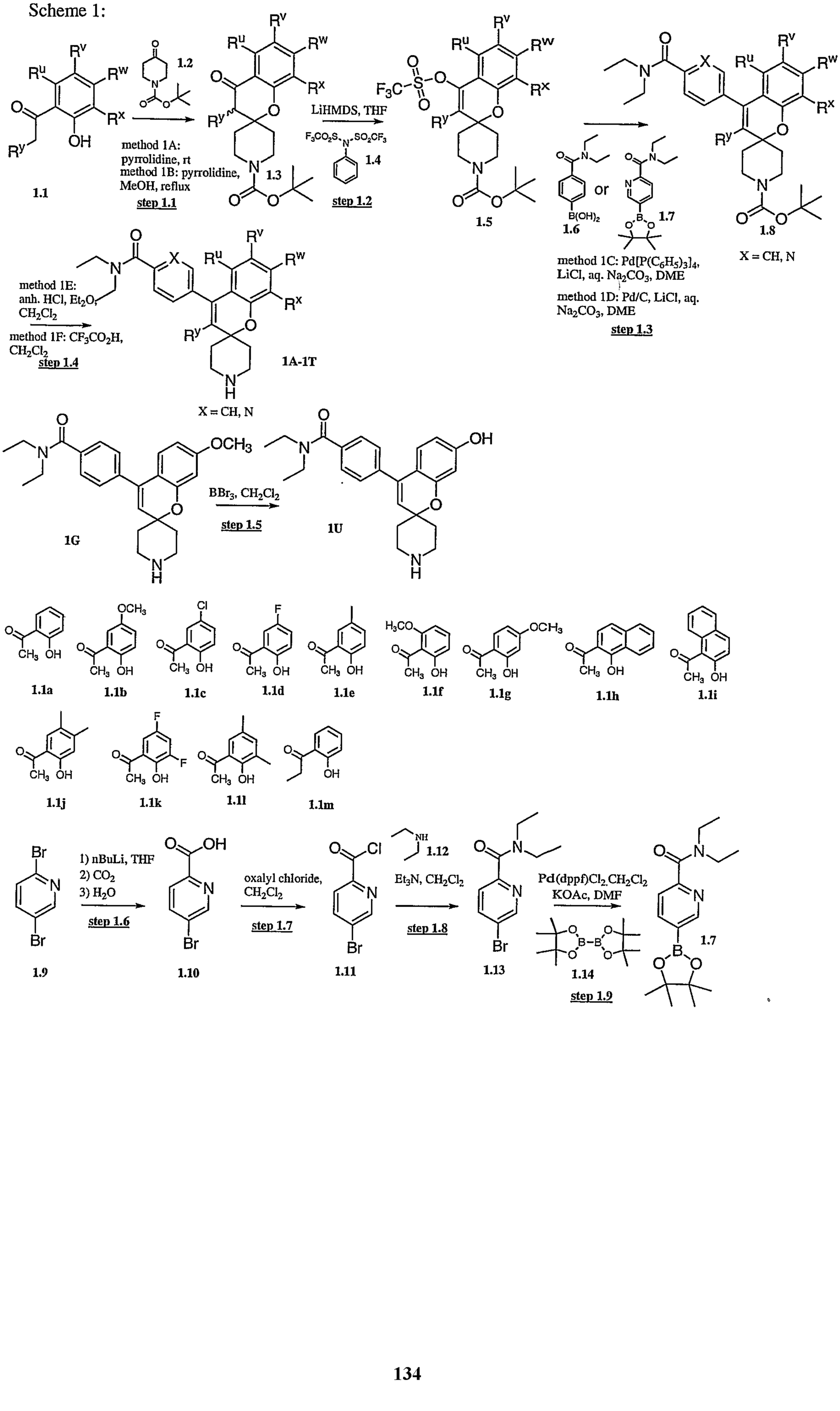
palladium, 10 wt.% (dry basis) on activated carbon, lithium chloride, and an aqueous solution of sodium carbonate afforded compound **35.10** which was converted to the final product compound **35B** under acidic conditions.

The synthesis of compounds **36A** and **36B** is outlined in Scheme 36. Coupling of 4-bromo-2-hydroxybenzoic acid (**36.3**) [obtained from 4-amino-2-hydroxybenzoic acid (**36.1**) under Sandmeyer conditions] with diethylamine (**1.12**) using *O*-(7-azabenzotriazol-1-yl)-*N*,*N*,*N*',*N*'-tetramethyluronium hexafluorophosphate (HATU) as coupling agent afforded the corresponding diethylaminocarbonyl derivative **36.4**. Suzuki type coupling of the boronate derivative **32.1** with **36.4** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded compound **36.5** which was converted to the final product (compound **36A**) under acidic conditions. Compound **36B** was obtained in 7 steps from 2-(3-methoxyphenyl)ethanamine (**36.6**). Coupling of **36.6** with ethyl chloroformate (**36.7**) afforded the ethyl carbamate derivative **36.8** which was cyclized to 3,4-dihydro-6-methoxyisoquinolin-1-(*2H*)-one (**36.9**) in the presence of polyphosphoric acid. Alkylation of **36.9** with ethyl iodide (**36.10**) in tetrahydrofuran in the presence of sodium hydride, afforded the methyl ether **36.11**, which was converted to the phenolic derivative **36.12** by treatment with boron tribromide. Condensation of **36.12** with trifluoromethanesulfonic anhydride (**36.13**) in dichloromethane in the presence of pyridine afforded the triflate derivative **36.14**. Suzuki type coupling of the boronate derivative **32.1** with **36.14** in *N*,*N*-dimethylformamide in the presence of dichloro[1,1'-bis(diphenylphosphino)ferrocene]palladium(II) dichloromethane adduct, abbreviated as [$Pd(dppf)Cl_2 \cdot CH_2Cl_2$], and potassium acetate afforded compound **36.15** which was converted to the final product (compound **36B**) under acidic conditions.

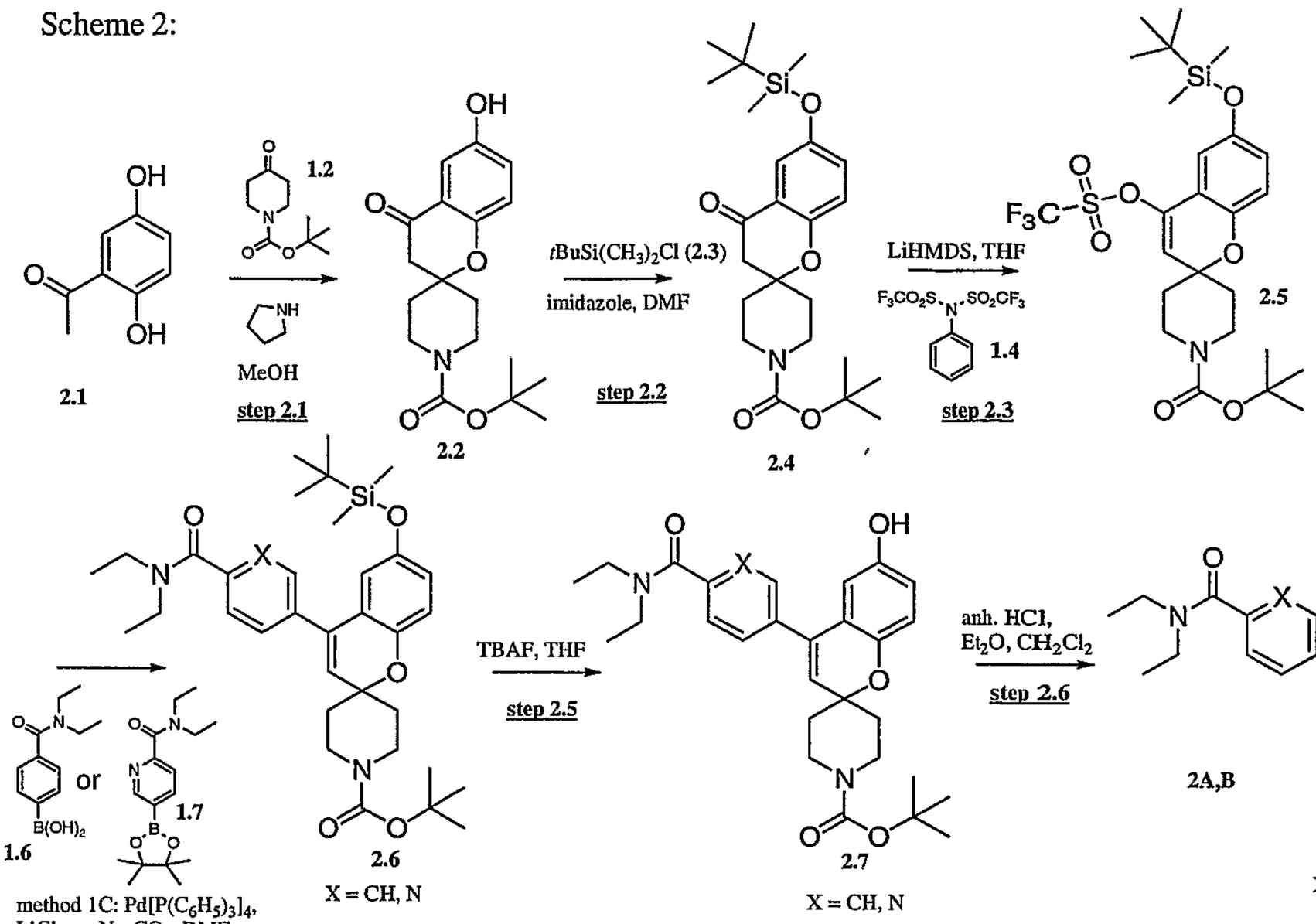
The synthesis of compounds **37A-37B** is outlined in Scheme 37. The 2'-hydroxyacetophenone **1.1a** was condensed with 1-benzyl-3-methylpiperidin-4-one (**37.1**) (racemic mixture) in refluxing methanol in the presence of pyrrolidine to provide the racemic ketones **37.2** and **37.3**. The diastereoisomers **37.2** and **37.3** were separated by column chromatography. Palladium catalyzed hydrogenation of **37.2** afforded the piperidine derivative **37.4**, which was converted to **37.5** by treatment

with *tert*-butyloxycarbonyl anhydride (**4.7**). Conversion of the ketone **37.5** to the enol triflate derivative **37.6** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **37.6** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the Boc derivative **37.7,** which was converted to the final product compound **37A** (racemic mixture) under acidic conditions. Similarly, palladium catalyzed hydrogenation of **37.3** afforded the piperidine derivative **37.8**, which was converted to **37.9** by treatment with *tert*-butyloxycarbonyl anhydride (**4.7**). Conversion of the ketone **37.9** to the enol triflate derivative **37.10** was achieved using *N*-phenylbis(trifluoromethanesulphonimide) **1.4** as triflating reagent. Suzuki type coupling of the enol triflate derivative **37.10** with 4-(*N*,*N*-diethylaminocarbonyl)phenyl boronic acid **1.6** in ethylene glycol dimethyl ether in the presence of tetrakis triphenylphosphine palladium (0), lithium chloride, and an aqueous solution of sodium carbonate afforded the Boc derivative **37.11,** which was converted to the final product compound **37B** (racemic mixture) under acidic conditions.

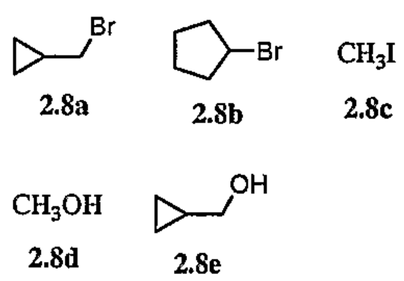
Scheme 1:


1.2
method 1A: pyrrolidine, rt
method 1B: pyrrolidine, MeOH, reflux
step 1.1
1.1
1.3
LiHMDS, THF
1.4
step 1.2
1.5
1.6
or
1.7
1.8
X = CH, N
method 1C: Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
method 1D: Pd/C, LiCl, aq. Na2CO3, DME
step 1.3
method 1E: anh. HCl, Et2O, CH2Cl2
method 1F: CF3CO2H, CH2Cl2
step 1.4
1A-1T
X = CH, N
1G
BBr3, CH2Cl2
step 1.5
1U
1.1a
1.1b
1.1c
1.1d
1.1e
1.1f
1.1g
1.1h
1.1i
1.1j
1.1k
1.1l
1.1m
1) nBuLi, THF
2) CO2
3) H2O
step 1.6
1.9
1.10
oxalyl chloride, CH2Cl2
step 1.7
1.11
1.12
Et3N, CH2Cl2
step 1.8
1.13
Pd(dppf)Cl2.CH2Cl2
KOAc, DMF
1.14
step 1.9
1.7

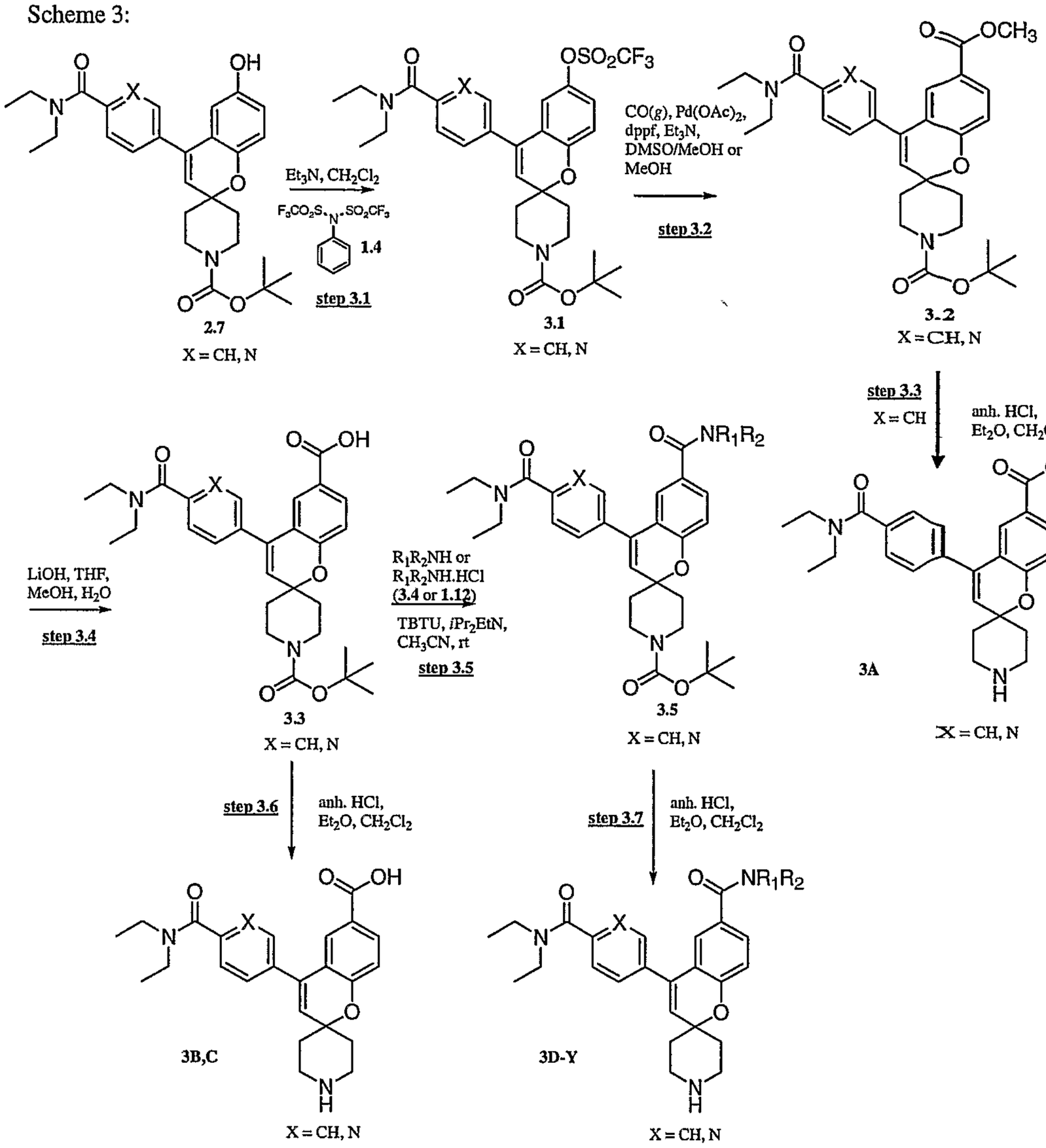
Scheme 2:



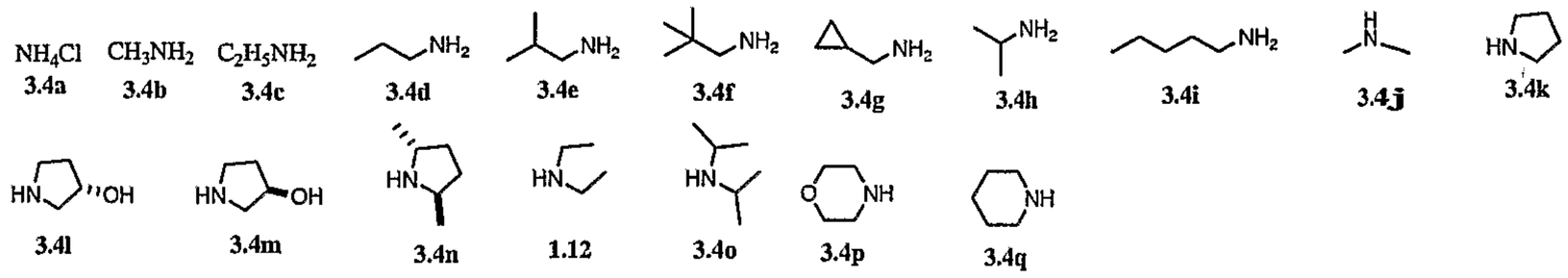
RX or ROH used in step 2.7:

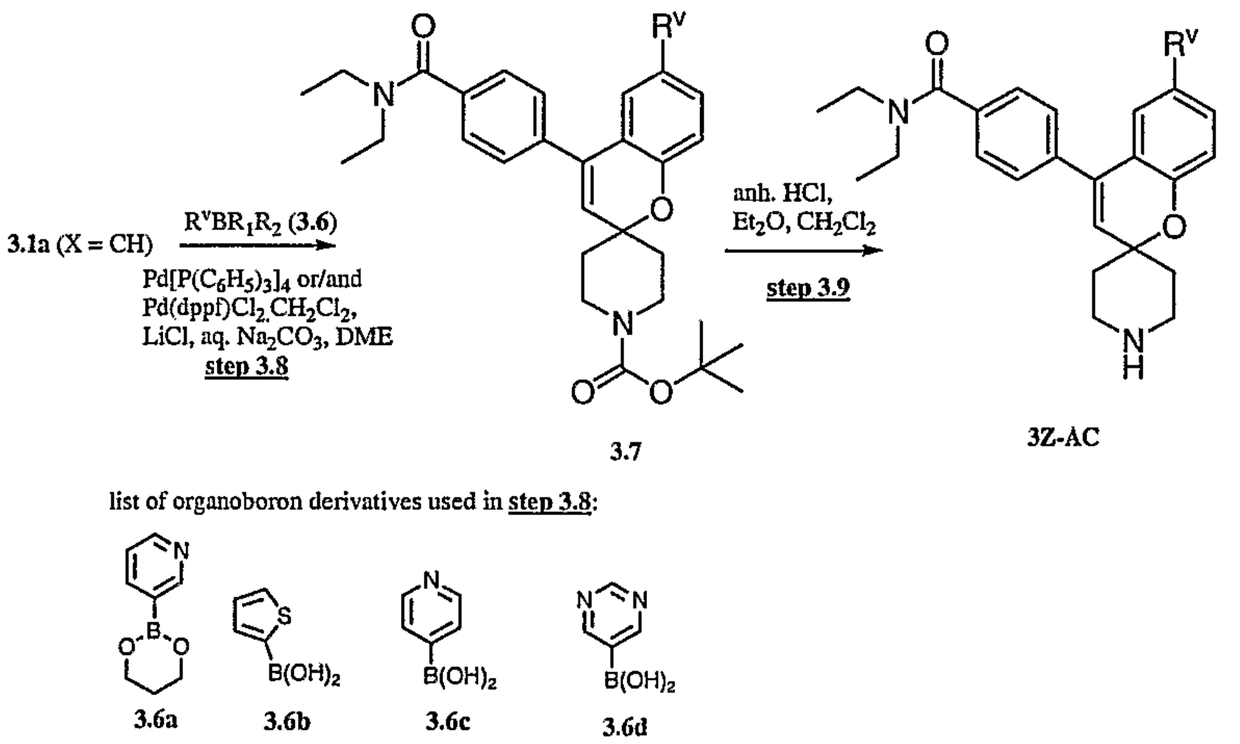


Scheme 3:



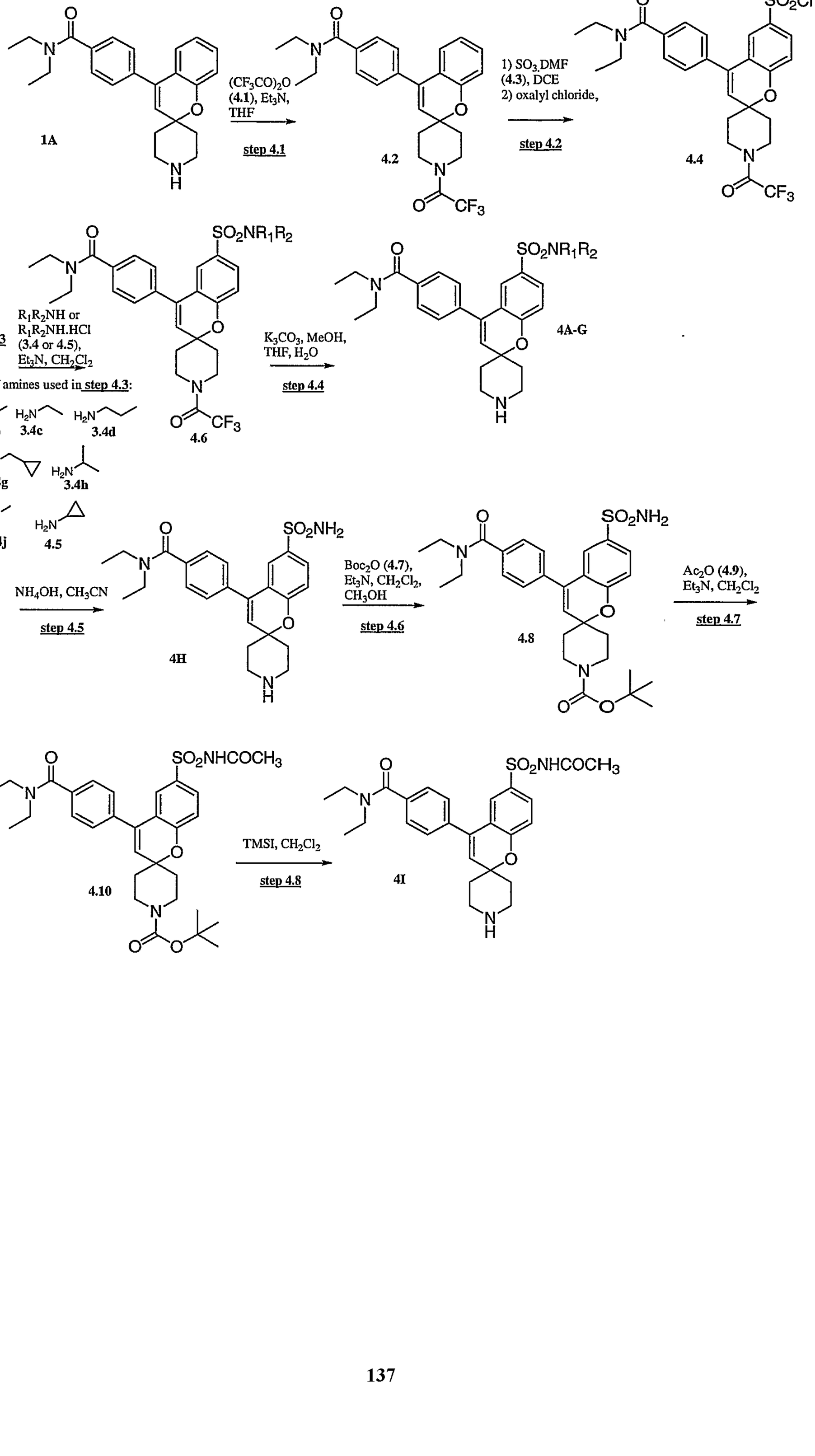
list of amines used in step 3.5:



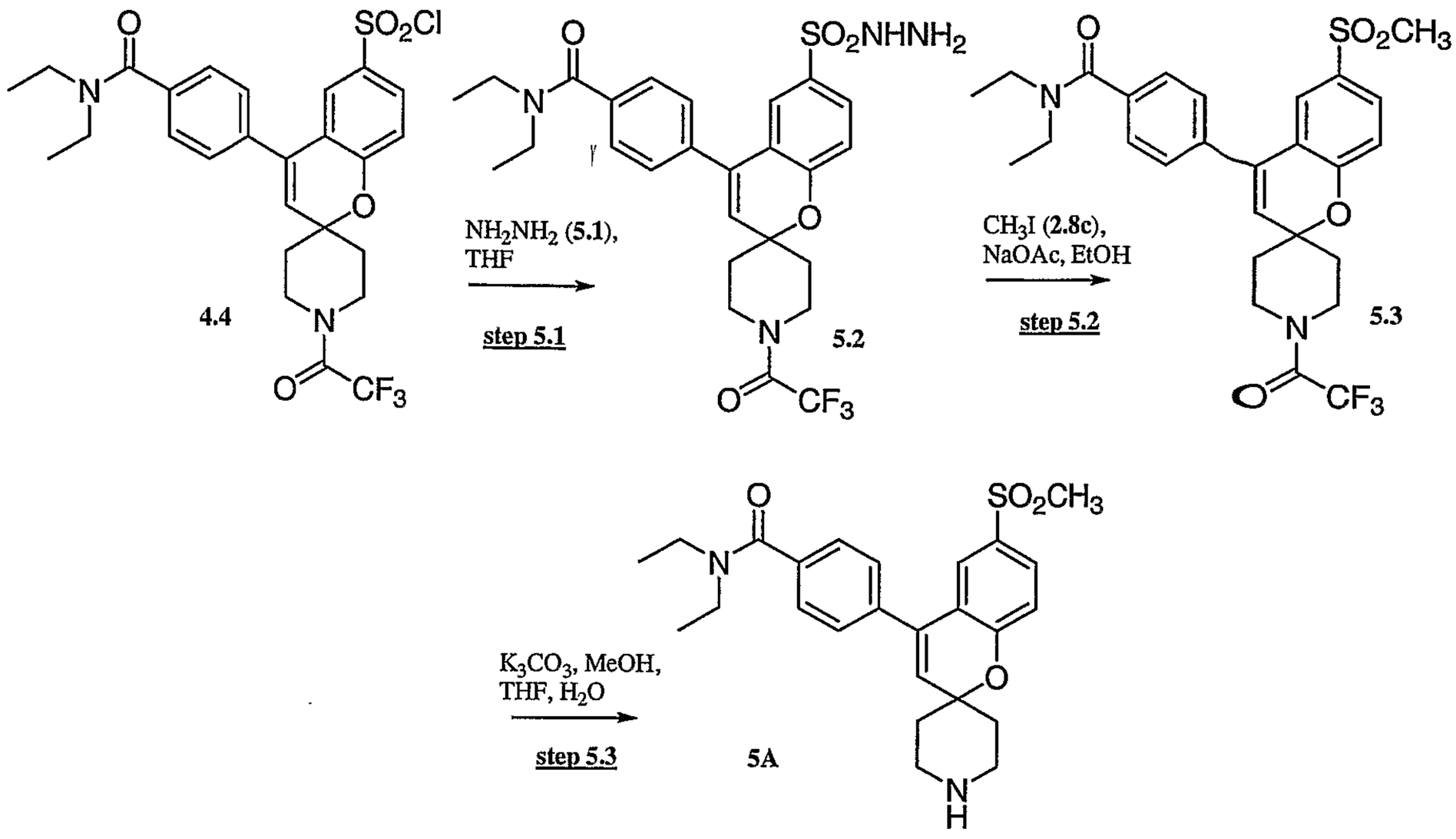


list of organoboron derivatives used in step 3.8:

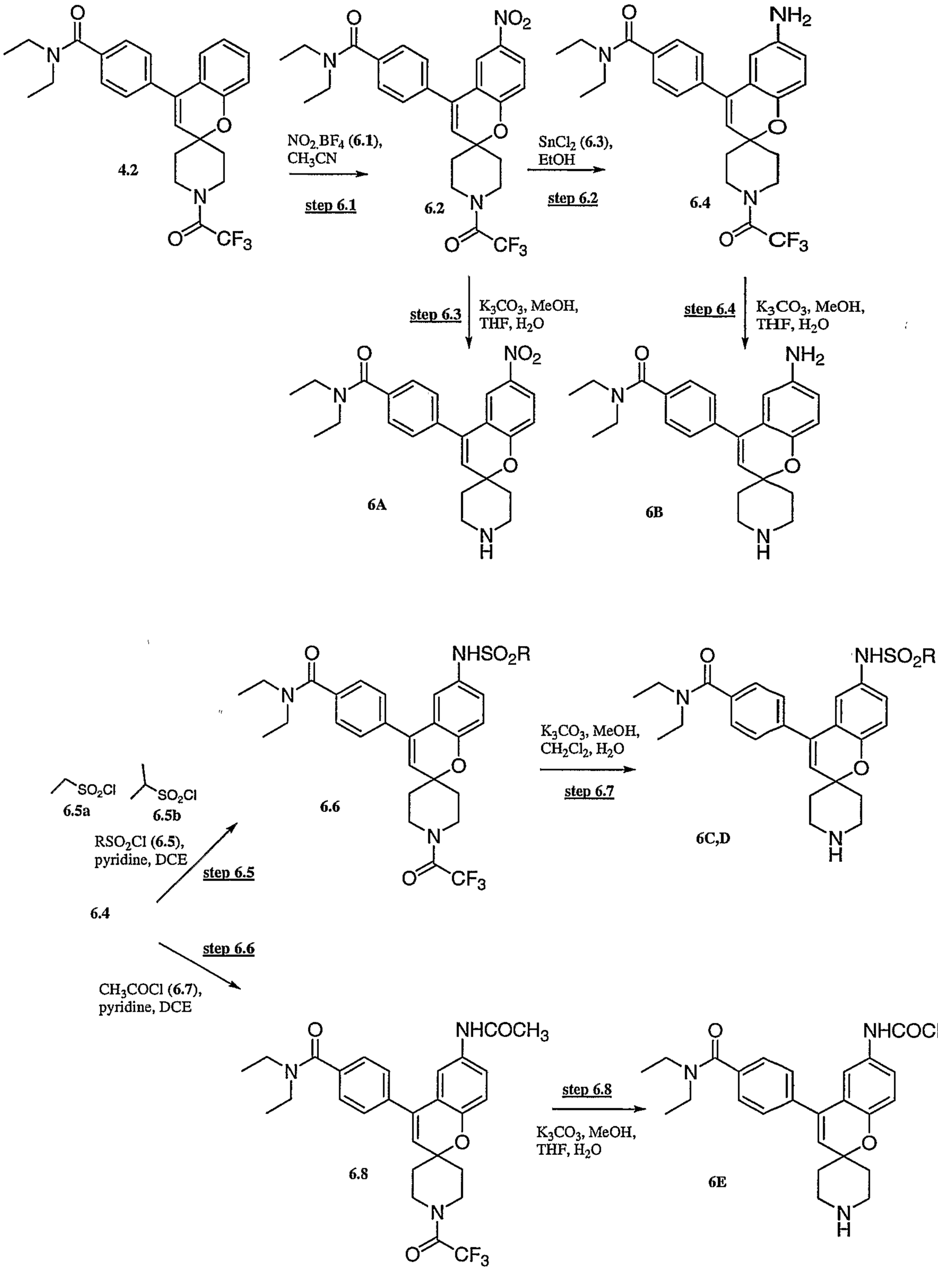
Scheme 4:


1A
(CF3CO)2O
(4.1), Et3N,
THF
step 4.1
4.2
1) SO3, DMF
(4.3), DCE
2) oxalyl chloride,
step 4.2
4.4
SO2Cl
step 4.3
R1R2NH or
R1R2NH.HCl
(3.4 or 4.5),
Et3N, CH2Cl2
4.6
SO2NR1R2
K2CO3, MeOH,
THF, H2O
step 4.4
4A-G
list of amines used in step 4.3:
3.4b
3.4c
3.4d
3.4g
3.4h
3.4j
4.5
4.4
NH4OH, CH3CN
step 4.5
4H
SO2NH2
Boc2O (4.7),
Et3N, CH2Cl2,
CH3OH
step 4.6
4.8
Ac2O (4.9),
Et3N, CH2Cl2
step 4.7
4.10
SO2NHCOCH3
TMSI, CH2Cl2
step 4.8
4I

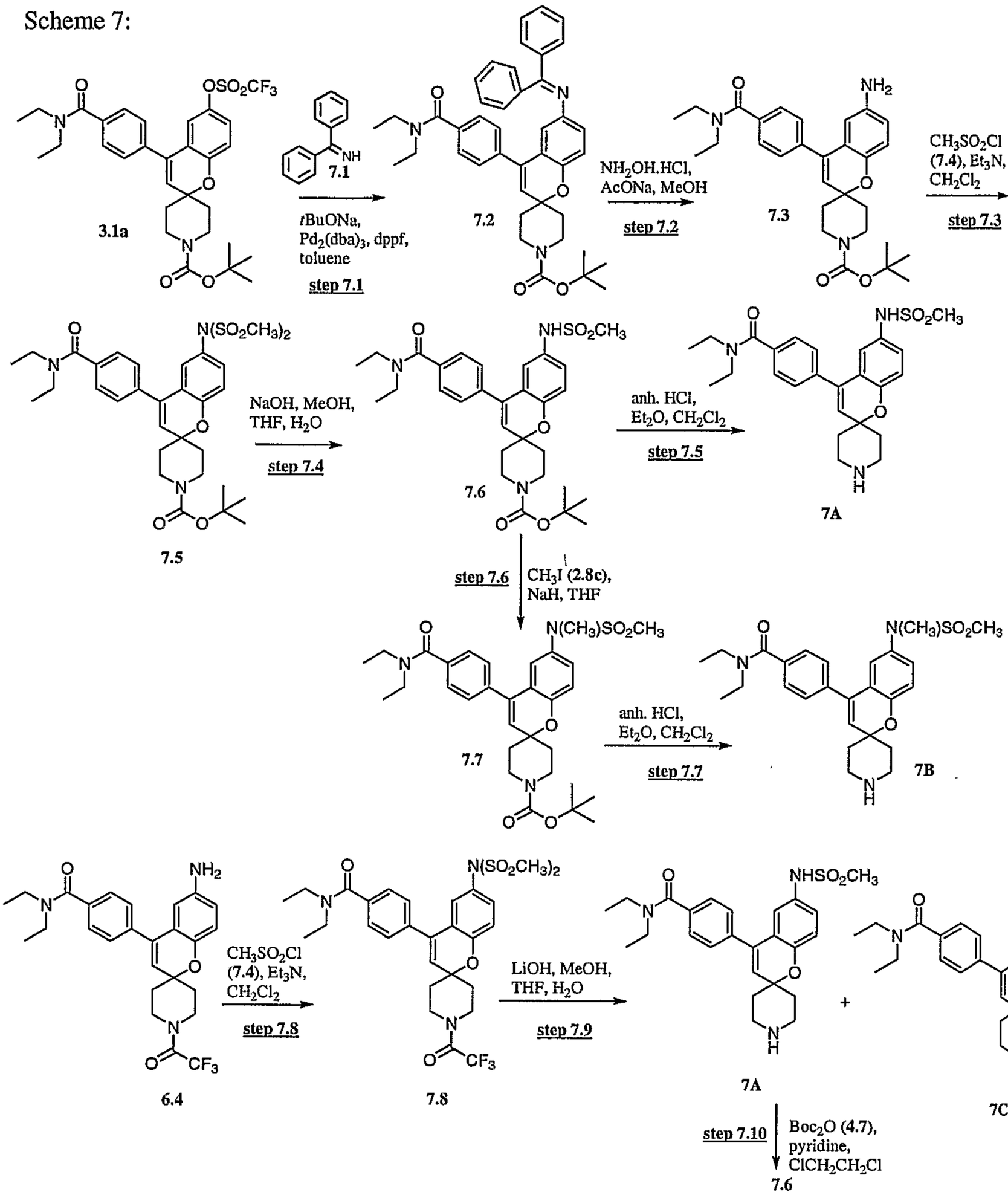
Scheme 5:


SO2Cl
4.4
NH2NH2 (5.1),
THF
step 5.1
SO2NHNH2
5.2
CH3I (2.8c),
NaOAc, EtOH
step 5.2
SO2CH3
5.3
K3CO3, MeOH,
THF, H2O
step 5.3
5A

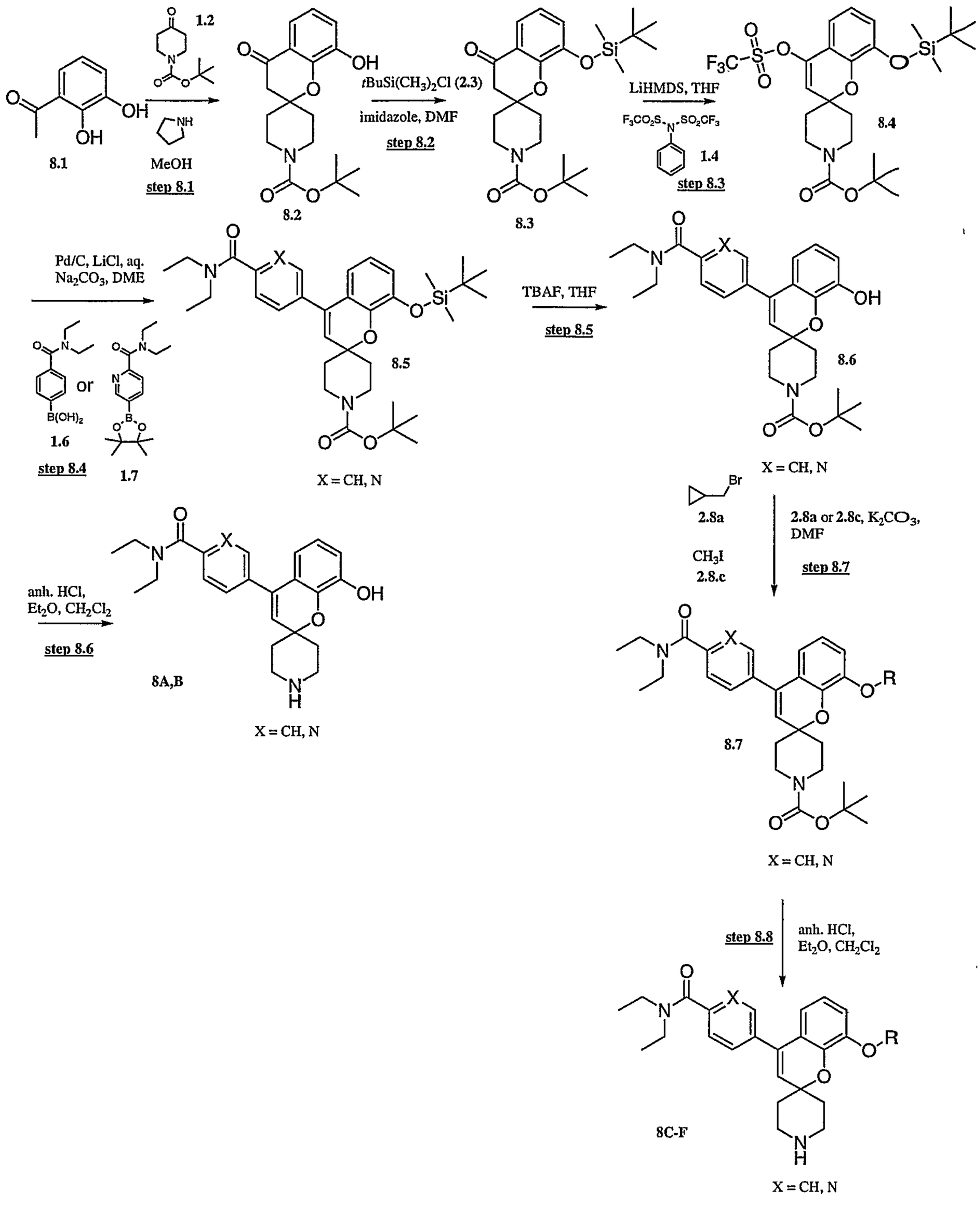
Scheme 6:


4.2
NO_2BF_4 (6.1), CH_3CN
step 6.1
6.2
$SnCl_2$ (6.3), EtOH
step 6.2
6.4
step 6.3
K_3CO_3, MeOH, THF, H_2O
step 6.4
K_3CO_3, MeOH, THF, H_2O
6A
6B
SO_2Cl
6.5a
SO_2Cl
6.5b
RSO_2Cl (6.5), pyridine, DCE
step 6.5
6.6
K_3CO_3, MeOH, CH_2Cl_2, H_2O
step 6.7
6C,D
step 6.6
CH_3COCl (6.7), pyridine, DCE
6.8
step 6.8
K_3CO_3, MeOH, THF, H_2O
6E

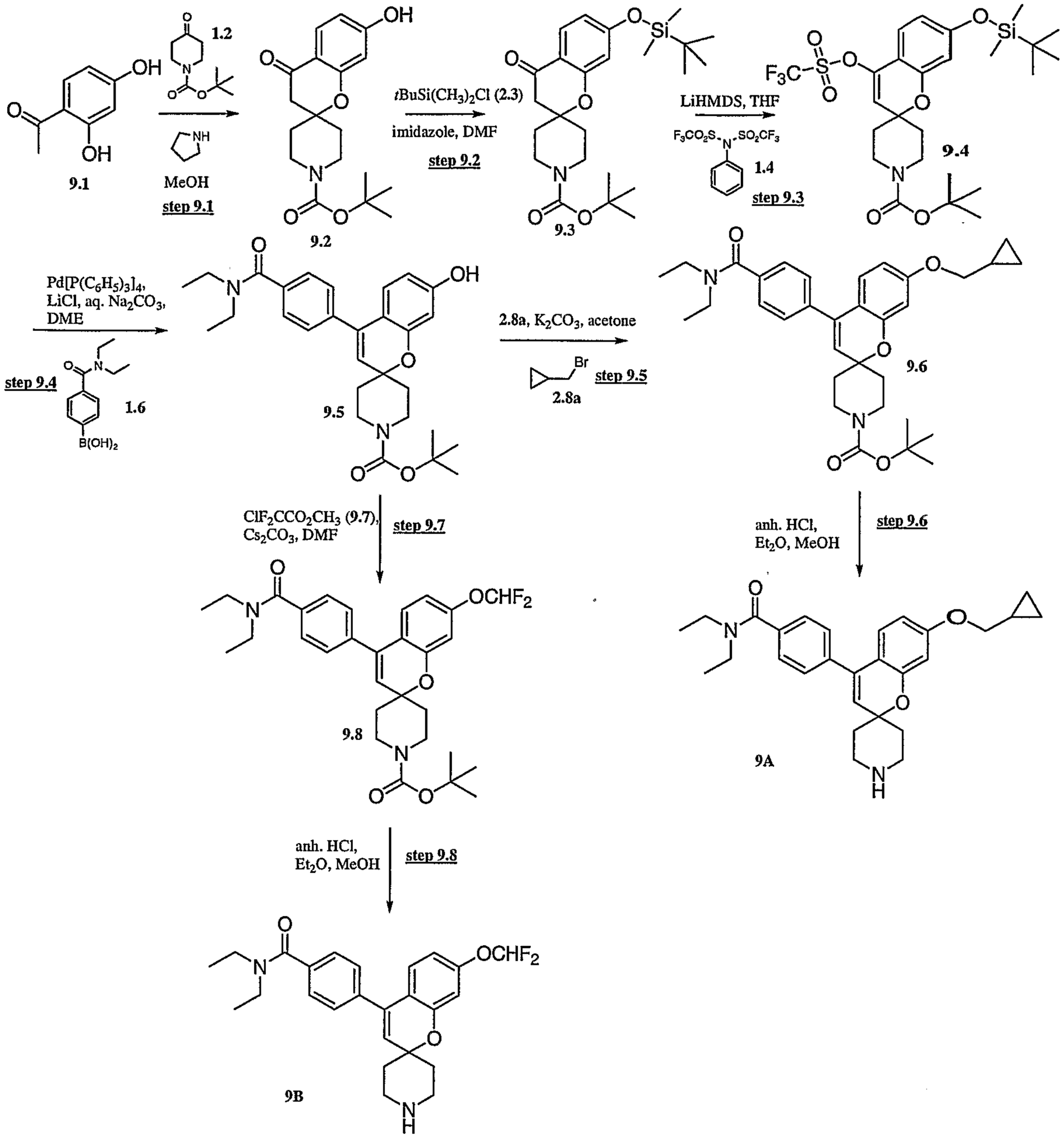
Scheme 7:


3.1a
7.1
tBuONa, Pd2(dba)3, dppf, toluene
step 7.1
7.2
NH2OH.HCl, AcONa, MeOH
step 7.2
7.3
CH3SO2Cl (7.4), Et3N, CH2Cl2
step 7.3
7.5
NaOH, MeOH, THF, H2O
step 7.4
7.6
anh. HCl, Et2O, CH2Cl2
step 7.5
7A
step 7.6
CH3I (2.8c), NaH, THF
7.7
anh. HCl, Et2O, CH2Cl2
step 7.7
7B
6.4
CH3SO2Cl (7.4), Et3N, CH2Cl2
step 7.8
7.8
LiOH, MeOH, THF, H2O
step 7.9
7A
7C
step 7.10
Boc2O (4.7), pyridine, ClCH2CH2Cl
7.6

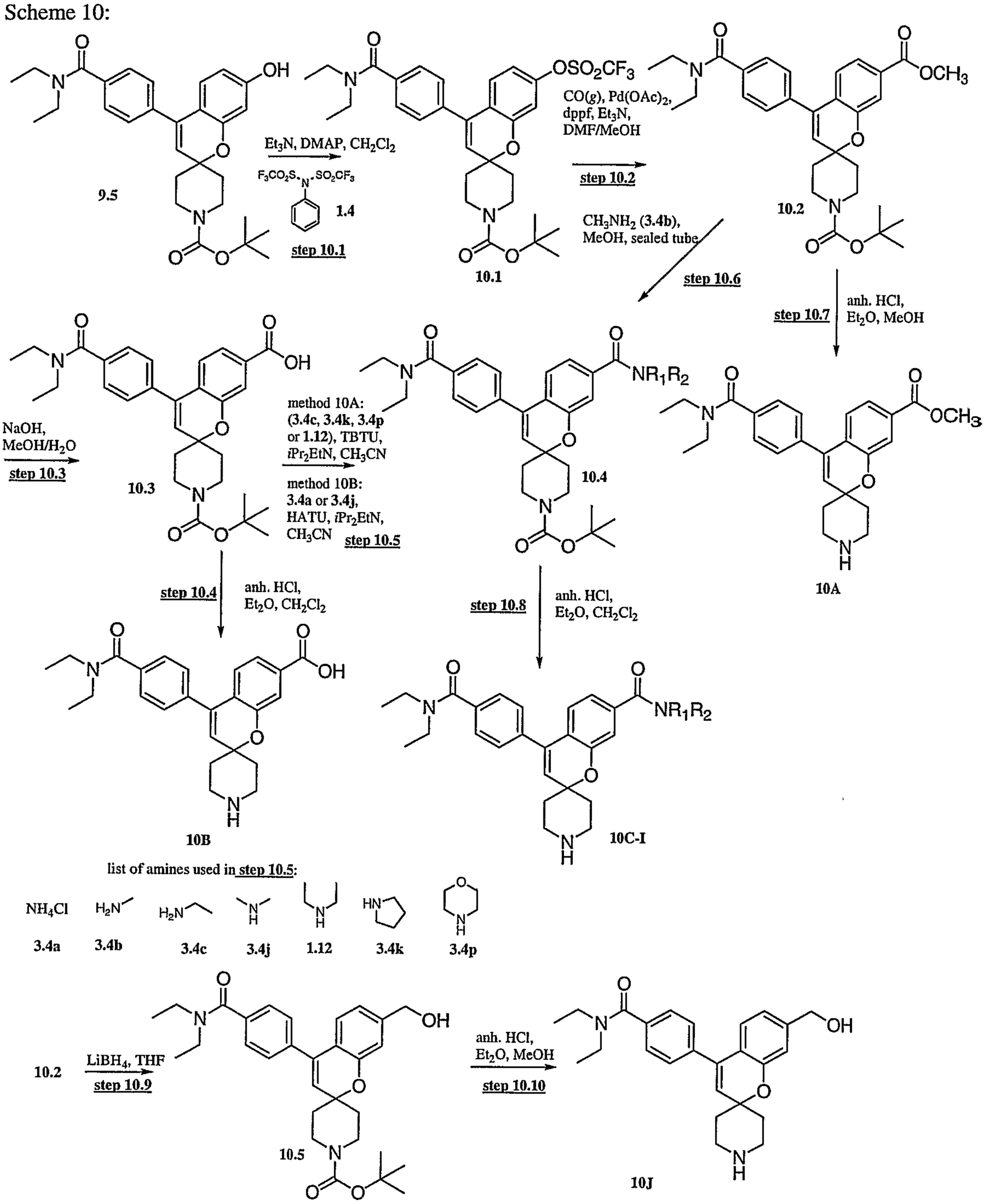
Scheme 8:


1.2
8.1
MeOH
step 8.1
8.2
tBuSi(CH3)2Cl (2.3)
imidazole, DMF
step 8.2
8.3
LiHMDS, THF
F3CO2S-N-SO2CF3
1.4
step 8.3
8.4
Pd/C, LiCl, aq.
Na2CO3, DME
or
B(OH)2
1.6
step 8.4
1.7
8.5
X = CH, N
TBAF, THF
step 8.5
8.6
X = CH, N
anh. HCl,
Et2O, CH2Cl2
step 8.6
8A,B
X = CH, N
Br
2.8a
CH3I
2.8.c
2.8a or 2.8c, K2CO3,
DMF
step 8.7
8.7
X = CH, N
step 8.8
anh. HCl,
Et2O, CH2Cl2
8C-F
X = CH, N

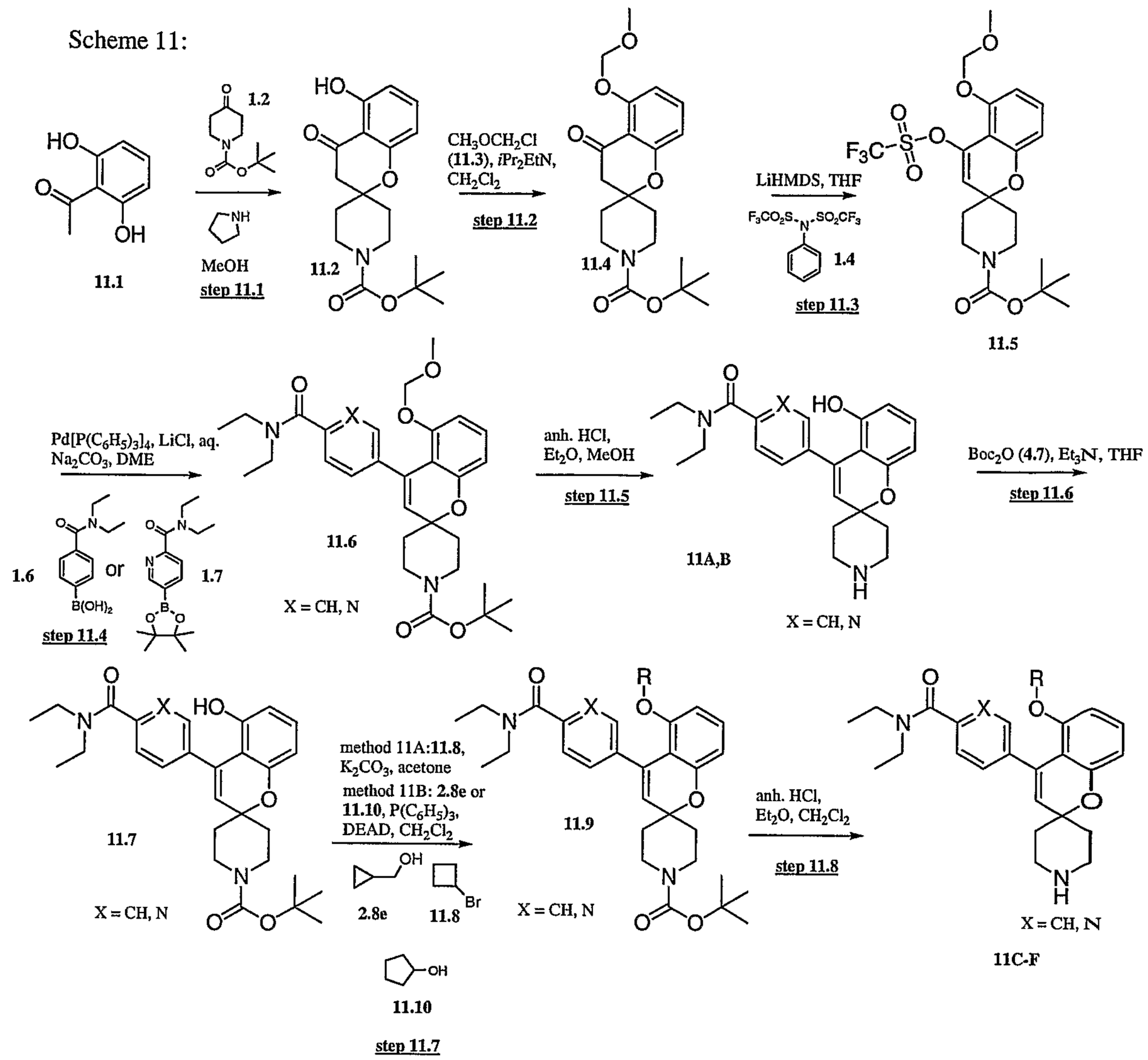
Scheme 9:


1.2
9.1
MeOH
step 9.1
9.2
tBuSi(CH3)2Cl (2.3)
imidazole, DMF
step 9.2
9.3
LiHMDS, THF
F3CO2S-N-SO2CF3
1.4
step 9.3
9.4
Pd[P(C6H5)3]4,
LiCl, aq. Na2CO3,
DME
step 9.4
1.6
B(OH)2
9.5
2.8a, K2CO3, acetone
2.8a
step 9.5
9.6
ClF2CCO2CH3 (9.7),
Cs2CO3, DMF
step 9.7
9.8
anh. HCl,
Et2O, MeOH
step 9.6
9A
anh. HCl,
Et2O, MeOH
step 9.8
9B

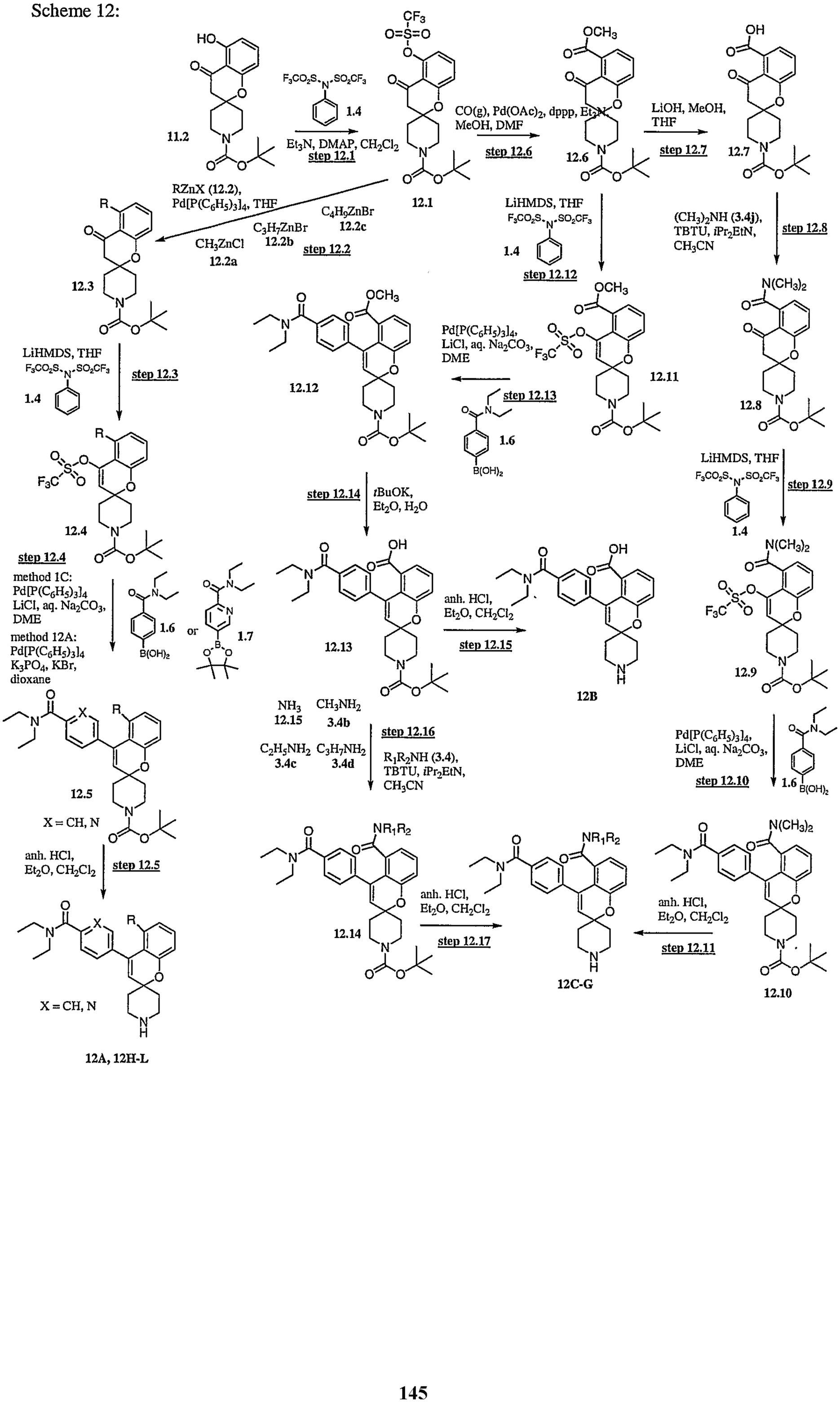
Scheme 10:


9.5
Et3N, DMAP, CH2Cl2
F3CO2S, N, SO2CF3
1.4
step 10.1
10.1
OSO2CF3
CO(g), Pd(OAc)2, dppf, Et3N, DMF/MeOH
step 10.2
10.2
CH3NH2 (3.4b), MeOH, sealed tube
step 10.6
step 10.7
anh. HCl, Et2O, MeOH
10A
NaOH, MeOH/H2O
step 10.3
10.3
method 10A: (3.4c, 3.4k, 3.4p or 1.12), TBTU, iPr2EtN, CH3CN
method 10B: 3.4a or 3.4j, HATU, iPr2EtN, CH3CN
step 10.5
10.4
step 10.4
anh. HCl, Et2O, CH2Cl2
10B
step 10.8
anh. HCl, Et2O, CH2Cl2
10C-I
list of amines used in step 10.5:
NH4Cl
3.4a
3.4b
3.4c
3.4j
1.12
3.4k
3.4p
10.2
LiBH4, THF
step 10.9
10.5
anh. HCl, Et2O, MeOH
step 10.10
10J

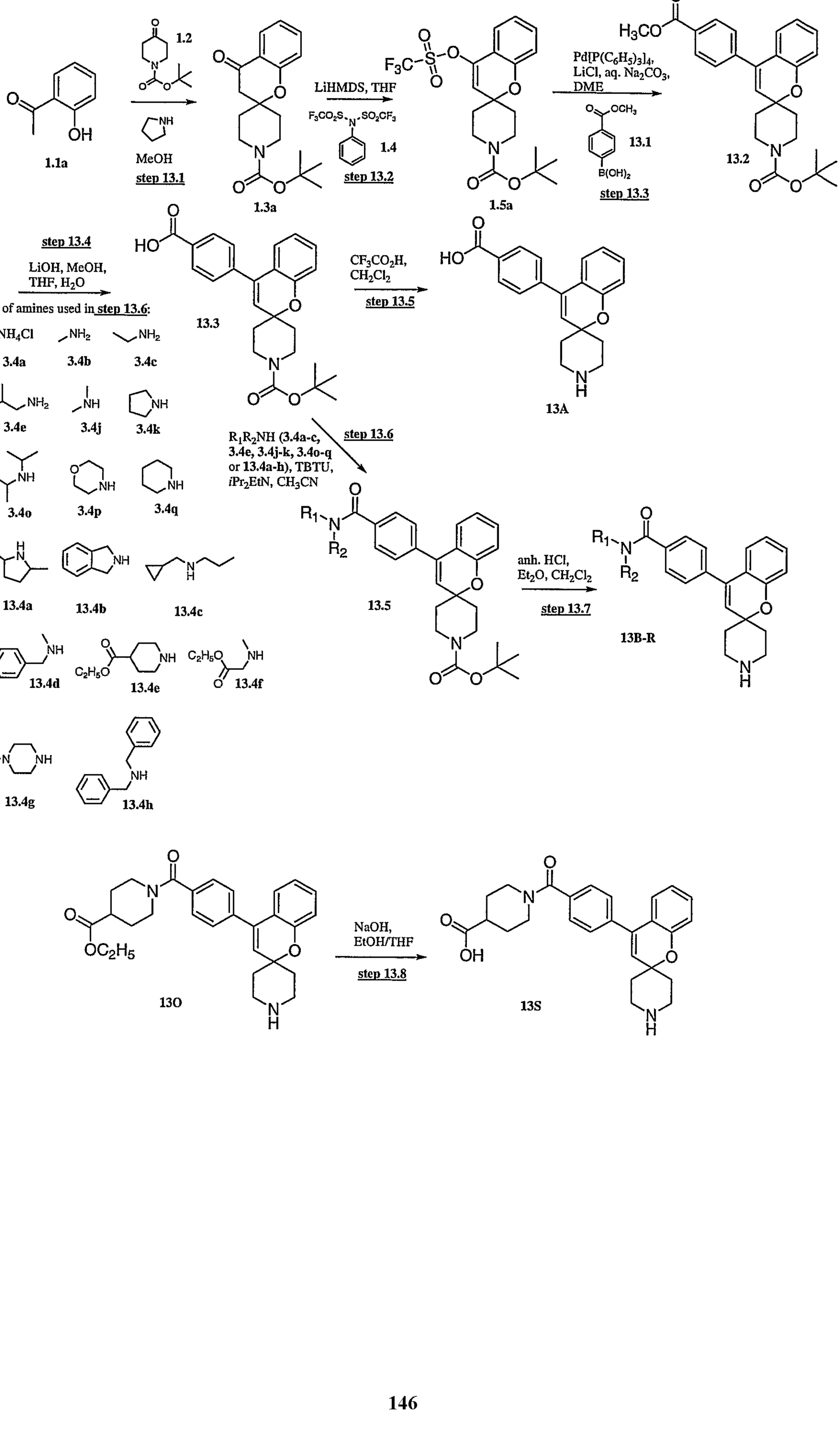
Scheme 11:


HO
O
OH
11.1
1.2
N
NH
MeOH
step 11.1
HO
O
O
N
11.2
CH3OCH2Cl
(11.3), iPr2EtN,
CH2Cl2
step 11.2
11.4
LiHMDS, THF
F3CO2S-N-SO2CF3
1.4
step 11.3
F3C-S
11.5
Pd[P(C6H5)3]4, LiCl, aq.
Na2CO3, DME
1.6
or
1.7
B(OH)2
step 11.4
X = CH, N
anh. HCl,
Et2O, MeOH
step 11.5
11A,B
Boc2O (4.7), Et3N, THF
step 11.6
11.7
method 11A:11.8,
K2CO3, acetone
method 11B: 2.8e or
11.10, P(C6H5)3,
DEAD, CH2Cl2
2.8e
11.8
Br
11.9
anh. HCl,
Et2O, CH2Cl2
step 11.8
11C-F
11.10
step 11.7

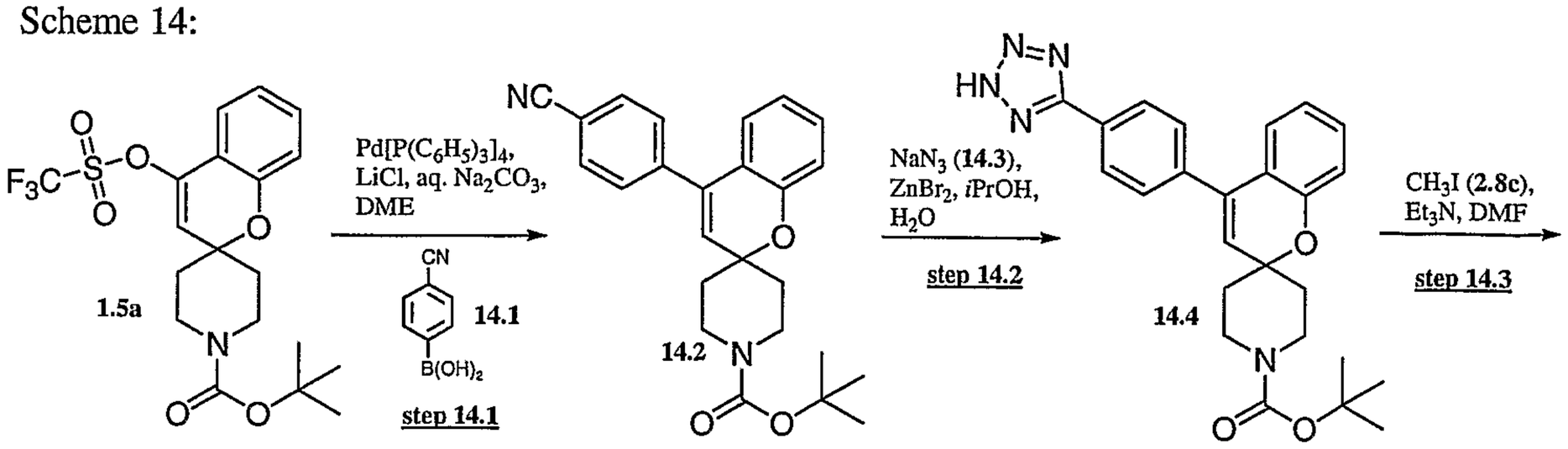
Scheme 12:

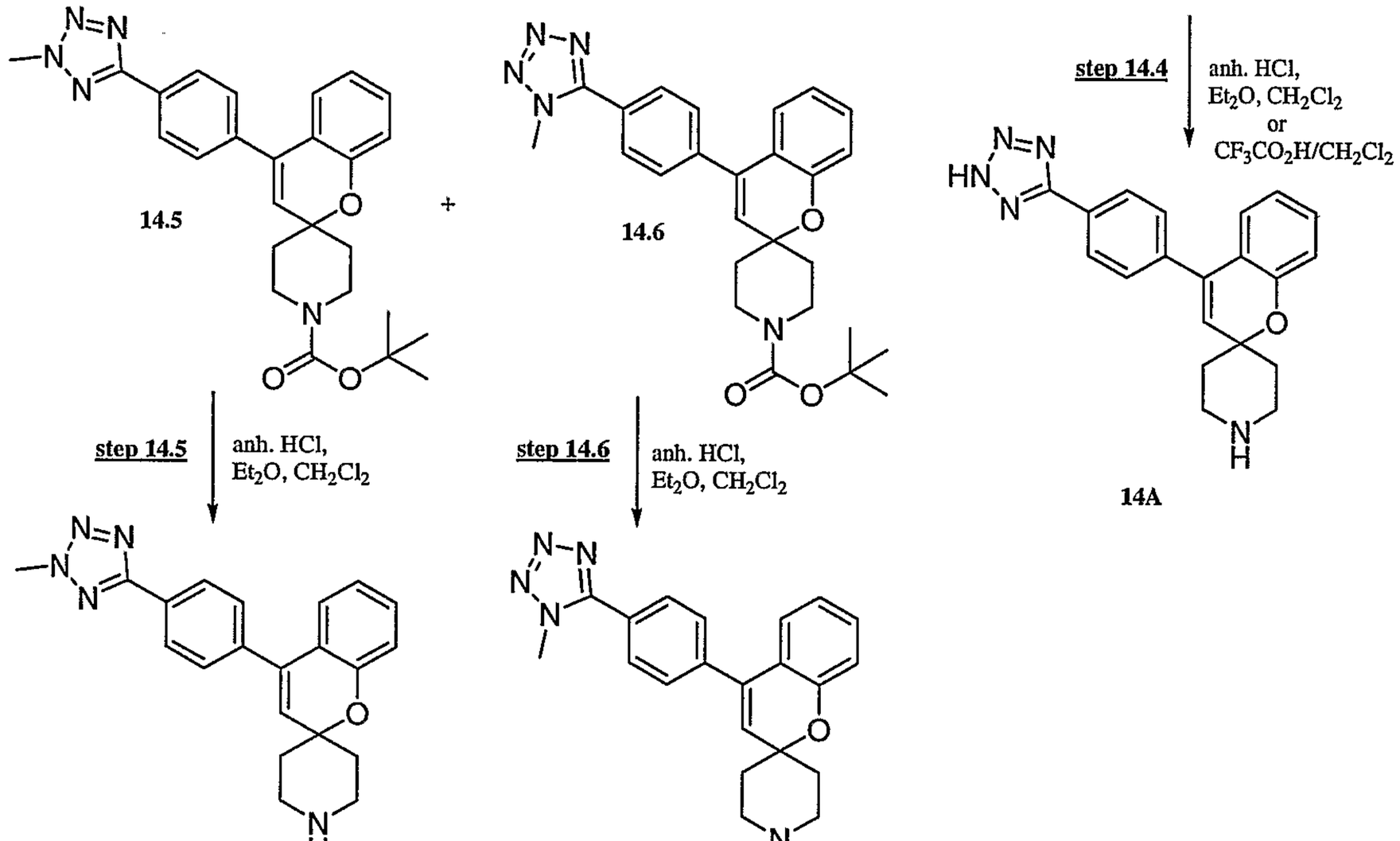

11.2
1.4
Et3N, DMAP, CH2Cl2
step 12.1
12.1
CO(g), Pd(OAc)2, dppp, Et3N
MeOH, DMF
step 12.6
12.6
LiOH, MeOH, THF
step 12.7
12.7
RZnX (12.2), Pd[P(C6H5)3]4, THF
CH3ZnCl 12.2a
C3H7ZnBr 12.2b
C4H9ZnBr 12.2c
step 12.2
12.3
LiHMDS, THF
step 12.3
12.4
step 12.4
method 1C: Pd[P(C6H5)3]4 LiCl, aq. Na2CO3, DME
method 12A: Pd[P(C6H5)3]4 K3PO4, KBr, dioxane
1.6
or 1.7
12.5
X = CH, N
anh. HCl, Et2O, CH2Cl2
step 12.5
12A, 12H-L
12.12
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
step 12.13
12.11
step 12.14
tBuOK, Et2O, H2O
12.13
NH3 12.15
CH3NH2 3.4b
C2H5NH2 3.4c
C3H7NH2 3.4d
step 12.16
R1R2NH (3.4), TBTU, iPr2EtN, CH3CN
anh. HCl, Et2O, CH2Cl2
step 12.15
12B
LiHMDS, THF
step 12.12
(CH3)2NH (3.4j), TBTU, iPr2EtN, CH3CN
step 12.8
12.8
LiHMDS, THF
step 12.9
12.9
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
step 12.10
12.10
anh. HCl, Et2O, CH2Cl2
step 12.11
12.14
anh. HCl, Et2O, CH2Cl2
step 12.17
12C-G

Scheme 13:

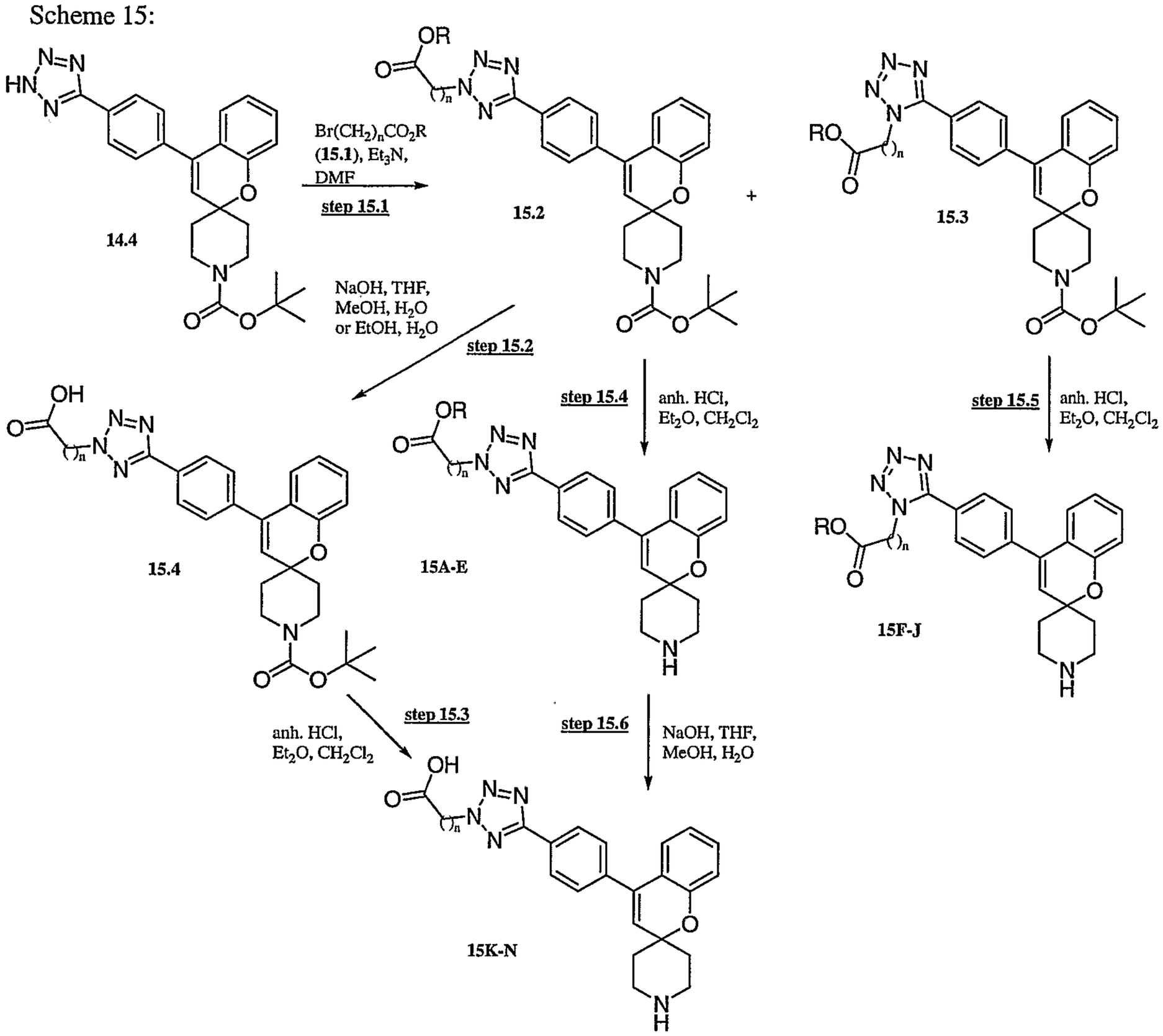

1.2
1.1a
MeOH
step 13.1
1.3a
LiHMDS, THF
1.4
step 13.2
1.5a
Pd[P(C6H5)3]4,
LiCl, aq. Na2CO3,
DME
13.1
step 13.3
13.2
step 13.4
LiOH, MeOH,
THF, H2O
list of amines used in step 13.6:
13.3
CF3CO2H,
CH2Cl2
step 13.5
13A
3.4a
3.4b
3.4c
3.4e
3.4j
3.4k
3.4o
3.4p
3.4q
R1R2NH (3.4a-c, 3.4e, 3.4j-k, 3.4o-q or 13.4a-h), TBTU, iPr2EtN, CH3CN
step 13.6
13.4a
13.4b
13.4c
13.4d
13.4e
13.4f
13.5
anh. HCl,
Et2O, CH2Cl2
step 13.7
13B-R
13.4g
13.4h
13O
NaOH,
EtOH/THF
step 13.8
13S

Scheme 14:


1.5a
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
CN
14.1
B(OH)2
step 14.1
NC
14.2
NaN3 (14.3), ZnBr2, iPrOH, H2O
step 14.2
14.4
CH3I (2.8c), Et3N, DMF
step 14.3


step 14.4
anh. HCl, Et2O, CH2Cl2 or CF3CO2H/CH2Cl2
14A
14.5
14.6
step 14.5
anh. HCl, Et2O, CH2Cl2
step 14.6
anh. HCl, Et2O, CH2Cl2
14B
14C

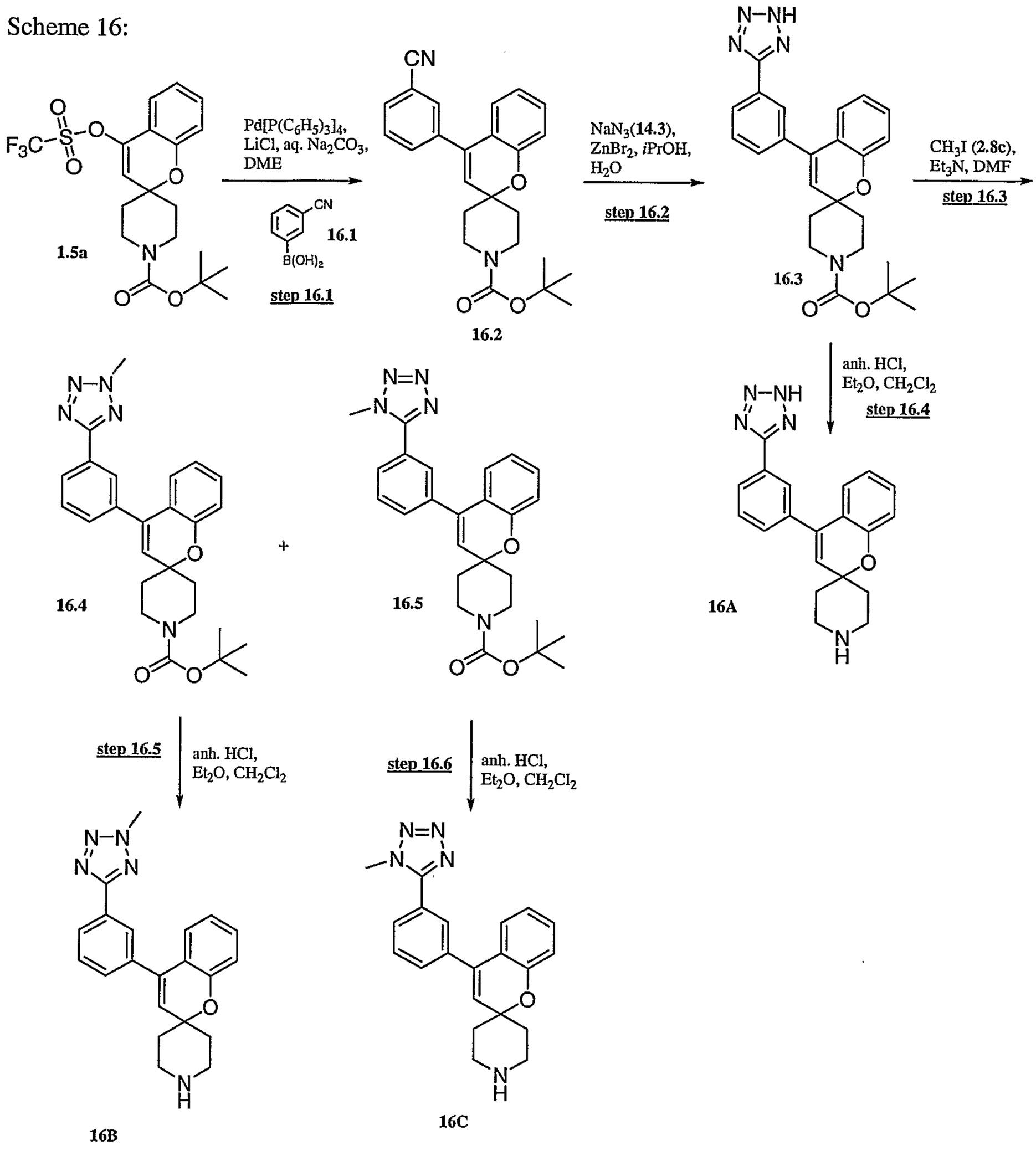
Scheme 15:



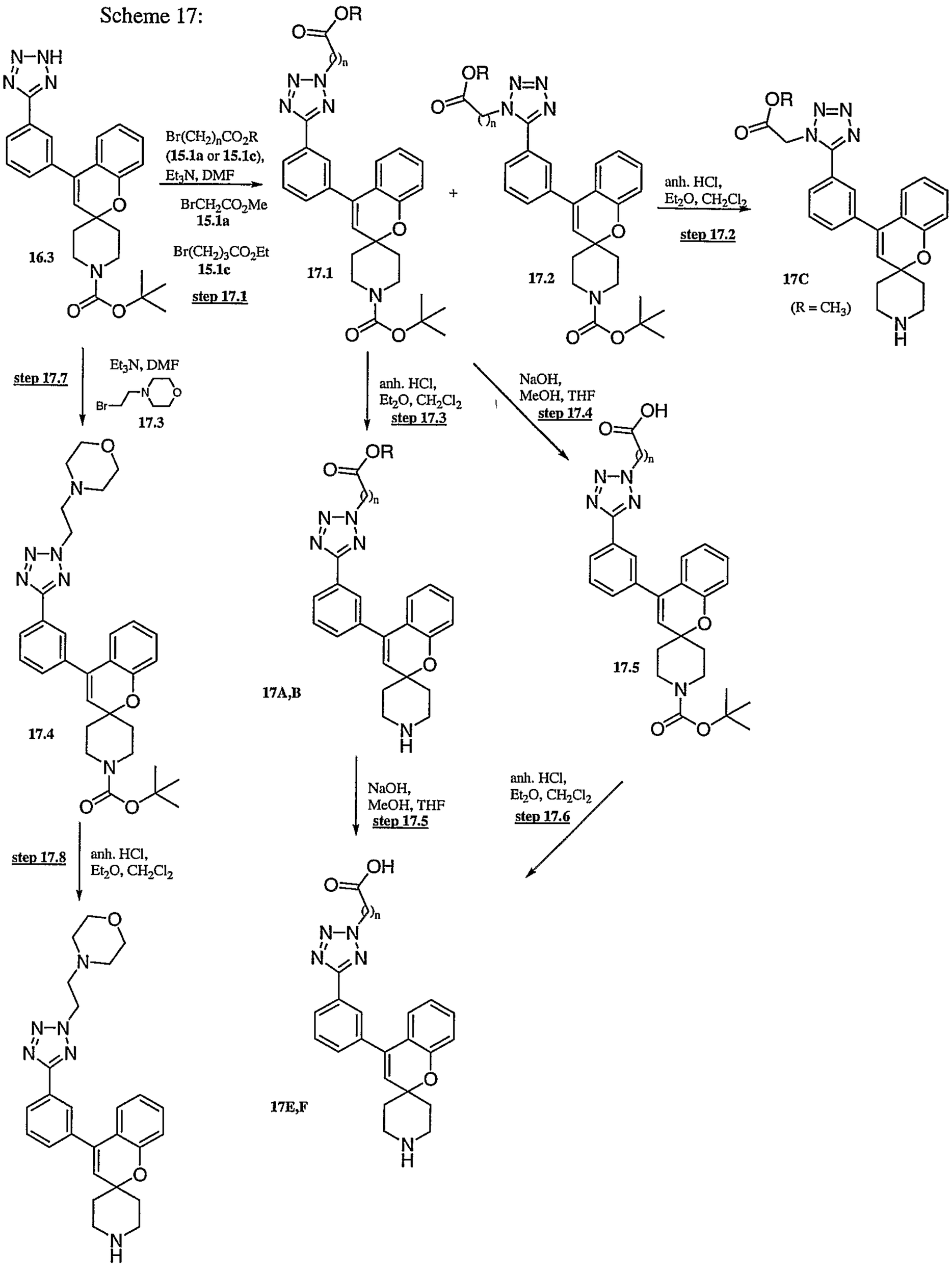
Br(CH$_2$)nCO$_2$R used in **step 15.1**:

BrCH$_2$CO$_2$Me	Br(CH$_2$)$_2$CO$_2$Me	Br(CH$_2$)$_3$CO$_2$Et	Br(CH$_2$)$_4$CO$_2$Et	Br(CH$_2$)$_5$CO$_2$Et
15.1a	**15.1b**	**15.1c**	**15.1d**	**15.1e**

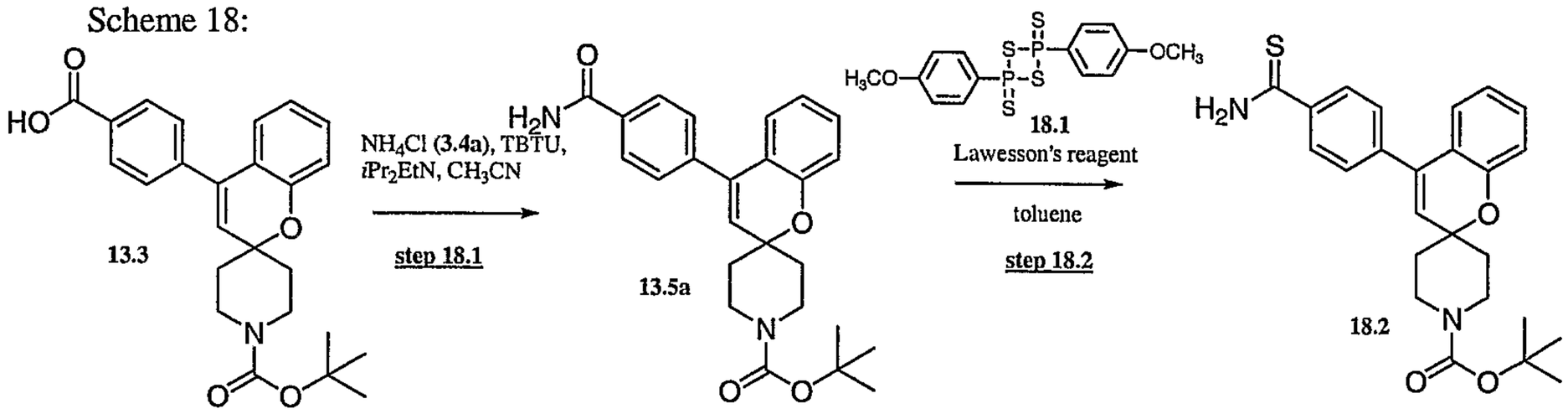
Scheme 16:


1.5a
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
16.1
step 16.1
NaN3(14.3), ZnBr2, iPrOH, H2O
step 16.2
16.3
CH3I (2.8c), Et3N, DMF
step 16.3
16.2
anh. HCl, Et2O, CH2Cl2
step 16.4
16A
16.4
16.5
step 16.5
step 16.6
16B
16C

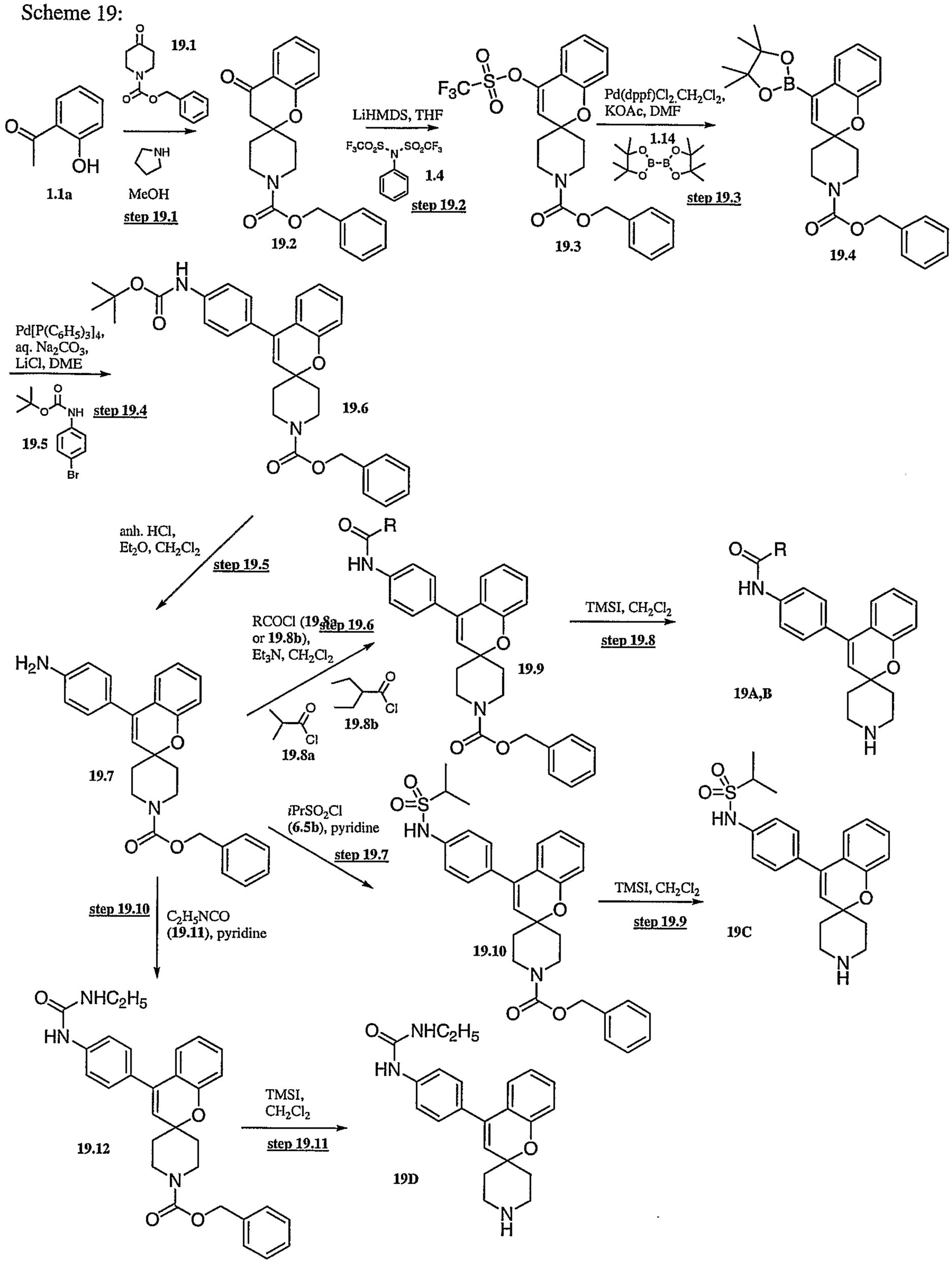
Scheme 17:


16.3
Br(CH2)nCO2R
(15.1a or 15.1c),
Et3N, DMF
BrCH2CO2Me
15.1a
Br(CH2)3CO2Et
15.1c
step 17.1
17.1
17.2
anh. HCl,
Et2O, CH2Cl2
step 17.2
17C
(R = CH3)
step 17.7
Et3N, DMF
17.3
anh. HCl,
Et2O, CH2Cl2
step 17.3
NaOH,
MeOH, THF
step 17.4
17.5
17.4
17A,B
NaOH,
MeOH, THF
step 17.5
anh. HCl,
Et2O, CH2Cl2
step 17.6
step 17.8
anh. HCl,
Et2O, CH2Cl2
17E,F
17D

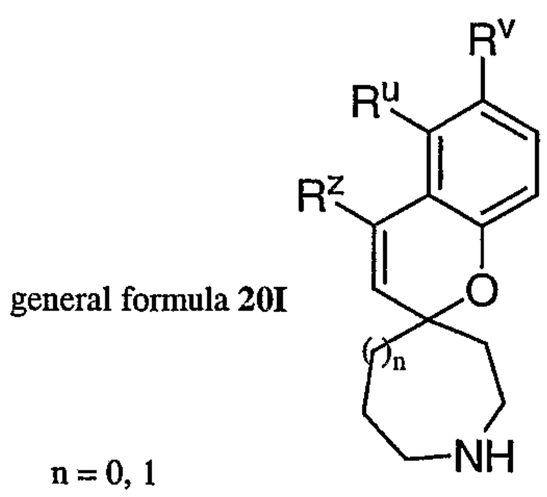
Scheme 18:


HO
O
13.3
step 18.1
NH4Cl (3.4a), TBTU,
iPr2EtN, CH3CN
H2N
13.5a
H3CO
OCH3
18.1
Lawesson's reagent
toluene
step 18.2
H2N
18.2
BrCH2COR (18.3a
or 18.3b), DMF
18.3a: BrCH2COtBu
18.3b: BrCH2COC6H5
step 18.3
18.4
anh. HCl,
Et2O, CH2Cl2
step 18.4
18A,B
NC
14.2
NH2OH.HCl
(18.5), Et3N,
EtOH
step 18.5
HO
H2N
18.6
CH3COCl
(6.7), pyridine
step 18.6
18.7
anh. HCl,
Et2O, CH2Cl2
step 18.7
18C

Scheme 19:


19.1
1.1a
MeOH
step 19.1
19.2
LiHMDS, THF
1.4
step 19.2
19.3
Pd(dppf)Cl2.CH2Cl2,
KOAc, DMF
1.14
step 19.3
19.4
Pd[P(C6H5)3]4,
aq. Na2CO3,
LiCl, DME
19.5
step 19.4
19.6
anh. HCl,
Et2O, CH2Cl2
step 19.5
RCOCl (19.8a
or 19.8b),
Et3N, CH2Cl2
step 19.6
19.8a
19.8b
19.7
19.9
TMSI, CH2Cl2
step 19.8
19A,B
iPrSO2Cl
(6.5b), pyridine
step 19.7
19.10
TMSI, CH2Cl2
step 19.9
19C
step 19.10
C2H5NCO
(19.11), pyridine
19.12
TMSI,
CH2Cl2
step 19.11
19D

Scheme 20:

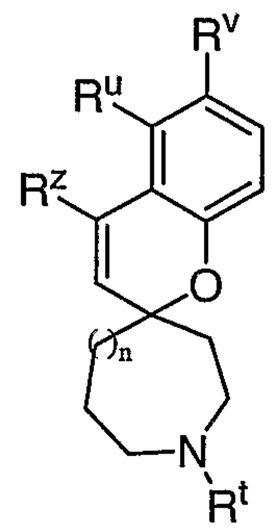


general formula **20I**

n = 0, 1

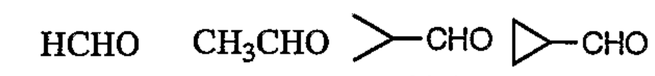
method 20A: HCHO (**20.1a**), Et_3N, $NaBH_3CN$, THF, MeOH
method 20B: RCHO (**20.1**), $NaBH_3CN$, AcOH, CH_2Cl_2
method 20C: RBr (**2.8a**, **20.2** or **15.1**), Et_3N, CH_2Cl_2

step 20.1

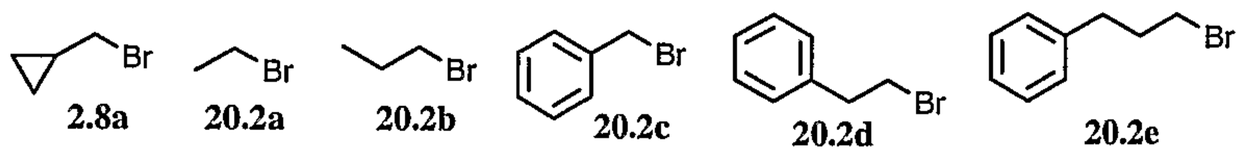


20 A-R

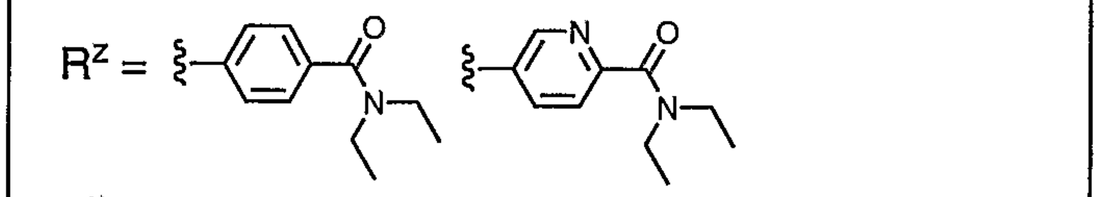
list of aldehydes and alkyl bromides used in **step 20.1**:



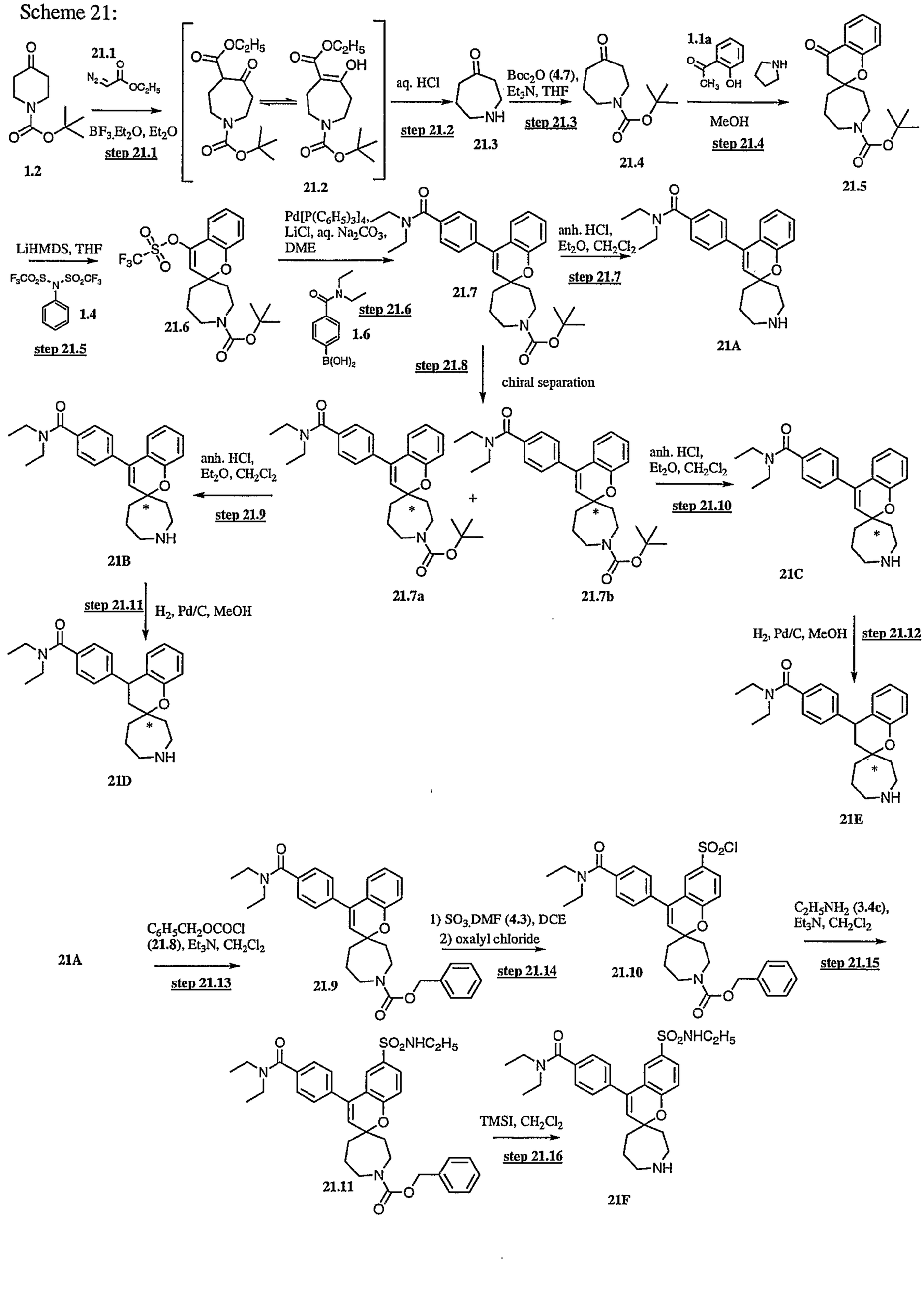
20.1a **20.1b** **20.1c** **20.1d**



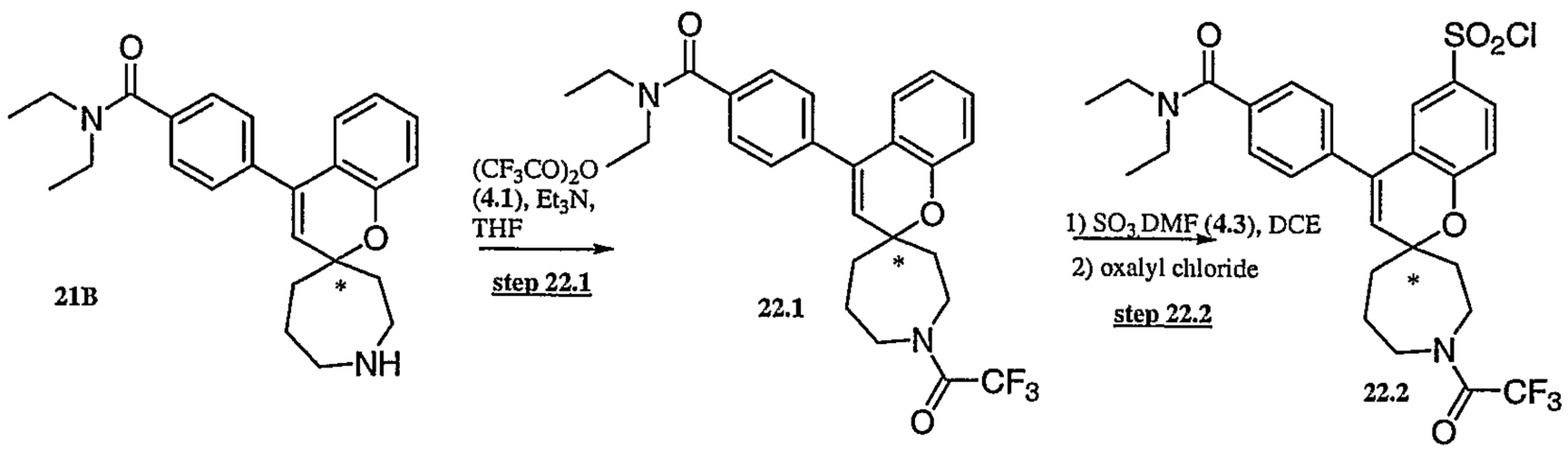
2.8a **20.2a** **20.2b** **20.2c** **20.2d** **20.2e**



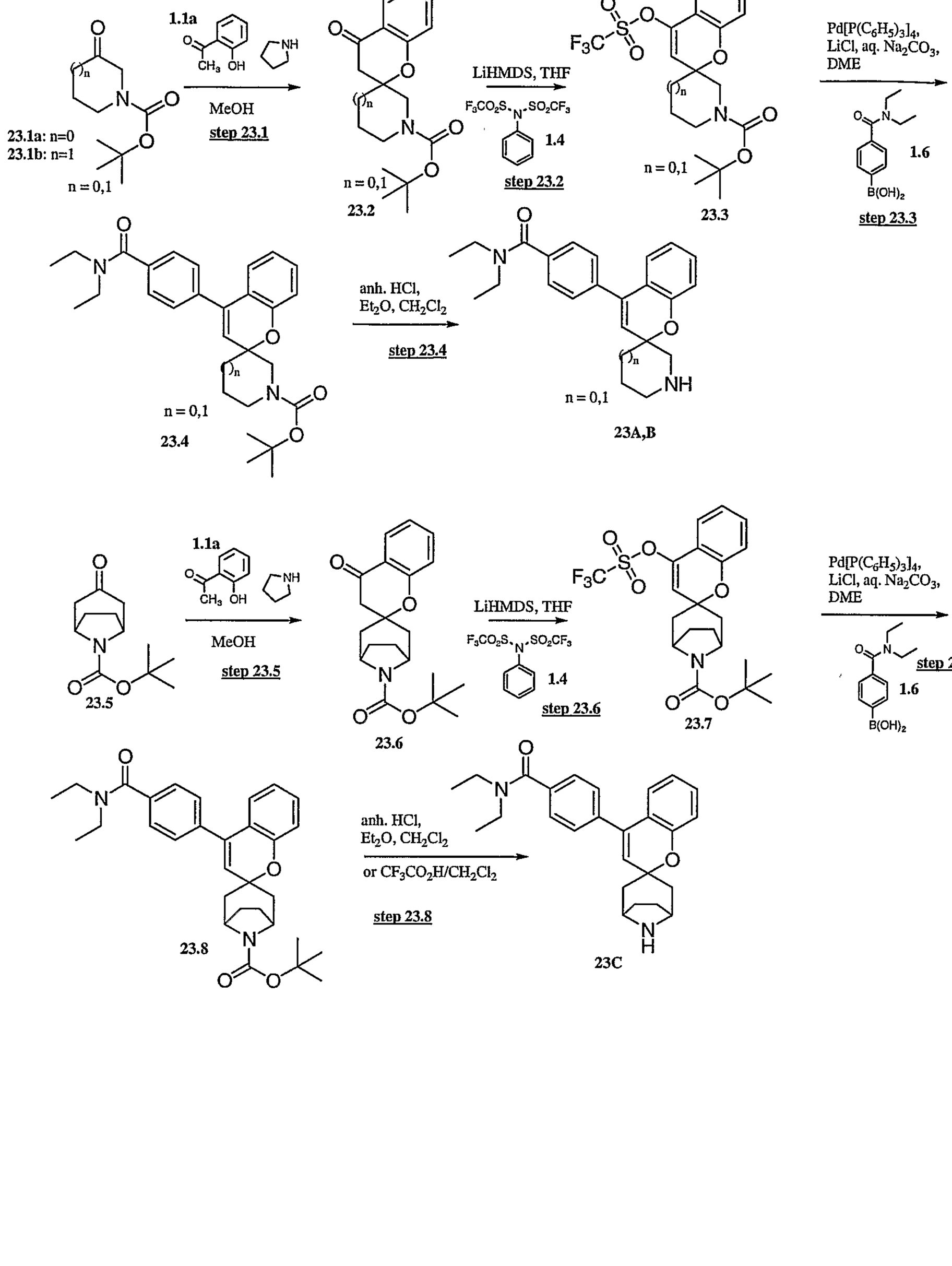
Scheme 21:


21.1
BF3.Et2O, Et2O
step 21.1
1.2
21.2
aq. HCl
step 21.2
21.3
Boc2O (4.7), Et3N, THF
step 21.3
21.4
1.1a
MeOH
step 21.4
21.5
LiHMDS, THF
1.4
step 21.5
21.6
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
step 21.6
1.6
21.7
anh. HCl, Et2O, CH2Cl2
step 21.7
21A
step 21.8
chiral separation
anh. HCl, Et2O, CH2Cl2
step 21.9
21B
21.7a
21.7b
anh. HCl, Et2O, CH2Cl2
step 21.10
21C
step 21.11
H2, Pd/C, MeOH
21D
H2, Pd/C, MeOH
step 21.12
21E
21A
C6H5CH2OCOCl (21.8), Et3N, CH2Cl2
step 21.13
21.9
1) SO3.DMF (4.3), DCE
2) oxalyl chloride
step 21.14
21.10
C2H5NH2 (3.4c), Et3N, CH2Cl2
step 21.15
21.11
TMSI, CH2Cl2
step 21.16
21F

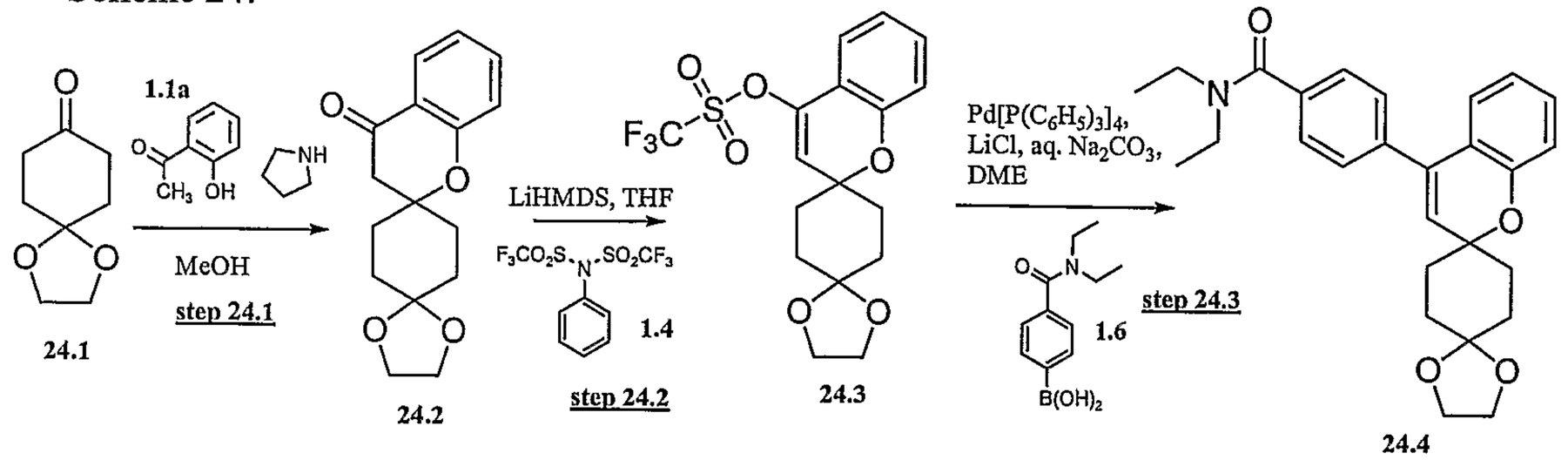
Scheme 22:

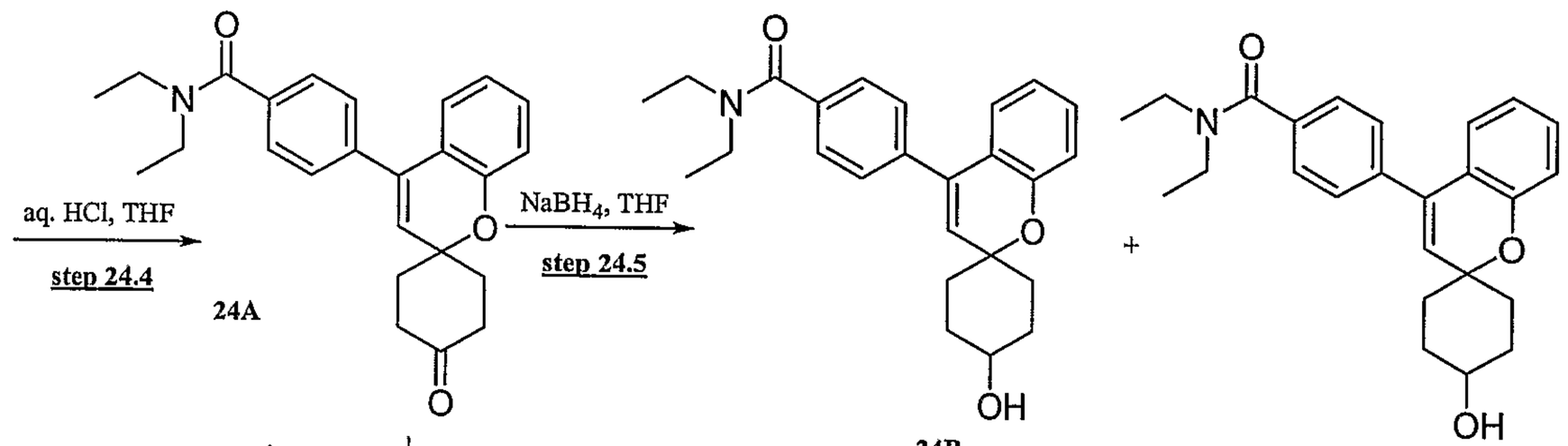

21B
(CF3CO)2O
(4.1), Et3N,
THF
step 22.1
22.1
1) SO3 DMF (4.3), DCE
2) oxalyl chloride
step 22.2
22.2
R1R2NH (3.4),
Et3N, CH2Cl2
step 22.3
22.3
K2CO3,
MeOH,
THF, H2O
step 22.4
22A-D
list of amines used in step 22.3:
3.4b
3.4c
3.4d
3.4g
NH2NH2 (5.1),
THF
step 22.5
22.4
CH3I (2.8c),
NaOAc, EtOH
step 22.6
22.5
K2CO3,
MeOH,
THF, H2O
step 22.7
22E

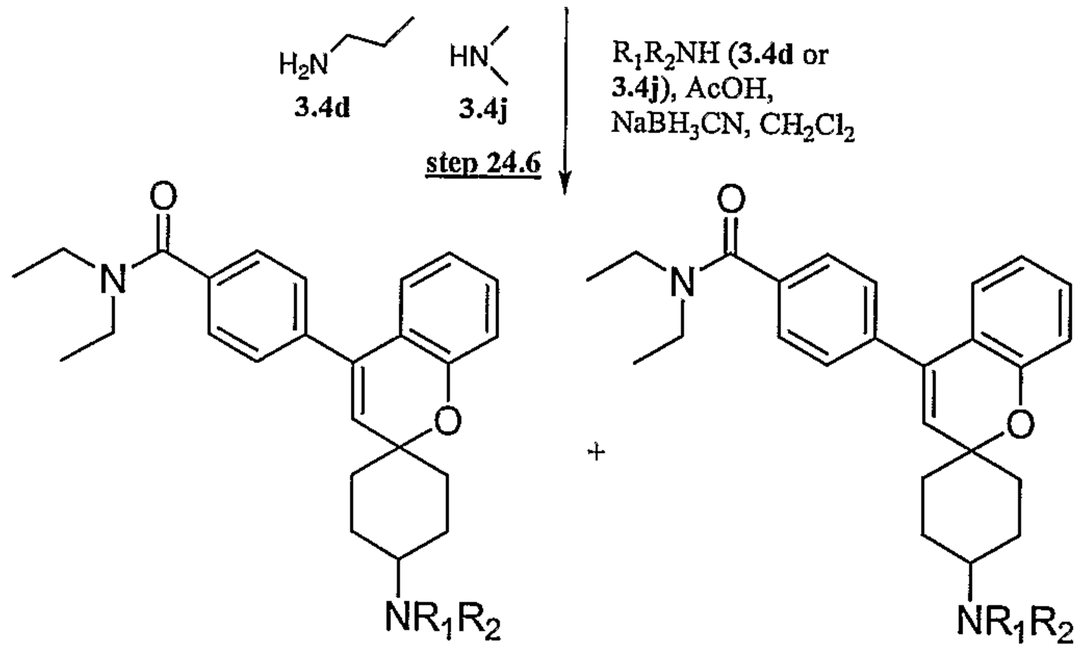
Scheme 23:


1.1a
MeOH
step 23.1
23.1a: n=0
23.1b: n=1
n = 0,1
LiHMDS, THF
1.4
step 23.2
23.2
23.3
Pd[P(C6H5)3]4,
LiCl, aq. Na2CO3,
DME
1.6
step 23.3
anh. HCl,
Et2O, CH2Cl2
step 23.4
23.4
23A,B
step 23.5
23.5
step 23.6
23.6
23.7
step 23.7
step 23.8
23.8
23C

Scheme 24:

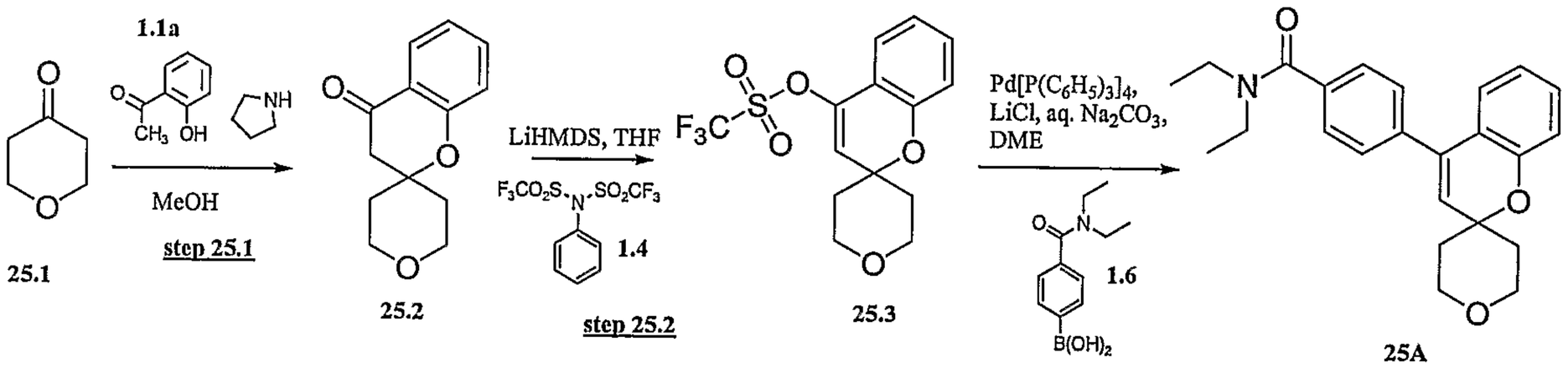




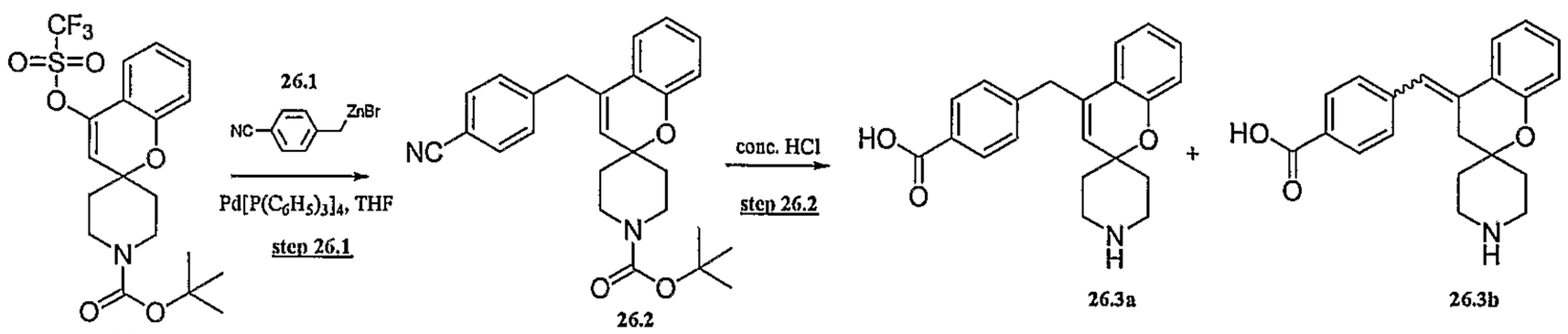


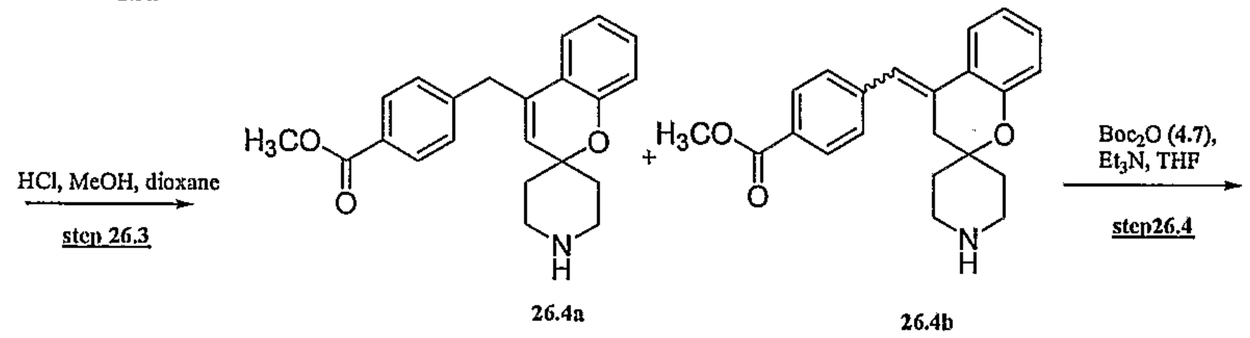
24 E,G 24 D,F

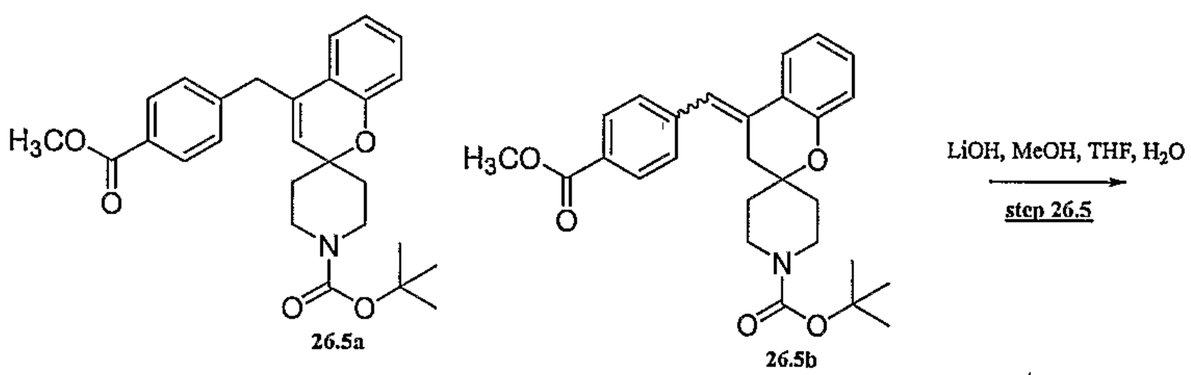
Scheme 25:

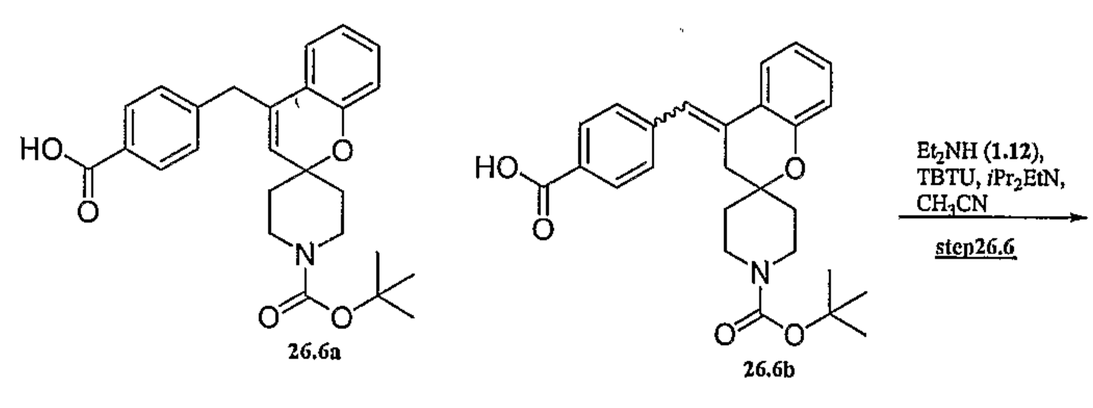


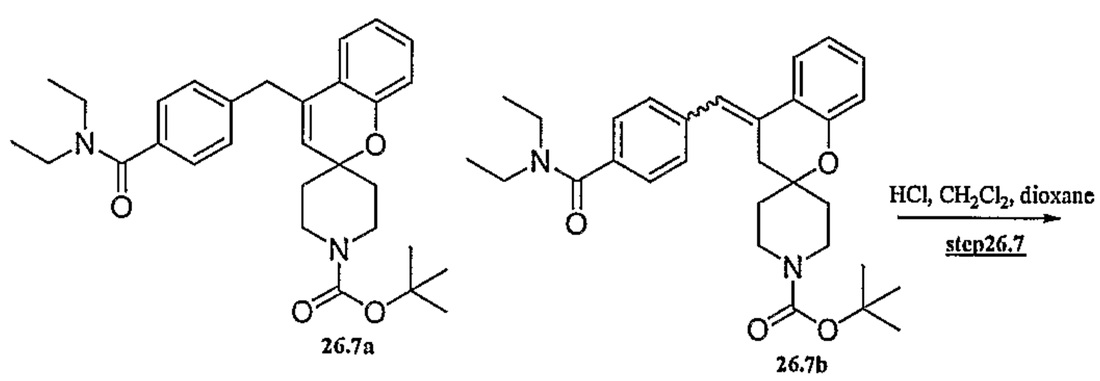
Scheme 26:

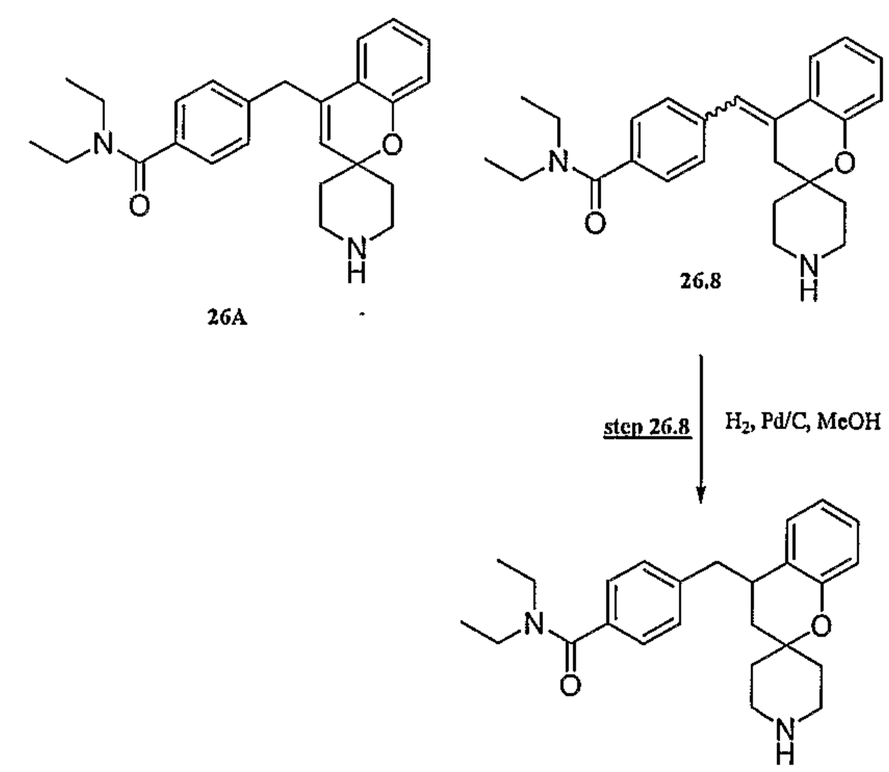

CF3
O=S=O
O
1.5a
26.1
NC
ZnBr
Pd[P(C6H5)3]4, THF
step 26.1
NC
26.2
conc. HCl
step 26.2
HO
O
N
H
26.3a
+
HO
O
N
H
26.3b


HCl, MeOH, dioxane
step 26.3
H3CO
O
N
H
26.4a
+
H3CO
O
N
H
26.4b
Boc2O (4.7),
Et3N, THF
step26.4

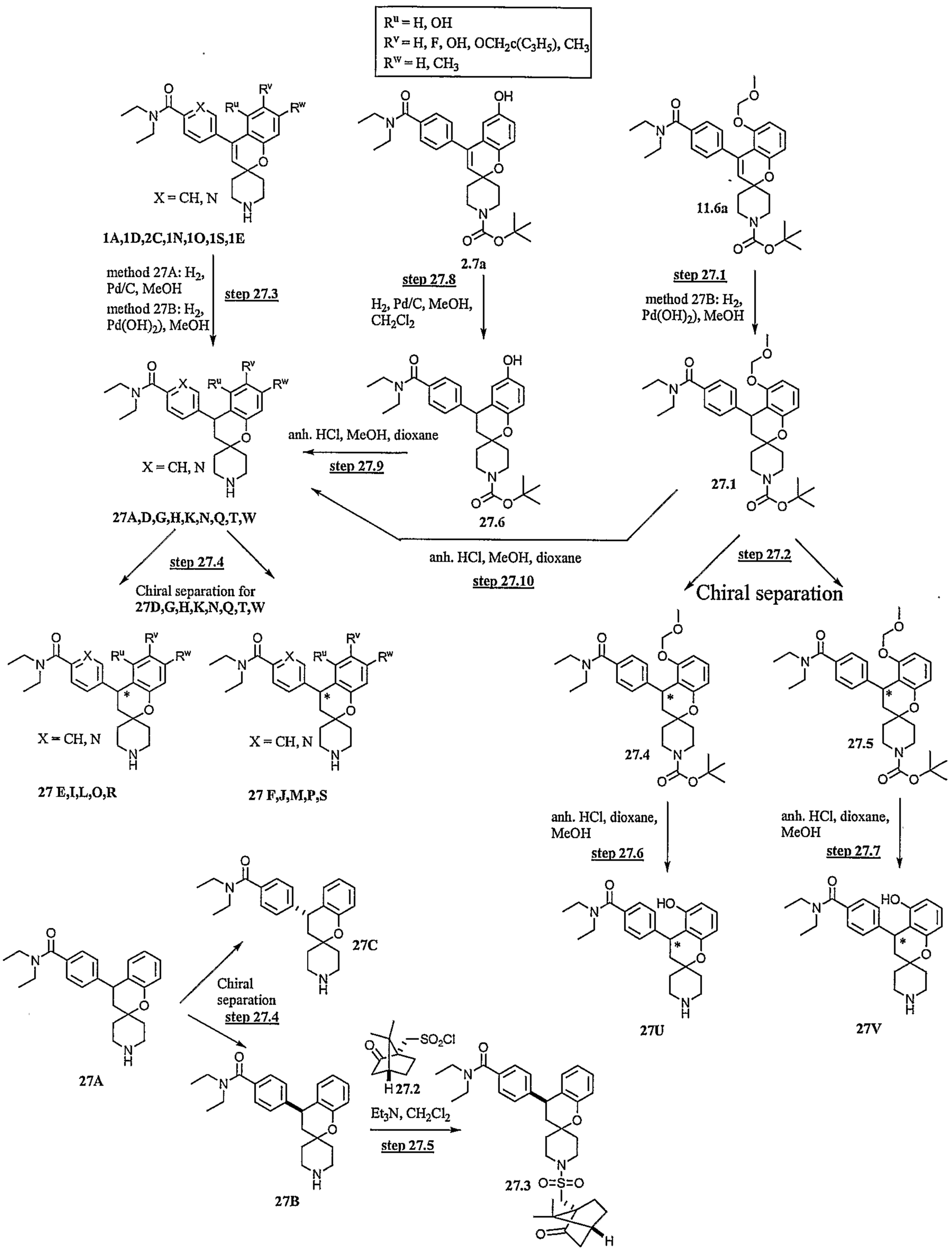

H3CO
O
N
O
O
26.5a
H3CO
O
N
O
O
26.5b
LiOH, MeOH, THF, H2O
step 26.5


HO
O
N
O
O
26.6a
HO
O
N
O
O
26.6b
Et2NH (1.12),
TBTU, iPr2EtN,
CH3CN
step26.6

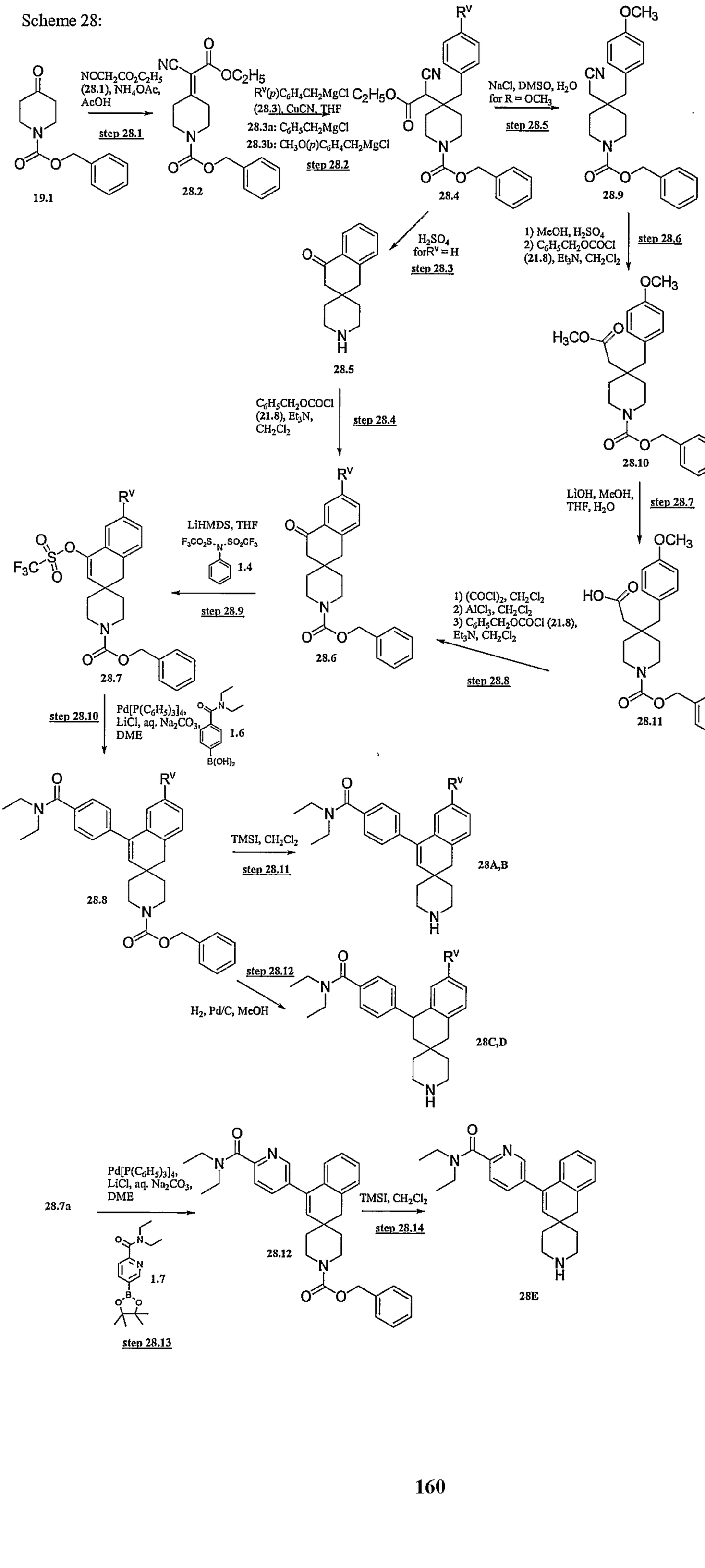

N
O
N
O
O
26.7a
N
O
N
O
O
26.7b
HCl, CH2Cl2, dioxane
step26.7


N
O
N
H
26A
N
O
N
H
26.8
step 26.8
H2, Pd/C, MeOH
N
O
O
N
H
26B

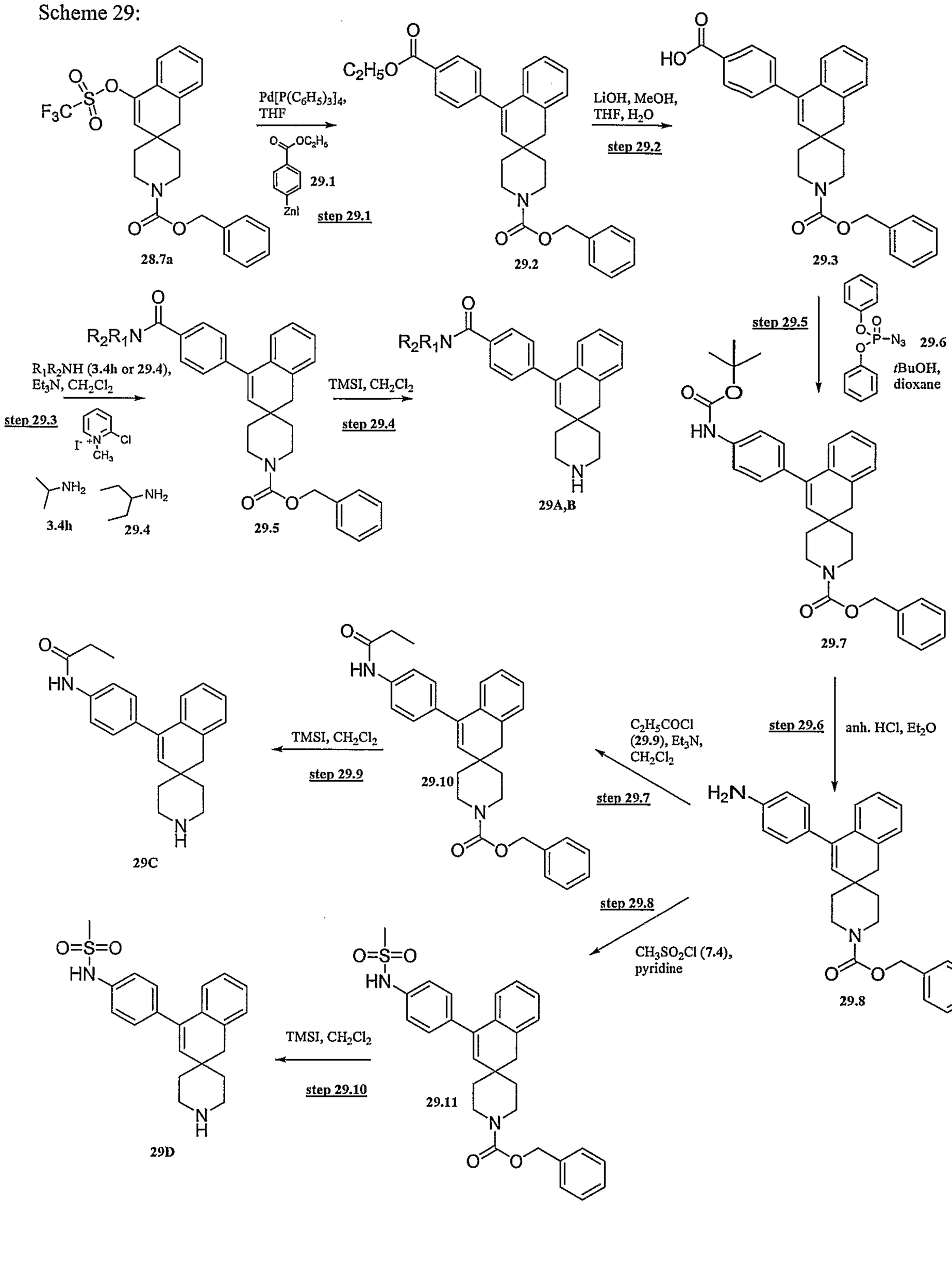
Scheme 27:


R^u = H, OH
R^v = H, F, OH, $OCH_2c(C_3H_5)$, CH_3
R^w = H, CH_3
X = CH, N
1A,1D,2C,1N,1O,1S,1E
2.7a
11.6a
step 27.1
method 27A: H_2, Pd/C, MeOH
method 27B: H_2, $Pd(OH)_2$, MeOH
step 27.3
step 27.8
H_2, Pd/C, MeOH, CH_2Cl_2
anh. HCl, MeOH, dioxane
step 27.9
27A,D,G,H,K,N,Q,T,W
27.6
27.1
step 27.4
Chiral separation for 27D,G,H,K,N,Q,T,W
anh. HCl, MeOH, dioxane
step 27.10
step 27.2
Chiral separation
27 E,I,L,O,R
27 F,J,M,P,S
27.4
27.5
anh. HCl, dioxane, MeOH
step 27.6
anh. HCl, dioxane, MeOH
step 27.7
27U
27V
27C
27A
Chiral separation
step 27.4
27B
H 27.2
SO_2Cl
Et_3N, CH_2Cl_2
step 27.5
27.3

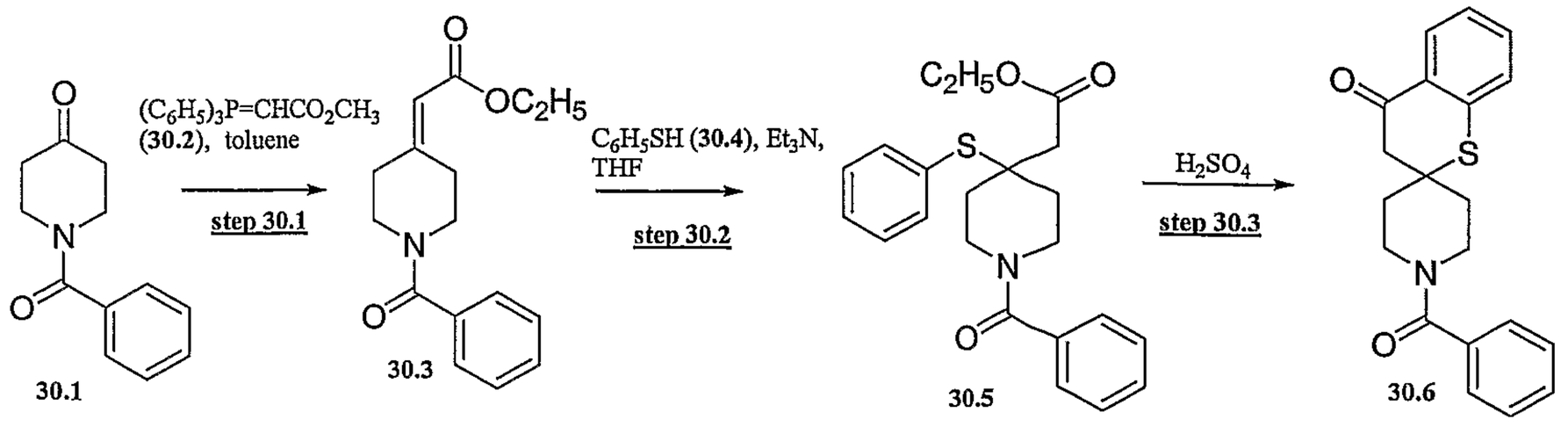
Scheme 28:

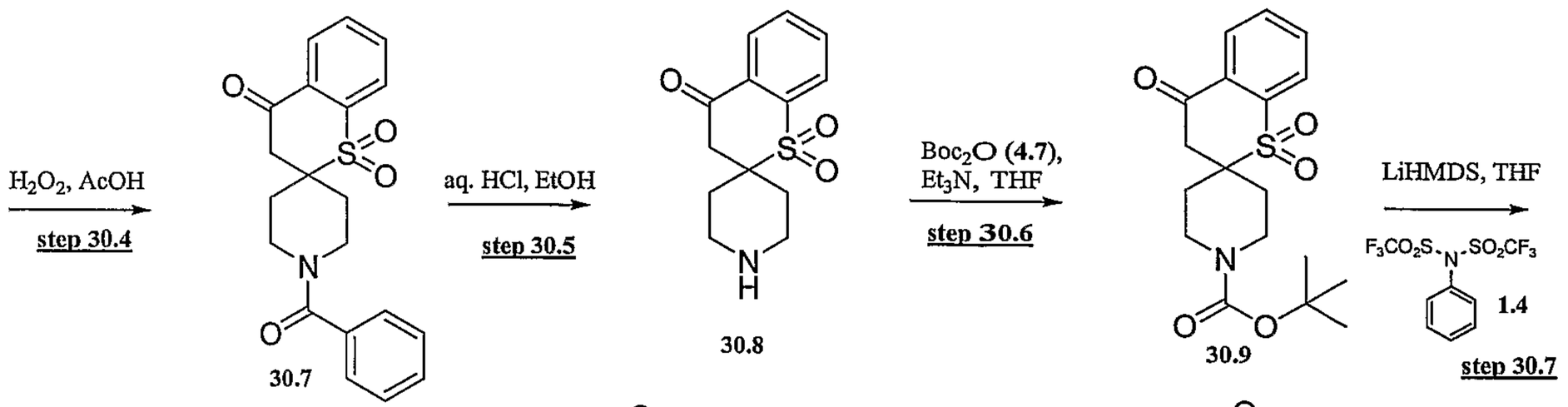

NCCH2CO2C2H5 (28.1), NH4OAc, AcOH
step 28.1
19.1
28.2
R^V(p)C6H4CH2MgCl (28.3), CuCN, THF
28.3a: C6H5CH2MgCl
28.3b: CH3O(p)C6H4CH2MgCl
step 28.2
28.4
NaCl, DMSO, H2O for R = OCH3
step 28.5
28.9
H2SO4 forR^V = H
step 28.3
28.5
1) MeOH, H2SO4
2) C6H5CH2OCOCl (21.8), Et3N, CH2Cl2
step 28.6
28.10
C6H5CH2OCOCl (21.8), Et3N, CH2Cl2
step 28.4
LiOH, MeOH, THF, H2O
step 28.7
28.6
1) (COCl)2, CH2Cl2
2) AlCl3, CH2Cl2
3) C6H5CH2OCOCl (21.8), Et3N, CH2Cl2
step 28.8
28.11
LiHMDS, THF
1.4
step 28.9
28.7
step 28.10
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
1.6
28.8
TMSI, CH2Cl2
step 28.11
28A,B
step 28.12
H2, Pd/C, MeOH
28C,D
28.7a
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
1.7
step 28.13
28.12
TMSI, CH2Cl2
step 28.14
28E

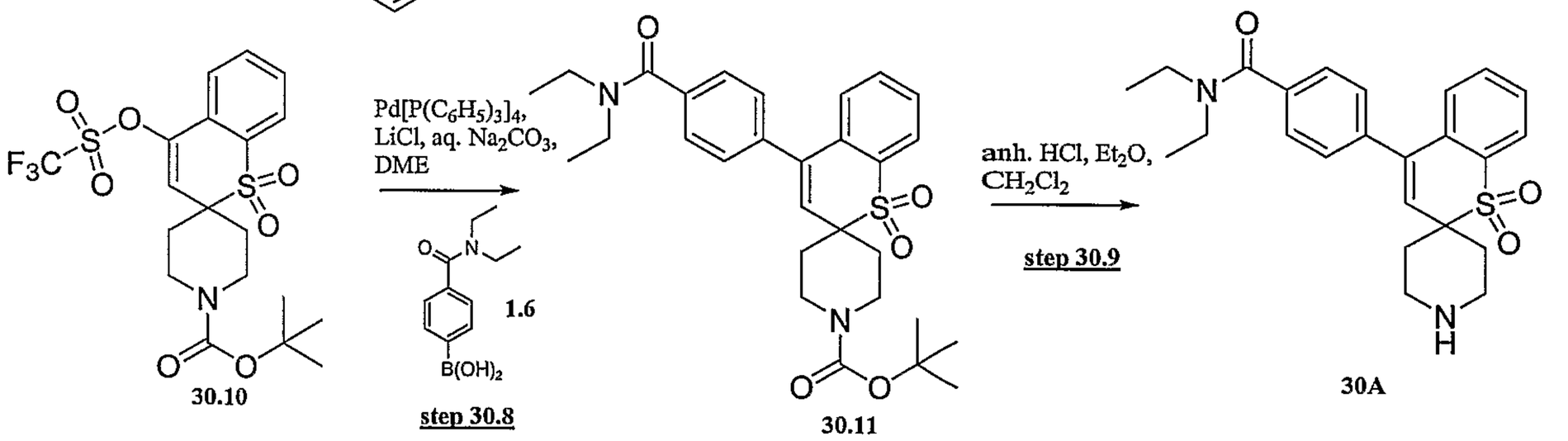
Scheme 29:


Pd[P(C6H5)3]4, THF
step 29.1
LiOH, MeOH, THF, H2O
step 29.2
step 29.5
step 29.3
R1R2NH (3.4h or 29.4), Et3N, CH2Cl2
TMSI, CH2Cl2
step 29.4
tBuOH, dioxane
step 29.6
anh. HCl, Et2O
step 29.7
C2H5COCl (29.9), Et3N, CH2Cl2
step 29.9
TMSI, CH2Cl2
step 29.8
CH3SO2Cl (7.4), pyridine
step 29.10
TMSI, CH2Cl2
28.7a
29.1
29.2
29.3
29.4
29.5
29.6
29.7
29.8
29.10
29.11
29A,B
3.4h
29C
29D

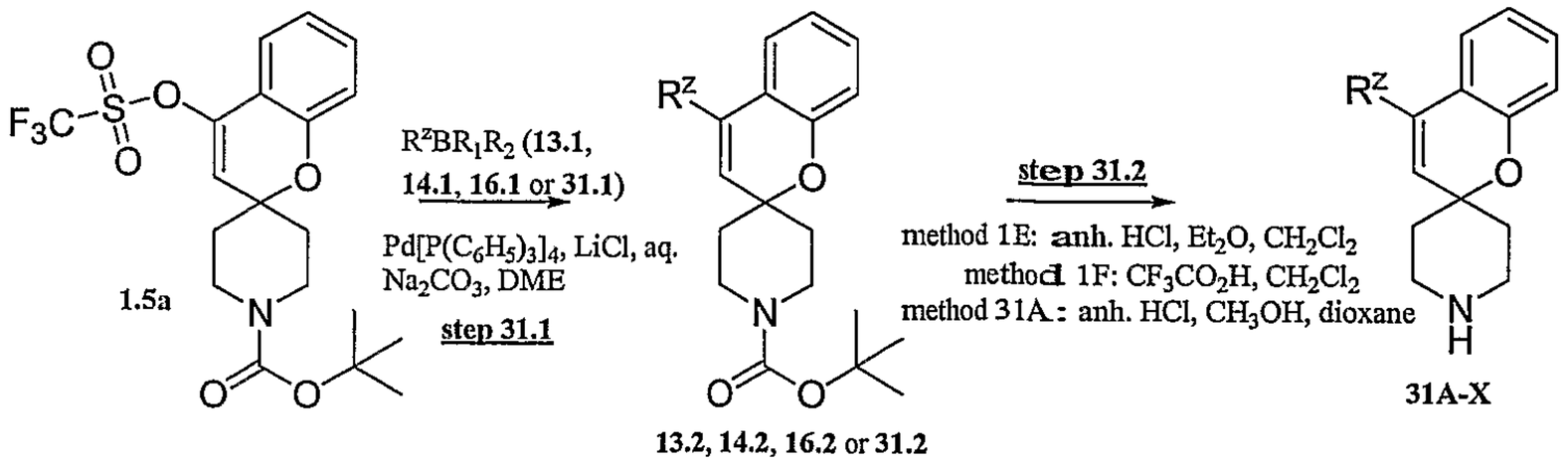
Scheme 30:


$(C_6H_5)_3P=CHCO_2CH_3$
(30.2), toluene
step 30.1
C_6H_5SH (30.4), Et_3N, THF
step 30.2
H_2SO_4
step 30.3
30.1
30.3
30.5
30.6

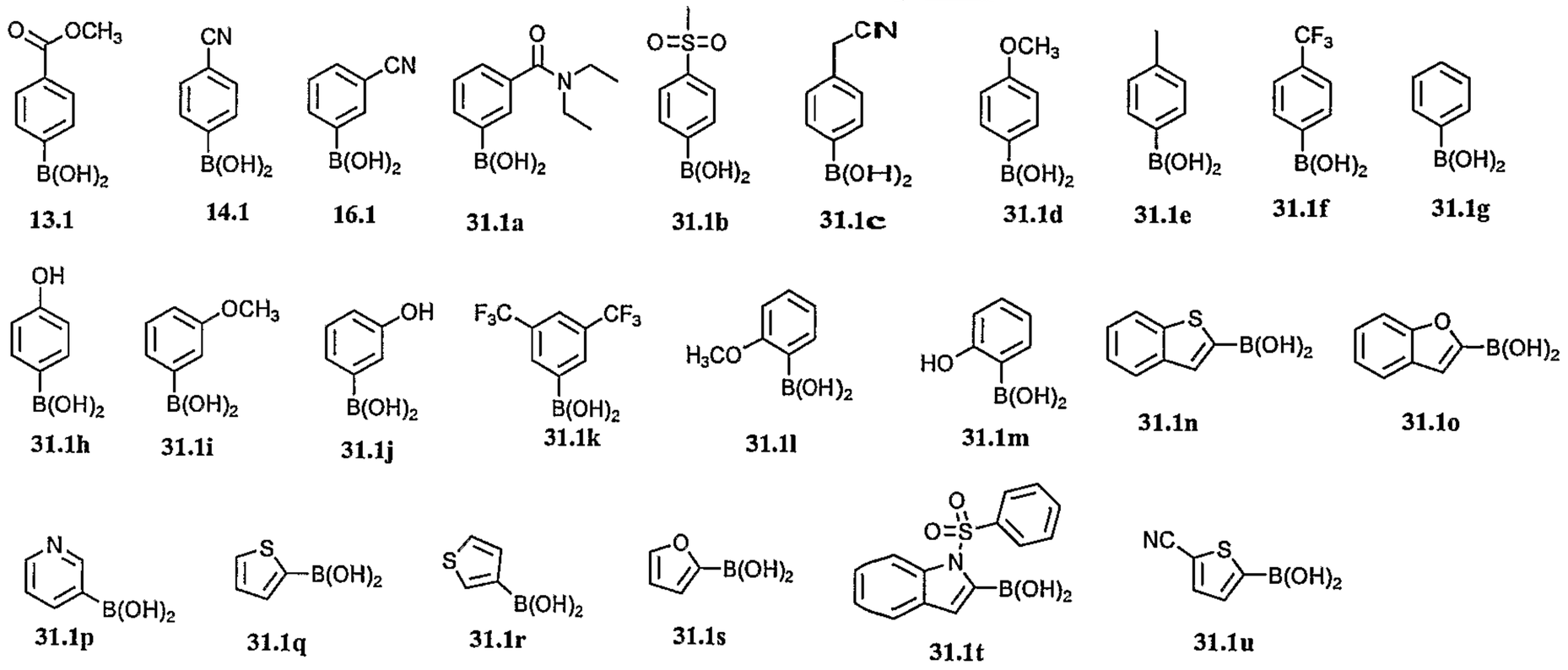

H_2O_2, AcOH
step 30.4
aq. HCl, EtOH
step 30.5
Boc_2O (4.7), Et_3N, THF
step 30.6
LiHMDS, THF
F_3CO_2S-N-SO_2CF_3
1.4
step 30.7
30.7
30.8
30.9

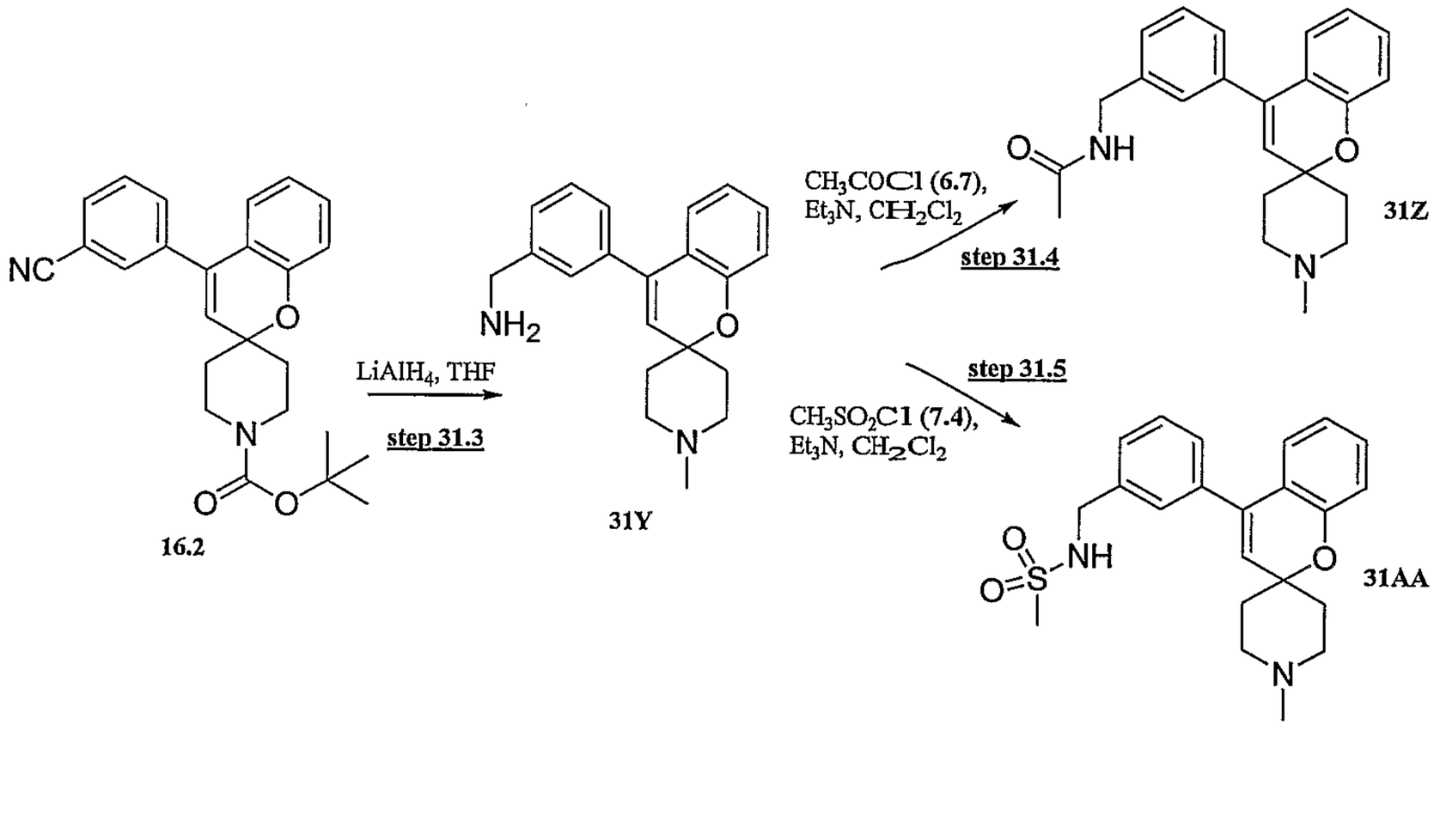

$Pd[P(C_6H_5)_3]_4$, LiCl, aq. Na_2CO_3, DME
1.6
step 30.8
anh. HCl, Et_2O, CH_2Cl_2
step 30.9
30.10
30.11
30A

Scheme 31:

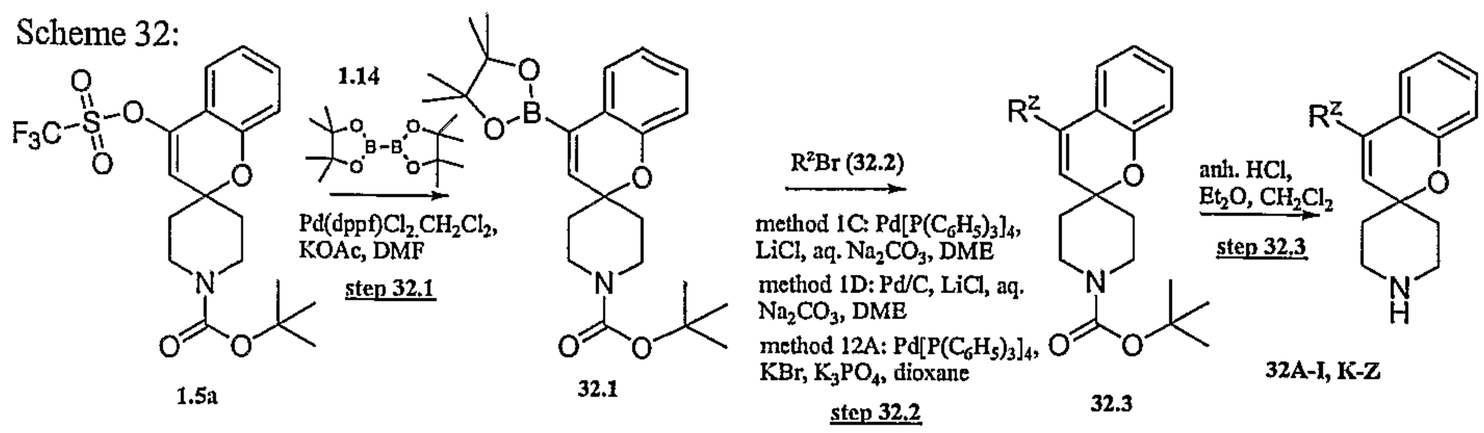


Commercially available boronic acid derivatives used in step **31.2**:

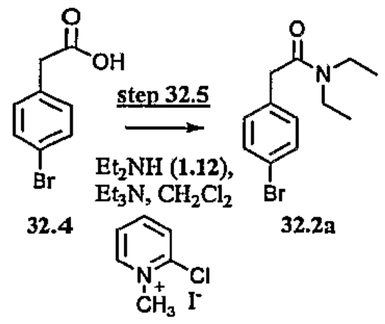


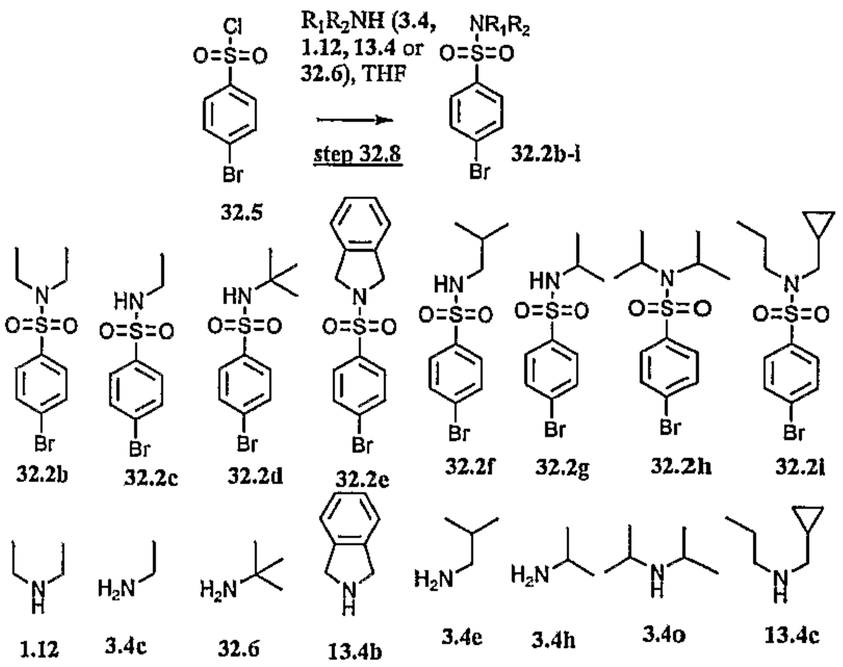


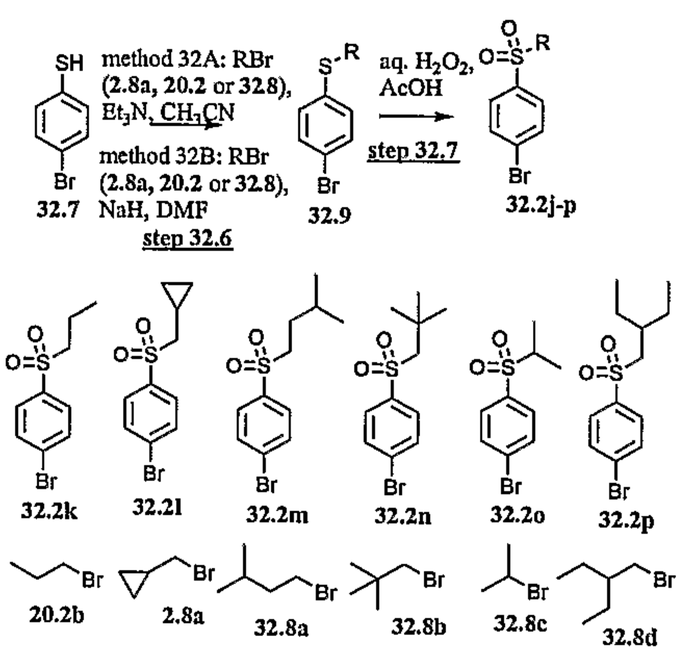
Scheme 32:

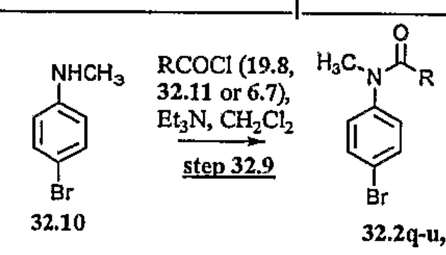


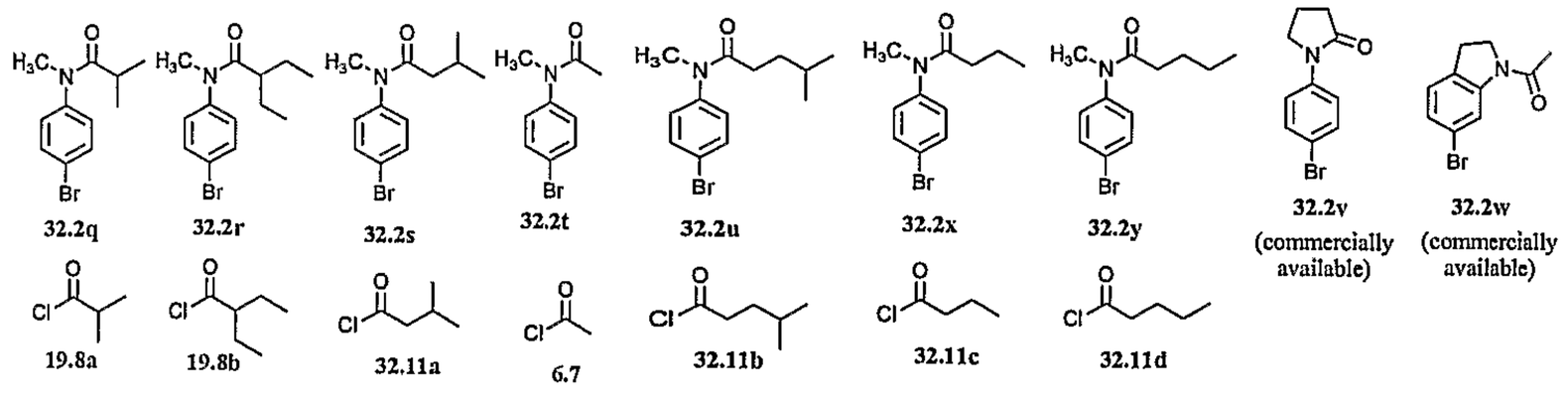
Description and preparation of aryl bromides (32.2) used in step 32.2:

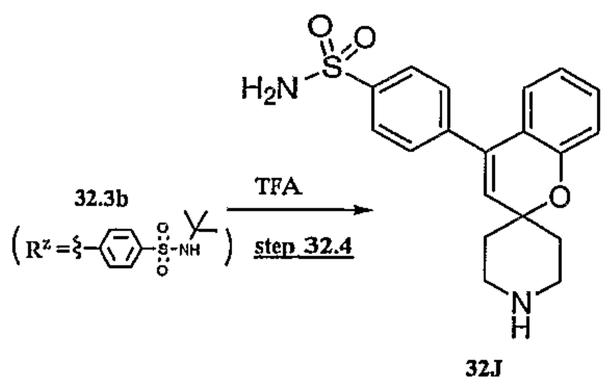




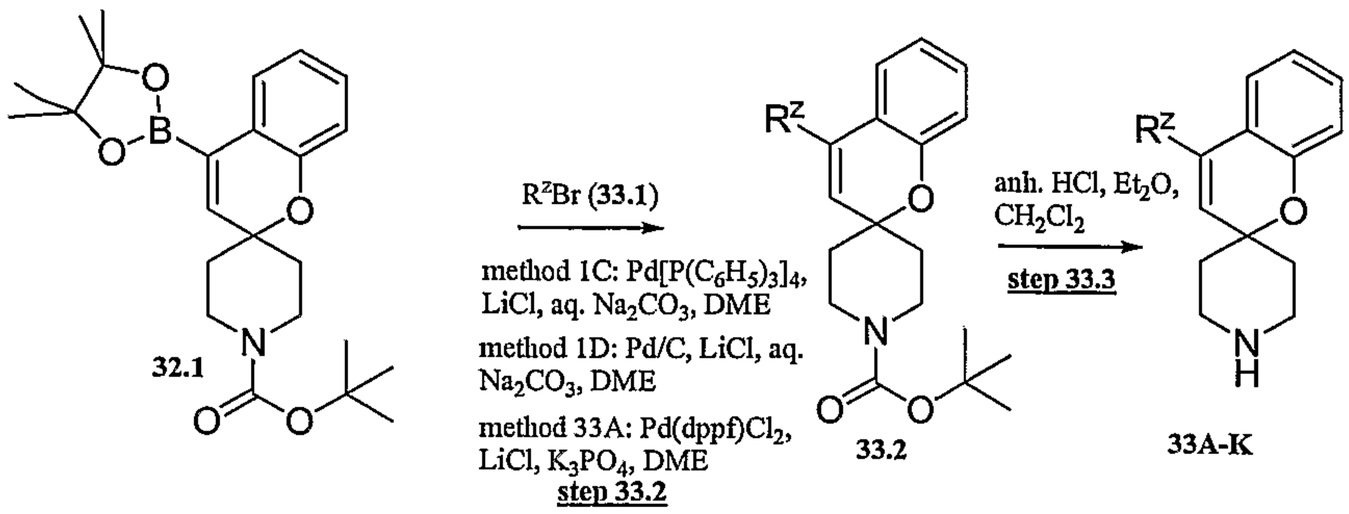




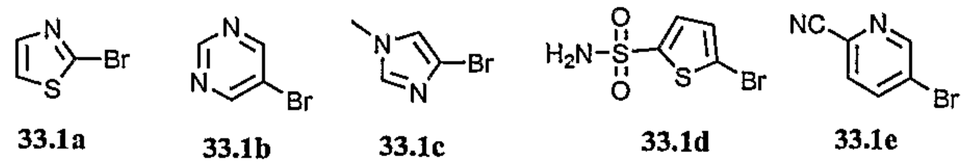




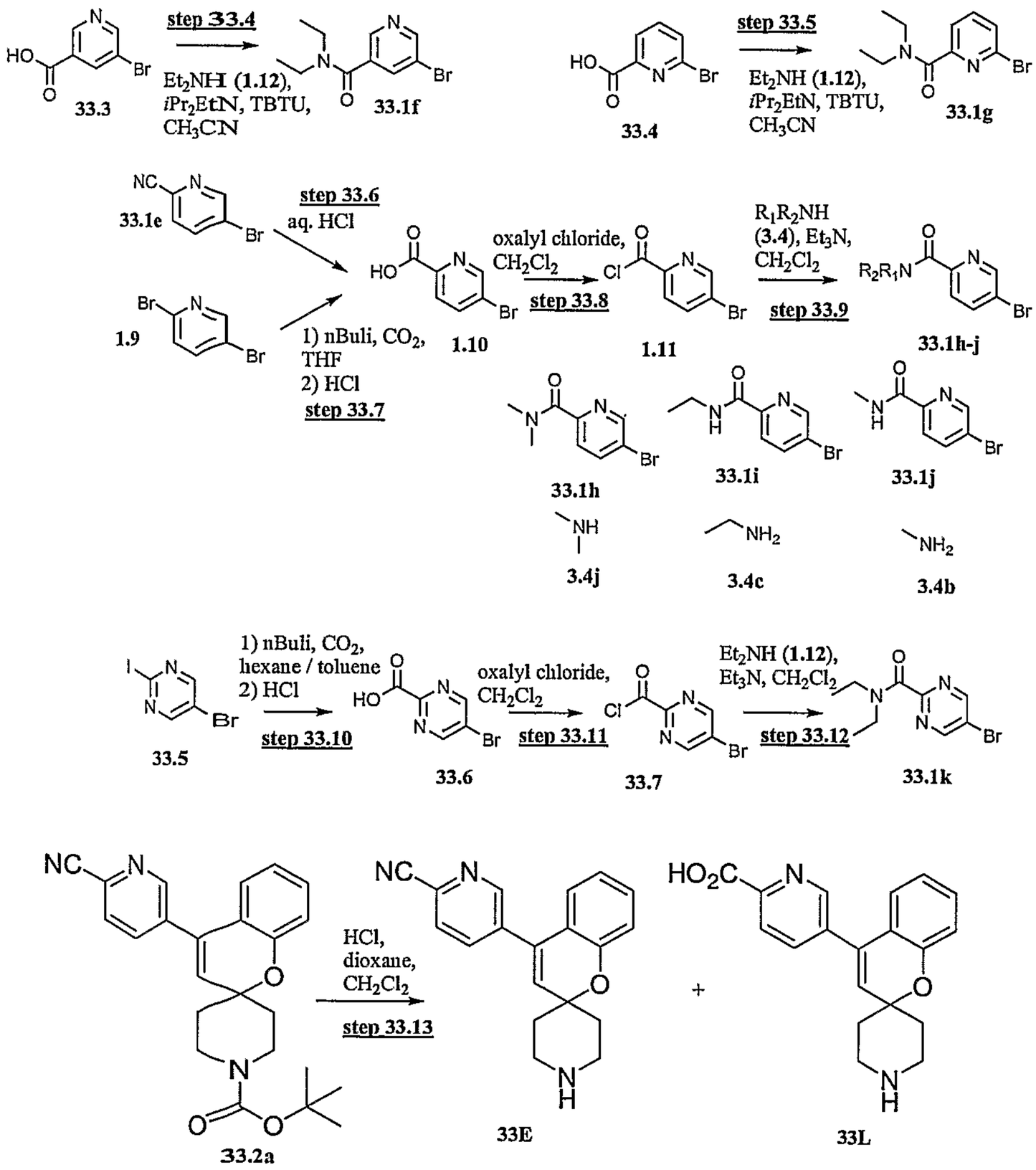
Scheme 33:



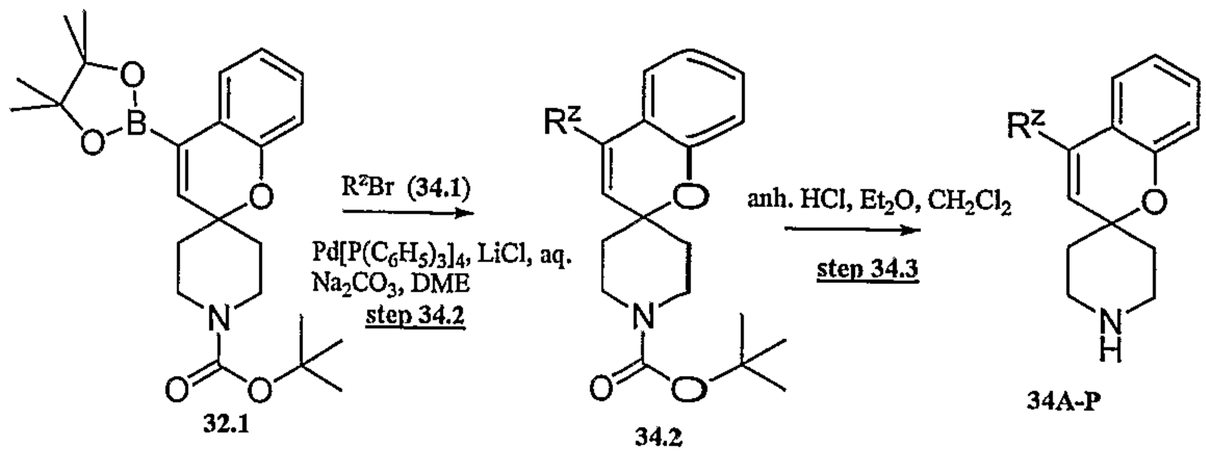
Commercially available R^zBr used in **step 33.2**:



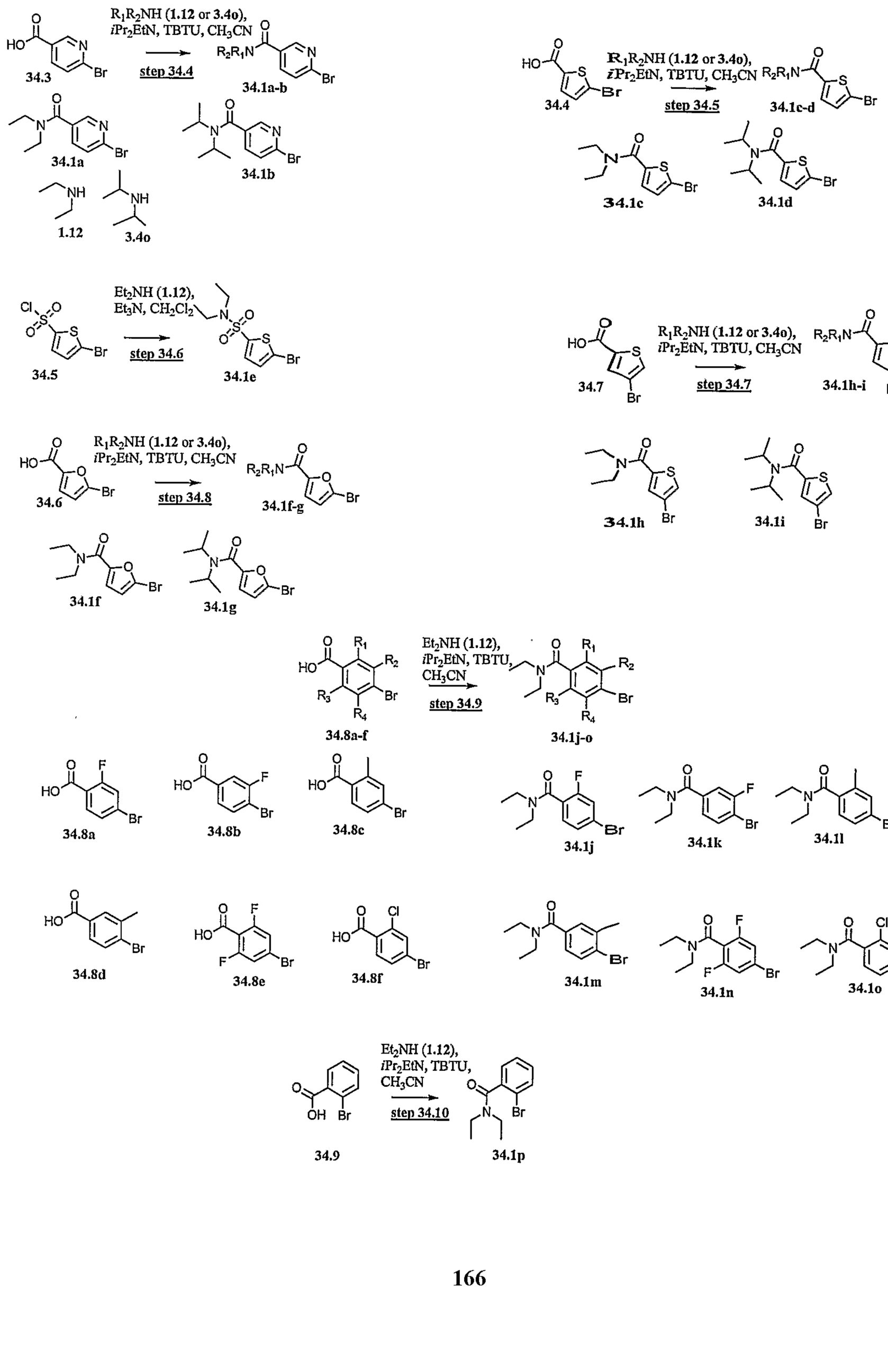
Preparation of R^zBr used in **step 33.2**:



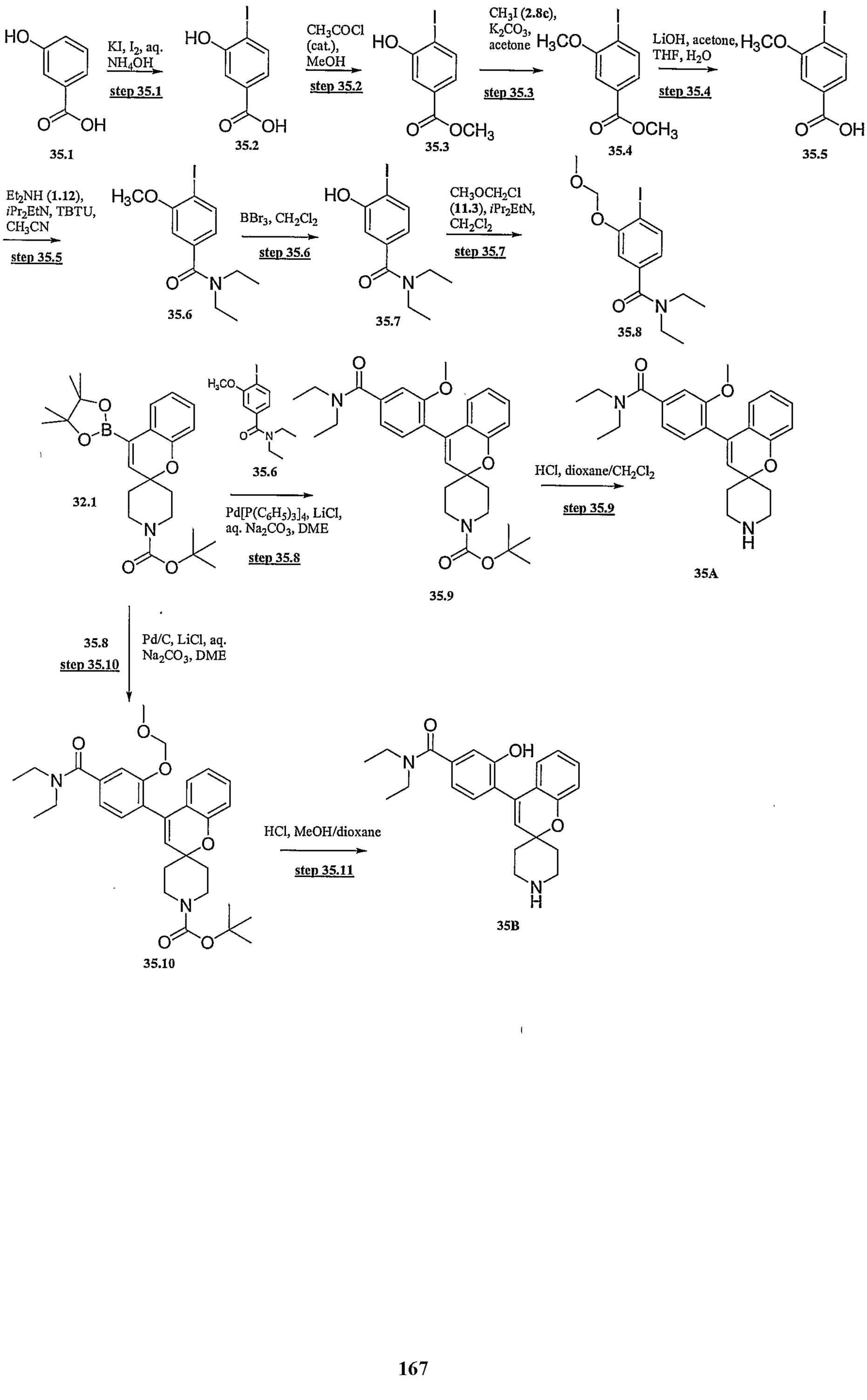
Scheme 34:



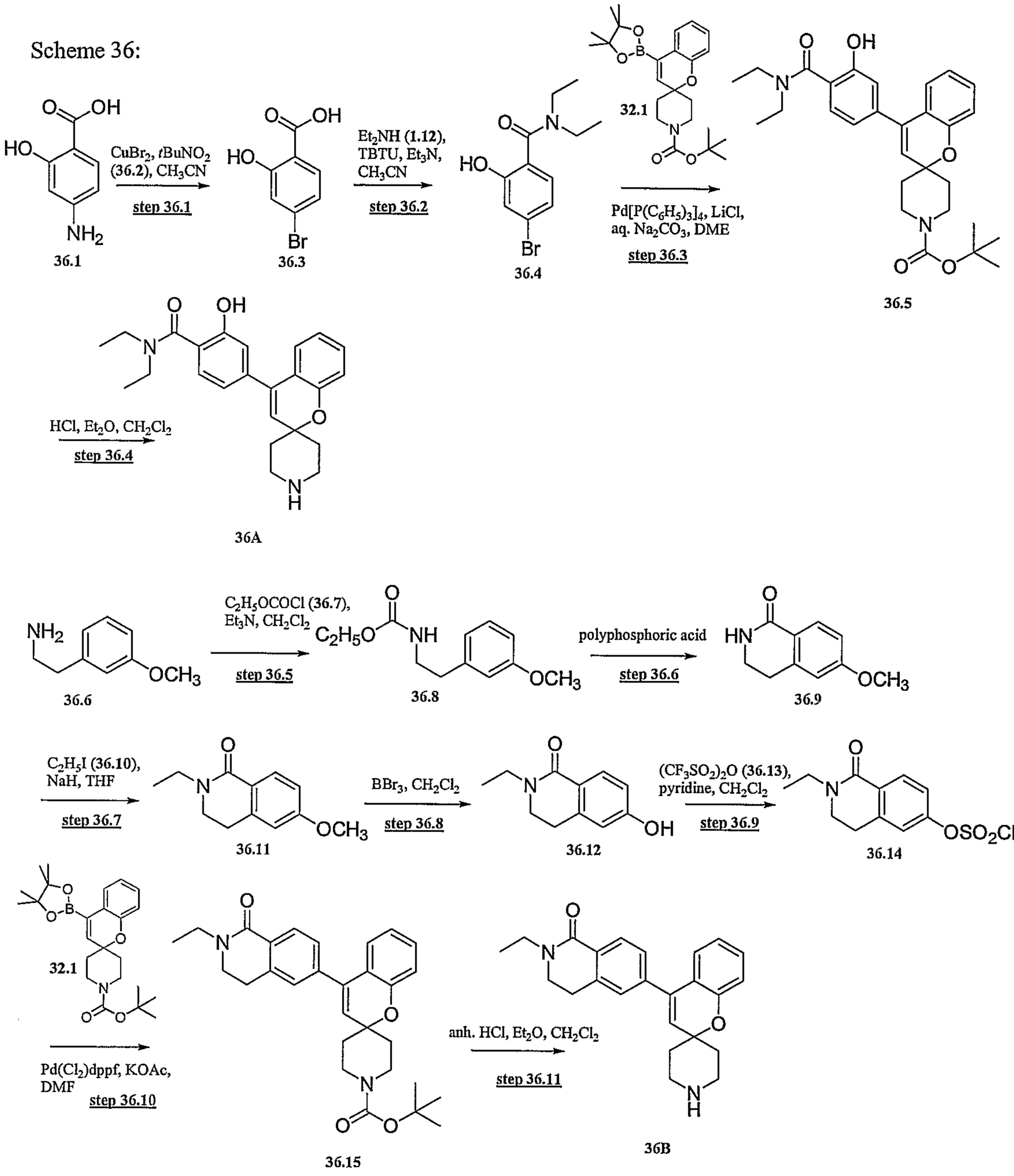
Preparation of R^ZBr used in **step 34.2**:



Scheme 35:


HO
KI, I2, aq. NH4OH
step 35.1
35.1
35.2
CH3COCl (cat.), MeOH
step 35.2
35.3
CH3I (2.8c), K2CO3, acetone
step 35.3
H3CO
35.4
LiOH, acetone, THF, H2O
step 35.4
35.5
Et2NH (1.12), iPr2EtN, TBTU, CH3CN
step 35.5
35.6
BBr3, CH2Cl2
step 35.6
35.7
CH3OCH2Cl (11.3), iPr2EtN, CH2Cl2
step 35.7
35.8
32.1
35.6
Pd[P(C6H5)3]4, LiCl, aq. Na2CO3, DME
step 35.8
35.9
HCl, dioxane/CH2Cl2
step 35.9
35A
35.8
step 35.10
Pd/C, LiCl, aq. Na2CO3, DME
35.10
HCl, MeOH/dioxane
step 35.11
35B

Scheme 36:



36.1 36.3 36.4 36.5

36A

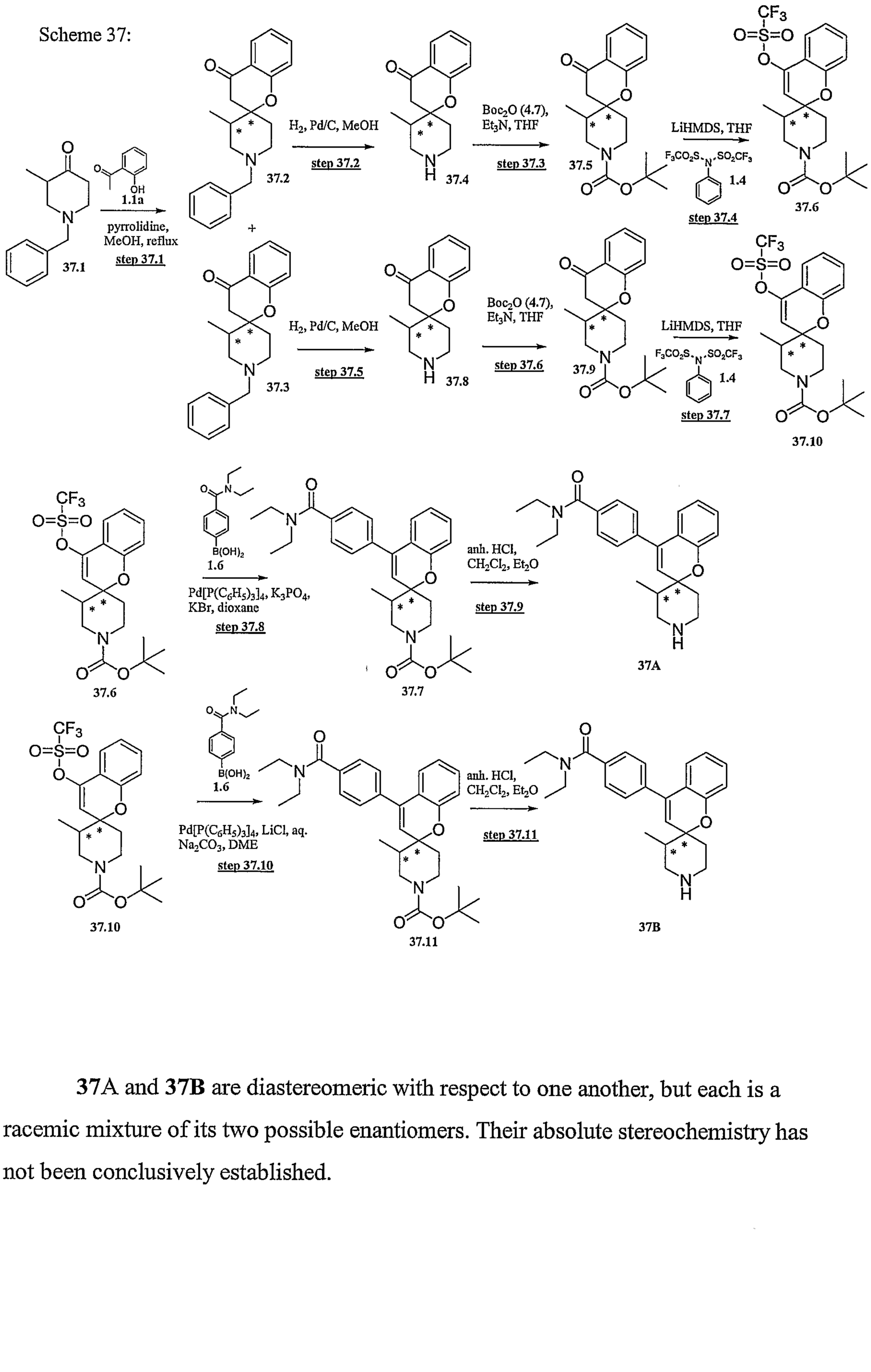
36.6 36.8 36.9

36.11 36.12 36.14

36.15

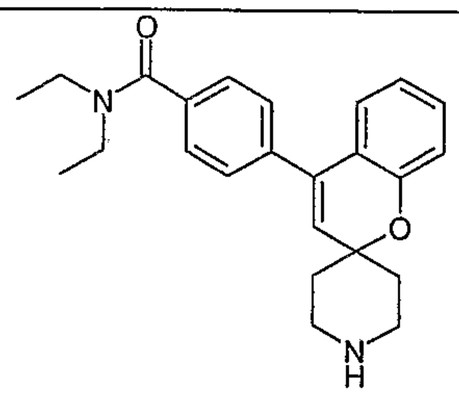
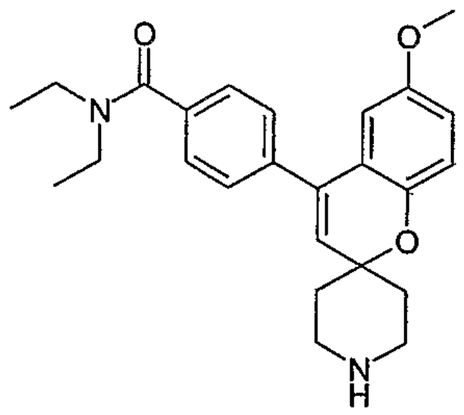
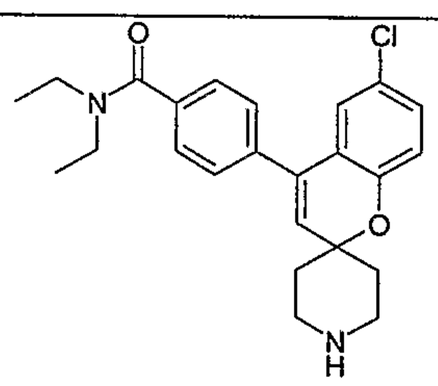
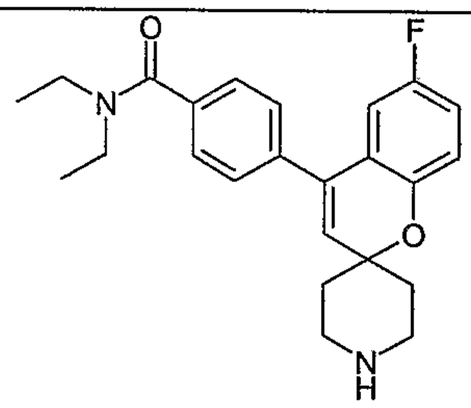
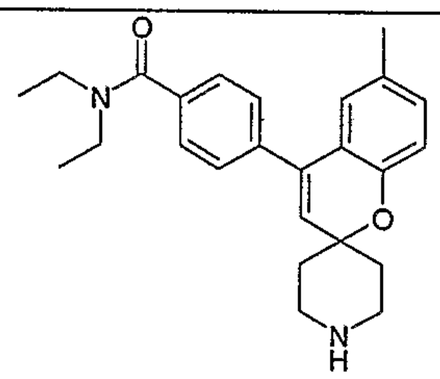
36B

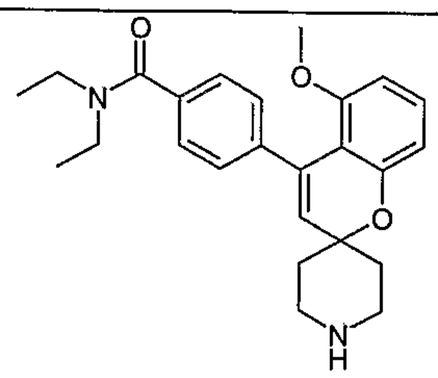
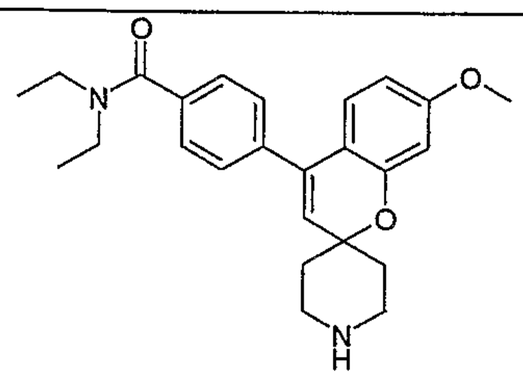
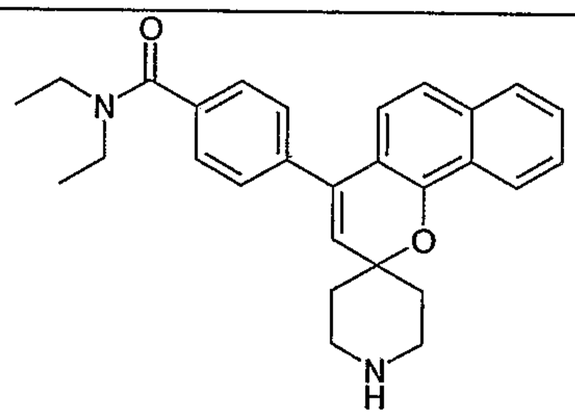
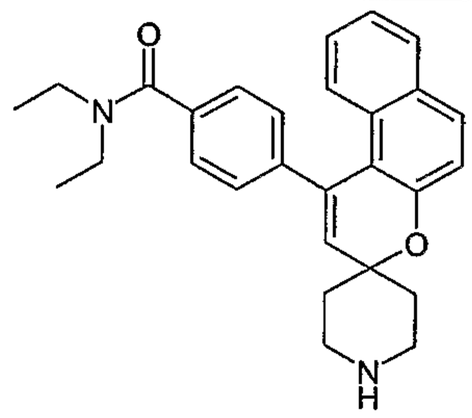
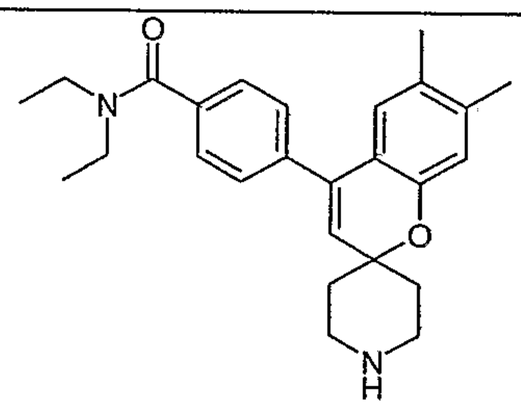
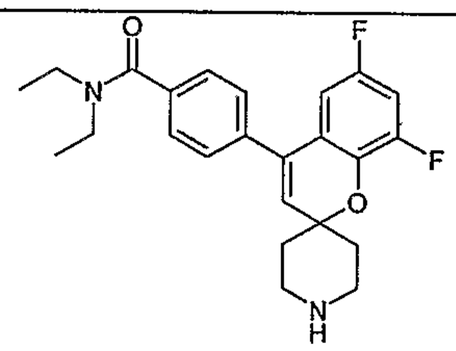
Scheme 37:

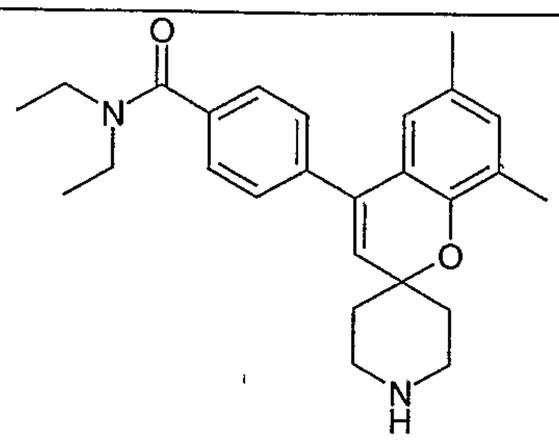
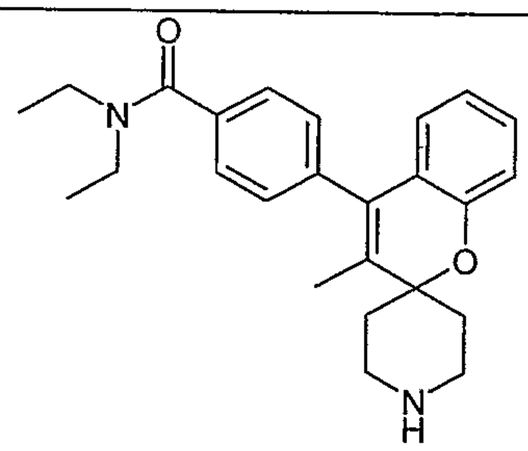
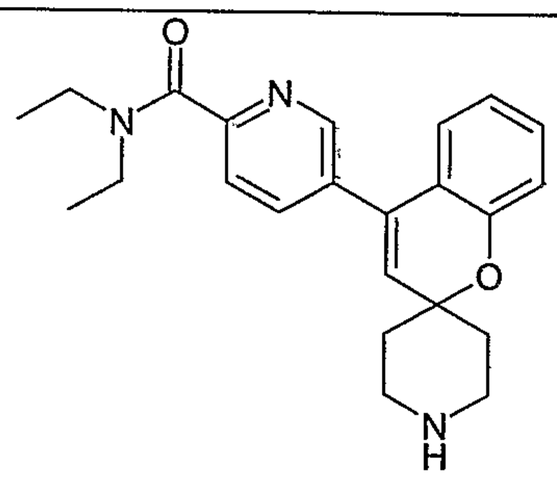
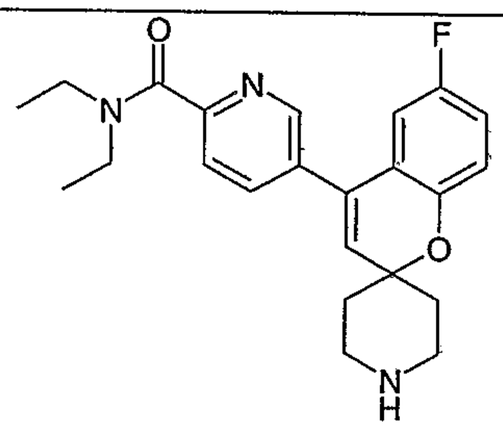
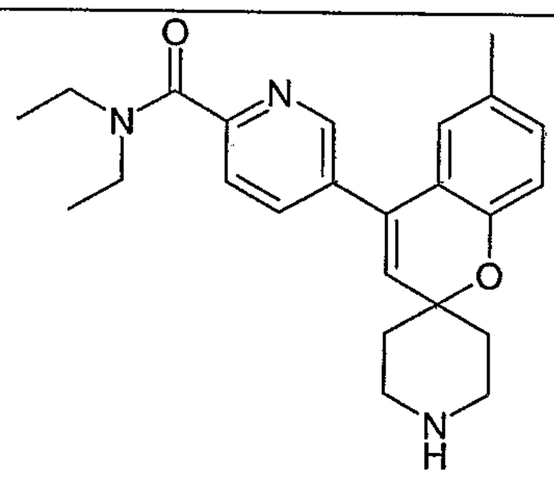


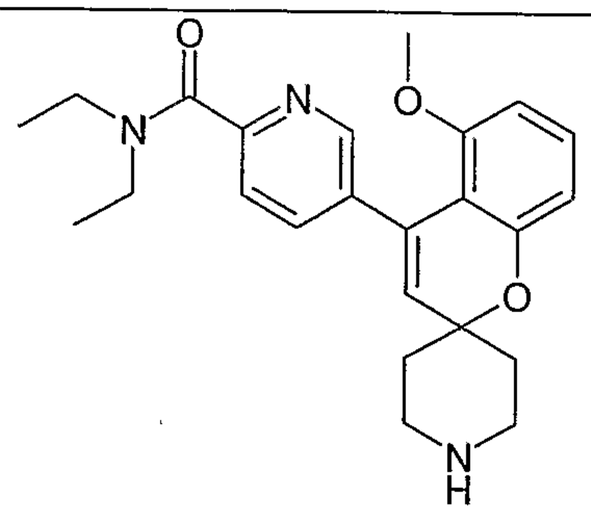
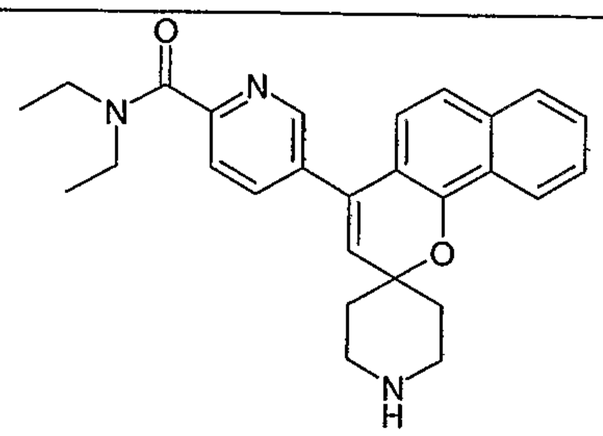
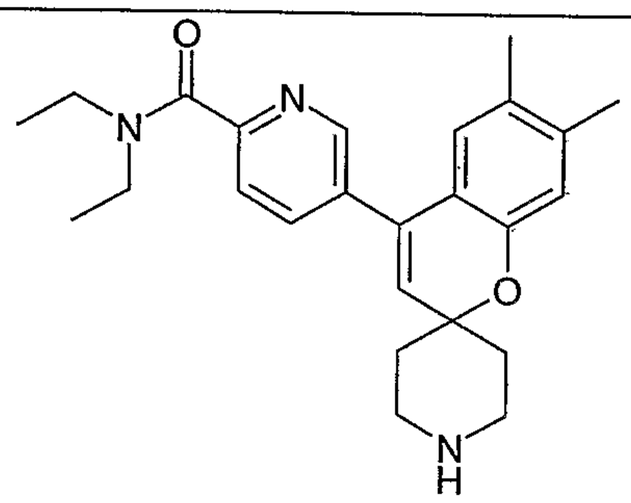
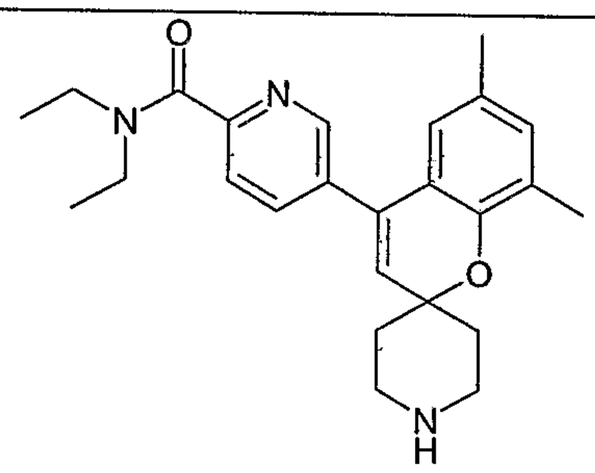
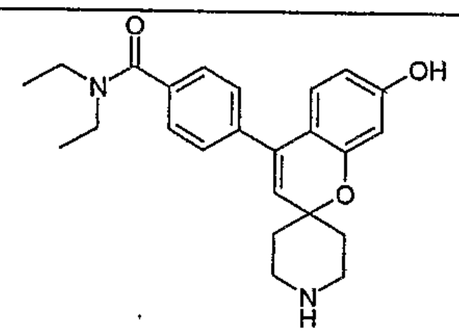
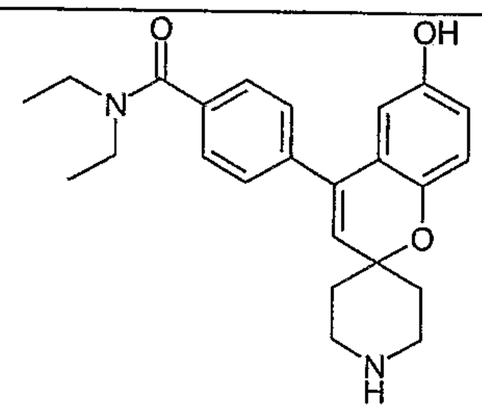
37A and **37B** are diastereomeric with respect to one another, but each is a racemic mixture of its two possible enantiomers. Their absolute stereochemistry has not been conclusively established.

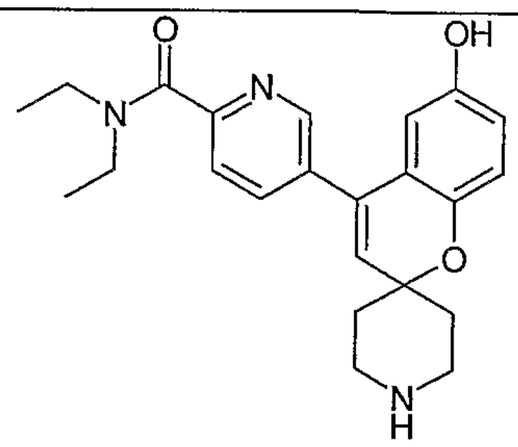
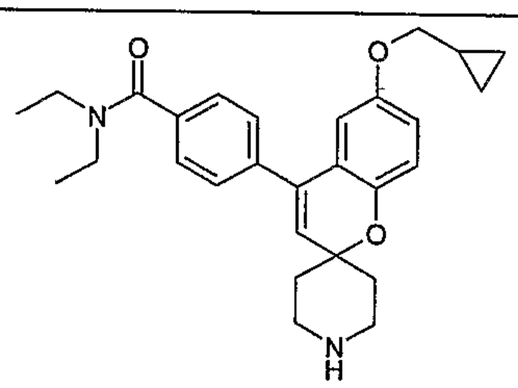
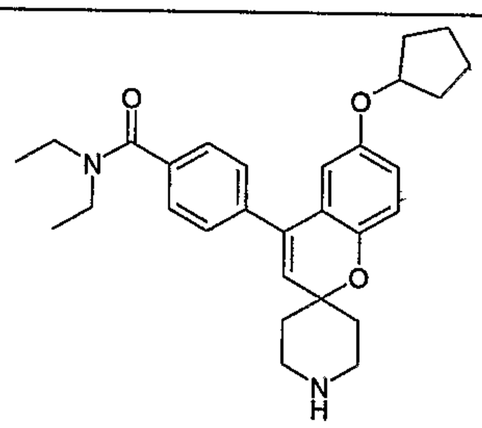
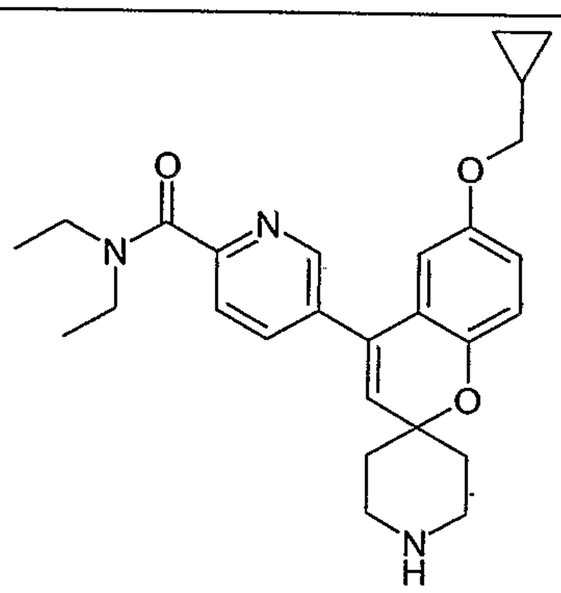
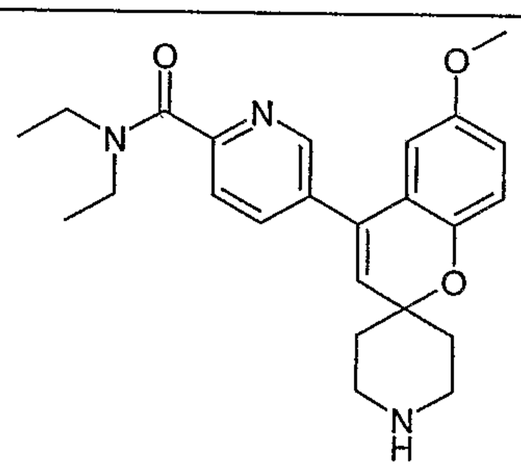
C. TABLE 1: EXAMPLES CLAIMED IN THE PRESENT INVENTION

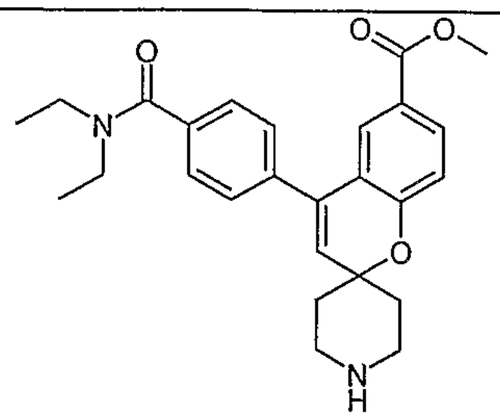
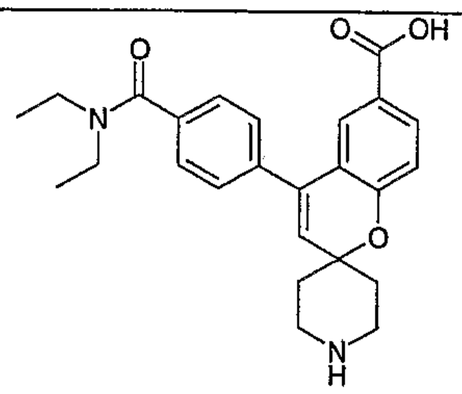
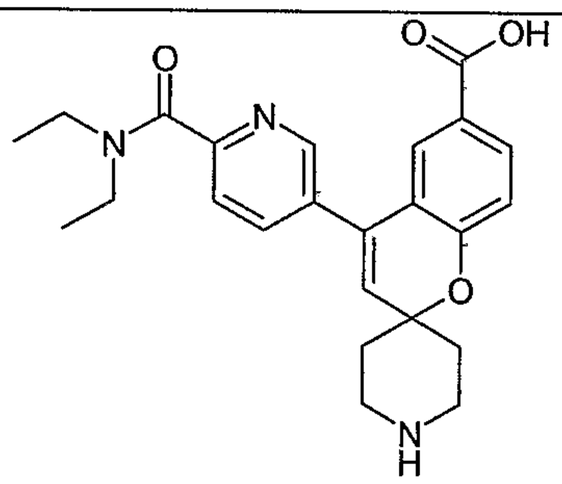
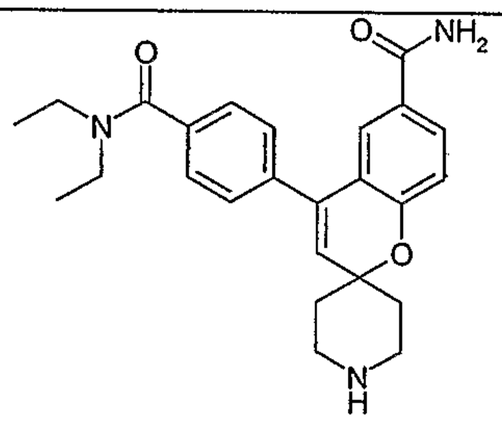
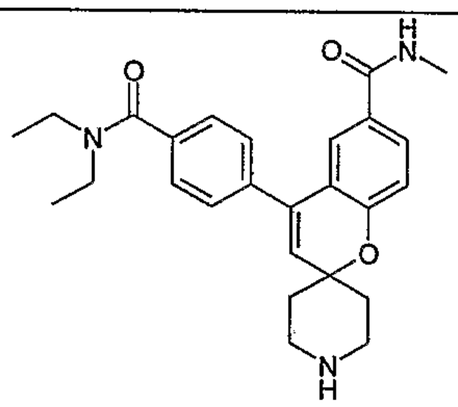
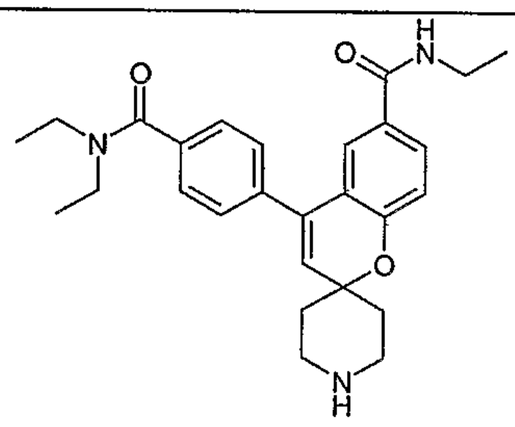
Example	***Structure***	[M+H]+
1A		377.4
1B		407.1
1C		411.2
1D		395.2
1E		391.3

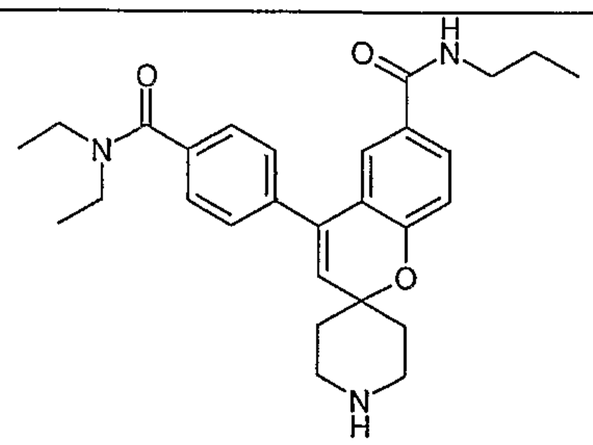
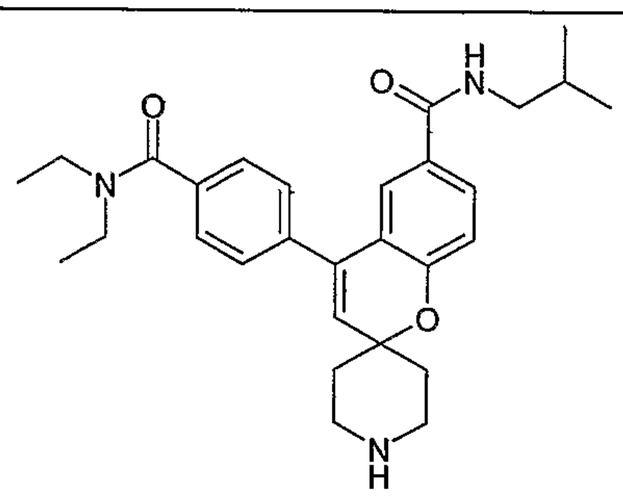
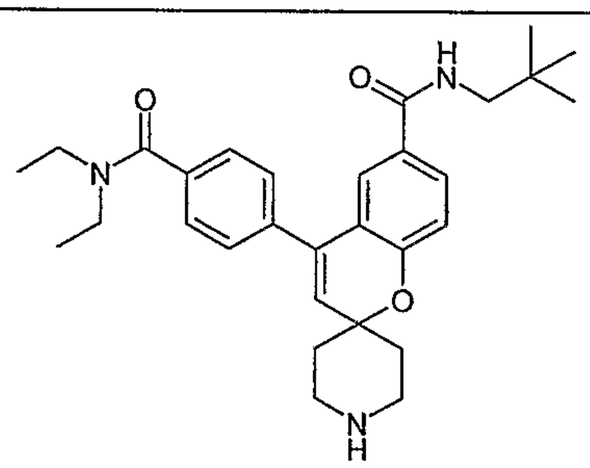
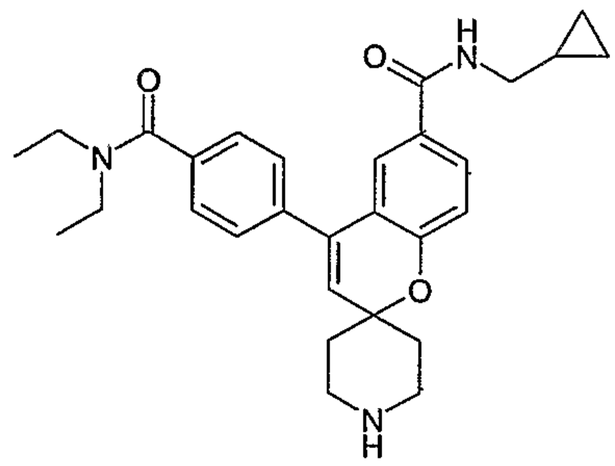
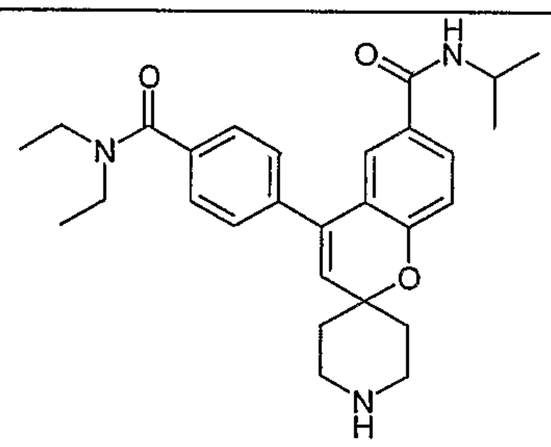
Example	***Structure***	[M+H]+
1F		407.2
1G		407.1
1H		427.4
1I		427.4
1J		405.4
1K		413.2

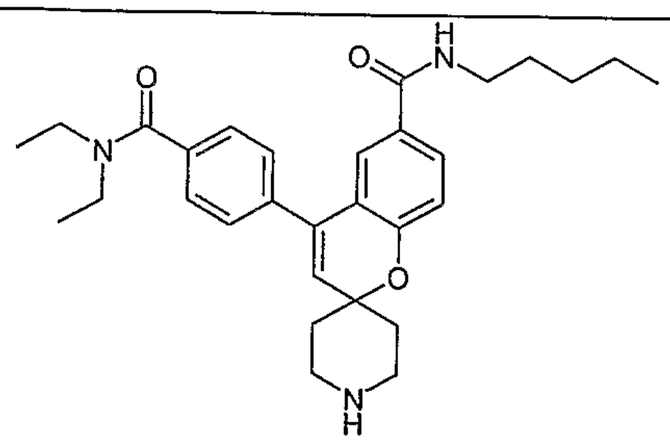
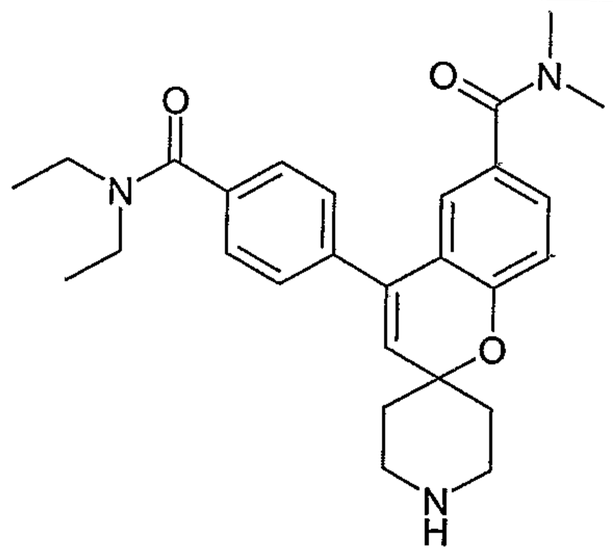
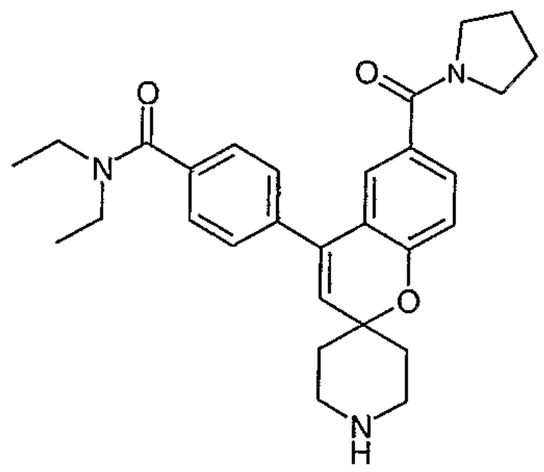
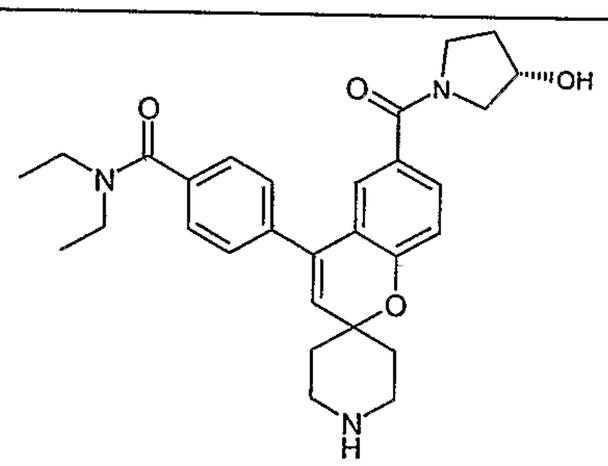
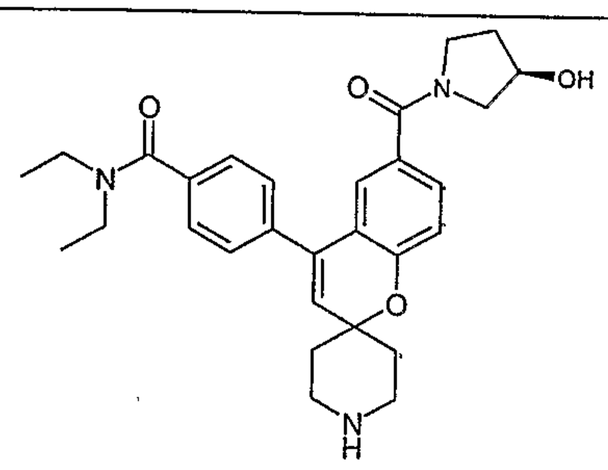
Example	***Structure***	[M+H]+
1L		405.4
1M		391.0
1N		378.4
1O		396.3
1P		392.3

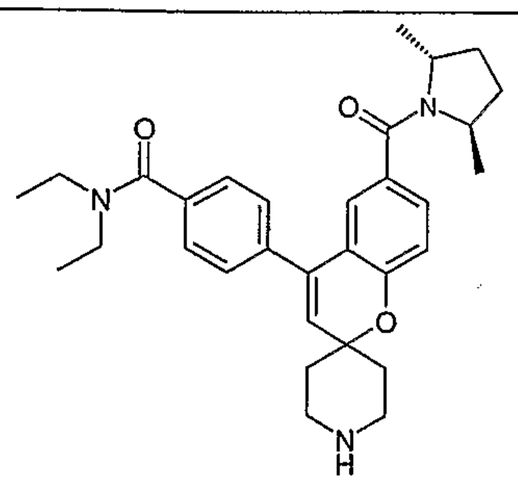
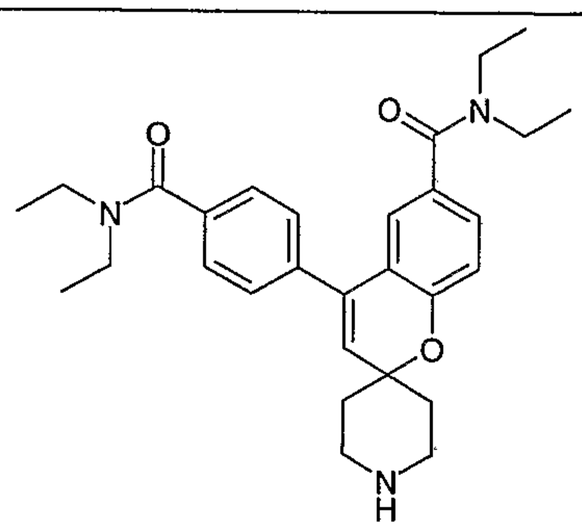
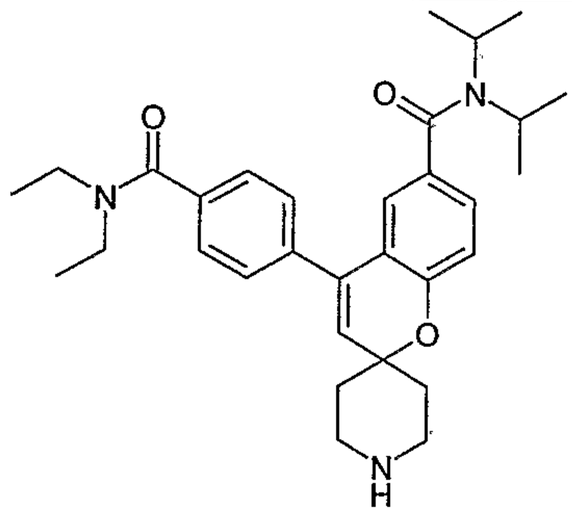
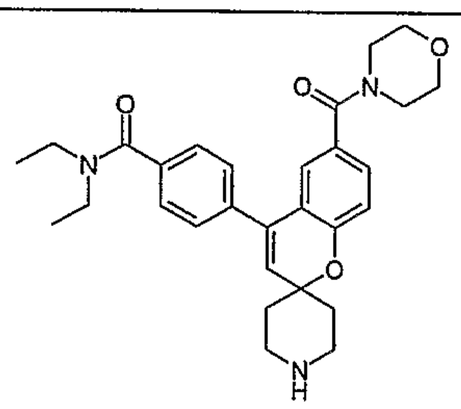
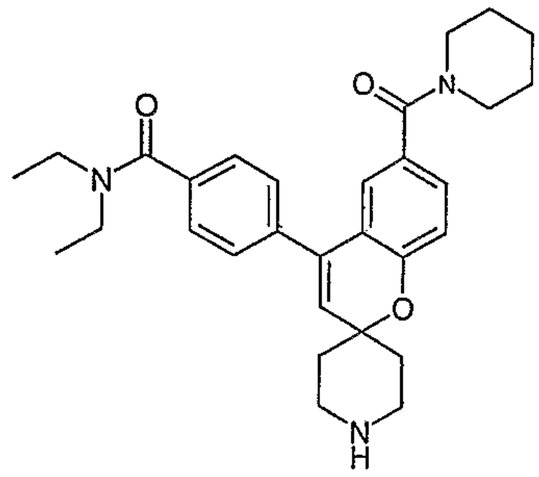
Example	***Structure***	[M+H]+
1Q		408.3
1R		428.3
1S		406.3
1T		406.4
1U		393.2
2A		393.3

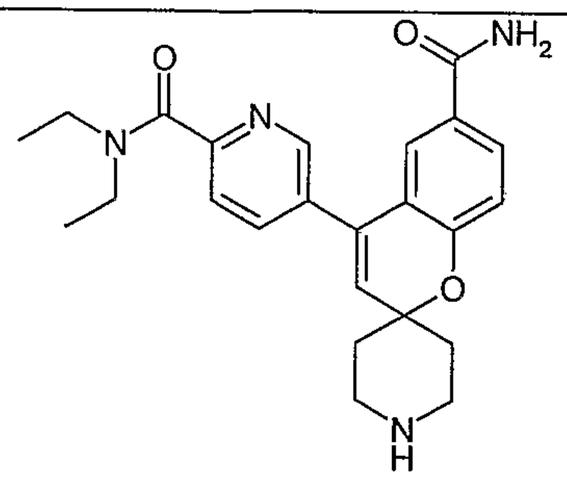
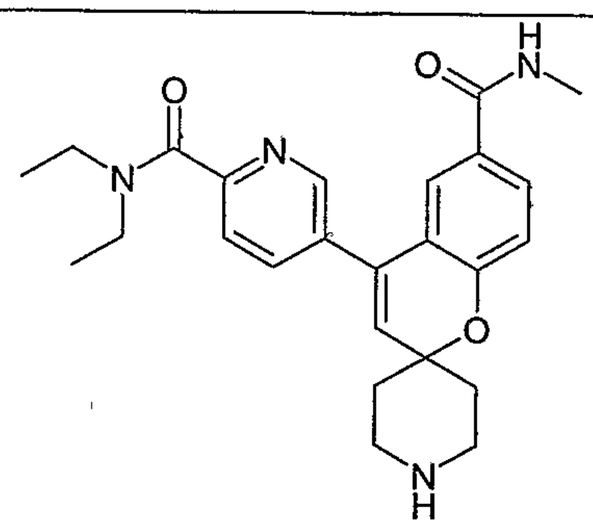
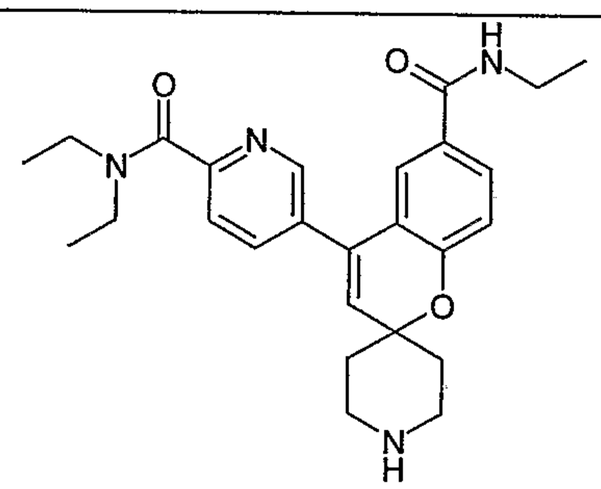
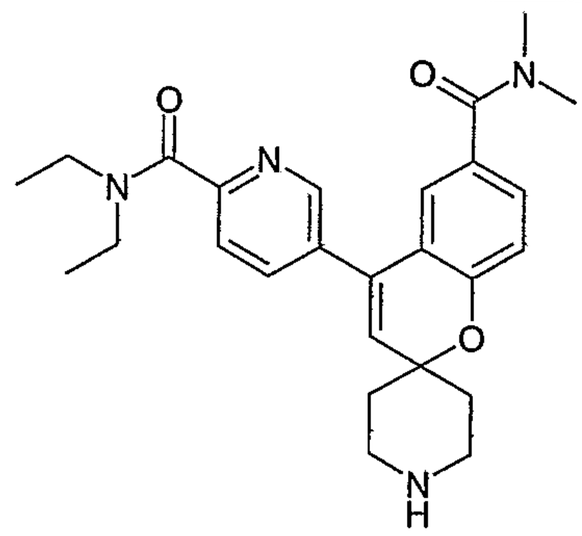
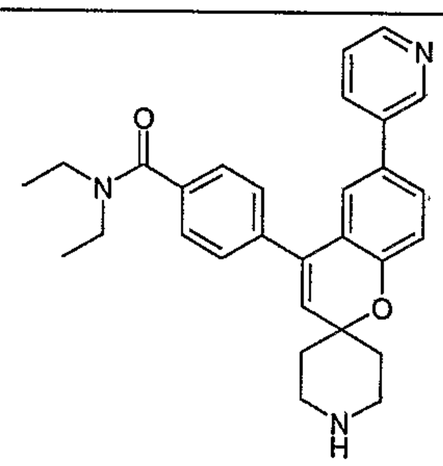
Example	***Structure***	[M+H]+
2B		394
2C		447.1
2D		461.1
2E		448.3
2F		408.3

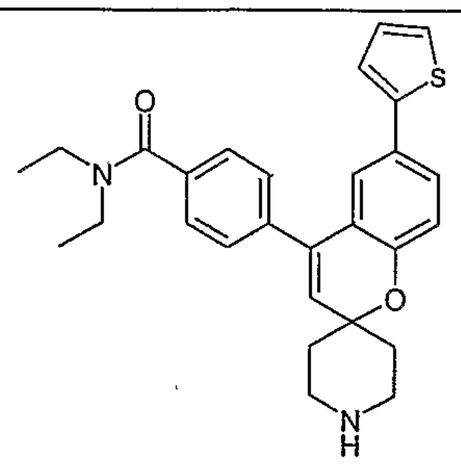
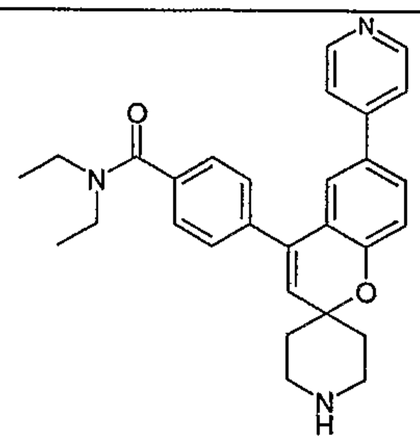
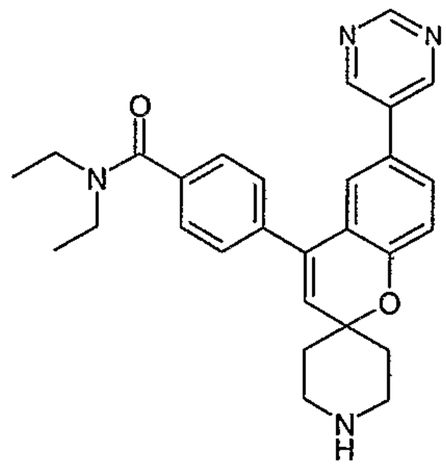
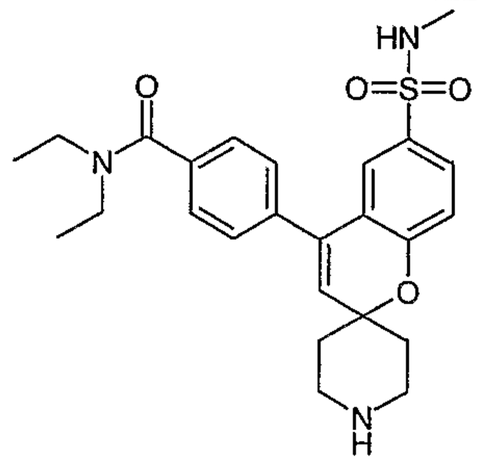
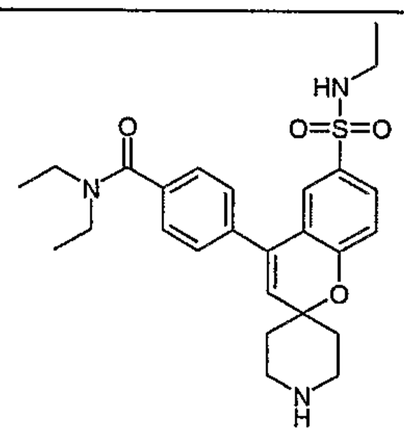
Example	***Structure***	[M+H]+
3A		435.0
3B		421.0
3C		422.2
3D		420.0
3E		434.3
3F		448.4

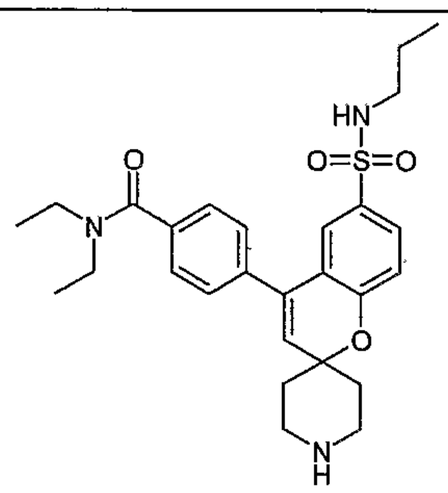
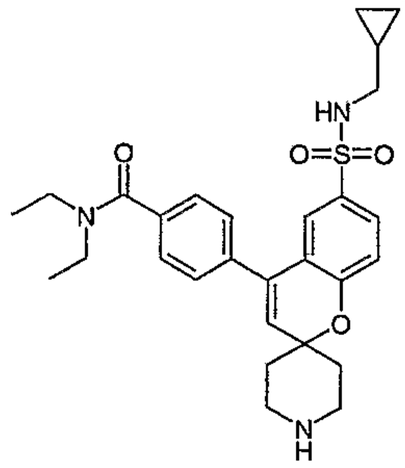
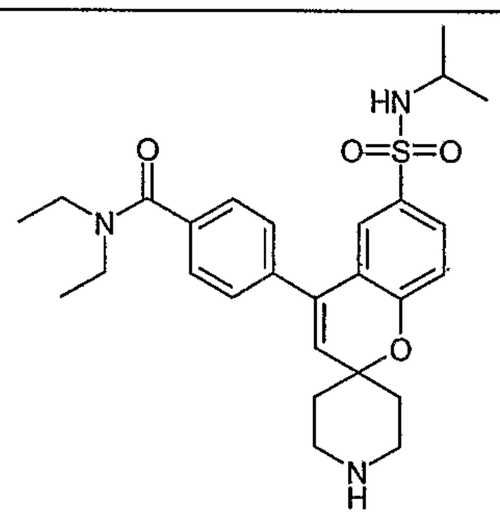
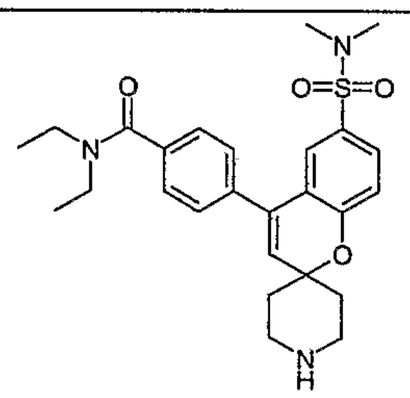
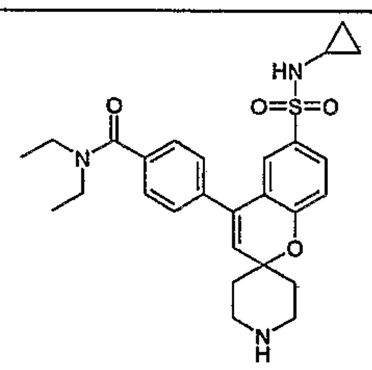
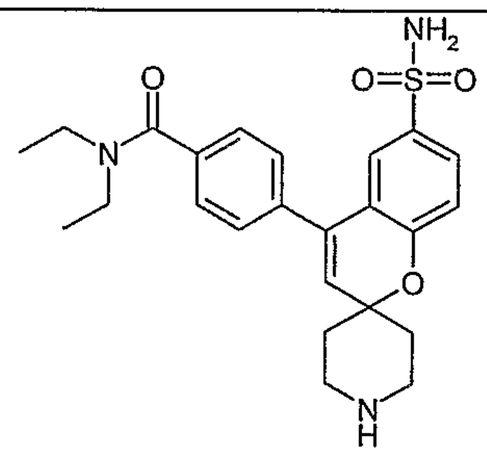
Example	***Structure***	[M+H]+
3G		462.4
3H		476.5
3I		490.6
3J		474.4
3K		462.5

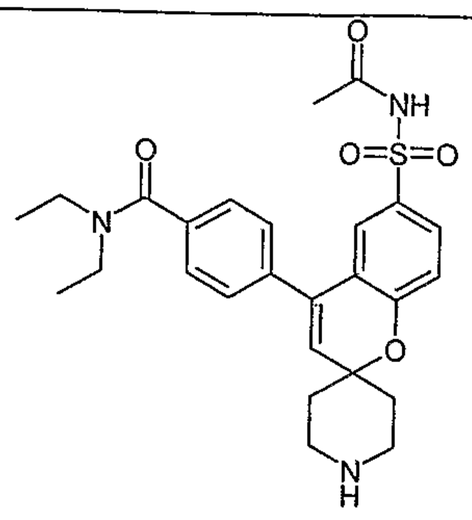
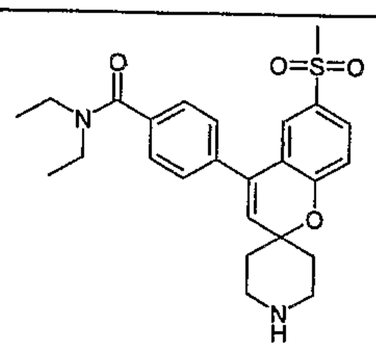
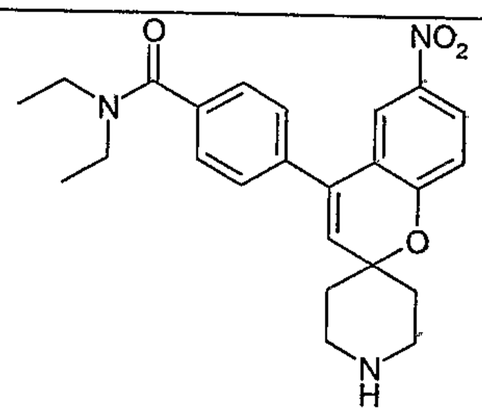
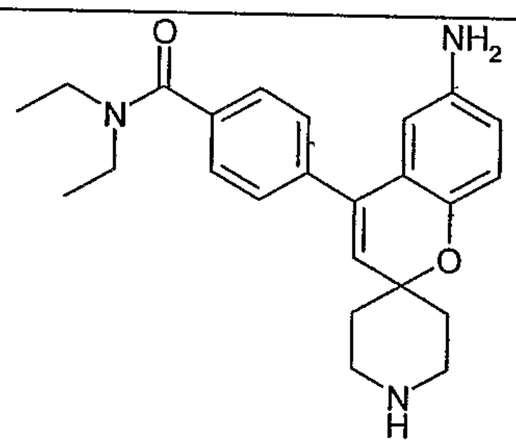
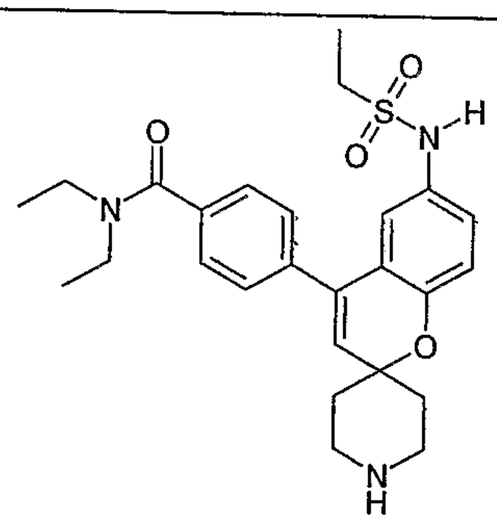
Example	***Structure***	[M+H]+
3L		490.5
3M		448.4
3N		474.5
3O		490.3
3P		490.5

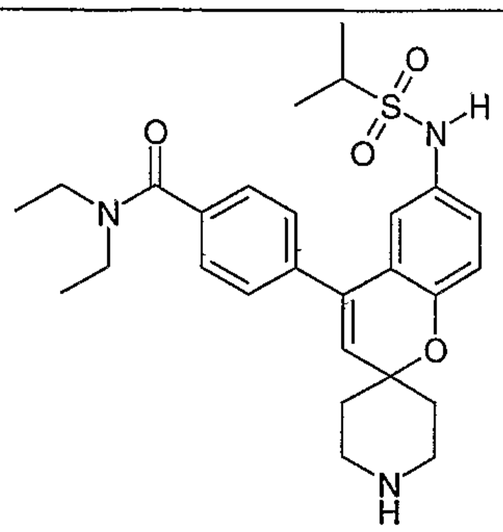
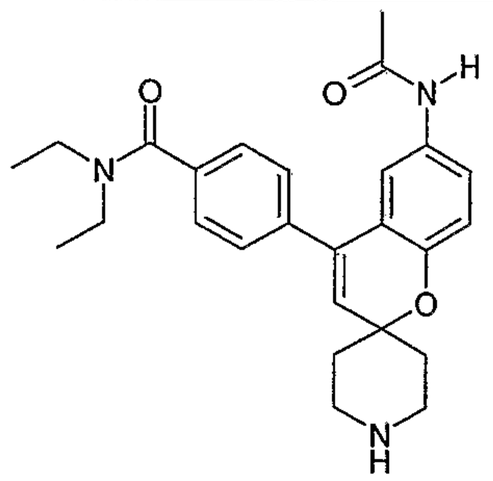
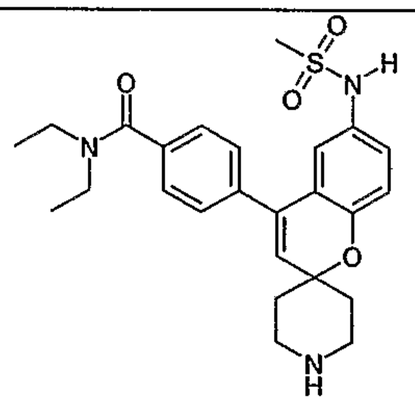
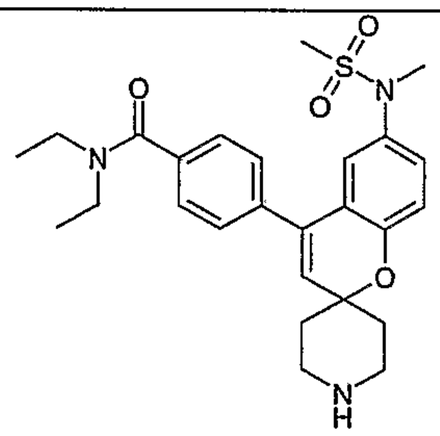
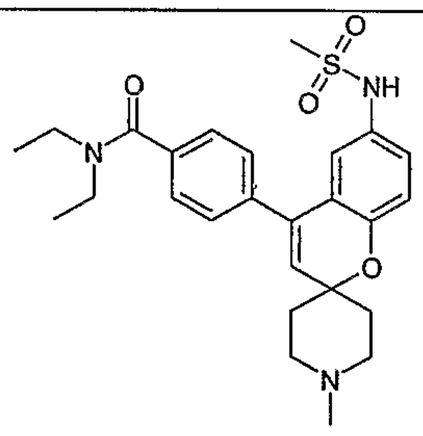
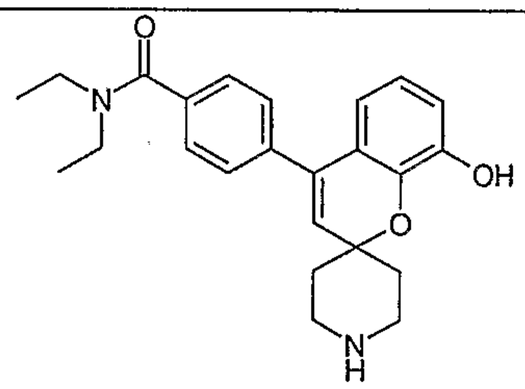
Example	***Structure***	[M+H]+
3Q		502.5
3R		476.5
3S		504.4
3T		490.1
3U		488.4

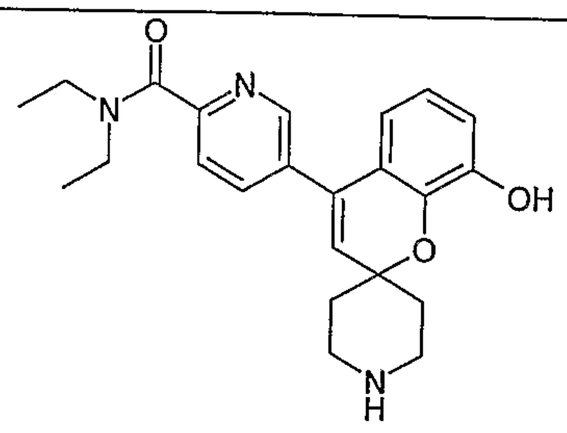
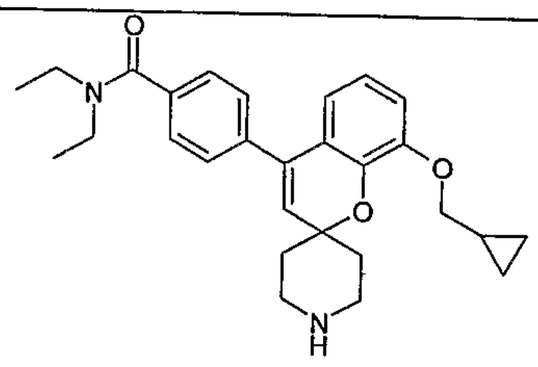
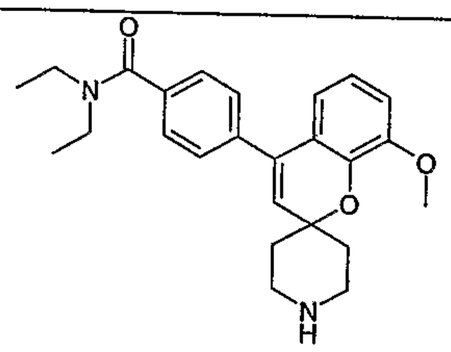
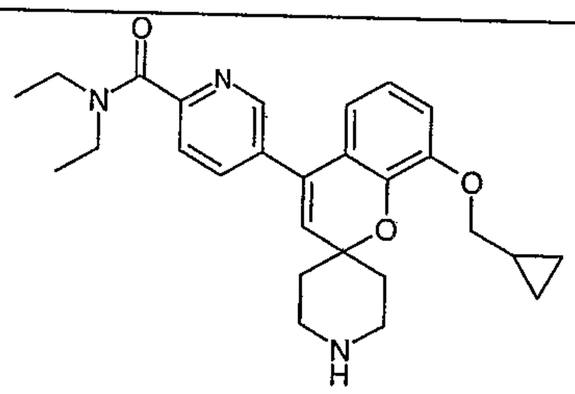
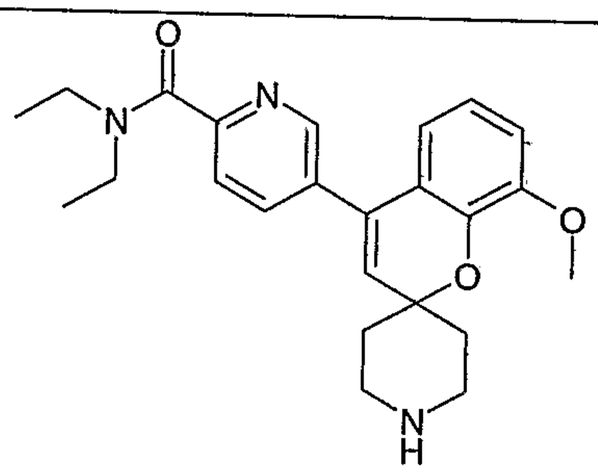
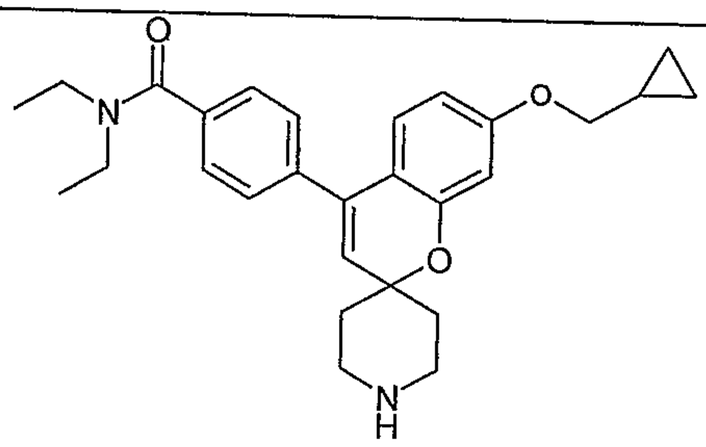
Example	***Structure***	[M+H]+
3V		421.3
3W		435.3
3X		449.3
3Y		449.3
3Z		454.0

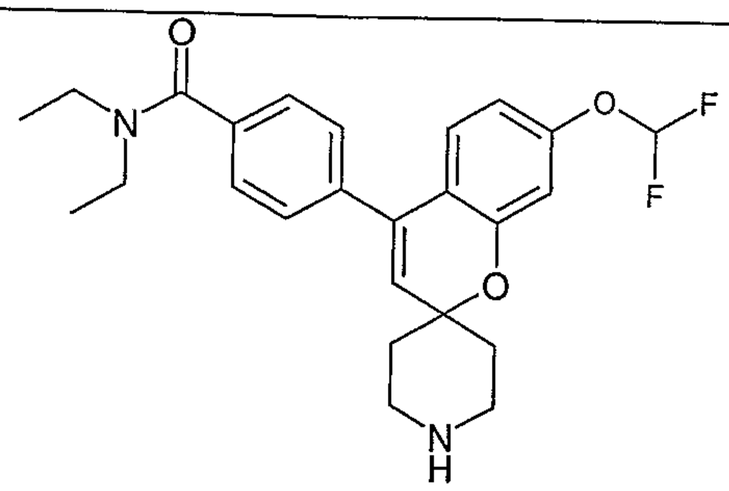
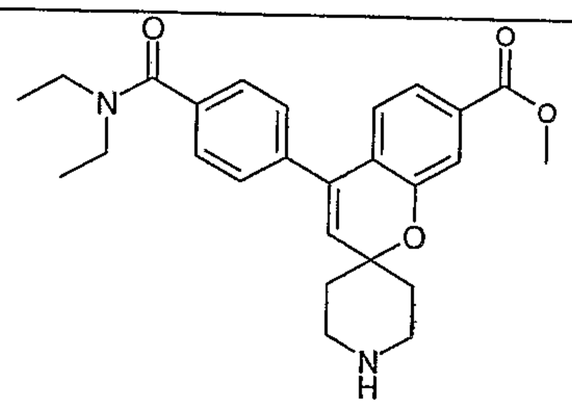
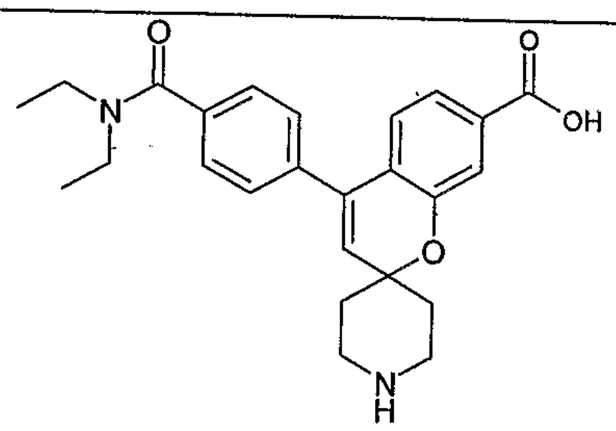
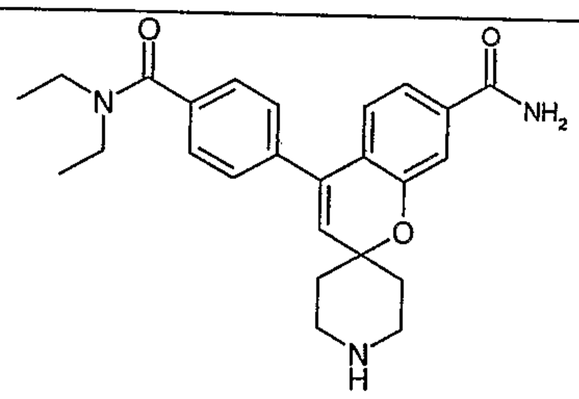
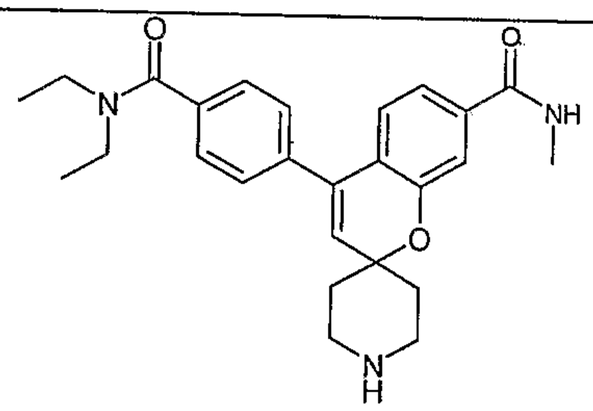
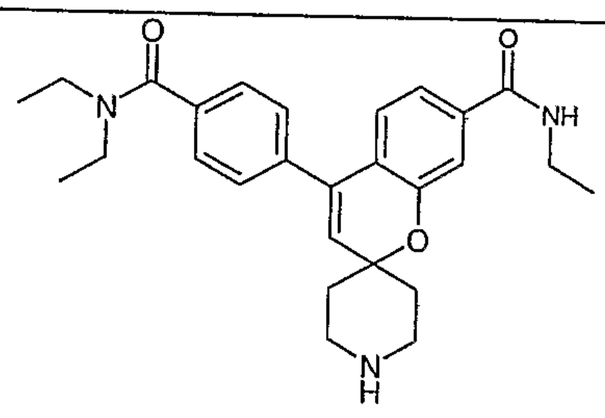
Example	***Structure***	[M+H]+
3AA		459.3
3AB		454.4
3AC		455.4
4A		470.2
4B		484.3

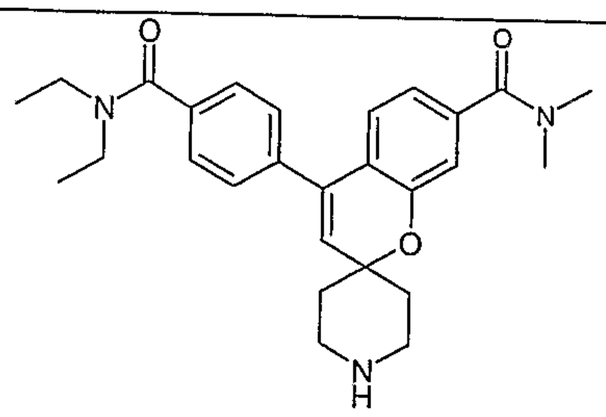
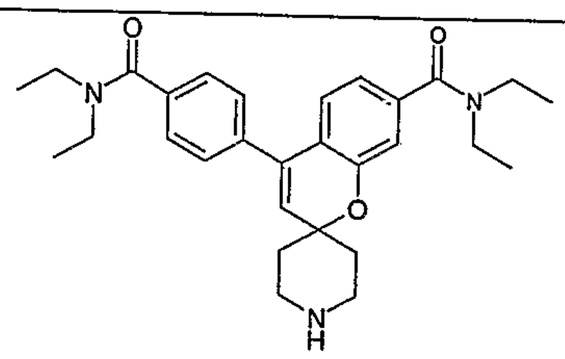
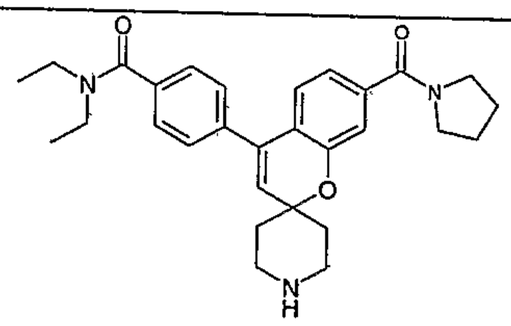
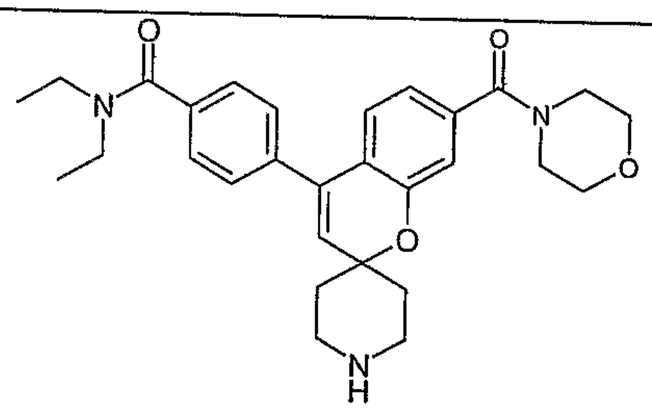
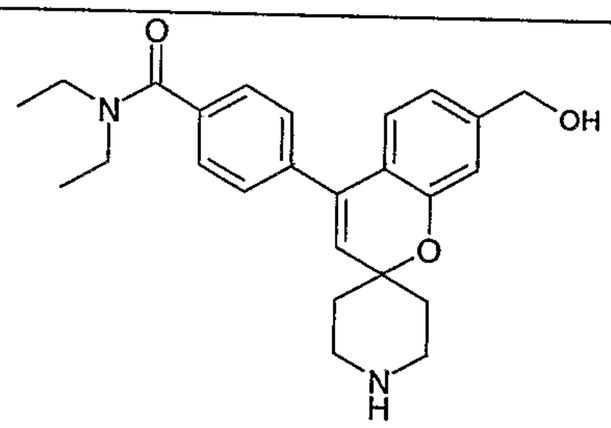
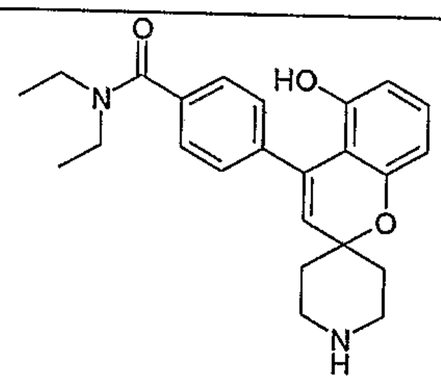
Example	***Structure***	[M+H]+
4C		498.3
4D		510.3
4E		498.3
4F		484.1
4G		496.2
4H		456.0

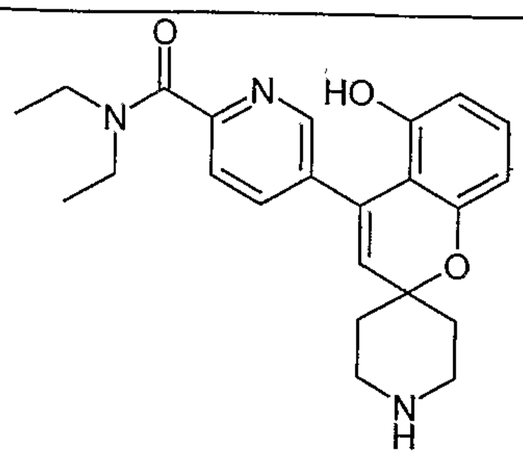
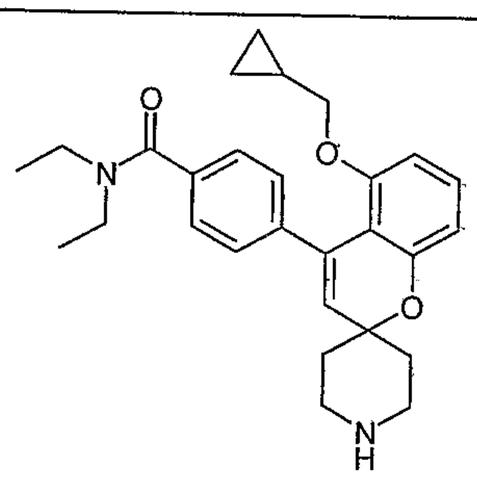
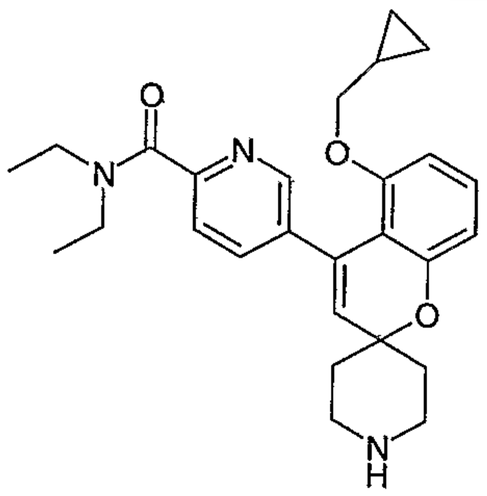
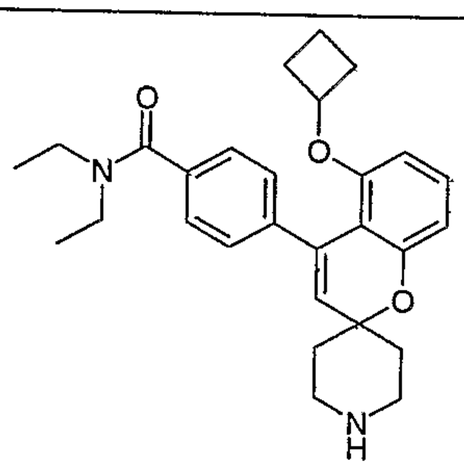
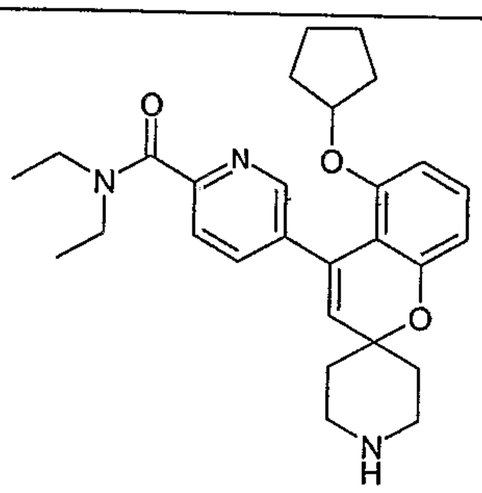
Example	***Structure***	[M+H]+
4I		498.3
5A		455.2
6A		422.3
6B		392.2
6C		484.2

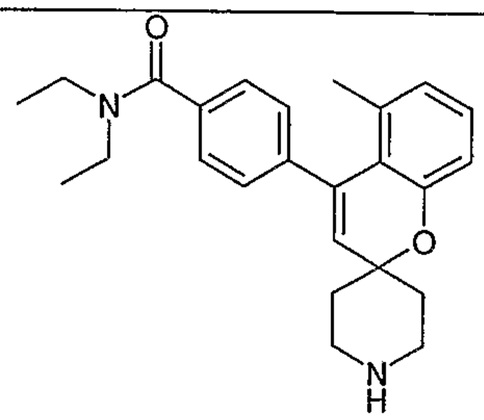
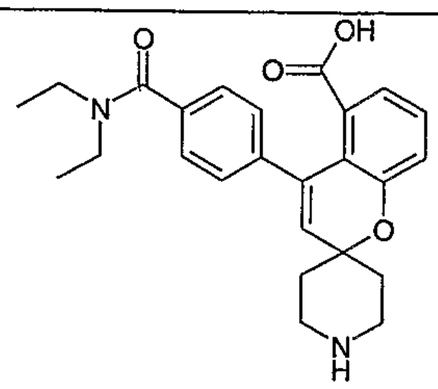
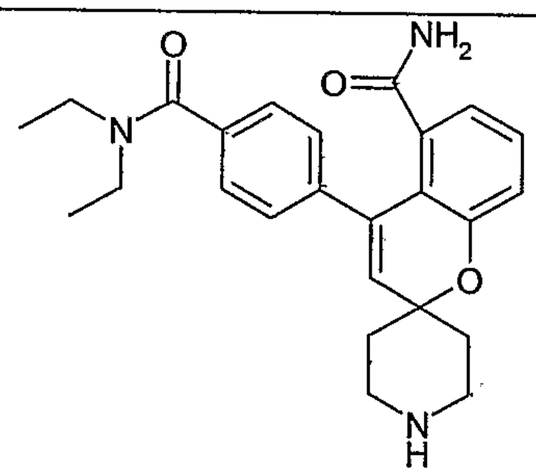
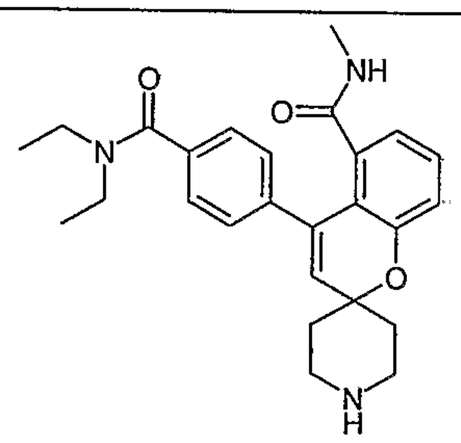
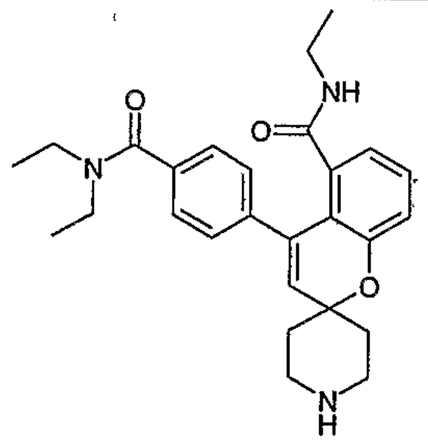
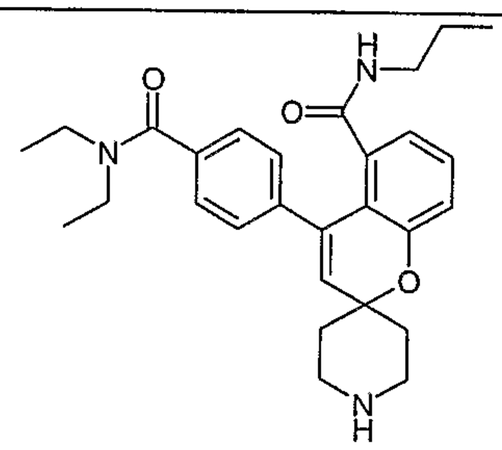
Example	***Structure***	[M+H]+
6D		498.2
6E		434.2
7A		470.4
7B		484.2
7C		484.2
8A		393.4

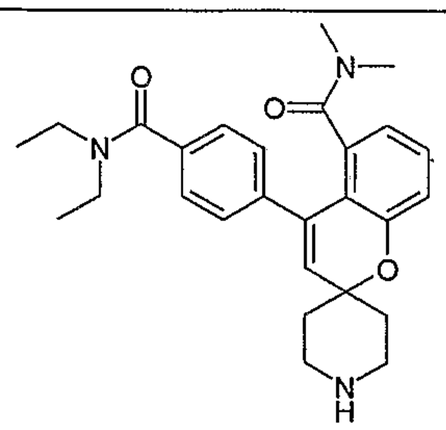
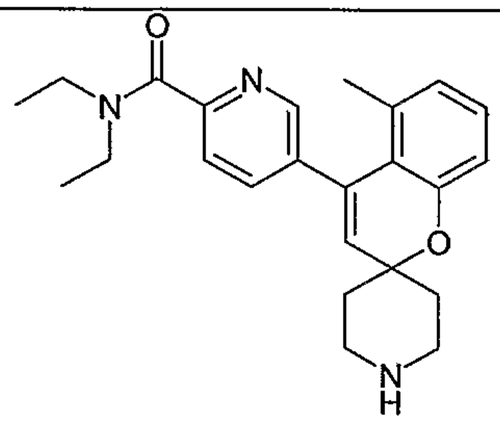
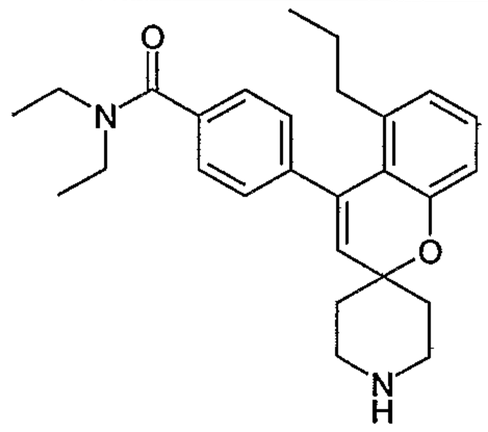
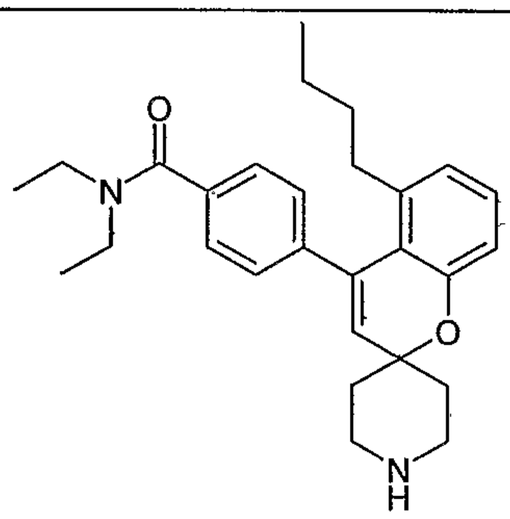
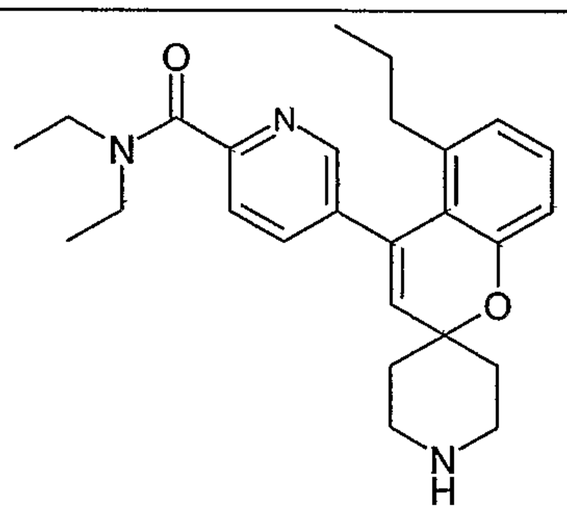
Example	***Structure***	[M+H]+
8B		394.2
8C		447.3
8D		407.3
8E		448.3
8F		408.4
9A		447.3

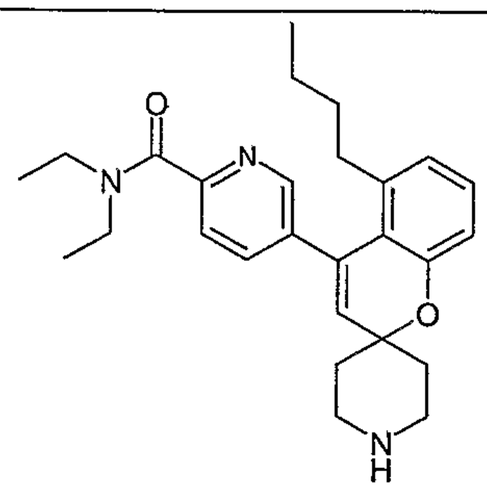
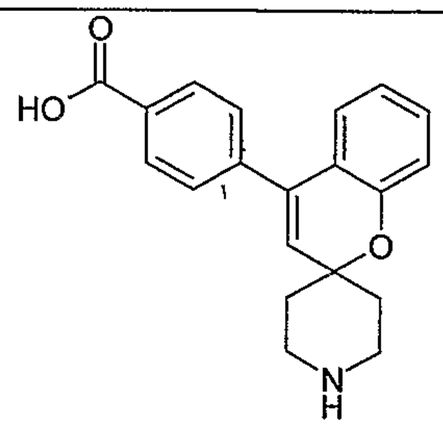
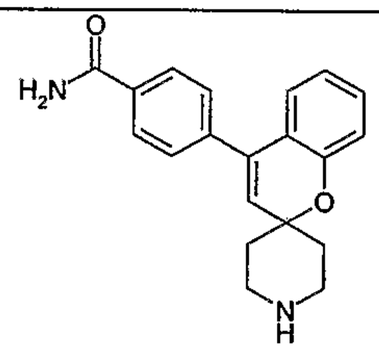
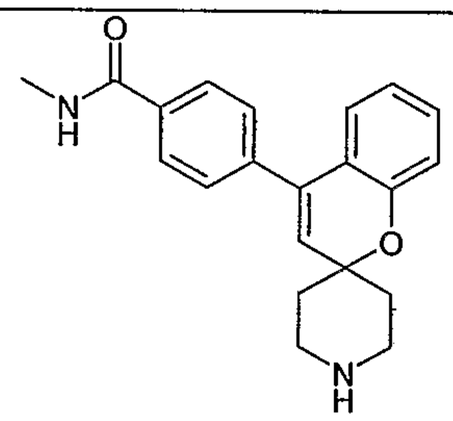
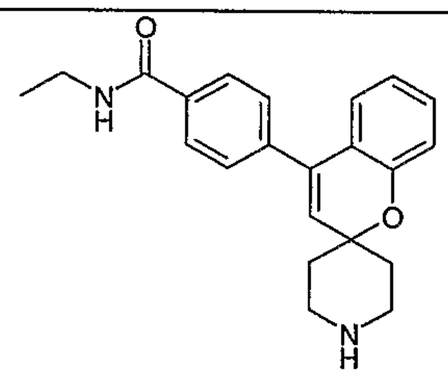
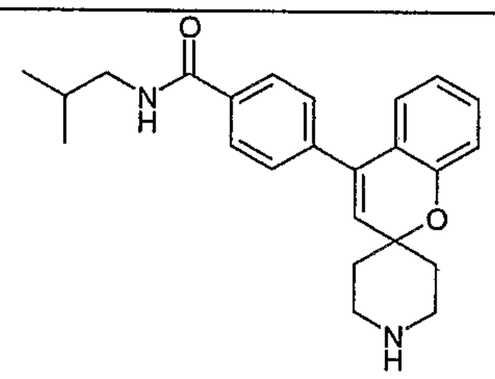
Example	***Structure***	**[M+H]+**
9B		443.4
10A		435.3
10B		421.3
10C		420.3
10D		434.3
10E		448.3

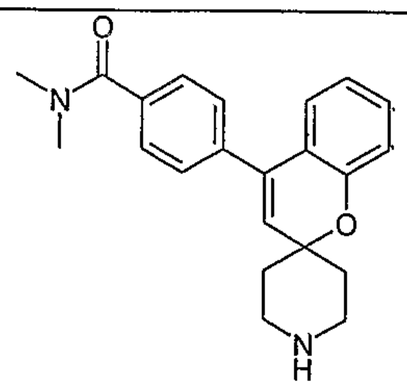
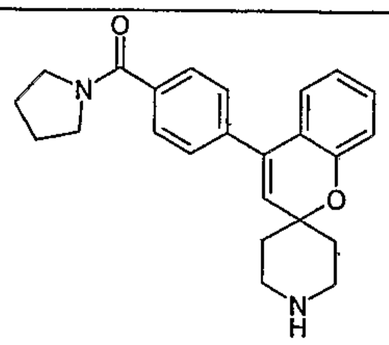
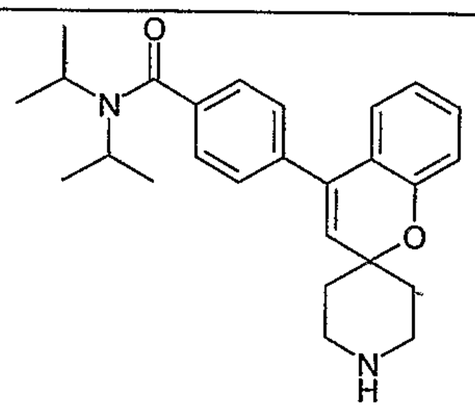
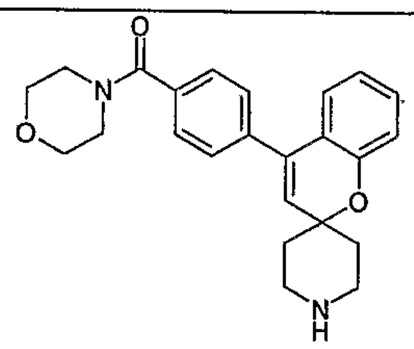
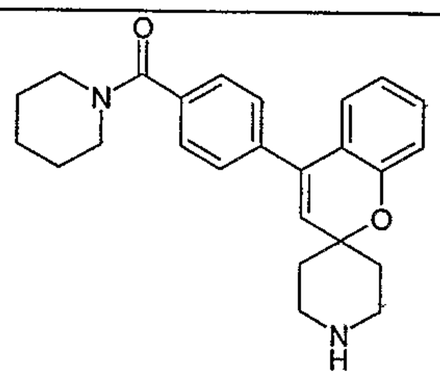
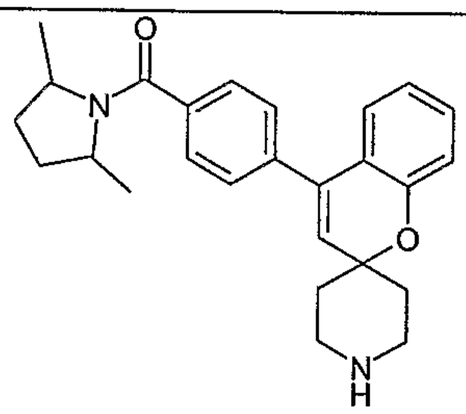
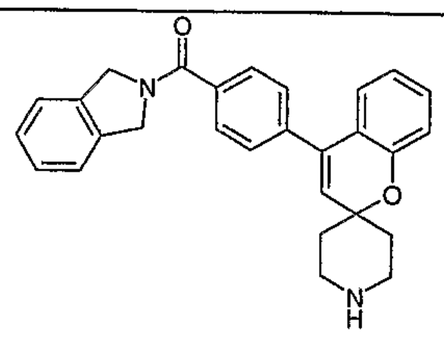
Example	***Structure***	**[M+H]+**
10F		448.3
10G		476.2
10H		474.3
10I		490.2
10J		407.4
11A		393.0

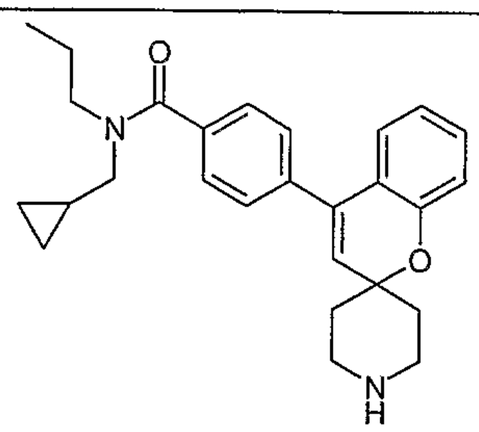
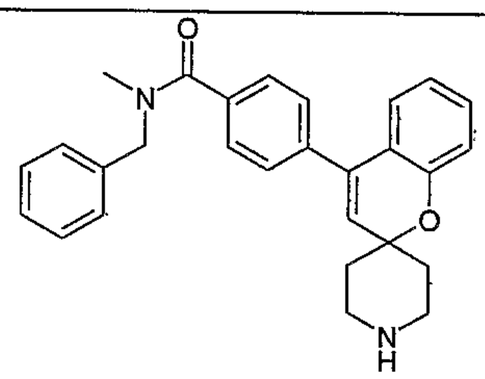
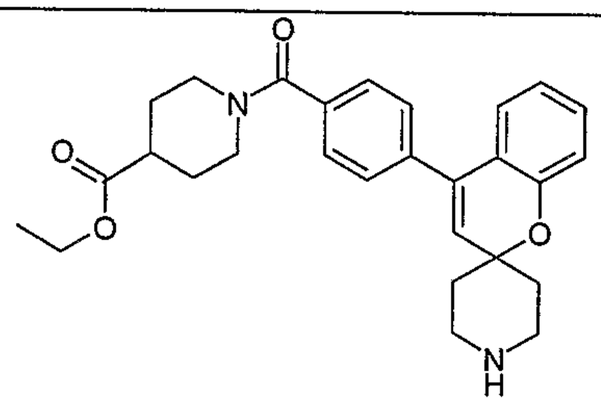
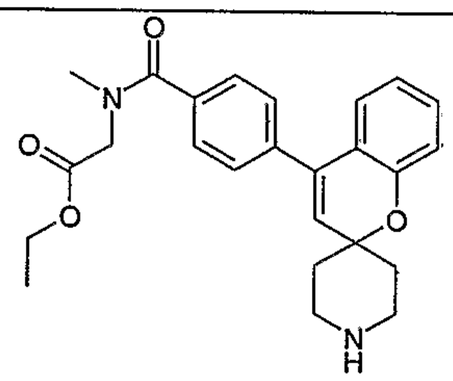
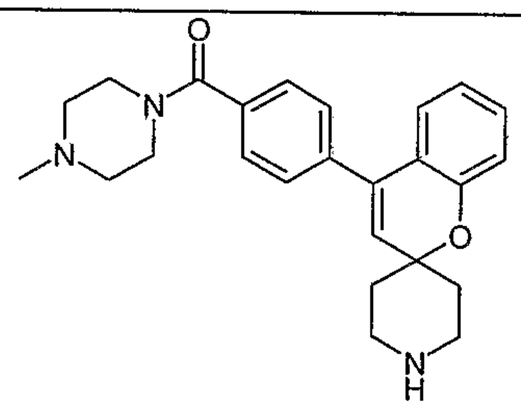
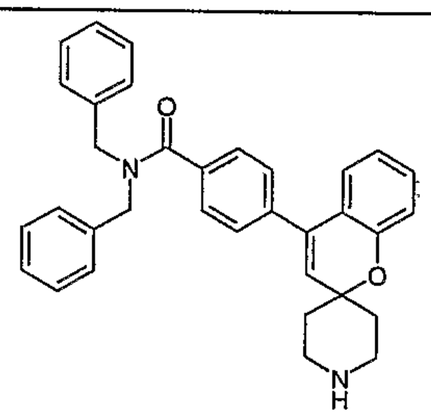
Example	***Structure***	[M+H]+
11B		394.3
11C		447.4
11D		448.4
11E		447.3
11F		462.4

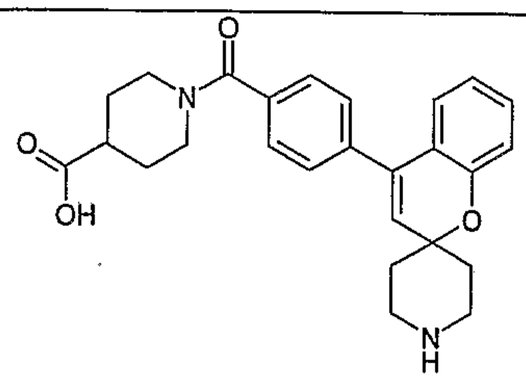
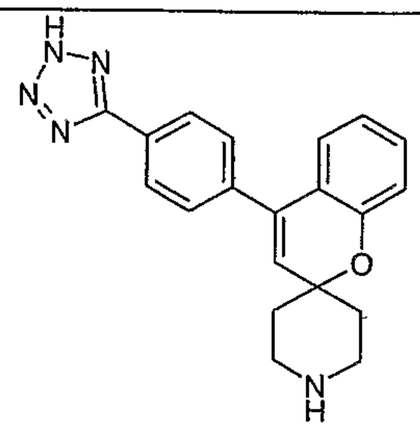
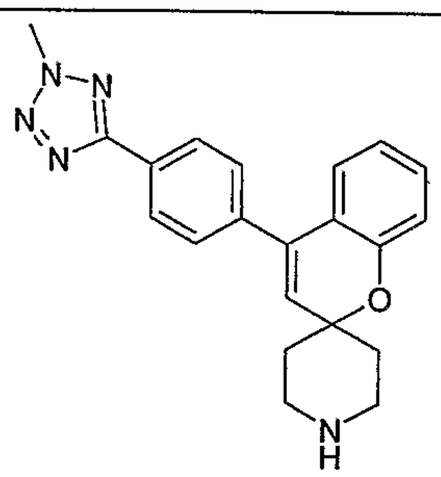
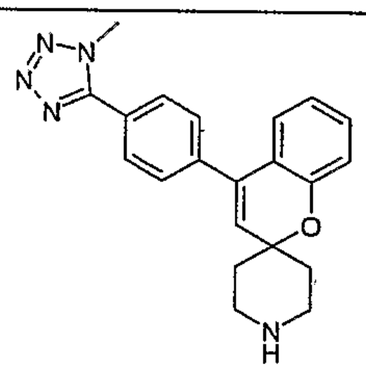
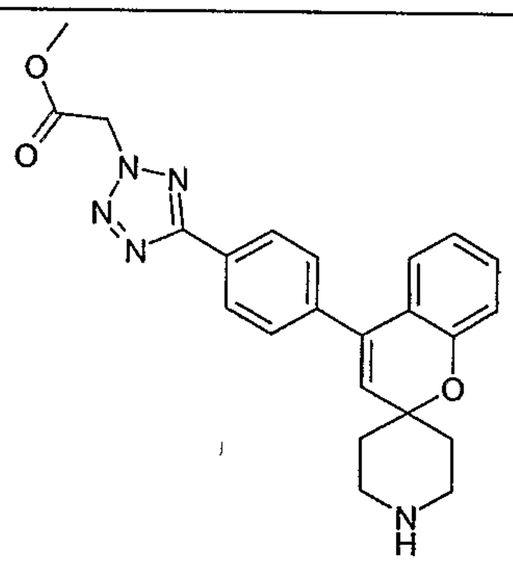
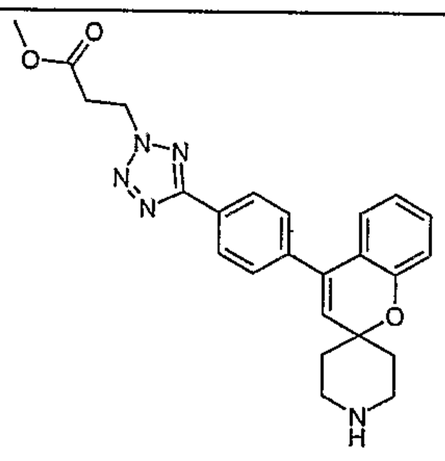
Example	***Structure***	[M+H]+
12A		391.4
12B		421.3
12C		420.3
12D		434.3
12E		448.4
12F		462.4

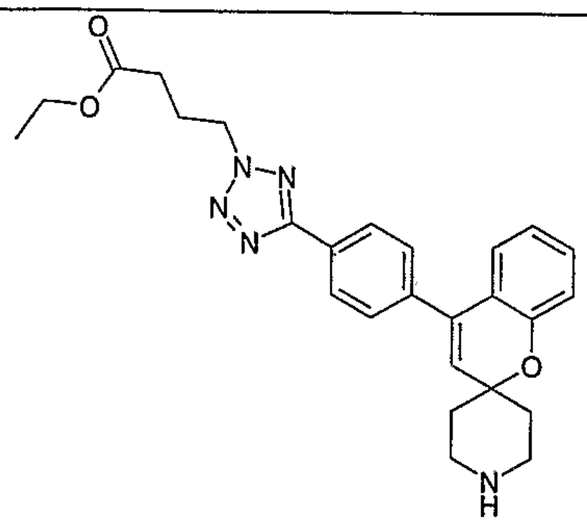
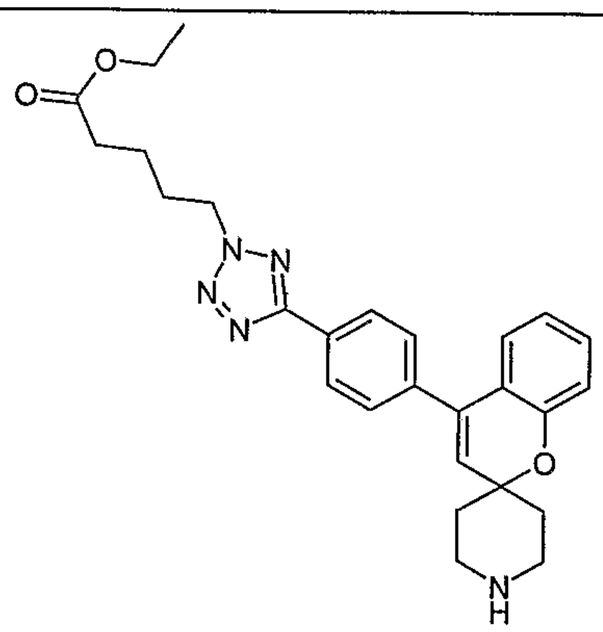
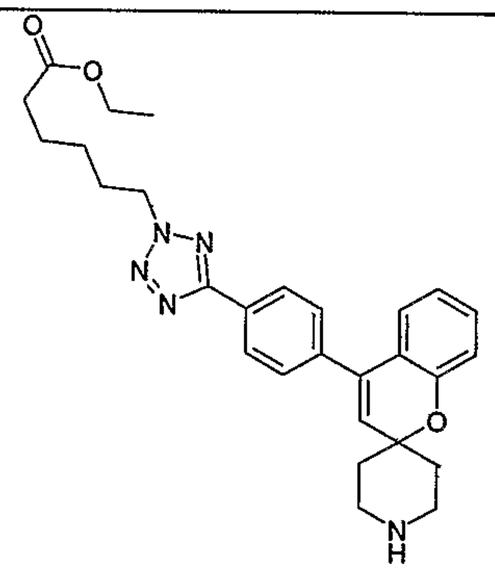
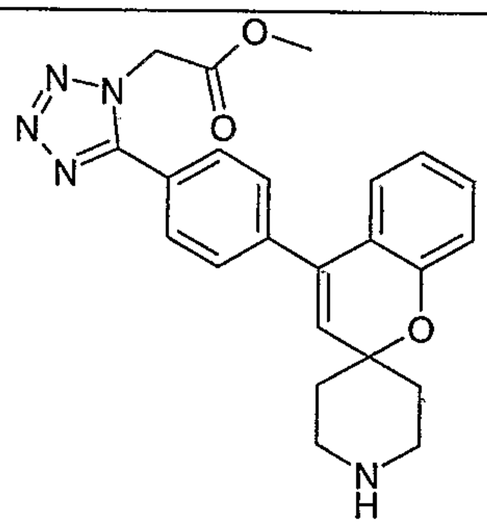
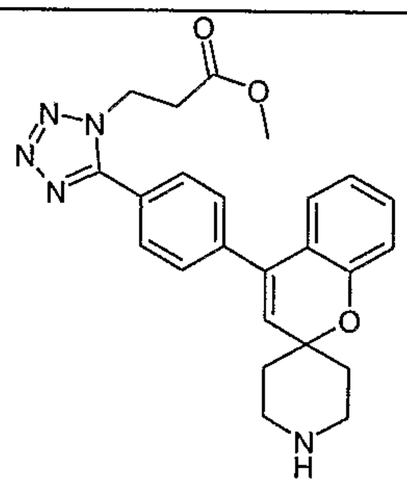
Example	***Structure***	[M+H]+
12G		448.4
12H		392.4
12I		419.4
12J		433.4
12K		420.4

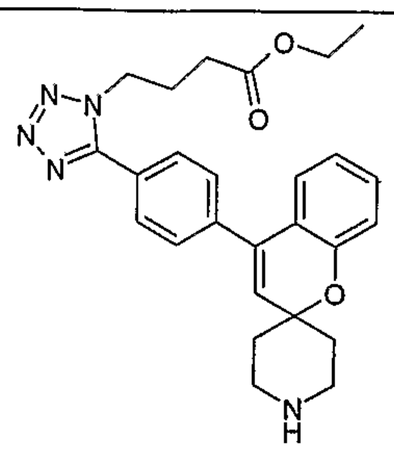
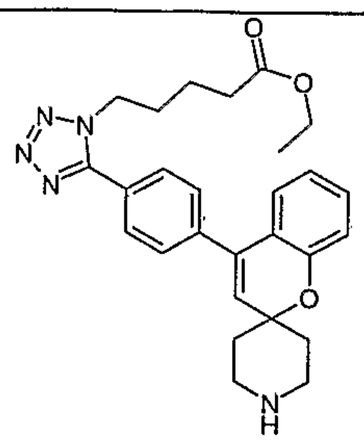
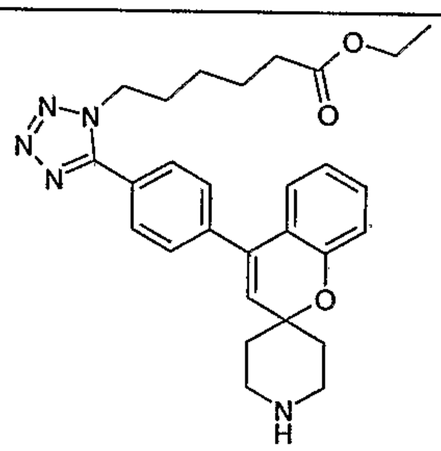
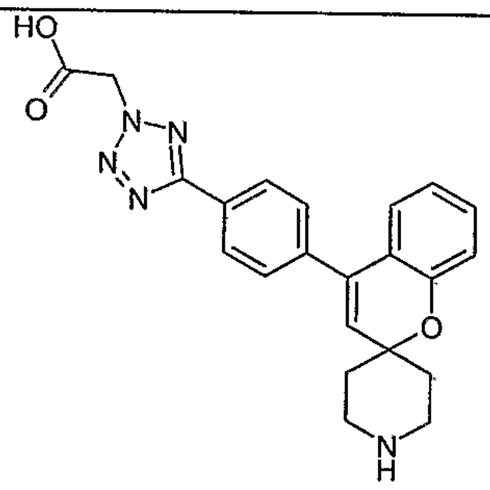
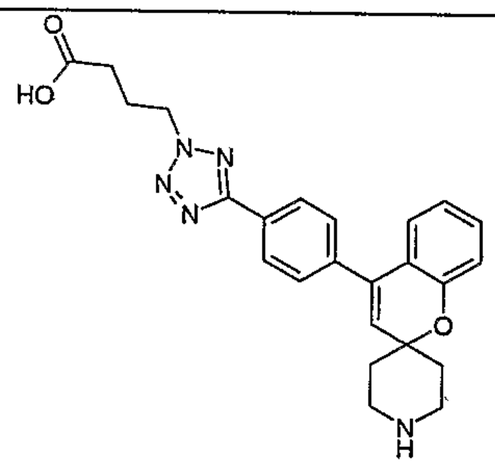
Example	***Structure***	[M+H]+
12L		434.3
13A		322.1
13B		321.1
13C		335.2
13D		349.2
13E		377.2

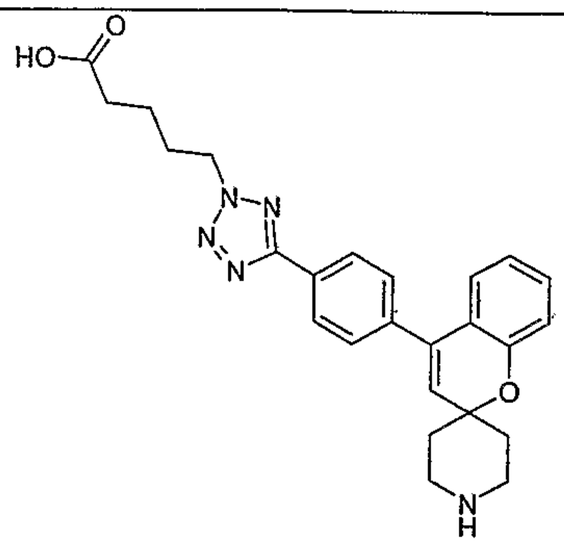
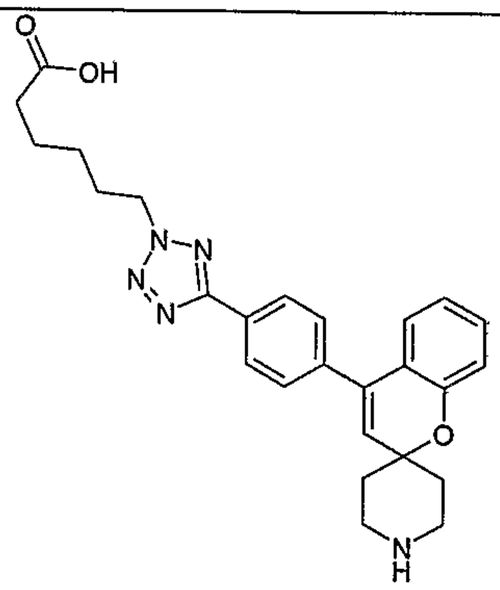
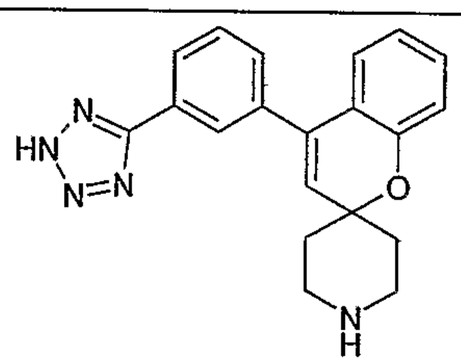
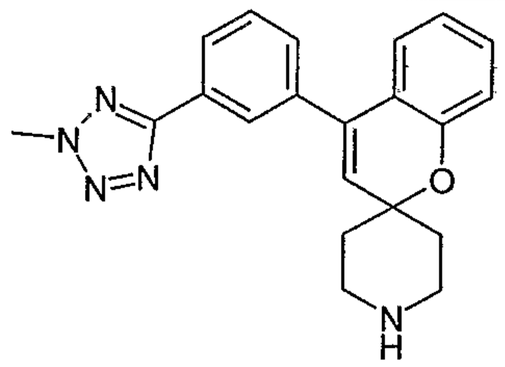
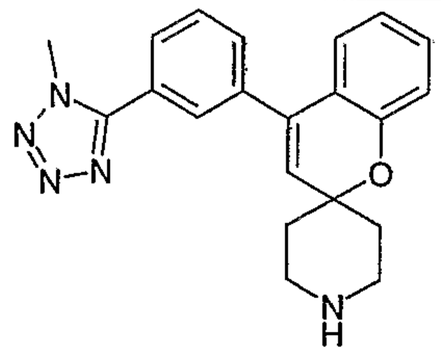
Example	***Structure***	[M+H]+
13F		349.1
13G		375.1
13H		405.3
13I		391.1
13J		389.1
13K		403.3
13L		423.1

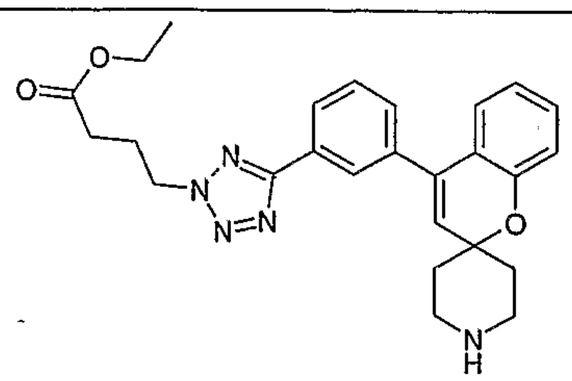
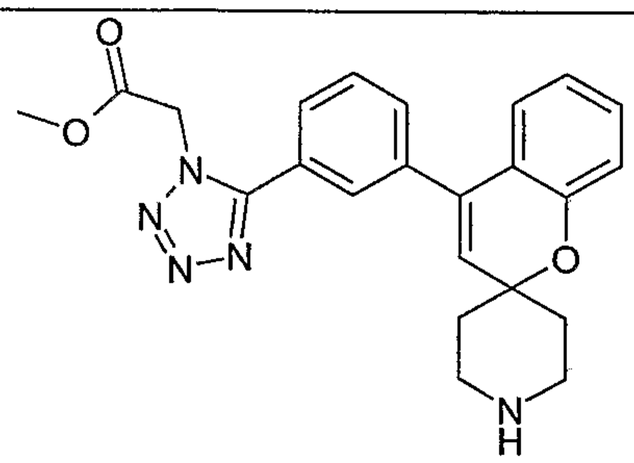
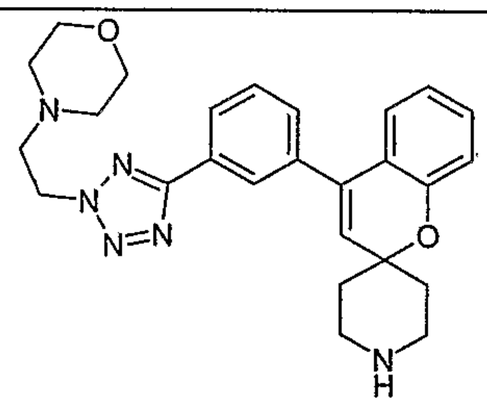
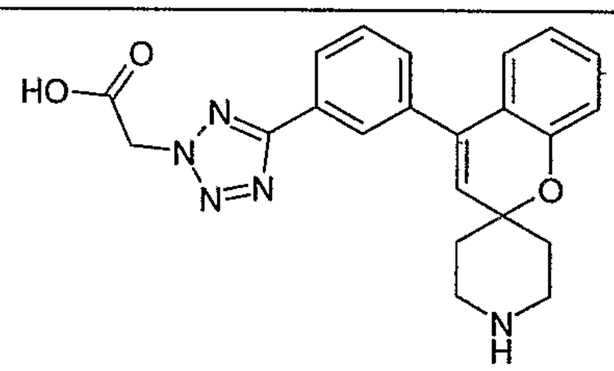
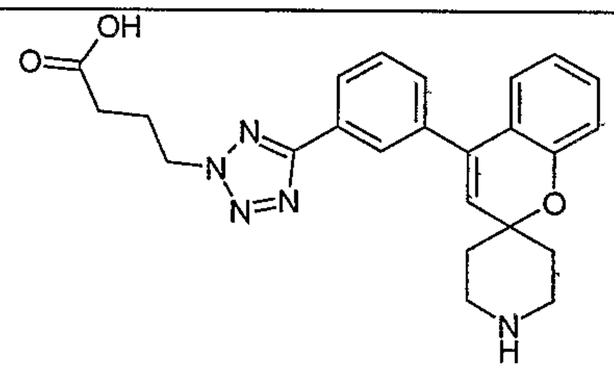
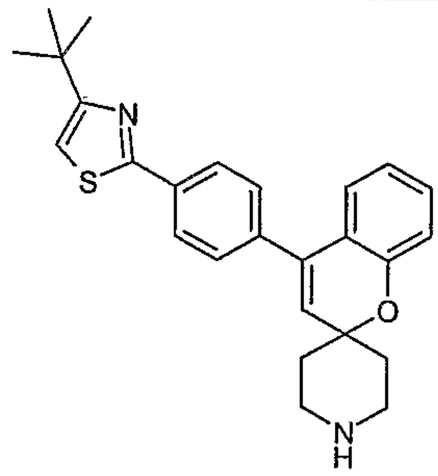
Example	***Structure***	[M+H]+
13M		417.2
13N		425.2
13O		461.2
13P		421.2
13Q		404.3
13R		501.2

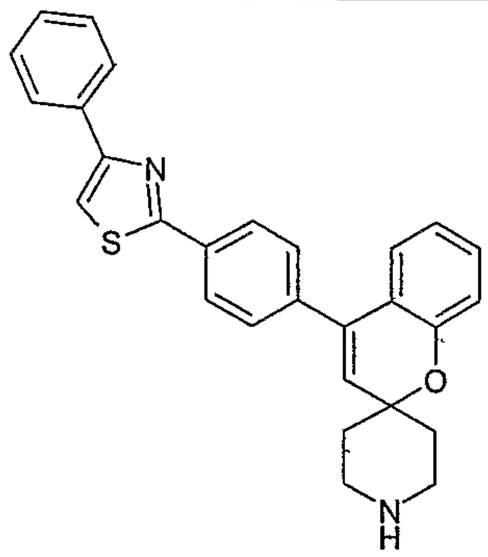
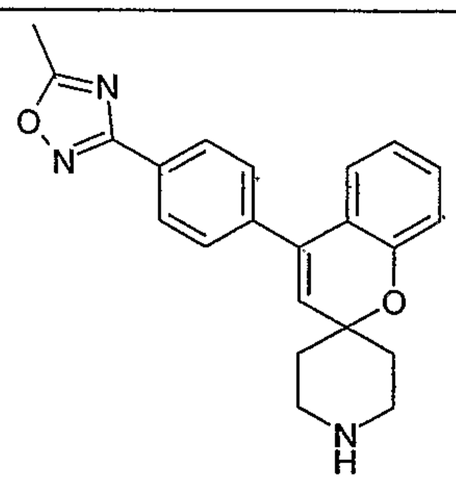
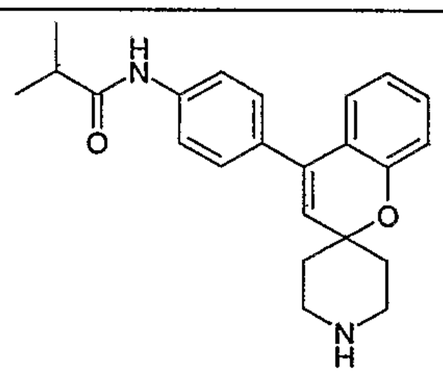
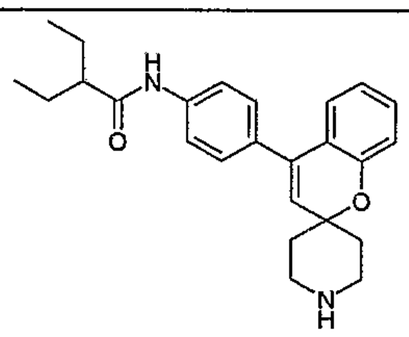
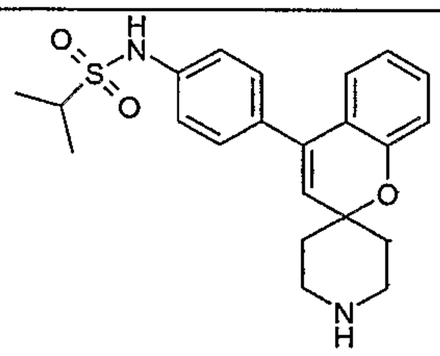
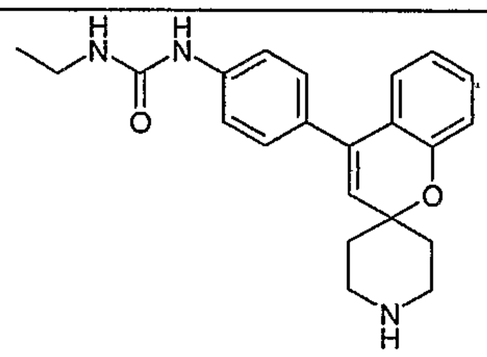
Example	***Structure***	[M+H]+
13S		433.1
14A		346.1
14B		360.1
14C		360.2
15A		418.1
15B		432.2

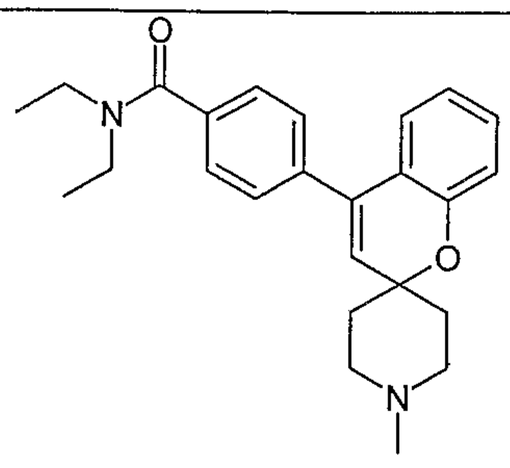
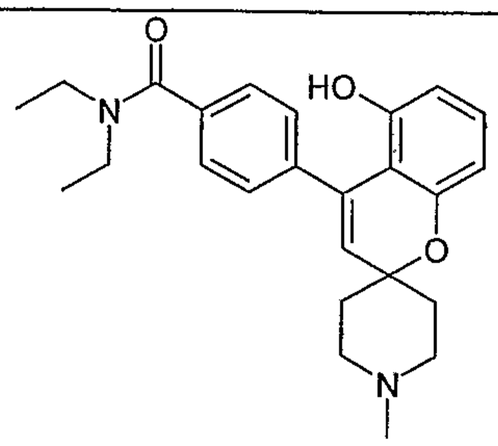
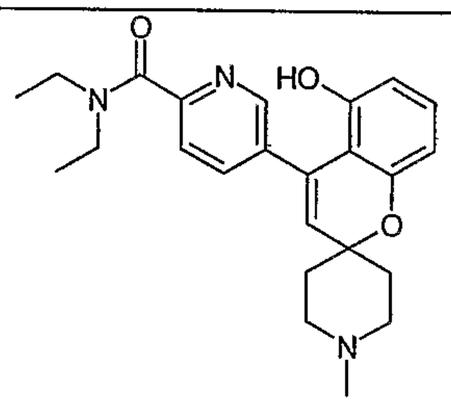
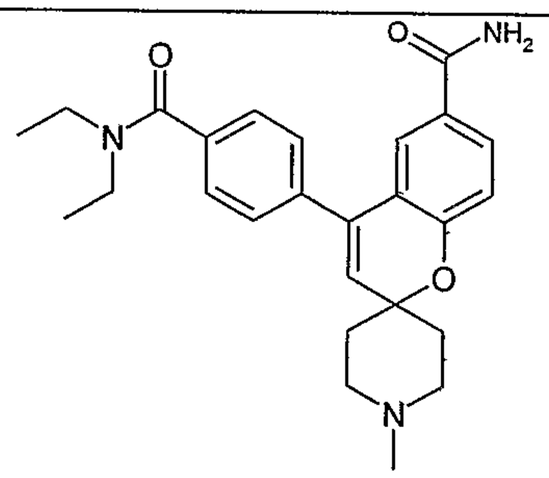
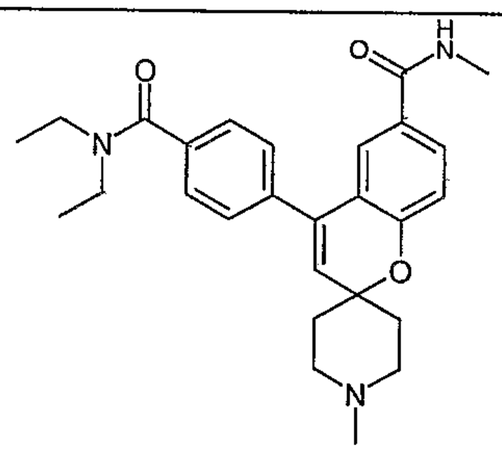
Example	***Structure***	[M+H]+
15C		460.2
15D		474.2
15E		488.2
15F		418.2
15G		432.1

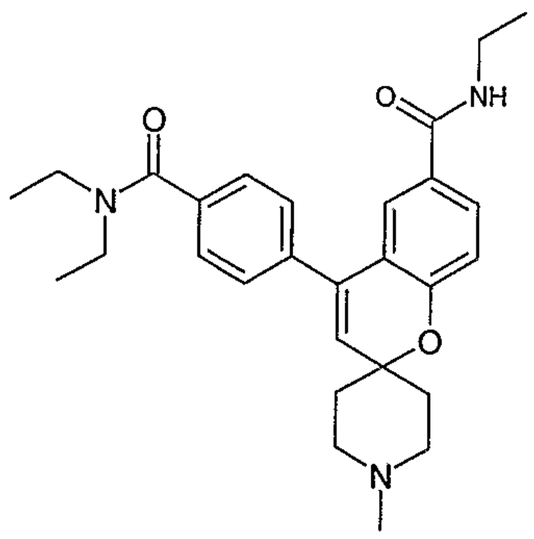
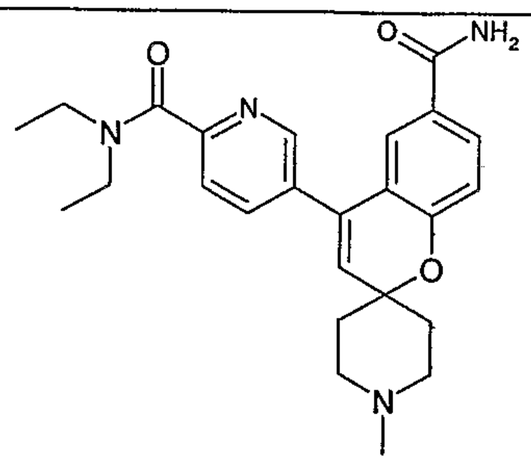
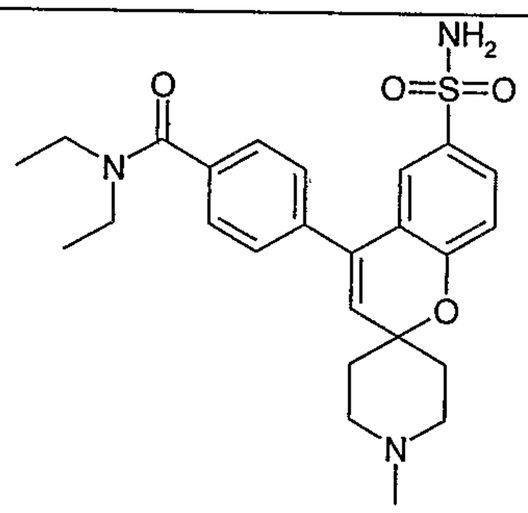
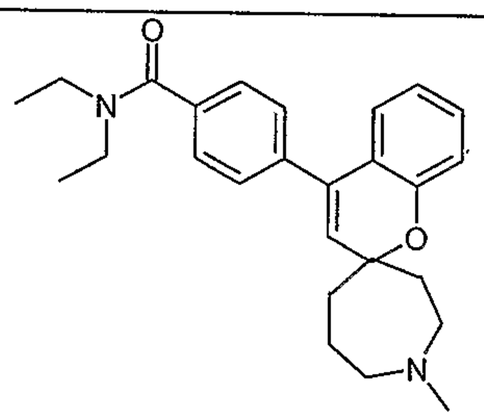
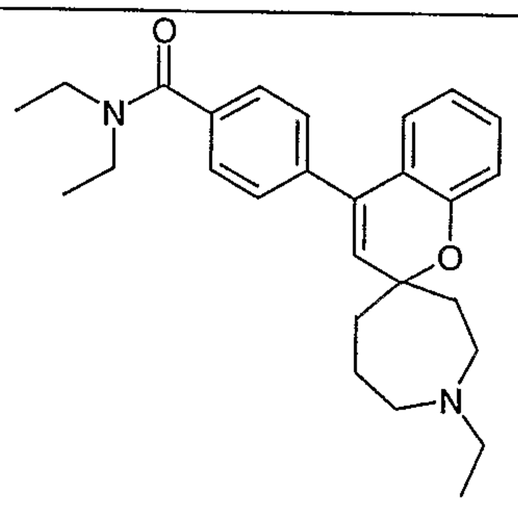
Example	***Structure***	[M+H]+
15H		460.2
15I		474.3
15J		488.3
15K		404.1
15L		432.1

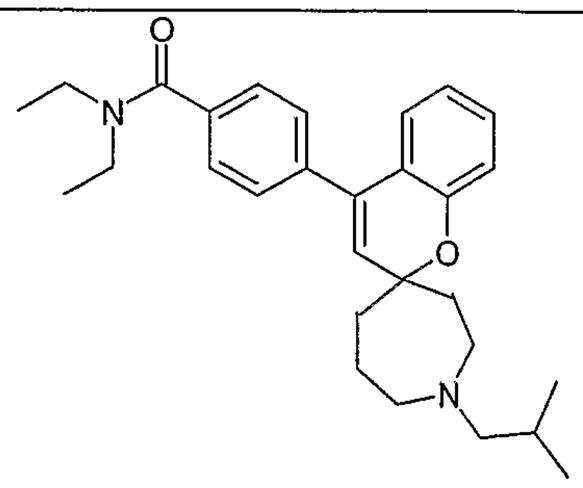
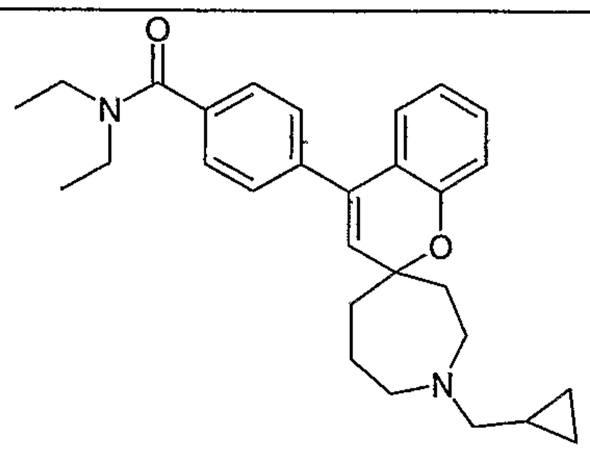
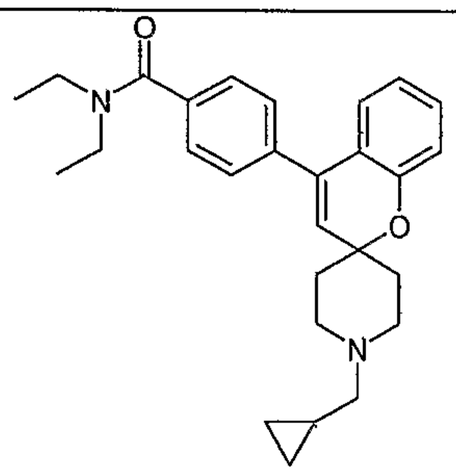
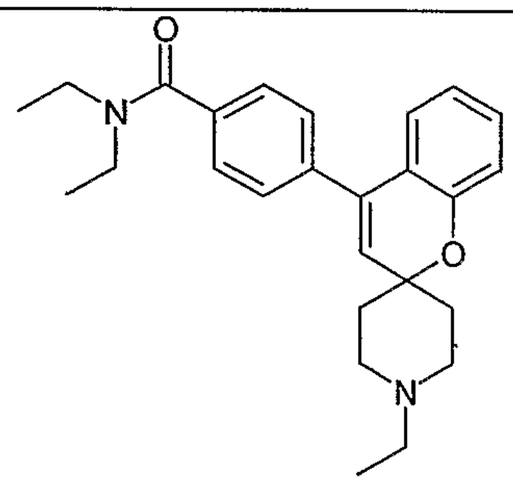
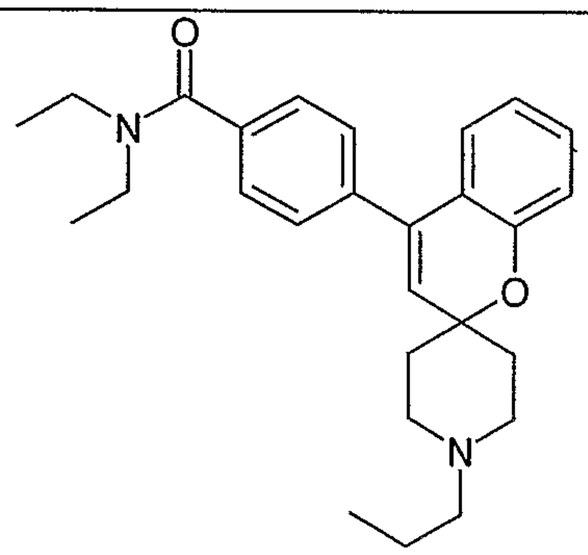
Example	***Structure***	[M+H]+
15M		446.2
15N		460.2
16A		346.1
16B		360.1
16C		360.1
17A		418.1

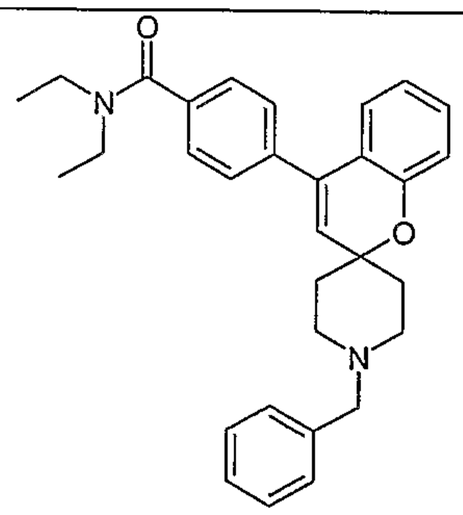
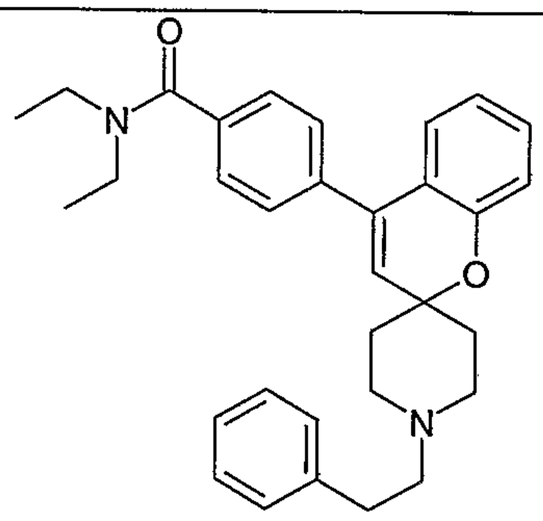
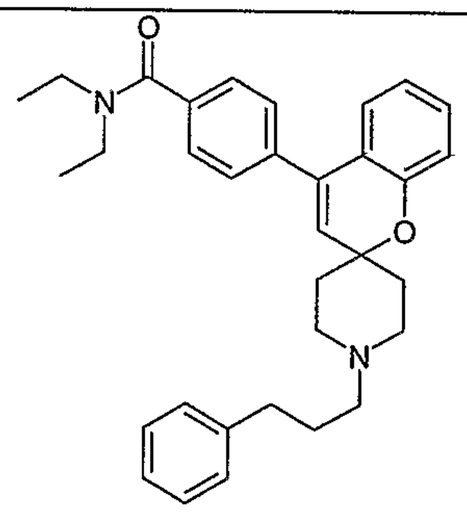
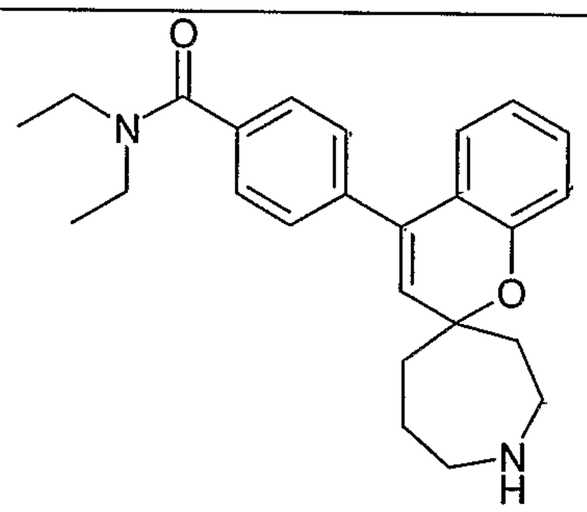
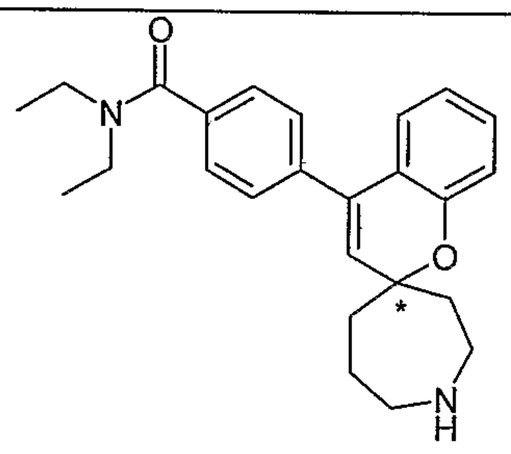
Example	***Structure***	[M+H]+
17B		460.2
17C		418.1
17D		459.2
17E		404.1
17F		432.1
18A		417.3

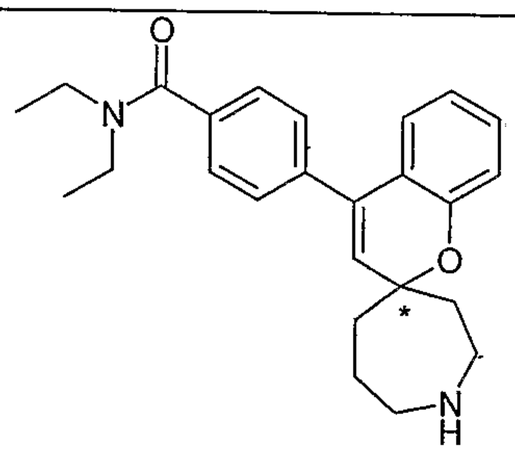
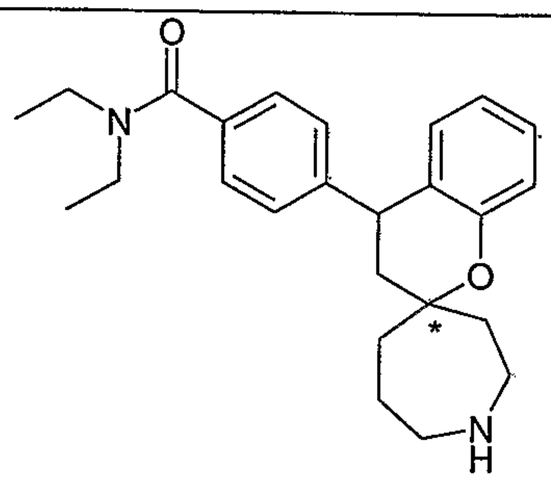
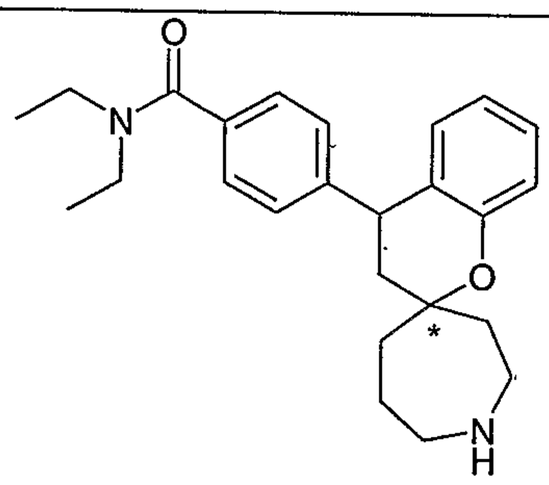
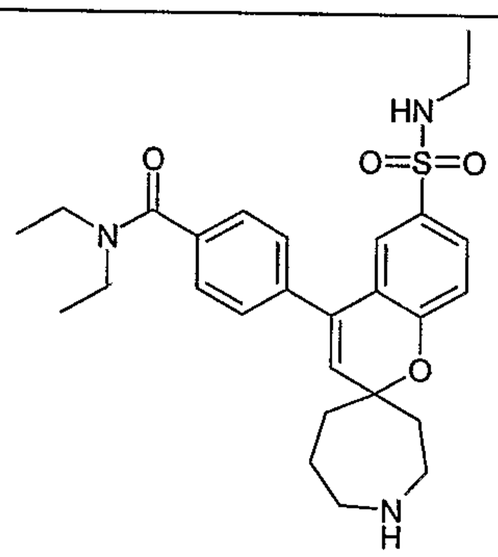
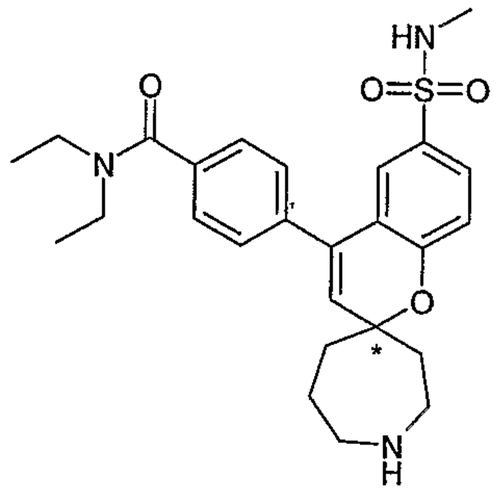
Example	***Structure***	[M+H]+
18B		437.1
18C		360.3
19A		363.4
19B		391.4
19C		399.3
19D		364.4

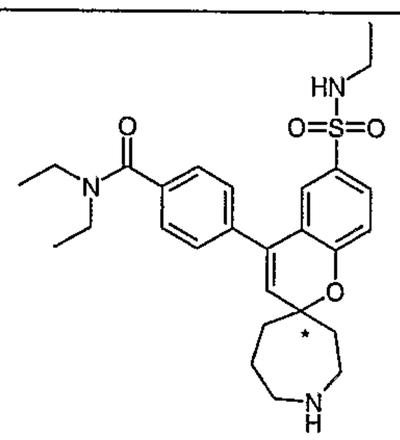
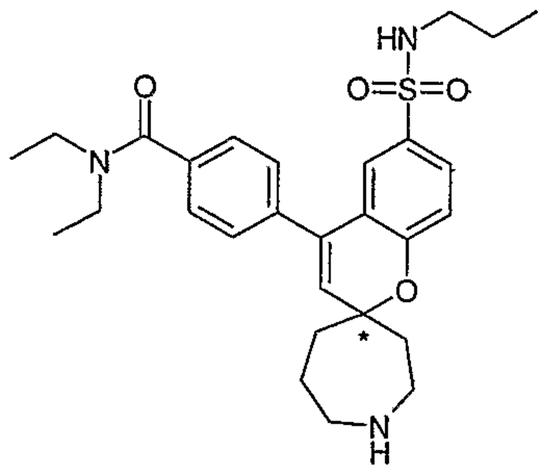
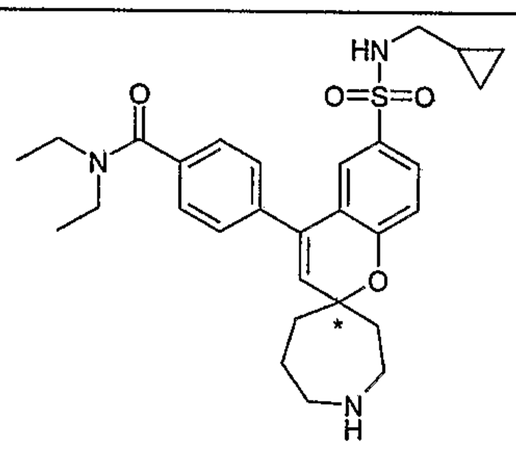
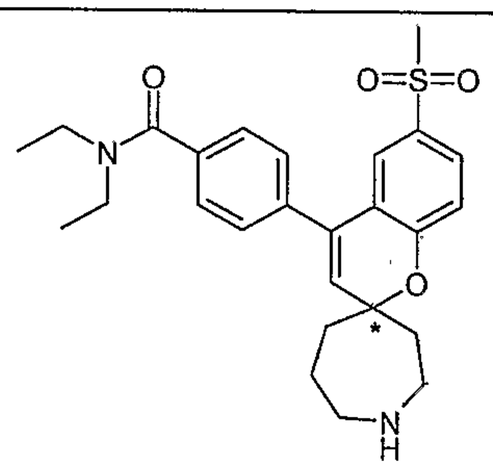
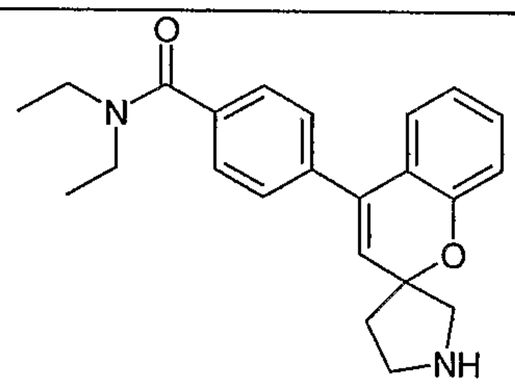
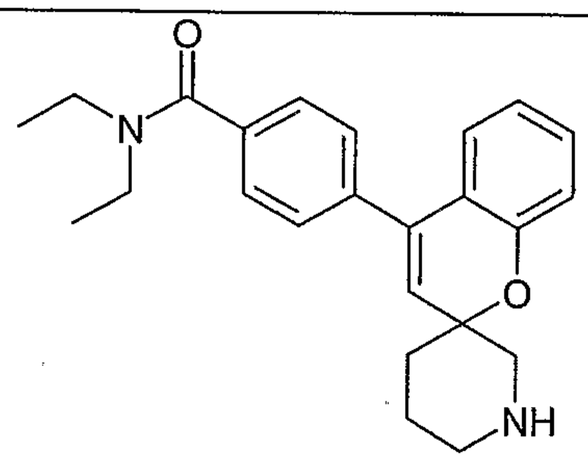
Example	***Structure***	[M+H]+
20A		391.2
20B		407.3
20C		408.3
20D		434.4
20E		448.5

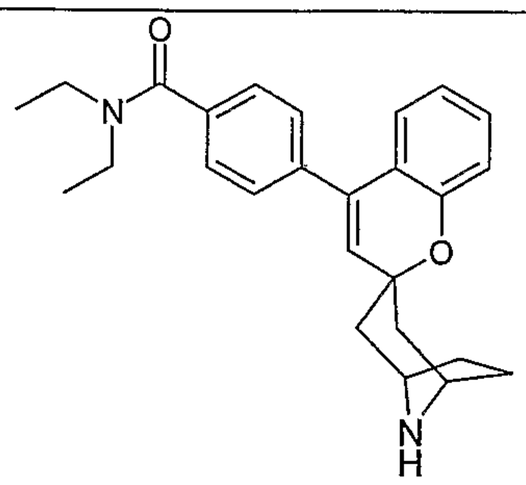
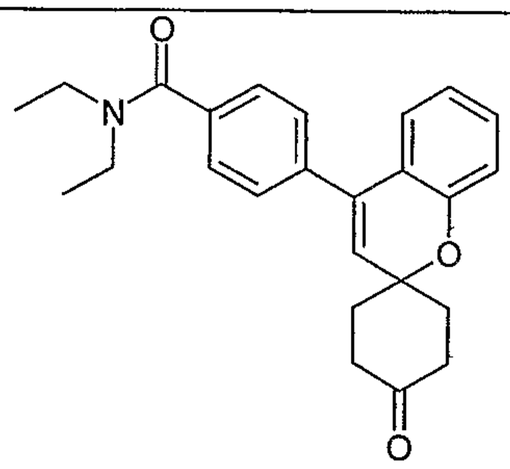
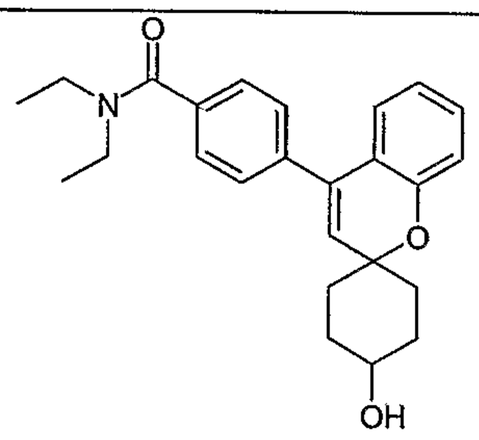
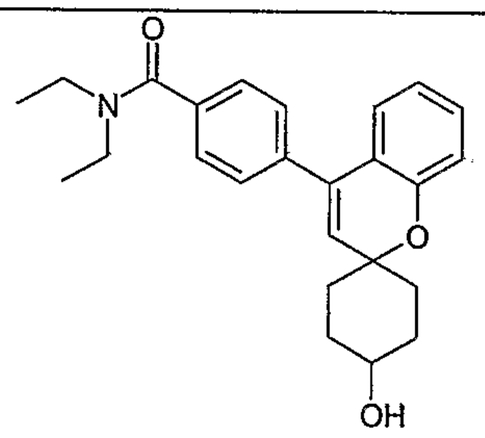
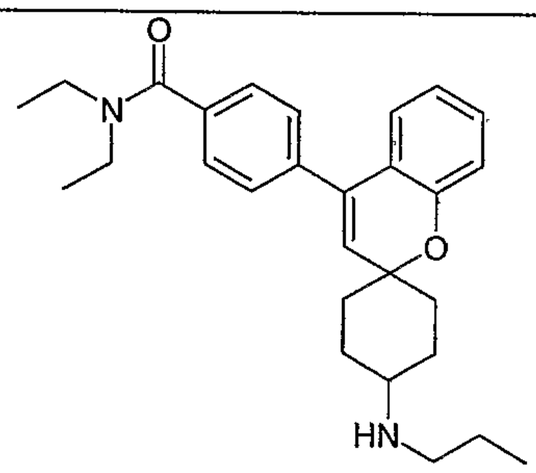
Example	***Structure***	[M+H]+
20F		462.5
20G		435.4
20H		470.3
20I		405.4
20J		419.4

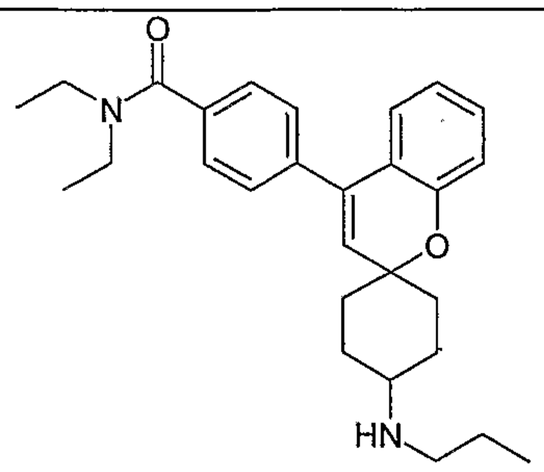
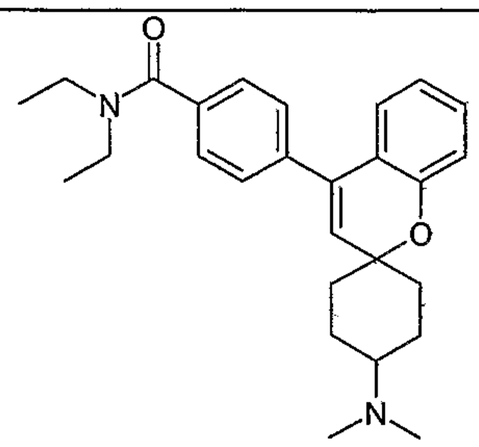
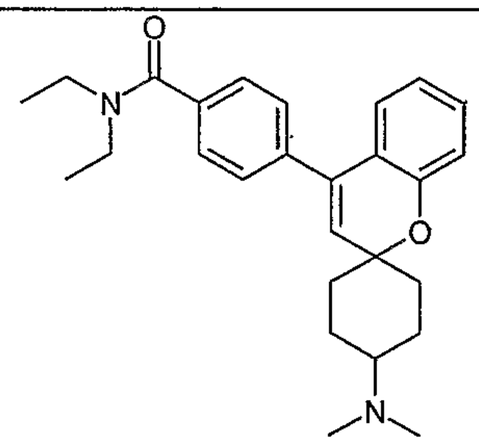
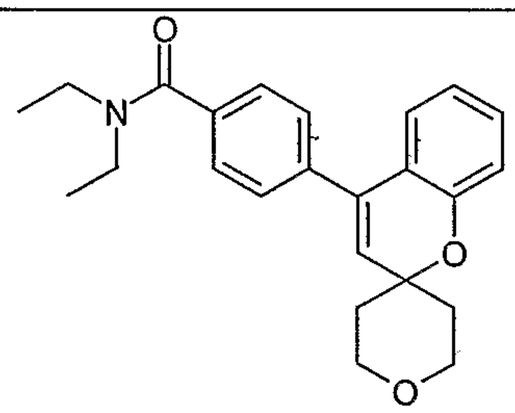
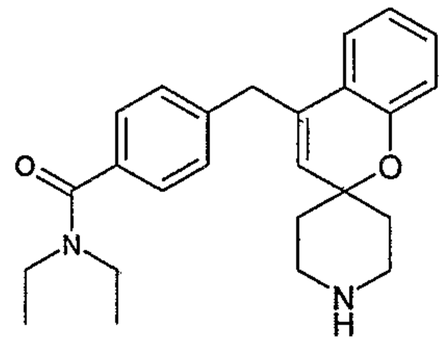
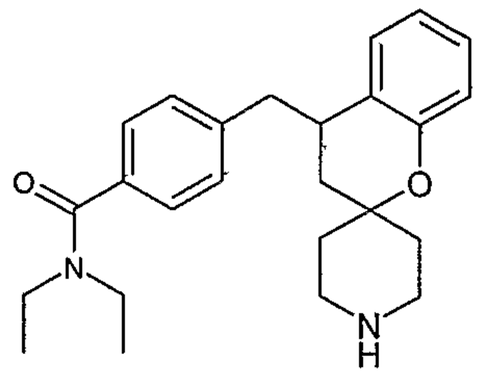
Example	***Structure***	[M+H]+
20K		447.5
20L		445.4
20M		431.0
20N		405.0
20O		419.1

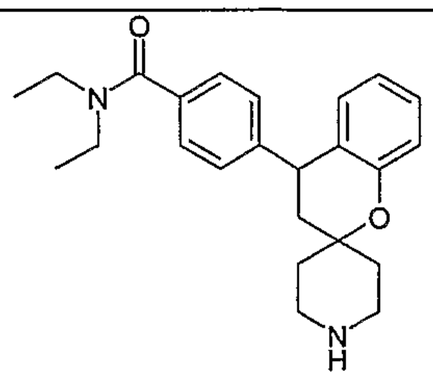
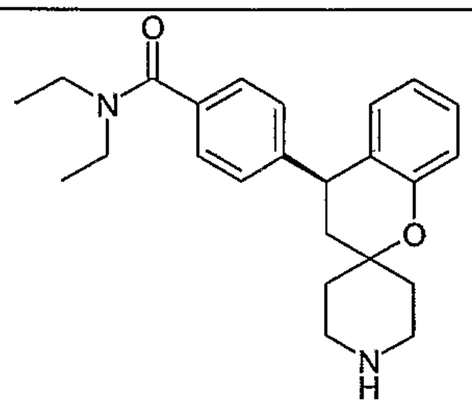
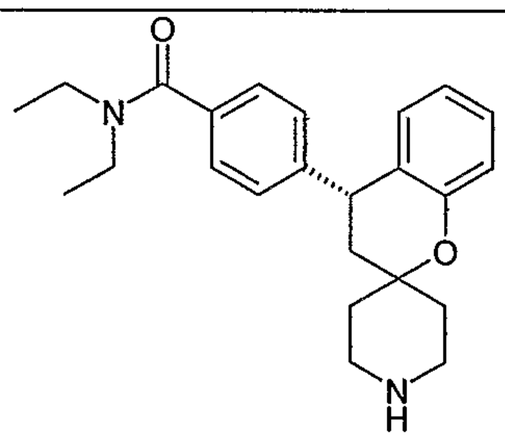
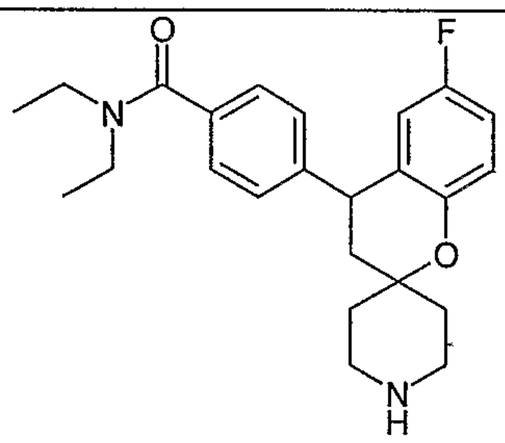
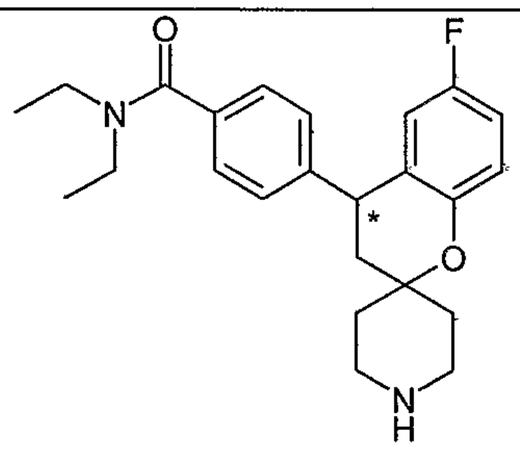
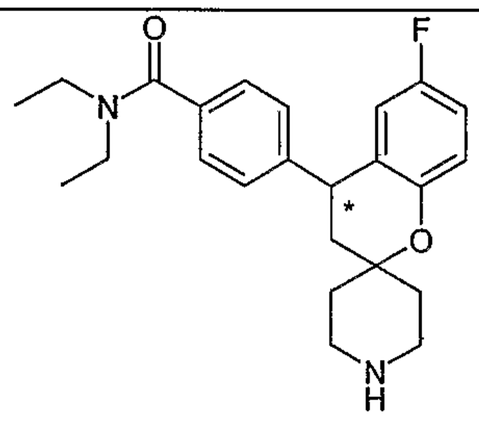
Example	***Structure***	[M+H]+
20P		467.3
20Q		481.3
20R		495.3
21A		391.2
21B		391.3

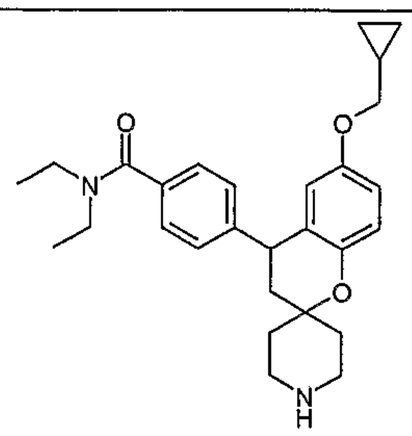
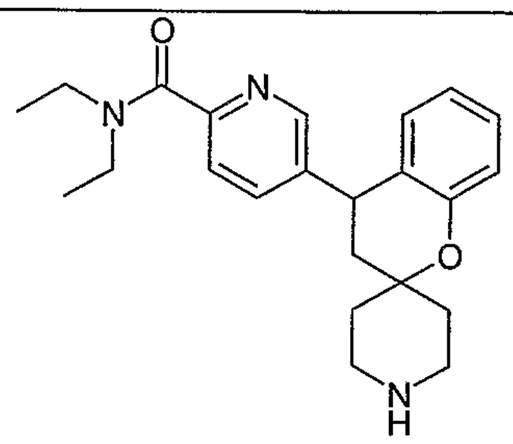
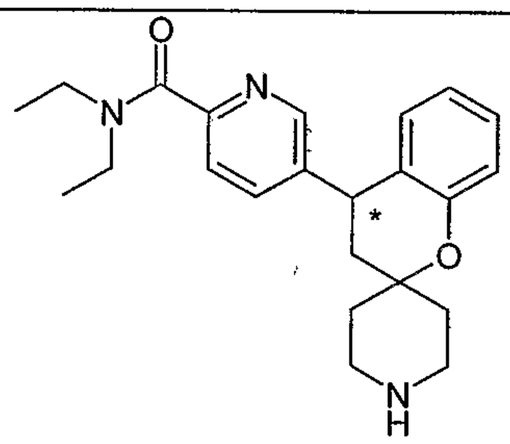
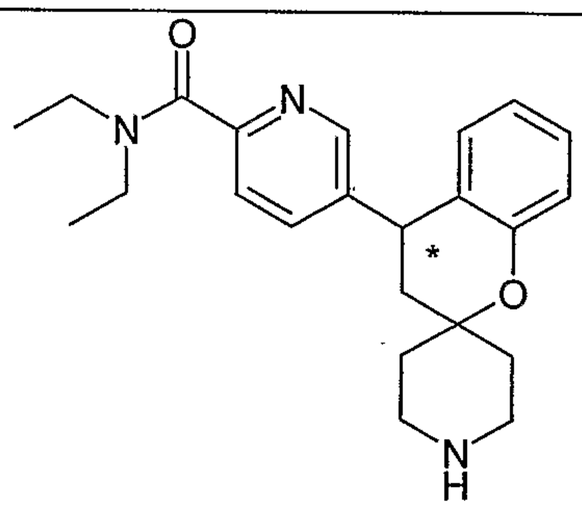
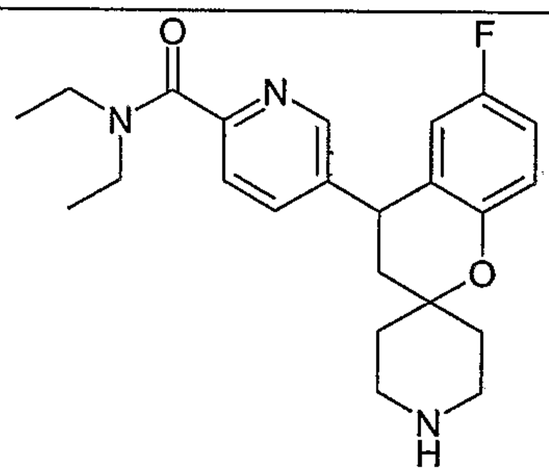
Example	***Structure***	[M+H]+
21C		391.3
21D		393.3
21E		393.3
21F		498.5
22A		484.2

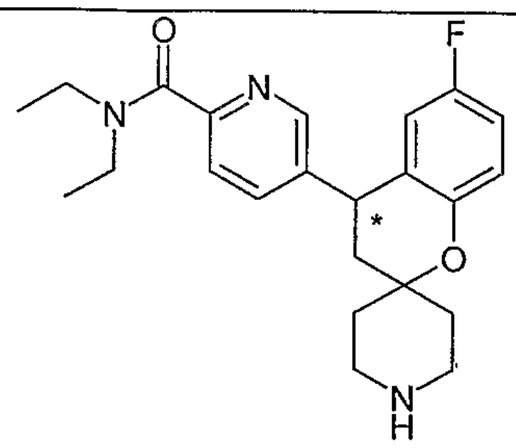
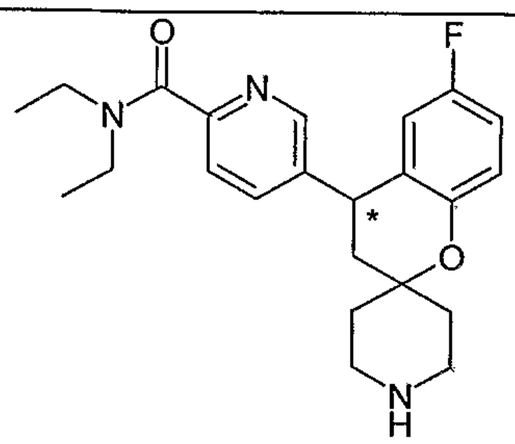
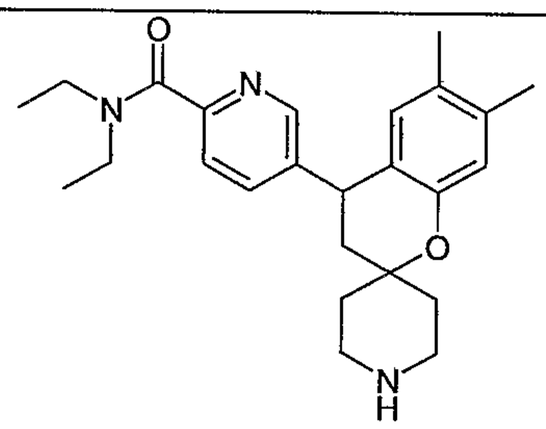
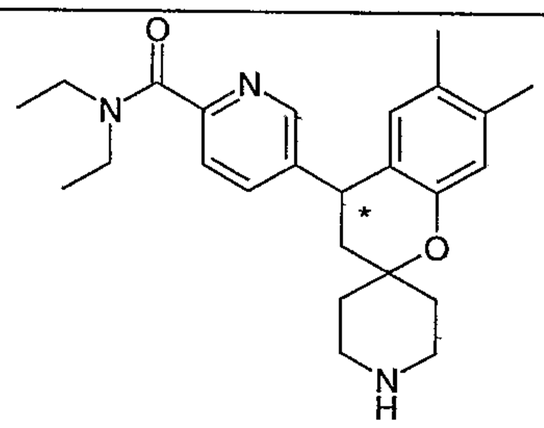
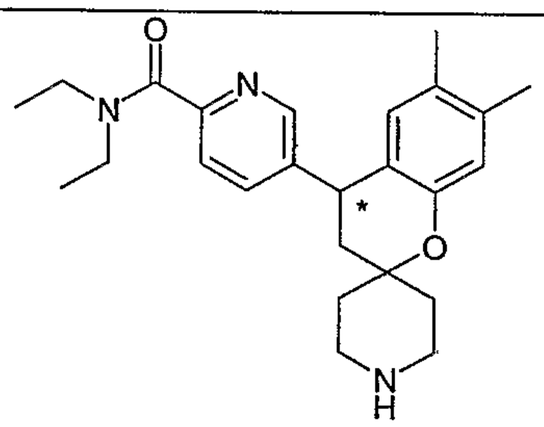
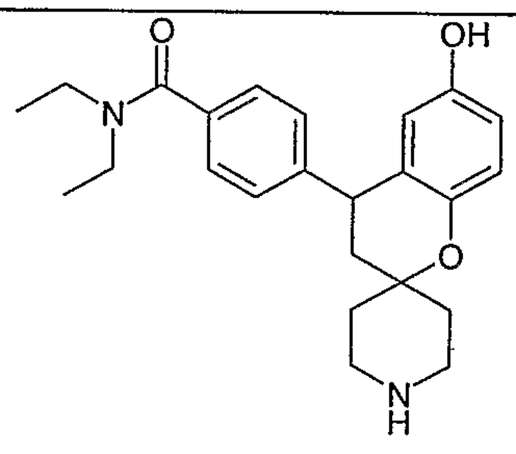
Example	***Structure***	[M+H]+
22B		498.3
22C		512.4
22D		524.3
22E		469.2
23A		363.2
23B		377.0

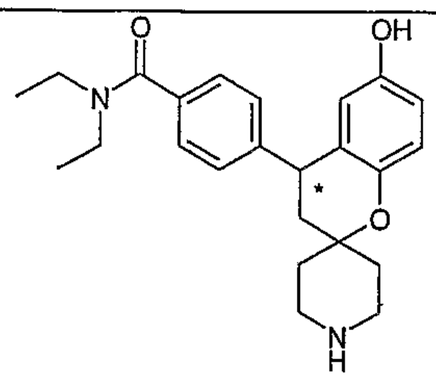
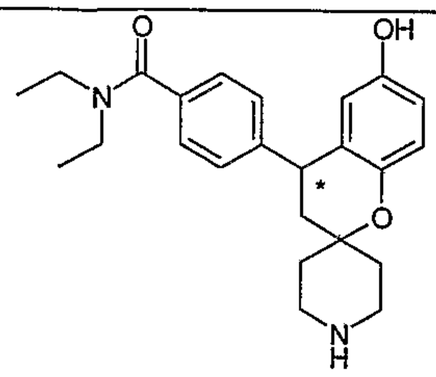
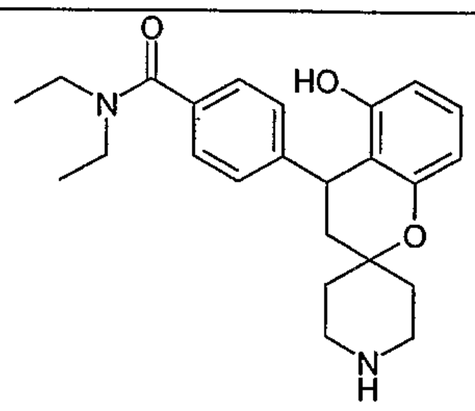
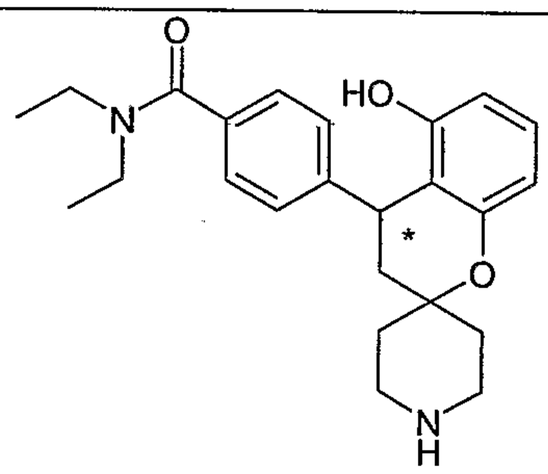
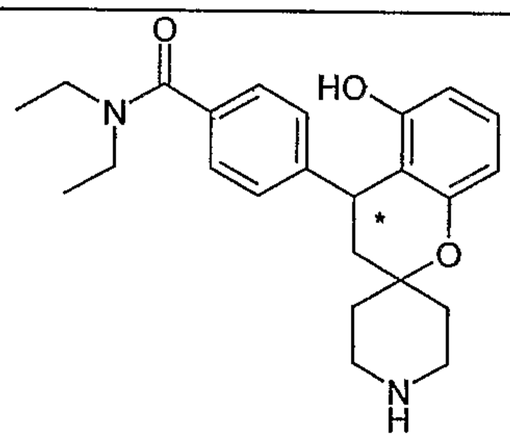
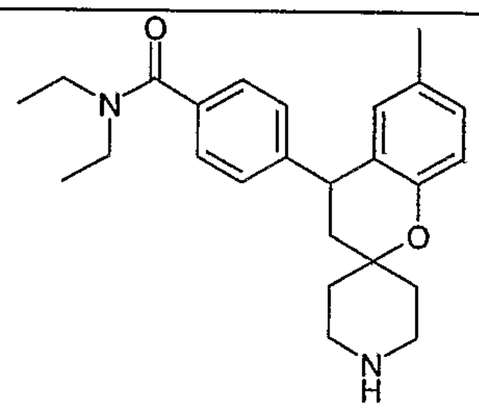
Example	***Structure***	[M+H]+
23C		403.2
24A		390.2
24B		392.2
24C		392.2
24D		433.2

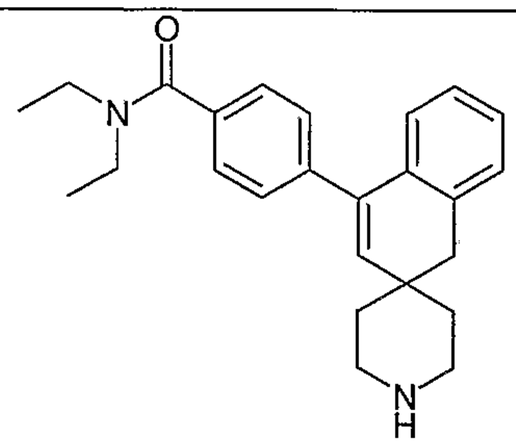
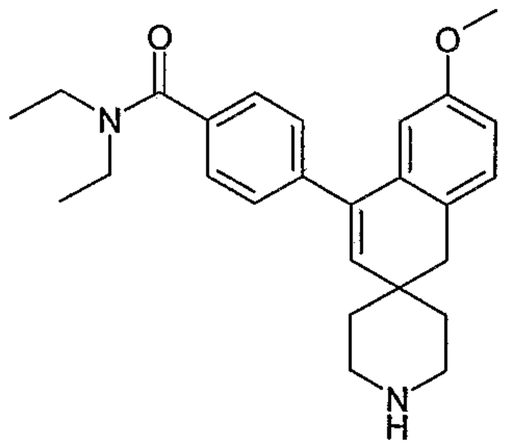
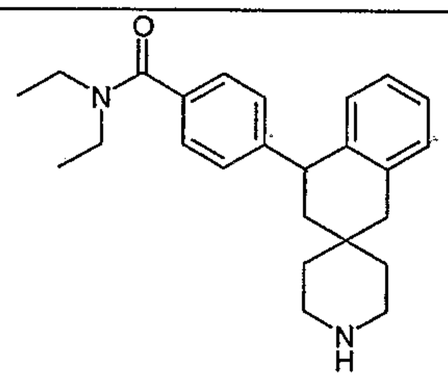
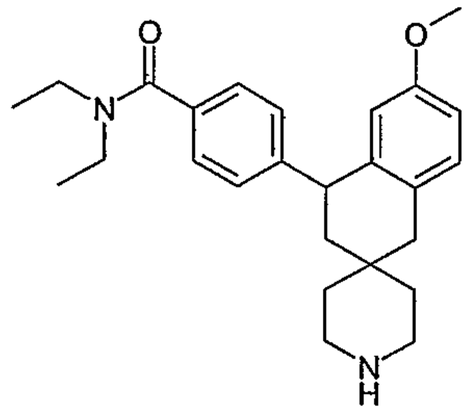
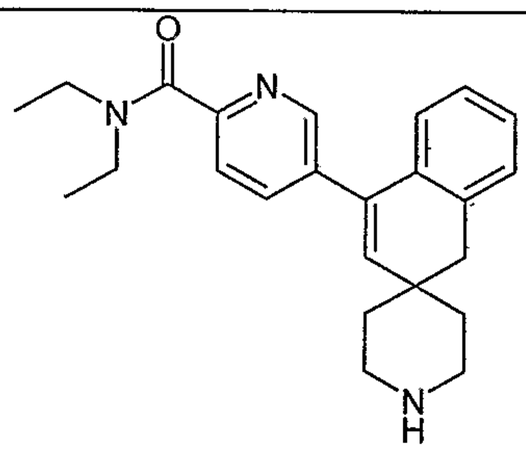
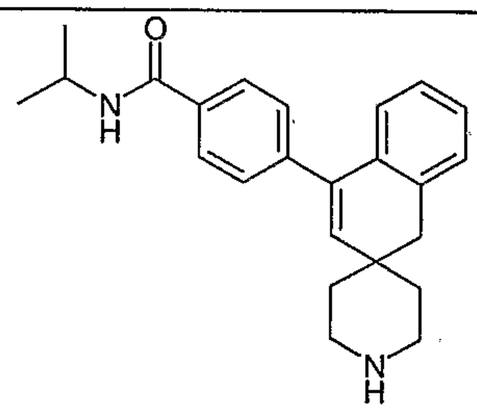
Example	***Structure***	[M+H]+
24E		433.2
24F		419.2
24G		419.2
25A		378.2
26A		391.0
26B		393.0

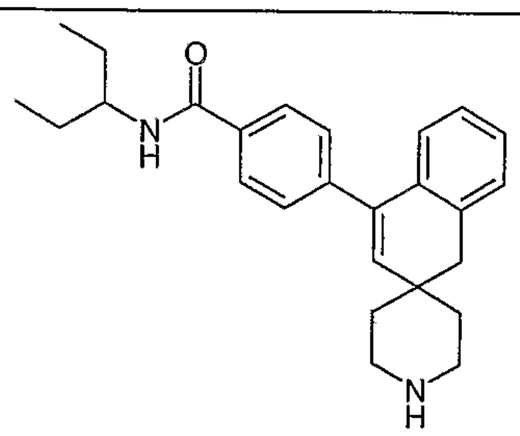
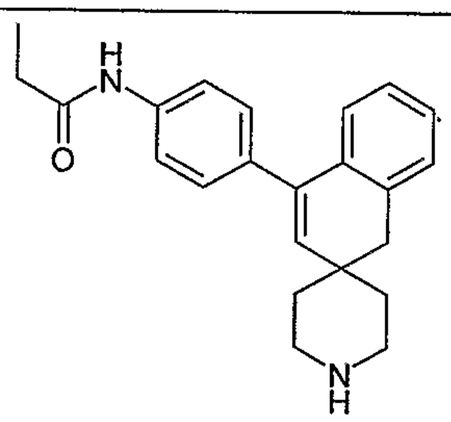
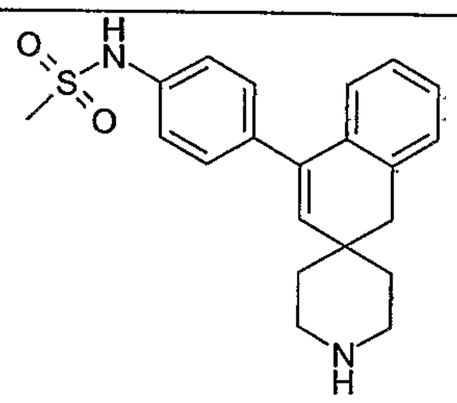
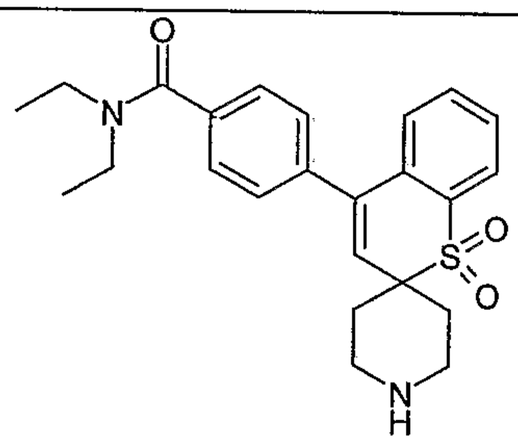
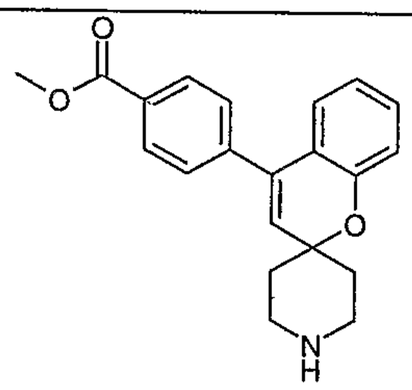
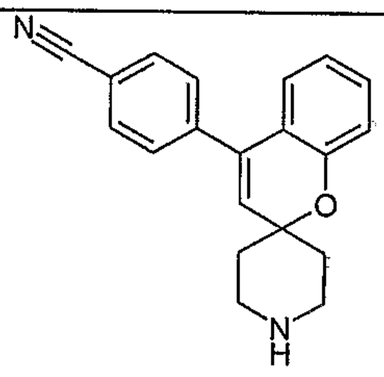
Example	***Structure***	[M+H]+
27A		379.1
27B		379.4
27C		379.4
27D		397.3
27E		397.4
27F		397.3

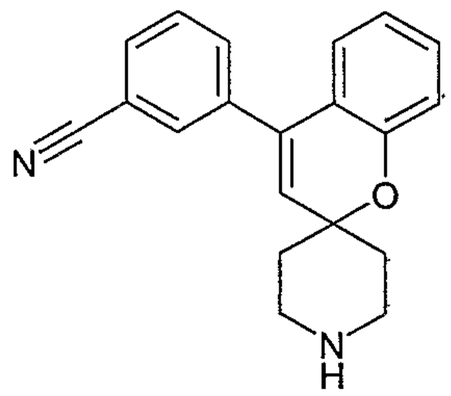
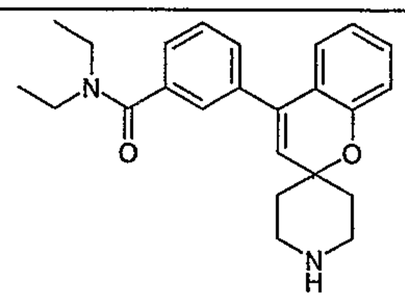
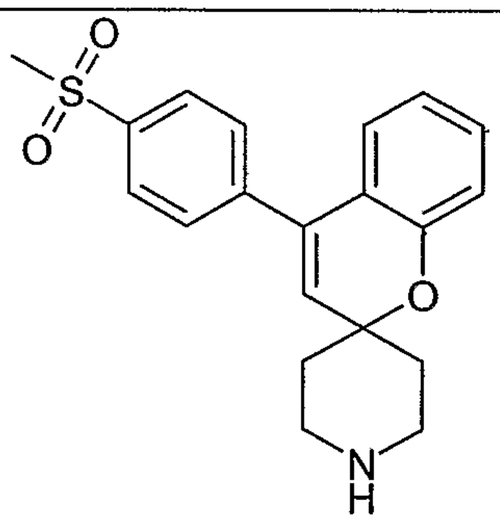
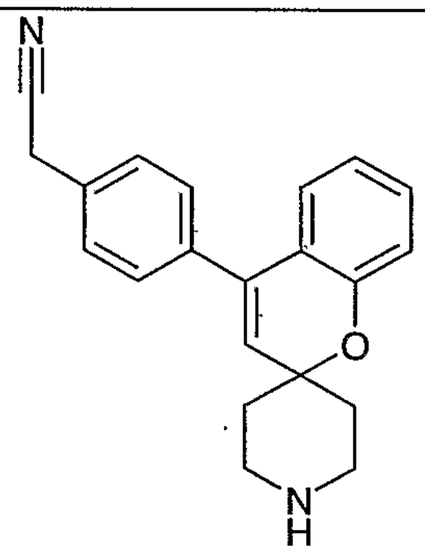
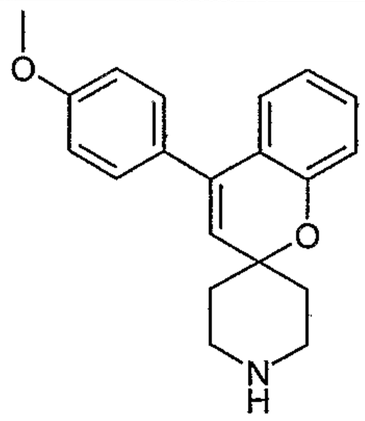
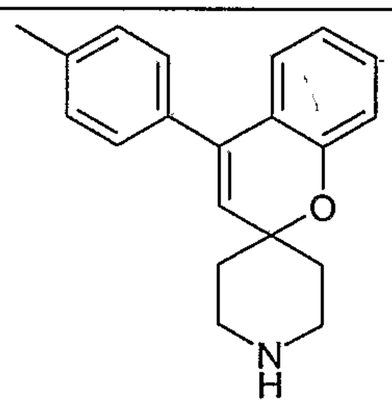
Example	***Structure***	[M+H]+
27G		449.3
27H		380.2
27I		380.2
27J		380.2
27K		398.3

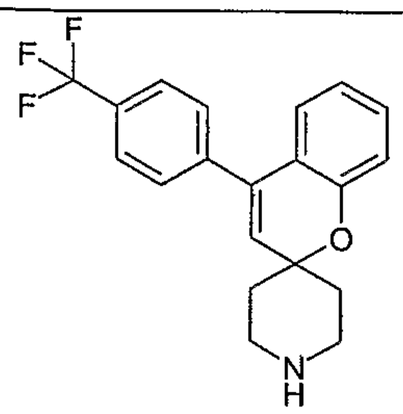
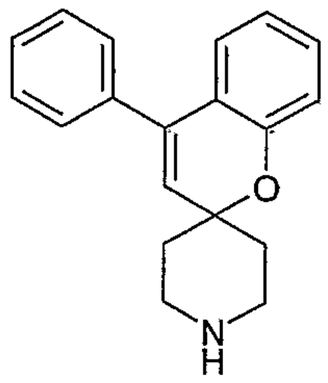
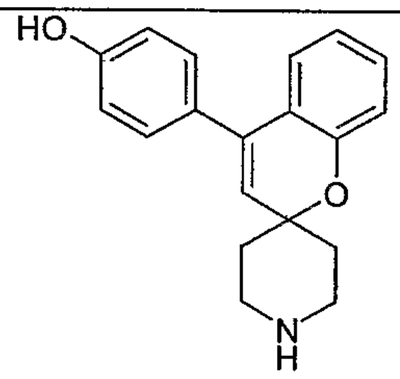
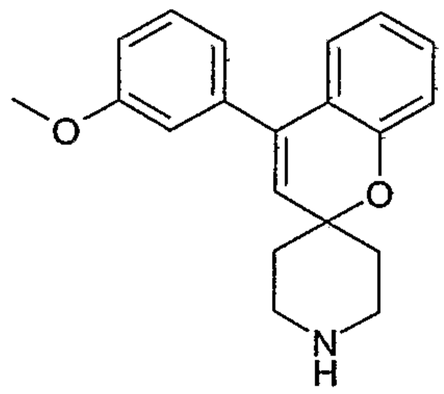
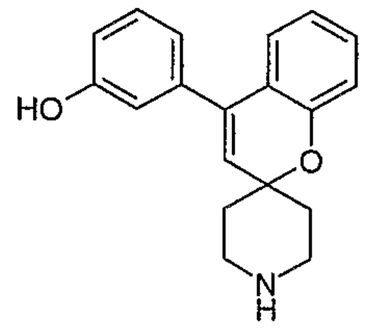
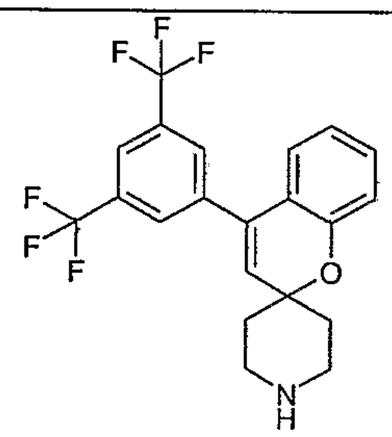
Example	***Structure***	[M+H]+
27L		398.3
27M		398.3
27N		408.3
27O		408.3
27P		408.3
27Q		395.4

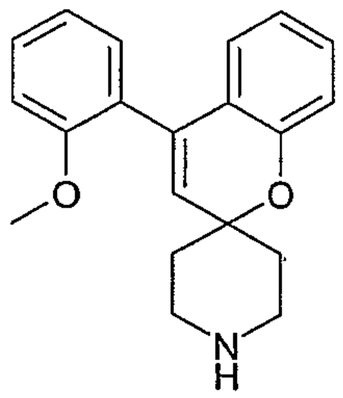
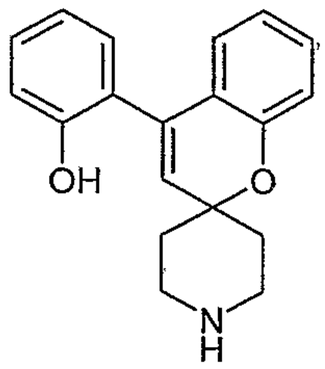
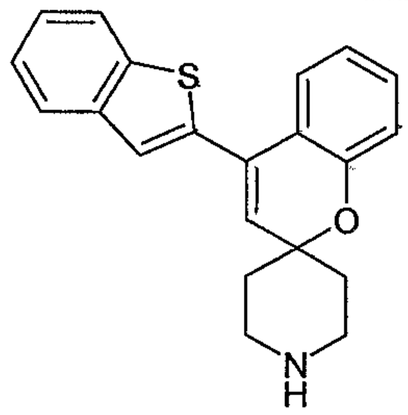
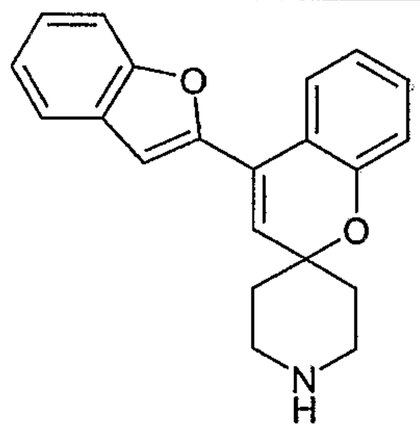
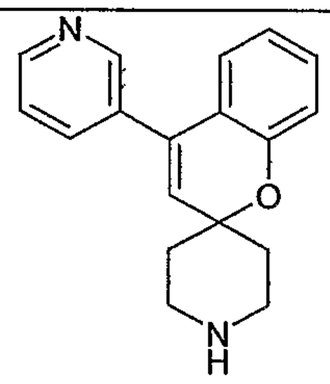
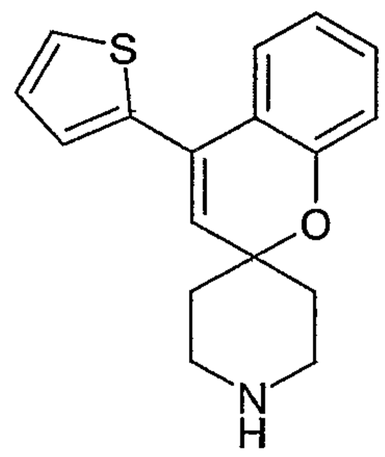
Example	***Structure***	[M+H]+
27R		395.1
27S		395.1
27T		395.3
27U		395.1
27V		395.1
27W		393.4

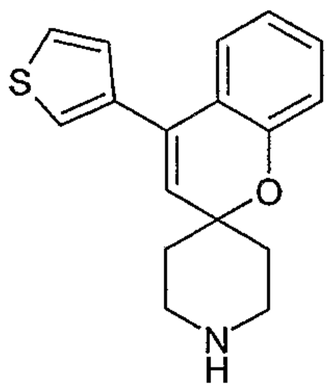
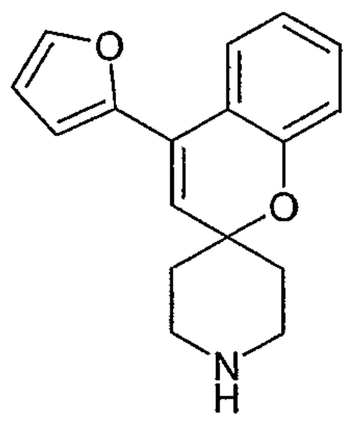
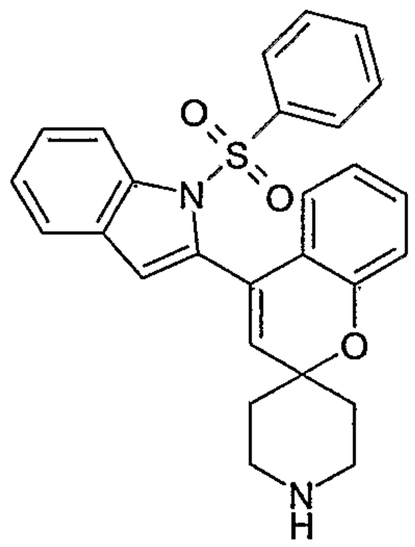
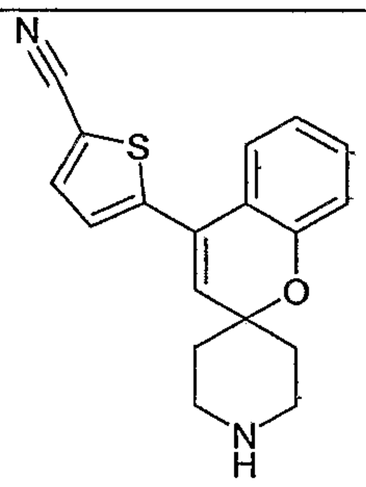
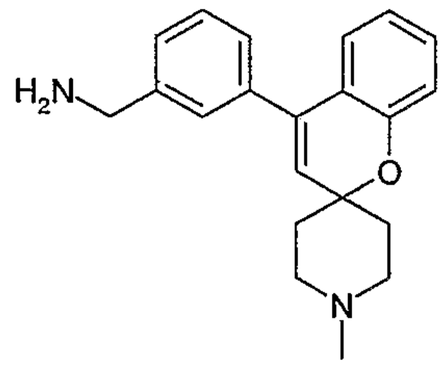
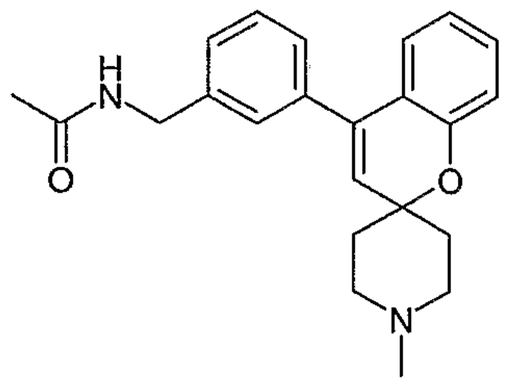
Example	***Structure***	[M+H]+
28A		375.1
28B		405.1
28C		377.1
28D		407.3
28E		376.4
29A		361.0

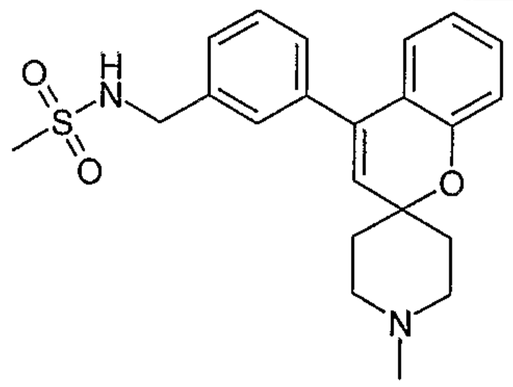
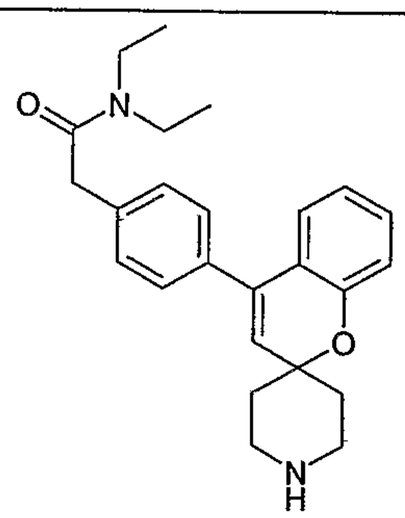
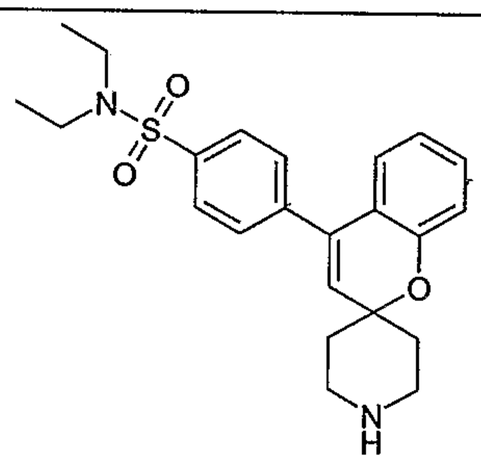
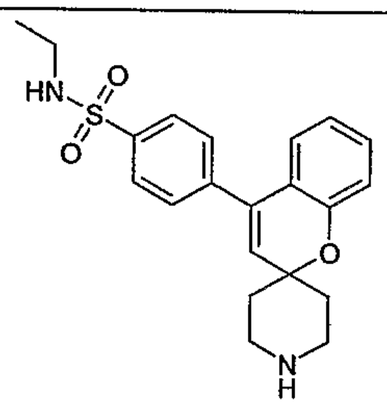
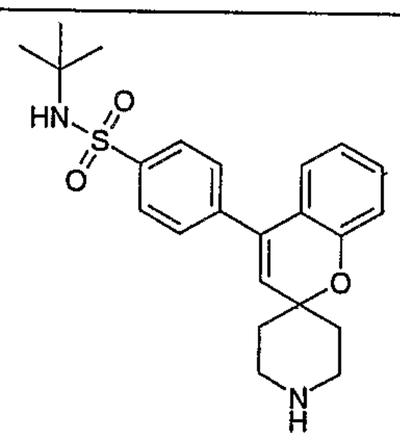
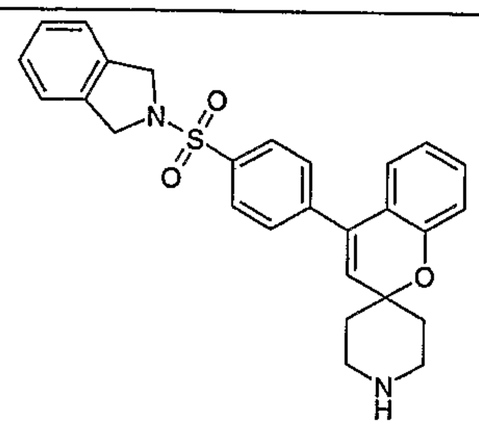
Example	***Structure***	[M+H]+
29B		389.1
29C		347.0
29D		368.9
30A		425.3
31A		336.0
31B		303.1

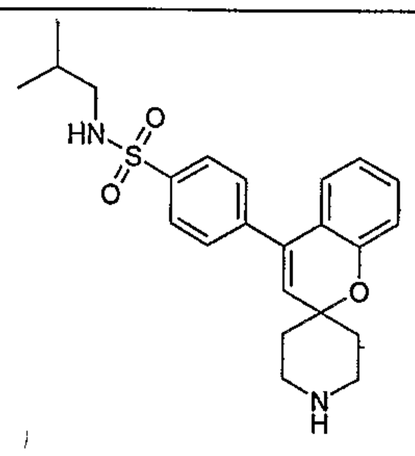
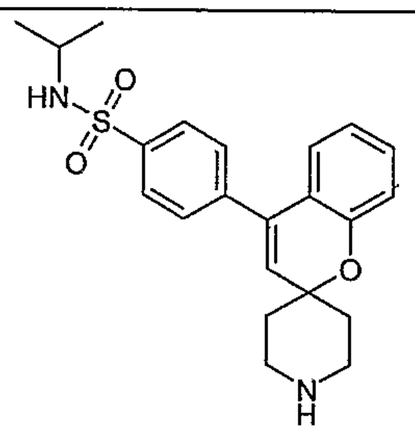
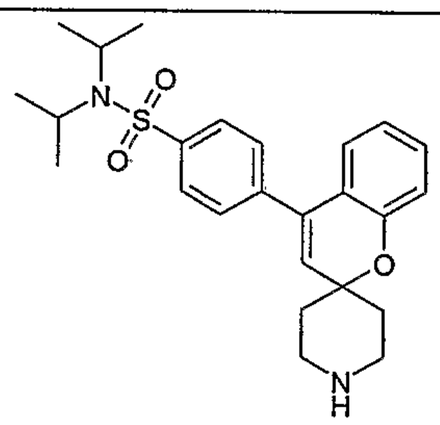
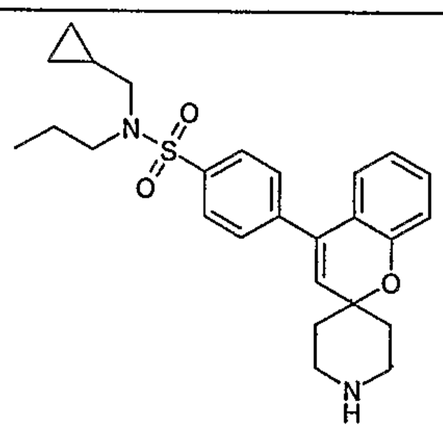
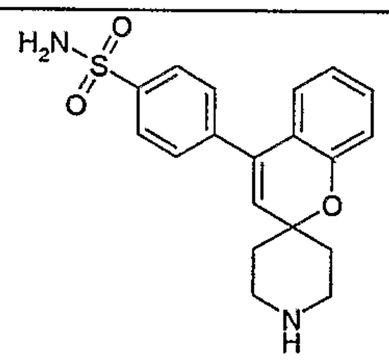
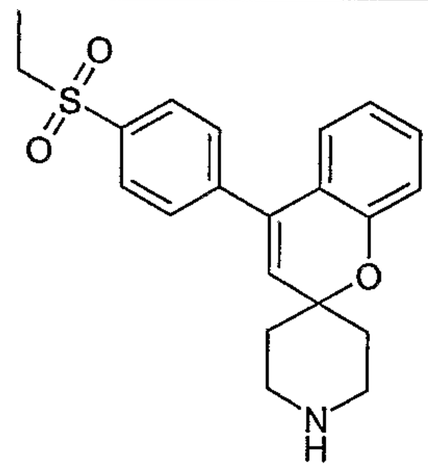
Example	***Structure***	[M+H]+
31C		303.1
31D		377.4
31E		356.1
31F		317.0
31G		308.0
31H		292.1

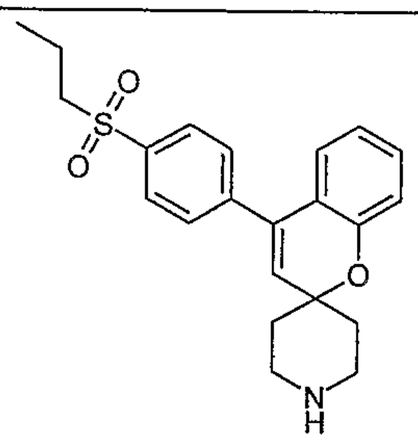
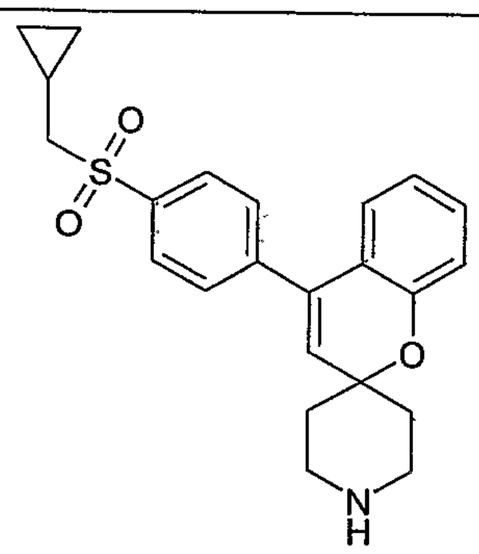
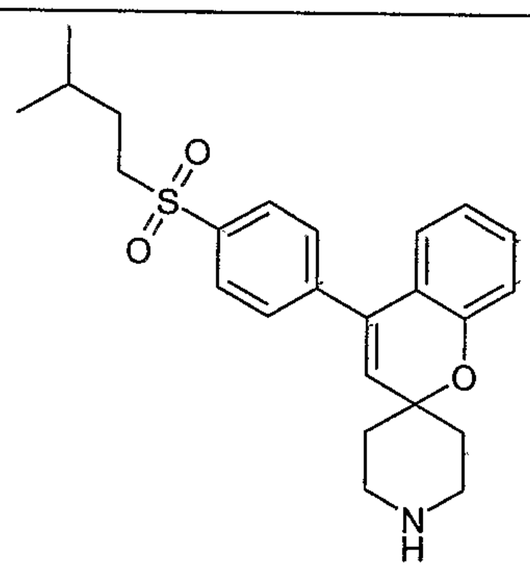
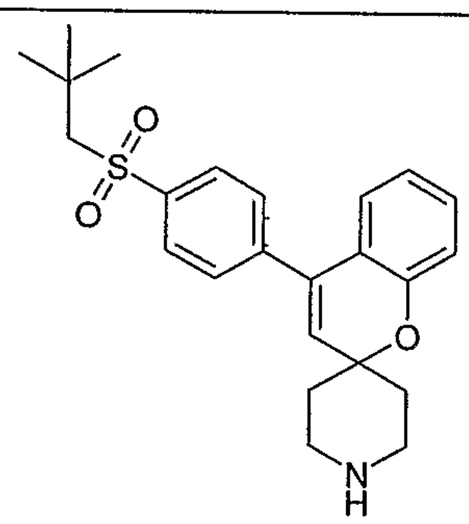
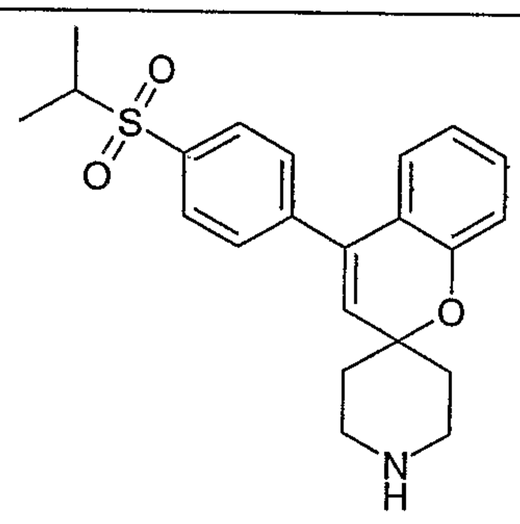
Example	***Structure***	[M+H]+
31I		346.1
31J		278.1
31K		294.0
31L		308.0
31M		294.0
31N		414.1

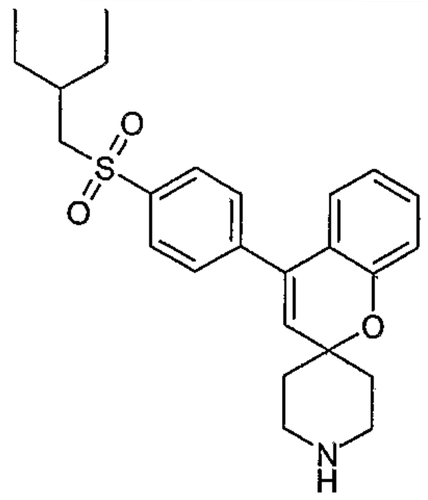
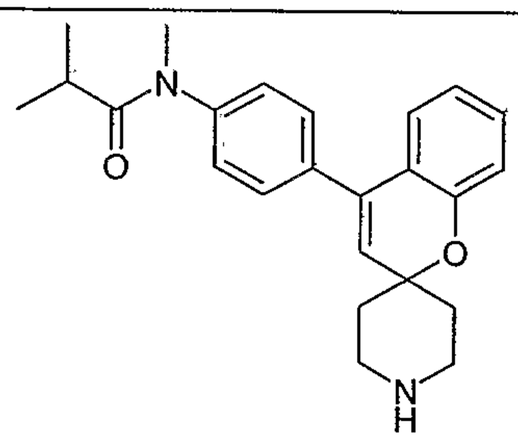
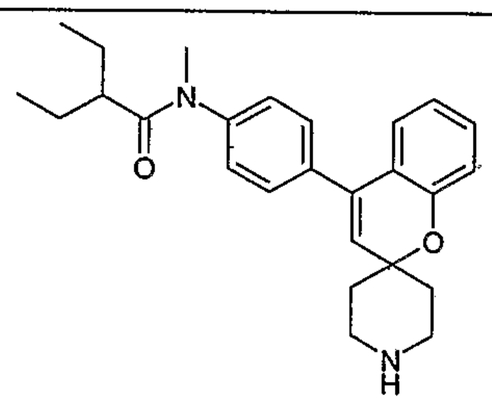
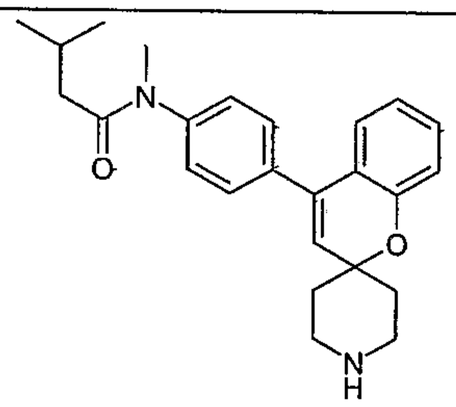
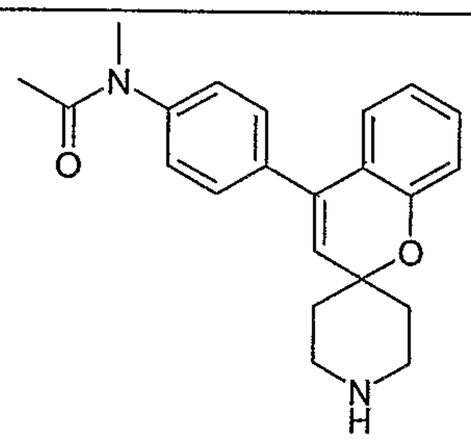
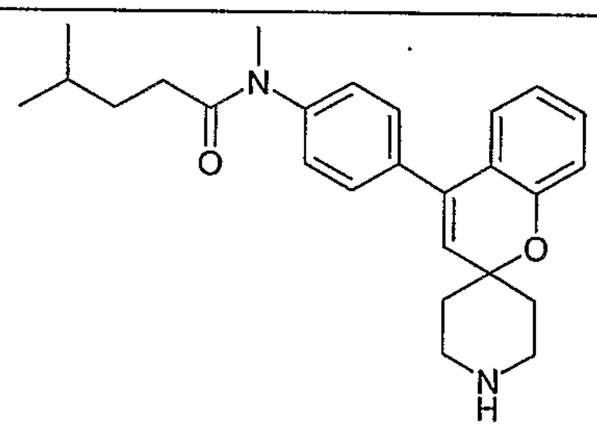
Example	***Structure***	[M+H]+
31O		308.0
31P		294.0
31Q		333.9
31R		318.1
31S		279.1
31T		283.9

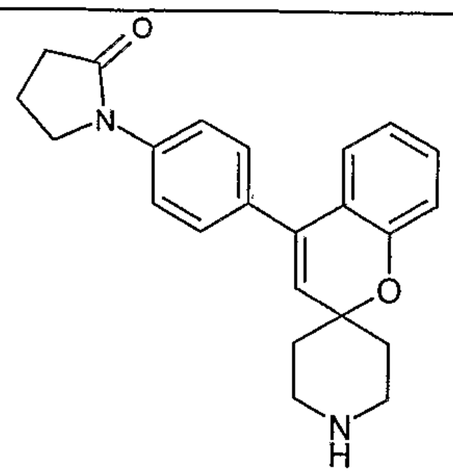
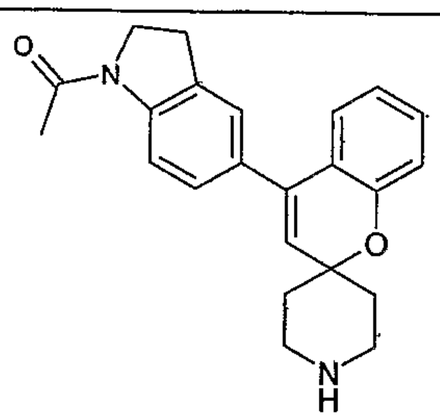
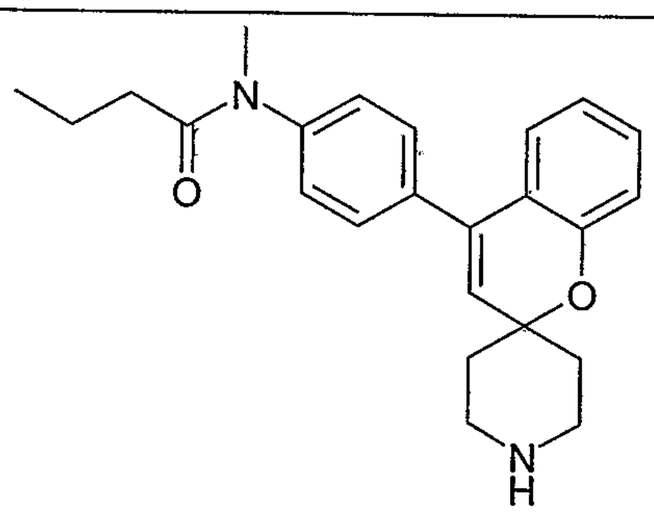
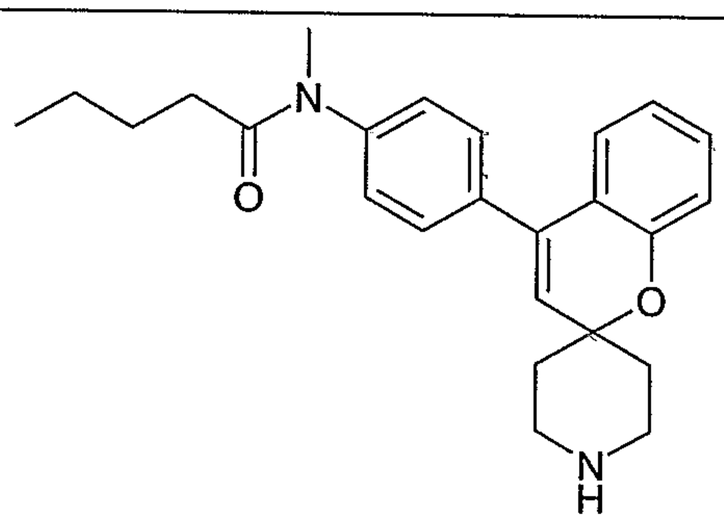
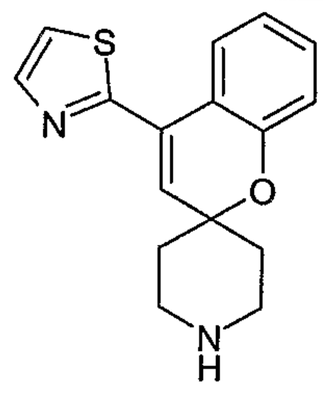
Example	***Structure***	[M+H]+
31U		284.1
31V		268.1
31W		457.1
31X		308.8
31Y		321.1
31Z		363.1

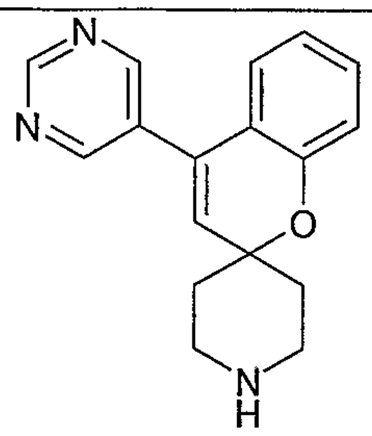
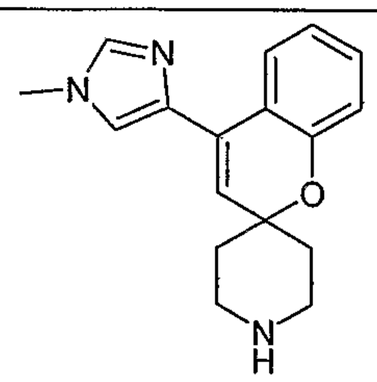
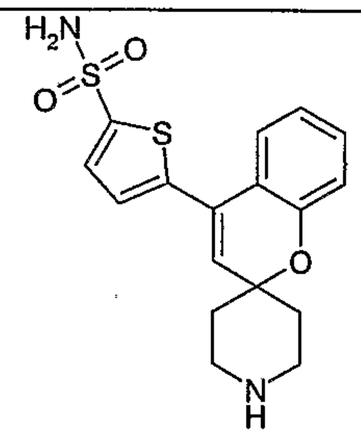
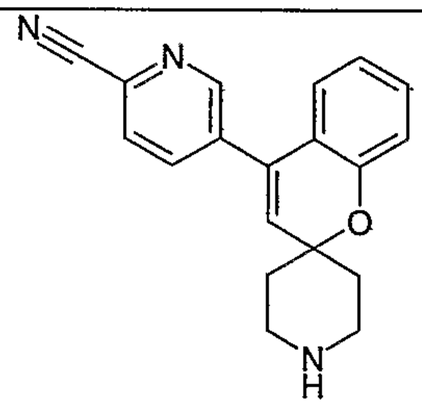
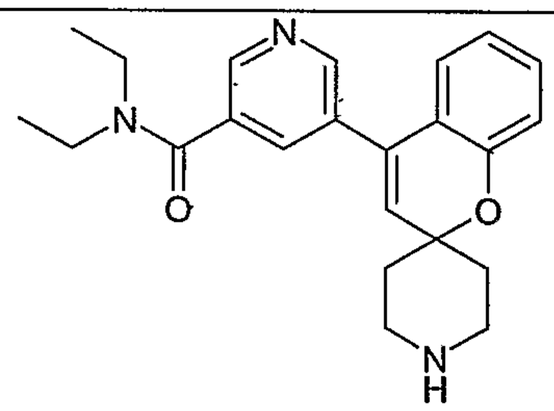
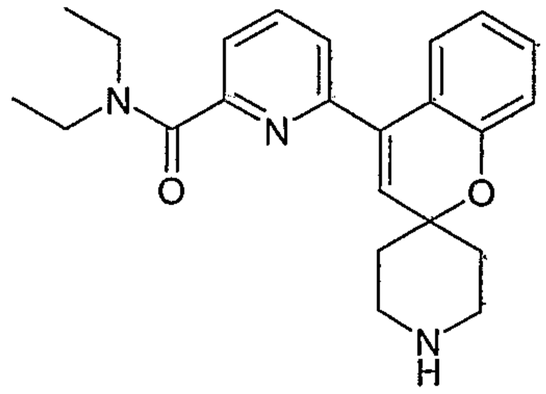
Example	***Structure***	[M+H]+
31AA		399.1
32A		391.3
32B		454.0
32C		385.3
32D		413.3
32E		459.3

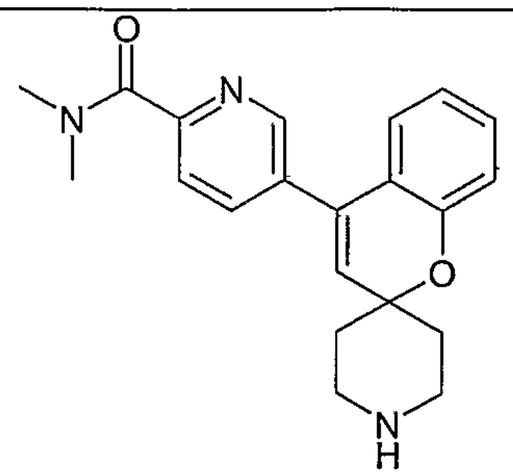
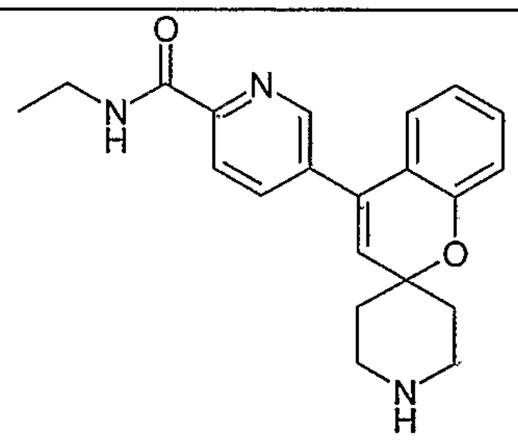
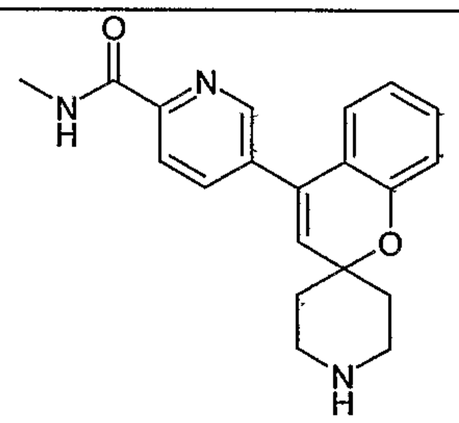
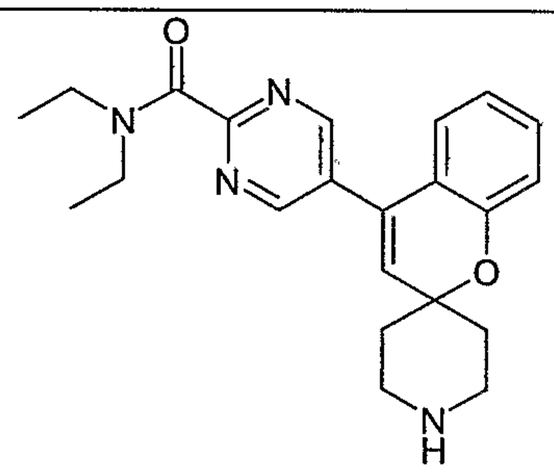
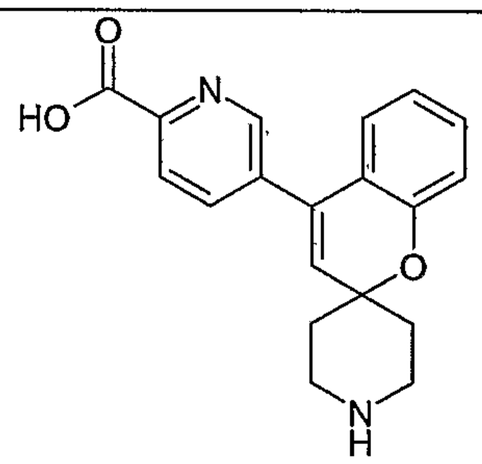
Example	***Structure***	[M+H]+
32F		413.3
32G		399.4
32H		441.4
32I		453.3
32J		357.4
32K		370.2

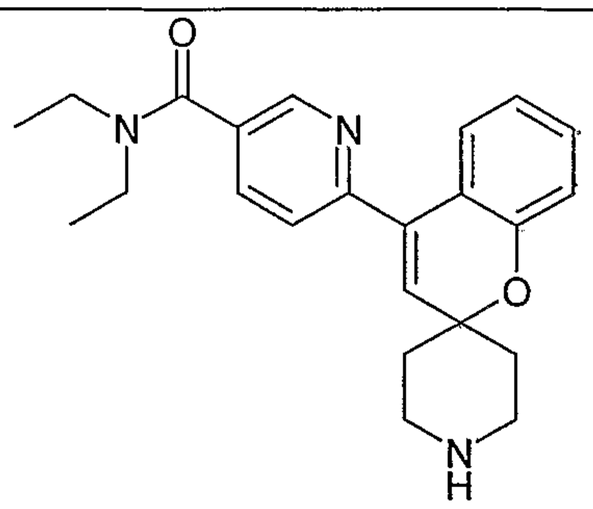
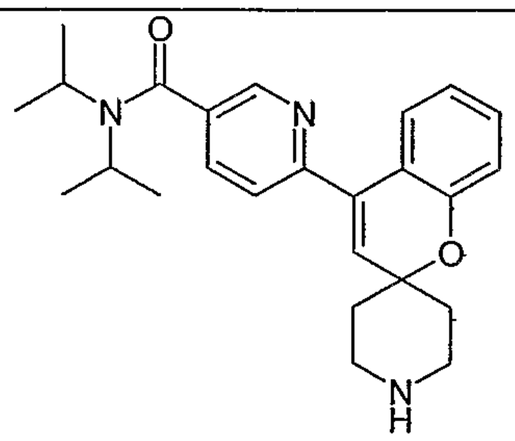
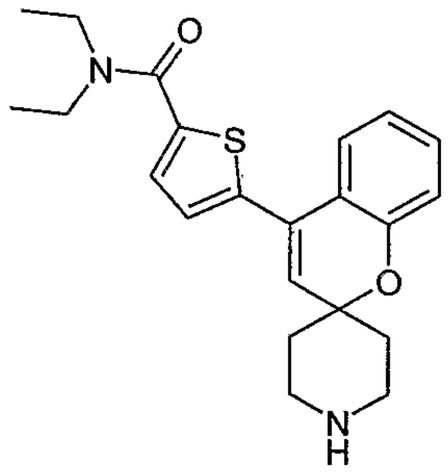
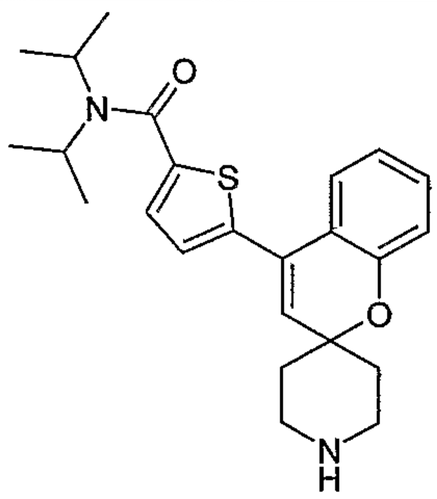
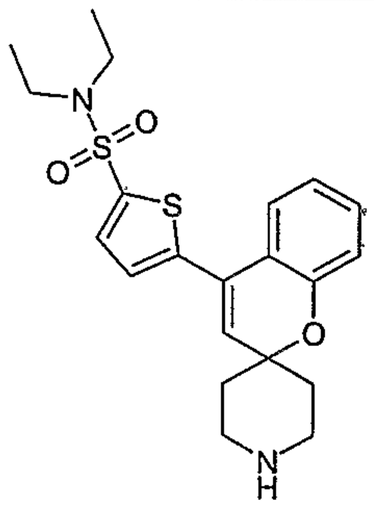
Example	***Structure***	[M+H]+
32L		384.2
32M		396.2
32N		412.2
32O		412.2
32P		384.2

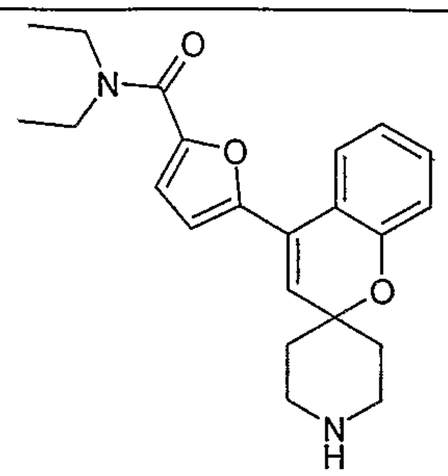
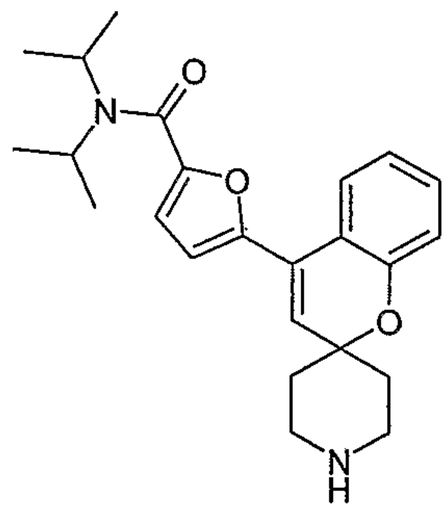
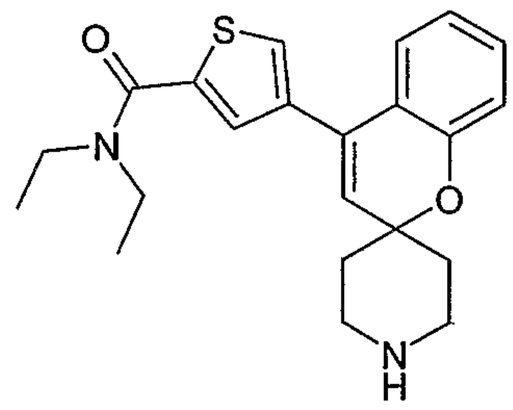
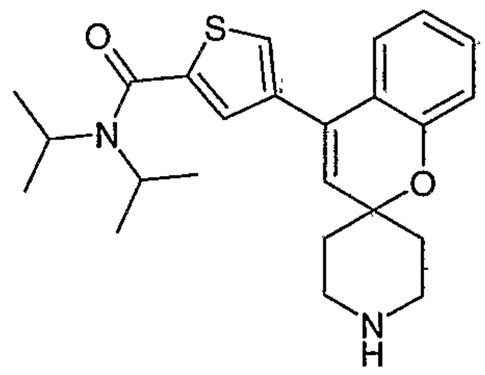
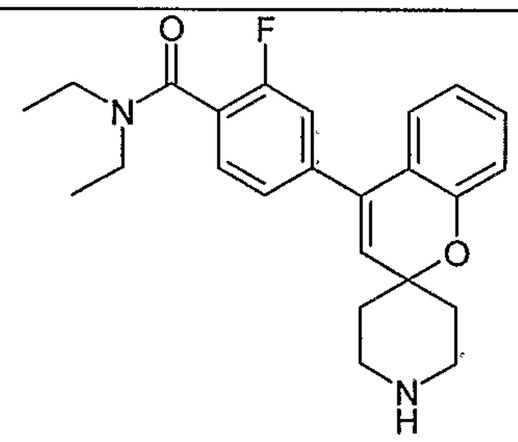
Example	***Structure***	[M+H]+
32Q		426.2
32R		377.3
32S		405.4
32T		391.3
32U		349.2
32V		405.3

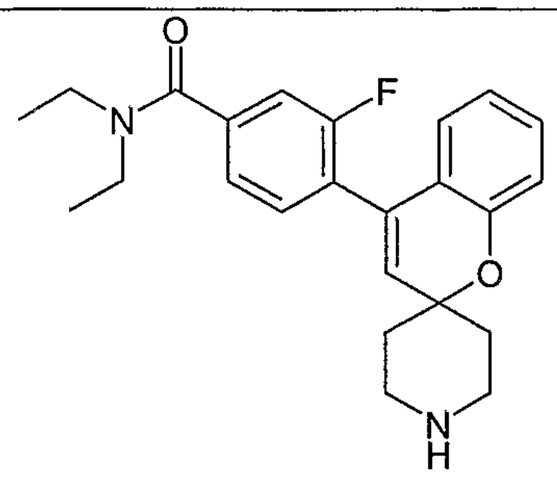
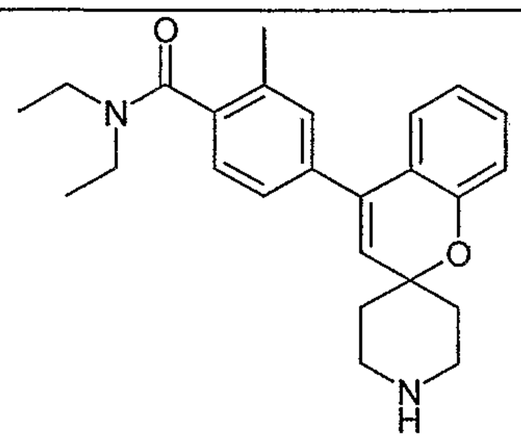
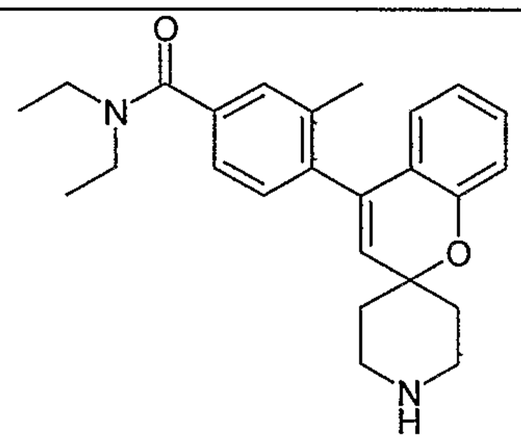
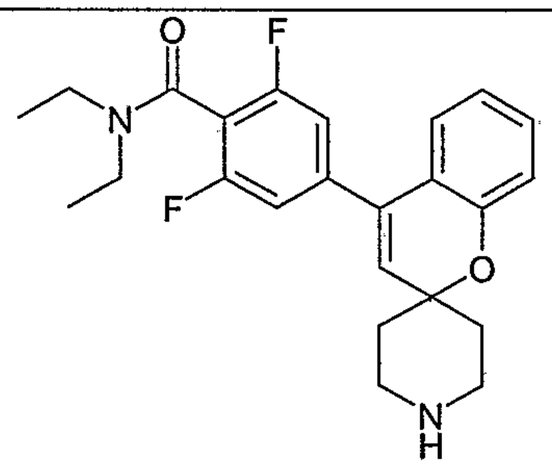
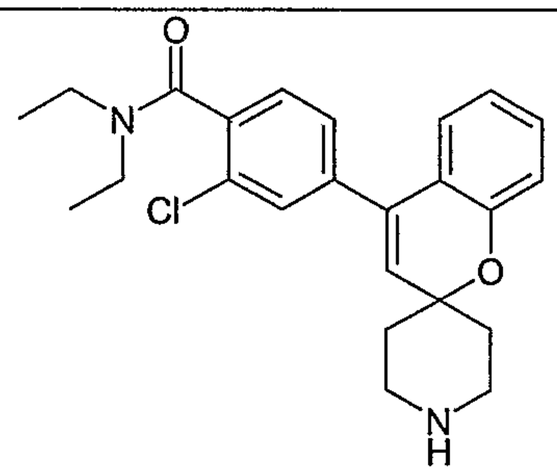
Example	***Structure***	[M+H]+
32W		361.2
32X		361.3
32Y		377.4
32Z		391.4
33A		284.9

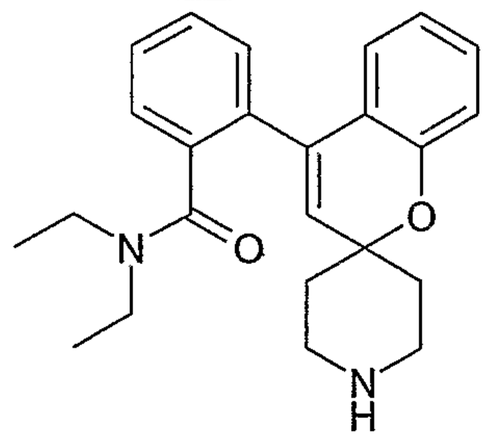
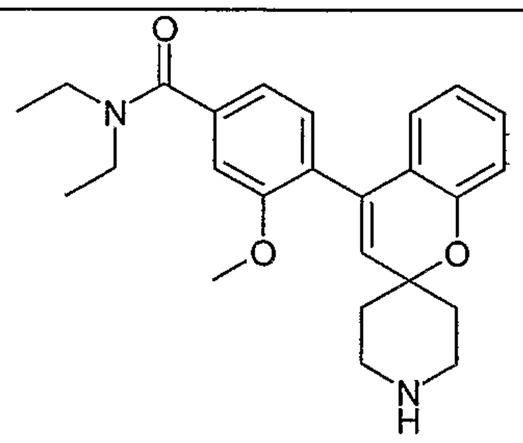
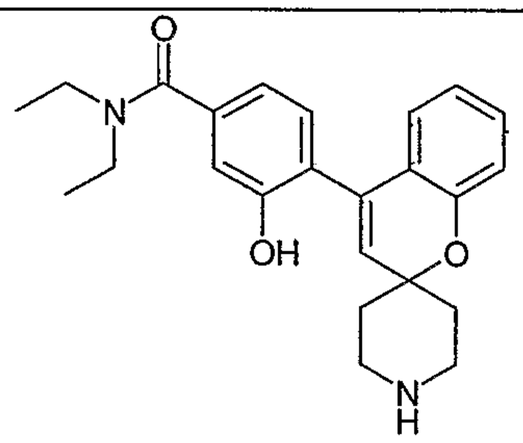
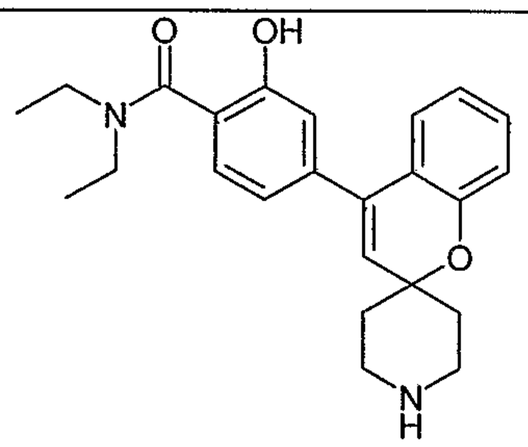
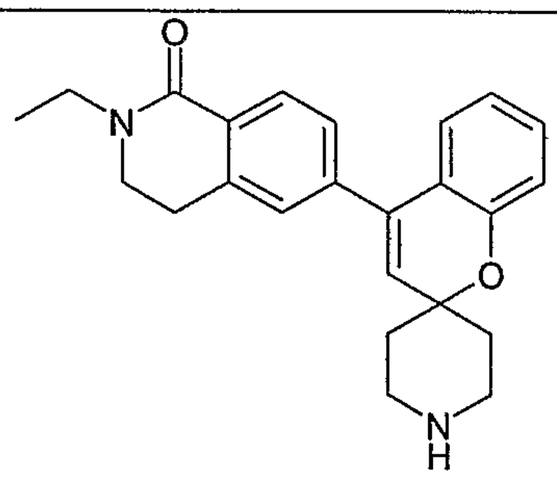
Example	***Structure***	[M+H]+
33B		279.9
33C		282.0
33D		362.9
33E		303.9
33F		378.3
33G		378.2

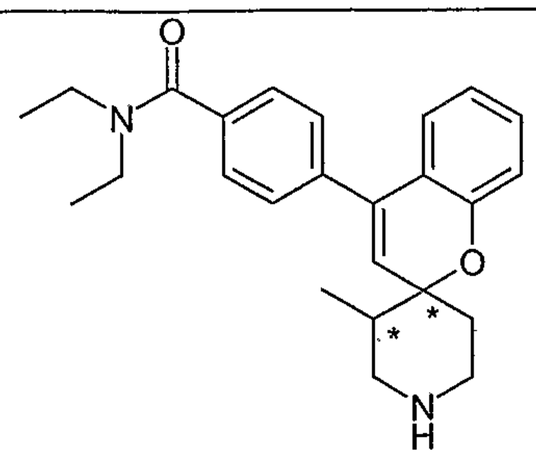
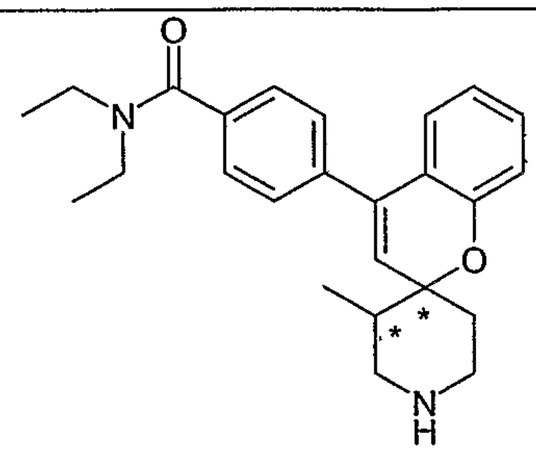
Example	***Structure***	[M+H]+
33H		350.2
33I		350.2
33J		336.2
33K		379.3
33L		321.9

Example	***Structure***	[M+H]+
34A		378.4
34B		406.4
34C		383.3
34D		411.4
34E		419.2

Example	***Structure***	[M+H]+
34F		367.3
34G		395.5
34H		383.4
34I		411.4
34J		395.0

Example	***Structure***	[M+H]+
34K		395.0
34L		391.0
34M		391.0
34N		413.0
34O		411.0

Example	***Structure***	[M+H]+
34P		377.4
35A		407.0
35B		393.3
36A		393.4
36B		375.3

Example	***Structure***	[M+H]+
37A		391.3
37B		391.3

21B and **21C** are enantiomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

21D and **21E** are diastereomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

24B and **24C** are geometric isomers with respect to one another (wherein the hydroxyl is either equatorial or axial), but the conformation of each has not been conclusively established.

24D and **24E** are geometric isomers with respect to one another (wherein the hydroxyl is either equatorial or axial), but the conformation of each has not been conclusively established.

24F and **24G** are geometric isomers with respect to one another (wherein the hydroxyl is either equatorial or axial), but the conformation of each has not been conclusively established.

27B and **27C** are enantiomeric with respect to one another, and their absolute stereochemistry has been conclusively established using X-ray crystallography.

27E and **27F** are enantiomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

27I and **27J** are enantiomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

27L and **27M** are enantiomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

27O and **27P** are enantiomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

27R and **27S** are enantiomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

27U and **27V** are enantiomeric with respect to one another, but their absolute stereochemistry has not been conclusively established.

37A and **37B** are diastereomeric with respect to one another, but each is a racemic mixture of its two possible enantiomers. Their absolute stereochemistry has not been conclusively established.

Biological Methods

In vitro Assays

The potencies of the compounds listed in **Table 1** were determined by testing the ability of a range of concentrations of each compound to inhibit the binding of the non-selective opioid antagonist, [^{3}H]diprenorphine, to the cloned human μ, κ, and δ opioid receptors, expressed in separate cell lines. IC_{50} values were obtained by nonlinear analysis of the data using GraphPad Prism version 3.00 for Windows (GraphPad Software, San Diego). K_i values were obtained by Cheng-Prusoff corrections of IC_{50} values.

Receptor binding

The receptor binding method (DeHaven and DeHaven-Hudkins, 1998) was a modification of the method of Raynor *et al.* (1994). After dilution in buffer A and homogenization as before, membrane proteins (10-80 μg) in 250 μL were added to mixtures containing test compound and [^{3}H]diprenorphine (0.5 to 1.0 nM, 40,000 to 50,000 dpm) in 250 μL of buffer A in 96-well deep-well polystyrene titer plates (Beckman). After incubation at room temperature for one hour, the samples were filtered through GF/B filters that had been presoaked in a solution of 0.5% (w/v) polyethylenimine and 0.1% (w/v) bovine serum albumin in water. The filters were rinsed 4 times with 1 mL of cold 50 mM Tris HCl, pH 7.8 and radioactivity remaining on the filters determined by scintillation spectroscopy. Nonspecific binding was determined by the minimum values of the titration curves and was confirmed by separate assay wells containing 10 μM naloxone. K_i values were determined by Cheng-Prusoff corrections of IC_{50} values derived from nonlinear regression fits of 12 point titration curves using GraphPad Prism® version 3.00 for Windows (GraphPad Software, San Diego, CA).

To determine the equilibrium dissociation constant for the inhibitors (K_i), radioligand bound (cpm) in the presence of various concentrations of test compounds was measured. The concentration to give half-maximal inhibition (EC_{50}) of radioligand binding was determined from a best nonlinear regression fit to the following equation,

$$Y = Bottom + \frac{(Top - Bottom)}{1 + 10^{X - LogEC50}}$$

where Y is the amount of radioligand bound at each concentration of test compound, Bottom is the calculated amount of radioligand bound in the presence of an infinite concentration of test compound, Top is the calculated amount of radioligand bound in the absence of test compound, X is the logarithm of the concentration of test compound, and $LogEC_{50}$ is the log of the concentration of test compound where the amount of radioligand bound is half-way between Top and Bottom. The nonlinear regression fit was performed using the program Prism® (GraphPad Software, San Diego, CA). The K_i values were then determined from the EC_{50} values by the following equation,

$$K_i = \frac{EC_{50}}{1 + \frac{[ligand]}{K_d}}$$

where [ligand] is the concentration of radioligand and K_d is the equilibrium dissociation constant for the radioligand.

Receptor-mediated [^{35}S]GTPγS binding

The potency and efficacy of compounds at each of the receptors are assessed by modifications of the methods of Selley et al., 1997 and Traynor and Nahorski, 1995 using receptor-mediated [35S]GTP□S binding in the same membrane preparations used to measure receptor binding. Assays are carried out in 96-well FlashPlates® (Perkin Elmer Life Sciences, Inc, Boston, MA). Membranes prepared from CHO cells expressing the appropriate receptor (50 -100 μg of protein) are added to assay mixtures containing agonist with or without antagonists, 100 pM [^{35}S]GTPγS (approx. 100,000 dpm), 3.0 μM GDP, 75 mM NaCl, 15 mM $MgCl_2$, 1.0 mM ethylene glycol-bis(β-aminoethyl ether)-*N,N,N',N'*-tetracetic acid, 1.1 mM dithiothreitol, 10 μg/mL leupeptin, 10 μg/mL pepstatin A, 200 μg/mL bacitracin, and 0.5 μg/mL aprotinin in 50 mM Tris-HCl buffer, pH 7.8. After incubation at room temperature

for one hour, the plates are sealed, centrifuged at 800 x g in a swinging bucket rotor for 5 min and bound radioactivity determined with a TopCount microplate scintillation counter (Packard Instrument Co., Meriden, CT).

EC_{50} values for agonists are determined from nonlinear regression fits of 8- or 12-point titration curves to the 4-parameter equation for a sigmoidal dose-response with a slope factor of 1.0 using GraphPad Prism® version 3.00 for Windows (GraphPad Software, San Diego, CA).

The potencies of the compounds were determined by testing the ability of a range of concentrations of each compound to inhibit the binding of the non-selective opioid antagonist, [^{3}H]diprenorphine, to the cloned human μ, κ, and δ opioid receptors, expressed in separate cell lines. All the compounds tested (compounds included in Table 1) bind with affinity to the human cloned δ opioid receptor less than 2 μM (K_i values). These compounds display high selectivity δ/κ and δ/μ (at least 10-fold). The potencies of the agonists were assessed by their abilities to stimulated [^{35}S]GTPγS binding to membranes containing the cloned human δ opioid receptors. All the compounds listed in Table 1 were agonists at the δ opioid receptor.

As example, **1A** (Table 1) binds to the delta, mu, and kappa opioid receptors with affinity (expressed as K_i value) of 0.93nM, 980 nM and >1000nM, respectively). Furthermore, **1A** displayed potent *in vitro* agonist activity (EC_{50} = 9.1 nM).

***In vivo* Assays**

Freunds Complete Adjuvant (FCA)-Induced Hyperalgesia

Rats were injected intraplantar with FCA and 24h later treated with tested compounds administered orally. Paw Pressure Thresholds (PPT) was assessed 30, 60, 120, and 240 minutes after drug treatment. **1A** significantly increased PPT by 170-180% in the inflamed paw 1-2h after oral administration (ED_{50} = 2.5 mg/kg p.o.). **1A** produced a similar increase in PPT in the uninflamed paw at the 2h time point, a change that is generally associated with effects mediated within the central nervous system.

Acetic Acid-Induced Writhing

Male ICR mice weighing 20-25g are injected s.c. with either vehicle or test compound 15 min before they are injected intraperitoneally with 0.6% acetic acid. At 5 minutes after treatment with acetic acid, the number of writhes is counted for 10 minutes. Dose response curves are expressed as the percent inhibition of acetic acid induced writhing, when compared to the mean number of writhes observed in the vehicle-treated mice. The mean percent inhibition (%I) of acetic acid-induced writhing for drug-treated mice is calculated according to the following formula:

$$\%I = \frac{\text{(Mean vehicle response – Mean individual response)}}{\text{(Mean vehicle response)}} \times 100$$

The mean individual response is the mean number of writhes in mice treated with test compound. The mean vehicle response is the mean number of writhes in mice treated with vehicle.

1A produces 69% inhibition of acetic acid-induced writhing at 30 mg/kg (s.c.)

Castor Oil-Induced Diarrhea

Mice were fasted overnight with water ad libitum. Mice were weighed, dosed orally with 0.6 mL of castor oil and placed in individual cubicles (11 cm x 10 cm) lined with a pre-weighed sheet of absorbent paper. Thirty min after receiving castor oil, mice were injected s.c with tested compound. Seventy-five min after dosing with castor oil, the mice and absorbent paper were reweighed and the number of mice with diarrhea (defined as wet, unformed stool) was determined.

Percent inhibition by tested compounds in castor oil-induced diarrhea assay was determined by the following formula:

$$\frac{\text{1-(agonist response)}}{\text{(vehicle response)}} \times 100$$

1A reduced incidence of diarrhea in a time-dependent manner: ED_{50} (s.c.) = 8.7 mg/kg.

Forced Swim Assay

Male Sprague-Dawley rats (approximately 200g) are placed in a tank of room temperature water for a fifteen min practice swim. Every five sec during the first five min of the practice swim, the rats are rated as immobile (floating with motion needed to keep head above the water), swimming (movement across the swim), or climbing (actively trying to climb out of the tank of water, upward directed movements of the forepaws). The percentage of time the rats spent in each of these responses is calculated.

Approximately 24 h after the practice swim, the rats are treated with vehicle or test compound and placed in the tank for a 5 min swim. As was the case with the practice swim, the rats are rated as immobile, swimming, or climbing during the test swim and the percentage of time spent in each of these responses is calculated. The data is analyzed by one-way ANOVA with post-hoc analysis to compare the behavioral response after vehicle treatment to the behavioral response after drug treatment for each of the three behavioral responses. The level of significance is set at $p < 0.05$.

Data for **1A** (presented as percent change ± SEM, relative to vehicle-treated rats)

RESPONSE	**3 mg/kg p.o.**	**30 mg/kg p.o.**
IMMOBILITY (% Decrease)	17 ± 10	43 ± 13*
SWIMMING (% Increase)	37 ± 17	137 ± 35*

*Values significantly different ($p < 0.05$) than vehicle-treated rats

Experimental Section

Introduction

Materials: All chemicals were reagent grade and used without further purification.

Analytical: Thin-layer chromatography (TLC) was performed on silica gel 60 flexible backed plates (250 microns) from Alltech and visualized by UV 254 irradiation and iodine. Flash chromatography was conducted using the ISCO CombiFlash with RediSep silica gel cartridges (4 g, 12 g, 40 g, 120 g). Flash chromatography was also conducted with silica gel (200-400 mesh, 60Å, Aldrich). Chromatographic elution solvent systems are reported as volume:volume ratios. All ^{1}H NMR spectra were recorded at ambient temperature on a Bruker-400 MHz spectrometer. They are reported in ppm on the δ scale, from TMS. LC-MS data were obtained using a Thermo-Finnigan Surveyor HPLC and a Thermo-Finnigan AQA MS using either positive or negative electrospray ionization. Program (positive) Solvent A: 10 mM ammonium acetate, pH 4.5, 1% acetonitrile; solvent B: acetonitrile; column: Michrom Bioresources Magic C18 Macro Bullet, detector: PDA λ = 220-300 nm. Gradient: 96%A-100%B in 3.2 minutes, hold 100%B for 0.4 minutes. Program (negative) Solvent A: 1 mM ammonium acetate, pH 4.5, 1% acetonitrile; solvent B: acetonitrile; column: Michrom Bioresources Magic C18 Macro Bullet, detector: PDA λ = 220-300 nm. Gradient: 96%A-100%B in 3.2 minutes, hold 100%B for 0.4 minutes.

EXAMPLE 1A

Preparation of **1.3a**:

Method 1A: Pyrrolidine (6.12 mL, 73.38 mmol, 2.0 eq) was added at room temperature to **1.2** (7.31 g, 36.69 mmol, 1.0 eq) and **1.1a** (5.00 g, 36.69 mmol, 1.0 eq). The solution was stirred overnight at room temperature and then concentrated under reduced pressure. Diethyl ether (500 mL) was added. The organic mixture was washed with a 1N aqueous solution of hydrochloric acid, a 1N aqueous solution of

sodium hydroxide, brine and dried over sodium sulfate. Hexane (300 mL) was added to the mixture. The resulting precipitate was collected by filtration, washed with hexane and used for the next step without further purification.

Yield: 68%

Method 1B: Pyrrolidine (42 mL, 73.38, 2.0 eq) was added drop wise at room temperature to a solution of **1.2** (49.8 g, 0.249 mol, 1.0 eq) and **1.1a** (34 g, 0.184 mol, 1.0 eq) in anhydrous methanol (400 mL). The solution was refluxed overnight and then concentrated under reduced pressure. Diethyl ether (500 mL) was added. The organic mixture was washed with a 1N aqueous solution of hydrochloric acid, a 1N aqueous solution of sodium hydroxide, brine and dried over sodium sulfate. Hexane (300 mL) was added to the mixture. The resulting precipitate was collected by filtration, washed with hexane, and used for the next step without further purification.

Yield: 72%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.86 (d, 1H), 7.50 (t, 1H), 7.00 (m, 2H), 3.87 (m, 2H), 3.22 (m, 2H), 2.72 (s, 2H), 2.05 (d, 2H), 1.61 (m, 2H), 1.46 (s, 9H)

Mass Spectral Analysis *m/z* = 318.0 $(M+H)^+$

Preparation of **1.5a**:

To a solution of **1.3a** (25 g, 0.078 mol, 1.0 eq) in tetrahydrofuran (250 mL) at -78°C under nitrogen was added drop wise a 1.0M solution of lithium bis(trimethylsilyl)amide in tetrahydrofuran (94.5 mL, 0.095 mol, 1.2 eq). The mixture was stirred for 1h at -78°C. A solution of **1.4** (33.8 g, 0.095 mol, 1.2 eq) in tetrahydrofuran (150 mL) was added drop wise. The mixture was warmed slowly to room temperature and stirring was continued for a further 12h. The mixture was then poured into ice water and the two phases were separated. The organic phase was washed with a 1N aqueous solution of hydrochloric acid, a 1N aqueous solution of sodium hydroxide, brine and dried over sodium sulfate. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 70%

^{1}H NMR (400MHz, DMSO d_6) □ 7.45-7.20 (m, 2H), 7.00 (m, 2H), 6.15 (s, 1H), 3.70 (m, 2H), 3.20 (m, 2H), 1.90 (m, 2H), 1.75 (m, 2H), 1.40 (s, 9H)

Mass Spectral Analysis *m/z* = 450.1 $(M+H)^+$

Preparation of **1.8a**:

Method 1C: To a solution of **1.5a** (15 g, 33.37 mmol, 1.0 eq) in dimethoxyethane (100 mL) was added sequentially a 2N aqueous solution of sodium carbonate (50.06 mL, 100.12 mmol, 3.0 eq), lithium chloride (4.24 g, 100.12 mmol, 3.0 eq), **1.6** (8.12 g, 36.71 mmol, 1.1 eq) and tetrakis(triphenylphosphine)palladium(0) (0.77 g, 0.67 mmol, 0.02 eq). The mixture was refluxed for 10h under nitrogen. The mixture was then cooled to room temperature and water (250 mL) was added. The mixture was extracted with ethyl acetate. The organic layer was further washed with brine and dried over sodium sulfate. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 73%

Method 1D: To a solution of **1.5a** (10 g, 22.25 mmol, 1.0 eq) in dimethoxyethane (67 mL) was added sequentially a 2N aqueous solution of sodium carbonate (33.37 mL, 66.75 mmol, 3.0 eq), lithium chloride (2.83 g, 66.75 mmol, 3.0 eq), **1.6** (4.40 g, 24.47 mmol, 1.1 eq) and palladium, 10 weight % (dry basis) on activated carbon, wet, Degussa type E101 NE/W (0.24 g, 0.11 mmol, 0.005 eq). The mixture was refluxed for 2h under nitrogen. The mixture was then cooled to room temperature and diluted with dichloromethane (350 mL). The mixture was filtered through a celite plug and dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was triturated with diethyl ether. The precipitate was collected by filtration.

Yield: 60%

^{1}H NMR (400MHz, $CDCl_3$) □ 7.35 (m, 4H), 7.15 (t, 1H), 7.00-6.80 (m, 3H), 5.55 (s, 1H), 3.85 (m, 2H), 3.55 (m, 2H), 3.30 (m, 4H), 2.00 (m, 2H), 1.65 (m, 2H), 1.40 (s, 9H); 1.20 (m, 6H)

Mass Spectral Analysis *m/z* = 477.2 $(M+H)^+$

Preparation of **1A**:

Method 1E: A 2.0M solution of hydrochloric acid in diethyl ether (34.6 mL, 69.24 mmol, 5.5 eq) was added drop wise to a cooled (0°C) solution of **1.8a** (6.00 g, 12.59 mmol, 1.0 eq) in anhydrous dichloromethane (70 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h. Diethyl ether (100 mL) was added to the solution and the resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 99%

Method 1F: Trifluoroacetic acid (10.33 mL, 134.09 mmol, 5.5 eq) was added drop wise to a cold (0°C) solution of **1.8a** (11.62 g, 24.38 mmol, 1.0 eq) in anhydrous dichloromethane (50 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h. The mixture was then concentrated under reduced pressure. A saturated solution of sodium bicarbonate (100 mL) was added to the mixture, which was extracted with dichloromethane. The organic phase was separated, washed with brine, dried over sodium sulfate and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added drop wise a 2.0M solution of anhydrous hydrochloric acid in diethyl ether (36.5 mL, 0.073 mol, 3.0 eq). The mixture was then stirred for 1h at room temperature and concentrated under reduced pressure. Diethyl ether was added. The resulting precipitate was collected by vacuum filtration and washed with diethyl ether.

Yield: 99%

^{1}H NMR (400MHz, DMSO d_6) δ 9.06 (m, 2H), 7.43 (s, 4H), 7.27 (t, 1H), 7.00 (m, 3H), 5.95 (s, 1H), 3.45 (m, 2H), 3.23 (m, 6H), 2.00 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 377.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{28}N_2O_2$, 1HCl

Theory: %C 69.80; %H 7.08; %N 6.78

Found: %C 69.73; %H 7.04; %N 6.81

EXAMPLE 1B

1B was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1b** and Method 1B was used.

Step 1.3: Method 1C was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 8.97 (m, 2H), 7.42 (m, 4H), 6.98 (m, 1H), 6.86 (m, 1H), 6.49 (m, 1H), 5.99 (s, 1H), 3.62 (m, 3H), 3.50 (m, 2H), 3.21 (m, 6H), 2.06 (m, 4H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 407.1 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_3$, 1HCl, $1.25H_2O$

Theory: %C 64.51; %H 7.25; %N 6.02

Found: %C 64.53; %H 7.11; %N 5.89

EXAMPLE 1C

1C was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1c** and Method 1A was used.

Step 1.3: Method 1C was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 9.05 (m, 1.5H), 7.45 (s, 4H), 7.30 (d, 1H), 7.10 (d, 1H), 6.90 (s, 1H), 6.00 (s, 1H), 3.1–3.55 (m, 8H), 2.05 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 411.2 $(M+H)^+$

EXAMPLE 1D

1D was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1d** and Method 1B was used.

Step 1.3: Method 1D was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 8.95 (m, 1H), 7.40 (s, 4H), 7.10 (m, 2H), 6.70 (m, 1H), 6.05 (s, 1H), 3.10-3.50 (m, 8H), 2.00 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 395.2 $(M+H)^+$

EXAMPLE 1E

1E was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1e** and Method 1A was used.

Step 1.3: Method 1D was used.

Step 1.4: Method 1E was used.

^1H NMR (400MHz, DMSO d_6) δ 8.92 (brm, 1H), 7.42 (s, 4H), 7.07 (dd, 1H), 6.94 (d, 1H), 6.79 (d, 1H), 5.92 (s, 1H), 3.45 (brs, 2H), 3.22 (brm, 6H), 2.18 (s, 3H), 2.08 (m, 2H), 1.97 (m, 2H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 391.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_2$, 1HCl, $1.5H_2O$

Theory: %C 66.13; %H 7.55; %N 6.17

Found: %C 65.73; %H 7.38; %N 6.05

EXAMPLE 1F

1F was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1f** and Method 1B was used.

Step 1.3: Method 1C was used.

Step 1.4: Method 1F was used.

^1H NMR (400MHz, DMSO d_6) δ 8.90 (m, 2H), 7.25 (m, 5H), 6.71 (m, 1H), 6.64 (m, 1H), 5.81 (s, 1H), 3.45 (m, 2H), 3.39 (m, 3H), 3.20 (m, 6H), 2.00 (m, 4H), 1.09 (m, 6H)

Mass Spectral Analysis *m/z* = 407.2 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_3$, 1HCl, $2H_2O$

Theory: %C 62.69; %H 7.36; %N 5.85

Found: %C 62.78; %H 6.90; %N 5.61

EXAMPLE 1G

1G was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1g** and Method 1B was used.

Step 1.3: Method 1C was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 8.95 (m, 1H), 8.85 (m, 1H), 7.38 (m, 4H), 6.89 (m, 1H), 6.68 (m, 1H), 6.54 (m, 1H), 5.78 (s, 1H), 3.76 (m, 3H), 3.45 (m, 2H), 3.21 (m, 6H), 2.09 (m, 2H), 1.98 (m, 2H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 407.1 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_3$, 1HCl, $0.5H_2O$

Theory: %C 66.43; %H 7.14; %N 6.20

Found: %C 66.25; %H 7.19; %N 6.11

EXAMPLE 1H

1H was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1h** and Method 1B was used.

Step 1.3: Method 1D was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 8.80 (brm, 1H), 8.33 (d, 1H), 7.90 (m, 1H), 7.58 (m, 2H), 7.51 (d, 1H), 7.46 (d, 4H), 7.16 (d, 1H), 5.97 (s, 1H), 3.46 (brs, 2H), 3.30 (brm, 6H), 2.25 (d, 2H), 2.05 (m, 2H), 1.13 (brd, 6H)

Mass Spectral Analysis *m/z* = 427.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{30}N_2O_2$, 1HCl, $1.5H_2O$

Theory: %C 68.63; %H 6.99; %N 5.72

Found: %C 68.96; %H 6.82; %N 5.75

EXAMPLE 1I

1I was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1i** and Method 1B was used.

Step 1.3: Method 1D was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 8.90 (brm, 1H), 7.94 (d, 1H), 7.87 (d, 1H), 7.37 (m, 3H), 7.28 (t, 1H), 7.24 (d, 2H), 7.10 (t, 1H), 6.96 (d, 1H), 6.04 (s, 1H), 3.44 (brs, 2H), 3.23 (brs, 6H), 2.09 (brm, 4H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 427.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{30}N_2O_2$, 1HCl, 0.67H_2O

Theory: %C 70.80; %H 6.86; %N 5.90

Found: %C 70.57; %H 6.72; %N 5.83

EXAMPLE 1J

1J was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1j** and Method 1A was used.

Step 1.3: Method 1D was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 9.09 (brm, 1H), 7.41 (s, 4H), 6.87 (s, 1H), 6.75 (s, 1H), 5.84 (s, 1H), 3.45 (brs, 2H), 3.20 (brm, 6H), 2.19 (s, 3H), 2.08 (s, 3H), 2.05 (m, 2H), 1.97 (m, 2H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 405.4 $(M+H)^+$

Elemental analysis:

$C_{26}H_{32}N_2O_2$, 1HCl, 0.5H_2O

Theory: %C 69.39; %H 7.62; %N 6.22

Found: %C 69.22; %H 7.49; %N 6.24

EXAMPLE 1K

1K was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1k** and Method 1B was used.

Step 1.3: Method 1C was used.

Step 1.4: Method 1F was used.

^{1}H NMR (400MHz, DMSO d_6) δ 9.25 (m, 1H), 7.40 (m, 4H), 7.35 (m, 1H), 6.61 (s, 1H), 3.25 (m, 8H), 2.06 (m, 4H), 1.02 (m, 6H)

Mass Spectral Analysis *m/z* = 413.2 $(M+H)^+$

EXAMPLE 1L

1L was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1l** and Method 1B was used.

Step 1.3: Method 1D was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 8.84 (brs, 1H), 7.41 (d, 4H), 6.96 (s, 1H), 6.61 (s, 1H), 5.86 (s, 1H), 3.45 (brs, 2H), 3.20 (brm, 6H), 2.23 (s, 3H), 2.13 (s, 3H), 2.08 (m, 2H), 1.96 (m, 2H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 405.4 $(M+H)^+$

Elemental analysis:

$C_{26}H_{32}N_2O_2$, 1HCl, $0.5H_2O$

Theory: %C 69.39; %H 7.62; %N 6.22

Found: %C 69.69; %H 7.56; %N 6.28

EXAMPLE 1M

1M was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1m** and Method 1B was used.

Step 1.3: Method 1C was used.

Step 1.4: Method 1E was used.

^{1}H NMR (400MHz, DMSO d_6) δ 9.05 (m, 2H), 7.46 (m, 2H), 7.20 (m, 3H), 7.01 (m, 1H), 6.82 (m, 1H), 6.48 (m, 1H), 3.45 (m, 2H), 3.28 (m, 6H), 2.24 (m, 2H), 2.06 (m, 2H), 1.60 (m, 3H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 391.0 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_2$, 1HCl, $0.25H_2O$

Theory: %C 69.59; %H 7.36; %N 6.49

Found: %C 69.25; %H 7.29; %N 6.58

EXAMPLE 1N

Preparation of **1.10**:

To an oven-dried 2-necked 500 mL flask charged with anhydrous toluene (90 mL) at -78°C was added *n*-butyl lithium (2.5 M solution in hexane, 40 mL, 0.1 mol, 1.0 eq). A solution of 2,5-dibromo-pyridine (**1.9**) (23.69 g, 0.1 mol, 1.0 eq) in anhydrous toluene (50 mL) was added dropwise. The reaction mixture was stirred at -78°C for 2h and then poured onto freshly crushed dry-ice (~ 500 g). The dry-ice mixture was then left at room temperature for 10h. The volatiles were removed under reduced pressure and the residue was dissolved in water. The insoluble solids were filtered and the filtrate was acidified to pH 2, at which point a light brown solid precipitated out. The solids were collected by filtration and recrystallized from acetic acid (500 mL). This provided **1.10** isolated as its acetic acid salt.

Yield: 74%

^{1}H NMR (400MHz, DMSO d_6) δ 8.84 (d, 1H), 8.25 (dd, 1H), 7.98 (d, 1H)

Mass Spectral Analysis *m/z* = 202.06 $(M+H)^+$

Preparation of **1.11**:

To a suspension of 5-bromo-pyridine-2-carboxylic acid (**1.10**) (808 mg, 3.01 mmol, 1.0 eq) in dry dichloromethane (5 mL) was added oxalyl chloride (0.34 mL, 3.96 mmol, 1.3 eq) followed by 2 drops of *N,N*-dimethylformamide. The reaction mixture was heated under reflux for 1h. After cooling to room temperature, the mixture was concentrated under reduced pressure to provide the crude product **1.11**, which was used for the next step without purification.

Preparation of **1.13**:

To a suspension of **1.11** (crude, as of 3.01 mmol, 1.0 eq) in dry tetrahydrofuran (5 mL) was added *N,N*-diethylamine (**1.12**) (1.56 mL, 15.08 mmol, 5.0 eq) drop wise. The reaction mixture was stirred at room temperature for 2h. Ethyl

acetate (20 mL) was added and the mixture was washed with water (20 mL), saturated aqueous sodium bicarbonate (30 mL), 1M aqueous hydrochloric acid (20 mL) and brine. The organics were dried over sodium sulfate, filtered and concentrated under reduced pressure to give a red/brown crystalline solid.

Yield: 88% over two steps

^{1}H NMR (400MHz, $CDCl_3$) δ 8.64 (d, 1H), 7.91 (dd, 1H), 7.53 (d, 1H), 3.56 (q, 2H), 3.39 (q, 2H), 1.27 (t, 3H), 1.17 (t, 3H)

Mass Spectral Analysis *m/z* = 257.15 $(M+H)^+$

Preparation of **1.7**:

To a solution of bis(pinacolato)diboron (**1.14**) (2.18 g, 8.6 mmol, 1.2 eq) in *N,N*-dimethylformamide (10 mL) at 0°C was added potassium acetate (2.3 g, 23.4 mmol, 3.0 eq), 1,1'-bis(diphenylphosphino)ferrocene palladium(II) chloride complex with dichloromethane (171 mg, 0.23 mmol, 0.03 eq). The reaction mixture was heated at 80°C at which point a solution of **1.13** (2.0 g, 7.8 mmol, 1.0 eq) in *N,N* -dimethylformamide (10 mL) was added dropwise. The reaction mixture was stirred at 80°C for another 10h. Ethyl acetate (75 mL) and water (50 mL) were added and the two phases were separated. The organic phase was washed with brine (50 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure to give a dark brown oil, which solidified to needles. The crude product was triturated with hexane. The resulting solid was collected by filtration.

Yield: 52 % ^{1}H NMR (400MHz, $CDCl_3$) δ 8.92 (d, 1H), 8.14 (dd, 1H), 7.53 (d, 1H), 3.55 (q, 2H), 3.32 (q, 2H), 1.36 (s, 12H), 1.27 (t, 3H), 1.12 (t, 3H)

Preparation of **1.8b**:

To a solution of **1.5a** (1.48 g, 3.29 mmol, 1.0 eq) in dimethoxyethane (DME) (20 mL) under nitrogen was added sequentially a 2M aqueous solution of sodium carbonate (4.94 mL, 9.87 mmol, 3.0 eq), lithium chloride (0.42 g, 9.87 mmol, 3.0 eq), palladium (70 mg, 10 wt. % (dry basis) on activated carbon, 0.033 mmol, 0.01 eq), and **1.7** (1.0 g, 3.29 mmol, 1.0 eq). The mixture was heated under reflux for 10h. Dichloromethane (200 mL) was added to dilute the reaction mixture and palladium(0) on carbon was filtered off on a celite pad. The filtrate was washed with brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude

product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 76%

^{1}H NMR (400MHz, $CDCl_3$) δ 8.56 (dd, 1H), 7.75 (dd, 1H), 7.64 (dd, 1H), 7.22 (m, 1H), 6.99–6.85 (m, 3H), 5.62 (s, 1H), 3.88 (m, 2H), 3.59 (q, 2H), 3.45 (q, 2H), 3.34 (m, 2H), 2.06 (m, 2H), 1.69 (m, 2H), 1.48 (s, 9H), 1.29 (t, 3H), 1.20 (t, 3H)

Mass Spectral Analysis *m/z* = 478.0 $(M+H)^+$

Preparation of **1N**:

To a cold (0°C) solution of **1.8b** (2 g, 4.18 mmol, 1.0 eq) in anhydrous dichloromethane (20 mL) was slowly added a 4.0 M solution of hydrogen chloride in dioxane (5.2 mL, 20.8 mmol, 5.0 eq). The reaction mixture was stirred at room temperature for 10h and then concentrated under reduced pressure. The resulting foamy solids were soaked in diethyl ether to give the fine powders, which were collected by filtration and washed sequentially with ethyl acetate and diethyl ether.

Yield: 95%

^{1}H NMR (400MHz, DMSO d_6) δ 8.99 (m, 2H), 8.60 (d, 1H), 7.90 (dd, 1H), 7.61 (d, 1H), 7.29 (m, 1H), 7.06 (d, 1H), 6.98 (m, 2H), 6.09 (s, 1H), 3.47 (q, 2H), 3.35–3.13 (m, 6H), 2.06 (m, 4H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 378.4 $(M+H)^+$

Elemental analysis:

$C_{23}H_{27}N_3O_2$, 2HCl, $0.5H_2O$

Theory: %C 60.13; %H 6.58; %N 9.15

Found: %C 60.34; %H 6.60; %N 9.10

EXAMPLE 1O

1O was obtained according to a procedure similar to the one described for **1N**, with the following exception:

Step 1.1: **1.1a** was replaced by **1.1d**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.96 (m, 1H), 8.62 (d, 1H), 7.92 (dd, 1H), 7.61 (d, 1H), 7.12 (m, 2H), 6.78 (dd, 1H), 6.20 (s, 1H), 3.47 (q, 2H), 3.30 (q, 2H), 3.24 (m, 4H), 2.05 (m, 4H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis $m/z = 396.3$ $(M+H)^+$

Elemental analysis:

$C_{23}H_{26}FN_3O_2$, 1.05HCl, $1H_2O$

Theory: %C 61.15; %H 6.48; %N 9.30; %Cl 8.24

Found: %C 61.11; %H 6.44; %N 9.18; %Cl 8.28

EXAMPLE 1P

1P was obtained according to a procedure similar to the one described for **1N**, with the following exception:

Step 1.1: **1.1a** was replaced by **1.1e**.

^1H NMR (400MHz, DMSO d_6) δ 8.93 (brm, 1H), 8.60 (d, 1H), 7.89 (dd, 1H), 7.61 (d, 1H), 7.09 (dd, 1H), 6.96 (d, 1H), 6.77 (s, 1H), 6.07 (s, 1H), 3.47 (q, 2H), 3.30 (q, 2H), 2.21 (brm, 4H), 2.18 (s, 3H), 2.04 (brm, 4H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis $m/z = 392.3$ $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}N_3O_2$, 2HCl

Theory: %C 62.07; %H 6.73; %N 9.05; %Cl 15.27

Found: %C 61.81; %H 6.69; %N 8.95; %Cl 15.42

EXAMPLE 1Q

1Q was obtained according to a procedure similar to the one described for **1N**, with the following exceptions:

Step 1.1: **1.1a** was replaced by **1.1f** and Method 1A was used.

^1H NMR (400MHz, DMSO d_6) δ 9.20 (m, 2H), 8.38 (m, 1H), 7.69 (m, 1H), 7.48 (m, 1H), 7.28 (m, 1H), 6.75 (m, 1H), 6.69 (m, 1H), 5.99 (s, 1H), 3.40 (m, 5H), 3.26 (m, 6H), 2.08 (m, 4H), 1.20 (m, 3H), 1.10 (m, 3H)

Mass Spectral Analysis $m/z = 408.3$ $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}N_3O_3$, 1HCl, $0.25H_2O$

Theory: %C 64.28; %H 6.85; %N 9.37; %Cl 7.91

Found: %C 64.07; %H 6.84; %N 9.23; %Cl 8.18

EXAMPLE 1R

1R was obtained according to a procedure similar to the one described for **1N**, with the following exception:

Step 1.1: **1.1a** was replaced by **1.1h**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.06 (brs, 0.5H), 8.90 (brs, 0.5H), 8.65 (d, 1H), 8.33 (d, 1H), 7.95 (dd, 1H), 7.91 (m, 1H), 7.64 (d, 1H), 7.59 (m, 2H), 7.53 (d, 1H), 7.14 (d, 1H), 6.11 (s, 1H), 3.48 (q, 2H), 3.32 (brm, 6H), 2.26 (d, 2H), 2.10 (m, 2H), 1.18 (t, 3H), 1.12 (t, 3H)

Mass Spectral Analysis *m/z* = 428.3 $(M+H)^+$

Elemental analysis:

$C_{27}H_{29}N_3O_2$, 1.8HCl, $1H_2O$

Theory: %C 63.44; %H 6.47; %N 8.22; %Cl 12.48

Found: %C 63.36; %H 6.22; %N 8.14; %Cl 12.87

EXAMPLE 1S

1S was obtained according to a procedure similar to the one described for **1N**, with the following exception:

Step 1.1: **1.1a** was replaced by **1.1j**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.89 (brm, 2H), 8.59 (d, 1H), 7.88 (dd, 1H), 7.61 (d, 1H), 6.89 (s, 1H), 6.73 (s, 1H), 5.99 (s, 1H), 3.47 (q, 2H), 3.30 (q, 2H), 3.20 (brm, 4H), 2.20 (s, 3H), 2.09 (s, 3H), 2.06 (m, 2H), 1.97 (m, 2H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 406.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{31}N_3O_2$, 2HCl, $2H_2O$

Theory: %C 58.36; %H, 7.25; %N 8.17 %Cl 13.78

Found: %C 58.45; %H 7.16; %N 8.16; %Cl 13.68

EXAMPLE 1T

1T was obtained according to a procedure similar to the one described for **1N**, with the following exception:

Step 1.1: **1.1a** was replaced by **1.1l**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.02 (brm, 1H), 8.56 (d, 1H), 7.87 (dd, 1H), 7.61 (d, 1H), 6.98 (s, 1H), 6.59 (s, 1H), 6.01 (s, 1H), 3.47 (q, 2H), 3.30 (q, 2H), 3.25 (m, 2H), 3.14 (brs, 2H), 2.24 (s, 3H), 2.15 (s, 3H), 2.09 (m, 2H), 2.02 (m, 2H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 406.4 $(M+H)^+$

Elemental analysis:

$C_{25}H_{31}N_3O_2$, 1.9HCl, $0.5H_2O$

Theory: %C 62.06; %H 7.06; %N 8.69; %Cl 13.92

Found: %C 61.90; %H 7.03; %N 8.45; %Cl 13.85

EXAMPLE 1U

Preparation of **1U**:

A solution of **1G** (1.00 g, 2.46 mmol, 1.0 eq) in dichloromethane (12 mL) was added drop wise to a cold (-78°C) solution of boron tribromide, 1.0M, in anhydrous dichloromethane (13.53 mL, 13.53 mmol, 5.5 eq). The mixture was warmed to room

temperature and stirring was continued for an additional 1h. Water (1.2 mL) was added drop wise to the cooled (0°C) reaction mixture and then a saturated solution of sodium bicarbonate (3.7 mL) was added. The resulting mixture was stirred for 1h at room temperature. A saturated solution of sodium bicarbonate was added to the mixture until the solution was basic when tested with pH paper. The phases were separated and the aqueous phase was extracted with dichloromethane. The organic phases were combined and washed with brine. A gummy residue stuck to the walls of the separatory funnel. It was dissolved in methanol and combined with the dichloromethane extracts. The combined organic layers were dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).

Yield: 79%

^{1}H NMR (400MHz, DMSO d_6) δ 9.66 (m, 1H), 7.37 (m, 4H), 6.77 (m, 1H), 6.32 (m, 2H), 5.62 (s, 1H), 3.32 (m, 5H), 2.89 (m, 2H), 2.76 (m, 2H), 1.78 (m, 2H), 1.67 (m, 2H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 393.2 $(M+H)^+$

Elemental analysis:

$C_{24}H_{28}N_2O_3$, $0.5H_2O$

Theory: %C 71.80; %H 7.28; %N 6.98

Found: %C 71.79; %H 7.13; %N 6.94

EXAMPLE 2A

Preparation of **2.2**:

Pyrrolidine (104 mL, 1.256 mol, 2.0 eq) was added at room temperature to **1.2** (125.2 g, 0.628 mol, 1.0 eq) and **2.1** (95.6 g, 0.628 mol, 1.0 eq). The solution was stirred at 70°C for 30 min and then cooled to room temperature and stirred for 48h. The mixture was then concentrated under reduced pressure and ethyl acetate (800 mL) was added. The organic mixture was washed with a 1N aqueous solution of hydrochloric acid, water, brine and dried over sodium sulfate. Diethyl ether (500 mL) was added to the organics and the mixture was stirred overnight at room temperature.

The resulting precipitate was collected by filtration, washed with hexane and used for the next step without further purification.

Yield: 75%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.31 (d, 1H), 7.08 (m, 1H), 6.87 (d, 1H), 6.06 (s, 1H), 3.86 (br s, 2H), 3.19 (br s, 2H), 2.69 (s, 2H), 2.02 (m, 2H), 1.58 (m, 2H), 1.47 (s, 9H)
Mass Spectral Analysis *m/z* = 332.4 $(M-H)^-$

Preparation of **2.4**:

To a solution of **2.3** (2.17 g, 14.4 mmol, 1.2 eq) and imidazole (2.04 g, 30.03 mmol, 2.5 eq) in dimethylformamide (20 mL) at room temperature under nitrogen was added drop wise a solution of **2.2** (4 g, 12.01 mmol, 1.0 eq) in dimethylformamide (15 mL). The mixture was stirred overnight at room temperature and then diluted with ethyl acetate. The organics were washed with water, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was triturated with methanol and then isolated using vacuum filtration and used without further purification.

Yield: 76%

^{1}H NMR (400MHz, DMSO d_6) δ 7.10 (m, 2H), 6.99 (d, 1H), 3.70 (m, 2H), 3.11 (brs, 2H), 2.81 (s, 2H), 1.84 (m, 2H), 1.60 (m, 2H), 1.40 (s, 9H), 0.94 (s, 9H), 0.17 (s, 6H)

Preparation of **2.5**:

To a solution of **2.4** (4 g, 8.94 mmol, 1.0 eq) in tetrahydrofuran (20 mL) at -78°C under nitrogen was added drop wise a 1.0M solution of lithium bis(trimethylsilyl)amide in tetrahydrofuran (6.2 mL, 10.72 mmol, 1.2 eq). The mixture was stirred for 1h at -78°C. A solution of **1.4** (3.83 g, 10.72 mmol, 1.2 eq) in tetrahydrofuran (20 mL) was added drop wise. The mixture was stirred and allowed to warm slowly to room temperature. The reaction was concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield: 90.5%

^{1}H NMR (400MHz, $CDCl_3$) δ 6.76 (m, 3H), 5.56 (s, 1H), 3.85 (br s, 2H), 3.26 (m, 2H), 2.05 (m, 2H), 1.65 (m, 2H), 1.47 (s, 9H), 0.97 (s, 9H), 0.18 (s, 6H)

Preparation of **2.6a**:

To a solution of **2.5** (4.47 g, 7.71 mmol, 1.0 eq) in dimethoxyethane (35 mL) was added sequentially a 2N aqueous solution of sodium carbonate (11.6 mL, 23.13 mmol, 3.0 eq), lithium chloride (0.98 g, 23.13 mmol, 3.0 eq), **1.6** (1.87 g, 8.48 mmol, 1.1 eq) and tetrakis(triphenylphosphine)palladium(0) (0.18 g, 0.15 mmol, 0.02 eq). The mixture was refluxed for 4h under nitrogen. The mixture was then cooled to room temperature and water was added. The mixture was extracted with ethyl acetate. The organic layer was further washed with a 2N aqueous solution of sodium hydroxide, brine and dried over sodium sulfate. The crude product was triturated with hexanes and used without further purification.

Yield: 84%

^{1}H NMR (400MHz, DMSO d_6) δ 7.39 (m, 4H), 6.87 (d, 1H), 6.69 (m, 1H), 6.37 (d, 1H), 5.89 (s, 1H), 3.71 (m, 2H), 3.45 (brs, 2H), 3.23 (m, 4H), 1.85 (m, 2H), 1.70 (m, 2H), 1.41 (s, 9H); 1.10 (m, 6H), 0.87 (s, 9H), 0.08 (s, 6H)

Mass Spectral Analysis m/z = 607.0 $(M+H)^+$

Preparation of **2.7a**:

To a solution of **2.6a** (0.50 g, 0.82 mmol, 1.0 eq) in tetrahydrofuran (10 mL) was added a 1N solution of tetrabutylammonium fluoride (2.5 mL, 2.47 mmol, 3.0 eq) in tetrahydrofuran at 0°C. The mixture was stirred for 1h at room temperature under nitrogen. The mixture was diluted with ethyl acetate. The organic layer was washed with a saturated solution of aqueous sodium bicarbonate, brine, a 1N solution of hydrochloric acid and brine. The solution was then dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was triturated with a diethyl ether/hexanes mixture (3:7) and used without further purification.

Yield: 74%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.34 (s, 4H), 6.80 (d, 1H), 6.67 (m, 1H), 6.49 (d, 1H), 5.87 (s, 1H), 5.57 (s, 1H), 3.84 (brs, 2H), 3.56 (brs, 2H), 3.30 (brs, 4H), 2.00 (m, 2H), 1.64 (m, 2H), 1.47 (s, 9H), 1.20 (m, 6H)

Mass Spectral Analysis *m/z* = 493.0 $(M+H)^+$

Preparation of **2A**:

A 2.0M solution of hydrochloric acid in diethyl ether (1.7 mL, 3.35 mmol, 5.5 eq) was added drop wise to a cooled (0°C) solution of **2.7a** (0.30 g, 0.61 mmol, 1.0 eq) in anhydrous dichloromethane (5 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h. Diethyl ether (100 mL) was added to the solution. The resulting precipitate was collected by filtration and washed with diethyl ether. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).

Yield: 50%

^{1}H NMR (400MHz, DMSO d_6) δ 9.03 (m, 2H), 7.42 (s, 4H), 6.85 (d, 1H), 6.64 (m, 1H), 6.42 (d, 1H), 5.91 (s, 1H), 3.49 (m, 4H), 3.21 (m, 5H), 2.08 (m, 2H), 1.96 (m, 2H), 1.13 (m, 6H)

Mass Spectral Analysis *m/z* = 393.3 $(M+H)^+$

Elemental analysis:

$C_{24}H_{28}N_2O_2$, 1HCl, $1H_2O$

Theory: %C 64.49; %H 6.99; %N 6.27

Found: %C 64.59; %H 6.67; %N 6.26

EXAMPLE 2B

2B was obtained according to a procedure similar to the one described for **2A**, with the following exception:

Step 2.4: **1.6** was replaced by **1.7**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.94 (brm, 2H), 8.59 (s, 1H), 7.90 (dd, 1H), 7.62 (d, 1H), 6.88 (d, 1H), 6.67 (dd, 1H), 6.38 (d, 1H), 6.06 (s, 1H), 3.47 (q, 2H), 3.22 (m, 6H), 2.07 (m, 2H), 1.97 (m, 2H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 394 $(M+H)^+$

Elemental analysis:

$C_{23}H_{27}N_3O_3$, 2HCl, $1.25H_2O$

Theory: %C 56.50; %H 6.49; %N 8.59; %Cl 14.50

Found: %C 56.55; %H 6.46; %N 8.39; %Cl 14.49

EXAMPLE 2C

Preparation of **2.9a**

A mixture of **2.7a** (0.210g, 0.00042 mol, 1.0 eq), cyclopropylmethyl bromide (**2.8a**) (0.12 mL, 0.0012 mol, 2.95 eq) and potassium carbonate (0.350g, 0.0025 mole, 6.0 eq) in *N*,*N*-dimethylformamide (5mL) was stirred for 48h at 80°C. The mixture was cooled to room tempearture, poured into water (50 mL) and extracted with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 96%

Mass Spectral Analysis *m/z* = 547.12 $(M+H)^+$

Preparation of **2C**

To a cold (0°C) solution of **2.9a** (0.200g, 0.00036 mol, 1.0 eq) in anhydrous dichloromethane (10 mL) was added drop wise a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (1.8 mL, 0.0036 mole, 10.0 eq). The mixture was warmed slowly to room temperature and stirring was continued for 12h at room temperature. The mixture was concentrated under reduced pressure. Diethyl ether was then added to the mixture, which was stirred for 1h at room temperature. The precipitate was collected by filtration, washed with diethyl ether and dried under vacuum.

Yield: 63%

^{1}H NMR (400MHz, DMSO d_6) δ 8.85 (m, 1H), 7.40 (s, 4H), 6.97 (d, 1H), 6.80 (m, 1H), 6.45 (d, 1H), 5.95 (s, 1H), 3.65 (d, 2H), 3.10-3.50 (m, 8H), 2.00 (m, 4H), 1.10 (m, 7H), 0.50 (m, 2H), 0.20 (m, 2H)

Mass Spectral Analysis *m/z* = 447.1 $(M+H)^+$

EXAMPLE 2D

2D was obtained according to a procedure similar to the one described for **2C**, with the following exception:

Step 2.7: **2.8a** was replaced by **2.8b** (method 2A).

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (s, 1H), 7.45 (s, 4H), 7.00 (m, 1H), 6.80 (m, 1H), 6.45 (m, 1H), 6.00 (s, 1H), 4.55 (m, 1H), 3.10–3.55 (m, 8H), 2.00 (m, 4H), 1.80 (m, 2H), 1.60 (m, 4H), 1.50 (m, 2H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 461.1 $(M+H)^+$

EXAMPLE 2E

Preparation of **2.7b:**

Intermediate **2.7b** was obtained according to a procedure similar to the one described for **2.7a** (see **2A**), except **1.6** was replaced by **1.7** in Step 2.4.

Preparation of **2.9b**:

To a solution of **2.7b** (1.0 g, 2.03 mmol, 1.0 eq), **2.8e** (0.29 g, 4.06 mmol, 2.0 eq), triphenylphosphine (1.06 g, 4.06 mmol, 2.0 eq) and triethylamine (0.82 g, 8.12 mmol, 4.0 eq) in tetrahydrofuran (50 mL) at 0°C was added diisopropyl azodicarboxylate (DIAD) (0.82 g, 4.06 mmol, 2.0 eq). The mixture was warmed to room temperature and stirred for 48h at room tempearture. Methylene chloride was added and the crude mixture was washed with water, concentrated under reduced pressure and purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 45%

^{1}H NMR (400MHz, $CDCl_3$) δ 8.56 (s, 1H), 7.76 (dd, 1H), 7.64 (d, 1H), 6.89 (d, 1H), 6.78 (m, 1H), 6.50 (d, 1H), 5.65 (s, 1H), 3.86 (brm, 2H), 3.62 (m, 4H), 3.45 (q, 2H), 3.32 (brm, 2H), 2.05 (brm, 2H), 1.67 (brm, 2H), 1.48 (s, 9H), 1.30 (m, 4H), 1.21 (t, 3H), 0.60 (m, 2H), 0.30 (m, 2H)

Mass Spectral Analysis *m/z* = 548.4 $(M+H)^+$

Preparation of **2E**:

To a solution of **2.9b** (0.50g, 0.913 mmol, 1.0 eq) in methylene chloride (3 mL) was slowly added an excess of a 1.0M solution of anhydrous hydrochloric acid in diethyl ether. The mixture was stirred for 16h at room tempearture and then concentrated under reduced pressure. This mixture (0.41 g) was purified by HPLC using a 20x150mm XTerra Reversed Phase-HPLC column (eluent: 95:5 A:B to 1:99 A:B where A is 0.1% ammonia in Milli-Q water and B is acetonitrile). After HPLC purification, the pure product (0.10 g, 0.22 mmol, 1.0 eq) was obtained as the free amine, which was dissolved in methanol (10 mL) at 0°C under nitrogen and treated with a 1.0M solution of anhydrous hydrochloric acid in diethyl ether (0.47 mL, 0.47 mmol, 2.1 eq). The mixture was stirred at 0°C for 30 min. The mixture was concentrated under reduced pressure and dried under vacuum.
Yield: 26%

^{1}H NMR (400MHz, $CDCl_3$) δ 9.75 (brs, 1H), 9.33 (brs, 1H), 9.18 (s, 1H), 8.45 (brd, 1H), 7.96 (brd, 1H), 6.94 (d, 1H), 6.80 (m, 1H), 6.42 (brm, 2H), 3.66 (brm, 4H), 3.46 (brm, 6H), 2.30 (brm, 4H), 1.35 (t, 3H), 1.22 (brm, 4H), 0.62 (m, 2H), 0.31 (m, 2H)
Mass Spectral Analysis *m/z* = 448.3 $(M+H)^+$
Elemental analysis:
$C_{27}H_{33}N_3O_3$, 1.75HCl, 1.5H_2O
Theory: %C 60.23; %H 7.07; %N 7.80; %Cl 11.52
Found: %C 60.50; %H 6.99; %N 7.77; %Cl 11.38

EXAMPLE 2F

2F was obtained according to a procedure similar to the one described for **2E**, with the following exception:
Step 2.7: **2.8e** was replaced by **2.8d**.
^{1}H NMR (400MHz, DMSO d_6) δ 9.10 (brs, 2H), 8.62 (d, 1H), 7.93 (dd, 1H), 7.61 (d, 1H), 7.03 (d, 1H), 6.89 (dd, 1H), 6.47 (d, 1H), 6.13 (s, 1H), 3.64 (s, 3H), 3.47 (q, 2H), 3.24 (m, 6H), 2.05 (brm, 4H), 1.17 (t, 3H), 1.11 (t, 3H)
Mass Spectral Analysis *m/z* = 408.3 $(M+H)^+$
Elemental analysis:
$C_{24}H_{29}N_3O_3$, 1.25 HCl, 1.25 H_2O

Theory: %C 60.61; %H 6.94; %N 8.84 %Cl 9.32

Found: %C 60.69; %H 6.87; %N 8.66; %Cl 9.35

Note: **2F** was also obtained according to a procedure similar to the one descibed for **2C** with the following exceptions:

Step 2.7: **2.8a** was replaced by **2.8c** and method 2C was used (alkylation reaction conducted in acetone instead of *N*,*N*-dimethylformamide).

EXAMPLE 3A

Preparation of **3.1a**:

To a cold (0°C) solution of **2.7a** (2.5g, 0.0050 mol, 1.0eq) in anhydrous dichloromethane (100 mL), was added *N*-triphenyltrifluoromethane sulfonimide (**1.4**) (2 g, 0.0055 mol, 1.1 eq) followed by addition of triethylamine (0.85 mL, 0.060 mol, 1.2 eq). The mixture was allowed to warm slowly to room temperature and stirring was continued for 12h. The mixture was diluted with ethyl acetate and washed successively with water, aqueous 1N NaOH, water, and brine. The organic layer was dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 78%

Mass Spectral Analysis *m/z* = 666.06 $(M+H+CH_3CN)^+$

Preparation of **3.2a**:

To a stirred solution of **3.1a** (2.5 g, 0.040 mol, 1.0 eq) in a mixture of methanol (30 mL) and dimethylsulfoxide (40 mL) was added triethylamine (1.23 mL, 0.088 mol, 2.2 eq). Carbon monoxide gas was bubbled through the mixture for 5 min. To the mixture was added palladium (II) acetate (0.090 g, 0.00040 mol, 0.1 eq) followed by 1,1'-bis(diphenylphosphino)ferrocene (0.443 g, 0.00080 mol, 0.2 eq). Carbon monoxide gas was bubbled through the mixture for 15 min and the mixture was then stirred under an atmosphere of carbon monoxide and heated at 65°C overnight. The mixture was cooled to room temperature and poured into water. The mixture was extracted with ethyl acetate. The combined organic extracts were washed with water, brine, dried over sodium sulfate and filtered. Evaporation of the

solvent under reduced pressure afforded a dark oil. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 75%

Mass Spectral Analysis *m/z* = 576.08 $(M+H+CH_3CN)^+$

Preparation of **3A**:

To a cold (0°C) solution of **3.2a** (0.140g, 0.00026 mole, 1.0 eq) in anhydrous dichloromethane (10 mL) was added drop wise a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (2.6 mL, 0.0026 mole, 10 .0eq). The mixture was warmed slowly to room temperature and stirring was continued for 12h at room temperature. An additional 1.0 mL of a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether was added to the reaction mixture, which was allowed to stir for an additional 12h at room temperature. The mixture was concentrated under reduced pressure. Diethyl ether was then added to the mixture, which was stirred for 2h at room temperature. The resulting precipitate was collected by filtration, washed with diethyl ether and dried under vacuum.

Yield: 53%

^{1}H NMR (400MHz, DMSO d_6) δ 9.08 (m, 2H), 7.90 (d, 1H), 7.60 (s, 1H), 7.40 (s, 4H), 7.15 (d, 1H), 6.00 (s, 1H), 3.70 (s, 3H), 3.10-3.50 (m, 8H), 2.1 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 435.0 $(M+H)^+$

EXAMPLE 3B

Preparation of **3.3a**:

To a cold (0°C) solution of **3.2a** (1.41g, 0.0026 mol, 1.0eq) in tetrahydrofuran (20 mL), was added a solution of lithium hydroxide monohydrate (0.332g, 0.0079 mole, 3.0 eq) in water (3mL). Methanol (6mL) was then added to the reaction mixture, which was stirred at room temperature for 12h. A solution of lithium hydroxide monohydrate (0.165g, 0.0058 mole, 1.5 eq) in water (3mL) was added to the reaction mixture, which was stirred for an additional 12h at room temperature.

The mixture was concentrated under reduced pressure and the residue was dissolved in ethyl acetate. The organic solution was dried over sodium sulfate and filtered. Evaporation of the filtrate provided a solid, which was triturated in hexane. The precipitate was collected by filtration.

Yield: 85%

Mass Spectral Analysis *m/z* = 562.08 $(M+H+CH_3CN)^+$

Preparation of **3B**:

To a cold (0°C) solution of **3.3a** (0.200g, 0.00038 mole, 1.0 eq) in anhydrous dichloromethane (10 mL) was added drop wise a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (1.9 mL, 0.0038 mole, 10 eq). The mixture was warmed slowly to room temperature and stirring was continued for 12h at room temperature. The desired product precipitates from the reaction mixture. The precipitate was collected by filtration, washed with diethyl ether and dried under vacuum.

Yield: 60%

^{1}H NMR (400MHz, DMSO d_6) δ 9.10 (m, 1.5H), 7.85 (d, 1H), 7.60 (s, 1H), 7.40 (s, 4H), 7.10 (d, 1H), 6.00 (s, 1H), 3.10-3.55 (m, 8H), 2.10 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 421.0 $(M+H)^+$

EXAMPLE 3C

3C was obtained according to a procedure similar to the one described for **3B**, with the following exception:

Step 3.1: **2.7a** (X=H) was replaced by **2.7b** (X=N).

^{1}H NMR (400MHz, DMSO d_6) δ 9.02 (brm, 2H), 8.64 (d, 1H), 7.94 (dd, 1H), 7.87 (dd, 1H), 7.66 (d, 1H), 7.52 (d, 1H), 7.16 (d, 1H), 6.19 (s, 1H), 3.48 (q, 2H), 3.25 (brm, 6H), 2.10 (brm, 4H), 1.18 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 422.2 $(M+H)^+$

EXAMPLE 3D

3D was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4a**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.33 (m, 2H), 7.83 (m, 2H), 7.54 (m, 1H), 7.42 (m, 4H), 7.22 (m, 1H), 7.10 (m, 1H), 6.01 (s, 1H), 5.60 (m, 2H), 3.42 (m, 2H), 3.25 (m, 4H), 2.11 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 420.0 $(M+H)^+$

Elemental analysis:

$C_{25}H_{29}N_3O_3$, 1HCl, $3H_2O$

Theory: %C 58.87; %H 7.11; %N 8.24

Found: %C 58.85; %H 6.74; %N 8.03

EXAMPLE 3E

Preparation of **3.5a**:

O-Benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (TBTU) (244.2 mg, 0.76 mmol, 1.1 eq) was added to a cooled (0°C) solution of **3.3a** (360.0 mg, 0.69 mmol, 1.0 eq), **3.4b** (256.8 mg, 3.80 mmol, 5.5 eq), and *N,N*-diisopropylethylamine (1.06 mL, 6.08 mmol, 7.7 eq) in acetonitrile (8 mL). The solution was stirred overnight at room temperature and then concentrated under reduced pressure. Ethyl acetate (10 mL) and a saturated aqueous solution of sodium bicarbonate (10 mL) were added to the crude product and the mixture was stirred for 20 min. The phases were separated and the organic phase was washed with an aqueous saturated solution of sodium bicarbonate and brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 68%

^{1}H NMR (400MHz, DMSO d_6) δ 8.28 (m, 1H), 7.70 (m, 1H), 7.50 (m, 1H), 7.42 (m, 4H), 7.04 (d, 1H), 5.94 (s, 1H), 3.72 (m, 2H), 3.45 (br s, 2H), 3.25 (m, 4H), 2.70 (d, 3H), 1.89 (m, 2H), 1.74 (m, 2H), 1.42 (s, 9H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 534.3 $(M+H)^+$

Preparation of **3E**:

A 2.0M solution of hydrochloric acid in diethyl ether (1.30 mL, 2.57 mmol, 5.5 eq) was added drop wise to a cooled (0°C) solution of **3.5a** (0.25 g, 0.47 mmol, 1.0 eq) in anhydrous dichloromethane (5 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h. Diethyl ether (100 mL) was added to the solution. The resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 99%

^{1}H NMR (400MHz, DMSO d_6) δ 9.14 (m, 2H), 8.34 (m, 1H), 7.77 (d, 1H), 7.54 (s, 1H), 7.44 (s, 4H), 7.12 (d, 1H), 6.01 (s, 1H), 3.63 (brs, 2H), 3.45 (brs, 2H), 3.24 (m, 4H), 2.69 (d, 3H), 2.09 (m, 4H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 434.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{31}N_3O_3$, 1HCl, 1.25H_2O

Theory: %C 63.40; %H 7.06; %N 8.53

Found: %C 63.13; %H 6.94; %N 8.39

EXAMPLE 3F

3F was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4c**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.20 (m, 2H), 8.37 (m, 1H), 7.79 (m, 1H), 7.55 (m, 1H), 7.44 (m, 4H), 7.10 (m, 1H), 6.01 (s, 1H), 3.61 (m, 2H), 3.45 (m, 2H), 3.22 (m, 6H), 2.10 (m, 4H), 1.10 (m, 9H)

Mass Spectral Analysis *m/z* = 448.4 $(M+H)^+$

Elemental analysis:

$C_{27}H_{33}N_3O_3$, 1HCl, 1H_2O

Theory: %C 64.59; %H 7.23; %N 8.37

Found: %C 64.70; %H 7.16; %N 8.30

EXAMPLE 3G

3G was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4d**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.16 (m, 2H), 8.36 (m, 1H), 7.78 (m, 1H), 7.55 (m, 1H), 7.44 (m, 4H), 7.10 (m, 1H), 6.00 (s, 1H), 3.44 (m, 2H), 3.20 (m, 8H), 2.10 (m, 4H), 1.45 (m, 2H), 1.12 (m, 6H), 0.80 (m, 3H)

Mass Spectral Analysis *m/z* = 462.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{35}N_3O_3$, 1HCl, 1.5H_2O

Theory: %C 64.05; %H 7.49; %N 8.00

Found: %C 63.76; %H 7.41; %N 7.76

EXAMPLE 3H

3H was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4e**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.23 (m, 2H), 8.36 (m, 1H), 7.79 (m, 1H), 7.55 (m, 1H), 7.45 (m, 4H), 7.12 (m, 1H), 6.01 (s, 1H), 3.45 (m, 2H), 3.24 (m, 6H), 3.01 (m, 2H), 2.06 (m, 4H), 1.76 (m, 1H), 1.11 (m, 6H), 0.81 (m, 6H)

Mass Spectral Analysis *m/z* = 476.5 $(M+H)^+$

Elemental analysis:

$C_{29}H_{37}N_3O_3$, 1HCl, 1.5H_2O

Theory: %C 64.61; %H 7.67; %N 7.79

Found: %C 64.94; %H 7.39; %N 7.77

EXAMPLE 3I

3I was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4f**.

^{1}H NMR (400MHz, DMSO d_6) 9.14 (brs, 2H), 8.23 (m, 1H), 7.80 (m, 1H), 7.54 (m, 1H), 7.44 (m, 4H), 7.11 (m, 1H), 6.02 (s, 1H), 3.45 (m, 2H), 3.23 (m, 6H), 3.01 (m, 2H), 2.10 (m, 4H), 1.12 (m, 6H), 0.83 (m, 9H)

Mass Spectral Analysis *m/z* = 490.6 $(M+H)^+$

Elemental analysis:

$C_{30}H_{39}N_3O_3$, 1HCl, $0.75H_2O$

Theory: %C 66.77; %H 7.75; %N 7.79

Found: %C 66.63; %H 7.64; %N 7.77

EXAMPLE 3J

3J was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4g**.

^1H NMR (400MHz, DMSO d_6) δ 9.21 (m, 2H), 8.45 (m, 1H), 7.80 (m, 1H), 7.54 (m, 1H), 7.44 (m, 4H), 7.11 (m, 1H), 6.01 (s, 1H), 3.45 (m, 2H), 3.24 (m, 6H), 3.09 (m, 2H), 2.11 (m, 4H), 1.12 (m, 6H), 0.96 (m, 1H), 0.36 (m, 2H), 0.16 (m, 2H)

Mass Spectral Analysis *m/z* = 474.4 $(M+H)^+$

Elemental analysis:

$C_{29}H_{35}N_3O_3$, 1HCl, $1.75H_2O$

Theory: %C 64.31; %H 7.35; %N 7.76

Found: %C 64.69; %H 7.17; %N 7.66

EXAMPLE 3K

3K was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4h**.

^1H NMR (400MHz, DMSO d_6) δ 9.36 (m, 2H), 8.13 (m, 1H), 7.82 (m, 1H), 7.54 (m, 1H), 7.44 (m, 4H), 7.11 (m, 1H), 6.00 (s, 1H), 4.01 (m, 1H), 3.45 (m, 2H), 3.22 (m, 6H), 2.10 (m, 4H), 1.15 (m, 12H)

Mass Spectral Analysis *m/z* = 462.5 $(M+H)^+$

Elemental analysis:

$C_{28}H_{35}N_3O_3$, 1HCl, $2.25H_2O$

Theory: %C 62.44; %H 7.58; %N 7.80

Found: %C 62.42; %H 7.58; %N 8.08

EXAMPLE 3L

3L was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4i**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.20 (m, 2H), 8.34 (m, 1H), 7.78 (m, 1H), 7.54 (m, 1H), 7.44 (m, 4H), 7.11 (m, 1H), 6.00 (s, 1H), 3.45 (m, 2H), 3.20 (m, 8H), 2.08 (m, 4H), 1.45 (m, 2H), 1.25 (m, 4H), 1.11 (m, 6H), 0.84 (m, 3H)

Mass Spectral Analysis *m/z* = 490.5 $(M+H)^+$

Elemental analysis:

$C_{30}H_{39}N_3O_3$, 1HCl, 1.5H_2O

Theory: %C 65.14; %H 7.84; %N 7.60

Found: %C 65.38; %H 7.60; %N 7.64

EXAMPLE 3M

3M was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4j**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.11 (m, 2H), 7.41 (m, 4H), 7.30 (m, 1H), 7.09 (m, 1H), 6.99 (m, 1H), 6.00 (s, 1H), 3.45 (m, 2H), 3.20 (m, 6H), 2.91 (m, 6H), 2.10 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 448.4 $(M+H)^+$

Elemental analysis:

$C_{27}H_{33}N_3O_3$, 1HCl, 1.25H_2O

Theory: %C 64.02; %H 7.26; %N 8.30

Found: %C 64.03; %H 7.21; %N 8.23

EXAMPLE 3N

3N was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4k**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.21 (m, 2H), 7.44 (m, 5H), 7.09 (m, 2H), 5.99 (s, 1H), 3 .41 (m, 2H), 3.36 (m, 4H), 3.21 (m, 6H), 2.10 (m, 4H), 1.78 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 474.5 $(M+H)^+$

Elemental analysis:

$C_{29}H_{35}N_3O_3$, 1HCl, 1.25H_2O

Theory: %C 65.40; %H 7.29; %N 7.89

Found: %C 65.48; %H 7.08; %N 7.90

EXAMPLE 3O

3O was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3 .5: **3.4b** was replaced by **3.4l**.

^{1}H NMR (400MHz, DMSO d_6) 9.03 (brs, 2H), 7.44 (m, 5H), 7.13 (m, 2H), 6.01 (s, 1H), 4 .96 (m, 1H), 4.24 (m, 1H), 3.44 (m, 6H), 3.22 (m, 6H), 2.09 (m, 4H), 1.86 (m, 1H), 1 .75 (m, 1H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 490.3 $(M+H)^+$

EXAMPLE 3P

3P was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3 .5: **3.4b** was replaced by **3.4m**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.25 (m, 2H), 7.44 (m, 5H), 7.10 (m, 2H), 6.00 (s, 1H), 4 .93 (m, 1H), 4.24 (m, 1H), 3.45 (m, 6H), 3.21 (m, 6H), 2.11 (m, 4H), 1.88 (m, 1H), 1 .76 (m, 1H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 490.5 $(M+H)^+$

Elemental analysis:

$C_{29}H_{35}N_3O_4$, 1HCl, 1.5H_2O

Theory: %C 62.98; %H 7.11; %N 7.60

Found: %C 62.79; %H 6.98; %N 7.58

EXAMPLE 3Q

3Q was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4n**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.25 (m, 2H), 7.40 (m, 5H), 7.09 (m, 1H), 6.99 (m, 1H), 6.01 (s, 1H), 4.10 (m, 2H), 3.45 (m, 2H), 3.25 (m, 6H), 2.11 (m, 6H), 2.51 (m, 2H), 1.19 (m, 9H), 0.80 (m, 3H)

Mass Spectral Analysis *m/z* = 502.5 $(M+H)^+$

Elemental analysis:

$C_{31}H_{39}N_3O_3$, 1HCl, $2H_2O$

Theory: %C 64.85; %H 7.72; %N 7.32

Found: %C 64.54; %H 7.37; %N 7.35

EXAMPLE 3R

3R was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **1.12**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.21 (m, 2H), 7.41 (m, 4H), 7.29 (m, 1H), 7.08 (m, 1H), 6.89 (m, 1H), 5.98 (s, 1H), 3.41 (m, 2H), 3.22 (m, 10H), 2.10 (m, 4H), 1.02 (m, 12H)

Mass Spectral Analysis *m/z* = 476.5 $(M+H)^+$

Elemental analysis:

$C_{29}H_{37}N_3O_3$, 1HCl, $1.25H_2O$

Theory: %C 65.15; %H 7.64; %N 7.86

Found: %C64.85; %H 7.26; %N 7.79

EXAMPLE 3S

3S was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4o**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.67 (m, 1H), 8.55 (m, 1H), 7.43 (m, 4H), 7.22 (m, 1H), 7.09 (m, 1H), 6.82 (m, 1H), 6.01 (s, 1H), 3.66 (m, 2H), 3.44 (m, 2H), 3.23 (m, 6H), 2.10 (m, 2H), 1.98 (m, 2H), 1.16 (m, 18H)

Mass Spectral Analysis *m/z* = 504.4 $(M+H)^+$

EXAMPLE 3T

3T was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4p**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (m, 1.3H), 7.45 (s, 4H), 7.32 (d, 1H), 7.10 (d, 1H), 7.00 (s, 1H), 6.00 (s, 1H), 4.10 (m, 4H), 3.35–3.60 (m, 8H), 3.20 (m, 4H), 2.10 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 490.1 $(M+H)^+$

EXAMPLE 3U

3U was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.4b** was replaced by **3.4q**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.23 (brs, 2H), 7.44 (m, 4H), 7.30 (m, 1H), 7.12 (m, 1H), 6.96 (m, 1H), 6.01 (s, 1H), 3.40 (m, 6H), 3.22 (m, 6H), 2.11 (m, 4H), 1.56 (m, 2H), 1.43 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 488.4 $(M+H)^+$

Elemental analysis:

$C_{30}H_{37}N_3O_3$, 1HCl, 1.75H_2O

Theory: %C 64.85; %H 7.53; %N 7.56

Found: %C 64.99; %H 7.37; %N 7.46

EXAMPLE 3V

3V was obtained according to a procedure similar to the one described for **3E**, with the following exceptions:

Step 3.5: **3.3a** (X=CH) was replaced by **3.3b** (X=N).

Step 3.5: **3.4b** was replaced by **3.4a**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.20 (brm, 2H), 8.63 (d, 1H), 7.92 (m, 2H), 7.83 (dd, 1H), 7.64 (d, 1H), 7.53 (d, 1H), 7.25 (brs, 1H), 7.12 (d, 1H), 6.16 (s, 1H), 3.48 (q, 2H), 3.31 (q, 2H), 3.22 (brm, 4H), 2.10 (brm, 4H), 1.18 (t, 3H), 1.12 (t, 3H)

Mass Spectral Analysis *m/z* = 421.3 $(M+H)^+$

Elemental analysis:

$C_{24}H_{28}N_4O_3$, 1.6HCl, $1.4H_2O$

Theory: %C 57.19; %H 6.48; %N 11.12; %Cl 11.25

Found: %C 57.14; %H 6.41; %N 10.98; %Cl 11.00

EXAMPLE 3W

3W was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.3a** was replaced by **3.3b**.

^1H NMR (400MHz, DMSO d_6) δ 9.21 (brm, 2H), 8.63 (d, 1H), 8.36 (m, 1H), 7.93 (dd, 1H), 7.79 (dd, 1H), 7.64 (d, 1H), 7.49 (d, 1H), 7.13 (d, 1H), 6.16 (s, 1H), 3.48 (q, 2H), 3.25 (brm, 6H), 2.71 (d, 3H), 2.10 (m, 4H), 1.18 (t, 3H), 1.12 (t, 3H)

Mass Spectral Analysis *m/z* = 435.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_4O_3$, 1.8HCl, $2H_2O$

Theory: %C 56.00; %H 6.73; %N 10.45; %Cl 11.90

Found: %C 56.16; %H 6.72; %N 10.47; %Cl 12.23

EXAMPLE 3X

3X was obtained according to a procedure similar to the one described for **3E**, with the following exceptions:

Step 3.5: **3.3a** was replaced by **3.3b**.

Step 3.5: **3.4b** was replaced by **3.4c**.

^1H NMR (400MHz, DMSO d_6) δ 9.23 (brm, 2H), 8.63 (d, 1H), 8.40 (t, 1H), 7.93 (dd, 1H), 7.81 (dd, 1H), 7.64 (d, 1H), 7.49 (d, 1H), 7.13 (d, 1H), 6.16 (s, 1H), 3.48 (q, 2H), 3.25 (brm, 8H), 2.10 (brm, 4H), 1.18 (t, 3H), 1.12 (t, 3H), 1.05 (t, 3H)

Mass Spectral Analysis *m/z* = 449.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{32}N_4O_3$, 2HCl, $1.5H_2O$

Theory: %C 56.93; %H 6.80; %N 10.21; %Cl 12.93

Found: %C 56.64; %H 6.86; %N 10.13; %Cl 12.59

EXAMPLE 3Y

3Y was obtained according to a procedure similar to the one described for **3E**, with the following exceptions:

Step 3.5: **3.3a** was replaced by **3.3b**.

Step 3.5: **3.4b** was replaced by **3.4j**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.06 (brs, 2H), 8.62 (d, 1H), 7.92 (dd, 1H), 7.63 (d, 1H), 7.36 (dd, 1H), 7.11 (d, 1H), 6.98 (d, 1H), 6.16 (s, 1H), 3.47 (q, 2H), 3.25 (brm, 6H), 2.91 (s, 6H), 2.10 (brm, 4H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 449.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{32}N_4O_3$, 1.75HCl, 1.25H_2O

Theory: %C 58.38; %H 6.83; %N 10.47; %Cl 11.60

Found: %C 58.37; %H 6.94; %N 10.21; %Cl 11.35

EXAMPLE 3Z

3Z was obtained according to a procedure similar to the one described for **3AC**, with the following exception:

Step 3.8: **3.6d** was replaced by **3.6a;** tetrakis(triphenylphosphine)palladium(0) was used.

^{1}H NMR (400MHz, DMSO d_6) δ 9.21 (brm, 2H), 9.01 (s, 1H), 8.73 (d, 1H), 8.47 (d, 1H), 7.87 (m, 1H), 7.76 (dd, 1H), 7.53 (d, 2H), 7.44 (d, 2H), 7.38 (d, 1H), 7.28 (d, 1H), 6.07 (s, 1H), 3.44 (m, 2H), 3.23 (brm, 6H), 2.11 (brm, 4H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 454.0 $(M+H)^+$

EXAMPLE 3AA

3AA was obtained according to a procedure similar to the one described for **3AC**, with the following exception:

Step 3.8: **3.6d** was replaced by **3.6b**; tetrakis(triphenylphosphine)palladium(0) was used.

^{1}H NMR (400MHz, DMSO d_6) δ 8.84 (brm, 2H), 7.58 (dd, 1H), 7.46 (m, 5H), 7.27 (d, 1H), 7.18 (d, 1H), 7.12 (d, 1H), 7.06 (m, 1H), 6.04 (s, 1H), 3.46 (m, 2H), 3.23 (brm, 6H), 2.13 (m, 2H), 2.01 (m, 2H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 459.3 $(M+H)^+$

Elemental analysis:

$C_{28}H_{30}N_2O_2S$, 1HCl, $0.5H_2O$

Theory: %C 66.71; %H 6.40; %N 5.56; % Cl 7.03

Found: %C 66.76; %H 6.27; %N 5.50; % Cl 7.34

EXAMPLE 3AB

3AB was obtained according to a procedure similar to the one described for **3AC**, with the following exception:

Step 3.8: **3.6d** was replaced by **3.6c**; tetrakis(triphenylphosphine)palladium(0) was used.

^{1}H NMR (400MHz, DMSO-d_6) δ 9.39 (b, 1H), 9.32 (b, 1H), 8.83 (d, 2H), 8.16 (d, 2H), 7.98 (d, 1H), 7.49 (m, 3H), 7.46 (d, 2H), 7.34 (d, 1H), 6.14 (s, 1H), 3.3-3.7 (m, 8H), 2.12 (m, 4H), 1.05-1.2 (b, 6H)

Mass Spectral Analysis *m/z* = 454.4 $(M+H)^+$

Elemental analysis:

$C_{29}H_{33}Cl_2N_3O_2$, 2HCl, $2.75H_2O$

Theory: %C 60.47; %H 6.74; %N 7.29

Found: %C 60.35; %H 6.46; %N 7.32

EXAMPLE 3AC

Preparation of **3.7a**:

To a solution of **3.1a** (1.50 g, 2.40 mmol, 1.0 eq) in dimethoxyethane (DME) (20 mL) was added sequentially a 2N aqueous solution of sodium carbonate (3.6 mL, 7.20 mmol, 3.0 eq), lithium chloride (0.305 g, 7.20 mmol, 3.0 eq), **3.6d** (0.357 g, 2.88 mmol, 1.2 eq) and tetrakis(triphenylphosphine)palladium(0) (0.277 g, 0.24 mmol, 0.10 eq). The mixture was heated at 120°C for 16h. After this time, only starting

material **3.1a** was observed by LC/MS. Therefore, additional quantities of **3.6d** (0.10 g, 0.81 mmol, 0.34 eq), tetrakis(triphenylphosphine)palladium(0) (0.10 g, 0.087 mmol, 0.036 eq) and [1,1'-bis(diphenylphosphino)ferrocene palladium (II) chloride, dichloromethane complex] (0.50 g, 0.68 mmol, 0.28 eq) were added to the reaction mixture, which was heated at 120°C for 5h. The crude mixture was cooled to room temperature, dissolved in ethyl acetate and the mixture was washed with water. The organic extract was dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity), and the product was used without further purification.

Yield: 20%

Mass Spectral Analysis $m/z = 555.5$ $(M+H)^+$

Preparation of **3AC**:

To a solution of **3.7a** (0.3 g, purity: 90%, 0.489 mmol, 1.0 eq) in methylene chloride (10 mL) was added an excess of a 1.0M solution of anhydrous hydrochloric acid in diethyl ether (10 mL). The mixture was stirred for 16h at room temperature, concentrated under reduced pressure and purified by column chromatography (eluent: methylene chloride/methanol mixtures of increasing polarity).

Yield: 90%

^{1}H NMR (400MHz, DMSO d_6) δ 9.26 (brs, 2H), 9.13 (s, 1H), 8.99 (s, 2H), 7.72 (d, 1H), 7.53 (d, 2H), 7.44 (d, 2H), 7.34 (s, 1H), 7.25 (d, 1H), 6.07 (s, 1H), 3.44 (brs, 2H), 3.23 (brm, 6H), 2.12 (brm, 4H), 1.12 (brd, 6H)

Mass Spectral Analysis $m/z = 455.4$ $(M+H)^+$

Elemental analysis:

$C_{28}H_{30}N_4O_2$, 2HCl, $2.75H_2O$

Theory: %C 58.28; %H 6.55; %N 9.71

Found: %C 58.53; %H 6.27; %N 9.74

EXAMPLE 4A

Preparation of **4.2**:

To a suspension of **1A** (21.9 g, 52.45 mmol, 1.0 eq) in tetrahydrofuran (200 mL) at 0°C was added triethylamine (18.3 mL, 131 mmol, 2.5 eq), followed by trifluoroacetic anhydride (**4.1**) (8.75 ml, 63 mmol, 1.2 eq) dropwise. The reaction mixture was slowly warmed up to and stirred at room temperature for 10h. Ethyl acetate (500 mL) was added and the organic layer was washed with a 1M aqueous solution of hydrochloric acid (5 x 100 mL) and brine, dried over sodium sulfate and filtered. The crude product was concentrated under reduced pressure and purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 93%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.42 (m, 2H), 7.36 (m, 2H), 7.22 (m, 1H), 7.02 (m, 1H), 6.96 (m, 1H), 6.90 (m, 1H), 5.54 (s, 1H), 4.39 (m, 1H), 3.87 (m, 1H), 3.71 (m, 1H), 3.58 (m, 2H), 3.35 (m, 3H), 2.22 (m, 2H), 1.74 (m, 2H), 1.22 (m, 6H)

Mass Spectral Analysis $m/z = 473.3\ (M+H)^+$

Preparation of **4.4**:

To a solution of **4.2** (4.0 g, 8.47 mmol, 1.0 eq) in dry dichloroethane (100 mL) was added sulfur trioxide *N,N*-dimethylformamide complex (**4.3**) (1.98 g, 12.9 mmol, 1.5 eq) portionwise. The reaction mixture was heated under reflux for 10h and then cooled down to 0-10°C at which point oxalyl chloride (1.2 mL, 13.55 mmol, 1.6 eq) was added drop wise. The reaction mixture was then stirred at 70°C for another 3h. The reaction was quenched with ice/water (100 mL). Dichloromethane (100 mL) was added and the two phases were separated. The aqueous phase was extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 79%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.90 (dd, 1H), 7.72 (d, 1H), 7.49 (m, 2H), 7.36 (m, 2H), 7.13 (d, 1H), 5.68 (s, 1H), 4.44 (m, 1H), 3.92 (m, 1H), 3.70 (m, 1H), 3.58 (m, 2H), 3.35 (m, 3H), 2.25 (m, 2H), 1.83 (m, 2H), 1.22 (m, 6H)

Mass Spectral Analysis *m/z* = 571.2 $(M+H)^+$

Preparation of **4.6a**:

To a solution of **4.4** (0.7 g, 1.22 mmol, 1.0 eq) in dry dichloromethane (30 mL) at 0°C was added triethylamine (0.85 mL, 6.10 mmol, 5.0 eq) and methylamine (**3.4b**) hydrochloride salt (0.25 g, 3.66 mmol, 3.0 eq) in one portion. The reaction mixture was slowly warmed up to room temperature and stirred at room temperature for 10h. Water (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 86%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.73 (dd, 1H), 7.53 (d, 1H), 7.45 (m, 2H), 7.35 (m, 2H), 7.07 (d, 1H), 5.63 (s, 1H), 4.42 (m, 1H), 4.29 (q, 1H), 3.90 (m, 1H), 3.69 (m, 1H), 3.58 (m, 2H), 3.35 (m, 3H), 2.63 (d, 3H), 2.22 (m, 2H), 1.79 (m, 2H), 1.22 (m, 6H)

Mass Spectral Analysis *m/z* = 566.2 $(M+H)^+$

Preparation of **4A**:

To a solution of **4.6a** (0.63 g, 1.11 mmol, 1.0 eq) in a mixture of methanol (20mL) and water (5 mL) at 0°C was added potassium carbonate (0.92 g, 6.66 mmol, 6.0 eq) portionwise. The reaction mixture was warmed up to room temperature and stirred at room temperature for 10h. Brine (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added a 2.0M solution of hydrogen chloride in diethyl ether (1.11 mL, 2.22 mmol, 2 eq) drop wise. The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under reduced pressure.

Yield: 85%

^{1}H NMR (400MHz, DMSO d_6) δ 8.99 (m, 2H), 7.66 (dd, 1H), 7.49–7.37 (m, 6H), 7.25 (d, 1H), 6.10 (s, 1H), 3.45 (m, 2H), 3.22 (m, 6H), 2.36 (d, 3H), 2.01 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 470.2 $(M+H)^+$

Elemental analysis:

$C_{25}H_{31}N_3O_4S$, 1HCl, $1.5H_2O$

Theory: %C 56.33; %H 6.62; %N 7.88

Found: %C 56.06; %H 6.50; %N 8.18

EXAMPLE 4B

4B was obtained according to a procedure similar to the one described for **4A**, with the following exception:

Step 4.3: **3.4b** was replaced by **3.4c**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.88 (brs, 1H), 7.67 (dd, 1H), 7.46 (m, 4H), 7.39 (d, 1H), 7.23 (d, 1H), 6.10 (s, 1H), 3.52-3.15 (m, 9H), 2.71 (m, 2H), 2.08 (m, 4H), 1.42 (m, 6H), 0.94 (t, 3H)

Mass Spectral Analysis *m/z* = 484.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{33}N_3O_4S$, 1HCl, $1.25H_2O$

Theory: %C 57.55; %H 6.78; %N 7.74

Found: %C 57.61; %H 6.75; %N 7.60

EXAMPLE 4C

4C was obtained according to a procedure similar to the one described for **4A**, with the following exception:

Step 4.3: **3.4b** was replaced by **3.4d**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.85 (m, 2H), 7.67 (dd, 1H), 7.51 (t, 1H), 7.45 (m, 3H), 7.39 (d, 1H), 7.23 (d, 1H), 6.10 (s, 1H), 3.45 (m, 2H), 3.24 (m, 7H), 2.63 (m, 2H), 2.08 (m, 4H), 1.34 (m, 2H), 1.12 (m, 6H), 0.77 (t, 3H)

Mass Spectral Analysis *m/z* = 498.3 $(M+H)^+$

Elemental analysis:

$C_{27}H_{35}N_3O_4S$, 1HCl, $1H_2O$

Theory: %C 58.74; %H 6.94; %N 7.61

Found: %C 58.82; %H 6.78; %N 7.56

EXAMPLE 4D

4D was obtained according to a procedure similar to the one described for **4A**, with the following exception:

Step 4.3: **3.4b** was replaced by **3.4g**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.90 (m, 2H), 7.68 (m, 2H), 7.45 (m, 3H), 7.40 (d, 1H), 7.22 (d, 1H), 6.09 (s, 1H), 3.45 (m, 2H), 3.24 (m, 7H), 2.59 (t, 2H), 2.07 (m, 4H), 1.12 (m, 6H), 0.75 (m, 1H), 0.32 (m, 2H), 0.04 (m, 2H)

Mass Spectral Analysis *m/z* = 510.3 $(M+H)^+$

Elemental analysis:

$C_{28}H_{33}N_3O_4S$, 1HCl, $1H_2O$

Theory: %C 59.61; %H 6.79; %N 7.45

Found: %C 59.55; %H 6.75; %N 7.40

EXAMPLE 4E

4E was obtained according to a procedure similar to the one described for **4A**, with the following exception:

Step 4.3: **3.4b** was replaced by **3.4h**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.79 (m, 2H), 7.69 (dd, 1H), 7.54 (d, 1H), 7.44 (m, 4H), 7.22 (d, 1H), 6.10 (s, 1H), 3.51-3.09 (m, 10H), 2.07 (m, 4H), 1.12 (m, 6H), 0.92 (d, 6H)

Mass Spectral Analysis *m/z* = 498.3 $(M+H)^+$

Elemental analysis:

$C_{27}H_{35}N_3O_4S$, 1HCl, $1.4H_2O$

Theory: %C 57.98; %H 6.99; %N 7.51

Found: %C 57.99; %H 7.04; %N 7.38

EXAMPLE 4F

4F was obtained according to a procedure similar to the one described for **4A**, with the following exception:

Step 4.3: **3.4b** was replaced by **3.4j**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.11 (m, 2H), 7.64 (dd, 1H), 7.46 (m, 4H), 7.29 (d, 1H), 7.24 (d, 1H), 6.13 (s, 1H), 3.45 (m, 2H), 3.23 (m, 6H), 2.56 (s, 6H), 2.11 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 484.1 $(M+H)^+$

Elemental analysis:

$C_{26}H_{33}N_3O_4S$, 1HCl, 2.75H_2O

Theory: %C 54.82; %H 6.99; %N 7.38

Found: %C 54.66; %H 6.89; %N 7.30

EXAMPLE 4G

4G was obtained according to a procedure similar to the one described for **4A**, with the following exception:

Step 4.3: **3.4b** was replaced by **4.5**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.85 (m, 2H), 7.83 (d, 1H), 7.69 (dd, 1H), 7.45 (m, 3H), 7.41 (d, 1H), 7.25 (d, 1H), 6.11 (s, 1H), 3.45 (m, 2H), 3.25 (m, 7H), 2.09 (m 5H), 1.12 (m, 6H), 0.45 (m, 2H), 0.34 (m, 2H)

Mass Spectral Analysis *m/z* = 496.2 $(M+H)^+$

Elemental analysis:

$C_{27}H_{33}N_3O_4S$, 1HCl, 0.75H_2O

Theory: %C 59.44; %H 6.56; %N 7.70

Found: %C 59.37; %H 6.46; %N 7.60

EXAMPLE 4H

Preparation of **4H**:

To a solution of **4.4** (1.5 g, 2.82 mmol) in acetonitrile (20 mL) was added a concentrated aqueous solution of ammonium hydroxide (28–35%, 20 mL). The reaction mixture was heated under reflux for 10h. Brine (100 mL) was added and the aqueous phase was adjusted to pH=10 with a 1M aqueous solution of sodium hydroxide. Chloroform (150 mL) was added and the two phases were separated. The

aqueous phase was extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil (0.32 g, 0.70 mmol, 1.0 eq) in dichloromethane/methanol was added drop wise a 2.0M solution of hydrogen chloride in diethyl ether (0.7 mL, 1.4 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 80%

^{1}H NMR (400MHz, DMSO d_6) δ 8.98 (m, 1.5H), 7.71 (dd, 1H), 7.45 (m, 5H), 7.27 (s, 2H), 7.22 (d, 1H), 6.09 (s, 1H), 3.46 (m, 2H), 3.23 (m, 6H), 2.07 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 456.0 $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}N_3O_4S$, 1HCl, $2H_2O$

Theory: %C 54.59; %H 6.49; %N 7.96

Found: %C 54.50; %H 6.49; %N 7.82

EXAMPLE 4I

Preparation of **4.8**:

To a suspension of **4H** (1.12 g, 2.45 mmol, 1.0 eq) in a mixture of dichloromethane (50 mL) and methanol (5 mL) at 0°C was added sequentially triethylamine (0.85 mL, 6.12 mmol, 2.5 eq), and di-*tert*-butyl dicarbonate **4.7** (0.80 g, 3.67 mmol, 1.5 eq) portion wise. The reaction mixture was slowly warmed to room temperature and stirred at room temperature for 10h. The solvents were removed under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 92%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.75 (dd, 1H), 7.57 (d, 1H), 7.43 (m, 2H), 7.35 (m, 2H), 7.03 (d, 1H), 5.65 (s, 1H), 4.83 (s, 2H), 3.89 (m, 2H), 3.57 (m, 2H), 3.32 (m, 4H), 2.04 (m, 2H), 1.71 (m, 2H), 1.47 (s, 9H), 1.21 (m, 6H)

Mass Spectral Analysis *m/z* = 556.3 $(M+H)^+$

Preparation of **4.10**:

To a solution of **4.8** (1.25 g, 2.25 mmol, 1.0 eq) in dichloromethane (40 mL) was added triethylamine (0.94 mL, 6.75 mmol, 3.0 eq), and acetic anhydride (**4.9**) (0.64 mL, 6.75 mmol, 3.0 eq) drop wise. The mixture was stirred at room temperature for 10h. Dichloromethane (100 mL) and water (100 mL) were added to the reaction mixture and the two phases were separated. The aqueous phase was extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 70%

Mass Spectral Analysis *m/z* = 598.3 $(M+H)^+$

Preparation of **4I**:

To a solution of **4.10** (0.16 g, 0.27 mmol, 1.0 eq) in dichloromethane (5 mL) was added iodotrimethylsilane (0.06 mL, 0.43 mmol, 1.6 eq) dropwise. The mixture was stirred at room temperature for 30 min. The mixture was diluted in chloroform (100 mL) and methanol (5 mL), washed with a 20% aqueous solution of sodium thiosulfate (2 x 30 mL) and a 1M aqueous solution of sodium carbonate (2 x 30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).

Yield: 60%

^{1}H NMR (400MHz, DMSO d_6) δ 7.73 (dd, 1H), 7.51 (d, 1H), 7.45 (s, 4H), 7.17 (d, 1H), 6.01 (s, 1H), 3.45 (brs, 2H), 3.38-3.15 (m, 7H), 2.07 (m, 4H), 1.79 (s, 3H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 498.3 $(M+H)^+$

EXAMPLE 5A

Preparation of **5.2**:

To a solution of **4.4** (1.4 g, 2.45 mmol, **1**.0 eq) in a mixture tetrahydrofuran (5 mL) and dichloromethane (1 mL) at 0°C was added a 1.0 M solution of hydrazine (**5.1**) in tetrahydrofuran (24.5 mL, 24.5 mmol, 10.0 eq) in one portion. The reaction mixture was stirred at 0°C for 30 min. Water (50 mL) and chloroform (100 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 70%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.78 (dd, 1H), 7.59 (d, 1H), 7.46 (d, 2H), 7.35 (d, 2H), 7.10 (d, 1H), 5.64 (s, 1H), 4.42 (m, 1H), 3.91 (m, 1H), 3.69 (m, 1H), 3.57 (m, 2H), 3.35 (m, 4H), 2.23 (m, 2H), 1.80 (m, 2H), 1.22 (m, 6H)

Mass Spectral Analysis *m/z* = 567.4 $(M+H)^+$

Preparation of **5.3**:

To a suspension of **5.2** (0.9 g, 1.59 mmol, 1.0 eq) in ethanol (10 mL) was added sodium acetate (0.87 g, 10.8 mmol, 6.65 eq) and iodomethane (**2.8c**) (0.54 mL, 8.85 mmol, 5.45 eq). The mixture was heated under reflux for 10h. Water (100 mL) and dichloromethane (100 mL) were added and the two phases were separated. The aqueous phase was extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 74%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.81 (dd, 1H), 7.64 (d, 1H), 7.46 (d, 2H), 7.35 (d, 2H), 7.11 (d, 1H), 5.64 (s, 1H), 4.42 (m, 1H), 3.91 (m, 1H), 3.69 (m, 1H), 3.57 (m, 2H), 3.35 (m, 3H), 3.00 (s, 3H), 2.23 (m, 2H), 1.80 (m, 2H), 1.22 (m, 6H)

Mass Spectral Analysis *m/z* = 551.2 $(M+H)^+$

Preparation of **5A**:

To a solution of **5.3** (0.65 g, 1.18 mmol, 1.0 eq) in a mixture of methanol (20 mL) and water (5 mL) at 0°C was added potassium carbonate (0.98 g, 7.08 mmol, 6.0 eq) portion wise. The mixture was warmed up to and stirred at room temperature for 10h. Brine (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added dropwise a 2.0M solution of hydrogen chloride in diethyl ether (1.18 mL, 2.36 mmol, 2.0 eq). The mixture was then stirred at room temperature for 1h, concentrated under reduced pressure, and dried under vacuum.

Yield: 88%

^{1}H NMR (400MHz, DMSO d_6) δ 9.07 (m, 2H), 7.83 (dd, 1H), 7.47 (m, 5H), 7.30 (d, 1H), 6.12 (s, 1H), 3.63-3.10 (m, 11H), 2.10 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 455.2 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_4S$, 1HCl, 1.33H_2O

Theory: %C 58.30; %H 6.59; %N 5.44

Found: %C 58.35; %H 6.56; %N 5.37

EXAMPLE 6A

Preparation of **6.2**:

To a cold (0°C) solution of **4.2** (0.23 g, 0.48 mmol, 1.0 eq) in dry acetonitrile (3 mL) under nitrogen was added nitronium tetrafluoroborate complex (**6.1**) (78.5 mg, 0.576 mmol, 1.2 eq) in one portion with rapid stirring. The reaction mixture was kept at 0°C for 1h and then quenched with ice/water (1:1) (15 mL). Dichloromethane (50 mL) was added and the two phases were separated. The aqueous phase was extracted with dichloromethane (3 x 30 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product

was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 38%

^{1}H NMR (400MHz, $CDCl_3$) δ 8.14 (dd, 1H), 7.97 (d, 1H), 7.48 (m, 2H), 7.36 (m, 2H), 7.06 (d, 1H), 5.66 (s, 1H), 4.43 (m, 1H), 3.92 (m, 1H), 3.70 (m, 1H), 3.58 (m, 2H), 3.36 (m, 3H), 2.23 (m, 2H), 1.82 (m, 2H), 1.23 (m, 6H)

Mass Spectral Analysis *m/z* = 518.3 $(M+H)^+$

Preparation of **6A**:

To a solution of **6.2** (0.2 g, 0.386 mmol, 1.0 eq) in a mixture of methanol (15 mL) and water (5 mL) at 0°C was added potassium carbonate (0.32 g, 2.32 mmol, 6.0 eq) portionwise. The mixture was warmed up to room temperature and stirred at room temperature for 10h. Brine (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 30 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by preparative liquid chromatography (mobile phase: acetonitrile/water/trifluoroacetic acid). The desired fractions were combined and concentrated under reduced pressure. The product was dissolved in chloroform (100 mL), washed with a 1M aqueous solution of sodium carbonate (2 x 30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added dropwise a 1.0M solution of hydrogen chloride in diethyl ether (0.8 mL, 0.8 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 50%

^{1}H NMR (400MHz, DMSO d_6) δ 9.01 (m, 2H), 8.19 (dd, 1H), 7.79 (d, 1H), 7.49 (m, 4H), 7.29 (d, 1H), 6.19 (s, 1H), 3.56-3.14 (m, 8H), 2.11 (m, 4H), 1.13 (m, 6H)

Mass Spectral Analysis *m/z* = 422.3 $(M+H)^+$

EXAMPLE 6B

Preparation of **6.4**:

To a cold (0°C) solution of **6.2** (1.92 g, 3.71 mmol, 1.0 eq) in ethanol (50 mL) was added tin (II) chloride dihydrate (**6.3**) (2.51 g, 11.13 mmol, 3.0 eq) in one portion. The reaction mixture was heated under reflux for 10h and then concentrated under reduced pressure to give the crude product, which was used for the next step without purification.

Mass Spectral Analysis *m/z* = 488.2 $(M+H)^+$

Preparation of **6B**:

To a suspension of **6.4** (1.3 g, crude, as of 0.91 mmol, 1.0 eq) in a mixture of methanol (30 mL) and water (10 mL) at 0°C was added potassium carbonate (0.75 g, 5.46 mmol, 6.0 eq) portion wise. The reaction mixture was warmed up to room temperature and stirred at room temperature for 10h. Brine (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 30 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by preparative liquid chromatography (mobile phase: acetonitrile/water/trifluoroacetic acid). The desired fractions were combined, concentrated under reduced pressure, and dried under vacuum.

Yield: 27% over two steps

^{1}H NMR (400MHz, DMSO d_6) δ 9.98 (brs, 2.5H), 9.11 (m, 2H), 7.44 (m, 4H), 7.23 (dd, 1H), 7.15 (d, 1H), 7.00 (d, 1H), 6.06 (s, 1H), 3.78-3.10 (m, 8H), 2.06 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 392.2 $(M+H)^+$

EXAMPLE 6C

Preparation of **6.6a**:

To a suspension of **6.4** (1.5 g, crude, as of 1.05 mmol, 1.0 eq) in dichloroethane (50 mL) at 0°C was added pyridine (0.42 g, 5.25 mmol, 5 eq) followed by drop wise addition of ethylsulfonyl chloride (**6.5a**) (0.30 mL, 3.15 mmol, 3.0 eq) dropwise. The mixture was stirred at 0°C for another 2h. A 1M aqueous solution of hydrochloric acid (100 mL) and chloroform (100 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL). The combined

organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 90%

Mass Spectral Analysis *m/z* = 580.3 $(M+H)^+$

Preparation of **6C**:

To a solution of **6.6a** (0.55 g, 0.9 mmol, 1.0 eq) in a mixture of methanol (20 mL) and water (5mL) at 0°C was added potassium carbonate (0.78 g, 5.4 mmol, 6.0 eq) portionwise. The mixture was warmed up to room temperature and stirred at room temperature for 10h. Brine (100 mL) and chloroform (100 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixture of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added drop wise a 1.0M solution of hydrogen chloride in diethyl ether (1.8 mL, 1.8 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 80%

^{1}H NMR (400MHz, DMSO d_6) δ 9.49 (s, 1H), 8.91 (m, 2H), 7.43 (m, 4H), 7.11 (dd, 1H), 7.02 (d, 1H), 6.93 (d, 1H), 6.00 (s, 1H), 3.45 (brs, 2H), 3.21 (m, 6H), 2.97 (q, 2H), 2.03 (m, 4H), 1.20-1.00 (m, 9H)

Mass Spectral Analysis *m/z* = 484.2 $(M+H)^+$

Elemental analysis:

$C_{26}H_{33}N_3O_4S$, 1HCl, $1.25H_2O$

Theory: %C 57.55; %H 6.78; %N 7.74

Found: %C 57.52; %H 6.67; %N 7.73

EXAMPLE 6D

6D was obtained according to a procedure similar to the one described for **6C**, with the following exception:

Step 6.5: **6.5a** was replaced by **6.5b**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.48 (s, 1H), 8.66 (brm, 1H), 7.43 (s, 4H), 7.12 (dd, 1H), 7.01 (d, 1H), 6.95 (d, 1H), 6.00 (s, 1H), 3.46 (brs, 4H), 3.23 (brm, 4H), 3.12 (m, 1H), 2.06 (m, 2H), 1.95 (m, 2H), 1.20 (d, 6H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 498.2 $(M+H)^+$

EXAMPLE 6E

Preparation of **6.8**:

To a suspension of **6.4** (1.0 g, crude, as of 0.58 mmol, 1.0 eq) in dichloroethane (30 mL) at 0°C was added pyridine (0.23 mL, 2.9 mmol, 5.0 eq) followed by a drop wise addition of acetyl chloride (**6.7**) (0.16 mL, 2.32 mmol, 4.0 eq). The reaction mixture was slowly warmed up to room tempearure and stirred at room temperature for 10h. A 1M aqueous solution of hydrochloric acid (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixture of increasing polarity).

Yield: 88%

Mass Spectral Analysis *m/z* = 530.2 $(M+H)^+$

Preparation of **6E**:

To a solution of **6.8** (0.27 g, 0.5 mmol, 1.0 eq) in a mixture of methanol (20 mL) and water (5 mL) at 0°C was added potassium carbonate (0.42 g, 3.0 mmol, 6.0 eq) portion wise. The reaction mixture was warmed up to room temperature and stirred at room temperature for 10h. Brine (100 mL) and chloroform (100 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 30 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was first purified by column chromatography (eluent: dichloromethane/methanol mixture of increasing polarity) and then repurified by preparative liquid chromatography (mobile phase: acetonitrile/water/trifluoroacetic acid). The desired fractions were combined and concentrated under reduced pressure. The product was dissolved in chloroform (100

mL) and washed with a 1M solution of sodium carbonate (2 x 30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added dropwise 1.0M hydrogen chloride in diethyl ether (1.0 mL, 1.0 mmol, 2 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under reduced pressure.

Yield: 73%

^{1}H NMR (400MHz, DMSO d_6) δ 9.34 (s, 1H), 8.80 (brs, 2H), 7.68 (d, 1H), 7.42 (s, 4H), 6.90 (t, 1H), 6.77 (d, 1H), 5.95 (s, 1H), 3.45 (brs, 2H), 3.25 (m, 6H), 2.15 (s, 3H), 2.04 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 434.2 $(M+H)^+$

Elemental analysis:

$C_{26}H_{31}N_3O_3$, 1HCl, 1.7H_2O

Theory: %C 62.38; %H 7.13; %N 8.39

Found: %C 62.26; %H 6.81; %N 8.29

EXAMPLE 7A

Preparation of **7.2**:

To a solution of **3.1a** (3 g, 4.80 mmol, 1.0 eq), sodium *tert*-butoxide (0.55 g, 5.67 mmol, 1.18 eq), tris(dibenzylideneacetone)dipalladium(0) (0.22 g, 0.24 mmol, 0.05 eq) and 1,1'-bis(diphenylphosphino)ferrocene (dppf) (0.39 g, 0.70 mmol, 0.145 eq) in anhydrous toluene (48 mL) was added **7.1** (0.95 mL, 5.67 mmol, 1.18 eq) at room temperature. The solution was stirred at 80°C overnight and then cooled to room temperature. The mixture was diluted with ethyl acetate and vacuum filtered through a plug of celite. The filtrate was washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 33%

Mass Spectral Analysis *m/z* = 656.6 $(M+H)^+$

Preparation of **7.3**:

To a solution of **7.2** (1.00 g, 1.52 mmol, 1.0 eq) in anhydrous methanol (5 mL) at room temperature under nitrogen was added hydroxylamine hydrochloride (0.21 g, 2.97 mmol, 1.95 eq) and sodium acetate (0.64 g, 7.78 mmol, 5.1 eq). The mixture was stirred overnight at room temperature. The mixture was then diluted with ethyl acetate, washed with a saturated aqueous solution of sodium bicarbonate and brine, dried over sodium sulfate and filtered. The organics were concentrated under reduced pressure and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield: 99%

Mass Spectral Analysis *m/z* = 492.5 $(M+H)^+$

Preparation of **7.5**:

To a solution of **7.3** (0.75 g, 1.53 mmol, 1.0 eq) and triethylamine (1.06 mL, 7.63 mmol, 5.0 eq) in dichloromethane (10 mL) at 0°C under nitrogen was added drop wise **7.4** (0.35 mL, 4.58 mmol, 3.0 eq). The mixture was stirred overnight at room temperature. An aqueous solution of sodium bicarbonate was added and the mixture was stirred for 20 min. The phases were separated and the organic phase was washed with an aqueous solution of sodium bicarbonate, brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was used for the next step without further purification.
Yield: 83%

Mass Spectral Analysis *m/z* = 648.5 $(M+H)^+$

Preparation of **7.6**:

To a solution of **7.5** (0.82 g, 1.27 mmol, 1.0 eq) in tetrahydrofuran (5 mL) and methanol (5 mL) was added a 1N aqueous solution of sodium hydroxide (5 mL, 5 mmol, 4.0 eq). The mixture was stirred at room temperature for 3h under nitrogen. The mixture was then neutralized with a 1N aqueous solution of hydrochloric acid (50 mL). The mixture was extracted with ethyl acetate and the organic layer was further washed with brine, dried over sodium sulfate, filtered and concentrated under reduced

pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 40%

^{1}H NMR (400MHz, DMSO d_6) δ 9.35 (m, 1H), 7.41 (s, 4H), 7.09 (m, 1H), 6.97 (d, 1H), 6.91 (d, 1H), 5.92 (s, 1H), 3.72 (m, 2H), 3.44 (m, 2H), 3.23 (m, 4H), 2.87 (s, 3H), 1.86 (m, 2H), 1.71 (m, 2H), 1.42 (s, 9H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 570.4 $(M+H)^+$

Preparation of **7A**:

A 2.0M solution of hydrochloric acid in diethyl ether (1.4 mL, 2.78 mmol, 5.5 eq) was added drop wise to a cooled (0°C) solution of **7.6** (0.29 g, 0.51 mmol, 1.0 eq) in anhydrous dichloromethane (5 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h at room temperature. Diethyl ether (100 mL) was added to the solution and the resulting precipitate was collected by filtration and washed with diethyl ether. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).

Yield: 25%

^{1}H NMR (400MHz, DMSO d_6) δ 9.42 (s, 1H), 8.85 (m, 2H), 7.43 (m, 4H), 7.12 (m, 1H), 7.05 (m, 1H), 6.93 (m, 1H), 6.00 (s, 1H), 3.45 (m, 2H), 3.37 (m, 2H), 3.24 (m, 4H), 2.88 (s, 3H), 2.07 (m, 2H), 1.98 (m, 2H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 470.4 $(M+H)^+$

Elemental analysis:

$C_{25}H_{31}N_3O_4S$, 1HCl, $2H_2O$

Theory: %C 55.39; %H 6.69; %N 7.75

Found: %C 55.03; %H 6.33; %N 7.36

EXAMPLE 7B

Preparation of **7.7**:

To a solution of **7.6** (0.5 g, 0.88 mmol, 1.0 eq) in dry tetrahydrofuran (20 mL) at 0°C was added sodium hydride (60% dispersion in mineral oil, 70 mg, 1.76 mmol, 2.0 eq) in one portion. The reaction mixture was kept at 0°C for 1h and methyliodide (**2.8c**) (0.08 mL, 1.1 mmol, 1.3 eq) was added drop wise. The mixture was kept at 0°C for

another 30 min, warmed up to room temperature, and then heated at 80°C for 10h. Water (50 mL) and chloroform (100 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 83%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.43 (m, 2H), 7.36 (m, 2H), 7.19 (dd, 1H), 7.01 (d, 1H), 6.95 (d, 1H), 5.61 (s, 1H), 3.87 (brs, 2H), 3.57 (brs, 2H), 3.32 (m, 4H), 3.21 (s, 3H), 2.81 (s 3H), 2.05 (m, 2H), 1.68 (m, 2H), 1.48 (s, 9H), 1.20 (m, 6H)

Mass Spectral Analysis *m/z* = 584.3 $(M+H)^+$

Preparation of **7B**

To a cold (0°C) solution of **7.7** (0.43 g, 0.73mmol, 1.0 eq) in anhydrous dichloromethane (20 mL) was added drop wise a 1.0 M solution of hydrogen chloride in diethyl ether (4.38 mL, 4.38 mmol, 6.0 eq). The reaction mixture was stirred at room temperature for 10h and then concentrated under reduced pressure. The crude product was purified by preparative liquid chromatography (mobile phase: acetonitrile/water/trifluoroacetic acid). The desired fractions were combined and concentrated under reduced pressure. The product was dissolved in chloroform (100 mL) and washed with a 1M solution of sodium carbonate (2 x 30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added dropwise 1.0M hydrogen chloride in diethyl ether (1.46 mL, 1.46 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 60%

^{1}H NMR (400MHz, DMSO d_6) δ 8.79 (m, 2H), 7.44 (m, 4H), 7.34 (dd, 1H), 7.10 (d, 1H), 7.00 (d, 1H), 6.03 (s, 1H), 3.23 (m, 8H), 3.14 (s, 3H), 2.89 (s, 3H), 2.04 (m, 4H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 484.2 $(M+H)^+$

Elemental analysis:

$C_{26}H_{33}N_3O_4S$, 1HCl, 1.3H_2O

Theory: %C 57.46; %H 6.79; %N 7.73

Found: %C 57.46; %H 6.86; %N 7.80

EXAMPLE 7C

Preparation of **7.8**:

To a suspension of **6.4** (2 g, crude, as of 1.4 mmol, 1.0 eq) in dichloromethane (50 mL) at 0°C was added triethylamine (0.98 mL, 7.0 mmol, 5 eq) followed by drop wise addition of methylsulfonyl chloride (**7.4**) (0.33 mL, 4.2 mmol, 3.0 eq). The reaction mixture was stirred at 0°C for 1h. A 1M aqueous solution of hydrochloric acid (100 mL) and chloroform (100 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure to give the crude product, which was used for the next step without purification.

Mass Spectral Analysis *m/z* = 644.2 $(M+H)^+$

Preparation of the Mixture of **7A** & **7C**:

To a suspension of **7.8** (1.57 g, crude, as of 1.4 mmol, 1.0 eq) in a mixture of methanol (20 mL), tetrahydrofuran (20 mL) and water (20 mL) was added lithium hydroxide hydrate (0.98 mL, 7.0 mmol, 5.0 eq). The reaction mixture was stirred at room temperature for 10h and then concentrated under reduced pressure to give the crude product as a mixture of **7A** and **7C**, which was carried over for the next step without purification.

Mass Spectral Analysis *m/z* = 470.2 $(M+H)^+$ (**7A**)

Mass Spectral Analysis *m/z* = 484.2 $(M+H)^+$ (**7C**)

Preparation of **7C**

To a suspension of the mixture of **7A** and **7C** (2.2 g, crude, as of 1.4 mmol, 1.0 eq) in dry dichloroethane (50 mL) at 0°C was added pyridine (0.34 mL, 4.2 mmol, 3 eq) followed by di-*tert*-butyl dicarbonate (**4.7**) (0.46 g, 2.1 mmol, 1.5 eq) portion wise. The reaction mixture was slowly warmed up to room temperature and stirred at room

temperature for 10h. Water (50 mL) and chloroform (100 mL) were added. The two phases were separated and the aqueous phase was further extracted with chloroform (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity to obtain **7.6** as pure compound; eluent: dichloromethane/methanol mixture of increasing polarity to obtain crude **7C**).

Yield: 62% for **7.6** over three steps

The crude **7C** (100 mg) was further purified by preparative liquid chromatography (mobile phase: acetonitrile/water/trifluoroacetic acid). The desired fractions were combined and concentrated under reduced pressure. The product was dissolved in chloroform (100 mL) and washed with a 1M aqueous solution of sodium carbonate (2 x 30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added drop wise a 1.0M solution of hydrogen chloride in diethyl ether (0.41 mL, 0.41 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

^{1}H NMR (400MHz, DMSO d_6) δ 10.47 (m, 1H), 9.435 & 9.422 (2s, 1H), 7.51-6.92 (m, 7H), 6.31 & 5.90 (2s, 1H,), 3.50-3.17 (m, 8H), 2.88 & 2.87 (2s, 3H,), 2.82 (d, 3H), 2.12 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis m/z = 484.2 $(M+H)^+$

Elemental analysis:

$C_{26}H_{33}N_3O_4S$, 1HCl, 0.9H_2O

Theory: %C 58.23; %H 6.73; %N 7.84

Found: %C 58.02; %H 6.68; %N 8.20

EXAMPLE 8A

8A was obtained according to a procedure similar to the one described for **2A**, with the following exception:

Step 2.1: **2.1** was replaced by **8.1** (see also step 8.1).

^{1}H NMR (400MHz, DMSO d_6) δ 9.16 (s, 1H), 8.92 (brs, 1H), 8.73 (brs, 1H), 7.40 (s, 4H), 6.78 (m, 2H), 6.43 (dd, 1H), 5.86 (s, 1H), 3.43 (brm, 4H), 3.20 (brm, 4H), 2.09 (m, 2H), 1.93 (m, 2H), 1.11 (brd, 6H)

Mass Spectral Analysis *m/z* = 393.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{28}N_2O_3$, 1HCl, 0.33H_2O

Theory: %C 66.27; %H 6.87; %N 6.44

Found: %C 66.24; %H 6.77; %N 6.44

EXAMPLE 8B

8B was obtained according to a procedure similar to the one described for **2A**, with the following exceptions:

Step 2.1: **2.1** was replaced by **8.1** (see also step 8.1).

Step 2.4: **1.6** was replaced by **1.7** (see also step 8.4).

^{1}H NMR (400MHz, DMSO d_6) δ 9.12 (brm, 1H), 8.99 (brm, 1H), 8.57 (d, 1H), 7.88 (dd, 1H), 7.59 (d, 1H), 6.84 (m, 1H), 6.78 (t, 1H), 6.40 (dd, 1H), 6.00 (s, 1H), 3.47 (q, 2H), 3.40 (m, 2H), 3.29 (q, 2H), 3.19 (m, 2H), 2.10 (m, 2H), 1.97 (m, 2H), 1.17 (t, 3H), 1.10 (t, 3H)

Mass Spectral Analysis *m/z* = 394.2 $(M+H)^+$

Elemental analysis:

$C_{24}H_{27}N_3O_3$,, 2HCl, 0.67H_2O

Theory: %C 57.74; %H 6.39; %N 8.78; %Cl 14.82

Found: %C 57.70; %H 6.28; %N 8.73; %Cl 14.47

EXAMPLE 8C

8C was obtained according to a procedure similar to the one described for **2C**, with the following exception:

Step 2.1: **2.1** was replaced by **8.1** (see also step 8.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.88 (brm, 2H), 7.42 (s, 4H), 7.00 (d, 1H), 6.86 (t, 1H), 6.58 (d, 1H), 5.97 (s, 1H), 3.90 (d, 2H), 3.44 (m, 2H), 3.23 (brm, 6H), 2.09 (m, 2H), 1.98 (m, 2H), 1.26 (m, 1H), 1.12 (brd, 6H), 0.59 (m, 2H), 0.37 (m, 2H)

Mass Spectral Analysis *m/z* = 447.3 $(M+H)^+$

Elemental analysis:

$C_{28}H_{34}N_2O_3$, 1HCl, $1.5H_2O$

Theory: %C 65.93; %H 7.51; %N 5.49

Found: %C 65.64; %H 7.29; %N 5.41

EXAMPLE 8D

8D was obtained according to a procedure similar to the one described for **2C**, with the following exceptions:

Step 2.1: **2.1** was replaced by **8.1** (see also step 8.1).

Step 2.7: **2.8a** was replaced by **2.8c** (method 2A was used) (see also step 8.7).

^{1}H NMR (400MHz, DMSO d_6) δ 8.78 (brs, 2H), 7.41 (s, 4H), 7.04 (d, 1H), 6.90 (t, 1H), 6.58 (d, 1H), 5.97 (s, 1H), 3.83 (s, 3H), 3.44 (brs, 2H), 3.20 (brm, 6H), 2.08 (m, 2H), 1.97 (m, 2H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 407.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_3$, 1HCl, $1H_2O$

Theory: %C 65.14; %H 7.22; %N 6.08

Found: %C 65.22; %H 6.85; %N 6.02

EXAMPLE 8E

8E was obtained according to a procedure similar to the one described for **2C**, with the following exceptions:

Step 2.1: **2.1** was replaced by **8.1** (see also step 8.1).

Step 2.4: **1.6** was replaced by **1.7** (see also step 8.4).

^{1}H NMR (400MHz, DMSO d_6) δ 8.94 (brm, 2H), 8.59 (d, 1H), 7.88 (dd, 1H), 7.60 (d, 1H), 7.03 (d, 1H), 6.88 (t, 1H), 6.56 (d, 1H), 6.11 (s, 1H), 3.91 (d, 2H), 3.47 (q, 2H0, 3.29 (m, 4H), 3.17 (m, 2H), 2.10 (m, 2H), 2.01 (m, 2H), 1.26 (m, 1H), 1.17 (t, 3H), 1.11 (t, 3H), 0.59 (m, 2H), 0.37 (m, 2H)

Mass Spectral Analysis *m/z* = 448.3 $(M+H)^+$

Elemental analysis:

$C_{27}H_{33}N_3O_3$, 1.2HCl, $0.8H_2O$

Theory: %C 64.12, %H 7.14; %N 8.31; %Cl 8.41

Found: %C 64.09; %H 7.20; %N 8.18; %Cl 8.15

EXAMPLE 8F

8F was obtained according to a procedure similar to the one described for **2C**, with the following exceptions:

Step 2.1: **2.1** was replaced by **8.1** (see also step 8.1).

Step 2.4: **1.6** was replaced by **1.7** (see also step 8.4).

Step 2.7: **2.8a** was replaced by **2.8c** (see also step 8.7).

^{1}H NMR (400MHz, DMSO d_6) δ 8.96 (brm, 2H), 8.59 (d, 1H), 7.88 (dd, 1H), 7.60 (d, 1H), 7.06 (d, 1H), 6.92 (t, 1H), 6.56 (d, 1H), 6.12 (s, 1H), 3.84 (S, 3H), 3.47 (q, 2H), 3.28 (m, 4H), 3.14 (m, 2H), 2.09 (m, 2H), 2.02 (m, 2H), 1.17 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 408.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}N_3O_3$, 2HCl, 1.5H_2O

Theory: %C 56.81; %H 6.75; %N 8.28; %Cl 13.97

Found: %C 56.80; %H 6.48; %N 8.24; %Cl 13.89

EXAMPLE 9A

9A was obtained according to a procedure similar to the one described for **2C**, with the following exception:

Step 2.1: **2.1** was replaced by **9.1** (see also step 9.1).

^{1}H NMR (400MHz, DMSO d_6) δ 9.68 (brd, 2H), 7.41 (d, 2H), 7.35 (d, 2H), 6.92 (d, 1H), 6.43 (s, 1H), 6.37 (d, 1H), 5.44 (s, 1H), 3.80 (d, 2H), 3.56 (brs, 2H), 3.40 (brs, 4H), 3.30 (brs, 2H), 2.30 (m, 2H), 2.19 (m, 2H), 1.27 (m, 4H), 1.17 (brs, 3H), 0.66 (m, 2H), 0.36 (m, 2H)

Mass Spectral Analysis *m/z* = 447.3 $(M+H)^+$

Elemental analysis:

$C_{28}H_{34}N_2O_3$, 1.0HCl, 1.3H_2O

Theory: %C 66.40; %H 7.48; %N 5.53

Found: %C 66.28; %H 7.48; %N 5.48

EXAMPLE 9B

Preparation of **9.5**:

9.5 was obtained according to a procedure similar to the one described for **2.7a** except **2.1** was replaced by **9.1** in step 2.1 (see also step 9.1).

Preparation of **9.8**:

To a solution of **9.5** (1.00 g, 2.02 mmol, 1.0 eq) in dimethylformamide (10 mL) was added sequentially cesium carbonate (3.30 g, 10.1 mmol, 5.0 eq) and methyl chlorodifluoroacetate (**9.7**) (1.47g, 10.1 mmol, 5.0 eq.). The reaction mixture was heated at 90°C for 48h, poured into water (100 mL) and extracted with ethyl acetate. The organic extracts were washed with a 1N aqueous solution of sodium hydroxide and brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane:ethyl acetate mixtures of increasing polarity).
Yield: 79%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.41 (d, 2H), 7.36 (d, 2H), 6.98 (d, 1H), 6.73 (d, 1H), 6.61 (dd, 1H), 6.52 (ts, 1H, J = 73.8 Hz); 5.54 (s, 1H), 3.86 (brs, 2H), 3.57 (brm, 2H), 3.32 (brm, 4H), 2.03 (d, 2H), 1.68 (m, 2H), 1.47 (s, 9H) 1.20 (brd, 6H)
Mass Spectral Analysis *m/z* = 543.4 $(M+H)^+$

Preparation of **9B**:

To a solution of **9.8** (860 mg, 1.58 mmol, 1.0 eq) in anhydrous methanol (15 mL) was added drop wise a 4.0M solution of hydrochloric acid in dioxane (4.0 mL, 15.8 mmol, 10.0 eq). The mixture was stirred at ambient temperature for 16h and the solvent was evaporated under vacuum. The crude oil was purified by reverse phase HPLC chromatography (eluent: acetonitrile/water (0.1% trifluoroacetic acid) mixtures of decreasing polarity). The solvent was evaporated under vacuum and a 1N solution of HCl in diethyl ether (25mL) was added. The resulting solid was filtered and washed with diethyl ether.
Yield: 23%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.42 (d, 2H), 7.35 (d, 2H), 7.02 (d, 1H), 6.75 (m, 1H), 6.66 (dd, 1H), 6.54 (ts, 1H, J = 73.4 Hz), 5.59 (s, 1H), 3.57 (brs, 2H), 3.41 (brd, 4H), 3.31 (brs, 2H), 2.26 (m, 4H), 1.21 (brd, 6H)

Mass Spectral Analysis *m/z* = 443.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{34}N_2O_3$, 1.0 HCl, 1.2 H_2O

Theory: %C 59.99; %H 6.32; %N 5.60

Found: %C 60.01; %H 6.25; %N 5.54

EXAMPLE 10A

10A was obtained from **9.5** according to a procedure similar to the one described for **3A**, with the following exception:

Step 3.1: **2.7a** was replaced by **9.5** (see also step 10.1).

^{1}H NMR (400MHz, DMSO d_6) δ 9.80 (brs, 1H), 7.60 (s, 1H), 7.58 (d, 1H), 7.42 (d, 2H), 7.36 (d, 2H), 7.09 (d, 1H), 5.75 (s, 1H), 3.91 (s, 3H), 3.61 (brs, 2H), 3.40 (m, 4H), 3.30 (brs, 2H), 2.27 (m, 4H), 1.20 (brd, 6H)

Mass Spectral Analysis *m/z* = 435.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{30}N_2O_4$, 1HCl, 1.1H_2O

Theory: %C 63.63; %H 6.82; %N 5.71

Found: %C 63.64; %H 6.75; %N 5.72

EXAMPLE 10B

10B was obtained according to a procedure similar to the one described for **3B**, with the following exception:

Step 3.1: **2.7a** was replaced by **9.5** (see also step 10.1).

^{1}H NMR (400MHz, DMSO-d_6) δ 13.10 (brs, 1H), 9.10 (brm, 2H), 7.57 (d, 1H), 7.52 (dd, 1H), 7.44 (s, 4H), 7.12 (d, 1H), 6.09 (s, 1H), 3.45 (brs, 2H), 3.35 (brm, 2H), 3.23 (brm, 4H), 2.08 (m, 4H), 1.10 (brd, 6H)

Mass Spectral Analysis *m/z* = 421.3 $(M+H)^+$

EXAMPLE 10C

10C was obtained according to a procedure similar to the one described for **3E**, with the following exceptions:

Step 3.5: **3.3a** was replaced by **10.3** and **3.4b** was replaced by **3.4a** (see also step 10.5).

^{1}H NMR (400MHz, $CDCl_3$) δ 9.50 (brd, 2H), 7.64 (brm, 2H), 7.32 (brm, 5H), 7.00 (brs, 2H), 5.68 (s, 1H), 3.50 (brm, 4H), 3.27 (brm, 4H), 2.62 (brs, 2H), 2.19 (brs, 2H), 1.17 (brd, 6H)

Mass Spectral Analysis *m/z* = 420.3 $(M+H)^+$

EXAMPLE 10D

Preparation of **10.2**:

Compound **10.2** was obtained according to a procedure similar to the one described for **3.2a** except **2.7a** was replaced by **9.5** in step 3.1 (see also step 10.1).

Preparation of **10.4**:

To a solution of a 2N solution of methylamine (**3.4b**) in methanol (10.0 mL, 20.0 mmol, 11.0 eq) was added portionwise at room temperature **10.2** (1.00g, 1.86 mmol) in a sealed tube. The mixture was heated at 60°C for 20h to form a homogeneous solution. The mixture was poured into water (25 mL), extracted with methylene chloride, washed with brine, dried over sodium sulfate, filtered and evaporated solvent to an off-white solid. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 80%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.47 (s, 1H), 7.45 (d, 2H), 7.23 (d, 1H), 7.04 (d, 1H), 6.20 (brs, 1H), 5.64 (s, 1H), 3.88 (brs, 2H), 3.57 (brm, 2H), 3.33 (brm, 4H), 3.00 (d, 3H), 2.03 (d, 2H), 1.68 (brm, 2H), 1.45 (s, 9H) 1.21 (brd, 6H)

Mass Spectral Analysis *m/z* = 534.4 $(M+H)^+$

Preparation of **10D**:

To a solution of **10.4a** (790mg, 1.48 mmol, 1.0 eq) in anhydrous methanol (20 mL) was added drop wise a 4M solution of hydrochloric acid in dioxane (3.7 mL, 14.8 mmol, 10.0 eq). The mixture was stirred at ambient temperature for 16h and the

solvent evaporated under vacuum to a white solid. The white solid was triturated in diethyl ether (50mL). The resulting solid was collected by filtration and washed with diethyl ether.

Yield: 85%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.43 (m, 3H), 7.34 (m, 3H), 7.05 (d, 1H), 6.90 (brd, 1H), 5.69, (s, 1H), 3.57 (brm, 2H), 3.35 (brm, 6H), 3.00 (d, 3H), 2.20 (brs, 4H), 1.19 (brd, 6H)

Mass Spectral Analysis *m/z* = 434.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{31}N_3O_3$, 1.0 HCl, 1.5 H_2O

Theory: %C 62.83; %H 7.10; %N 8.45

Found: %C 62.74; %H 6.95; %N 8.29

EXAMPLE 10E

10E was obtained according to a procedure similar to the one described for **3E**, with the following exceptions:

Step 3.5: **3.3a** was replaced by **10.3** and **3.4b** was replaced by **3.4c** (see also step 10.5) (method 10A was used).

^{1}H NMR (400MHz, $CDCl_3$) δ 9.68 (brs, 2H), 7.43 (m, 3H), 7.34 (m, 3H), 7.06 (d, 1H), 6.61 (brs, 1H), 5.68 (s, 1H), 3.57 (brs, 2H), 3.50 (brm, 2H), 3.40 (brs, 2H), 3.32 (brs, 2H), 2.25 (brs, 4H), 1.28 (brm, 6H), 1.15 (brs, 3H)

Mass Spectral Analysis *m/z* = 448.3 $(M+H)^+$

EXAMPLE 10F

10F was obtained according to a procedure similar to the one described for **3E**, with the following exceptions:

Step 3.5: **3.3a** was replaced by **10.3** and **3.4b** was replaced by **3.4j** (see also step 10.5) and TBTU was replaced by HATU (method 10B was used).

^{1}H NMR (400MHz, DMSO d_6) δ 9.77 (brm, 2H), 7.42 (d, 2H), 7.36 (d, 2H), 7.08 (d, 1H), 7.03 (s, 1H), 6.97 (d, 1H), 5.66 (s, 1H), 3.59 (brs, 2H), 3.40 (brs, 4H), 3.32 (brs, 2H), 3.12 (s, 3H), 3.04 (s, 3H), 2.28 (m, 4H), 1.20 (brd, 6H)

Mass Spectral Analysis *m/z* = 448.3 $(M+H)^+$

Elemental analysis:

$C_{27}H_{33}N_3O_3$, 1HCl, $1.7H_2O$

Theory: %C 63.01; %H 7.32; %N 8.16

Found: %C 63.06; %H 7.18; %N 8.09

EXAMPLE 10G

10G was obtained according to a procedure similar to the one described for **3E**, with the following exceptions:

Step 3.5: **3.3a** was replaced by **10.3** and **3.4b** was replaced by **1.12** (see also step 10.5) (method 10A was used).

^{1}H NMR (400MHz, DMSO d_6) δ 9.73 (brs, 2H), 7.43 (d, 2H), 7.36 (d, 2H), 7.07 (d, 1H), 6.98 (s, 1H), 6.92 (d, 1H), 5.67 (s, 1H), 3.56 (brs, 4H), 3.40 (brs, 4H), 3.31 (brs, 4H), 2.26 (brs, 4H), 1.22 (brd, 12H)

Mass Spectral Analysis *m/z* = 476.2 $(M+H)^+$

Elemental analysis:

$C_{29}H_{37}N_3O_3$, 1HCl, $1.7H_2O$

Theory: %C 64.18; %H 7.69; %N 7.74

Found: %C 64.08; %H 7.45; %N 7.60

EXAMPLE 10H

10H was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.3a** was replaced by **10.3** and **3.4b** was replaced by **3.4k** (see also step 10.5) (method 10A was used).

^{1}H NMR (400MHz, DMSO d_6) δ 9.77 (brs, 2H), 7.43 (d, 2H), 7.37 (d, 2H), 7.12 (s, 1H), 7.09 (s, 2H), 5.68 (s, 1H), 3.64 (m, 2H), 3.60 (brm, 2H), 3.47 (m, 2H), 3.40 (brm, 4H), 3.30 (brs, 2H), 2.30 (brs, 4H), 2.00 (m, 2H), 1.93 (m, 2H), 1.24 (brd, 6H)

Mass Spectral Analysis *m/z* = 474.3 $(M+H)^+$

Elemental analysis:

$C_{29}H_{35}N_3O_3$, 1HCl, 0.7 H_2O

Theory: %C 66.64; %H 7.21; %N 8.04

Found: %C 66.56; %H 7.07; %N 7.91

EXAMPLE 10I

10I was obtained according to a procedure similar to the one described for **3E**, with the following exception:

Step 3.5: **3.3a** was replaced by **10.3** and **3.4b** was replaced by **3.4c** (see also step 10.5) (method 10A was used).

^{1}H NMR (400MHz, $CDCl_3$) δ 9.70 (brs, 2H), 7.44 (d, 2H), 7.35 (d, 2H), 7.09 (d, 1H), 7.02 (s, 1H), 6.96 (dd, 1H), 5.68 (s, 1H), 3.73 (brm, 6H), 3.58 (brs, 4H), 3.41 (brm, 4H), 3.31 (brs, 2H), 2.28 (m, 4H), 1.21 (m, 6H)

Mass Spectral Analysis *m/z* = 490.2 $(M+H)^+$

EXAMPLE 10J

Preparation of **10.5**:

To a slurry of $LiBH_4$ (82.0 mg, 3.75 mmol, 2.0 eq.) in tetrahydrofuran (20 mL) cooled to 0° C under a nitrogen atmosphere was added drop wise a solution of **10.2** (1.00g, 1.87 mmol, 1.0 eq) in tetrahydrofuran (10 mL). The reaction mixture was warmed to room temperature and stirred for 16h at room temperature. The reaction mixture was quenched with water (0.54 mL, 8 eq.), extracted with ethyl acetate, washed with brine, dried over sodium sulfate and filtered. The solvent was removed under vacuum and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 49%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.40 (d, 2H), 7.36 (d, 2H), 6.98 (m, 2H), 6.85 (d, 1H), 5.56 (s, 1H), 4.65 (s, 2H), 3.87 (brs, 2H), 3.57 (brs, 2H), 3.32 (brm, 4H), 2.05 (d, 2H), 1.91 (brt, 1H), 1.66 (m, 2H), 1.48 (s, 9H) 1.21 (brd, 6H)

Mass Spectral Analysis *m/z* = 507.3 $(M+H)^+$

Preparation of **10J**:

To a solution of **10.5** (460mg, 0.91 mmol, 1.0 eq) in anhydrous methanol (30 mL) was added drop wise a 4M solution of hydrochloric acid in dioxane (2.3 mL, 9.1 mmol, 10.0 eq). The mixture was stirred at room temperature for 16h and the solvent was evaporated under vacuum. The residue was triturated in ethyl ether (50mL); the solid

was collected by filtration and washed with diethyl ether. The crude product was purified by column chromatography (eluent: methylene chloride/methanol mixtures of increasing polarity).

Yield: 46%

^{1}H NMR (400MHz, $CDCl_3$) δ 9.62 (brs, 2H), 7.38 (brd, 4H), 7.00 (m, 2H), 6.90 (brd, 1H), 5.60, (brs, 1H), 4.66 (brs, 2H), 3.58 (brm, 2H), 3.40 (brm, 4H), 3.31 (brm, 2H), 2.50 (brs, 1H), 2.25 (brs, 4H), 1.21 (brd, 6H)

Mass Spectral Analysis *m/z* = 407.4 $(M+H)^+$

Elemental analysis:

$C_{26}H_{31}N_3O_3$, 1HCl, 0.7H_2O

Theory: %C 65.91; %H 7.17; %N 6.15

Found: %C 65.93; %H 6.99; %N 6.08

EXAMPLE 11A

Preparation of **11.2**:

2',6'-hydroxyacetophenone (**11.1**) (200.0g g, 1.31 mol, 1.0 eq) was added portion wise at room temperature to pyrrolidine (220 mL, 2.0 eq) followed by portion wise addition of 1-Boc-4-piperidone (**1.2**) (262.0 g, 1.31 mo, 1.0 eq). Anhydrous methanol (100 mL) was then added and the red slurry heated to reflux to dissolve all solids. On dissolution the reaction was cooled to room temperature overnight with stirring to form a solid mass. This solid mass was dissolved in ethyl acetate, washed with a 1N aqueous solution of hydrochloric acid, a 1N aqueous solution of sodium hydroxide and brine, dried over sodium sulfate and filtered. The solvent was evaporated under vacuum. A mixture of hexane and diethyl ether (80:20) (400 mL) was added to the mixture and the resulting precipitate was collected by filtration, washed with hexane and used for the next step without further purification.

Yield: 74%.

^{1}H NMR (400MHz, $CDCl_3$) δ 11.61 (s, 1H), 7.37 (t, 1H), 6.49 (d, 1H), 6.44 (d, 1H), 3.89 (brs, 2H), 3.20 (brm, 2H), 2.73 (s, 2H), 2.02 (d, 2H), 1.64 (m, 2H), 1.46 (s, 9H)

Mass Spectral Analysis *m/z* = 334.0 $(M+H)^+$

Preparation of **11.4**:

To a solution of **11.2** (140.0 g, 0.420 mol, 1.0 eq) in dichloromethane (700 mL) at ambient temperature under nitrogen was added drop wise diisopropylethylamine (294.0 mL, 1.68 mol, 4.0 eq). To this solution was added drop wise chloro(methoxy)methane (**11.3**) (100.0 g, 1.26 mol, 3.0 eq). The mixture was heated to reflux for 16h, cooled to room temperature and the solvent was removed under vacuum to afford a brown oil. This oil was dissolved in ethyl acetate (700 mL) and washed with a 1N aqueous solution of hydrochloric acid, an aqueous saturated solution of sodium bicarbonate and brine. The organic extracts were dried over sodium sulfate, filtered and the solvent was removed under vacuum to afford a brown oil. Diethyl ether (400 mL) was added and the resulting white precipitate was filtered and used for the next step without further purification.

Yield: 83%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.36 (t, 1H), 6.74 (d, 1H), 6.65 (d, 1H), 5.27 (s, 2H), 3.86 (brs, 2H), 3.52 (s, 3H), 3.22 (m, 2H), 2.69 (s, 2H), 2.02 (d, 2H), 1.60 (m, 2H), 1.46 (s, 9H)

Mass Spectral Analysis *m/z* = 378.2 $(M+H)^+$

Preparation of **11.5**:

To a solution of **11.4** (131.2 g, 0.348 mol) in tetrahydrofuran (600 mL) at -78°C under nitrogen atmosphere was added drop wise a 1.0M solution of LiHMDS in tetrahydrofuran (420.0 mL, 1.2 eq). The mixture was stirred for 1h at -78°C. A solution of **1.4** (149.4 g, 0.418 mol, 1.2 eq) in tetrahydrofuran (200 mL) was added drop wise. The mixture was warmed slowly to room temperature and stirring was continued for a further 12h at room temperature. The mixture was then poured into ice water and the two phases were separated. The organic phase was washed with a 1N aqueous solution of hydrochloric acid, a 1N aqueous solution of sodium hydroxide and brine, dried over sodium sulfate and filtered. The solvent was removed under vacuum and the tan oily residue was used for the next step without further purification.

Yield: 100%

^{1}H NMR (400MHz, $CDCl_3$) δ 6.98 (t, 1H), 6.62 (d, 1H), 6.39 (d, 1H), 5.24 (s, 1H), 5.03 (s, 2H), 3.62 (brs, 2H), 3.30 (s, 3H), 3.07 (m, 2H), 1.84 (d, 2H), 1.46 (m, 2H), 1.26 (s, 9H)

Mass Spectral Analysis *m/z* = 510.0 $(M+H)^+$

Preparation of **11.6a**:

To a solution of **11.5** (100 g, 196 mmol, 1.0 eq) in dimethoxyethane (DME) (600 mL) was added sequentially a 2N aqueous solution of sodium carbonate (294 mL, 588 mmol, 3.0 eq), lithium chloride (25.0 g, 588 mmol, 3.0 eq), 4-(*N,N*-diethylaminocarbonyl)phenylboronic acid) (**1.6**) (36.9 g, 166 mmol, 1.1 eq) and tetrakis(triphenylphosphine)palladium(0) (4.54 g, 3.92 mmol, 0.02 eq). The mixture was refluxed for 10h under nitrogen. The mixture was then cooled to room temperature, filtered through a celite pad and the filtercake was washed with DME (100mL) and water (750 mL). The aqueous mixture was extracted with ethyl acetate. The organic layer was further washed with brine and dried over sodium sulfate. The crude product was purified by chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 62%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.21 (d, 2H), 7.17 (d, 2H), 7.05 (t, 1H), 6.60 (m, 2H), 5.45 (s, 1H), 4.58 (s, 2H), 3.71 (brs, 2H), 3.45 (brm, 2H), 3.22 (brm, 4H), 3.06 (s, 3H), 1.90 (d, 2H), 1.56 (m, 2H), 1.38 (s, 9H), 1.09 (brd, 6H)

Mass Spectral Analysis *m/z* = 537.4 $(M+H)^+$

Preparation of **11A**:

To a solution of **11.6a** (25.0 g, 46.6 mmol, 1.0 eq) in anhydrous methanol (250 mL) was added drop wise a 4M solution of hydrochloric acid in dioxane (58.2 mL, 233 mmol, 5.0 eq). The mixture was stirred at room temperature for 16h and the solvent was evaporated under vacuum to afford a brown oil. Methanol (20 mL) followed by diethyl ether (300 mL) was added to the brown oil and the resulting precipitate was collected by filtration and washed with diethyl ether. The solid was used for the next step without further purification.

Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) δ 9.55 (s, 1H), 9.07 (brs, 2H), 7.27 (m, 4H), 7.06 (t, 1H), 6.52 (d, 1H), 6.47 (d, 1H), 5.76 (s, 1H), 3.42 (brm, 2H), 3.35 (s, 4H), 3.19, (brm, 6H), 2.03 (m, 4H), 1.11 (brm, 6H)

Mass Spectral Analysis *m/z* = 393.0 $(M+H)^+$

Elemental analysis:

$C_{24}H_{28}N_2O_3$, 1HCl, 0.67H_2O

Theory: %C 65.37; %H 6.93; %N 6.35

Found: %C 65.41; %H 6.98; %N 6.31

EXAMPLE 11B

11B was obtained according to a procedure similar to the one described for **11A**, with the following exception:

Step 11.4: **1.6** was replaced by **1.7**.

^{1}H NMR (400MHz, DMSO d_6) 9.67 (brs, 1H), 9.23 (brd, 2H), 8.50 (s, 1H), 7.79 (d, 1H), 7.52 (d, 1H), 7.09 (t, 1H), 6.57 (d, 1H), 6.50 (d, 1H), 5.93 (s, 1H), 3.43 (q, 2H), 3.26 (q, 2H), 3.21 (m, 2H), 3.14 (m, 2H), 2.05 (m, 4H), 1.18 (t, 3H), 1.11 (t, 3H)

Mass Spectral Analysis *m/z* = 394.3 $(M+H)^+$

Elemental analysis:

$C_{23}H_{27}N_3O_3$, 2HCl, 1.5H_2O

Theory: %C 55.99; %H 6.54; %N 8.52

Found: %C 56.11; %H 6.54; %N 8.53

EXAMPLE 11C

Preparation of **11.7a**:

To a slurry of **11A** (10.0 g, 23.3 mmol, 1.0 eq) in tetrahydrofuran (200 mL) under a nitrogen atmosphere was added triethylamine (9.75 mL, 69.9 mmol, 3.0 eq). The reaction mixture was cooled to 0°C. A solution of di-*tert*-butyl dicarbonate (**4.7**) (4.58 g, 21.0 mmol, 0.9 eq) in tetrahydrofuran (50 mL) was added drop wise to the reaction mixture which was stirred for 3h at room temperature. The solvent was evaporated under vacuum and the residue was dissolved in ethyl acetate (500 mL), washed with water and brine, and dried over sodium sulfate and filtered. The solvent was evaporated under vacuum. The residue was sonicated and triturated in a mixture

ethyl acetate/methanol 95:5 (75 mL). The solid was collected by filtration and washed with ethyl acetate.

Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) δ 9.49 (s, 1H), 7.31 (s, 4H), 7.08 (t, 1H), 6.54 (d, 1H), 6.47 (d, 1H), 5.77 (s, 1H), 3.70 (m, 2H), 3.48 (brm, 2H), 3.30 (brm, 4H), 1.87 (d, 2H), 1.74 (m, 2H), 1.47 (s, 9H) 1.16 (brs, 6H)

Mass Spectral Analysis *m/z* = 493.4 $(M+H)^+$

Preparation of **11.9a**:

To a solution of **11.7a** (1.00 g, 2.02 mmol, 1.0 eq) in dichloromethane (4 mL) under a nitrogen atmosphere was added sequentially cyclopropylmethanol (**2.8e**) (189 mg, 2.63 mmol, 1.3 eq) and triphenylphosphine (690 mg, 2.63 mmol, 1.3 eq). The reaction mixture was stirred for 5 min at room temperature and a solution of diethylazodicarboxylate (460 mg, 2.63 mmol, 1.3 eq) was added drop wise. The reaction was stirred an additional 30 min at room temperature and the solvent was evaporated under vacuum. The crude product was purified by chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 42%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.31 (d, 2H), 7.27 (d, 2H), 7.13 (t, 1H), 6.64 (d, 1H), 6.42 (d, 1H), 5.50 (s, 1H), 3.78 (brd, 2H), 3.54 (brm, 2H), 3.49 (d, 2H), 3.35 (brt, 4H), 2.02 (d, 2H), 1.69 (m, 2H), 1.47 (s, 9H) 1.26 (brd, 6H), 0.53 (m, 1H), 0.29 (m, 2H), -0.07 (m, 2H)

Mass Spectral Analysis *m/z* = 547.5 $(M+H)^+$

Preparation of **11C**:

To a solution of **11.9a** (460 mg, 0.84 mmol, 1.0 eq) in anhydrous methanol (15 mL) was added dropwise a 4M solution of hydrochloric acid in dioxane (2.0 mL, 8.4 mmol, 10.0 eq). The mixture was stirred at room temperature for 16h and the solvent was evaporated under vacuum. The residue was triturated in diethyl ether (50mL). The resulting solid was collected by filtration and washed with diethyl ether.

Yield: 97%

^{1}H NMR (400MHz, $CDCl_3$) δ 9.67 (brs, 2H), 7.32 (d, 2H), 7.26 (d, 2H), 7.16 (t, 1H), 6.64 (d, 1H), 6.46 (d, 1H), 5.50 (s, 1H), 3.54 (brm, 2H), 3.49 (d, 2H), 3.36 (brm, 6H), 2.28 (d, 2H), 2.18 (m, 2H), 1.19 (brd, 6H), 0.53 (m, 1H), 0.30 (m, 2H), -0.07 (m, 2H)

Mass Spectral Analysis *m/z* = 447.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{34}N_2O_3$, 1.0 HCl, 0.7 H_2O

Theory: %C 67.73; %H 7.41; %N 5.64

Found: %C 67.73; %H 7.24; %N 5.59

EXAMPLE 11D

11D was obtained according to a procedure similar to the one described for **11C**, with the following exceptions:

Step 11.4: **1.6** was replaced by **1.7**.

^{1}H NMR (400MHz, $CDCl_3$) δ 9.67 (brs, 1H), 8.44 (m, 1H), 7.61 (dd, 1H), 7.55 (d, 1H), 7.19 (t, 1H), 6.64 (d, 1H), 6.43 (d, 1H), 5.55 (s, 1H), 3.56 (q, 2H), 3.50 (d, 2H), 3.46 (q, 2H), 3.38 (m, 4H), 2.29 (m, 2H), 2.21 (m, 2H), 1.28 (t, 3H), 1.17 (t, 3H), 0.54 (m, 1H), 0.33 (m, 2H), -0.05 (m, 2H)

Mass Spectral Analysis *m/z* = 448.4 $(M+H)^+$

EXAMPLE 11E

Preparation of **11.9b**:

To a solution of **11.7a** (1.00 g, 2.02 mmol, 1.0 eq) in acetone (20mL) was added sequentially potassium carbonate (1.70 g, 12.1 mmol, 6.0 eq) and bromocyclobutane (**11.8**) (1.66 g, 12.1 mmol mmol, 6.0 eq). The reaction mixture was refluxed for 90h, poured into water (100 mL) and extracted with ethyl acetate. The organic extracts were washed with a 1N aqueous solution of sodium hydroxide and brine, dried over sodium sulfate and filtered. The solvent was evaporated and the crude product was first purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity) and then repurified by reverse phase HPLC chromatography (eluent: acetonitrile/water (0.1% trifluoroacetic acid) mixtures of decreasing polarity).

Yield: 18%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.31 (d, 2H), 7.27 (d, 2H), 7.11 (t, 1H), 6.64 (d, 1H), 6.26 (d, 1H), 4.36 (m, 1H), 5.50 (s, 1H), 3.79 (brd, 2H), 3.54 (brm, 2H), 3.48 (d, 2H), 3.34 (brm, 4H), 2.12 (m, 2H), 2.02 (d, 2H), 1.67 (m, 2H), 1.55 (m, 2H), 1.47 (s, 9H) 1.19 (brd, 6H)

Mass Spectral Analysis *m/z* = 547.5 $(M+H)^+$

Preparation of **11E**:

To a solution of **11.9b** (200 mg, 0.37 mmol, 1.0 eq) in anhydrous methanol (25 mL) was added drop wise a 2M solution of hydrochloric acid in diethyl ether (0.73 mL, 1.44 mmol, 4.0 eq). The mixture was stirred at room temperature for 16h and the solvent was evaporated under vacuum. The residue was triturated in diethyl ether (50mL). The solid was collected by filtration and washed with diethyl ether.
Yield: 96%

^{1}H NMR (400MHz, DMSO d_6) δ 9.14 (brs, 2H), 7.29 (d, 2H), 7.24 (d, 2H), 7.19 (t, 1H), 6.68 (d, 1H), 6.42 (d, 1H), 5.79 (s, 1H), 4.43 (m, 1H), 3.40 (brm, 4H), 3.35 (brs, 4H), 3.17 (brm, 4H), 2.10 (m, 2H), 2.03 (m, 2H), 1.45 (m, 2H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 447.3 $(M+H)^+$

EXAMPLE 11F

11F was obtained according to a procedure similar to the one described for **11C**, with the following exceptions:

Step 11.4: **1.6** was replaced by **1.7**.

Step 11.7: **2.8e** was replaced by **11.10**.

^{1}H NMR (400MHz, $CDCl_3$) δ 9.71 (brd, 2H), 8.40 (s, 1H), 7.56 (m, 2H), 7.18 (t, 1H), 6.62 (d, 1H), 6.48 (d, 1H), 5.50 (s, 1H), 4.50 (m, 1H), 3.58 (m, 2H), 3.48 (m, 2H), 3.38 (brs, 4H), 2.30 (d, 2H), 2.22 (brs, 2H), 1.64 (m, 2H), 1.36 (m, 2H), 1.30 (m, 5H), 1.19 (m, 5H)

Mass Spectral Analysis *m/z* = 462.4 $(M+H)^+$

EXAMPLE 12A

Preparation of **12.1**:

To a solution of compound **11.2** (3.33 g, 10 mmol) in anhydrous methylene chloride (100 mL) was added sequentially triethylamine (3.48 mL, 25 mmol, 2.5 eq), 4-dimethylaminopyridine (122 mg, 1 mmol, 0.1 eq) and *N*-phenyltrifluoromethanesulfonimide (**1.4**) (4.48 g, 12.5 mmol, 1.25 eq). The reaction mixture was stirred at room temperature for 24 h, washed with a saturated aqueous solution of sodium bicarbonate, dried over sodium sulfate and filtered. The solvent was evaporated under vacuum and the residue was purified by column chromatography (eluent: hexane/ethyl acetate, 3:1).

Yield: 92.5%

^{1}H NMR (400MHz, DMSO d_6) δ 7.52 (t, 1H), 7.09 (d, 1H), 6.88 (d, 1H), 3.90 (m, 2H), 3.21 (m, 2H), 2.80 (s, 2H), 2.03 (m, 2H), 1.63 (m, 2H), 1.48 (s, 9H)

Preparation of **12.3**:

To a solution of **12.1** (5.4 g, 11.6 mmol) in tetrahydrofuran (100 mL) at room temperature was added tetrakis(triphenylphosphine)palladium(0) (670 mg, 0.58 mmol, 0.05 eq) followed by drop wise addition of a 2.0 M solution of methylzinc chloride (**12.2a**) in tetrahydrofuran (10 mL, 20 mmol, 1.72 eq). The mixture was stirred at room temperature for 2 days. The reaction mixture was then quenched with a saturated aqueous solution of ammonium chloride and extracted with ethyl acetate. The organic layer was washed with brine and dried over sodium sulfate. The solvent was evaporated under vacuum and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate, 4:1).

Yield: 80.6%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.30 (t, 1H), 6.86 (d, 1H), 6.80 (d, 1H), 3.88 (m, 2H), 2.70 (s, 2H), 2.60 (s, 3H), 2.00 (m, 2H), 1.60 (m, 2H), 1.45 (s, 9H)

Preparation of **12.4**:

To a solution of **12.3** (2.8 g, 8.46 mmol) in anhydrous tetrahydrofuran (80 mL) at -78°C under nitrogen was added drop wise a 1.0 M solution of LiHMDS in tetrahydrofuran (11 mL, 11 mmol, 1.1 eq). The reaction mixture was stirred for 45 min at -78°C. A solution of *N*-phenyltrifluoromethanesulfonimide (**1.4**) (3.95 g, 11

mmol, 1.1 eq) in tetrahydrofuran (15 mL) was added drop wise to the reaction mixture. The mixture was warmed slowly to room temperature and stirring was continued for a further 3 h at room temperature. The mixture was then poured into ice water and extracted with a mixture of hexane and diethyl ether (1:1). The organic layer was washed with water and brine, and dried over sodium sulfate and filtered. The organics were concentrated under vacuum and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate, 6:1).

Yield: 61.3%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.11 (t, 1H), 6.80 (m, 2H), 3.82 (m, 2H), 3.29 (m, 2H), 2.50 (s, 3H), 2.03 (m, 2H), 1.68 (m, 2H), 1.48 (s, 9H)

Preparation of **12.5**:

To a solution of **12.4** (848 mg, 1.83 mmol) in dimethoxyethane (DME) (16 mL) was added sequentially a 2 N aqueous solution of sodium carbonate (3.1 mL, 6.2 mmol, 3.4 eq), lithium chloride (259 mg, 6.1 mmol, 3.3 eq), 4-(*N,N*-diethylaminocarbonyl)phenylboronic acid (**1.6**) (486 mg, 2.2 mmol, 1.2 eq) and tetrakis(triphenylphosphine)palladium(0) (64 mg, 0.055 mmol, 0.03 eq). The mixture was refluxed overnight under nitrogen. The mixture was then cooled to room temperature and water (20 mL) was added. The mixture was extracted with ethyl acetate. The organic layer was further washed with brine, dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate, 1:1).

Yield: 96.9%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.36 (d, 2H), 7.26 (d, 2H), 7.10 (t, 1H), 6.86 (d, 1H), 6.70 (d, 1H), 5.60 (s, 1H), 3.80 (m, 2H), 3.55 (m, 2H), 3.30 (m, 4H), 2.00 (m, 2H), 1.74 (s, 3H), 1.65 (m, 2H), 1.49 (s, 9H), 1.20 (m, 6H)

Preparation of **12A**:

To a solution of **12.5** (860 mg, 1.76 mmol) in methylene chloride (10 mL) was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (30 mL). The

mixture was stirred at room temperature for 24 h and diethyl ether was added. The resulting precipitate was collected by filtration and washed with diethyl ether.
Yield: 97.8%

^{1}H NMR (400MHz, DMSO d_6) δ 8.99 (m, 2H), 7.38 (d, 2H), 7.29 (d, 2H), 7.18 (t, 1H), 6.93 (d, 1H), 6.80 (d, 1H), 5.95 (s, 1H), 3.45 (m, 2H), 3.20 (m, 6H), 2.00 (m, 4H), 1.70 (s, 3H), 1.10 (m, 6H)

Mass Spectral Analysis m/z = 391.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{28}N_2O_2$, 1HCl, 1/2H_2O

Theory: %C 68.87; %H 7.40; %N 6.43

Found: %C 68.99; %H 7.33; %N 6.39

EXAMPLE 12B

Preparation of **12.6**:

To a solution of **12.1** (14.4 g, 31 mmol) in *N*,*N*-dimethylformamide was added sequentially methanol (50 mL), triethylamine (7 mL, 50 mmol, 1.6 eq), 1,3-*bis*(diphenylphosphino)propane (dppp) (1.04 g, 2.5mmol, 0.08 eq) and palladium (II) acetate (565 mg, 2.5 mmol, 0.08 eq). The carbon monoxide was then bubbled through the reaction solution while the mixture was heated to 65-70°C for 3.5h. The reaction mixture was cooled to room temperature, diluted with diethyl ether and washed with water and brine. The organic layer was dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate, 4:1).
Yield: 87.9%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.50 (t, 1H), 7.10 (d, 1H), 6.99 (d, 1H), 3.94 (s, 3H), 3.90 (m, 2H), 3.21 (m, 2H), 2.73 (s, 2H), 2.05 (m, 2H), 1.63 (m, 2H), 1.48 (s, 9H)

Preparation of **12.11**:

To a solution of **12.6** (13.2 g, 35.2 mmol) in anhydrous tetrahydrofuran (300 mL) at -78°C was added drop wise a 1.0 M solution of LiHMDS in tetrahydrofuran (42 mL, 42 mmol, 1.2 eq) under nitrogen. The reaction mixture was stirred for 45 min at -

78°C. A solution of *N*-phenyltrifluoromethanesulfonimide (**1.4**) (15.1 g, 42 mmol, 1.2 eq) in tetrahydrofuran (60 mL) was added drop wise to the reaction mixture. The mixture was warmed slowly to room temperature and stirred for 3h. The mixture was then poured into ice water and extracted with a mixture of hexane and diethyl ether (1:1). The organic layer was washed with water and brine, dried over sodium sulfate and filtered. The organics were concentrated under vacuum and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate, 4:1).
Yield: 90.2%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.32 (d, 1H), 7.26 (t, 1H), 7.10 (d, 1H), 5.70 (s, 1H), 3.90 (s, 3H), 3.83 (m, 2H), 3.30 (m, 2H), 2.10 (m, 2H), 1.77 (m, 2H), 1.48 (s, 9H)

Preparation of **12.12**:

To a solution of **12.11** (16 g, 31.6 mmol) in dimethoxyethane (DME) (260 mL) was added sequentially a 2 N aqueous solution of sodium carbonate (53 mL, 106 mmol, 3.4 eq), lithium chloride (4.5 mg, 106 mmol, 3.4 eq.), 4-(*N,N*-diethylaminocarbonyl)phenylboronic acid (**1.6**) (8.4 g, 38 mmol, 1.2 eq) and tetrakis(triphenylphosphine)palladium(0) (1.1 g, 0.95 mmol, 0.03 eq). The mixture was refluxed overnight under nitrogen and then cooled to room temperature. Water (300 mL) was added to the mixture and the crude product was extracted with ethyl acetate. The organic layer was further washed with brine, dried over sodium sulfate and filtered. The organics were concentrated under vacuum and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate, 1:1).
Yield: 98.5%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.33 (d, 2H), 7.25 (m, 4H), 7.15 (d, 1H), 5.72 (s, 1H), 3.85 (m, 2H), 3.53 (m, 2H), 3.32 (m, 4H), 3.10 (s, 3H), 2.06 (m, 2H), 1.76 (m, 2H), 1.50 (s, 9H), 1.20 (m, 6H)

Preparation of **12.13**:

To a suspension of potassium *tert*-butoxide (9 g, 80 mmol, 8.0 eq) in diethyl ether (200 mL) was added drop wise water (0.72 mL, 40 mmol, 4.0 eq) at 0°C. The slurry

was stirred for 30 min. To this mixture was added **12.12** (5.34 g, 10 mmol). The ice-bath was removed and the reaction mixture was stirred at room temperature overnight and quenched by addition of ice water. The aqueous layer was separated, acidified to pH 2-3 with a 1N aqueous solution of hydrochloric acid and extracted with methylene chloride. The organic layers were combined, dried over sodium sulfate and concentrated under vacuum. The crude product was used for the next step without further purification.

Yield: 86.9%

^{1}H NMR (400MHz, DMSO d_6) δ 12.55 (brs, 1H), 7.23 (m, 7H), 5.98 (s, 1H), 3.68 (m, 2H), 3.42-3.20 (m, 6H), 1.80 (m, 4H), 1.42 (s, 9H), 1.10 (m, 6H)

Preparation of **12B**:

To a solution of **12.13** (300 mg, 0.58 mmol) in methylene chloride (4 mL) was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (15 mL). The mixture was stirred at room temperature for 24 h and diluted with diethyl ether. The resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 95%

^{1}H NMR (400MHz, DMSO d_6) δ 12.61 (brs, 1H), 8.69 (m, 6H), 7.38-7.25 (m, 7H), 6.06 (s, 1H), 3.41 (m, 2H), 3.25 (m, 6H), 2.06 (m, 4H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 421.3 $(M+H)^+$

EXAMPLE 12C

Preparation of **12.14a**

To a solution of **12.13** (780 mg, 1.5 mmol) in acetonitrile (50 mL) was added sequentially diisopropylethylamine (1.75 mL, 10 mmol, 6.7 eq), a 0.5 M solution of ammonia (**12.15**) in dioxane (30 mL, 15mmol, 10 eq) and TBTU (580 mg, 1.8 mmol, 1.2 eq). The reaction mixture was stirred at room temperature for 3 days and then concentrated under vacuum. The residue was dissolved in ethyl acetate and washed with a saturated aqueous solution of sodium bicarbonate. The organic layer was dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was purified by column chromatography (eluent: hexane/acetone, 1:1).

Yield: 60.4%

^{1}H NMR (400MHz, DMSO d_6) δ 7.51 (s, 1H), 7.29 (t, 1H), 7.22 (s, 4H), 7.10 (d, 1H), 7.05 (d, 1H), 6.97 (s, 1H), 5.90 (s, 1H), 3.63 (m, 2H), 3.41 (m, 2H), 3.32 (m, 2H), 3.20 (m, 2H), 1.80 (m, 4H), 1.42 (s, 9H), 1.10 (m, 6H)

Preparation of **12C**:

To a solution of **12.14a** (420 mg, 0.81 mmol) in methylene chloride (6 mL) was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (20 mL). The mixture was stirred at room temperature for 2 days and diluted with diethyl ether. The resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 87.5%

^{1}H NMR (400MHz, DMSO d_6) δ 9.21 (m, 2H), 7.54 (s, 1H), 7.32-7.10 (m, 7H), 6.88 (s, 1H), 5.98 (s, 1H), 3.42 (m, 2H), 3.20 (m, 6H), 2.10 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 420.3 $(M+H)^+$

EXAMPLE 12D

12D was obtained according to a procedure similar to the one described for **12C**, with the following exception:

Step 12.16: **12.15** was replaced by **3.4b**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.19 (m, 2H), 7.83 (m, 1H), 7.30-7.20 (m, 6H), 7.00 (d, 1H), 5.96 (s, 1H), 3.41 (m, 2H), 3.20 (m, 6H), 2.11 (m, 4H), 2.06 (d, 3H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 434.3 $(M+H)^+$

EXAMPLE 12E

12E was obtained according to a procedure similar to the one described for **12C**, with the following exception:

Step 12.16: **12.15** was replaced by **3.4c**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.18 (m, 2H), 7.90 (t, 1H), 7.30-7.20 (m, 6H), 7.00 (d, 1H), 5.96 (s, 1H), 3.40 (m, 2H), 3.20 (m, 6H), 2.50 (m, 2H), 2.10 (m, 4H), 1.10 (m, 6H), 0.78 (t, 3H)

Mass Spectral Analysis *m/z* = 448.4 $(M+H)^+$

Elemental analysis:

$C_{27}H_{33}N_3O_3$, $5/4H_2O$

Theory: %C 68.99; %H 7.61; %N 8.94

Found: %C 69.27; %H 7.43; %N 8.93

EXAMPLE 12F

12 F was obtained according to a procedure similar to the one described for **12C**, with the following exception:

Step 12.16: **12.15** was replaced by **3.4d**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.98 (m, 2H), 7.91 (t, 1H), 7.31 (m, 1H), 7.20 (m, 5H), 7.00 (m, 1H), 5.96 (s, 1H), 3.45 (m, 4H), 3.20 (m, 6H), 2.40 (m, 2H), 2.08 (m, 4H), 1.10 (m, 6H), 0.70 (t, 3H)

Mass Spectral Analysis *m/z* = 462.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{35}N_3O_3$, 1HCl, $7/3H_2O$

Theory: %C 62.27; %H 7.59; %N 7.78

Found: %C 62.37; %H 7.23; %N 7.74

EXAMPLE 12G

Preparation of **12.7**:

To a solution of **12.6** (2.25 g, 6 mmol) in a mixed solvent of methanol (40 mL), tetrahydrofuran (40 mL) and water (40 mL) was added lithium hydroxide (1.52 g, 36.2 mmol, 6.0 eq) in one portion. The reaction mixture was stirred at room temperature overnight. The mixture was concentrated under vacuum and extracted with diethyl ether. The aqueous phase was acidified to pH 2-3 using a 1 N aqueous solution of hydrochloric acid. The acidified solution was extracted with methylene chloride. The organics were combined, dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was used in the next step without further purification.

Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) δ 12.93 (brs, 1H), 7.59 (t, 1H), 7.15 (d, 1H), 6.97 (d, 1H), 3.71 (m, 2H), 3.12 (m, 2H), 1.90 (m, 2H), 1.65 (m, 2H), 1.40 (s, 9H)

Preparation of **12.8**:

To a solution of **12.7** (1.63 g, 4.5 mmol) in acetonitrile (100 mL) was added sequentially diisopropylethylamine (5.23, 30 mmol, 6.7 eq), dimethylamine (**3.4j**) hydrochloride (1.14 g, 14 mmol, 3.0 eq) and TBTU (1.74 g, 5.4 mmol, 1.2 eq). The reaction mixture was stirred at room temperature for 3 days and then concentrated under vacuum. The residue was dissolved in ethyl acetate and washed with a saturated aqueous solution of sodium bicarbonate. The organic layer was dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was purified by column chromatography (eluent: hexane/acetone, 2:1).
Yield: 60%

^{1}H NMR (400MHz, DMSO d_6) δ 7.50 (t, 1H), 7.00 (d, 1H), 6.85 (d, 1H), 3.89 (m, 2H), 3.22 (m, 2H), 3.14 (s, 3H), 2.74 (s, 3H), 2.03 (m, 2H), 1.62 (m, 2H), 1.48 (s, 6H)

Preparation of **12.9**:

To a solution of **12.8** (950 mg, 2.45 mmol) in anhydrous tetrahydrofuran (20 mL) at -78°C under nitrogen was added drop wise a 1.0 M solution of LiHMDS in tetrahydrofuran (3.2 mL, 3.2 mmol, 1.3 eq). The reaction mixture was stirred for 45 min at -78°C. A solution of *N*-phenyltrifluoromethanesulfonimide (**1.4**) (1.15 g, 3.2 mmol, 1.3 eq) in tetrahydrofuran (8 mL) was added drop wise to the reaction mixture. The mixture was warmed slowly to room temperature and stirring was continued for an additional 2.5 h at room temperature. The mixture was then poured into ice water and extracted with a mixture of hexane and diethyl ether (1:1). The organic layer was washed with water and brine, and dried over sodium sulfate and filtered. The organic extracts were concentrated under vacuum and the crude product was purified by column chromatography (eluent: methylene chloride/ethyl acetate, 3:1).
Yield: 78.6%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.28 (t, 1H), 6.96 (d, 1H), 6.83 (d, 1H), 5.65 (s, 1H), 3.80 (m, 2H), 3.38 (m, 1H), 3.20 (m, 1H), 3.10 (s, 3H), 2.92 (s, 3H), 2.09 (m, 2H), 1.70 (m, 2H), 1.48 (s, 9H)

Preparation of **12.10**:

To a solution of **12.9** (950 mg, 1.83 mmol) in dimethoxyethane (DME) (16 mL) was added sequentially a 2N aqueous solution of sodium carbonate (3.1 mL, 6.2 mmol, 3.4 eq), lithium chloride (259 mg, 6.1 mmol, 3.3 eq.), 4-(*N,N*-diethylaminocarbonyl)phenylboronic acid (**1.6**) (486 mg, 2.2 mmol, 1.2 eq) and tetrakis(triphenylphosphine)palladium(0) (64 mg, 0.055 mmol, 0.03 eq). The mixture was refluxed overnight under nitrogen and then cooled to room temperature. To this mixture was added water (20 mL) and the crude product was extracted with ethyl acetate. The organic layer was washed with brine, dried over sodium sulfate and filtered. The organics were concentrated under vacuum and the crude product was purified by column chromatography (eluent: hexane/acetone, 2:1).
Yield: 88%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.35 (d, 2H), 7.25 (m, 3H), 7.05 (d, 1H), 6.91 (d, 1H), 5.62 (s, 1H), 3.86 (m, 2H), 3.55 (m, 2H), 3.30 (m, 4H), 2.69 (s, 3H), 2.30 (s, 3H), 2.10 (m, 1H), 1.98 (m, 1H), 1.70 (m, 2H), 1.49 (s, 6H), 1.20 (m, 6H)

Preparation of **12G**:

To a solution of **12.10** (840 mg, 1.54 mmol) in methylene chloride (10 mL) was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (30 mL). The mixture was stirred at room temperature for 2 days and diluted with diethyl ether. The resulting precipitate was collected by filtration and washed with diethyl ether.
Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) δ 9.28 (m, 2H), 7.35-7.19 (m, 6H), 6.90 (d, 1H), 5.96 (s, 1H), 3.43 (m, 2H), 3.22 (m, 6H), 2.66 (s, 3H), 2.18 (s, 3H), 2.18 (s, 3H), 2.09 (m, 4H), 1.11 (m, 6H)
Mass Spectral Analysis *m/z* = 448.4 $(M+H)^+$

EXAMPLE 12H

12H was obtained according to a procedure similar to the one described for **12A**, with the following exception:
Step 12.4: **1.6** was replaced by **1.7**.

^{1}H NMR (400MHz, DMSO d_6) 9.20 (m, 2H), 8.48 (s, 1H), 7.73 (d, 1H), 7.58 (d, 1H), 7.20 (t, 1H), 6.98 (d, 1H), 6.82 (d, 1H), 6.10 (s, 1H), 3.42-3.12 (m, 8H), 2.02 (m, 4H), 1.70 (s, 3H), 1.18 (t, 3H), 1.10 (t, 3H)

Mass Spectral Analysis *m/z* = 392.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}N_3O_3$, 7/5HCl, 7/5H_2O

Theory: %C 61.60; %H 7.15; %N 8.98; %Cl 10.61

Found: %C 61.70; %H 6.78; %N 8.86; %Cl 10.73

EXAMPLE 12I

12I was obtained according to a procedure similar to the one described for **12A**, with the following exception:

Step 12.2: **12.2a** was replaced by **12.2b**.

^{1}H NMR (400MHz, DMSO d_6) 8.89 (brs, 2H), 7.12 (d, 2H), 7.04 (d, 2H), 6.95 (t, 1H), 6.71 (d, 1H), 6.58 (d, 1H), 5.66 (s, 1H), 3.20 (brs, 2H), 2.92 (brm, 6H), 1.75 (brm, 6H), 0.86 (brm, 8H), 0.22 (t, 3H)

Mass Spectral Analysis *m/z* = 419.4 $(M+H)^+$

Elemental analysis:

$C_{27}H_{34}N_2O_2$, 1HCl, 1H_2O

Theory: %C 68.55; %H 7.88; %N 5.92

Found: %C 68.42; %H 7.73; %N 5.92

EXAMPLE 12J

12J was obtained according to a procedure similar to the one described for **12A**, with the following exception:

Step 12.2: **12.2a** was replaced by **12.2c**.

^{1}H NMR (400MHz, DMSO d_6) 9.12 (brs, 1.5H), 7.54 (d, 2H), 7.47 (d, 2H), 7.38 (t, 1H), 7.13 (d, 1H), 7.02 (d, 1H), 6.09 (s, 1H), 3.62 (brs, 2H), 3.36 (brm, 5H), 2.18 (brm, 6H), 1.30 (brm, 8H), 1.00 (m, 2H), 0.81 (t, 3H)

Mass Spectral Analysis *m/z* = 433.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{36}N_2O_2$, 1HCl, 2H_2O

Theory: %C 66.58; %H 8.18; %N 5.55

Found: %C 66.82; %H 7.88; %N 5.59

EXAMPLE 12K

12K was obtained according to a procedure similar to the one described for **12A**, with the following exceptions:

Step 12.2: **12.2a** was replaced by **12.2b**.

Step 12.4: **1.6** was replaced by **1.7** and Method 12A was used.

^{1}H NMR (400MHz, DMSO d_6) 9.73 (brs, 1H), 9.61 (brs, 1H), 8.47 (s, 1H), 7.65 (m, 2H), 7.20 (m, 1H), 6.90 (d, 1H), 6.82 (d, 1H), 5.66 (s, 1H), 3.59 (q, 2H), 3.41 (brm, 6H), 2.24 (brs, 4H), 2.01 (brm, 2H), 1.25 (brm, 8H), 0.54 (t, 3H)

Mass Spectral Analysis $m/z = 420.4$ $(M+H)^+$

EXAMPLE 12L

12L was obtained according to a procedure similar to the one described for **12A**, with the following exceptions:

Step 12.2: **12.2a** was replaced by **12.2c**.

Step 12.4: **1.6** was replaced by **1.7** and Method 12A was used.

^{1}H NMR (400MHz, DMSO d_6) 8.86 (brd, 1.5H), 8.43 (d, 1H), 7.66 (dd, 1H), 7.48 (d, 1H), 7.16 (t, 1H), 6.91 (d, 1H), 6.79 (d, 1H), 5.98 (s, 1H), 3.40 (q, 2H), 3.12 (brm, 5H), 1.94 (brm, 6H), 1.10 (m, 5H), 1.01 (t, 3H), 0.76 (m, 2H), 0.56 (t, 3H)

Mass Spectral Analysis $m/z = 434.3$ $(M+H)^+$

EXAMPLE 13A

Preparation of **13.2**:

To a solution of **1.5a** (7.80 g, 17.35 mmol, 1.0 eq) in dimethoxyethane (75 mL) was added sequentially a 2N aqueous solution of sodium carbonate (26.03 mL, 52.06 mmol, 3.0 eq), lithium chloride (2.21 g, 52.06 mmol, 3.0 eq), **13.1** (3.44 g, 19.09 mmol, 1.1 eq) and tetrakis(triphenylphosphine)palladium(0) (0.40 g, 0.35 mmol, 0.02 eq). The mixture was refluxed overnight under nitrogen. The mixture was then cooled to room temperature and water (250 mL) was added. The mixture was extracted with ethyl acetate. The organic layer was further washed with brine and

dried over sodium sulfate. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield: 64%

^{1}H NMR (400MHz, DMSO d_6) δ 8.02 (d, 2H), 7.49 (d, 2H), 7.23 (m, 1H), 6.99 (d, 1H), 6.92 (m, 2H), 5.92 (s, 1H), 3.88 (s, 3H), 3.70 (m, 2H), 3.27 (m, 2H), 1.89 (m, 2H), 1.71 (m, 2H), 1.42 (s, 9H)
Mass Spectral Analysis *m/z* = 436.0 $(M+H)^+$

Preparation of **13.3**:

A solution of **13.2** (4.71 g, 10.81 mmol, 1.0 eq) in tetrahydrofuran (30 mL) at 0°C under nitrogen was added drop wise to a solution of lithium hydroxide monohydrate (0.54 g, 12.98 mmol, 1.2 eq) in water (30 mL). The mixture was stirred overnight at room temperature. The mixture was then concentrated under reduced pressure and redissolved in water. The mixture was then acidified to pH 2 using concentrated hydrochloric acid. The resulting precipitate was collected by filtration and the crude product was used for the next step without further purification.
Yield: 98%

^{1}H NMR (400MHz, DMSO d_6) δ 13.03 (br s, 1H), 8.01 (d, 2H), 7.47 (d, 2H), 7.23 (m, 1H), 6.98 (d, 1H), 6.92 (m, 2H), 5.91 (s, 1H), 3.70 (m, 2H), 3.28 (m, 2H), 1.86 (m, 2H), 1.72 (m, 2H), 1.42 (s, 9H)
Mass Spectral Analysis *m/z* = 420.1 $(M-H)^-$

Preparation of **13A**:

Trifluoroacetic acid (0.15 mL, 1.96 mmol, 5.5 eq) was added drop wise to a cold (0°C) solution of **13.3** (0.15 g, 0.36 mmol, 1.0 eq) in anhydrous dichloromethane (5 mL). The mixture was warmed to room temperature and stirred overnight at room temperature. The mixture was then concentrated under reduced pressure. The crude product was triturated with diethyl ether. The resulting precipitate was collected by filtration.
Yield: 87%

^{1}H NMR (400MHz, DMSO d_6) δ 13.05 (brs, 1H), 8.67 (m, 2H), 8.02 (d, 2H), 7.49 (d, 2H), 7.27 (m, 1H), 7.05 (d, 1H), 6.96 (m, 2H), 5.98 (s, 1H), 3.26 (m, 4H), 2.08 (m, 2H), 1.97 (m, 2H)

Mass Spectral Analysis *m/z* = 322.1 $(M+H)^+$

Elemental analysis:

$C_{20}H_{19}NO_3$, CF_3CO_2H, $0.2H_2O$

Theory: %C 60.19; %H 4.68; %N 3.19

Found: %C 60.18; %H 4.61; %N 3.24

EXAMPLE 13B

Preparation of **13.5a**:

O-Benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (150.8 mg, 0.47 mmol, 1.1 eq) was added to a cooled (0°C) solution of **13.3** (180.0 mg, 0.43 mmol, 1.0 eq), **3.4a** (50.3 mg, 0.94 mmol, 2.2 eq), and *N,N*-diisopropylethylamine (0.25 mL, 0.94 mmol, 2.2 eq) in acetonitrile (5 mL). The solution was stirred overnight at room temperature and then concentrated under reduced pressure. Ethyl acetate (10 mL) and a saturated aqueous solution of sodium bicarbonate (10 mL) were added to the crude product and the mixture was stirred for 20 min at room temperature. The phases were separated and the organic phase was washed with a saturated aqueous solution of sodium bicarbonate, brine, dried over sodium sulfate and filtered. The organics were concentrated under reduced pressure and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 10%

Mass Spectral Analysis *m/z* = 421.2 $(M+H)^+$

Preparation of **13B**:

A 2.0M solution of hydrochloric acid in diethyl ether (0.12 mL, 0.24 mmol, 5.5 eq) was added drop wise to a cooled (0°C) solution of **13.5a** (18 mg, 0.04 mmol, 1.0 eq) in anhydrous methanol (5 mL). The mixture was stirred overnight at room temperature and then concentrated under reduced pressure. The crude product was triturated with ethyl acetate. The resulting precipitate was collected by filtration.

Yield: 70%

^{1}H NMR (400MHz, DMSO d_6) δ 8.99 (m, 2H), 8.06 (m, 1H), 7.95 (m, 2H), 7.46 (m, 3H), 7.27 (m, 1H), 7.06 (m, 1H), 6.96 (m, 2H), 5.95 (s, 1H), 3.24 (m, 4H), 2.08 (m, 4H)

Mass Spectral Analysis *m/z* = 321.1 $(M+H)^+$

EXAMPLE 13C

13C was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4b**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.05 (m, 2H), 8.55 (m, 1H), 7.92 (m, 2H), 7.41 (m, 2H), 7.26 (m, 1H), 7.06 (m, 1H), 6.95 (m, 2H), 5.95 (s, 1H), 3.20 (m, 4H), 2.81 (m, 3H), 2.08 (m, 4H)

Mass Spectral Analysis *m/z* = 335.2 $(M+H)^+$

EXAMPLE 13D

13D was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4c**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.50 (m, 1H), 7.90 (d, 2H), 7.40 (d, 2H), 7.20 (m, 1H), 6.90 (m, 3H), 5.85 (s, 1H), 3.30 (m, 2H), 2.90 (m, 2H), 2.70 (m, 2H), 1.85-1.70 (m, 4H), 1.10 (t, 3H)

Mass Spectral Analysis *m/z* = 349.2 $(M+H)^+$

Elemental analysis:

$C_{22}H_{24}N_2O_2$, 0.25 $(CH_3)_2CO$, 0.25H_2O

Theory: %C 70.89; %H 7.32; %N 7.27

Found: %C 71.13; %H 7.04; %N 7.07

EXAMPLE 13E

13E was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4e**.

^{1}H NMR (400MHz, $CDCl_3$) δ 9.75 (brs, 1H), 9.31 (brs, 1H), 7.81 (d, 2H), 7.39 (d, 2H), 7.21 (m, 1H), 6.98 (m, 2H), 6.90 (m, 1H), 6.25 (m, 1H), 5.56 (s, 1H), 3.46 (m, 2H), 3.33 (m, 4H), 2.30 (m, 2H), 2.12 (m, 2H), 1.94 (m, 1H), 1.04 (d, 6H)

Mass Spectral Analysis *m/z* = 377.2 $(M+H)^+$

EXAMPLE 13F

13F was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4j**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.08 (m, 2H), 7.42 (m, 4H), 7.24 (m, 1H), 7.00 (m, 3H), 5.91 (s, 1H), 3.25 (m, 4H), 2.96 (m, 6H), 2.07 (m, 4H)

Mass Spectral Analysis *m/z* = 349.1 $(M+H)^+$

EXAMPLE 13G

13G was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4k**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.91 (m, 2H), 7.58 (d, 2H), 7.41 (d, 2H), 7.25 (m, 1H), 7.00 (m, 3H), 5.92 (s, 1H), 3.49 (m, 2H), 3.41 (m, 2H), 3.24 (m, 4H), 2.09 (m, 2H), 2.00 (m, 2H), 1.84 (m, 4H)

Mass Spectral Analysis *m/z* = 375.1 $(M+H)^+$

EXAMPLE 13H

13H was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4o**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.98 (m, 2H), 7.39 (dd, 4H), 7.24 (m, 1H), 6.95 (m, 3H), 5.91 (s, 1H), 3.66 (brs, 2H), 3.22 (m, 4H), 2.10 (m, 4H), 1.30 (m, 12H)

Mass Spectral Analysis *m/z* = 405.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{32}N_2O_2$, 1HCl, $0.5H_2O$

Theory: %C 69.39; %H 7.62; %N 6.22

Found: %C 69.31; %H 7.64; %N 6.19

EXAMPLE 13I

13I was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4p**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.91 (m, 2H), 7.46 (m, 4H), 7.26 (m, 1H), 7.01 (m, 3H), 5.94 (s, 1H), 3.61 (m, 6H), 3.35 (m, 2H), 3.21 (m, 4H), 2.09 (m, 2H), 1.98 (m, 2H)

Mass Spectral Analysis *m/z* = 391.1 $(M+H)^+$

EXAMPLE 13J

13J was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **3.4q**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.90 (m, 2H), 7.44 (m, 4H), 7.26 (m, 1H), 7.00 (m, 3H), 5.91 (s, 1H), 3.59 (m, 2H), 3.21 (m, 6H), 2.09 (m, 2H), 1.99 (m, 2H), 1.55 (m, 6H)

Mass Spectral Analysis *m/z* = 389.1 $(M+H)^+$

EXAMPLE 13K

13K was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **13.4a**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.75 (m, 2H), 7.49 (m, 2H), 7.41 (m, 2H), 7.26 (m, 1H), 7.05 (m, 1H), 6.97 (m, 2H), 5.95 (s, 1H), 4.00 (brm, 4H), 3.23 (m, 4H), 2.10 (m, 2H), 1.97 (m, 2H), 1.64 (m, 2H), 1.15 (brm, 6H)

Mass Spectral Analysis *m/z* = 403.3 $(M+H)^+$

Elemental analysis:

$C_{26}H_{30}N_2O_2$, 1HCl, $0.3H_2O$

Theory: %C 70.27; %H 7.17; %N 6.30

Found: %C 70.02; %H 7.04; %N 6.27

EXAMPLE 13L

13L was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **13.4b**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.90 (m, 2H), 7.70 (d, 2H), 7.50 (d, 2H), 7.40 (m, 1H), 7.30 (m, 4H), 7.00 (m, 3H), 5.95 (s, 1H), 4.90 (s, 2H), 4.80 (s, 2H), 3.30 (brm, 4H), 2.05 (m, 4H)

Mass Spectral Analysis *m/z* = 423.1 $(M+H)^+$

Elemental analysis:

$C_{28}H_{26}N_2O_2$, 1HCl, $1H_2O$

Theory: %C 70.50; %H 6.13; %N 5.87

Found: %C 70.58; %H 5.95; %N 5.89

EXAMPLE 13M

13M was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **13.4c**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (m, 1H), 7.40 (m, 4H), 7.25 (m, 1H), 7.00 (m, 3H), 5.90 (s, 1H), 3.55-3.05 (m, 8H), 2.05 (m, 4H), 1.60 (m, 2H), 1.10 (m, 1H), 0.90 (m, 2H), 0.65 (m, 1H), 0.40 (m, 2H), 0.15 (m, 1H), 0.10 (m, 1H)

Mass Spectral Analysis *m/z* = 417.2 $(M+H)^+$

Elemental analysis:

$C_{27}H_{32}N_2O_2$, 1HCl, $0.4H_2O$

Theory: %C 70.46; %H 7.40; %N 6.09

Found: %C 70.54; %H 7.30; %N 6.15

EXAMPLE 13N

13N was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **13.4d**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.88 (m, 2H), 7.40 (brm, 10H), 7.00 (m, 3H), 5.94 (s, 1H), 4.70 (m, 1H), 4.52 (m, 1H), 3.21 (m, 4H), 2.88 (m, 3H), 2.02 (m, 4H)

Mass Spectral Analysis *m/z* = 425.2 $(M+H)^+$

Elemental analysis:

$C_{28}H_{28}N_2O_2$, 1HCl, $0.6H_2O$

Theory: %C 71.28; %H 6.45; %N 5.94

Found: %C 71.13; %H 6.51; %N 5.97

EXAMPLE 13O

13O was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **13.4e**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.65 (m, 2H), 7.45 (m, 4H), 7.26 (m, 1H), 7.00 (m, 3H), 5.95 (s, 1H), 4.36 (m, 2H), 4.11 (m, 2H), 3.88 (m, 2H), 3.60 (m, 2H), 3.00 (m, 2H), 2.65 (m, 1H), 2.09 (m, 2H), 1.99 (m, 4H), 1.52 (m, 2H), 1.19 (m, 3H)

Mass Spectral Analysis *m/z* = 461.2 $(M+H)^+$

EXAMPLE 13P

13P was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **13.4f**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.60 (m, 2H), 7.47 (m, 4H), 7.25 (m, 1H), 7.00 (m, 3H), 5.95 (s, 1H), 4.18 (m, 2H), 3.80 (brs, 4H), 3.24 (m, 2H), 3.00 (s, 3H), 2.10 (m, 2H), 1.94 (m, 2H), 1.20 (m, 3H)

Mass Spectral Analysis *m/z* = 421.2 $(M+H)^+$

EXAMPLE 13Q

13Q was obtained according to a procedure similar to the one described for **13B**, with the following exception:

Step 13.6: **3.4a** was replaced by **13.4g**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.32 (brs, 1H), 8.80 (m, 2H), 7.54 (m, 2H), 7.46 (m, 2H), 7.27 (m, 1H), 7.00 (m, 3H), 5.92 (s, 1H), 4.54 (brs, 2H), 3.84 (brs, 2H), 3.45 (m, 2H), 3.24 (m, 4H), 3.12 (m, 2H), 2.83 (s, 3H), 2.10 (m, 2H), 1.97 (m, 2H)
Mass Spectral Analysis *m/z* = 404.3 $(M+H)^+$

EXAMPLE 13R

13R was obtained according to a procedure similar to the one described for **13B**, with the following exception:
Step 13.6: **3.4a** was replaced by **13.4h**.
^{1}H NMR (400MHz, DMSO d_6) δ 9.55 (m, 1H), 8.95 (m, 1H), 7.55 (m, 5H), 7.30 (brm, 10H), 7.04 (m, 1H), 6.95 (m, 2H), 5.93 (s, 1H), 4.62 (s, 2H), 4.46 (s, 2H), 3.20 (m, 4H), 2.02 (m, 4H)
Mass Spectral Analysis *m/z* = 501.2 $(M+H)^+$

EXAMPLE 13S

Preparation of **13S**:
A 2N aqueous solution of sodium hydroxide (1.0 mL, 2 mmol, 9.2 eq) was added to a solution of **13O** (0.10 g, 0.22 mmol, 1.0 eq) in tetrahydrofuran (5 mL) and anhydrous absolute ethanol (1 mL). The mixture was stirred for 10h at room temperature and acidified to pH 6 using a 2N aqueous solution of hydrochloric acid. The mixture was concentrated under reduced pressure. The crude product was dissolved in dichloromethane. The mixture was filtered and the filtrate was concentrated under reduced pressure.
Yield: 60%

^{1}H NMR (400MHz, DMSO d_6) δ 7.43 (m, 4H), 7.25 (m, 1H), 7.01 (m, 2H), 6.94 (m, 1H), 5.93 (s, 1H), 4.33 (br s, 2H), 3.65-2.90 (m, 9H), 1.91 (m, 6H), 1.52 (m, 2H)
Mass Spectral Analysis *m/z* = 433.1 $(M+H)^+$

EXAMPLE 14A

Preparation of **14.2**:
To a solution of **1.5a** (5.00 g, 11.12 mmol, 1.0 eq) in dimethoxyethane (17 mL) was added sequentially a 2N aqueous solution of sodium carbonate (16.69 mL, 33.37

mmol, 3.0 eq), lithium chloride (1.41 g, 33.37 mmol, 3.0 eq), **14.1** (1.80 g, 12.24 mmol, 1.1 eq) and tetrakis(triphenylphosphine)palladium(0) (0.26 g, 0.22 mmol, 0.02 eq). The mixture was refluxed for 10h under nitrogen. The mixture was then cooled to room temperature and a 1N aqueous solution of sodium hydroxide was added. The mixture was extracted with dichloromethane. The organic layer was further washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was triturated with diethyl ether. The resulting solid was collected bu filtration.

Yield: 78%

^{1}H NMR (400MHz, DMSO d_6) δ 7.90 (d, 2H), 7.50 (d, 2H), 7.20 (m, 1H), 7.00 (m, 1H), 6.90 (m, 2H), 5.95 (s, 1H), 3.70 (m, 2H), 3.25 (m, 2H), 1.85 (m, 2H), 1.70 (m, 2H), 1.40 (s, 9H)

Mass Spectral Analysis *m/z* = 403.1 $(M+H)^+$

Preparation of **14.4**:

A mixture of **14.2** (3.49 g, 8.67 mmol, 1.0 eq), **14.3** (1.13 g, 17.34 mmol, 2.0 eq) and zinc bromide (0.98 g, 4.34 mmol, 0.5 eq) in isopropanol (70 mL) and water (50 mL) was refluxed for 3 days. The reaction mixture was then cooled to 0°C and acidified to pH 1 using a 3N aqueous solution of hydrochloric acid. The mixture was extracted with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. Diethyl ether (30 mL) was added. The resulting precipitate was collected by filtration and washed with diethyl ether. The crude compound was used for the next step without further purification.

Yield: 89%

^{1}H NMR (400MHz, DMSO d_6) δ 8.10 (d, 2H), 7.55 (d, 2H), 7.20 (m, 1H), 7.00 (m, 2H), 6.90 (m, 1H), 5.90 (s, 1H), 3.70 (m, 2H), 3.30 (m, 2H), 1.90 (m, 2H), 1.70 (m, 2H), 1.40 (s, 9H)

Mass Spectral Analysis *m/z* = 446.0 $(M+H)^+$

Preparation of **14A**:

A 2.0M solution of hydrochloric acid in diethyl ether (21.3 mL, 42.58 mmol, 5.5 eq) was added drop wise to a cooled (0°C) solution of **14.4** (3.71 g, 7.74 mmol, 1.0 eq) in

anhydrous dichloromethane (25 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h at room temperature. Diethyl ether (100 mL) was added to the solution. The resulting precipitate was collected by filtration and washed with diethyl ether. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).
Yield: 20%

^{1}H NMR (400MHz, DMSO d_6) δ 9.08 (brs, 2H), 8.16 (d, 2H), 7.61 (d, 2H), 7.28 (m, 1H), 7.02 (m, 3H), 6.02 (s, 1H), 3.59 (brs, 1H), 3.24 (m, 4H), 2.06 (m, 4H)

Mass Spectral Analysis *m/z* = 346.1 $(M+H)^+$

Elemental analysis:

$C_{20}H_{19}N_5O$, 1HCl, $0.5H_2O$

Theory: %C 61.46; %H 5.42; %N 17.92

Found: %C 61.52; %H 5.23; %N 17.63

EXAMPLE 14B

Preparation of **14.5** and **14.6**

Methyl iodide (**2.8c**) (0.35 mL, 0.0056 mol, 5.0 eq) was added drop wise to a solution of **14.4** (0.500 g, 0.0011 mol, 1.0 eq) and triethylamine (0.80 mL, 0.0056 mol, 5.0 eq) in anhydrous dimethylformamide (5 mL) and the mixture was stirred at room temperature for 3 days. The mixture was poured into water (50 mL) and extracted with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by flash column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield **14.5** (major regioisomer): 65%

Mass Spectral Analysis *m/z* = 460.1 $(M+H)^+$

Yield **14.6** (minor regioisomer): 17%

Mass Spectral Analysis *m/z* = 460.2 $(M+H)^+$

Preparation of **14B**

A 2.0M anhydrous solution of hydrochloric acid in diethyl ether (10 mL) was added drop wise to a cold (0°C) solution of **14.5** (0.330 g, 0.00071 mol, 1.0 eq) in anhydrous dichloromethane (10 mL). The mixture was warmed to room temperature and stirring was continued for an additional 16 h at room temperature. The mixture was concentrated under reduced pressure and diethyl ether was added to the residue. The resulting precipitate was collected by filtration and washed with diethyl ether.
Yield: 90%

^{1}H NMR (400MHz, DMSO d_6) δ 8.80 (m, 1H), 8.10 (d, 2H), 7.55 (d, 2H), 7.25 (t, 1H), 6.90-7.10 (m, 3H), 6.00 (s, 1H), 4.45 (s, 3H), 3.15-3.40 (m, 4H), 1.95-2.15 (m, 4H)

Mass Spectral Analysis *m/z* = 360.1 $(M+H)^+$

EXAMPLE 14C

Preparation of **14C**

A 2.0M anhydrous solution of hydrochloric acid in diethyl ether (5 mL) was added drop wise to a cold (0°C) solution of **14.6** (0.090 g, 0.00019 mol, 1.0 eq) in anhydrous dichloromethane (10 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h at room temperature. The mixture was concentrated under reduced pressure and diethyl ether was added to the reisdue. The resulting precipitate was collected by filtration and washed with diethyl ether.
Yield: 88%

^{1}H NMR (400MHz, DMSO d_6) δ 8.80 (m, 1.5H), 7.90 (d, 2H), 7.60 (d, 2H), 7.25 (t, 1H), 6.90-7.10 (m, 3H), 6.00 (s, 1H), 4.20 (s, 3H), 3.20 (m, 4H), 1.95-2.15 (m, 4H)

Mass Spectral Analysis *m/z* = 360.2 $(M+H)^+$

EXAMPLE 15A

15A was obtained according to a procedure similar to the one described for **15C**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1a**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.87 (brm, 1H), 8.16 (d, 2H), 7.59 (d, 2H), 7.29 (m, 1H), 7.06 (m, 2H), 6.97 (m, 1H), 6.02 (s, 1H), 5.96 (s, 2H), 3.77 (s, 3H), 3.23 (brm, 4H), 2.11 (brm, 2H), 2.00 (brm, 2H)

Mass Spectral Analysis *m/z* = 418.1 $(M+H)^+$

EXAMPLE 15B

15B was obtained according to a procedure similar to the one described for **15C**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1b**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.75 (m, 1H), 8.15 (d, 2H), 7.57 (d, 2H), 7.25 (t, 1H), 7.00 (m, 3H), 6.00 (s, 1H), 5.00 (t, 2H), 3.60 (s, 3H), 3.10-3.40 (m, 6H), 1.95-2.18 (m, 4H)

Mass Spectral Analysis *m/z* = 432.2 $(M+H)^+$

EXAMPLE 15C

Preparation of **15.2a** and **15.3a**:

Ethyl bromobutyrate (**15.1c**) (0.40 mL, 0.0028 mol, 2.5 eq) was added drop wise to a solution of **14.4** (0.500 g, 0.0011 mol, 1.0 eq) and triethylamine (0.40 mL, 0.0028 mol, 2.5 eq) in anhydrous *N*,*N*-dimethylformamide and the mixture was stirred at room temperature for 3 days. The mixture was poured into water (50 mL) and extracted with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by flash column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield **15.2a** (major regioisomer): 82%.

(15.2a) ^{1}H NMR (400MHz, DMSO d_6) δ 8.10 (d, 2H), 7.50 (d, 2H), 7.20 (m, 1H), 7.00 (m, 2H), 6.90 (m, 1H), 5.90 (s, 1H), 4.70 (t, 2H), 4.00 (q, 2H), 3.70 (m, 2H), 3.30 (m, 2H), 2.40 (m, 2H), 2.10 (m, 2H), 1.90 (m, 2H), 1.70 (m, 2H), 1.40 (s, 9H), 1.15 (t, 3H)

Mass Spectral Analysis *m/z* = 560.2 $(M+H)^+$

Yield **15.3a** (minor regioisomer): 6%.

(15.3a) ^{1}H NMR (400MHz, DMSO d_6) δ 7.90 (d, 2H), 7.60 (d, 2H), 7.20 (m, 1H), 7.00 (m, 2H), 6.90 (m, 1H), 5.95 (s, 1H), 4.55 (t, 2H), 4.00 (q, 2H), 3.70 (m, 2H), 3.30 (m, 2H), 2.40 (m, 2H), 2.10 (m, 2H), 1.90 (m, 2H), 1.70 (m, 2H), 1.40 (s, 9H), 1.10 (t, 3H)

Mass Spectral Analysis *m/z* = 560.2 $(M+H)^+$

Preparation of **15C**:

A 2.0M anhydrous solution of hydrochloric acid in diethyl ether (10 mL) was added drop wise to a cold (0°C) solution of **15.2a** (0.520 g, 0.00092 mol, 1.0 eq) in anhydrous dichloromethane (10 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10h at room temperature. An additional amount of a 2.0M anhydrous solution of hydrochloric acid in diethyl ether (10 mL) was added to the mixture, which was stirred for an additional 6h at room temperature. The mixture was concentrated under reduced pressure and diethyl ether was added. The resulting precipitate was collected by filtration and washed with diethyl ether.
Yield: 70%

^{1}H NMR (400MHz, DMSO d_6) δ 8.80 (m, 1H), 8.15 (d, 2H), 7.60 (d, 2H), 7.25 (m, 1H), 7.00 (m, 3H), 6.00 (s, 1H), 4.80 (t, 2H), 4.00 (q, 2H), 3.35 (m, 2H), 3.20 (m, 2H), 2.40 (m, 2H), 2.20 (m, 2H), 2.10 (m, 2H), 1.95 (m, 2H), 1.15 (t, 3H)

Mass Spectral Analysis *m/z* = 460.2 $(M+H)^+$

EXAMPLE 15D

15D was obtained according to a procedure similar to the one described for **15C**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1d**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.90 (brm, 1.5H), 8.14 (d, 2H), 7.57 (d, 2H), 7.28 (t, 1H), 7.04 (m, 2H), 6.96 (m, 1H), 6.00 (s, 1H), 4.78 (t, 2H), 4.04 (q, 2H), 3.22 (brm, 4H), 2.37 (t, 2H), 2.11 (brm, 2H), 2.01 (brm, 4H), 1.57 (m, 2H), 1.16 (t, 3H)

Mass Spectral Analysis *m/z* = 474.2 $(M+H)^+$

EXAMPLE 15E

15E was obtained according to a procedure similar to the one described for **15C**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1e**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.88 (brm, 1.5H), 8.14 (d, 2H), 7.57 (d, 2H), 7.28 (t, 1H), 7.05 (m, 2H), 6.96 (m, 1H), 6.00 (s, 1H), 4.76 (t, 2H), 4.02 (q, 2H), 3.22 (brm, 4H), 2.29 (t, 2H), 2.10 (brm, 2H), 2.00 (brm, 4H), 1.57 (m, 2H), 1.30 (m, 2H), 1.14 (t, 3H)

Mass Spectral Analysis *m/z* = 488.2 $(M+H)^+$

EXAMPLE 15F

15F was obtained according to a procedure similar to the one described for **15H**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1a**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.86 (brm, 1H), 7.84 (d, 2H), 7.62 (d, 2H), 7.29 (m, 1H), 7.07 (d, 1H), 6.99 (m, 2H), 6.03 (s, 1H), 5.71 (s, 2H), 3.70 (s, 3H), 3.23 (m, 4H), 2.11 (brm, 2H), 2.00 (brm, 2H)

Mass Spectral Analysis *m/z* = 418.2 $(M+H)^+$

EXAMPLE 15G

15G was obtained according to a procedure similar to the one described for **15H**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1b**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.78 (brm, 1H), 7.91 (d, 2H), 7.64 (d, 2H), 7.29 (m, 1H), 7.05 (m, 2H), 6.98 (m, 1H), 6.04 (s, 1H), 4.71 (t, 2H), 3.56 (s, 3H), 3.23 (m, 4H), 3.11 (t, 2H), 2.12 (brm, 2H), 2.00 (brm, 2H)

Mass Spectral Analysis *m/z* = 432.1 $(M+H)^+$

EXAMPLE 15H

Preparation of **15H**

A 2.0M anhydrous solution of hydrochloric acid in diethyl ether (10 mL) was added drop wise to a cold (0°C) solution of **15.3a** (0.030 g, 0.000053 mol, 1.0 eq) in anhydrous dichloromethane (10 mL). The mixture was warmed to room temperature

and stirring was continued for an additional 10h at room temperature. An additional amount of a 2.0M anhydrous solution of hydrochloric acid in diethyl ether (10 mL) was added to the mixture, which was stirred for an additional 6h at room temperature. The mixture was concentrated under reduced pressure and diethyl ether was added. The resulting precipitate was collected by filtration and washed with diethyl ether.
Yield: 57%

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (m, 1.5H), 7.90 (d, 2H), 7.62 (d, 2H), 7.30 (m, 1H), 7.05 (m, 2H), 6.95 (m, 1H), 6.00 (s, 1H), 4.60 (t, 2H), 4.00 (q, 2H), 3.25 (m, 4H), 2.40 (m, 2H), 2.10 (m, 6H), 1.15 (t, 3H)

Mass Spectral Analysis *m/z* = 460.2 $(M+H)^+$

EXAMPLE 15I

15I was obtained according to a procedure similar to the one described for **15H**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1d**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.96 (brm, 1.5H), 7.89 (d, 2H), 7.63 (d, 2H), 7.29 (t, 1H), 7.06 (m, 2H), 6.97 (m, 1H), 6.03 (s, 1H), 4.55 (t, 2H), 4.01 (q, 2H), 3.22 (brm, 4H), 2.29 (t, 2H), 2.12 (brm, 2H), 2.02 (brm, 2H), 1.85 (m, 2H), 1.49 (m, 2H), 1.13 (t, 3H)

Mass Spectral Analysis *m/z* = 474.3 $(M+H)^+$

EXAMPLE 15J

15J was obtained according to a procedure similar to the one described for **15H**, with the following exception:

Step 15.1: **15.1c** was replaced by **15.1e**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.93 (brm, 1H), 7.87 (d, 2H), 7.62 (d, 2H), 7.29 (t, 1H), 7.05 (m, 2H), 6.97 (m, 1H), 6.03 (s, 1H), 4.52 (t, 2H), 4.01 (q, 2H), 3.23 (brm, 4H), 2.22 (t, 2H), 2.11 (brm, 2H), 2.02 (brm, 2H), 1.83 (m, 2H), 1.47 (m, 2H), 1.23 (m, 2H), 1.14 (t, 3H)

Mass Spectral Analysis *m/z* = 488.3 $(M+H)^+$

EXAMPLE 15K

15K was obtained according to a procedure similar to the one described for **15L**, with the following exception:

Step 15.6: **15C** was replaced by **15A**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.18 (d, 2H), 7.60 (d, 2H), 7.29 (t, 1H), 7.06 (t, 2H), 6.97 (m, 1H), 6.02 (s, 1H), 5.80 (s, 2H), 3.27 (brm, 4H), 2.13 (brm, 2H), 2.00 (brm, 2H)

Mass Spectral Analysis *m/z* = 404.1 $(M+H)^+$

EXAMPLE 15L

Preparation of **15L**

A 2N aqueous solution of sodium hydroxide (1.8 mL, 0.0036 mol, 5.5 eq) was added to a solution of **15C** (0.300 g, 0.00060 mol, 1.0 eq) in tetrahydrofuran (10 mL) and absolute ethanol (1 mL). The mixture was stirred for 10h at room temperature and acidified to pH 6 using a 2N aqueous solution of hydrochloric acid. The mixture was concentrated under reduced pressure and diethyl ether was added. The mixture was then stirred for 1h at room temperature. The resulting precipitate was collected by filtration and washed several times with water and diethyl ether.

Yield: 98%

^{1}H NMR (400MHz, DMSO d_6 + CF_3CO_2D) δ 8.80 (m, 1H), 8.20 (m, 2H), 7.70 (m, 2H), 7.30 (m, 1H), 7.00 (m, 3H), 6.00 (s, 1H), 4.80 (m, 2H), 3.30 (m, 4H), 2.60-1.95 (m, 8H)

Mass Spectral Analysis *m/z* = 432.1 $(M+H)^+$

EXAMPLE 15M

15M was obtained according to a procedure similar to the one described for **15L**, with the following exception:

Step 15.6: **15C** was replaced by **15D**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.76 (brm 1H), 8.16 (d, 2H), 7.58 (d, 2H), 7.29 (t, 1H), 7.06 (t, 2H), 6.97 (m, 1H), 6.00 (s, 1H), 4.78 (t, 2H), 3.24 (m, 4H), 2.31 (t, 2H), 2.13 (brm, 2H), 2.01 (brm, 4H), 1.56 (m, 2H)

Mass Spectral Analysis *m/z* = 446.2 $(M+H)^+$

EXAMPLE 15N

15N was obtained according to a procedure similar to the one described for **15L**, with the following exception:

Step 15.6: **15C** was replaced by **15E**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.62 (brm, 1.5H), 8.15 (d, 2H), 7.57 (d, 2H), 7.28 (m, 1H), 7.05 (m, 2H), 6.97 (m, 1H), 6.00 (s, 1H), 4.76 (t, 2H), 3.25 (brm, 4H), 2.21 (t, 2H), 2.11 (brm, 2H), 1.98 (brm, 4H), 1.55 (m, 2H), 1.31 (m, 2H)

Mass Spectral Analysis *m/z* = 460.2 $(M+H)^+$

EXAMPLE 16A

16A was obtained according to a procedure similar to the one described for **14A**, with the following exception:

Step 14.1: **14.1** was replaced by **16.1** (see also step 16.1).

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (brs, 2H), 8.12 (t, 2H), 7.70 (t, 1H), 7.60 (t, 1H), 7.25 (t, 1H), 7.00 (m, 3H), 6.00 (s, 1H), 3.30 (m, 4H), 2.05 (m, 4H)

Mass Spectral Analysis *m/z* = 346.1 $(M+H)^+$

EXAMPLE 16B

16B was obtained according to a procedure similar to the one described for **14B**, with the following exception:

Step 14.1: **14.1** was replaced by **16.1** (see also step 16.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.66 (brm, 2H), 8.11 (m, 1H), 8.01 (m, 1H), 7.66 (t, 1H), 7.54 (m, 1H), 7.28 (m, 1H), 7.06 (d, 1H), 6.97 (m, 2H), 6.00 (s, 1H), 4.43 (s, 3H), 3.23 (brm, 4H), 2.12 (brm, 2H), 2.00 (brm, 2H)

Mass Spectral Analysis *m/z* = 360.1 $(M+H)^+$

EXAMPLE 16C

16C was obtained according to a procedure similar to the one described for **14C**, with the following exception:

Step 14.1: **14.1** was replaced by **16.1** (see also step 16.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.73 (brm, 2H), 7.91 (m, 1H), 7.83 (t, 1H), 7.72 (t, 1H), 7.03 (m, 1H), 7.28 (m, 1H), 7.05 (m, 2H), 6.96 (m, 1H), 6.02 (s, 1H), 4.20 (s, 3H), 3.23 (brm, 4H), 2.11 (brm, 2H), 1.99 (brm, 2H)

Mass Spectral Analysis *m/z* = 360.1 $(M+H)^+$

EXAMPLE 17A

17A was obtained according to a procedure similar to the one described for **15A**, with the following exception:

Step 15.1: **14.4** was replaced by **16.3** (see also step 17.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.93 (brs, 1.5H), 8.13 (m, 1H), 8.03 (t, 1H), 7.68 (t, 1H), 7.56 (m, 1H), 7.28 (m, 1H), 7.07 (m, 1H), 6.97 (m, 2H), 6.01 (s, 1H), 5.94 (s, 2H), 3.75 (s, 3H), 3.22 (brm, 4H), 2.12 (brm, 2H), 2.02 (brm, 2H)

Mass Spectral Analysis *m/z* = 418.1 $(M+H)^+$

EXAMPLE 17B

17B was obtained according to a procedure similar to the one described for **15C**, with the following exception:

Step 15.1: **14.4** was replaced by **16.3** (see also step 17.1).

^{1}H NMR (400MHz, DMSO d_6) δ 9.07 (brs, 2H), 8.11 (m, 1H), 8.01 (t, 1H), 7.66 (t, 1H), 7.54 (m, 1H), 7.28 (m, 1H), 7.07 (dd, 1H), 6.96 (m, 2H), 5.99 (s, 1H), 4.79 (t, 2H), 4.03 (q, 2H), 3.22 (brm, 4H), 2.42 (t, 2H), 2.21 (m, 2H), 2.09 (brm, 4H), 1.16 (t, 3H)

Mass Spectral Analysis *m/z* = 460.2 $(M+H)^+$

EXAMPLE 17C

17C was obtained according to a procedure similar to the one described for **15F**, with the following exceptions:

Step 15.1: **14.4** was replaced by **16.3** (see also step 17.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.95 (brs, 2H), 7.80 (m, 1H), 7.69 (m, 3H), 7.28 (m, 1H), 7.06 (d, 1H), 6.97 (m, 2H), 5.99 (s, 1H), 5.70 (s, 2H), 3.64 (s, 3H), 3.23 (brm, 4H), 2.10 (brm, 2H), 2.01 (brm, 2H)

Mass Spectral Analysis *m/z* = 418.1 $(M+H)^+$

EXAMPLE 17D

17D was obtained according to a procedure similar to the one described for **15C**, with the following exceptions:

Step 15.1: **14.4** was replaced by **16.3** (see also step 17.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.37 (dt, 1H), 8.30 (t, 1H), 7.81 (t, 1H), 7.71 (dt, 1H), 7.44 (m, 1H), 7.22 (m, 2H), 7.10 (m, 1H), 5.98 (s, 1H), 5.47 (t, 2H), 4.22 (brs, 2H), 4.15 (t, 2H), 4.02-3.46 (brm, 10H), 2.48 (brm, 2H), 2.22 (brm, 2H)

Mass Spectral Analysis *m/z* = 459.2 $(M+H)^+$

EXAMPLE 17E

17E was obtained according to a procedure similar to the one described for **15K**, with the following exceptions:

Step 15.1: **14.4** was replaced by **16.3** (see also step 17.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.87 (brm, 2H), 8.13 (dt, 1H), 8.03 (t, 1H), 7.68 (t, 1H), 7.56 (m, 1H), 7.28 (m, 1H), 7.07 (d, 1H), 6.98 (m, 2H), 6.01 (s, 1H), 5.77 (s, 2H), 3.24 (brm, 4H), 2.12 (brm, 2H), 2.02 (brm, 2H)

Mass Spectral Analysis *m/z* = 404.1 $(M+H)^+$

EXAMPLE 17F

17F was obtained according to a procedure similar to the one described for **15L**, with the following exception:

Step 15.1: **14.4** was replaced by **16.3** (see also step 17.1).

^{1}H NMR (400MHz, DMSO d_6) δ 8.11 (dt, 1H), 8.01 (m, 1H), 7.66 (t, 1H), 7.54 (dt, 1H), 7.28 (m, 1H), 7.07 (d, 1H), 6.97 (m, 2H), 5.99 (s, 1H), 4.78 (t, 2H), 3.21 (brm, 4H), 2.34 (t, 2H), 2.18 (m, 2H), 2.10 (brm, 4H)

Mass Spectral Analysis *m/z* = 432.1 $(M+H)^+$

EXAMPLE 18A

Preparation of **18.2**:

A mixture of **13.5a** (0.300g, 0.00071 mole, 1.0 eq), and the Lawesson's reagent (**18.1**) (0.288g, 0.00071 mole, 1 eq) in toluene (10 mL) was refluxed for 6h. The mixture

was cooled to room temperature, poured onto a saturated aqueous solution of sodium bicarbonate (50 mL) and extracted with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. Diethyl ether was added to the mixture, which was stirred at room temperature for 1h. The resulting precipitate was collected by filtration, washed with diethyl ether and used for the next step without further purification.

Yield: 64%

Mass Spectral Analysis *m/z* = 434.93 $(M-H)^-$

Preparation of **18.4a**:

A mixture of **18.2** (1g, 0.0022 mole, 1.0 eq) and 1-bromopinacolone (**18.3a**) (0.30 mL, 0.0022 mole, 1.0 eq) in *N*,*N*-dimethylformamide (5 mL) was stirred at room temperature for 48h. The mixture was poured into a saturated aqueous solution of sodium bicarbonate and extracted with ethyl acetate. The organic phase was washed with brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by flash column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 55%

^{1}H NMR (400MHz, DMSO d_6) δ 8.00 (d, 2H), 7.45 (d, 2H), 7.35 (s, 1H), 7.20 (t, 1H), 7.00 (d, 2H), 6.90 (t, 1H), 5.90 (s, 1H), 3.70 (m, 2H), 3.30 (m, 2H), 1.90 (m, 2H), 1.70 (m, 2H), 1.30 (s, 9H), 1.35 (s, 9H)

Mass Spectral Analysis *m/z* = 517.2 $(M+H)^+$

Preparation of **18A**:

To a cold (0°C) solution of **18.4a** (0.600g, 0.0011 mole, 1.0 eq) in anhydrous dichloromethane (20 mL) was added drop wise a 2.0M solution of anhydrous hydrochloric acid in diethyl ether (5.8 mL, 0.0011 mole, 10.0 eq). The mixture was warmed slowly to room temperature and stirring was continued for 12h. The mixture was concentrated under reduced pressure. Diethyl ether was then added to the mixture, which was stirred for 1h at room temperature. The precipitate was collected by filtration, washed with diethyl ether and dried under vacuum.

Yield: 80%

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (s, 2H), 8.00 (d, 2H), 7.50 (d, 2H), 7.40 (s, 1H), 7.25 (t, 1H), 7.00 (m, 3H), 6.00 (s, 1H), 3.20 (m, 4H), 2.00 (m, 4H), 1.30 (s, 9H)

Mass Spectral Analysis *m/z* = 417.3 $(M+H)^+$

EXAMPLE 18B

18B was obtained according to a procedure similar to the one described for **18A**, with the following exception:

Step 18.3: **18.3a** was replaced by **18.3b**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.93 (brs, 2H), 8.24 (s, 1H), 8.10 (m, 4H), 7.52 (m, 4H), 7.40 (m, 1H), 7.29 (m, 1H), 7.06 (t, 2H), 6.97 (m, 1H), 6.00 (s, 1H), 3.22 (brm, 4H), 2.07 (brm, 4H)

Mass Spectral Analysis *m/z* = 437.1 $(M+H)^+$

EXAMPLE 18C

Preparation of **18.6**:

A mixture of **14.2** (1g, 0.00248 mole, 1.0 eq), hydroxylamine hydrochloride (**18.5**) (0.260g, 0.0037 mole, 1.5 eq.) and triethylamine (0.70 mL, 0.0049 mole, 2.0 eq) in absolute ethanol (15 mL) was refluxed for 6h. The mixture was cooled to room temperature and poured onto water. The resulting precipitate was collected by filtration, washed with water, dried under high vacuum and used for the next step without further purification.

Yield: 75%

Mass Spectral Analysis *m/z* = 436.2 $(M+H)^+$

Preparation of **18.7**

Acetyl chloride (**6.7**) (0.07 mL, 0.00097 mol, 2.0 eq) was added drop wise to a refluxing solution of **18.6** (0.212g, 0.00048 mole, 1.0 eq) in pyridine (2 mL). The mixture was heated to reflux for 3h. The mixture was cooled to room temperature, poured onto a saturated aqueous solution of sodium bicarbonate and extracted with ethyl acetate. The organic phase was washed with a 1N aqueous solution of

hydrochloric acid and brine, dried over sodium sulfate and filtered. The organics were concentrated under reduced pressure and the crude product was purified by flash column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 35%

^{1}H NMR (400MHz, $CDCl_3$) δ 8.10 (d, 2H), 7.45 (d, 2H), 7.20 (m, 1H), 7.00 (m, 1H), 6.95 (m, 1H), 6.85 (m, 1H), 5.60 (s, 1H), 3.90 (m, 2H), 3.35 (m, 2H), 2.65 (s, 3H), 2.05 (d, 2H), 1.70 (m, 2H), 1.55 (s, 4H), 1.40 (s, 5H)

Mass Spectral Analysis *m/z* = 460.1 $(M+H)^+$

Preparation of **18C**

To a cold (0°C) solution of **18.7** (0.300g, 0.00065 mole, 1.0 eq) in anhydrous dichloromethane (20 mL) was added drop wise a 2.0M solution of anhydrous hydrochloric acid in diethyl ether (3.2 mL, 0.0065 mole, 10.0 eq). The mixture was warmed slowly to room temperature and stirring was continued for 12h. The mixture was concentrated under reduced pressure. Diethyl ether was then added to the mixture, which was stirred for 1h at room temperature. The precipitate was collected by filtration, washed with diethyl ether and dried under vacuum.

Yield: 60%

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (m, 2H), 8.10 (m, 2H), 7.60 (m, 2H), 7.30 (m, 1H), 7.05 (m, 3H), 6.00 (s, 1H), 3.30 (m, 4H), 2.45-2.80 (m, 3H), 2.10 (m, 4H)

Mass Spectral Analysis *m/z* = 360.3 $(M+H)^+$

EXAMPLE 19A

Preparation of **19.2**:

To a solution of **19.1** (29.75 g, 127.5 mmol, 1.2 eq) in dry methanol (200 mL) was added pyrrolidine (17.6 mL, 212.6 mmol, 2.0 eq) followed by 2'-hydroxyacetophenone (**1.1a**) (12.8 mL, 106.3 mmol, 1.0 eq). The mixture was heated under reflux for 10h. The volatiles were removed under reduced pressure and the residue was dissolved in ethyl acetate (500 mL), washed with a 1M aqueous solution of hydrochloric acid (3 x 200 mL), a 1M aqueous solution of sodium hydroxide (3 x

200 mL) and brine. The organics were dried over sodium sulfate, filtered and concentrated under reduced pressure to give the crude product, which was used in the next step without further purification.

^{1}H NMR (400MHz, $CDCl_3$) δ 7.86 (dd, 1H), 7.50 (m, 1H), 7.42-7.29 (m, 5H), 7.00 (m, 2H), 5.14 (s, 2H), 3.97 (brs, 2H), 3.29 (brs, 2H), 2.71 (s, 2H), 2.04 (m, 2H), 1.61 (m, 2H)

Mass Spectral Analysis *m/z* = 352.1 $(M+H)^+$

Preparation of **19.3**:

Under nitrogen, to an oven-dried two-necked 1L flask charged with a solution of **19.2** (45.4 g, as of 106.3 mmol, 1.0 eq) in dry tetrahydrofuran (350 mL) at -78°C was added a solution of 1.0M solution of lithium bis(trimethylsilyl)amide in tetrahydrofuran (127.6 mL, 127.6 mmol, 1.2 eq) over a 45 min time period. The reaction mixture was kept at -78°C for 1h and a solution of *N*-phenylbis(trifluoromethanesulfonamide) (**1.4**) (45.57 g, 127.6 mmol, 1.2 eq) in tetrahydrofuran (150 mL) was added over a 45 min time period. The reaction mixture was kept at -78°C for 1h, then slowly warmed up to room temperature and stirred for an additional 10h at room temperature. Ice water (300 mL) was added to quench the reaction and the product was extracted with diethyl ether (500 mL). The organic phase was then washed with a 1M aqueous solution of hydrochloric acid (3 x 150 mL), a 1M aqueous solution of sodium hydroxide (3 x 150 mL), and brine, dried over sodium sulfate and filtered. The organics were concentrated under reduced pressure to give the crude product, which was used for the next step without further purification.

Mass Spectral Analysis *m/z* = 484.0 $(M+H)^+$

Preparation of **19.4**:

To a solution of **1.14** (53.58 g, 212.6 mmol, 2.0 eq) in *N,N*-dimethylformamide (200 mL) at 0°C was added potassium acetate (31.3 g, 318.9 mmol, 3.0 eq), 1,1'-bis(diphenylphosphino)ferrocene palladium(II) chloride complex with dichloromethane (2.33 g, 3.19 mmol, 0.03 eq). The reaction mixture was heated to 80°C at which point a solution of **19.3** (60 g, crude, as of 106.3 mmol, 1.0 eq) in *N,N* -

dimethylformamide (100 mL) was added to the reaction mixture over a 30 min time period. The reaction mixture was then stirred at 80°C for 10h. Diethyl ether (500 mL) and water (300 mL) were added and the two phases were separated. The organic phase was washed with a 1M aqueous solution of hydrochloric acid (2 x 150 mL) and brine, dried over sodium sulfate and filtered. The organics were concentrated under reduced pressure and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 75 % over three steps

^{1}H NMR (400MHz, $CDCl_3$) δ 7.71 (dd, 1H), 7.43-7.28 (m, 5H), 7.11 (m, 1H), 6.90 (m, 1H), 6.82 (dd, 1H), 6.27 (s, 1H), 5.14 (s, 2H), 3.94 (brs, 2H), 3.34 (brs, 2H), 1.96 (m, 2H), 1.61 (m, 2H), 1.33 (s, 12H)

Mass Spectral Analysis *m/z* = 462.2 $(M+H)^+$

Preparation of **19.6**:

To a solution of *tert*-butyl 4-bromophenylcarbamate (**19.5**) (20.7 g, 76 mmol, 1.04 eq) in dimethoxyethane (200 mL) was added sequentially a 2M aqueous solution of sodium carbonate (109.5 mL, 210 mmol, 3.0 eq), lithium chloride (9.28 g, 210 mmol, 3.0 eq), tetrakis(triphenylphosphine)palladium(0) (1.69 g, 1.46 mmol, 0.02 eq), and **19.4** (33.7 g, 73 mmol, 1.0 eq) under nitrogen. The reaction mixture was heated under reflux for 10h. Water (500 mL) and diethyl ether (300 mL) were added and the two phases were separated. The organic phase was washed with brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting foamy solids were soaked with hexane and the fine powders were collected by filtration.

Yield: 91%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.43-7.30 (m, 7H), 7.28-7.23 (m, 2H), 7.17 (m, 1H), 7.02 (m, 1H), 6.92 (m, 1H), 6.85 (m, 1H), 6.53 (s, 1H), 5.50 (s, 1H), 5.15 (s, 2H), 3.96 (brs, 2H), 3.40 (brs, 2H), 2.06 (m, 2H), 1.67 (m, 2H), 1 53 (s, 9H)

Mass Spectral Analysis *m/z* = 527.4 $(M+H)^+$

Preparation of **19.7**:

To a cold (0°C) solution of **19.6** (35.5 g, 67 mmol, 1.0 eq) in anhydrous dichloromethane (150 mL) was slowly added a 2.0M solution of hydrogen chloride in diethyl ether (167.5 mL, 335 mmol, 5.0 eq). The reaction mixture was stirred at room temperature for 10h and then concentrated under reduced pressure. The resulting foamy solids were soaked in diethyl ether and the fine powders were collected by filtration. This crude product was used for the next steps without further purification.
Mass Spectral Analysis $m/z = 427.3\ (M+H)^+$

Preparation of **19.9a**:

To a suspension of **19.7** (1.28 g, crude, as of 3 mmol, 1.0 eq) in dry dichloromethane (80 mL) at 0°C was slowly added triethylamine (2.1 mL, 15 mmol, 5.0 eq) followed by drop wise addition of isobutyryl chloride (**19.8a**) (0.48 mL, 4.5 mmol, 1.5 eq). The mixture was slowly warmed to room temperature and stirred for 10h at room temperature. Dichloromethane (100 mL) was added and the mixture was washed with a 1N aqueous solution of hydrochloric acid (3 x 50 mL), a saturated aqueous solution of sodium bicarbonate (2 x 50 mL) and brine, dried over sodium sulfate and filtered. The crude product was concentrated under reduced pressure and purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 81 % over two steps
^{1}H NMR (400MHz, $CDCl_3$) δ 7.57 (d, 2H), 7.40-7.27 (m, 8H), 7.17 (m, 1H), 7.01 (d, 1H), 6.93 (d, 1H), 6.85 (m, 1H), 5.50 (s, 1H), 5.15 (s, 2H), 3.96 (brs, 2H), 3.41 (brs, 2H), 2.53 (m, 1H), 2.06 (m, 2H), 1.67 (m, 2H), 1.28 (d, 6H)
Mass Spectral Analysis $m/z = 467.3\ (M+H)^+$

Preparation of **19A**

To a stirred solution of **19.9a** (1.2 g, 2.44 mmol, 1.0 eq) in dry dichloromethane (20 mL) was added iodotrimethylsilane (0.66 mL, 4.89 mmol, 2.0 eq) drop wise. After stirring at room temperature for 1h, the mixture was concentrated to dryness under reduced pressure. A 1N aqueous solution of hydrochloric acid (300 mL) and diethyl ether (200 mL) were added to the residue. The resulting solid was collected by filtration, washed with diethyl ether, and dried under vacuum.
Yield: 92 %

^{1}H NMR (400MHz, DMSO d_6) δ 10.02 (s, 1H), 8.98 (brs, 2H), 7.70 (d, 2H), 7.36-7.22 (m, 3H), 7.02 (m, 2H), 6.94 (m, 1H), 5.82 (s, 1H), 3.21 (m, 4H), 2.63 (m, 1H), 2.03 (m, 4H), 1.11 (d, 6H)

Mass Spectral Analysis *m/z* = 363.4 $(M+H)^+$

EXAMPLE 19B

19B was obtained according to a procedure similar to the one described for **19A**, with the following exception:

Step 19.6: **19.8a** was replaced by **19.8b**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.04 (s, 1H), 8.90 (m, 2H), 7.71 (m, 2H), 7.29 (m, 2H), 7.25 (m, 1H), 7.03 (m, 2H), 6.94 (m, 1H), 5.82 (s, 1H), 3.44-3.11 (m, 4H), 2.25 (m, 1H), 2.02 (m, 4H), 1.51 (m, 4H), 0.86 (t, 6H)

Mass Spectral Analysis *m/z* = 391.4 $(M+H)^+$

EXAMPLE 19C

Preparation of **19.10**:

To a solution of **19.7** (4.63 g, crude, as of 10 mmol, 1.0 eq) in dry pyridine (10 mL) at 0°C was slowly added isopropylsulfonyl chloride (**6.5b**) (1.68 mL, 15 mmol, 1.5 eq). The reaction mixture was stirred at room temperature for 10h. Pyridine was removed under reduced pressure and the residue was dissolved in ethyl acetate (200 mL). The solution was washed with a 1M aqueous solution of hydrochloric acid (5 x 50 mL) and brine, dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 55 % over two steps

^{1}H NMR (400MHz, $CDCl_3$) δ 7.43-7.16 (m, 10H), 6.99 (dd, 1H), 6.94 (dd, 1H), 6.86 (m, 1H), 6.60 (s, 1H), 5.51 (s, 1H), 5.15 (s, 2H), 3.96 (brs, 2H), 3.49-3.30 (m, 3H), 2.06 (m, 2H), 1.67 (m, 2H), 1.43 (d, 6H)

Mass Spectral Analysis *m/z* = 533.3 $(M+H)^+$

Preparation of **19C**:

To a stirred solution of **19.9a** (1.37 g, 2.57 mmol, 1.0 eq) in dry dichloromethane (20 mL) was added iodotrimethylsilane (0.70 mL, 5.14 mmol, 2.0 eq) dropwise. The mixture was stirred at room temperature for 1h and then concentrated under reduced pressure. To the residue was added a 1M aqueous solution of hydrochloric acid (300 mL) and diethyl ether (200 mL). The resulting solid was collected by filtration and washed with diethyl ether. The crude compound was further purified by preparative liquid chromatography (mobile phase: acetonitrile/water/trifluoroacetic acid). The desired fractions were combined, concentrated under reduced pressure, and dried unde vacuum.

Yield: 66%

^{1}H NMR (400MHz, DMSO d_6) δ 9.93 (brs, 1H), 8.67 (brs, 2H), 7.36-7.22 (m, 5H), 7.05-6.91 (m, 3H), 5.83 (s, 1H), 3.32-3.14 (m, 5H), 2.06 (m, 2H), 1.93 (m, 2H), 1.26 (d, 6H)

Mass Spectral Analysis *m/z* = 399.3 $(M+H)^+$

EXAMPLE 19D

Preparation of **19.12**:

To a solution of **19.7** (1.28 g, crude, as of 2.67 mmol, 1.0 eq) in dry pyridine (15 mL) at 0°C was slowly added ethyl isocyanate (**19.11**) (0.33mL, 4.15 mmol, 1.5 eq). The reaction mixture was stirred at room temperature for 10h. Pyridine was removed under reduced pressure and the residue was partitioned between water (100 mL) and dichlorometnane (200 mL). The organic layer was washed with brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 78 % over two steps

^{1}H NMR (400MHz, $CDCl_3$) δ 7.44-7.12 (m, 10H), 7.05-6.79 (m, 4H), 5.45 (s, 1H), 5.16 (m, 3H), 3.95 (brs, 2H), 3.50-3.26 (m, 4H), 2.04 (m, 2H), 1.65 (m, 2H), 1.16 (t, 3H)

Mass Spectral Analysis *m/z* = 498.4 $(M+H)^+$

Preparation of **19D**:

To a stirred solution of **19.12** (1.03 g, 2.09 mmol, 1.0 eq) in dry dichloromethane (20 mL) was added iodotrimethylsilane (0.57 mL, 4.18 mmol, 2.0 eq) drop wise. The reaction mixture was stirred at room temperature for 1h and then concentrated under reduced pressure. The residue was suspended in methanol (50 mL) and stirred for another 1h at room temperature. The resulting solid was collected by filtration and washed with methanol. The solid was further washed with a 1M aqueous solution of sodium hydroxide (3 x 10 mL) and water (2 x 10mL), and then dried under vacuum.

Yield: 60%

^{1}H NMR (400MHz, DMSO d_6) δ 8.54 (s, 1H), 7.44 (d, 2H), 7.18 (m, 3H), 6.98 (m, 1H), 6.91 (m, 1H), 6.86 (m, 1H), 6.13 (t, 1H), 5.72 (s, 1H), 3.11 (m, 2H), 2.89 (m, 2H), 2.74 (m, 2H), 1.77 (m, 2H), 1.67 (m, 2H), 1.06 (t, 3H)

Mass Spectral Analysis *m/z* = 364.4 $(M+H)^+$

EXAMPLE 20A

Preparation of **20A**:

Triethylamine (0.37 mL, 2.66 mmol, 2.2 eq) was added to a solution of **1A** (0.50 g, 1.21 mmol, 1.0 eq) in anhydrous tetrahydrofuran (4 mL). Anhydrous methanol (4 mL) was then added followed by **20.1a** (0.20 mL, 2.42 mmol, 2.0 eq). Sodium cyanoborohydride (0.09 g, 1.45 mmol, 1.2 eq) was added to the reaction mixture which was stirred for 30 min at room temperature under nitrogen. The mixture was concentrated under reduced pressure. Dichloromethane (30 mL) and water (10 mL) were added and the suspension was stirred at room temperature for 10 min. The phases were separated. The organic phase was further washed with water and brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added drop wise a 2.0M solution of anhydrous hydrochloric acid in diethyl ether (5 mL). The mixture was then stirred for 1h at room temperature and concentrated under reduced pressure. Diethyl ether was added. The resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 65%

^{1}H NMR (400MHz, DMSO d_6) δ 10.63 (brs, 0.25H), 10.50 (brs, 0.75H), 7.42 (m, 4H), 7.28 (m, 1H), 7.08 (d, 1H), 6.98 (m, 2H), 6.27 (s, 0.25H), 5.85 (s, 0.75H), 3.37 (brm, 8H), 2.82 (s, 3H), 2.11 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 391.2 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_2$, 1HCl, 0.9H_2O

Theory: %C 67.75; %H 7.46; %N 6.32

Found: %C 67.89; %H 7.32; %N 6.26

EXAMPLE 20B

20B was obtained according to a procedure similar to the one described for **20A**, with the following exception:

Step 20.1: **1A** was replaced by **11A**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.42 (brs, 1H), 9.47 (s, 1H), 7.30 (m, 4H), 7.08 (t, 1H), 6.60 (d, 1H), 6.46 (d, 1H), 5.68 (s, 1H), 3.40 (m, 4H), 3.30 (s, 3H), 3.20 (m, 2H), 2.81 (s, 2H), 2.15 (m, 2H), 2.05 (m, 2H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 407.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_3$, 1HCl, 0.5H_2O

Theory: %C 66.43; %H 7.14; %N 6.20

Found: %C 66.53; %H 7.06; %N 6.24

EXAMPLE 20C

20C was obtained according to a procedure similar to the one described for **20A**, with the following exception:

Step 20.1: **1A** was replaced by **11B**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.79 (brs, 1H), 9.74 (d, 1H), 8.41 (s, 1H), 7.69 (dd, 1H), 7.45 (d, 1H), 7.09 (t, 1H), 6.62 (d, 1H), 6.49 (d, 2H), 5.81 (s, 1H), 3.42 (m, 4H), 3.30 (m, 4H), 2.79 (d, 3H), 2.12 (m, 4H), 1.16 (m, 3H), 1.08 (m, 3H)

Mass Spectral Analysis *m/z* = 408.3 $(M+H)^+$

EXAMPLE 20D

20D was obtained according to a procedure similar to the one described for **20A**, with the following exception:

Step 20.1: **1A** was replaced by **3D**.

^{1}H NMR (400MHz, DMSO d_6) δ 11.00 (m, 0.25H), 10.85 (m, 0.75H), 7.80 (m, 2H), 7.54 (m, 1H), 7.40 (m, 4H), 7.22 (m, 1H), 7.10 (m, 0.75H), 7.02 (m, 0.25H), 6.32 (s, 0.25H), 5.91 (s, 0.75H), 3.33 (m, 10H), 2.80 (m, 2H), 2.20 (m, 3H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 434.4 $(M+H)^+$

Elemental analysis:

$C_{26}H_{31}N_3O_3$, 1HCl, $1H_2O$

Theory: %C 63.99; %H 7.02; %N 8.61

Found: %C 64.11; %H 6.70; %N 8.49

EXAMPLE 20E

20E was obtained according to a procedure similar to the one described for **20A**, with the following exception:

Step 20.1: **1A** was replaced by **3E**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.84 (m, 1H), 8.31 (m, 1H), 7.78 (m, 1H), 7.52 (m, 1H), 7.42 (m, 3H), 7.10 (m, 1H), 5.90 (s, 1H), 3.46 (m, 2H), 3.31 (m, 10H), 2.82 (m, 2H), 2.72 (m, 2H), 2.12 (m, 3H), 1.16 (m, 6H)

Mass Spectral Analysis *m/z* = 448.5 $(M+H)^+$

Elemental analysis:

$C_{27}H_{33}N_3O_3$, 1HCl, $1H_2O$

Theory: %C 64.59; %H 7.23; %N 8.37

Found: %C 64.77; %H 7.27; %N 8.40

EXAMPLE 20F

20F was obtained according to a procedure similar to the one described for **20A**, with the following exception:

Step 20.1: **1A** was replaced by **3F**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.80 (brs, 1H), 8.35 (m, 1H), 7.78 (m, 1H), 7.50 (m, 1H), 7.40 (m, 3H), 7.09 (m, 1H), 5.93 (s, 1H), 3.41 (m, 2H), 3.20 (m, 10H), 2.72 (m, 2H), 2.10 (m, 3H), 1.10 (m, 9H)

Mass Spectral Analysis *m/z* = 462.5 $(M+H)^+$

Elemental analysis:

$C_{28}H_{35}N_3O_3$, 1HCl, $1H_2O$

Theory: %C 65.17; %H 7.42; %N 8.14

Found: %C 65.28; %H 7.37; %N 8.21

EXAMPLE 20G

20G was obtained according to a procedure similar to the one described for **20A**, with the following exception:

Step 20.1: **1A** was replaced by **3V**.

^1H NMR (400MHz, $CDCl_3$) δ 8.57 (s, 1H), 7.70 (m, 2H), 7.66 (d, 1H), 7.38 (s, 1H), 7.02 (d, 1H), 5.70 (s, 1H), 3.61 (m, 2H), 3.46 (m, 2H), 2.62 (m, 2H), 2.52 (m 2H), 2.12 (m, 2H), 2.78 (m, 2H), 1.30 (t, 3H), 1.23 (t, 3H)

Mass Spectral Analysis *m/z* = 435.4 $(M+H)^+$

EXAMPLE 20H

20H was obtained according to a procedure similar to the one described for **20L**, with the following exception:

Step 20.1: **21A** was replaced by **4H** and **20.1d** was replaced by **20.1a**.

^1H NMR (400MHz, DMSO d_6) δ 10.44-10.12 (m, 1H), 7.74 (dd, 0.7H), 7.67 (dd, 0.7H), 7.45 (m, 5H), 7.27 (m, 3H), 6.38 (s, 0.3H), 6.00 (s, 0.7H), 3.53-3.16 (m, 8H), 2.84 (m, 3H), 2.35-2.03 (m, 4H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 470.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{31}N_3O_4S$, 1HCl, $1H_2O$

Theory: %C 57.30 %H 6.54 %N 8.02

Found: %C 57.46 %H 6.44 %N 7.96

EXAMPLE 20I

20I was obtained according to a procedure similar to the one described for **20L**, with the following exception:

Step 20.1: **20.1d** was replaced by **20.1a**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.62 (brs, 1H), 7.41 (m, 4H), 7.24 (m, 1H), 6.97 (m, 2H), 6.93 (m, 1H), 5.92 & 5.86 (2s, 1H, rotamer), 3.55–2.92 (m, 8H), 2.80 & 2.77 (d, 3H), 2.56-1.76 (m, 6H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 405.4 $(M+H)^+$

EXAMPLE 20J

20J was obtained according to a procedure similar to the one described for **20L**, with the following exception:

Step 20.1: **20.1d** was replaced by **20.1b**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.72 (m, 1H), 7.41 (m, 4H), 7.24 (m, 1H), 6.95 (m, 3H), 5.91 & 5.84 (2s, 1H, rotamer), 3.56-2.94 (m, 10H), 2.57-1.77 (m, 6H), 1.27 (m, 3H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 419.4 $(M+H)^+$

EXAMPLE 20K

20K was obtained according to a procedure similar to the one described for **20L**, with the following exception:

Step 20.1: **20.1d** was replaced by **20.1c**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.99 (m, 1H), 7.41 (m, 4H), 7.25 (m, 1H), 6.95 (m, 3H), 5.88 & 5.86 (2s, 1H rotamer), 3.70-2.93 (m, 10H), 2.57-1.76 (m, 7H), 1.12 (m, 6H), 0.99 (m, 6H)

Mass Spectral Analysis *m/z* = 447.5 $(M+H)^+$

EXAMPLE 20L

Preparation of **20L**:

To a stirred solution of cyclopropanecarbaldehyde (**20.1d**) (0.22 mL, 3.0 mmol, 2.0 eq) in dry dichloromethane (25 mL) was added sequentially **21A** (0.64 g, 1.5 mmol, 1.0 eq), acetic acid (0.10 mL, 1.8 mmol, 1.2 eq), and sodium cyanoborohydride (0.14 g, 2.25 mmol, 1.5 eq). The reaction mixture was stirred at room temperature for 10h. Water (40 mL) was added and the aqueous layer was basified to pH=10 with a 1M aqueous solution of sodium hydroxide. The two phases were separated and the aqueous phase was saturated with sodium chloride and extracted with

dichloromethane (3 x 50 mL). The combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in dichloromethane was added dropwise a 2.0M solution of hydrogen chloride in diethyl ether (1.0 mL, 2.0 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 65%

^{1}H NMR (400MHz, DMSO d_6) δ 10.66 (brs, 1H), 7.41 (m, 4H), 7.25 (m, 1H), 7.03-6.89 (m, 3H), 5.91 & 5.86 (2s, 1H, rotomer), 3.80-2.95 (m, 10H), 2.44-1.78 (m, 6H), 1.12 (m, 7H), 0.64 (m, 2H), 0.42 (m, 2H)

Mass Spectral Analysis *m/z* = 445.4 $(M+H)^+$

EXAMPLE 20M

Preparation of **20M**:

Triethylamine (0.98 mL, 7.00 mmol, 3.3 eq) was added to a solution of **1A** (0.80 g, 2.12 mmol, 1.0 eq) in anhydrous dichloromethane (5 mL). Compound **2.8a** (0.68 mL, 7.00 mmol, 3.3 eq) was then added to the reaction mixture, which was stirred overnight at room temperature under nitrogen. The mixture was concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity). To a solution of the purified product in dichloromethane (5 mL) was added at 0°C a 2.0 M solution of hydrochloric acid in diethyl ether (3.2mL, 1.16 mmol, 5.5 eq). Diethyl ether was added to the mixture. The resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 46%

^{1}H NMR (400MHz, DMSO d_6) δ 10.83 (m, 0.25H), 10.71 (m, 0.75H), 7.45 (m, 4H), 7.28 (m, 1H), 7.08 (m, 1H), 7.00 (m, 2H), 6.24 (s, 0.25H), 5.85 (s, 0.75H), 3.47 (m, 5H), 3.25 (m, 4H), 3.06 (m, 2H), 2.18 (m, 4H), 1.12 (m, 6H), 0.65 (m, 2H), 0.43 (m, 2H)

Mass Spectral Analysis *m/z* = 431.0 $(M+H)^+$

EXAMPLE 20N

20N was obtained according to a procedure similar to the one described for **20M**, with the following exception:

Step 20.1: **2.8a** was replaced by **20.2a**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.10 (m, 1H), 7.43 (m, 4H), 7.28 (m, 1H), 7.09 (m, 1H), 6.98 (m, 2H), 6.28 (s, 0.25H), 5.85 (s, 0.75H), 3.35 (brm, 10H), 2.15 (m, 4H), 1.28 (m, 3H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 405.0 $(M+H)^+$

EXAMPLE 20O

20O was obtained according to a procedure similar to the one described for **20M**, with the following exception:

Step 20.1: **2.8a** was replaced by **20.2b**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.18 (m, 1H), 7.45 (m, 4H), 7.29 (m, 1H), 7.09 (m, 1H), 6.98 (m, 2H), 6.25 (m, 0.25H), 5.84 (m, 0.75H), 3.41 (m, 4H), 3.21 (m, 4H), 3.09 (m, 2H), 2.16 (m, 4H), 1.75 (m, 2H), 1.11 (m, 6H), 0.91 (m, 3H)

Mass Spectral Analysis *m/z* = 419.1 $(M+H)^+$

EXAMPLE 20P

20P was obtained according to a procedure similar to the one described for **20M**, with the following exception:

Step 20.1: **2.8a** was replaced by **20.2c**.

^{1}H NMR (400MHz, $CDCl_3$) δ 7.35 (m, 9H), 7.17 (m, 1H), 6.98 (dd, 1H), 6.94 (dd, 1H), 6.84 (m, 1H), 5.61 (s, 1H), 3.58 (brs, 4H), 3.32 (brs, 2H), 2.60 (brm, 4H), 2.08 (brm, 2H), 1.81 (brm, 2H), 1.20 (brd, 6H)

Mass Spectral Analysis *m/z* = 467.3 $(M+H)^+$

EXAMPLE 20Q

20Q was obtained according to a procedure similar to the one described for **20M**, with the following exception:

Step 20.1: **2.8a** was replaced by **20.2d**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.95 (brs, 0.5H) 7.44 (m, 4H), 7.33 (m, 6H), 7.04 (d, 1H), 6.99 (m, 2H), 6.24 (s, 0.3H), 5.87 (s, 0.7H), 3.40 (brm, 10H), 3.12 (m, 2H), 2.18 (brm, 4H), 1.13 (brd, 6H)

Mass Spectral Analysis *m/z* = 481.3 $(M+H)^+$

EXAMPLE 20R

20R was obtained according to a procedure similar to the one described for **20M**, with the following exception:

Step 20.1: **2.8a** was replaced by **20.2e**.

^{1}H NMR (400MHz, DMSO d_6) δ 10.70 (brm, 0.50H), 7.43 (m, 4H), 7.28 (m, 6H), 7.08 (d, 1H), 6.97 (m, 2H), 6.36 (s, 0.3H), 5.83 (s, 0.7H), 3.44 (m, 4H), 3.18 (brm, 6H), 2.67 (t, 2H), 2.12 (brm, 6H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 495.3 $(M+H)^+$

EXAMPLE 21A

Preparation of **21.2**:

To a stirred solution of *N*-boc 4- piperidone (**1.2**) (2.0 g, 10 mmol, 1.0 eq) in dry diethyl ether (15 mL) at -25°C was simultaneously but independently added ethyl diazoacetate (**21.1**) (1.35 mL, 13 mmol, 1.3 eq) and boron trifluoride diethyl ether complex (1.33 mL, 10.5 mmol, 1.05 eq) under nitrogen atmosphere over a 20 min time period. The reaction mixture was stirred for another 1h at -25°C. A 1M aqueous solution of potassium carbonate was added drop wise to the stirred reaction mixture until gaseous evolution ceased. The two phases were separated and the organic phase was dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was used for the next step without further purification.

Preparation of **21.3**:

A mixture of the crude **21.2** (3 g, as of 10 mmol) in a 4M aqueous hydrochloric acid solution (50 mL) was heated under reflux for 6h. Water was removed under reduced pressure and the resulting solid was washed with diethyl ether and dried under vacuum.

Yield: 90% over two steps

^{1}H NMR (400MHz, DMSO d_6) δ 9.41 (brs, 2H), 3.30 (m, 2H), 3.21 (m, 2H), 2.77 (m, 2H), 2.62 (m, 2H), 1.94 (m, 2H)

Preparation of **21.4**:

To a suspension of **21.3** (4.98 g, 33.3 mmol, 1.0 eq) in dry dichloromethane (100 mL) at 0°C was slowly added triethylamine (11 mL, 79.92 mmol, 2.4 eq) followed by a solution of di-*tert*-butyl-dicarbonate (**4.7**) (8.72 g, 39.96 mmol, 1.2 eq) in dichloromethane (30 mL) over a 20 min time period. The reaction mixture was stirred at room temperature for 10h and washed with a 1M aqueous solution of hydrochloric acid (3 x 100 mL), brine, dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure and the crude product was used for next step without further purification.
^{1}H NMR (400MHz, $CDCl_3$) δ 3.58 (m, 4H), 2.65 (m, 4H), 1.78 (m, 2H), 1.45 (s, 9H)

Preparation of **21.5**:

To a solution of **21.4** (2.56 g, 12 mmol, 1.0 eq) in dry methanol (30 mL) was added pyrrolidine (2 mL, 24 mmol, 2.0 eq) followed by 2'-hydroxyacetophenone (**1.1a**) (1.44 mL, 12 mmol, 1.0 eq). The mixture was heated under reflux for 10h. The volatiles were removed under reduced pressure and the residue was dissolved in ethyl acetate (200 mL) and washed with a 1M aqueous solution of hydrochloric acid (3 x 50 mL), a 1M aqueous solution of sodium hydroxide (3 x 50 mL) and brine, dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield: 72% over two steps
^{1}H NMR (400MHz, $CDCl_3$) δ 7.85 (dd, 1H), 7.49 (m, 1H), 6.99 (m, 2H), 3.78-3.49 (m, 2H), 3.32 (m, 2H), 2.83-2.63 (m, 2H), 2.19 (m, 2H), 2.00-1.55 (m, 4H), 1.47 (s, 9H)
Mass Spectral Analysis *m/z* = 331.9 $(M+H)^+$

Preparation of **21.6**:

To an oven-dried two-neck 250 mL flask charged with a solution of **21.5** (2.86 g, 8.6 mmol, 1.0 eq) in dry tetrahydrofuran (40 mL) at -78°C under nitrogen was added a 1.0M solution of lithium bis(trimethylsilyl)amide in tetrahydrofuran (10.3 mL, 10.3 mmol, 1.2 eq) over a 10 min time period. The mixture was kept at -78°C for 1h and a solution of *N*-phenylbis(trifluoromethanesulfonamide) (**1.4**) (3.68 g, 10.3 mmol, 1.2 eq) in tetrahydrofuran (20 mL) was added to the mixture over a 10 min time period. The mixture was kept at -78°C for another 1h, then slowly warmed to room temperature and stirred for an additional 10h at room temperature. Ice water (50 mL) was added to quench the reaction and the product was extracted with diethyl ether (200 mL). The organic phase was then washed with a 1N aqueous solution of hydrochloric acid (3 x 50 mL), a 1N aqueous solution of sodium hydroxide (3 x 50 mL) and brine, dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield: 85%
^{1}H NMR (400MHz, $CDCl_3$) δ 7.30-7.23 (m, 2H), 6.97 (m, 1H), 6.89 (m, 1H), 5.60 (s, 1H), 3.80-3.53 (m, 2H), 3.36-3.24 (m, 2H), 2.30-2.06 (m, 3H), 1.90-1.64 (m, 3H), 1.47 (s, 9H)

Preparation of **21.7**:

To a solution of **21.6** (3.38 g, 7.3 mmol, 1.0 eq) in dimethoxyethane (50 mL) was added sequentially a 2M aqueous solution of sodium carbonate (11 mL, 22 mmol, 3.0 eq), lithium chloride (0.93 g, 22 mmol, 3.0 eq), tetrakis(triphenylphosphine)palladium(0) (0.17 g, 0.15mmol, 0.02 eq), and 4-*N,N*-diethylphenylboronic acid (**1.6**) (1.77 g, 8.02 mmol, 1.1 eq) under a nitrogen athmosphere. The reaction mixture was heated under reflux for 10h and then cooled to room temperature. Water (200 mL) and diethyl ether (300 mL) were added and the two phases were separated. The organic phase was washed with brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield: 81%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.39 (m, 4H), 7.18 (m, 1H), 6.99 (d, 1H), 6.92 (d, 1H), 6.85 (m, 1H), 5.60 (s, 1H), 3.86-3.50 (m, 4H), 3.42-3.24 (m, 4H), 2.27-1.68 (m, 6H), 1 48 (s, 9H), 1.21 (m, 6H)

Mass Spectral Analysis *m/z* = 491.0 $(M+H)^+$

Preparation of **21A**:

To a cold (0°C) solution of **21.7** (1.15 g, 2.34 mmol, 1.0 eq) in anhydrous dichloromethane (20 mL) was added dropwise a 4.0M solution of hydrogen chloride in dioxane (3.51 mL, 14.04 mmol, 6.0 eq). The mixture was stirred at room temperature for 10h and concentrated under reduced pressure. The resulting foamy solids were soaked in diethyl ether. The resulting fine powder was collected by filtration and washed with diethyl ether.

Yield: 98%

^{1}H NMR (400MHz, $CDCl_3$) δ 9.76 (m, 2H), 7.41 (m, 2H), 7.36 (m, 2H), 7.20 (m, 1H), 7.00 (dd, 1H), 6.97 (dd, 1H), 6.88 (m, 1H), 5.63 (s, 1H), 3.68-3.23 (m, 8H), 2.50-2.23 (m, 4H), 2.02-1.82 (m, 2H), 1.35-1.07 (m, 6H)

Mass Spectral Analysis *m/z* = 391.2 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_2$, 1HCl

Theory: %C 70.32; %H 7.32; %N 6.56

Found: %C 70.14; %H 7.23; %N 6.55

EXAMPLE 21B

Preparation of **21.7a & 21.7b**:

The racemic compound **21.7** (15 g) was resolved by chiral HPLC to provide **21.7a** (6.7 g) and **21.7b** (6.0 g) as pure enantiomers.

Chiral separation conditions:

Column: Chiralcel OJ, 4.6 x 250 mm

Flow: 1.0 mL / min

Temperature: room temperature

Detection: 335 nm

Mobile Phase: Methanol

21.7a:^{1}H NMR (400MHz, $CDCl_3$) δ 7.38 (m, 4H), 7.18 (m, 1H), 6.99 (dd, 1H), 6.92 (dd, 1H), 6.85 (m, 1H), 5.60 (s, 1H), 3.84-3.49 (m, 4H), 3.31 (m, 4H), 2.25-1.65 (m, 6H), 1.48 (s, 9H), 1.21 (m, 6H)

Mass Spectral Analysis *m/z* = 491.3 $(M+H)^+$

$[\square]_D^{25}$ = - 1.04 (c. 1.14 mg/mL, MeOH)

Chiral purity: ee= 99%; t_R = 4.6 min

21.7b:^{1}H NMR (400MHz, $CDCl_3$) δ 7.39 (m, 4H), 7.18 (m, 1H), 6.99 (dd, 1H), 6.92 (dd, 1H), 6.85 (m, 1H), 5.60 (s, 1H), 3.85-3.48 (m, 4H), 3.31 (m, 4H), 2.25-1.66 (m, 6H), 1.48 (s, 9H), 1.21 (m, 6H)

Mass Spectral Analysis *m/z* = 491.3 $(M+H)^+$

$[\square]_D^{25}$ = + 1.07 (c. 1.16 mg/mL, MeOH)

Chiral purity: ee= 99%; t_R = 5.2 min

Preparation of **21B**:

To a cold (0°C) solution of **21.7a** (1.3 g, 2.65 mmol, 1.0 eq) in anhydrous dichloromethane (20 mL) was added drop wise a 4.0M solution of hydrogen chloride in dioxane (3.31 mL, 13.25 mmol, 5.0 eq). The reaction mixture was stirred at room temperature for 10h and then concentrated under reduced pressure. The foamy solids were soaked in diethyl ether and the resulting fine powder was collected by filtration and washed with diethyl ether.

Yield: 87%

^{1}H NMR (400MHz, DMSO d_6) δ 8.97 (brs, 2H), 7.41 (m, 4H), 7.24 (m, 1H), 7.00-6.89 (m, 3H), 5.89 (s, 1H), 3.54-3.01 (m, 8H), 2.30-2.10 (m, 3H), 2.03-1.88 (m, 2H), 1.78 (m, 1H), 1.23-0.99 (m, 6H)

Mass Spectral Analysis *m/z* = 391.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_2$, 1HCl, 1/6 H_2O

Theory: %C 69.83; %H 7.35; %N 6.51

Found: %C 69.84; %H 7.27; %N 6.46

$[\alpha]_D^{25}$ = + 0.18 (c. 10.0 mg/mL, MeOH)

EXAMPLE 21C

Preparation of **21C**:

To a cold (0°C) solution of **21.7b** (1.3 g, 2.65 mmol, 1.0 eq) in anhydrous dichloromethane (20 mL) was added drop wise a 4.0 M solution of hydrogen chloride in dioxane (3.31 mL, 13.25 mmol, 5.0 eq). The reaction mixture was stirred at room temperature for 10h and then concentrated under reduced pressure. The foamy solids were soaked in diethyl ether and the resulting fine powder was collected by filtration and washed with diethyl ether.

Yield: 89%

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (brs, 2H), 7.41 (m, 4H), 7.24 (m, 1H), 7.02-6.89 (m, 3H), 5.89 (s, 1H), 3.52-3.02 (m, 8H), 2.35-2.10 (m, 3H), 2.04-1.88 (m, 2H), 1.78 (m, 1H), 1.23-0.99 (m, 6H)

Mass Spectral Analysis *m/z* = 391.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{30}N_2O_2$, 1HCl, 1/6 H_2O

Theory: %C 69.83; %H 7.35; %N 6.51

Found: %C 69.84; %H 7.32; %N 6.47

$[\alpha]_D^{25}$ = - 0.18 (c. 10.25 mg/mL, MeOH)

EXAMPLE 21D

Preparation of **21D**:

To a stirred solution of **21B** (0.47 g, 1.1 mmol, 1.0 eq) in methanol (20 mL) was added palladium [90 mg, 10 wt.% (dry basis) on activated carbon, 20% wt. eq]. The reaction mixture was stirred under hydrogen atmosphere using a hydrogen balloon at room temperature for 10h. The palladium on activated carbon was filtered off on a celite pad and the filtrate was concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol/ammonium hydroxide mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in dichloromethane was added dropwise a 2.0M solution of hydrogen chloride in diethyl ether (1.1 mL, 2.2 mmol, 2.0 eq). The

mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 89%

^{1}H NMR (400MHz, DMSO d_6) δ 8.88 (brs, 2H), 7.30 (m, 4H), 7.12 (m, 1H), 6.86 (m, 1H), 6.78 (m, 1H), 6.62 (m, 1H), 4.20 (m, 1H), 3.50-2.96 (m, 8H), 2.29-1.66 (m, 8H), 1.10 (brm, 6H)

Mass Spectral Analysis *m/z* = 393.3 $(M+H)^+$

EXAMPLE 21E

Preparation of **21E**:

To a stirred solution of **21C** (0.49 g, 1.14 mmol, 1.0 eq) in methanol (20 mL) was added palladium [98 mg, 10 wt.% (dry basis) on activated carbon, 20% wt. eq]. The reaction mixture was stirred under hydrogen using a hydrogen balloon at room temperature for 10h. The palladium on activated carbon was filtered off on a celite pad and the filtrate was concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol/ammonium hydroxide mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in dichloromethane was added dropwise a 2.0M solution of hydrogen chloride in diethyl ether (1.14 mL, 2.28 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 93%

^{1}H NMR (400MHz, DMSO d_6) δ 8.80 (brs, 2H), 7.29 (m, 4H), 7.12 (m, 1H), 6.85 (m, 1H), 6.77 (m, 1H), 6.62 (m, 1H), 4.20 (m, 1H), 3.52-2.96 (m, 8H), 2.22-1.66 (m, 8H), 1.10 (brm, 6H)

Mass Spectral Analysis *m/z* = 393.3 $(M+H)^+$

EXAMPLE 21F

Preparation of **21.9**:

To a stirred solution of **21A** (1.93 g, 4.52 mmol, 1.0 eq) in dry dichloromethane (30 mL) at O°C was added triethylamine (1.51 mL, 10.85 mmol, 2.4 eq) followed by drop wise addition of benzyl chloroformate (**21.8**) (0.76 mL, 5.42 mmol, 1.2 eq). The

reaction mixture was slowly warmed to room temperature and stirred for 10h at room temperature. The volatiles were removed under reduced pressure and the residue was partitioned between diethyl ether (200 mL) and water (100 mL). The organic layer was washed with a 1N aqueous solution of hydrochloric acid (3 x 50 mL) and brine, dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure to give the crude product, which was used for the next step without further purification.

Mass Spectral Analysis $m/z = 525.0\ (M+H)^+$

Preparation of **21.10**:

To a solution of **21.9** (0.9 g, crude, as of 1.71 mmol, 1.0 eq) in dry dichloroethane (10 mL) was added sulfur trioxide *N,N*-dimethylformamide complex (**4.3**) (315 mg, 2.06 mmol, 1.2 eq) portion wise. The reaction mixture was heated at 75°C for 10h and then cooled down to 0–10°C at which point oxalyl chloride (0.2 mL, 2.22 mmol, 1.3 eq) was added drop wise. The mixture was then stirred at 65°C for another 3h and then quenched with ice water (50 mL) at room pemperature. Dichloromethane (100 mL) was added and the two phases were separated. The aqueous phase was extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure to give the crude product, which was used for next step without further purification.

Mass Spectral Analysis $m/z = 622.9\ (M+H)^+$

Preparation of **21.11**:

To a solution of **21.10** (0.9 g, crude, as of 1.4 mmol, 1.0 eq) in dry dichloromethane (50 mL) at 0°C was slowly added triethylamine (0.4 mL, 2.8 mmol, 2.0 eq) and a 2.0M solution of ethylamine (**3.4c**) in tetrahydrofuran (7 mL, 14 mmol, 10.0 eq) drop wise. The mixture was slowly warmed to room temperature and stirred for 10h at room temperature. Water (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 34% over three steps

^{1}H NMR (400MHz, $CDCl_3$) δ 7.68 (m, 1H), 7.50 (m, 1H), 7.43 (m, 2H), 7.40-7.30 (m, 7H), 6.98 (d, 1H), 5.66 & 5.44 (2s, 1H), 5.18 & 5.16 (2s, 2H), 4.21 (t, 1H), 3.89-3.23 (m, 8H), 2.97 (m, 2H), 2.32-1.66 (m, 6H), 1.35-1.05 (m, 9H)

Mass Spectral Analysis *m/z* = 631.95 $(M+H)^+$

Preparation of **21F**:

To a solution of **21.11** (0.35 g, 0.55 mmol, 1.0 eq) in dichloromethane (10 mL) was added iodotrimethylsilane (0.15 mL, 1.1 mmol, 2.0 eq) drop wise. The mixture was stirred at room temperature for 2h. The mixture was diluted with chloroform 9100 mL) and methanol (5 mL). The solution was washed with a 20% aqueous solution of sodium thiosulfate (2 x 30 mL), with a 1M aqueous solution of sodium carbonate (2 x 30 mL), dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure and the crude product was purified by preparative liquid chromatography (mobile phase: acetonitrile/water/trifluoroacetic acid). The desired fractions were combined and concentrated under reduced pressure. The product was dissolved in dichloromethane (50 mL); the organic phase was washed with a 1N aqueous solution of sodium hydroxide (2 x 20 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added dropwise a 1.0M solution of hydrogen chloride in diethyl ether (1.1 mL, 1.1 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 56%

^{1}H NMR (400MHz, DMSO d_6) δ 9.03 (brs, 2H), 7.65 (dd, 1H), 7.54-7.36 (m, 6H), 7.16 (d, 1H), 6.04 (s, 1H), 3.54-3.02 (m, 8H), 2.71 (m, 2H), 2.37-2.13 (m, 3H), 2.06-1.72 (m, 3H), 1.22-1.03 (m, 6H), 0.94 (t, 3H)

Mass Spectral Analysis *m/z* = 498.5 $(M+H)^+$

Elemental analysis:

$C_{27}H_{35}N_3O_4S$, 1HCl, $0.33H_2O$

Theory: %C 60.04; %H 6.84; %N 7.78

Found: %C 59.93; %H 6.81; %N 7.80

EXAMPLE 22A

Preparation of **22.1**:

To a suspension of **21B** (4.06 g, 9.5 mmol, 1.0 eq) in tetrahydrofuran (50 mL) at 0°C was added triethylamine (3.3 mL, 23.75 mmol, 2.5 eq) followed by drop wise addition of trifluoroacetic anhydride (**4.1**) (1.6ml, 11.4 mmol, 1.2 eq). The reaction mixture was slowly warmed to room temperature and stirred for 10h at room temperature. Ethyl acetate (200 mL) was added to the reaction mixture and the organic layer was washed with a 1M aqueous solution of hydrochloric acid (3 x 50 mL) and brine, dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure to give the crude product, which was used for the next step without further purification.

Mass Spectral Analysis $m/z = 487.2\ (M+H)^+$

Preparation of **22.2**:

To a solution of **22.1** (5.0 g, as of 9.5 mmol, 1.0 eq) in dry dichloroethane (100 mL) was added sulfur trioxide *N,N*-dimethylformamide complex (**4.3**) (2.18 g, 14.25 mmol, 1.5 eq) portion wise. The mixture was heated under reflux for 10h and then cooled to 0-10°C at which point oxalyl chloride (1.33 mL, 15.2 mmol, 1.6 eq) was added drop wise. The mixture was then stirred at 70°C for another 3h and quenched with ice water (1:1) (150 mL) at room temperature. Dichloromethane (100 mL) was added to the reaction mixture and the two phases were separated. The aqueous phase was further extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 84% over two steps

^{1}H NMR (400MHz, $CDCl_3$) δ 7.88 (m, 1H), 7.70 (m, 1H), 7.48 (m, 2H), 7.35 (m, 2H), 7.08 (d, 1H), 5.716 & 5.706 (2s, 1H), 4.03-3.26 (m, 8H), 2.49-2.21 (m, 3H), 2.03-1.72 (m, 3H), 1.33-1.11 (m, 6H)

Mass Spectral Analysis $m/z = 585.2\ (M+H)^+$

Preparation of **22.3a**:

To a solution of **22.2** (0.6 g, 1.02 mmol, 1.0 eq) in dry dichloromethane (30 mL) at 0°C was added triethylamine (0.71 mL, 5.10 mmol, 5.0 eq) and methylamine (**3.4b**) hydrochloride salt (0.21 g, 3.06 mmol, 3.0 eq) in one portion. The reaction mixture was slowly warmed to room temperature and stirred for 10h at room temperature. Water (50 mL) and dichloromethane (50 mL) were added to the mixture and the two phases were separated. The aqueous phase was further extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 89%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.71 (dd, 1H), 7.51 (t, 1H), 7.45 (m, 2H), 7.34 (m, 2H), 7.02 (d, 1H), 5.665 & 5.657 (2s, 1H), 4.29 (m, 1H), 4.02-3.25 (m, 8H), 2.63 (d, 3H), 2.47-2.19 (m, 3H), 1.99-1.68 (m, 3H), 1.22 (m, 6H)

Mass Spectral Analysis *m/z* = 580.3 $(M+H)^+$

Preparation of **22A**:

To a solution of **22.3a** (0.53 g, 0.91 mmol, 1.0 eq) in a mixture of methanol (20 mL) and water (5 mL) at 0°C was added potassium carbonate (0.75 g, 5.46 mmol, 6.0 eq) portion wise. The reaction mixture was warmed to room temperature and stirred for 10h at room temperature. Brine (50 mL) and chloroform (50 mL) were added to the reaction mixture and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added drop wise a 2.0M solution of hydrogen chloride in diethyl ether (0.91 mL, 1.82 mmol, 2.0 eq). The mixture was stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 82%

^{1}H NMR (400MHz, DMSO d_6) δ 9.04 (brs, 2H), 7.64 (dd, 1H), 7.49–7.34 (m, 6H), 7.17 (d, 1H), 6.04 (s, 1H), 3.45 (m, 2H), 3.31-3.15 (m, 5H), 3.09 (m, 1H), 2.35 (d, 3H), 2.28 (m, 2H), 2.18 (m, 1H), 1.99 (m, 2H), 1.80 (m, 1H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 484.2 $(M+H)^+$

Elemental analysis:

$C_{26}H_{33}N_3O_4S$, 1HCl, $1.2H_2O$

Theory: %C 57.65; %H 6.77; %N 7.76

Found: %C 57.69; %H 6.62; %N 7.71

$[\alpha]_D^{25}$ = - 0.42 (c. 9.4 mg/mL, MeOH)

EXAMPLE 22B

22B was obtained according to a procedure similar to the one described for **22A**, with the following exception:

Step 22.3: **3.4b** was replaced by **3.4c**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.98 (brs, 1H), 7.65 (dd, 1H), 7.44 (m, 5H), 7.37 (d, 1H), 7.16 (d, 1H), 6.04 (s, 1H), 3.45 (m, 2H), 3.32-3.05 (m, 6H), 2.71 (m, 2H), 2.35-1.75 (m, 6H), 1.12 (m, 6H), 0.94 (t, 3H)

Mass Spectral Analysis *m/z* = 498.3 $(M+H)^+$

Elemental analysis:

$C_{27}H_{35}N_3O_4S$, 1HCl, $1.1H_2O$

Theory: %C 58.54; %H 6.95; %N 7.59

Found: %C 58.55; %H 6.82; %N 7.55

$[\alpha]_D^{25}$ = -0.51 (c = 9.25 mg/ml, MeOH)

EXAMPLE 22C

22C was obtained according to a procedure similar to the one described for **22A**, with the following exception:

Step 22.3: **3.4b** was replaced by **3.4d**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.05 (brs, 2H), 7.65 (dd, 1H), 7.56 (t, 1H), 7.43 (m, 4H), 7.37 (d, 1H), 7.16 (d, 1H), 6.04 (s, 1H), 3.53-3.04 (m, 8H), 2.63 (m, 2H), 2.35-1.75 (m, 6H), 1.33 (m, 2H), 1.12 (m, 6H), 0.77 (t, 3H)

Mass Spectral Analysis *m/z* = 512.4 $(M+H)^+$

Elemental analysis:

$C_{28}H_{37}N_3O_4S$, 1HCl, $0.5H_2O$

Theory: %C 60.36; %H 7.06; %N 7.54

Found: %C 60.28; %H 7.10; %N 7.53

$[\alpha]_D^{25}$ = -0.60 (c = 9.55 mg/ml, MeOH)

EXAMPLE 22D

22D was obtained according to a procedure similar to the one described for **22A**, with the following exception:

Step 22.3: **3.4b** was replaced by **3.4g**.

^1H NMR (400MHz, DMSO d_6) δ 9.0 (brs, 2H), 7.66 (m, 2H), 7.42 (m, 5H), 7.16 (d, 1H), 6.04 (s, 1H), 3.45 (m, 2H), 3.22 (m, 6H), 2.59 (m, 2H), 2.35-1.75 (m, 6H), 1.12 (m, 6H), 0.75 (m, 1H), 0.32 (m, 2H), 0.03 (m, 2H)

Mass Spectral Analysis *m/z* = 524.3 $(M+H)^+$

Elemental analysis:

$C_{29}H_{37}N_3O_4S$, 1HCl, $0.66H_2O$

Theory: %C 60.88; %H 6.93; %N 7.34

Found: %C 60.92; %H 6.96; %N 7.37

$[\alpha]_D^{25}$ = -0.59 (c = 9.35 mg/ml, MeOH)

EXAMPLE 22E

Preparation of **22.4**:

To a solution of **22.2** (0.86 g, 1.47 mmol, 1.0 eq) in tetrahydrofuran (5 mL) at 0°C was added a 1.0M solution of hydrazine in tetrahydrofuran (**5.1**) (15 mL, 15 mmol, 15.0 eq) in one portion. The reaction mixture was stirred at 0°C for 30 min. Water (50 mL) and dichloromethane (100 mL) were added and the two phases were separated. The aqueous phase was extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 72%

Mass Spectral Analysis $m/z = 581.2\ (M+H)^+$

Preparation of **22.5**:

To a suspension of **22.4** (0.62 g, 1.06 mmol, 1.0 eq) in ethanol (10 mL) was added sodium acetate (0.58 g, 7.1 mmol, 6.7 eq) and iodomethane (**2.8c**) (0.37 mL, 5.8 mmol, 5.5 eq). The reaction mixture was heated under reflux for 10h. Water (100 mL) and dichloromethane (100 mL) were added and the two phases were separated. The aqueous phase was extracted with dichloromethane (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 78%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.78 (m, 1H), 7.61 (t, 1H), 7.45 (m, 2H), 7.35 (m, 2H), 7.06 (d, 1H), 5.685 & 5.675 (2s, 1H), 4.01-3.42 (m, 6H), 3.33 (brs, 2H), 3.00 (s, 3H), 2.46-2.22 (m, 3H), 2.00-1.69 (m, 3H), 1.22 (m, 6H)

Mass Spectral Analysis $m/z = 565.3\ (M+H)^+$

Preparation of **22E**:

To a solution of **22.5** (0.45 g, 0.8 mmol, 1.0 eq) in a mixture of methanol (20 mL) and water (5 mL) at 0°C was added potassium carbonate (0.86 g, 4.8 mmol, 6.0 eq) portion wise. The reaction mixture was warmed to room temperature and stirred for 10h at room temperature. Brine (50 mL) and chloroform (50 mL) were added and the two phases were separated. The aqueous phase was extracted with chloroform (3 x 50 mL) and the combined organic layers were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added dropwise a 2.0M solution of hydrogen chloride in diethyl ether (0.8 mL, 1.6 mmol, 2.0 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 86%

^{1}H NMR (400MHz, DMSO d_6) δ 9.01 (brs, 2H), 7.80 (dd, 1H), 7.46 (m, 5H), 7.22 (d, 1H), 6.06 (s, 1H), 3.45 (m, 2H), 3.32-3.03 (m, 9H), 2.29 (m, 2H), 2.18 (m, 1H), 1.99 (m, 2H), 1.81 (m, 1H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 469.2 $(M+H)^+$

Elemental analysis:

$C_{26}H_{32}N_2O_4S$, 1HCl

Theory: %C 61.83; %H 6.59; %N 5.55

Found: %C 61.82; %H 6.60; %N 5.51

$[\alpha]_D^{25}$ = - 0.45 (c. 10.3 mg/mL, MeOH)

EXAMPLE 23A

23A was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: Method **1B** was used and **1.2** was replaced by **23.1a** (see also step 23.1).

Step 1.3: Method **1C** was used (see also step 23.3).

Step 1.4: Method **1E** was used (see also step 23.4).

^{1}H NMR (400MHz, $CDCl_3$) δ 10.20 (m, 2H), 7.40 (m, 4H), 7.22 (m, 1H), 7.04 (m, 2H), 6.91 (m, 1H), 5.66 (s, 1H), 3.85-3.50 (m, 5H), 3.31 (m, 3H), 2.60 (m, 1H), 2.13 (m, 1H), 1.27 (m, 3H), 1.16 (m, 3H)

Mass Spectral Analysis *m/z* = 363.2 $(M+H)^+$

EXAMPLE 23B

23B was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: Method 1B was used and **1.2** was replaced by **23.1b** (see also step 23.1).

Step 1.3: Method 1C was used (see also step 23.3).

Step 1.4: Method 1E was used (see also step 23.4).

^{1}H NMR (400MHz, $CDCl_3$) δ 10.33 (m, 1H), 9.21 (m, 1H), 7.39 (m, 5H), 7.21 (m, 1H), 6.98 (m, 1H), 6.87 (m, 1H), 5.50 (s, 1H), 3.55 (m, 4H), 3.34 (m, 2H), 2.93 (m, 2H), 2.44 (m, 1H), 2.33 (m, 1H), 1.83 (m, 1H), 1.70 (m, 1H), 1.26 (m, 3H), 1.16 (m, 3H)

Mass Spectral Analysis *m/z* = 377.0 $(M+H)^+$

EXAMPLE 23C

23C was obtained according to a procedure similar to the one described for **1A**, with the following exceptions:

Step 1.1: Method 1B was used and **1.2** was replaced by **23.5** (see also step 23.5).

Step 1.3: Method 1C was used (see also step 23.7).

Step 1.4: Method 1E was used (see also step 23.8).

^{1}H NMR (400MHz, DMSO d_6) δ 9.28 (brm, 2H), 7.43 (d, 2H), 7.35 (d, 2H), 7.27 (m, 1H), 7.01 (d, 1H), 6.97 (m, 2H), 5.57 (s, 1H), 4.01 (brs, 2H), 3.44 (brs, 2H), 3.22 (brs, 2H), 2.36 (m, 2H), 2.27 (m, 4H), 2.04 (m, 2H), 1.12 (brd, 6H)

Mass Spectral Analysis *m/z* = 403.2 $(M+H)^+$

EXAMPLE 24A

Preparation of **24.2**:

To a solution of **24.1** (9.37 g, 60 mmol, 1.0 eq) in dry methanol (100 mL) was added pyrrolidine (10 mL, 120 mmol, 2.0 eq) followed by 2'-hydroxyacetophenone (**1.1a**) (7.22 mL, 60 mmol, 1.0 eq). The reaction mixture was heated under reflux for 10h. The volatiles were removed under reduced pressure and the residue was dissolved in ethyl acetate (200 mL). The mixture was washed with a 1M aqueous solution of hydrochloric acid (3 x 50 mL), with a 1M aqueous solution of sodium hydroxide (3 x 50 mL) and brine. The organic extracts were dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 100%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.86 (dd, 1H), 7.48 (m, 1H), 6.98 (m, 2H), 3.96 (m, 4H), 2.71 (s, 2H), 2.12 (m, 2H), 1.99 (m, 2H), 1.74 (m, 2H), 1.61 (m, 2H)

Preparation of **24.3**:

To an oven-dried two-neck 500 mL flask charged with a solution of **24.2** (16.46 g, 60 mmol, 1.0 eq) in dry tetrahydrofuran (100 mL) at -78°C under nitrogen was added a 1.0M solution of lithium bis(trimethylsilyl)amide in tetrahydrofuran (72 mL, 72 mmol, 1.2 eq) over a 30 min time period. The mixture was kept at -78°C for 1h and a

solution of *N*-phenylbis(trifluoromethanesulfonamide) (**1.4**) (25.72 g, 72 mmol, 1.2 eq) in tetrahydrofuran (100 mL) was added to the mixture over a 30 min time period. The reaction mixture was kept at -78°C for 1h, and was slowly warmed to room temperature and stirred for 10h at room temperature. Ice water (100 mL) was added to quench the reaction and the product was extracted with diethyl ether (200 mL). The organic phase was then washed with a 1M aqueous solution of hydrochloric acid (3 x 100 mL), with a 1M aqueous solution of sodium hydroxide (3 x 100 mL) and brine, dried over sodium sulfate and filtered. The filtrate was concentrated under reduced pressure and the crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 90%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.34-7.19 (m, 2H), 6.97 (m, 1H), 6.89 (m, 1H), 5.60 (s, 1H), 4.03-3.91 (m, 4H), 2.20 (m, 2H), 2.09-1.97 (m, 2H), 1.81 (m, 2H), 1.62 (m, 2H)

Preparation of **24.4**:

To a solution of **24.3** (22 g, 54.14 mmol, 1.0 eq) in dimethoxyethane (200 mL) under nitrogen was added sequentially a 2M aqueous solution of sodium carbonate (81.2 mL, 162.42 mmol, 3.0 eq), lithium chloride (6.88 g, 162.42 mmol, 3.0 eq), tetrakis(triphenylphosphine)palladium(0) (1.25 g, 1.08 mmol, 0.02 eq), and 4-*N,N*-diethylphenylboronic acid (**1.6**) (13.16 g, 59.55 mmol, 1.1 eq). The reaction mixture was heated under reflux for 10h. Water (200 mL) and diethyl ether (300 mL) were added and the two phases were separated. The aqueous phase was further extracted with diethyl ether (2 x 100 mL) and the combined organic extracts were washed with brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).

Yield: 95%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.38 (m, 4H), 7.18 (m, 1H), 6.99 (m, 1H), 6.93 (m, 1H), 6.85 (m, 1H), 5.62 (s, 1H), 3.99 (m, 4H), 3.57 (brs, 2H), 3.32 (brs, 2H), 2.24-2.02 (m, 4H), 1.80 (m, 2H), 1.65 (m, 2H), 1.21 (m, 6H)

Preparation of **24A**:

To a cold (0°C) solution of **24.4** (22.32 g, 51.48 mmol, 1.0 eq) in tetrahydrofuran (200 mL) was added a 1.0M aqueous solution of hydrochloric acid (155 mL, 155 mmol, 3.0 eq). The mixture was stirred at room temperature for 10h and then concentrated under reduced pressure. The resulting solid was collected by filtration, washed with hexane/ethyl acetate mixture (20:1), and dried under vacuum.

Yield: 85%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.40 (m, 4H), 7.23 (m, 1H), 7.04 (d, 1H0, 7.00 (d, 1H), 6.91 (m, 1H), 5.62 (s, 1H), 3.57 (brs, 2H), 3.32 (brs, 2H), 2.87 (m, 2H), 2.50 (m, 2H), 2.33 (m, 2H), 1.94 (m, 2H), 1.21 (m, 6H)

Mass Spectral Analysis *m/z* = 390.2 $(M+H)^+$

EXAMPLE 24B / EXAMPLE 24C

Preparation of **24B / 24C**:

To a solution of **24A** (0.51 g, 1.3 mmol, 1.0 eq) in dry tetrafydrofuran (30 mL) at 0°C was added sodium borohydride (50 mg, 1.3 mmol, 1.0 eq) in one portion under a nitrogen athmosphere. The reaction mixture was stirred at room temperature for 1h. Water (50 mL) and diethyl ether (100 mL) were added and the two phases were separated. The aqueous phase was further extracted with diethyl ether (2 x 50 mL) and the combined organic layers were washed with brine, dried over sodium sulfate, filtered, and concentrated to give the mixture of two isomers. The crude product was purified by preparative liquid chromatography affording **24B** and **24C**.

(24B) ^{1}H NMR (400MHz, $CDCl_3$) δ 7.39 (m, 4H), 7.18 (m, 1H), 6.97 (m, 2H), 6.85 (m, 1H), 5.55 (s, 1H), 3.73 (m, 1H), 3.58 (brs, 2H), 3.33 (brs, 2H), 2.51 (brs, 4H), 2.21 (m, 2H), 1.52 (m, 2H), 1.22 (brd, 6H)

Mass Spectral Analysis *m/z* = 392.2 $(M+H)^+$

(24C) ^{1}H NMR (400MHz, $CDCl_3$) δ 7.39 (m, 4H), 7.18 (m, 1H), 7.01-6.81 (m, 3H), 5.73 & 5.55 (2s, 1H), 4.07 & 3.74 (2m, 1H), 3.59 (brs, 2H), 3.34 (brs, 2H), 3.16 (brs, 4H), 2.31-1.89 (m, 2H), 1.68-1.46 (m, 2H), 1.22 (m, 6H)

Mass Spectral Analysis *m/z* = 392.2 $(M+H)^+$

EXAMPLE 24D / EXAMPLE 24E

Preparation of **24D / 24E**:

To a stirred solution of **24A** (0.63 mL, 1.62 mmol, 2.0 eq) in dry dichloromethane (20 mL) was added sequentially *n*-propylamine (**3.4d**) (0.16 g, 1.94 mmol, 1.2 eq), acetic acid (0.11 mL, 1.94 mmol, 1.2 eq), and sodium cyanoborohydride (0.153 g, 2.43 mmol, 1.5 eq). The reaction mixture was stirred at room temperature for 10h. Water (40 mL) was added and the aqueous layer was basified to pH=10 with a 1M aqueous solution of sodium hydroxide. The two phases were separated and the aqueous phase was saturated with sodium chloride and extracted with dichloromethane (3 x 50 mL). The combined organic extracts were dried over sodium sulfate, filtered, and concentrated under reduced pressure to give the crude mixture, which was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).

(24D) ^{1}H NMR (400MHz, $CDCl_3$) δ 7.38 (m, 4H), 7.17 (m, 1H), 6.99 (dd, 1H), 6.90 (dd, 1H), 6.84 (m, 1H), 5.91 (s, 1H), 3.57 (brs, 2H), 3.31 (brs, 2H), 2.75 (brs, 1H), 2.65 (t, 2H), 2.11 (m, 2H), 1.98 (m, 2H), 1.82-1.46 (m, 7H), 1.21 (m, 6H), 0.95 (t, 3H)
Mass Spectral Analysis *m/z* = 433.2 $(M+H)^+$

(24E) ^{1}H NMR (400MHz, $CDCl_3$) δ 7.38 (m, 4H), 7.16 (m, 1H), 6.98 (dd, 1H), 6.93 (dd, 1H), 6.83 (m, 1H), 5.54 (s, 1H), 3.57 (brs, 2H), 3.31 (brs, 2H), 2.64 (t, 2H), 2.53 (m, 1H), 2.20 (m, 2H), 1.83-1.42 (m, 7H), 1.21 (m, 6H), 0.94 (t, 3H)
Mass Spectral Analysis *m/z* = 433.2 $(M+H)^+$

EXAMPLE 24F

24F was obtained according to a procedure similar to the one described for **24D**, with the following exception:

Step 24.6: **3.4d** was replaced by **3.4j**.

^{1}H NMR (400MHz, $CDCl_3$) δ 7.38 (m, 4H), 7.17 (m, 1H), 6.96 (m, 2H), 6.84 (m, 1H), 5.54 (s, 1H), 3.57 (m, 2H), 3.32 (m, 2H), 2.35 (s, 6H), 2.25 (m, 3H), 1.79 (m, 4H), 1.46 (m, 2H), 1.26 (m, 3H), 1.16 (m, 3H)
Mass Spectral Analysis *m/z* = 419.2 $(M+H)^+$

EXAMPLE 24G

24G was obtained according to a procedure similar to the one described for **24E**, with the following exception:

Step 24.6: **3.4d** was replaced by **3.4j**.

^{1}H NMR (400MHz, $CDCl_3$) δ 7.40 (m, 4H), 7.18 (m, 1H), 7.00 (m, 1H), 6.91 (m, 1H), 6.85 (m, 1H), 5.89 (s, 1H), 3.57 (m, 2H), 3.32 (m, 2H), 2.51 (m, 7H), 2.20 (m, 2H), 2.06 (m, 2H), 1.76 (m, 4H), 1.26 (m, 3H), 1.16 (m, 3H)

Mass Spectral Analysis *m/z* = 419.2 $(M+H)^+$

EXAMPLE 25A

25A was obtained according to a procedure similar to the one described for compound **1.8a** with the following exception:

Step 1.1: **1.2** was replaced by **25.1** (see also step 25.1).

^{1}H NMR (400MHz, DMSO d_6) δ 7.42 (d, 2H), 7.38 (d, 2H), 7.19 (m, 1H), 6.97 (m, 2H), 6.86 (m, 1H), 5.62 (s, 1H), 3.96 (m, 2H), 3.79 (m, 2H), 3.57 (brs, 2H), 3.32 (brs, 2H), 2.03 (d, 2H), 1.84 (m, 2H), 1.21 (brd, 6H)

Mass Spectral Analysis *m/z* = 378.2 $(M+H)^+$

EXAMPLE 26A

Preparation of **26.2**:

To a solution of **1.5a** (2.08 g, 4.63 mmol, 1 eq) in dry tetrahydrofuran (40 mL) was added *tetrakis*(triphenylphosphine)palladium(0) (0.535 g, 0.463 mmol, 0.1 eq), followed by 4-cyanobenzylzinc bromide (**26.1**) (0.5M solution in tetrahydrofuran, 23.16 mL, 11.58 mmol, 2.5 eq) drop wise under a nitrogen athmosphere. The reaction mixture was stirred at room temperature for 10h. A saturated aqueous solution of ammonium chloride (40 mL) was added to quench the reaction and diethyl ether (50 mL) was added to partition the two phases. The aqueous phase was extracted with diethyl ether (3 x 50 mL) and the combined organic layers were washed with brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixture of increasing polarity).

Yield: 62 %

^{1}H NMR (400MHz, $CDCl_3$) δ 7.59 (d, 2H), 7.34 (d, 2H), 7.14 (m, 1H), 7.00 (dd, 1H), 6.88 (dd, 1H), 6.82 (m, 1H), 5.28 (s, 1H), 3.95-3.75 (m, 4H), 3.28 (m, 2H), 1.99 (m, 2H), 1.59 (m, 2H), 1.46 (s, 9H)

Mass Spectral Analysis *m/z* = 417 $(M+H)^+$

Preparation of **26.3a** & **26.3b**:

A mixture of **26.2** (1.2 g, 2.88 mmol) in concentrated hydrochloric acid (30 mL) was heated under reflux for 10h and then concentrated under reduced pressure to give the crude mixture of **26.3a** and **26.3b**. A 80 mg quantity of the mixture was purified by preparative liquid chromatography. The remaining mixture (**26.3a/26.3b**) was used for the next step without further purification.

26.3a: ^{1}H NMR (400MHz, DMSO-d_6) δ 12.87 (s,b, 1H), 8.58 (m, 2H), 7.86 (m, 2H), 7.41 (m, 2H), 7.21-7.12 (m, 2H), 6.92 (dd, 1H), 6.86 (m, 1H), 5.70 (s, 1H), 3.85 (s, 2H), 3.19 (m, 4H), 2.06 (m, 2H), 1.86 (m, 2H)

Mass Spectral Analysis *m/z* = 336.2 $(M+H)^+$

26.3b: ^{1}H NMR (400MHz, DMSO-d_6) δ 13.00 (s,b, 1H), 8.68 (m, 1H), 8.29 (m, 1H), 7.97 (m, 2H), 7.84 (dd, 1H), 7.50 (m, 2H), 7.41 (s, 1H), 7.27 (m, 1H), 7.03-6.94 (m, 2H), 3.19-3.00 (m, 4H), 2.82 (s, 2H), 1.91 (m, 2H), 1.63 (m, 2H)

Mass Spectral Analysis *m/z* = 336.2 $(M+H)^+$

Preparation of **26.4a** & **26.4b**:

To a solution of the mixture of **26.3a** and **26.3b** (1 g, 2.69 mmol) in methanol (50 mL) was slowly added a 4.0M solution of hydrogen chloride in dioxane (20 mL). The reaction mixture was stirred at room temperature for 10h and concentrated under reduced pressure. The residue was dissolved in ethyl acetate (100 mL), washed with a 1M aqueous solution of sodium carbonate (4 x 50 mL), brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure to give the crude mixture of **26.4a** and **26.4b**. A small amount (150 mg) of the crude mixture was purified by column chromatography (eluent: hexane/ethyl acetate mixture of increasing polarity) and repurified preparative liquid chromatography. The remaining mixture (**26.4a/26.4b**) was used for the next step without further purification.

Yield: 90 %

26.4a: ^{1}H NMR (400MHz, $CDCl_3$) δ 9.05 (s,b, 1H), 8.72 (s,b, 1H), 7.98 (d, 2H), 7.29 (d, 2H), 7.17 (m, 1H), 7.11 (m, 1H), 6.93-6.85 (m, 2H), 5.29 (s, 1H), 3.91 (s, 3H), 3.80 (s, 2H), 3.37 (m, 4H), 2.24 (m, 2H), 1.95 (m, 2H)

Mass Spectral Analysis *m/z* = 350.2 $(M+H)^+$

26.4b: ^{1}H NMR (400MHz, $CDCl_3$) δ 9.42 (s,b, 1H), 8.95 (s,b, 1H), 8.05 (d, 2H), 7.66 (d, 1H), 7.40-7.22 (m, 4H), 7.00 (m, 1H), 6.92 (d, 1H), 3.94 (s, 3H), 3.25 (m, 4H), 2.78 (s, 2H), 2.04 (m, 2H), 1.75 (m, 2H)

Mass Spectral Analysis *m/z* = 350.2 $(M+H)^+$

Preparation of **26.5a** & **26.5b**:

To a solution of the mixture of **26.4a** and **26.4b** (0.5 g, 1.5 mmol, 1 eq) in dry dichloromethane (30 mL) at 0°C was slowly added triethylamine (0.42 mL, 3 mmol, 2 eq) and a solution of di-*tert*-butyl-dicarbonate **4.7** (0.38 g, 1.74 mmol, 1.2 eq) in dichloromethane (10 mL) drop wise. The reaction mixture was slowly warmed up to room temperature and stirred at room temperature for 10h. Dichloromethane (50 mL) was added and the mixture was washed with a 1N aqueous solution of hydrochloric acid (3 x 50 mL), brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure to give the crude mixture of **26.5a** and **26.5b**, which was used for the next step without purification.

Preparation of **26.6a** & **26.6b**:

To a solution of the mixture of **26.5a** and **26.5b** (0.57 g, 1.26 mmol, 1 eq) in a mixture methanol (15mL), tetrahydrofuran (15mL) and water (15 mL) was added lithium hydroxide monohydrate (0.21 g, 5 mmol, 4 eq) in one portion. The reaction mixture was stirred at room temperature for 10h. The volatiles were removed under reduced pressure and the remaining aqueous solution was acidified to pH = 3 with a 1N aqueous solution of hydrochloric acid while stirring. The mixture was stirred for 1h at room temperature and left at room temperature for 10h. The resulting solid was collected by filtration, washed with water, and dried under vacuum to give the

mixture of **26.6a** and **26.6b**, which was used for the next step without further purification.

Preparation of **26.7a** & **26.7b**:

To a stirred solution of the mixture of **26.6a** and **26.6b** (0.49 g, 1.12 mmol, 1 eq) in acetonitrile (20 mL) was slowly added diisopropylethylamine (0.46 mL, 2.69 mmol, 2.4 eq), diethylamine **1.12** (0.24 g, 3.36 mmol, 3 eq) at room temperature. The mixture was stirred for 10 min at room temperature. The mixture was cooled to 0°C and *O*-benzotriazol-1-yl-*N,N,N',N'*-tetramethyluronium tetrafluoroborate (TBTU) (0.43 g, 1.34 mmol, 1.2 eq) was added portion wise. The reaction mixture was slowly warmed up to room tempearture and stirred at room temperature for an additional 10h. The volatiles were removed under reduced pressure and the residue was partitioned between ethyl acetate (100 mL) and a 1M aqueous solution of sodium bicarbonate (100 mL). The organic phase was washed with a 1M aqueous solution of sodium bicarbonate (2 x 50 mL), a 1M aqueous solution of hydrochloric acid (3 x 50 mL), brine, dried over sodium sulfate, filtered, and concentrated under reduced pressure to give the crude mixture of **26.7a** and **26.7b**. The crude mixture was purified by column chromatography (eluent: hexane/ethyl acetate mixture of increasing polarity). A small amount (85 mg) of the purified mixture was separated bypreparative liquid chromatography. The remaining mixture (**26.7a/26.7b**) was used for the next step without further purification.

Yield: 81% over three steps

26.7a: ^{1}H NMR (400MHz, $CDCl_3$) δ 7.33-7.24 (m, 4H), 7.15-7.07 (m, 2H), 6.89-6.80 (m, 2H), 5.25 (s, 1H), 3.84 (m, 2H), 3.74 (s, 2H), 3.55 (m, 2H), 3.28 (m, 4H), 1.98 (m, 2H), 1.57 (m, 2H), 1.46 (s, 9H), 1.18 (m, 6H)

Mass Spectral Analysis *m/z* = 491.1 $(M+H)^+$

26.7b: ^{1}H NMR (400MHz, $CDCl_3$) δ 7.63 (dd, 1H), 7.39 (m, 2H), 7.31 (m, 2H), 7.22 (m, 1H), 7.17 (s, 1H), 6.95 (m, 1H), 6.90 (dd, 1H), 3.81 (m, 2H), 3.58 (m, 2H), 3.34 (m, 2H), 3.17 (m, 2H), 2.71 (s, 2H), 1.82 (m, 2H), 1.43 (s, 9H), 1.38 (m, 2H), 1.22 (m, 6H)

Mass Spectral Analysis *m/z* = 491.1 $(M+H)^+$

Preparation of **26A**

To a cold (O°C) stirred solution of the mixture of **26.7a** and **26.7b** (0.36 g, 0.73 mmol, 1 eq) in dry dichloromethane (20 mL) was added dropwise a 4.0 M solution of hydrogen chloride in dioxane (1.8 mL, 7.2 mmol, 10 eq). The mixture was stirred at room temperature for 10h and concentrated under reduced pressure to give the crude mixture of **26A** and **26.8**. The crude mixture was purified by preparative liquid chromatography.

Yield: 85%

26A: ^{1}H NMR (400MHz, $CDCl_3$) δ 9.35 (s,b, 1H), 9.00 (s,b, 1H), 7.30 (m, 4H), 7.14 (m, 2H), 6.87 (m, 2H), 5.28 (s, 1H), 3.76 (s, 2H), 3.55 (m, 2H), 3.24 (m, 6H), 2.11 (m, 2H), 1.93 (m, 2H), 1.20 (m, 6H)

Mass Spectral Analysis *m/z* = 391.0 $(M+H)^+$

26.8: ^{1}H NMR (400MHz, $CDCl_3$) δ 9.12 (s,b, 1H), 8.71 (s,b, 1H), 7.65 (d, 1H), 7.39 (d, 2H), 7.31 (d, 2H), 7.28-7.19 (m, 2H), 7.00 (m, 1H), 6.92 (d, 1H), 3.59 (m, 2H), 3.29 (m, 6H), 2.78 (s, 2H), 2.05 (m, 2H), 1.78 (m, 2H), 1.23 (m, 6H)

Mass Spectral Analysis *m/z* = 391.0 $(M+H)^+$

EXAMPLE 26B

Preparation of **26B**:

To a stirred solution of **26.8** (0.12 g, 0.26 mmol, 1 eq) in methanol (10 mL) was added palladium [24 mg, 10 wt.% (dry basis) on activated carbon, 20% wt. eq]. The reaction mixture was stirred under hydrogen atmosphere using a hydrogen balloon at room temperature for 10h. The palladium on activated carbon was filtered off on a celite pad and the filtrate was concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol/ammonium hydroxide mixture of increasing polarity). The desired fractions were combined and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in dichloromethane was added dropwise a 2.0M solution of hydrogen chloride in diethyl ether (0.26 mL, 0.52 mmol, 2 eq). The mixture was then stirred for 1h at room temperature, concentrated under reduced pressure, and dried under vacuum.

Yield: 88%

^{1}H NMR (400MHz, $CDCl_3$) δ 9.41 (s,b, 1H), 8.95 (s,b, 1H), 7.40 (m, 1H), 7.33 (m, 2H), 7.25-7.14 (m, 3H), 6.97 (m, 1H), 6.86 (m, 1H), 3.62-3.04 (m, 10H), 2.63 (m, 1H), 2.03-1.49 (m, 6H), 1.20 (m, 6H)

Mass Spectral Analysis *m/z* = 393.0 $(M+H)^+$

EXAMPLE 27A

Preparation of **27A**:

A solution of **1A** (0.66 g, 1.75 mmol, 1.0 eq) in anhydrous methanol (13 mL) was hydrogenated at atmospheric pressure in the presence of palladium hydroxide [$Pd(OH)_2$: Pearlman's catalyst] (0.120 g, 0.09 mmol, 0.05 eq) for 10h. The mixture was then filtered through celite. The filtrate was concentrated and was hydrogenated at atmospheric pressure in the presence of palladium hydroxide (0.120 g) for an additional 10h. The mixture was filtered through celite and the filtrate was concentrated to dryness under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous dichloromethane was added drop wise a 2.0M solution of anhydrous hydrochloric acid in diethyl ether (5 mL). The mixture was then stirred for 1h at room temperature and concentrated under reduced pressure. Diethyl ether was added. The resulting precipitate was collected by filtration and washed with diethyl ether and ethyl acetate.

Yield: 63%

^{1}H NMR (400MHz, DMSO d_6) δ 9.15 (m, 2H), 7.30 (m, 4H), 7.10 (m, 1H), 6.90 (m, 1H), 6.75 (m, 1H), 6.60 (m, 1H), 4.20 (m, 1H), 3.40 (m, 3H), 3.20 (m, 4H), 3.00 (m, 1H), 2.15 (m, 1H), 1.95 (m, 5H), 1.05 (m, 6H)

Mass Spectral Analysis *m/z* = 379.1 $(M+H)^+$

Elemental analysis:

$C_{24}H_{30}N_2O_2$, 1HCl, 0.75H_2O

Theory: %C 67.28; %H 7.65; %N 6.54

Found: %C 67.32; %H 7.63; %N 6.37

EXAMPLE 27B

Preparation of **27B**:

27A (racemic mixture) (10 g, 24.10 mmol, 1.0 eq) was resolved using Chiral HPLC method:

Column: Chiralpak AD-H, 4.6 x 250mm, 5μ, Chiral Technologies PN# 19325

Column temperature: room temperature

Detection: UV photo diode array, 200 to 300nm, extract at 275nm

Injection volume: 40μL of 2 mg / mL sample in EtOH : MeOH (80 : 20)

Flow: 1 mL / minute

Mobile Phase: 85% Solution A, 15% Solution B

Solution A: 0.1% Di-isopropylethylamine in Hexane (HPLC Grade)

Solution B: 80% Ethanol, 20% Methanol (both HPLC Grade)

Note: Methanol is miscible in Hexane only if first dissolved in Ethanol. Solution B should be pre-mixed

Run time: 25 min.

HPLC: Waters Alliance 2695 (system dwell volume is ~350 μL)

Detector: Waters 996 (resolution: 4.8 nm, scan rate: 1 Hz)

Yield: 40%

^{1}H NMR (400MHz, DMSO d_6) δ 9.10 (m, 2H), 7.28 (m, 4H), 7.14 (m, 1H), 6.90 (d, 1H), 6.80 (m, 1H), 6.63 (d, 1H), 4.25 (m, 1H), 3.42 (m, 3H), 3.24 (m, 4H), 2.97 (m, 1H), 2.20 (m, 1H), 1.97 (m, 5H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 379.4 $(M+H)^+$

Chiral HPLC Method: t_R = 8.64 min. (*ee* = 97%)

Elemental analysis:

$C_{24}H_{30}N_2O_2$, 1HCl, 0.25H_2O

Theory: %C 68.72; %H 7.57; %N 6.68

Found: %C 68.87; %H 7.52; %N 6.68

$[\alpha]_D^{25}$ = +58.40 (c. 0.01, MeOH)

DETERMINATION OF ABSOLUTE CONFIGURATION OF EXAMPLE 27B

Preparation of **27.3**:

Compound **27.2** (0.45g, 1.78 mmol, 1.1 eq) was added at 0°C to a solution of **27B** (0.67 g, 1.61 mmol, 1 eq) and triethylamine (0.74 mL, 5.33 mmol, 3.3 eq) in

dichloromethane (6 mL). The reaction was warmed to room temperature and stirred overnight at room temperature. The mixture was washed with a saturated aqueous solution of sodium hydrogenocarbonate and brine, dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: hexane/ethyl acetate mixtures of increasing polarity).
Yield: 64%

^{1}H NMR (400MHz, DMSO d_6) δ 7.30 (m, 4H), 7.11 (t, 1H), 6.90 (d, 1H), 6.77 (t, 1H), 6.61 (d, 1H), 4.23 (m, 1H), 3.39 (br m, 9H), 2.93 (d, 1H), 2.37 (m, 2H), 2.24 (m, 1H), 2.06 (m, 2H), 1.93 (m, 6H), 1.53 (m, 1H), 1.41 (m, 1H), 1.10 (m, 6H), 1.03 (s, 3H), 0.83 (s, 3H)

Mass Spectral Analysis *m/z* = 593.4 $(M+H)^+$

Elemental analysis:

$C_{33}H_{44}N_2O_5S$, 0.25H2O

Theory: %C 68.37; %H 7.51; %N 4.69

Theory: %C 68.38; %H 7.50; %N 4.55

X-Ray Crystallography data:

Single crystals were grown as needles by dissolving **27.3** (10 mg, 0.017 mmol, 1 eq) in isopropanol (1 mL) and letting sit still at room temperature for 72 h.

Crystal data and structure refinement for **27.3**:

Identification code: ptut001

Empirical formula: $C_{34}H_{44}N_2O_5S$

Formula weight: 592.77

Temperature: 120(2) K

Wavelength: 0.71073 A

Crystal system, space group: Monoclinic, P2(1)

Unit cell dimensions:

a = 15.135(2) A, alpha = 90 deg

b = 6.1924(10) A, beta = 91.802(2) deg

c = 16.602(3) A, gamma = 90 deg

Volume: 1555.2(4) A^3

Z, Calculated density: 2, 1.266 Mg/m^3

Absorption coefficient: 0.148 mm^{-1}

F(000): 636

Crystal size: 0.30 x 0.08 x 0.04 mm

Theta range for data collection: 1.79 to 27.79 deg

Limiting indices: -18<=h<=19, -7<=k<=7, -20<=l<=21

Reflections collected/unique: 12166/6251 [R(int) = 0.0168]

Completeness to theta = 27.79: 91.9 %

Absorption correction: Semi-empirical from equivalents

Max. and min. transmission: 0.9941 and 0.9569

Refinement method: Full-matrix least-squares on F^2

Data/restraints/parameters: 6251/1/383

Goodness-of-fit on F^2: 1.040

Final R indices [I>2sigma(I)]: R1 = 0.0392, wR2 = 0.1030

R indices (all data): R1 = 0.0401, wR2 = 0.1041

Absolute structure parameter: -0.03(6)

Largest diff. peak and hole: 0.365 and -0.200 $e.A^{-3}$

EXAMPLE 27C

Preparation of **27C**:

27A (racemic mixture) (10 g, 24.10 mmol, 1 eq) was resolved using Chiral HPLC method:

Column: Chiralpak AD-H, 4.6 x 250mm, 5μ, Chiral Technologies PN# 19325

Column temperature: room temperature

Detection: UV photo diode array, 200 to 300nm, extract at 275nm

Injection volume: 40μL of 2 mg / mL sample in EtOH : MeOH (80 : 20)

Flow: 1 mL / minute

Mobile phase: 85% Solution A, 15% Solution B

Solution A: 0.1% Di-isopropylethylamine in Hexane (HPLC Grade)

Solution B: 80% Ethanol, 20% Methanol (both HPLC Grade)

Run time: 25 min

HPLC: Waters Alliance 2695 (system dwell volume is ~350 μL.)

Detector: Waters 996 (Resolution: 4.8 nm, Scan Rate: 1 Hz)

Yield: 40%

^{1}H NMR (400MHz, DMSO d_6) δ 9.12 (m, 2H), 7.28 (m, 4H), 7.14 (m, 1H), 6.90 (d, 1H), 6.79 (m, 1H), 6.63 (d, 1H), 4.25 (m, 1H), 3.44 (m, 3H), 3.24 (m, 4H), 2.96 (m, 1H), 2.18 (m, 1H), 1.97 (m, 5H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 379.4 $(M+H)^+$

Chiral HPLC Method: t_R = 11.914 min. (*ee* = 100%)

Elemental analysis:

$C_{24}H_{30}N_2O_2$, 1HCl, 0.25H_2O

Theory: %C 68.72; %H 7.57; %N 6.68

Found: %C 68.79; %H 7.55; %N 6.68

$[\alpha]_D^{25}$ = -63.59 (c. 0.01, MeOH)

EXAMPLE 27D

27D was obtained according to a procedure similar to the one described for **27A**, with the following exception:

Step 27.3: Method 27A was used and **1A** was replaced by **1D**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.05 (m, 2H), 7.31 (q, 4H), 6.98 (m, 2H), 6.36 (dd, 1H), 6.47 (dd, 1H), 3.51-3.33 (m, 2H), 3.29-3.11 (m, 5H), 2.96 (m, 1H), 2.19 (m, 1H), 2.05-1.82 (m, 5H), 1.20-1.00 (m, 6H)

Mass Spectral Analysis *m/z* = 397.3 $(M+H)^+$

EXAMPLE 27E

27E was obtained from **27D** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 8.82 (m, 2H), 7.31 (m, 4H), 6.97 (m, 2H), 6.37 (m, 1H), 4.27 (m, 1H), 3.42 (m, 2H), 3.23 (m, 5H), 2.97 (m, 1H), 2.20 (m, 1H), 1.94 (m, 5H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 397.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}FN_2O_2$, 1HCl, $0.33H_2O$

Theory: %C 65.71; %H 7.09; %N 6.36

Found: %C 65.68; %H 7.07; %N 6.41

$[\alpha]_D^{25}$ = +6.53 (c = 9.85 mg/mL, MeOH)

EXAMPLE 27F

27F was obtained from **27D** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 8.92 (m, 2H), 7.32 (m, 4H), 6.98 (m, 2H), 6.37 (m, 1H), 4.27 (m, 1H), 3.42 (m, 2H), 3.24 (m, 5H), 2.97 (m, 1H), 2.20 (m, 1H), 1.95 (m, 5H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 397.3 $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}FN_2O_2$, 1HCl, $0.2H_2O$

Theory: %C 66.03; %H 7.02; %N 6.42

Found: %C 66.07; %H 6.99; %N 6.34

$[\alpha]_D^{25}$ = -6.54 (c = 9.75 mg/mL, MeOH)

EXAMPLE 27G

27G was obtained according to a procedure similar to the one described for **27A**, with the following exception:

Step 27.3: Method 27A was used and **1A** was replaced by **2C**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.12 (brs, 1H), 8.97 (brs, 1H), 7.32 (d, 2H), 7.27 (d, 2H), 6.84 (d, 1H), 6.73 (dd, 1H), 6.12 (d, 1H), 4.21 (m, 1H), 3.55 (m, 3H), 3.42 (brs, 1H), 3.20 (brm, 5H), 2.94 (m, 1H), 2.16 (m, 1H), 1.92 (m, 5H), 1.09 (m, 7H), 0.46 (m, 2H), 0.18 (m, 2H)

Mass Spectral Analysis m/z = 449.3 $(M+H)^+$

Elemental analysis:

$C_{28}H_{36}N_2O_3$, 1HCl, $1H_2O$

Theory: %C 66.85; %H 7.81; %N 5.57; %Cl 7.05

Found: %C 67.02; %H 7.51; %N 5.54; %Cl 7.25

EXAMPLE 27H

27H was obtained according to a procedure similar to the one described for **27A**, with the following exception:

Step 27.3: Method 27A was used and **1A** was replaced by **1N**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.07 (m, 1.5H), 8.53 (d, 1H), 7.70 (dd, 1H), 7.52 (d, 1H), 7.16 (m, 1H), 6.93 (dd, 1H), 6.82 (m, 1H), 6.63 (d, 1H), 4.36 (dd, 1H), 3.45 (q, 2H), 3.33-3.15 (m, 5H), 2.98 (m, 1H), 2.22 (m, 1H), 2.07-1.85 (m, 5H), 1.15 (t, 3H), 1.09 (t, 3H)

Mass Spectral Analysis m/z = 380.2 $(M+H)^+$

EXAMPLE 27I

27I was obtained from **27H** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 8.89 (m, 2H), 8.52 (d, 1H), 7.68 (dd, 1H), 7.51 (d, 1H), 7.16 (m, 1H), 6.94 (m, 1H), 6.82 (m, 1H), 6.62 (m, 1H), 4.35 (m, 1H), 3.44 (q, 2H), 3.26 (m, 5H), 2.98 (m, 1H), 2.23 (m, 1H), 1.95 (m, 5H), 1.15 (t, 3H), 1.09 (t, 3H)

Mass Spectral Analysis m/z = 380.2 $(M+H)^+$

Elemental analysis:

$C_{23}H_{29}N_3O_2$, 1.3HCl, 1.4H_2O

Theory: %C 61.10; %H 7.38; %N 9.29; %Cl 10.19

Found: %C 61.01; %H 7.35; %N 9.21; %Cl 10.41

$[\alpha]_D^{25}$ = +4.46 (c = 9.65 mg/mL, MeOH)

EXAMPLE 27J

27J was obtained from **27H** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 9.08 (m, 2H), 8.53 (d, 1H), 7.70 (dd, 1H), 7.52 (d, 1H), 7.16 (m, 1H), 6.93 (m, 1H), 6.82 (m, 1H), 6.63 (m, 1H), 4.36 (m, 1H), 3.45 (q, 2H), 3.25 (m, 5H), 2.97 (m, 1H), 2.22 (m, 1H), 1.97 (m, 5H), 1.15 (t, 3H), 1.09 (t, 3H)

Mass Spectral Analysis *m/z* = 380.2 $(M+H)^+$

Elemental analysis:

$C_{23}H_{29}N_3O_2$, 2HCl, 1.75H_2O

Theory: %C 57.08; %H 7.19; %N 8.68; %Cl 14.65

Found: %C 56.92; %H 7.15; %N 8.58; %Cl 15.02

$[\alpha]_D^{25}$ = -3.55 (c = 10.3 mg/ml, MeOH)

EXAMPLE 27K

27K was obtained according to a procedure similar to the one described for **27A**, with the following exception:

Step 27.3: Method 27A was used and **1A** was replaced by **1O**.

^{1}H NMR (400MHz, DMSO d_6) δ 9.17-8.85 (m, 2H), 8.53 (d, 1H), 7.70 (dd, 1H), 7.52 (d, 1H), 7.06-6.94 (m, 2H), 6.41 (dd, 1H), 4.37 (dd, 1H), 3.49-3.35 (m, 2H), 3.32-3.14 (m, 5H), 2.97 (m, 1H), 2.23 (m, 1H), 2.05-1.82 (m, 5H), 1.15 (t, 3H), 1.09 (t, 3H)

Mass Spectral Analysis *m/z* = 398.3 $(M+H)^+$

EXAMPLE 27L

27L was obtained from **27K** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 9.15 (m, 2H), 8.54 (d, 1H), 7.72 (dd, 1H), 7.54 (d, 1H), 7.00 (m, 2H), 6.42 (dd, 1H), 4.38 (m, 1H), 3.45 (q, 2H), 3.25 (m, 5H), 2.96 (m, 1H), 2.22 (m, 1H), 1.96 (m, 5H), 1.15 (t, 2H), 1.09 (t, 3H)

Mass Spectral Analysis *m/z* = 398.3 $(M+H)^+$

Elemental analysis:

$C_{23}H_{28}FN_3O_2$, 2HCl, $1.75H_2O$

Theory: %C 55.04; %H 6.73; %Cl 14.13; %N 8.37

Found: %C 54.85; %H 6.53; %Cl 14.28; %N 8.45

$[\alpha]_D^{25} = +4.19$ (c = 10.2 mg/mL, MeOH)

EXAMPLE 27M

27M was obtained from **27K** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 9.14 (m, 2H), 8.54 (d, 1H), 7.79 (dd, 1H), 7.54 (d, 1H), 7.00 (m, 2H), 6.42 (dd, 1H), 4.38 (m, 1H), 3.45 (q, 2H), 3.25 (m, 5H), 2.96 (m, 1H), 2.23 (m, 1H), 1.96 (m, 5H), 1.15 (t, 3H), 1.09 (t, 3H)

Mass Spectral Analysis *m/z* = 398.3 $(M+H)^+$

Elemental analysis:

$C_{23}H_{28}FN_3O_2$, 2HCl, $1.75H_2O$

Theory: %C 55.04; %H 6.73; %N 8.37; %Cl 14.13

Found: %C 54.85; %H 6.66; %N 8.37; %Cl 14.31

$[\alpha]_D^{25} = -4.09$ (c = 10.25 mg/mL, MeOH)

EXAMPLE 27N

27N was obtained according to a procedure similar to the one described for **27A**, with the following exception:

Step 27.3: **1A** was replaced by **1S**.

Mass Spectral Analysis *m/z* = 408.3 $(M+H)^+$

EXAMPLE 27O

27O was obtained from **27N** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 8.93 (brs, 1H), 8.75 (brs, 1H), 8.50 (d, 1H), 7.65 (dd, 1H), 7.50 (d, 1H), 6.74 (s, 1H), 6.37 (s, 1H), 4.26 (m, 1H), 3.45 (q, 2H), 3.24 (m, 5H), 2.94 (m, 1H), 2.18 (m, 1H), 2.14 (s, 3H), 1.99 (s, 3H), 1.90 (m, 5H), 1.15 (t, 3H), 1.08 (t, 3H)

Mass Spectral Analysis *m/z* = 408.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{33}N_3O_2$, 1.25HCl, 1.63H_2O

Theory: %C 62.25; %H 7.84; %N 8.70; %Cl 9.19

Found: %C 62.52; %H 7.64; %N 8.30; %Cl 8.80

EXAMPLE 27P

27P was obtained from **27N** by chiral HPLC chromatography

^{1}H NMR (400MHz, DMSO d_6) δ 9.00 (brs, 1H), 8.82 (brs, 1H), 8.50 (d, 1H), 7.65 (dd, 1H), 7.50 (d, 1H), 6.74 (s, 1H), 6.37 (s, 1H), 4.26 (m, 1H), 3.45 (q, 2H), 3.24 (m, 5H), 2.94 (m, 1H), 2.18 (m, 1H), 2.13 (s, 3H), 1.99 (s, 3H), 1.88 (m, 5H), 1.15 (t, 3H), 1.09 (t, 3H)

Mass Spectral Analysis *m/z* = 408.3 $(M+H)^+$

Elemental analysis:

$C_{25}H_{33}N_3O_2$, 1.2HCl, 1.6H_2O

Theory: %C 62.54; %H 7.85; %N 8.75; %Cl 8.86

Found: %C 62.61; %H 7.73; %N 8.44; %Cl 8.52

EXAMPLE 27Q

Preparation of **27.6**:

A solution of **2.7a** (15.00 g, 30.45 mmol, 1 eq) in anhydrous dichloromethane (50 mL) and anhydrous methanol (100 mL) was hydrogenated at 1 atm, in the presence of palladium, 10 weight % (dry basis) on activated carbon, wet, Degussa type E101 NE/W (3.24 g, 1.52 mmol, 0.05 eq) for 10 h. The mixture was then filtered through celite and the filtrate was concentrated to dryness under reduced pressure. The product was used without further purification.

Yield: 99%

Mass Spectral Analysis *m/z* = 495.4 $(M+H)^+$

Preparation of **27Q**:

A 4.0M solution of hydrochloric acid in dioxane (41.9 mL, 167.46 mmol, 5.5 eq) was added drop wise to a cooled (0°C) solution of **27.6** (15.06 g, 30.45 mmol, 1 eq) in anhydrous methanol (50 mL). The mixture was warmed to room temperature and stirring was continued for an additional 10 h at room temperature. The mixture was

concentrated under reduced pressure. Diethyl ether (100 mL) was added to the solution. The resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 85%

^{1}H NMR (400MHz, DMSO d_6) δ 9.03 (m, 1H), 8.90 (m, 1H), 8.80 (s, 1H), 7.28 (m, 4H), 6.71 (d, 1H), 6.53 (m, 1H), 6.05 (d, 1H), 4.16 (m, 1H), 3.43 (m, 3H), 3.21 (m, 5H), 2.92 (m, 1H), 2.11 (m, 1H), 1.98 (m, 1H), 1.90 (m, 4H), 1.11 (m, 6H)

Mass Spectral Analysis *m/z* = 395.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{30}N_2O_2$, 1HCl, 0.75H2O

Theory: %C 64.85, %H 7.37, %N 6.30

Found: %C 65.12, %H 7.43, %N 6.18

EXAMPLE 27R

Preparation of **27R**:

27R was obtained from **27Q** by chiral HPLC chromatography

27Q (racemic mixture) (10 g, 23.20 mmol, 1 eq) was resolved using Chiral HPLC method:

Column: Chiralpak AD-H, 4.4 x 250mm

Column temperature: 25°C

Detection: UV at 230nm

Flow: 2.0 mL/minute

Mobile phase: 80% carbon dioxide, 20% ethanol, 0.1% ethane sulfonic acid

Run time: 24 min.

The relevant fractions were combined and concentrated under reduced pressure. An aqueous 1N solution of sodium hydroxide was added to the resulting oil until the solution was basic using pH paper. The aqueous mixture was extracted with dichloromethane. The organic extracts were combined, dried over sodium sulfate, filtered and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous methanol was added drop wise a 4M solution of anhydrous hydrochloric acid in dioxane (5.5 eq). The mixture was then stirred for 1 hour at room temperature and concentrated under reduced pressure. The crude product was

purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).

Yield: 30%

^{1}H NMR (400MHz, DMSO d_6) δ 9.19 (m, 1H), 9.05 (m, 1H), 7.31 (m, 4H), 6.73 (d, 1H), 6.54 (m, 1H), 6.05 (d, 1H), 4.16 (m, 1H), 3.42 (br s, 2H), 3.17 (br m, 6H), 2.91 (m, 1H), 2.11 (m, 1H), 1.98 (m, 1H), 1.90 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 395.1 $(M+H)^+$

Chiral HPLC purity: t_R = 9.932 min. (*ee* = >99%)

$[\alpha]_D^{24.2}$ = +21.49 (c. 0.01, MeOH)

EXAMPLE 27S

Preparation of **27S**:

27S was obtained from **27Q** by chiral HPLC chromatography

27Q (racemic mixture) (10 g, 23.20 mmol, 1 eq) was resolved using Chiral HPLC method:

Column: Chiralpak AD-H, 4.4 x 250mm

Column Temperature: 25°C

Detection: UV at 230nm

Flow: 2.0 mL/minute

Mobile Phase: 80% carbon dioxide, 20% ethanol, 0.1% ethane sulfonic acid

Run Time: 24 min.

The relevant fractions were combined and concentrated under reduced pressure. An aqueous 1N solution of sodium hydroxide was added to the resulting oil until the solution was basic using pH paper. The aqueous mixture was extracted with dichloromethane. The organic extracts were combined, dried over sodium sulfate, filtered and concentrated under reduced pressure. To a cold (0°C) solution of the resulting oil in anhydrous methanol was added drop wise a 4M solution of anhydrous hydrochloric acid in dioxane (5.5 eq). The mixture was then stirred for 1 h at room temperature and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).

Yield: 18%

^{1}H NMR (400MHz, DMSO d_6) δ 9.03 (m, 1H), 8.87 (m, 1H), 8.80 (s, 1H), 7.31 (m, 4H), 6.71 (d, 1H), 6.55 (d, 1H), 6.05 (m, 1H), 4.18 (m, 1H), 3.36 (m, 2H), 3.18 (m, 5H), 2.93 (m, 1H), 2.11 (m, 1H), 1.98 (m, 1H), 1.87 (m, 4H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 395.1 $(M+H)^+$

Chiral HPLC prity: t_R = 13.371 min. (*ee* = 98.1%)

$[\alpha]_D^{24.2}$ = -25.96 (c. 0.01, MeOH)

EXAMPLE 27T

Preparation of **27.1**:

A solution of **11.6a** (15.00 g, 27.95 mmol, 1 eq) in anhydrous methanol (100 mL) was hydrogenated at 70 psi in the presence of palladium hydroxide [$Pd(OH)_2$: Pearlman's catalyst] (1.96 g, 1.40 mmol, 0.05 eq) for 10 h. The mixture was filtered through celite. The filtrate was concentrated under reduced pressure and was hydrogenated at 70 psi in the presence of palladium hydroxide (1.96 g) for an additional 10 h. The mixture was filtered through celite and the filtrate was concentrated to dryness under reduced pressure. The crude product was used without further purification.

Yield: 84%

^{1}H NMR (400MHz, DMSO d_6) δ 7.23 (d, 2H), 7.11 (m, 3H), 6.60 (d, 1H), 6.52 (d, 1H), 4.85 (d, 1H), 4.74 (d, 1H), 4.16 (m, 1H), 3.61 (m, 2H), 3.30 (br m, 6H), 2.83 (s, 3H), 2.24 (m, 1H), 1.75 (m, 2H), 1.64 (m, 1H), 1.52 (m, 2H), 1.39 (s, 9H), 1.06 (m, 6H)

Mass Spectral Analysis *m/z* = 539.5 $(M+H)^+$

Preparation of **27T**:

To a cold (0°C) solution of **27.1** (2.00 g, 3.71 mmol, 1.0 eq) in anhydrous methanol (40 mL) was added drop wise a 4M solution of anhydrous hydrochloric acid in dioxane (9.3 mL, 37.20 mmol, 10.0 eq). The mixture was then stirred for 10 h at room temperature and concentrated under reduced pressure. Diethyl ether was added. The resulting precipitate was collected by filtration and washed with diethyl ether.

Yield: 99%

^{1}H NMR (400MHz, DMSO d_6) δ 9.30 (br s, 1H), 9.03 (br s, 1H), 8.96 (br s, 1H), 7.21 (d, 2H), 7.14 (d, 2H), 6.99 (t, 1H), 6.43 (d, 1H), 6.35 (d, 1H), 4.15 (m, 1H), 3.87 (br s, 3H), 3.39 (m, 2H), 3.15 (m, 5H), 2.90 (m, 1H), 2.25 (m, 1H), 1.83 (br m, 5H), 1.09 (m, 6H)

Mass Spectral Analysis *m/z* = 395.3 $(M+H)^+$

EXAMPLE 27U

Preparation of **27.4**:

Compound **27.1** (racemic mixture) (10 g, 18.56 mmol, 1 eq) was resolved using Chiral HPLC method:

Column: Chiralpak AD-H, 4.4 x 250mm

Column temperature: 25°C

Detection: UV at 280nm

Flow: 2.0 mL/minute

Mobile phase: 75% carbon dioxide, 25% isopropanol

Run time: 10 minutes.

The relevant fractions were combined and concentrated under reduced pressure. The crude product was used without further purification.

Yield: 79%

^{1}H NMR (400MHz, DMSO d_6) δ 7.21 (d, 2H), 7.11 (m, 3H), 6.60 (d, 1H), 6.55 (d, 1H), 4.83 (d, 1H), 4.74 (d, 1H), 4.16 (m, 1H), 3.62 (m, 2H), 3.15 (br m, 6H), 2.83 (s, 3H), 2.24 (m, 1H), 1.75 (m, 2H), 1.61 (m, 1H), 1.50 (m, 2H), 1.39 (s, 9H), 1.06 (m, 6H)

Mass Spectral Analysis *m/z* = 539.1 $(M+H)^+$

Chiral HPLC purity: t_R = 4.728 min. (*ee* = >99%)

$[\alpha]_D^{24.1}$ = -32.97 (c. 0.01, MeOH)

Preparation of **27U**:

To a cold (0°C) solution of **27.4** (1.00 g, 1.86 mmol , 1 eq) in anhydrous methanol was added drop wise a 4M solution of anhydrous hydrochloric acid in dioxane (2.5 mL, 10.21 mmol , 5.5 eq). The mixture was stirred for 10 hours at room temperature

and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).
Yield: 88%
^{1}H NMR (400MHz, DMSO d_6) δ 9.30 (s, 1H), 9.00 (m, 2H), 7.21 (d, 2H), 7.14 (d, 2H), 6.99 (t, 1H), 6.41 (d, 1H), 6.35 (d, 1H), 4.15 (m, 1H), 3.42 (br s, 5H), 3.12 (m, 2H), 2.90 (m, 1H), 2.24 (m, 1H), 1.83 (m, 4H), 1.72 (m, 1H), 1.09 (m, 6H)
Mass Spectral Analysis *m/z* = 395.1 $(M+H)^+$
$[\alpha]_D^{24.2}$ = +3.24 (c. 0.01, MeOH)

EXAMPLE 27V

Preparation of **27.5**:

27.1 (racemic mixture) (10 g, 18.56 mmol, 1 eq) was resolved using Chiral HPLC method:
Column: Chiralpak AD-H, 4.4 x 250mm
Column temperature: 25°C
Detection: UV at 280nm
Flow: 2.0 mL/minute
Mobile phase: 75% carbon dioxide, 25% isopropanol
Run time: 10 minutes.
The relevant fractions were combined and concentrated under reduced pressure. The crude product was used without further purification.
Yield: 83%
^{1}H NMR (400MHz, DMSO d_6) δ 7.23 (d, 2H), 7.11 (m, 3H), 6.58 (d, 1H), 6.54 (d, 1H), 4.85 (d, 1H), 4.73 (d, 1H), 4.16 (m, 1H), 3.63 (m, 2H), 3.16 (br m, 6H), 2.83 (s, 3H), 2.24 (m, 1H), 1.75 (m, 2H), 1.61 (m, 1H), 1.52 (m, 2H), 1.39 (s, 9H), 1.05 (m, 6H)
Mass Spectral Analysis *m/z* = 539.1 $(M+H)^+$
Chiral HPLC Method: t_R = 5.943 min. (*ee* = 98.7%)
$[\alpha]_D^{24.0}$ = +29.88 (c. 0.01, MeOH)

Preparation of **27V**:

To a cold (0°C) solution of **27.5** (1.00 g, 1.86 mmol, 1 eq) in anhydrous methanol was added drop wise a 4M solution of anhydrous hydrochloric acid in dioxane (2.5 mL, 10.21 mmol , 5.5 eq). The mixture was then stirred for 10 h at room temperature and concentrated under reduced pressure. The crude product was purified by column chromatography (eluent: dichloromethane/methanol mixtures of increasing polarity).
Yield: 92%

^{1}H NMR (400MHz, DMSO d_6) δ 9.32 (s, 1H), 9.09 (br s, 2H), 7.21 (d, 2H), 7.12 (d, 2H), 6.99 (t, 1H), 6.41 (d, 1H), 6.38 (d, 1H), 4.16 (m, 1H), 3.36 (m, 5H), 3.13 (br m, 2H), 2.90 (m, 1H), 2.24 (m, 1H), 1.81 (br m, 5H), 1.09 (m, 6H)

Mass Spectral Analysis *m/z* = 395.1 $(M+H)^+$

$[\alpha]_D^{24.3}$ = -6.35 (c. 0.01, MeOH)

EXAMPLE 27W

27W was obtained according to a procedure similar to the one described for **27A**, with the following exception:

Step 27.3: **1A** was replaced by **1E**.

^{1}H NMR (400MHz, $CDCl_3$) δ 7.34 (d, 2H), 7.18 (d, 2H), 6.96 (d, 1H), 6.78 (d, 1H), 6.54 (s, 1H), 4.06 (m, 1H), 3.72 (q, 1H), 3.55 (brm, 3H), 3.28 (brm, 3H), 3.17 (m, 1H), 3.03 (m, 1H), 2.14 (m, 5H), 1.97 (m, 2H), 1.49 (t, 1H), 1.20 (brd, 6H)

Mass Spectral Analysis *m/z* = 393.4 $(M+H)^+$

EXAMPLE 28A

Preparation of **28.2**:

To a solution of benzyl 4-oxopiperidine-1-carboxylate (**19.1**) (37.26 g, 160 mmol) in toluene (450 mL) were added ethyl cyanoacetate (**28.1**) (18.8 g , 166 mmol, 1.04 eq) , acetic acid (2 mL) and ammonium acetate (1.24 g, 16 mmol, 0.1 eq). The reaction mixture was refluxed for 2h with azeotropic removal of water formed during the reaction using a Dean-Stark trap. Additional ethyl cyanoacetate (10 g, 88.4 mmol, 0.55 eq), acetic acid (2 mL) and ammonium acetate (1.24 g, 6 mmol, 0.0375 eq) was added to the reaction mixture, which was then refluxed for 1.5h. Additional ethyl cyanoacetate (10 g, 88.4 mmol, 0.55 eq), acetic acid (2 mL) and ammonium acetate (1.24 g, 6 mmol, 0.0375 eq) were added, and refluxed for an additional 1h. The

reaction mixture was cooled to room temperature and washed with a saturated aqueous solution of sodium bicarbonate, and dried over sodium sulfate. The mixture was filtered and the filtrate was concentrated under vacuum. To the residue was added hexane (300 mL) and ethyl acetate (20 mL). The mixture was kept at room temperature overnight. The solid was collected by filtration, washed with hexane and dried under vacuum.

Yield: 87.7%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.35 (m, 5H), 5.19 (s, 2H), 4.30 (q, 2H), 3.70 (m, 2H), 3.63 (m, 2H), 3.18 (m, 2H), 2.80 (m, 2H), 1.39 (t, 3H)

Preparation of **28.4a**:

To a suspension of copper (I) cyanide (17.3 g, 193.2 mmol, 2.0 eq) in anhydrous tetrahydrofuran (400 mL) was added drop wise a 2.0 M solution of benzylmagnesium chloride (**28.3a**) (192 mL, 384 mmol, 4.0 eq) in tetrahydrofuran under a nitrogen atmosphere at 0°C. After the reaction mixture was stirred at room temperature for 2h, a solution of compound **28.2** (31.5 g, 96 mmol) in tetrahydrofuran (100 mL) was added dropwise at -30°C. After the addition, the reaction mixture was stirred at room temperature overnight, and then quenched with a saturated aqueous solution of ammonium chloride, and filtered. The filtrate was extracted by diethyl ether and the combined organic extracts were dried over sodium sulfate. The organics were concentrated under reduced pressure and the residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 4:1:1).

Yield: 100%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.35-7.20 (m, 10H), 5.11 (s, 2H), 4.25 (q, 2H), 3.72-3.50 (m, 5H), 3.06 (d, 1H), 2.91 (d, 1H), 1.90-1.65 (m, 4H), 1.32 (t, 3H)

Preparation of **28.6a**:

Concentrated sulfuric acid (210 mL) was added slowly to **28.4a** (38 g, 90.5 mmol) at 0°C. The mixture was warmed to room temperature, stirred for 30 min at room temperature, and then heated at 90°C overnight. The reaction mixture was cooled in an ice bath and carefully basified to pH = 9-10 with a 6 N aqueous solution of sodium

hydroxide. The mixture was extracted with methylene chloride, and the organic extracts were combined, dried over sodium sulfate and concentrated under vacuum. The residue was dissolved in methylene chloride (500 mL). To this solution was added triethylamine (30 mL, 215.6 mmol, 2.4 eq) followed by drop wise addition of benzyl chloroformate (**21.8**) (16 mL, 106.5 mmol, 1.2 eq) at 0°C. The reaction mixture was stirred at 0°C for 1h and then washed with a saturated aqueous solution of sodium bicarbonate. The organic layer was dried over sodium sulfate and concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 4:1:1).

Yield: 41.2%

^{1}H NMR (400MHz, $CDCl_3$) δ 8.00 (d, 1H), 7.50 (t, 1H), 7.33-7.23 (m, 7H), 5.11 (s, 2H), 2.98 (s, 2H), 2.62 (s, 2H), 1.50 (m, 4H)

Preparation of **28.7a**:

A 1.0 M solution of lithium bis(trimethylsilyl)amide in tetrahydrofuran (3.6 mL, 3.6 mmol, 1.2 eq) was added at -78°C to a solution of **28.6a** (1.047 g, 3.0 mmol) in tetrahydrofuran (30mL). After 45 min, a solution of **1.4** (1.3 g, 3.6 mmol, 1.2 eq) in tetrahydrofuran (8 mL) was added drop wise to the reaction mixture. The reaction mixture was then warmed to room temperature and stirred for 2.5 h, quenched by addition of water (40 mL), and extracted with a mixture of hexane and diethyl ether (1:1). The organic extracts were combined and washed with water, brine and dried over sodium sulfate. Evaporation of the solvent gave the crude product, which was used for the next step without further purification.

Yield: 100%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.35-7.18 (m, 9H), 5.98 (s, 1H), 5.11 (s, 2H), 3.70 (m, 2H), 3.40 (m, 2H), 2.83 (s, 2H), 1.66-1.56 (m, 4H)

Preparation of **28.8a**:

To the solution of crude **28.7a** (3 mmol) in dimethoxyethane (25 mL) was added sequentially a 2 N aqueous solution of sodium carbonate (5 mL, 10 mmol, 3.3 eq), lithium chloride (424 mg, 10 mmol, 3.3 eq), 4-(*N*,*N*-

diethylaminocarbonyl)phenylboronic acid (796 mg, 3.6 mmol, 1.2 eq) and tetrakis(triphenylphosphine)palladium(0) (104 mg, 0.09 mmol, 0.03 eq). The reaction mixture was refluxed overnight, cooled to room temperature, diluted with water (30 mL) and extracted with diethyl ether. The combined organic extracts were dried over sodium sulfate and concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 2:1:1).
Yield: 91.9%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.36-7.12 (m, 12H), 7.00 (d, 1H), 6.00 (s, 1H), 5.13 (s, 2H), 3.70 (m, 2H), 3.58 (m, 2H), 3.45 (m, 2H), 3.30 (m, 2H), 2.82 (s, 2H), 1.65-1.52 (m, 4H), 1.21 (m, 6H)

Preparation of **28A**:

Iodotrimethylsilane (0.29 mL, 2 mmol, 2 eq) was added to a solution of **28.8a** (508 mg, 1mmol) in anhydrous methylene chloride (10 mL) under a nitrogen athmosphere. The reaction mixture was stirred at room temperature for 2h and quenched with a 1N aqueous solution of hydrochloric acid (30 mL) and extracted with diethyl ether. The aqueous phase was basified to pH = 9-10 with a 3N aqueous solution of sodium hydroxide, and extracted with methylene chloride. The organic extracts were combined, dried over sodium sulfate and concentrated under vacuum. The residue was dissolved in methylene chloride (3 mL) and diluted with diethyl ether (15 mL). To this solution was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (1.5 mL, 3 mmol, 3.0 eq) and the reaction was stirred at room temperature for 30 min. The solid was collected by filtration, washed with diethyl ether and dried under vacuum.
Yield: 92.7%

^{1}H NMR (400MHz, $CDCl_3$) δ 8.90 (m, 2H), 7.40-7.20 (m, 7H), 6.97 (d, 1H), 6.20 (s, 1H), 3.42 (m, 2H), 3.20 (m, 6H), 2.82 (s, 2H), 1.70 (m, 4H), 1.10 (m, 6H)
Mass Spectral Analysis *m/z* = 375.1 $(M+H)^+$

EXAMPLE 28B

Preparation of **28.4b**:

Compound **28.4b** was prepared as described for **28.4a** except **28.3a** was replaced by **23.8b**.

Preparation of **28.9**:

To a solution of compound **28.4b** (29 g, 64.4 mmol) in dimethylsulfoxide (200 mL) was added sodium chloride (1.5 g, 25.6 mmol, 0.4 eq) and water (3.0 mL, 167 mmol, 2.6 eq). The reaction mixture was heated at 160°C for 2h and then cooled to room temperature. Water (600 mL) was added to the mixture and the crude product was extracted with diethyl ether. The organic extracts were combined, washed with water and brine, dried over sodium sulfate, and concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 4:1:1).
Yield: 94.8%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.35 (m, 5H), 7.08 (d, 2H), 6.83 (d, 2H), 5.12 (s, 2H), 3.80 (s, 3H), 3.68 (m, 2H), 3.40 (m, 2H), 2.74 (s, 2H), 2.21 (s, 2H), 1.60-1.52 (m, 4H)

Preparation of **28.10**:

To a solution of compound **28.9** (7.56 g, 20 mmol) in methanol (200 mL) was added concentrated sulfuric acid (40 mL). The mixture was heated at reflux for 2 days. The reaction mixture was cooled to 0°C, basified to pH = 9 by slow addition of a 6 N aqueous solution of sodium hydroxide, and then concentrated under vacuum to remove the methanol. The mixture was extracted with methylene chloride. The organic extracts were combined, dried over sodium sulfate, filtered and concentrated under vacuum. The residue was dissolved in methylene chloride (80 mL) and cooled to 0°C. To this solution was added triethylamine (9.6 mL, 69 mmol, 3.5 eq) and followed by drop wise addition of benzyl chloroformate (**21.8**) (6.4 mL, 95%, 42.7 mmol, 2.1 eq). The reaction mixture was stirred at 0°C for 1h, washed with a saturated aqueous solution of sodium bicarbonate, dried over sodium sulfate, filtered and concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 4:1:1).
Yield: 94.8%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.38 (m, 5H), 7.10 (d, 2H), 6.80 (d, 2H), 5.12 (s, 2H), 3.80 (s, 3H), 3.75 (m, 2H), 3.70 (s, 3H), 3.32 (m, 2H), 2.73 (s, 2H), 2.30 (s, 2H), 1.50 (m, 4H)

Preparation of **28.11**:

Compound **28.10** (2.06 g, 5 mmol) was dissolved in mixture of methanol (40 mL), tetrahydrofuran (40 mL) and water (40 mL). To this solution was added lithium hydroxide (1.52 g, 36 mmol, 7.2 eq) in one portion. The reaction mixture was stirred at room temperature overnight, concentrated under vacuum, acidified with a 3 N aqueous solution of hydrochloric acid and extracted with methylene chloride. The combined organic extracts were dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was used fro the next step without further purification.

Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) □ 12.22 (brs, 1H), 7.33 (m, 5H), 7.10 (d, 2H), 6.86 (d, 2H), 5.06 (s, 2H), 3.73 (s, 3H), 3.60 (m, 2H), 3.32 (m, 2H), 2.69 (s, 2H), 2.17 (s, 2H), 1.45-1.35 (m, 4H)

Preparation of **28.6b**:

To a solution of **28.11** (1.98 g, 5 mmol) in anhydrous methylene chloride (10 mL) was added a 2.0 M solution of oxalyl chloride in methylene chloride (20 mL, 40 mmol, 8.0 eq) followed by 2 drops of anhydrous *N,N*-dimethylformamide. The reaction mixture was stirred at room temperature for 4h and then concentrated under vacuum. The resulting acyl chloride was dissolved in anhydrous methylene chloride (100 mL) and aluminum chloride (1.35 g, 10 mmol, 2.0 eq) was added in one portion. The reaction mixture was stirred at room temperature overnight and then quenched with water (60 mL) followed by addition of concentrated ammonium hydroxide to basify the aqueous layer. The organic layer was separated and the aqueous layer was further extracted with methylene chloride. The combined organic extracts were dried over sodium sulfate, filtered and concentrated under vacuum. The residue was then dissolved in methylene chloride (60 mL) and cooled to 0°C. To this solution was added triethylamine (3.0 mL, 21.6 mmol, 4.3 eq) followed by benzyl chloroformate (**21.8**)

(2.0 mL, 13.3 mmol, 2.7 eq). The reaction mixture was stirred at 0°C for 1h and then washed with a saturated aqueous solution of sodium bicarbonate, dried over sodium sulfate, filtered and concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 4:1:1).
Yield: 89.7%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.48 (d, 1H), 7.35 (m, 5H), 7.16 (d, 1H), 7.10 (dd, 1H), 5.11 (s, 2H), 3.81 (s, 3H), 3.50 (m, 4H), 2.90 (s, 2H), 2.60 (s, 2H), 1.50 (m, 4H)

Preparation of **28B**:

28B was obtained from **28.6b** according to a procedure similar to the one described for **28A**.

^{1}H NMR (DMSO d_6) δ 8.90 (m, 2H), 7.48 (d, 2H), 7.40 (d, 2H), 7.26 (d, 1H), 6.85 (dd, 1H), 6.45 (d, 1H), 6.20 (s, 1H), 3.64 (s, 3H), 3.42 (m, 4H), 3.18 (m, 4H), 2.78 (s, 2H), 1.70 (m, 4H), 1.11 (m, 6H)
Mass Spectral Analysis *m/z* = 405.1 $(M+H)^+$

EXAMPLE 28C

Preparation of **28C**:

Compound **28.8a** (800 mg, 1.58 mmol) was dissolved in a mixture of methylene chloride (5 mL) and methanol (50 mL), and the reaction mixture was hydrogenated in the presence of 10% Pd/C (240 mg) using a hydrogen balloon. After 2 days at room temperature, the reaction mixture was filtered through celite and the filtrate was concentrated under vacuum. The residue was dissolved in methylene chloride (10 ml) and added 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (2 mL, 4 mmol, 2.5 eq). The mixture was stirred for 1 h at room temperature and then concentrated under vacuum.
Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) δ 9.12 (brs, 2H), 7.28-7.03 (m, 7H), 6.66 (d, 1H), 4.10 (m, 1H), 3.40 (m, 2H), 3.20-3.08 (m, 6H), 2.85 (d, 1H), 2.78 (d, 1H), 2.10 (m, 1H), 1.60 (m, 5H), 1.10 (m, 6H).

Mass Spectral Analysis *m/z* = 377.1 $(M+H)^+$

EXAMPLE 28D

28D was obtained according to a procedure similar to the one described for **28C**, with the following exception:

Step 28.12: **28.8a** was replaced by **28.8b**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.77 (m, 2H), 7.28 (m, 4H), 7.89 (d, 1H), 6.75 (dd, 1H), 6.16 (d, 1H), 4.09 (m, 1H), 3.55 (s, 3H), 3.49-3.00 (m, 8H), 2.73 (m, 2H), 2.10 (m, 1H), 1.59 (m, 5H), 1.10 (m, 6H)

Mass Spectral Analysis *m/z* = 407.3 $(M+H)^+$

EXAMPLE 28E

28E was obtained according to a procedure similar to the one described for **28A**, with the following exception:

Step 28.10: **1.6** was replaced by **1.7** (see also step 28.13).

^{1}H NMR (400MHz, DMSO d_6) 8.91 (m, 2H), 8.61 (s, 1H), 7.89 (d, 1H), 760 (d, 1H), 7.31-7.20 (m, 3H), 6.90 (d, 1H), 6.33 (s, 1H), 3.45-3.15 (m, 8H), 2.83 (s, 2H), 1.70 (m, 4H), 1.12 (m, 6H)

Mass Spectral Analysis *m/z* = 376.4 $(M+H)^+$

Elemental analysis:

$C_{24}H_{29}N_{30}$, 4/3HCl, $1H_2O$

Theory: %C 65.20; %H 7.37; %N 9.50; %C 10.69

Found: %C 64.94; %H 7.06; %N 9.36; %Cl 10.56

EXAMPLE 29A

Preparation of **29.2**:

To a solution of crude compound **28.7a** (12 mmol) in anhydrous tetrahydrofuran (200 mL) at room temperature was added a 0.5 M solution of 4-(ethoxycarbonyl)phenylzinc iodide (**29.1**) in tetrahydrofuran (60 mL, 30 mmol, 2.5 eq) followed by tetrakis(triphenylphosphine)palladium(0) (833 mg, 0.72 mmol, 0.06 eq). The reaction mixture was heated at 40°C for 2 days and then cooled to room temperature. The reaction was quenched by addition of a saturated aqueous solution of ammonium chloride and extracted with ethyl acetate. The organic extracts were

combined, dried over sodium sulfate and filtered. The organic extracts were concentrated under reduced pressure and the residue was purified by column chromatography (eluent: hexane/ethyl acetate, 5:1).
Yield: 86.6%

^{1}H NMR (400MHz, $CDCl_3$) δ 8.05 (d, 2H), 7.40-7.10 (m, 10H), 6.96 (d, 1H), 6.00 (s, 1H), 5.13 (s, 2H), 4.40 (q, 2H), 3.70 (m, 2H), 3.48 (m, 2H), 2.82 (s, 2H), 1.66-1.53 (m, 6H), 1.40 (t, 3H)

Preparation of **29.3**:

Lithium hydroxide (3.36 g, 80 mmol, 8.0 eq) was added to a solution of **29.2** (4.81 g, 10 mmol) in a mixture of methanol (100 mL), tetrahydrofuran (100 mL) and water (100 mL). The reaction mixture was stirred at room temperature overnight, concentrated under vacuum and acidified to pH = 1-2 with a 3N aqueous solution of hydrochloric acid. The acidified solution was extracted with methylene chloride and the organic extracts were combined, dried over sodium sulfate, filtered and concentrated under vacuum. The crude product was used for the next step without further purification.
Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) δ 13.00 (brs, 1H), 7.99 (d, 2H), 7.48 (d, 2H), 7.38-7.15 (m, 8H), 6.91 (d, 1H), 6.18 (s, 1H), 5.10 (s, 2H), 3.60-3.46 (m, 4H), 2.82 (s, 2H), 1.53 (m, 2H), 1.42 (m, 2H)

Preparation of **29.5a**:

To a solution of **29.3** (680 mg, 1.5 mmol, 1.0 eq)) in methylene chloride (40 mL) was added *iso*propylamine (**3.4h**) (0.26 mL, 3 mmol, 2.0 eq) followed by triethylamine (0.84 ml, 6 mmol, 4.0 eq) and the Mukaiyama acylating reagent (2-chloro-1-methylpyridinium iodide) (461 mg, 1.8 mmol, 1.2 eq). The reaction mixture was stirred at room temperature overnight, washed with a saturated aqueous solution of sodium bicarbonate, dried over sodium sulfate, and filtered. The organic extracts were concentrated under reduced pressure and the residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 2:1:1).

Yield: 95.8%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.78 (d, 2H), 7.40-7.10 (m, 10H), 6.94(d, 1H), 6.00 (s, 1H), 5.95 (d, 1H), 5.12 (s, 2H), 4.31 (m, 1H), 3.70 (m, 2H), 3.46 (m, 2H), 2.81 (s, 2H), 1.62-1.52 (m, 6H), 1.30 (d, 6H)

Preparation of **29A**:

Iodotrimethylsilane (0.37 mL, 2.6 mmol, 2.0 eq) was added to a solution **29.5** (620 mg, 1.26 mmol) in anhydrous methylene chloride (20 mL) under a nitrogen athmosphere. The reaction mixture was stirred at room temperature for 2h, quenched with a 1N aqueous solution of hydrochloric acid (40 mL), and the mixture was extracted with diethyl ether. The aqueous phase was basified to pH = 9-10 with a 3N aqueous solution of sodium hydroxide and extracted with methylene chloride. The organic extracts were combined, dried over sodium sulfate, filtered and concentrated under vacuum. The residue was dissolved in methylene chloride (4 mL) and diluted with diethyl ether (20 mL). To this solution was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (2.0 mL, 4 mmol, 3.2 eq) and the mixture was stirred at room temperature for 30 min. The resulting precipitate was collected by filtration, washed with diethyl ether and dried under vacuum.

Yield: 100%

^{1}H NMR (400MHz, DMSO d_6) δ 8.90 (brd, 2H), 8.29 (d, 1H), 7.90 (d, 2H), 7.43 (d, 2H), 7.31-7.16 (m, 3H), 6.90 (d, 1H), 6.18 (s, 1H), 4.11 (m, 1H), 3.16 (m, 4H), 2.86 (s, 2H), 1.70 (m, 4H), 1.20 (d, 6H)

Mass Spectral Analysis *m/z* = 361.0 $(M+H)^+$

EXAMPLE 29B

29B was obtained according to a procedure similar to the one described for **29A**, with the following exception:

Step 29.3: **3.4h** was replaced by **29.4**.

^{1}H NMR (400MHz, DMSO d_6) δ 8.89 (m, 2H), 8.10 (d, 1H), 7.92 (d, 2H), 7.45 (d, 2H), 7.31 (d, 1H), 7.25 (t, 1H), 7.20 (t, 1H), 6.90 (d, 1H), 6.18 (s, 1H), 3.80 (m, 1H), 3.20 (m, 4H), 2.88 (s, 2H), 1.60 (m, 8H), 0.90 (t, 6H)

Mass Spectral Analysis *m/z* = 389.1 $(M+H)^+$

EXAMPLE 29C

Preparation of **29.7**:

To a solution of the carboxylic acid **29.3** (1.82 g, 4 mmol) in a mixture of dioxane (18 mL) and *tert*-butyl alcohol (18 mL) was added triethylamine (0.78 mL, 5.6 mmol, 1.4 eq) and diphenylphosphoryl azide (**29.6**) (1.12 mL, 5.2 mmol, 1.3 eq). The reaction mixture was refluxed overnight and concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 5:1:1) to afford the desired crude carbamate **29.7**, which was used for the next step without further purification.
Yield: 33.4%

Preparation of **29.8**:

To a solution of the crude carbamate **29.7** (700 mg) in methylene chloride (15 mL) was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (15 mL, 30 mmol). The reaction mixture was stirred at room temperature overnight and then diethyl ether was added to the reaction mixture, which was stirred for an additional 2h at room temperature. The resulting precipitate was collected by filtration and used for the next step without further purification.
Yield: 57%

^{1}H NMR (400MHz, DMSO d_6) δ 10.15 (brs, 3H), 7.40-7.15 (12H), 6.89 (d, 1H), 6.10 (s, 1H), 5.10 (s, 2H), 3.59 (m, 2H), 3.46 (m, 2H), 2.81 (s, 2H), 1.54 (m, 2H), 1.41 (m, 2H)

Preparation of **29.10**:

Triethylamine (0.42 mL, 3 mmol) was added to a suspension of **29.8** (300 mg, 0.65 mmol) in methylene chloride (20 mL) at 0°C followed by drop wise addition of propionyl chloride (**29.9**) (0.12 mL, 1.3 mmol, 2.0 eq). The reaction mixture was stirred at room temperature for 6h and washed with a saturated aqueous solution of sodium bicarbonate. The organic layer was dried over sodium sulfate, filtered and

concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/methylene chloride/ethyl acetate, 2:1:1).
Yield: 89.5%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.54 (d, 2H), 7.38-7.10 (m, 11H), 7.00 (d, 1H), 5.95 (s, 1H), 5.12 (s, 2H), 3.70 (m, 2H), 3.44 (m, 2H), 2.80 (s, 2H), 2.42 (q, 2H), 1.60 (m, 2H), 1.50 (m, 2H), 1.28 (t, 3H)

Preparation of **29C**:

Iodotrimethylsilane (0.21 mL, 1.47 mmol, 2.0 eq) was added to a solution of compound **29.10** (220 mg, 0.46 mmol) in anhydrous methylene chloride (8 mL) under a nitrogen athmosphere. The reaction mixture was stirred at room temperature for 2h and quenched with a 1 N aqueous solution of hydrochloric acid (15 mL). The crude product was extracted with diethyl ether. The aqueous layer was basified to pH = 9-10 with a 3M aqueous solution of sodium hydroxide and the mixture was extracted with methylene chloride. The organic extracts were combined, dried over sodium sulfate and concentrated under vacuum. The residue was dissolved in methylene chloride (3 mL) and diluted with diethyl ether (10 mL). To this solution was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (0.7 mL, 1.4 mmol, 3.0 eq) and the mixture was stirred at room temperature for 30 min. The solid was collected by filtration, washed with diethyl ether and dried under vacuum.
Yield: 83.9%

^{1}H NMR (400 MHz, DMSO d_6) δ 10.05 (s, 1H), 8.94 (brd, 2H), 7.66 (d, 2H), 7.30-7.20 (m, 5H), 6.96 (d, 1H), 6.08 (s, 1H), 3.15 (m, 4H), 2.82 (s, 2H), 2.34 (q, 2H), 1.68 (m, 4H), 1.10 (t, 3H)
Mass Spectral Analysis *m/z* = 347.0 $(M+H)^+$

EXAMPLE 29D

Preparation of **29.11**:

Methanesulfonyl chloride (**7.4**) (0.051 mL, 0.66 mmol, 2.0 eq) was added to a solution of **29.8** (150 mg, 0.326 mmol) in pyridine (6 mL) at 0°C. The reaction mixture was stirred at room temperature overnight, diluted with methylene chloride

(40 mL) and washed with a 1N aqueous solution of hydrochloric acid and brine. The organic layer was dried over sodium sulfate and concentrated under vacuum. The residue was purified by column chromatography (eluent: hexane/ethyl acetate, 1:1).
Yield: 97.7%

^{1}H NMR (400MHz, $CDCl_3$) δ 7.38-7.13 (m, 12H), 6.99 (d, 1H), 6.50 (s, 1H), 5.96 (s, 1H), 5.12 (s, 2H), 3.70 (m, 2H), 3.46 (m, 2H), 3.08 (s, 3H), 2.81 (s, 2H), 1.62-1.52 (m, 4H)

Preparation of **29D**:

Iodotrimethylsilane (0.14 mL, 0.98 mmol, 3.5 eq) was added to a solution of **29.11** (140 mg, 0.28 mmol) in anhydrous methylene chloride (6 mL) under a nitrogen athmosphere. The reaction mixture was stirred at room temperature for 2h and quenched with a 1N aqueous solution of hydrochloric acid (10 mL). The crude product was extracted with diethyl ether. The aqueous layer was basified to pH = 9-10 with a 3N aqueous solution of sodium hydroxide and extracted with methylene chloride. The organic extracts were combined, dried over sodium sulfate, filtered and concentrated under vacuum. The residue was dissolved in methylene chloride (3 mL) and diluted with diethyl ether (10 mL). To this solution was added a 2.0 M solution of anhydrous hydrochloric acid in diethyl ether (0.42 mL, 0.84 mmol, 3.0 eq) and the mixture was stirred at room temperature for 30 min. The solid was collected by filtration, washed with diethyl ether and dried under vacuum.
Yield: 90.5%

^{1}H NMR (400MHz, DMSO d_6) δ ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.88 (s, 1H), 8.91 (brd, 2H), 7.35-7.18 (m, 7H), 6.96 (d, 1H), 6.09 (s, 1H), 3.12 (m, 4H), 3.02 (s, 3H), 2.82 (s, 2H), 1.68 (m, 4H)
Mass Spectral Analysis *m/z* = 368.9 $(M+H)^+$

EXAMPLE 30A

Preparation of **30.3**:

A mixture of **30.1** (10.2 g, 0.050 mol, 1.0 eq) and **30.2** (25 g, 0.075 mol, 1.5 eq) in toluene (100 mL) under nitrogen was refluxed for 2h. The mixture was concentrated

DEMANDE OU BREVET VOLUMINEUX

LA PRÉSENTE PARTIE DE CETTE DEMANDE OU CE BREVET COMPREND PLUS D'UN TOME.

CECI EST LE TOME 1 DE 2
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JUMBO APPLICATIONS/PATENTS

THIS SECTION OF THE APPLICATION/PATENT CONTAINS MORE THAN ONE VOLUME

THIS IS VOLUME 1 OF 2
CONTAINING PAGES 1 TO 403

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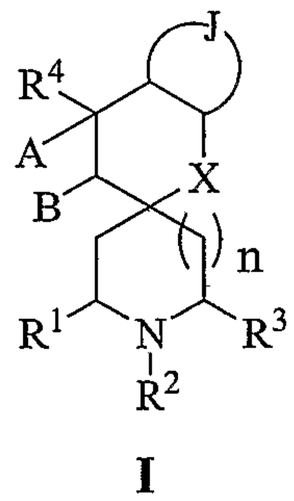
NOM DU FICHIER / FILE NAME :

NOTE POUR LE TOME / VOLUME NOTE:

What is claimed:

1. A compound of formula I:



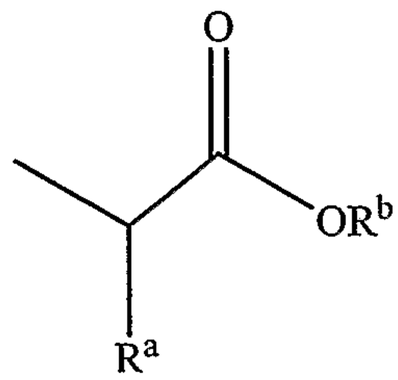
I

wherein:

R^1 and R^3 are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^1 and R^3 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

R^2 is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^1 and R^2 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^2 and R^3 when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

provided that R^2 is not



each R^a is independently H or alkyl;

each R^b is independently H, alkyl, or aryl;

n is the integer 0, 1, 2 or 3;

A and B are each independently H, fluoro, or alkyl, or together form a double bond between the carbon atoms to which they are attached;

R^4 is –Y-W;

Y is a single bond, $C(R^a)(R^b)$, $C(R^a)(R^b)C(R^a)(R^b)$, or $C(R^a)(R^b)C(R^a)(R^b)C(R^a)(R^b)$;

W is aryl or heteroaryl;

X is $-CH_2-$, -O-, -S-, -SO, $-SO_2$, or $-N(R^5)-$;

R^5 is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-COR^b$, or $-SO_2R^b$; and

J forms a 6-membered aryl or a 5- or 6-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

$-S-C_{1-4}$ alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl,

$-NH_2$,

$-N(C_{1-4}$ alkyl$)_2$, and

pyrrolyl;

n is 1,

R^1 and R^3 are each H,

A and B together form a double bond between the carbon atoms to which they are attached,

Y is a single bond; and

X is –O-;

then R^2 is other than H or methyl; and

provided that when:

(b) J taken together with the carbon atoms to which it is attached forms a phenyl ring,

W is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

-S-C_{1-4} alkyl,

n is 1,

R^1 and R^3 are each H,

A and B together form a double bond between the carbon atoms to which they are attached,

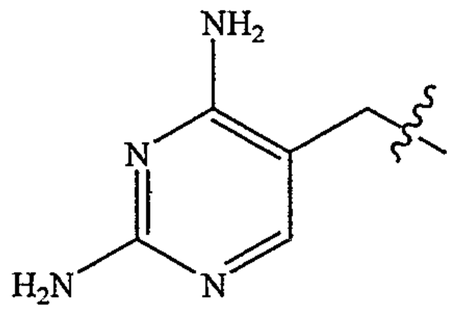
Y is a single bond; and

X is –O-;

then R^2 is other than H or benzyl; and

provided that when:

(c) J forms a 6-membered aryl ring, it is not substituted with:



;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

2. A compound according to claim 1, wherein J is -C-D-E- or -C-D-E-F-;

wherein C, D, E, and F are each independently -O-, -S-, -SO-, -SO_2-, =N-, =CH-, or -NH-;

wherein the latter two moieties are each independently optionally substituted;

provided that each -O- ring atom within J is directly attached only to carbon or nitrogen atoms;

provided that each -S- ring atom within J is directly attached only to carbon or nitrogen atoms; and

provided that when J is -C-D-E-F-, at least one of C, D, E, and F is =CH-.

3. A compound according to claim 1, wherein X is $-CH_2-$, -O-, -S-, -SO, or $-SO_2$.

4. A compound according to claim 1, wherein said X is -O-.

5. A compound according to claim 1,

wherein said J, taken together with the carbon atoms to which it is attached, forms an optionally substituted 6-membered aryl ring.

6. A compound according to claim 5, wherein said 6-membered aryl ring is optionally substituted phenyl.

7. A compound according to claim 1,

wherein said J, taken together with the carbon atoms to which it is attached, forms an optionally substituted 5- or 6-membered heteroaryl ring.

8. A compound according to claim 1, wherein R^1 and R^3 are each independently H, alkyl, alkenyl, or alkynyl.

9. A compound according to claim 8, wherein R^1 and R^3 are each independently H, C_1-C_3 alkyl, C_2-C_3 alkenyl, or C_2-C_3 alkynyl.

10. A compound according to claim 1, wherein at least one of R^1 and R^3 is H.

11. A compound according to claim 1, wherein R^2 is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl.

12. A compound according to claim 1, wherein R^2 is H or alkyl.

13. A compound according to claim 12, wherein R^2 is alkyl.

14. A compound according to claim 13, wherein R^2 is lower alkyl.

15. A compound according to claim 1, wherein n is the integer 1.

16. A compound according to claim 1, wherein R^1 and R^3 are each independently H, alkyl, or alkenyl.

17. A compound according to claim 1,

wherein A and B taken together form a double bond between the carbon atoms to which they are attached.

18. A compound according to claim 17, wherein n is the integer 1.

19. A compound according to claim 18, wherein at least one of R^1 and R^3 is H.

20. A compound according to claim 1, wherein A and B are each H.

21. A compound according to claim 20, wherein n is the integer 1.

22. A compound according to claim 21, wherein at least one of R^1 and R^3 is H.

23. A compound according to claim 1,

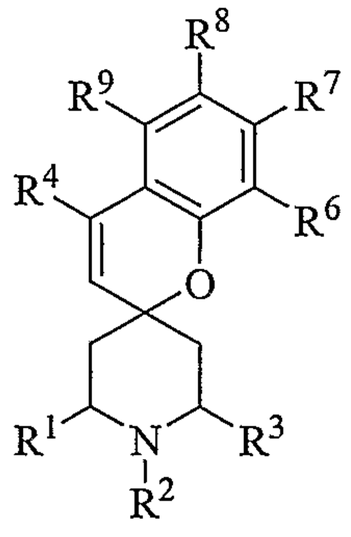
wherein:

R^4 is aryl substituted with $-C(=O)NR^{11}R^{12}$;

R^{11} is H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, heteroarylalkyl, or COR^{12}; and

each R^{12} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, or heteroarylalkyl, or R^{11} and R^{12} taken together with the nitrogen atom to which they are attached form a 4- to 8-membered heterocycloalkyl ring, wherein 1 or 2 of the heterocycloalkyl ring carbon atoms independently may be optionally replaced by -O-, -S-, -SO-, $-SO_2-$, –NH-, -N(alkyl)-, or –N(aryl)- groups.

24. A compound according to claim 1, of formula II:



II ;

wherein:

R^6, R^7, R^8 and R^9 are each independently H or $-(CH_2)_mR^{10}$;

m is the integer 0, 1, 2, 3, or 4;

each R^{10} is independently alkyl, halo, perhaloalkyl, $-OR^5$, $-OCF_2H$, $-OCF_3$, -CN, $-CO_2R^5$, $-C(=O)NR^{11}R^{12}$, $-S(=O)_2R^{13}$, $-S(=O)_2NR^{11}R^{12}$, $-NR^{11}R^{12}$, $-NR^{14}C(=O)R^{15}$, $-NR^{14}S(=O)_2R^{15}$, aryl, or heteroaryl;

each R^{11} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, heteroarylalkyl, or COR^{12};

each R^{12} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, or heteroarylalkyl, or R^{11} and R^{12} taken together with the nitrogen atom to which they are attached form a 4- to 8-membered heterocycloalkyl ring, wherein 1 or 2 of the heterocycloalkyl ring carbon atoms independently may be optionally replaced by -O-, -S-, -SO-, $-SO_2-$, –NH-, -N(alkyl)-, or –N(aryl)- groups;

each R^{13} is independently -OH, alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, or alkylcycloalkyl;

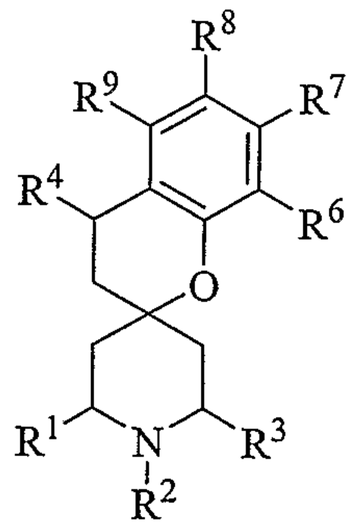
each R^{14} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, aryl, heteroaryl, alkylheterocycloalkyl, aralkyl, or heteroarylalkyl; and

each R^{15} is independently alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, alkylcycloalkyl, heterocycloalkyl, or alkylheterocycloalkyl.

25. A compound according to claim 24, wherein R^1 and R^3 are each H.

26. A compound according to claim 24, wherein R^4 is aryl substituted with $-C(=O)NR^{11}R^{12}$.

27. A compound according to claim 1, of formula III:



III

wherein:

R^6, R^7, R^8 and R^9 are each independently H or $-(CH_2)_mR^{10}$;

m is the integer 0, 1, 2, 3 or 4;

each R^{10} is independently alkyl, halo, perhaloalkyl, $-OR^5$, $-OCF_2H$, $-OCF_3$, $-CN$, $-CO_2R^5$, $-C(=O)NR^{11}R^{12}$, $-S(=O)_2R^{13}$, $-S(=O)_2NR^{11}R^{12}$, $-NR^{11}R^{12}$, $-NR^{14}C(=O)R^{15}$, $-NR^{14}S(=O)_2R^{15}$, aryl, or heteroaryl;

each R^{11} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, heteroarylalkyl, or COR^{12};

each R^{12} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, alkylheterocycloalkyl, aryl, heteroaryl, aralkyl, or heteroarylalkyl, or R^{11} and R^{12} taken together with the nitrogen atom to which they are attached form a 4- to 8-membered heterocycloalkyl ring, wherein 1 or 2 of the heterocycloalkyl ring carbon atoms independently may be optionally replaced by -O-, -S-, -SO-, $-SO_2$-, –NH-, -N(alkyl)-, or –N(aryl)- groups;

each R^{13} is independently -OH, alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, or alkylcycloalkyl;

each R^{14} is independently H, alkyl, cycloalkyl, heterocycloalkyl, alkylcycloalkyl, aryl, heteroaryl, alkylheterocycloalkyl, aralkyl, or heteroarylalkyl; and

each R^{15} is independently alkyl, aryl, aralkyl, heteroaryl, heteroarylalkyl, cycloalkyl, alkylcycloalkyl, heterocycloalkyl, or alkylheterocycloalkyl.

28. A compound according to claim 27, wherein R^1 and R^3 are each H.

29. A compound according to claim 27, wherein R^4 is aryl substituted with $-C(=O)NR^{11}R^{12}$.

30. A compound selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-6-fluoro-spiro[2H,1-benzopyran-2,4'-piperidine] hydrochloride;

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-6-hydroxyspiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-3,4-dihydrospiro[2H,1-benzopyran-2,4'-piperidine] hydrochloride;

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-*N*-methyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*-ethylaminocarbonyl)phenyl]spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*-propyl-*N*-cyclopropylmethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(isoindolineaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(4-carboxypiperidineaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(2*H*-tetrazolyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(4-carboxypropyl-tetrazol-2-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-(3-pyridyl)-spiro[2H,1-benzopyran-2,4'-piperidine];

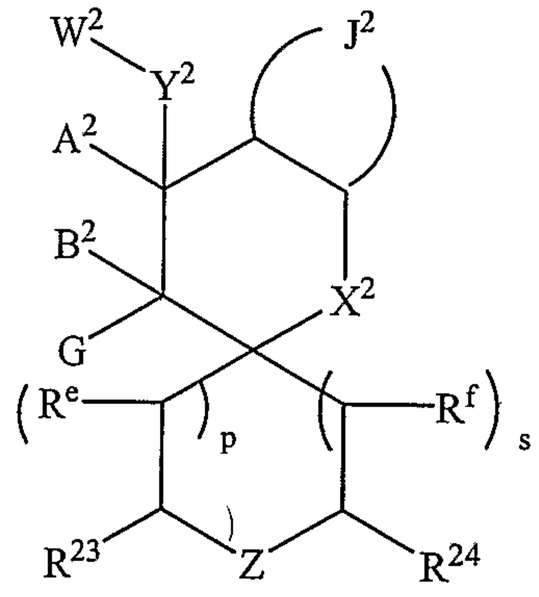
4-[4-(methanesulfonyl)-phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]spiro[2H,1-benzopyran-2,4'-nortropine];

or

a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

31. A compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

-C(=O)-H

-S-C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H,

-N(C_{1-4} alkyl)S(=O)$_2$-H,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

-NH_2,

-N=C(aryl)$_2$,

-N(H)C_{1-4} alkyl,

-N(C_{1-4} alkyl)$_2$,

-OS(=O)$_2$-C_{1-4} alkyl optionally substituted with one or more halogens,

-OS(=O)$_2$-C_{6-12} aryl optionally substituted with C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-N(C_{1-4} alkyl)S(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H, and

-N(C_{1-4} alkyl)S(=O)$_2$-H;

p and s are each 1,

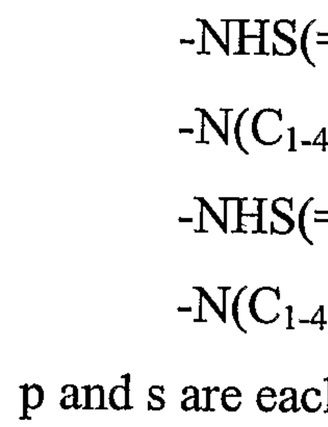
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



, wherein t is an integer from 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-S-C_{1-4} alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

$-NH_2$,

$-N(C_{1-4}\text{ alkyl})_2$, and

pyrrolyl;

p and s are each 1,

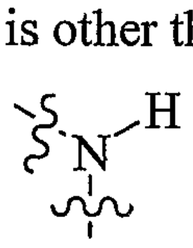
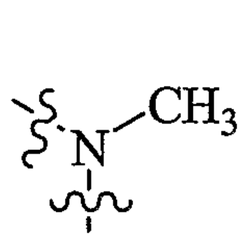
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:


or

; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached forms unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

$-S-C_{1-4}$ alkyl,

p and s are each 1,

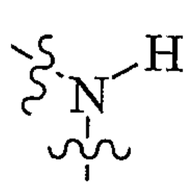
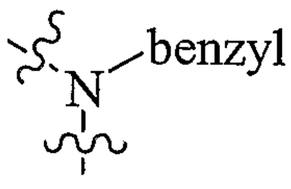
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond,

Y^2 is a single bond; and

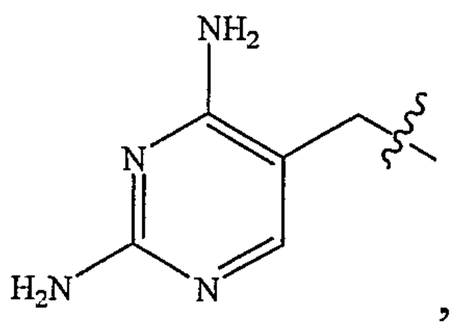
X^2 is –O-;

then Z is other than:

 or  ; and

provided that when:

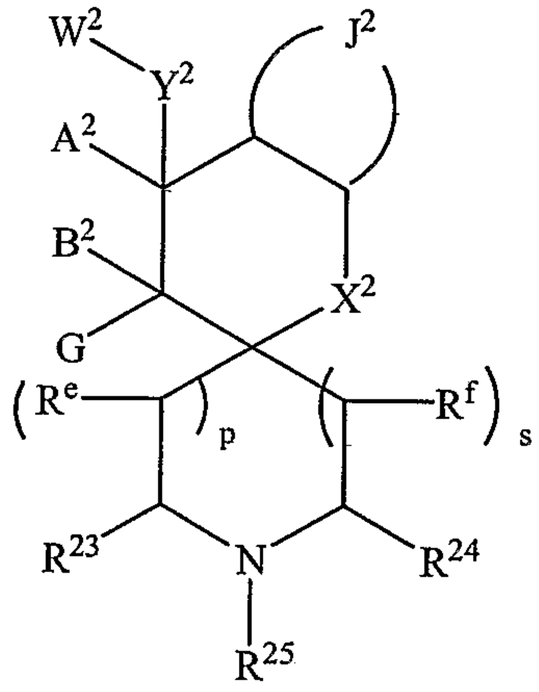
(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:

 , then Z is other than $-N(R^{25})-$ or $-CH(NH_2)-$;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

32. A compound according to claim 31, wherein Z is $-N(R^{25})-$, -CH(OH)-, or $-CH(NR^cR^d))-$.

33. A compound according to claim 31 of formula V:



V

34. A compound according to claim 31, wherein Y^2 is a single bond.

35. A compound according to claim 31, wherein W^2 is aryl, alkaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl.

36. A compound according to claim 31, wherein R^{23} and R^{24} are each independently H, alkyl, alkenyl, or alkynyl.

37. A compound according to claim 36, wherein R^{23} and R^{24} are each independently H, C_1-C_3 alkyl, C_2-C_3 alkenyl, or C_2-C_3 alkynyl.

38. A compound according to claim 31, wherein at least one of R^{23} and R^{24} is H.

39. A compound according to claim 31, wherein R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl.

40. A compound according to claim 31 wherein R^{25} is H or alkyl.

41. A compound according to claim 31, wherein p is 1 or 2.

42. A compound according to claim 41, wherein s is 1.

43. A compound according to claim 31, wherein s is 1.

44. A compound according to claim 31, wherein A^2 and B^2 are each independently H, fluoro, or alkyl.

45. A compound according to claim 31, wherein A^2 and B^2 are each H.

46. A compound according to claim 31, wherein A^2 and B^2 taken together form a double bond between the carbon atoms to which they are attached.

47. A compound according to claim 31, wherein G is H.

48. A compound according to claim 31, wherein X^2 is $-CH_2$-, -O-, -S-, -S(=O)-, -S(=O)$_2$-, or $-N(R^{26})$-.

49. A compound according to claim 48, wherein X^2 is -CH_2-, -O-, or -S(=O)$_2$.

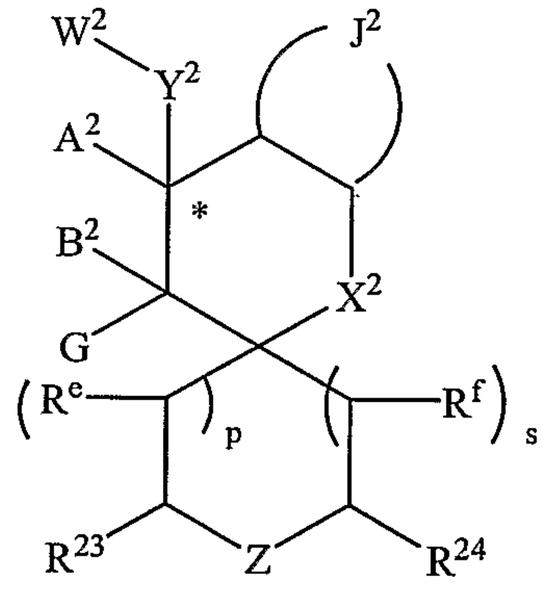
50. A compound according to claim 49, wherein X^2 is -CH_2- or -O-.

51. A compound according to claim 50, wherein X^2 is -O-.

52. A compound according to claim 31, wherein J^2 forms a 6- to 10-membered aryl ring when taken together with the carbon atoms to which it is attached.

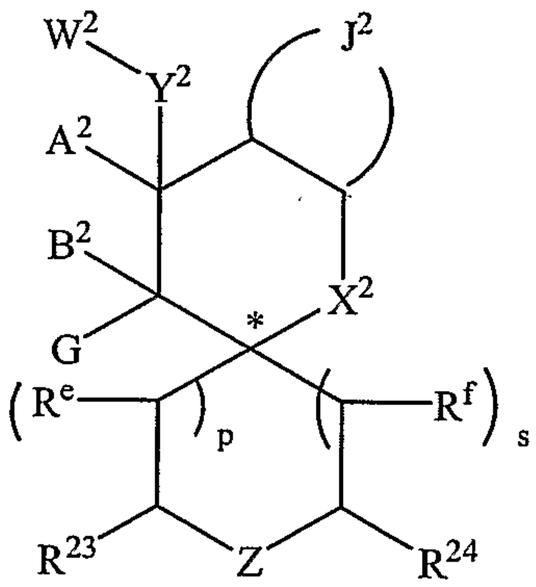
53. A compound according to claim 52, wherein J^2 forms a 6-membered aryl ring when taken together with the carbon atoms to which it is attached.

54. A compound according to claim 44 of formula VI:



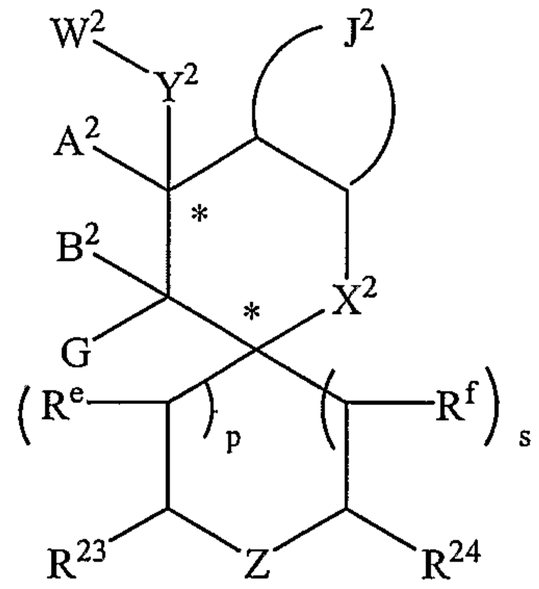
VI

55. A compound according to claim 31 of formula VII:



VII

56. A compound according to claim 44 of formula VIII:



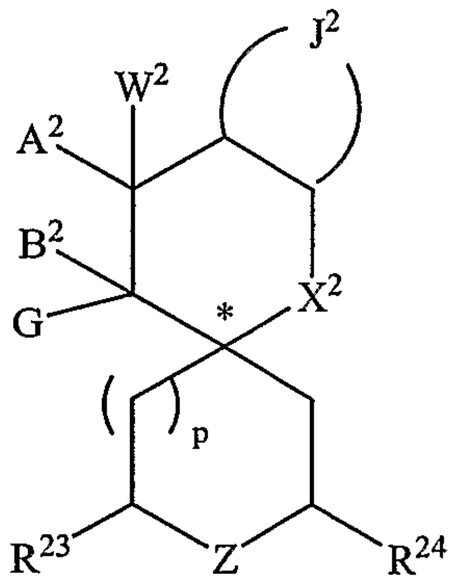
VIII

57. A compound according to claim 32, wherein Y^2 is a single bond.

58. A compound according to claim 57, wherein X^2 is $-CH_2-$ or-O.

59. A compound according to claim 58, wherein p is 1 or 2 and s is 1.

60. A compound according to claim 59 of formula IX:



IX

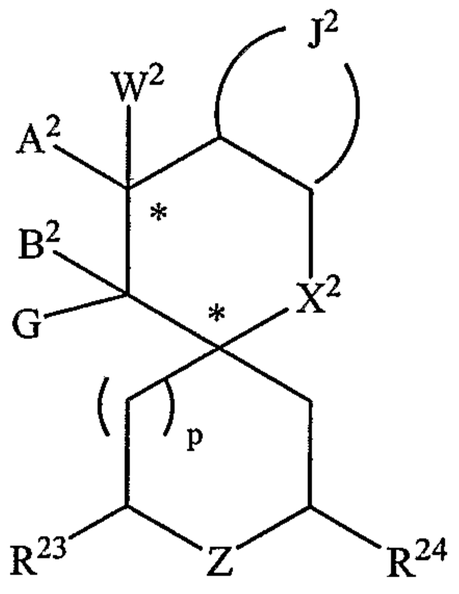
61. A compound according to claim 59 of formula X:

X ;

wherein

A^2 and B^2 are each independently H, fluoro, or alkyl.

62. A compound according to claim 61 of formula XI:



XI .

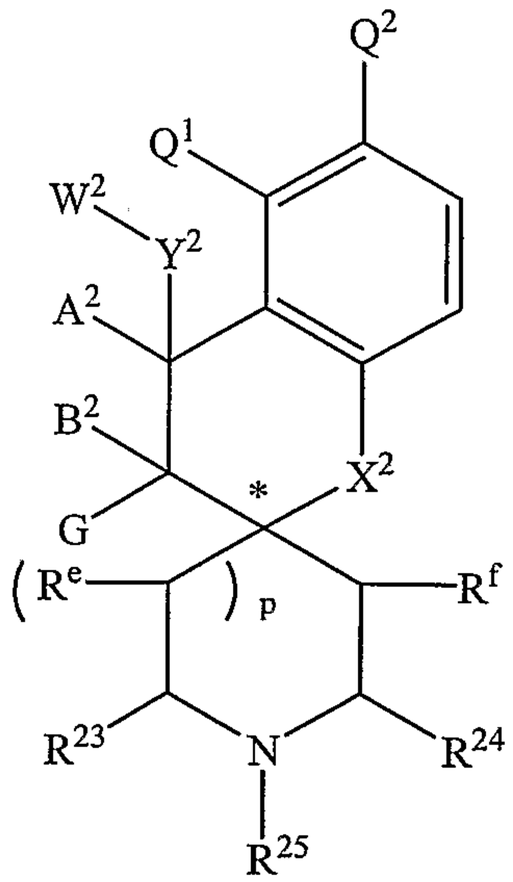
63. A compound according to claim 60, wherein Z is $-N(R^{25})-$.

64. A compound according to claim 63, wherein W^2 is aryl, alkaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl.

65. A compound according to claim 64, wherein said aryl, alkaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl in W^2 is optionally substituted with at least one of alkyl, aryl, hydroxyl, carboxyl, *N*,*N*-dialkylaminocarbonyl, $-S(=O)_2-N(alkyl)_2$, $-N(H)S(=O)_2$-alkyl, and $-N(alkyl)C(=O)$-alkyl.

66. A compound according to claim 65, wherein J^2 forms a 6-membered aryl ring when taken together with the carbon atoms to which it is attached.

67. A compound according to claim 66 of formula XII:

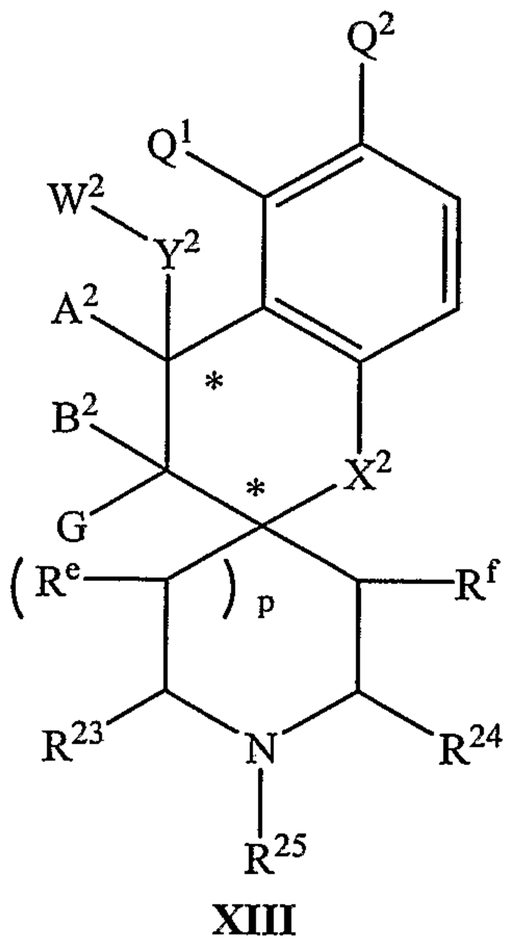


XII ;

wherein:

Q^1 and Q^2 are each independently H, halo, alkyl, hydroxyl, alkoxyl, cycloalkyl substituted alkoxyl, aminocarbonyl, $-S(=O)_2$-alkyl, $-S(=O)_2$-N(H)alkyl, $-S(=O)_2$-N(H)cycloalkylalkyl, or $-N(H)S(=O)_2$-alkyl.

68. A compound according to claim 67 of formula XIII:

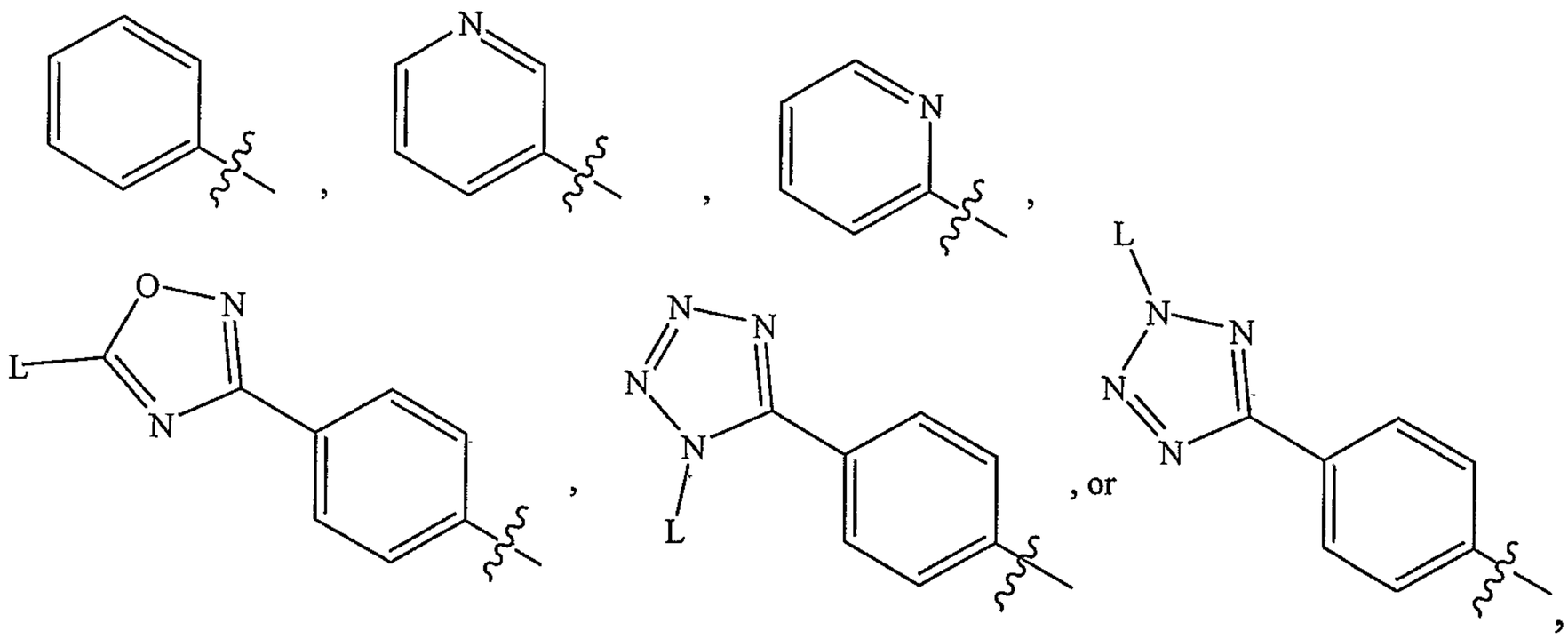


XIII

wherein:

A^2 and B^2 are each independently H, fluoro, or alkyl.

69. A compound according to claim 67, wherein W^2 is:



wherein W^2 is optionally substituted with at least one of alkyl, aryl, hydroxyl, carboxyl, *N*,*N*-dialkylaminocarbonyl, -S(=O)$_2$-N(alkyl)$_2$, -N(H)S(=O)$_2$-alkyl, and –N(alkyl)C(=O)-alkyl; and L is H or alkyl.

70. A compound according to claim 31, selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[5-methoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-hydroxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[1,2-dihydronaphthalene-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-2-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-3-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-3-methyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[-6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-aminocarbonyl-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-propylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(5-*N*,*N*-diisopropylaminocarbonyl)pyrid-2-yl]-spiro[2H,1-benzopyran-2,4'-piperidine

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-ethylsulfonylamino-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-methylsulfonylamino-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-methyl-2H,1-benzopyran-2,4'-piperidine];

4-[4-(2*H*-tetrazol-5-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(2-methyl-tetrazol-5-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[3-(2-(3-carboxyprop-1-yl)-tetrazol-5-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[4-(5-Methyl-[1,2,4]oxadiazol-3-yl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-(1'-methyl-piperidine)];

4-[(4-*N*,*N*-diethylaminosulfonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

4-[(4-(*N*-methyl-*N*-(3-methylbutanoyl)-amino)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

71. A compound according to claim 70, selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[5-methoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-hydroxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[1,2-dihydronaphthalene-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-2-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl-3-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-3-methyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[-6-cyclopropylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-aminocarbonyl-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-propylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-3,4-dihydro-2H,1-benzopyran-2,4'-piperidine]; and

4-[(5-*N*,*N*-diisopropylaminocarbonyl)pyrid-2-yl]-spiro[2H,1-benzopyran-2,4'-piperidine];

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

72. A compound according to claim 71, selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-fluoro-2H,1-benzopyran-2,4'-piperidine];

4-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[5-methoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[5-hydroxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[1,2-dihydronaphthalene-2,4'-piperidine];

4-[(2-N,N-diethylaminocarbonyl)pyrid-5-yl]-spiro[6-cyclopropyylmethoxy-2H,1-benzopyran-2,4'-piperidine];

4-[(4-N,N-diethylaminocarbonyl)phenyl]-spiro[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl-2-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

4-[(4-*N*,*N*-diethylaminocarbonyl-3-hydroxy)phenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

73. A compound according to claim 54, selected from the group consisting of:

4*-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine]; and

4*-[(2-*N*,*N*-diethylaminocarbonyl)pyrid-5-yl]-spiro[3,4-dihydro-2H,1-benzopyran-2,4'-piperidine];

or a partial stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

74. A compound according to claim 55, selected from the group consisting of:

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[6-cyclopropylmethylaminosulfonyl-2H,1-benzopyran-2,4'-azepane];

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[6-propylaminosulfonyl-2H,1-benzopyran-2,4'-azepane]; and

4-[(4-*N*,*N*-diethylaminocarbonyl)phenyl]-spiro*[6-methanesulfonyl-2H,1-benzopyran-2,4'-azepane];

or a partial stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

75. A compound according to claim 31, wherein R^e and R^f are each independently H or C_1-C_3 alkyl.

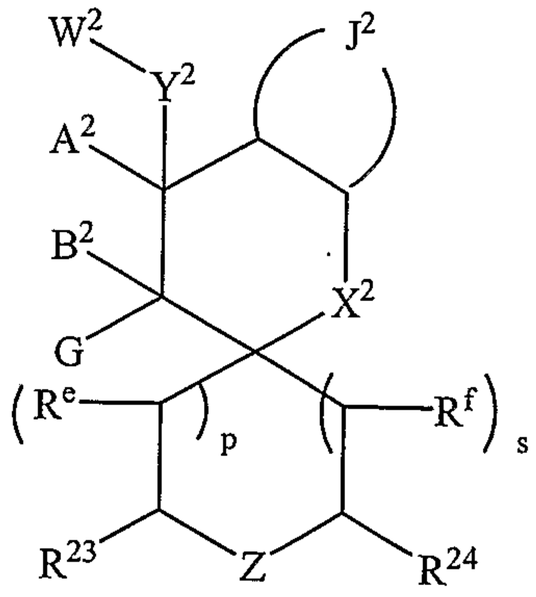
76. A compound according to claim 75, wherein R^e and R^f are each independently H or methyl.

77. A compound according to claim 76, wherein at least one of R^e and R^f is H.

78. A compound according to claim 77, wherein R^e and R^f are each H.

79. A pharmaceutical composition, comprising:

a pharmaceutically acceptable carrier; and a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

-C(=O)-H

-S-C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H,

-N(C_{1-4} alkyl)S(=O)$_2$-H,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

-NH_2,

-N=C(aryl)$_2$,

-N(H)C_{1-4} alkyl,

-N(C_{1-4} alkyl)$_2$,

-OS(=O)$_2$-C_{1-4} alkyl optionally substituted with one or more halogens,

-OS(=O)$_2$-C_{6-12} aryl optionally substituted with C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-N(C_{1-4} alkyl)S(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H, and

-N(C_{1-4} alkyl)S(=O)$_2$-H;

p and s are each 1,

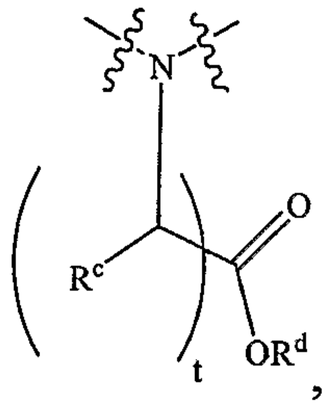
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



, wherein t is an integer from 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-S-C_{1-4} alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

$-NH_2$,

$-N(C_{1-4}$ alkyl$)_2$, and

pyrrolyl;

p and s are each 1,

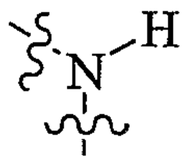
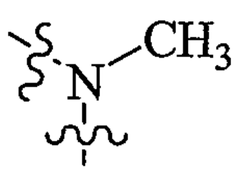
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:

 or  ; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached is unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

$-S-C_{1-4}$ alkyl,

p and s are each 1,

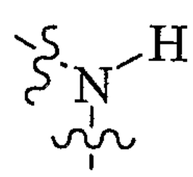
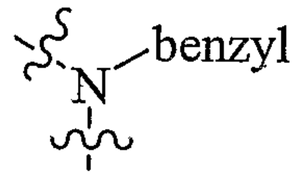
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

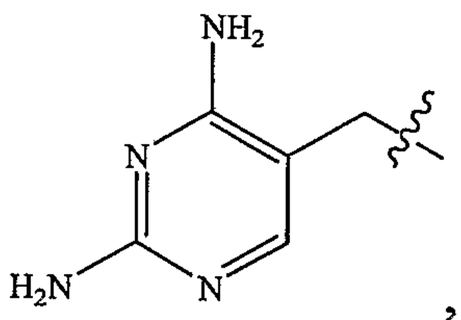
X^2 is –O-;

then Z is other than:


or

; and

provided that when:

(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:


, then Z is other than $–N(R^{25})-$ or $-CH(NH_2)-$;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

80. A pharmaceutical composition according to claim 79, further comprising an opioid, an agent for the treatment of neuralgia/neuropathic pain, an agent for the treatment of depression, an agent for the treatment of incontinence, or an antiParkinson's agent.

81. A pharmaceutical composition according to claim 80,

wherein said opioid is alfentanil, allylprodine, alphaprodine, anileridine, benzylmorphine, bezitramide, buprenorphine, butorphanol, clonitazene, codeine, cyclazocine, desomorphine, dextromoramide, dezocine, diampromide, diamorphone, dihydrocodeine, dihydromorphine, dimenoxadol, dimepheptanol, dimethylthiambutene, dioaphetylbutyrate, dipipanone, eptazocine, ethoheptazine, ethylmethylthiambutene, ethylmorphine, etonitazene, fentanyl, heroin, hydrocodone, hydromorphone, hydroxypethidine, isomethadone, ketobemidone, levallorphan, levorphanol, levophenacylmorphan, lofentanil, loperamide, meperidine, meptazinol, metazocine, methadone, metopon, morphine, myrophine, nalbuphine, narceine, nicomorphine,

norlevorphanol, normethadone, nalorphine, normorphine, norpinanone, opium, oxycodone, oxymorphone, papaveretum, pentazocine, phenadoxone, phenomorphan, phanazocine, phenoperidine, piminodine, piritramide, propheptazine, promedol, properidine, propiram, propoxyphene, sulfentanil, tilidine, tramadol, a diastereoisomer thereof, a pharmaceutically acceptable salt thereof, a complex thereof, or a mixture thereof.

82. A pharmaceutical composition according to claim 80, wherein said agent for the treatment of neuralgia/neuropathic pain is a mild OTC analgesic, a narcotic analgesic, an anti seizure medication or an anti-depressant.

83. A pharmaceutical composition according to claim 80, wherein said agent for the treatment of depression is a selective serotonin re-uptake inhibitor, a tricyclic compound, a monoamine oxidase inhibitor, or an antidepressent compound belonging to the heterocyclic class.

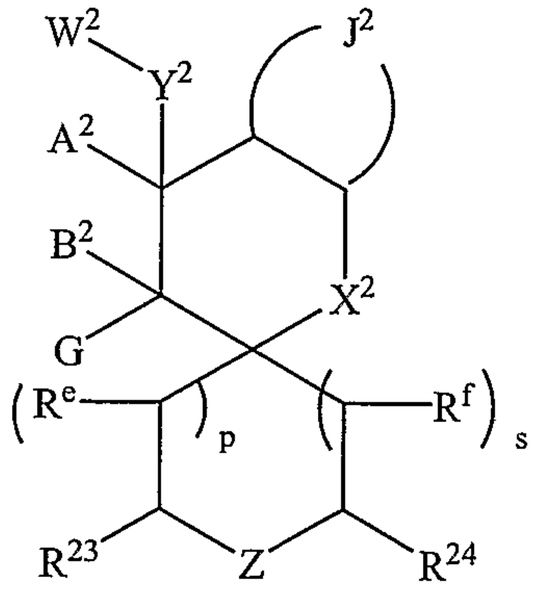
84. A pharmaceutical composition according to claim 80, wherein said agent for the treatment of urge incontinence is an anticholinergic agent, an antispasmodic medication, a tricyclic antidepressant, a calcium channel blocker or a beta agonist.

85. A pharmaceutical composition according to claim 80, further comprising:

an antibiotic, antiviral, antifungal, anti-inflammatory, anesthetic, or mixture thereof.

86. A method of binding opioid receptors in a patient in need thereof, comprising the step of:

administering to said patient an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

87. A method according to claim 86,

wherein said compound binds δ opioid receptors.

88. A method according to claim 87,

wherein said δ opioid receptors are located in the central nervous system.

89. A method according to claim 87,

wherein said δ opioid receptors are located peripherally to the central nervous system.

90. A method according to claim 86,

wherein said binding modulates the activity of said opioid receptors.

91. A method according to claim 90,

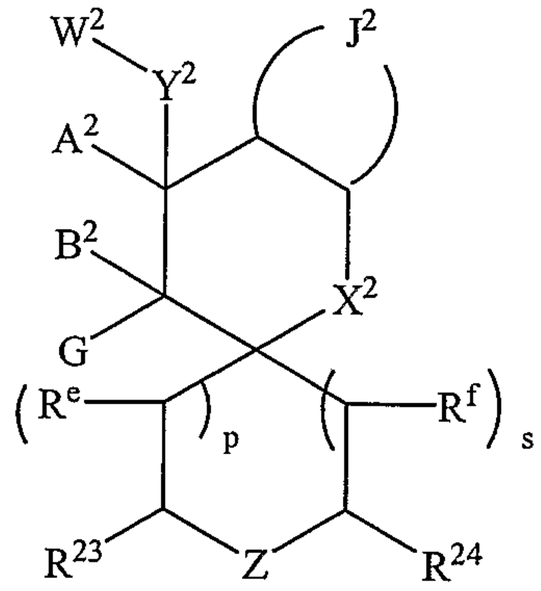
wherein said binding agonizes the activity of said opioid receptors.

92. A method according to claim 88,

wherein said compound does not substantially cross the blood-brain barrier.

93. A method of preventing or treating pain, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

94. A method according to claim 93, further comprising the step of:

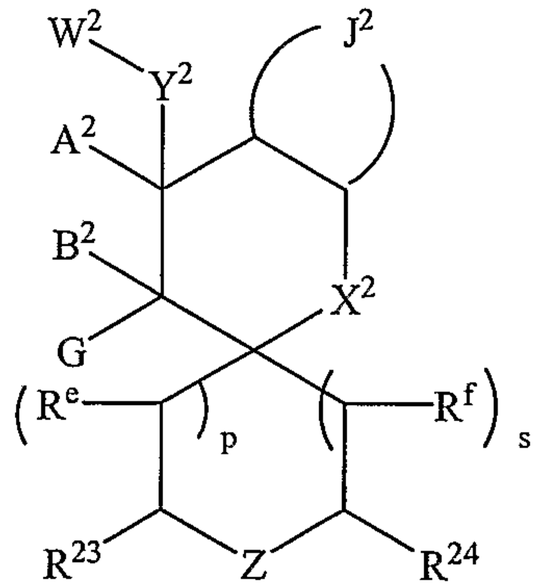
administering to said patient an effective amount of an opioid.

95. A method according to claim 94,

wherein said opioid is alfentanil, allylprodine, alphaprodine, anileridine, benzylmorphine, bezitramide, buprenorphine, butorphanol, clonitazene, codeine, cyclazocine, desomorphine, dextromoramide, dezocine, diampromide, diamorphone, dihydrocodeine, dihydromorphine, dimenoxadol, dimepheptanol, dimethylthiambutene, dioaphetylbutyrate, dipipanone, eptazocine, ethoheptazine, ethylmethylthiambutene, ethylmorphine, etonitazene, fentanyl, heroin, hydrocodone, hydromorphone, hydroxypethidine, isomethadone, ketobemidone, levallorphan, levorphanol, levophenacylmorphan, lofentanil, loperamide, meperidine, meptazinol, metazocine, methadone, metopon, morphine, myrophine, nalbuphine, narceine, nicomorphine, norlevorphanol, normethadone, nalorphine, normorphine, norpinanone, opium, oxycodone, oxymorphone, papaveretum, pentazocine, phenadoxone, phenomorphan, phanazocine, phenoperidine, piminodine, piritramide, propheptazine, promedol, properidine, propiram, propoxyphene, sulfentanil, tilidine, tramadol, a diastereoisomer thereof, a pharmaceutically acceptable salt thereof, a complex thereof, or a mixture thereof.

96. A method for preventing or treating gastrointestinal dysfunction, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

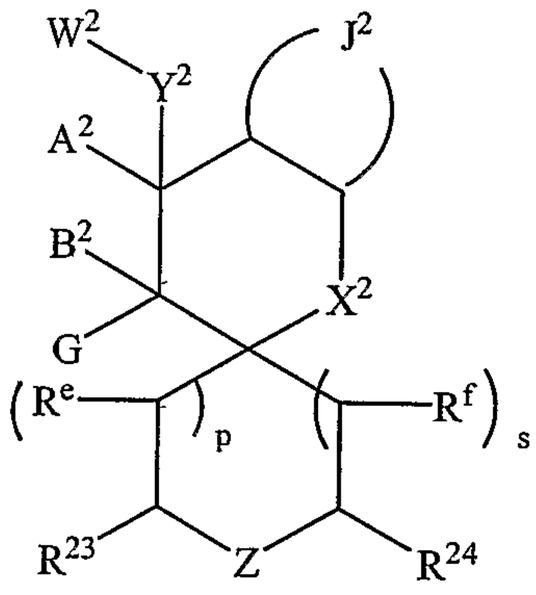
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

97. A method for preventing or treating a urogenital tract disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

98. A method according to claim 97,

wherein said urogenital tract disorder is incontinence or overactive bladder.

99. A method according to claim 98, wherein said incontinence is stress urinary incontinence or urge urinary incontinence.

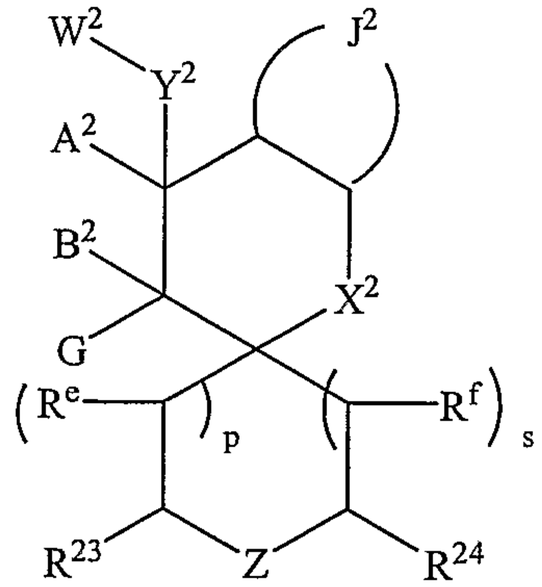
100. A method according to claim 98, wherein said urogenital tract disorder is overactive bladder.

101. A method according to claim 98 further comprising the step of:

administering to said patient an effective amount of an agent for the treatment of incontinence.

102. A method of preventing or treating an immunomodulatory disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

103. A method according to claim 102,

wherein said immunomodulatory disorder is selected from the group consisting of:

an autoimmune disease, a collagen disease, an allergy, a side effect associated with the administration of an anti-tumor agent, and a side effect associated with the administration of an antiviral agent.

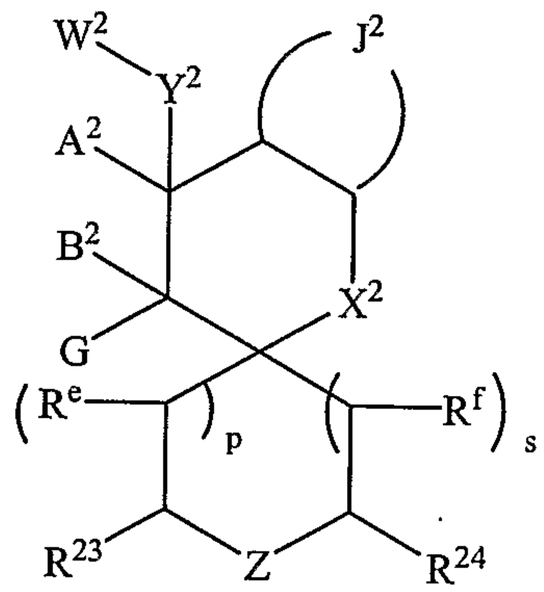
104. A method according to claim 103,

wherein said autoimmune disease is selected from the group consisting of:

arthritis, an autoimmune disorder associated with a skin graft, an autoimmune disorder associated with organ transplant, and an autoimmune disorder associated with surgery.

105. A method for preventing or treating an inflammatory disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

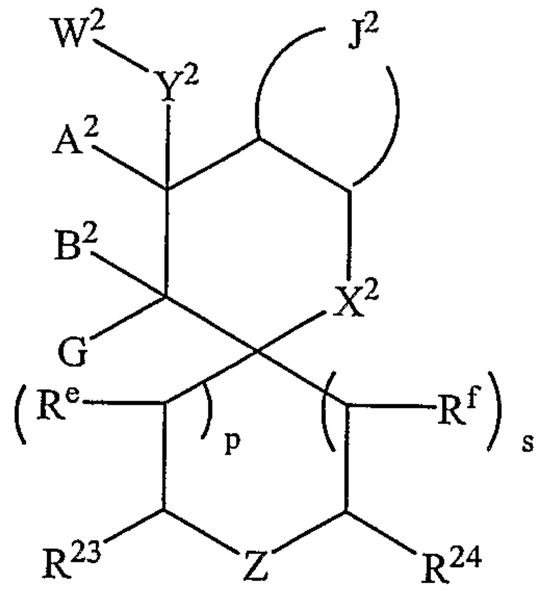
or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

106. A method according to claim 105,

wherein said inflammatory disorder is arthritis, psoriasis, asthma, or inflammatory bowel disease.

107. A method for preventing or treating a respiratory function disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

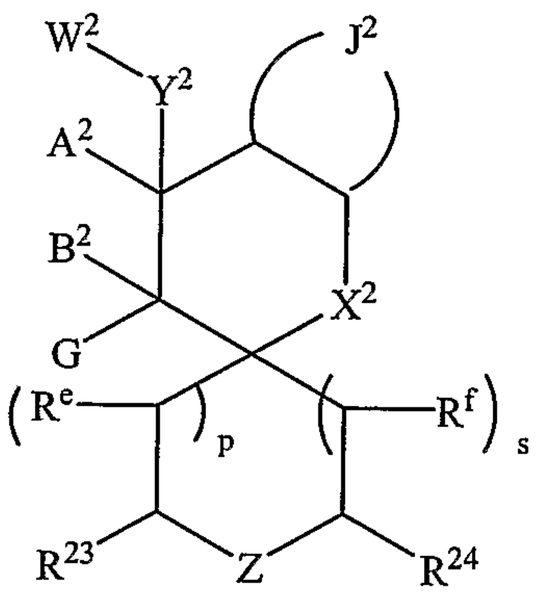
or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

108. A method according to claim 107,

wherein said respiratory function disorder is asthma or lung edema.

109. A method for preventing or treating anxiety, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken

together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

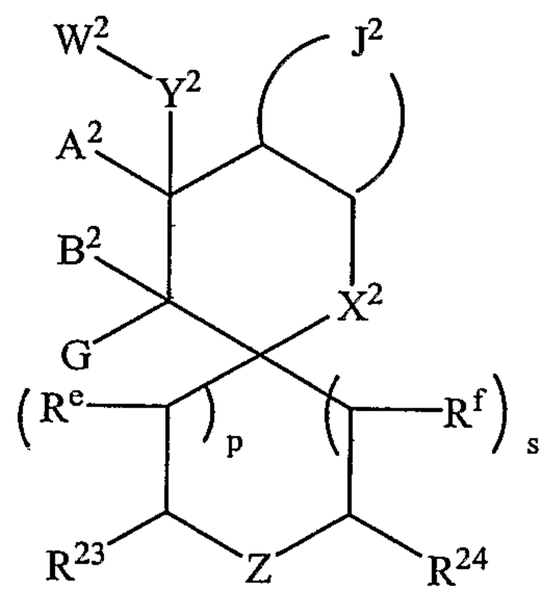
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

110. A method for preventing or treating a mood disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)-$alkenyl, $-(CH_2)-$alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

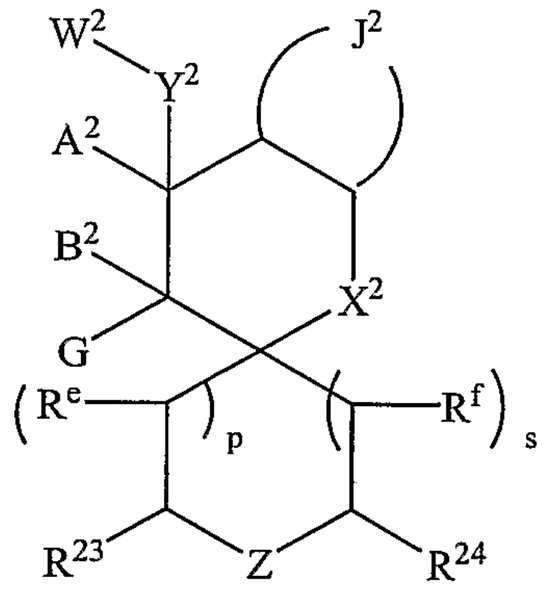
111. A method according to claim 110, wherein said mood disorder is selected from the group consisting of depression, bipolar manic-depression, and seasonal affective disorder.

112. A method according to claim 110 further comprising the step of:

administering to said patient an effective amount of an agent for the treatment of depression.

113. A method for preventing or treating a stress-related disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, -(CH_2)-alkenyl, -(CH_2)-alkynyl, aryl, -C(=O)R^d, or -S(=O)$_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

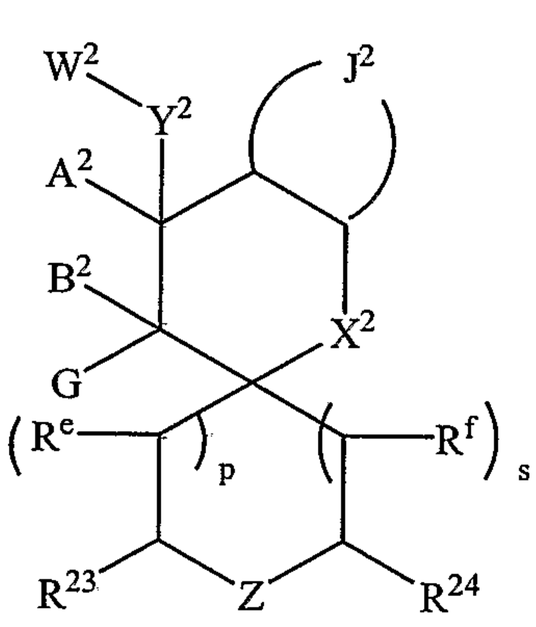
or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

114. A method according to claim 113,

wherein said stress-related disorder is a disorder selected from the group consisting of post-traumatic stress disorder, panic disorder, generalized anxiety disorder, social phobia, and obsessive-compulsive disorder.

115. A method for preventing or treating attention deficit hyperactivity disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or –[C(R^c)(R^d)]$_k$-;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

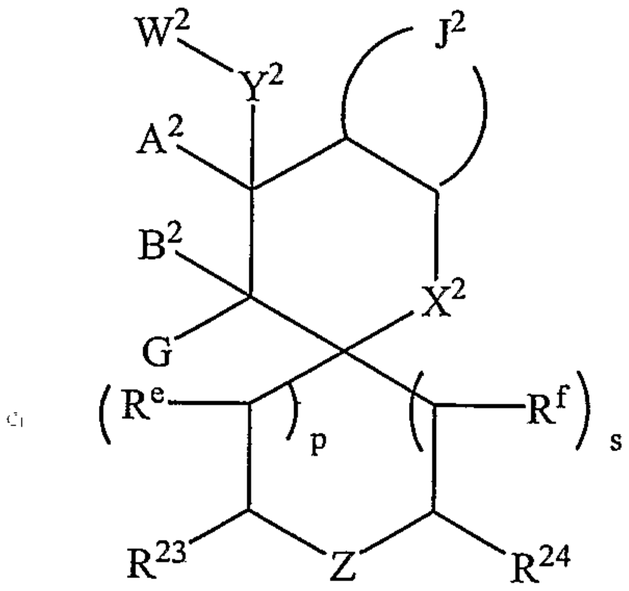
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

116. A method for preventing or treating sympathetic nervous system disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

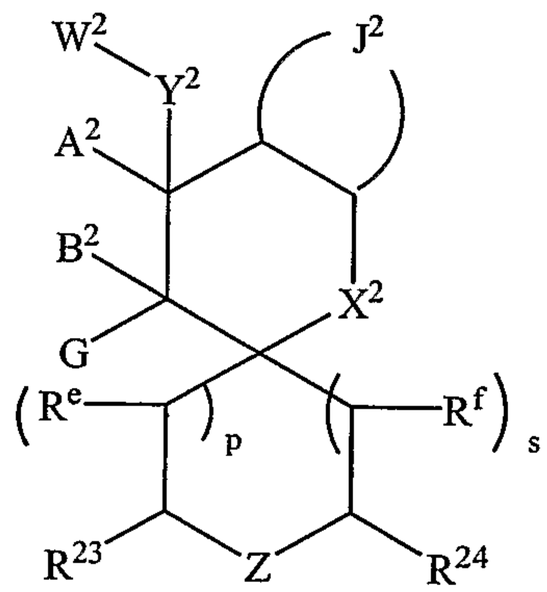
or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

117. A method according to claim 116,

wherein said sympathetic nervous system disorder is hypertension.

118. A method for preventing or treating tussis, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken

together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

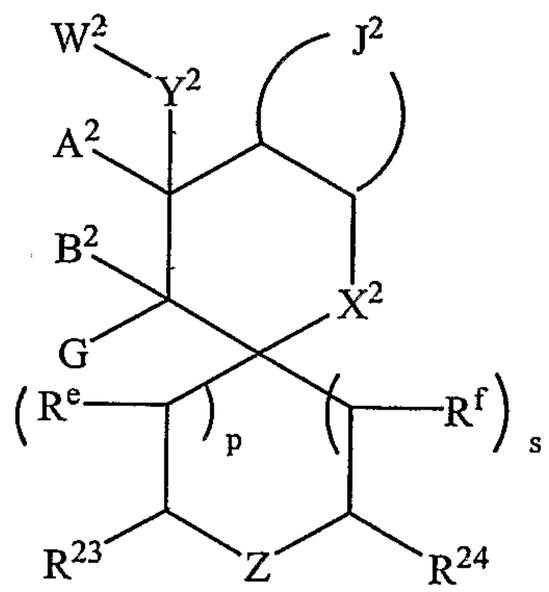
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

119. A method for preventing or treating a motor disorder, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

120. A method according to claim 119,

wherein said motor disorder is tremors, Parkinson's disease, Tourette's syndrome or dyskenesia.

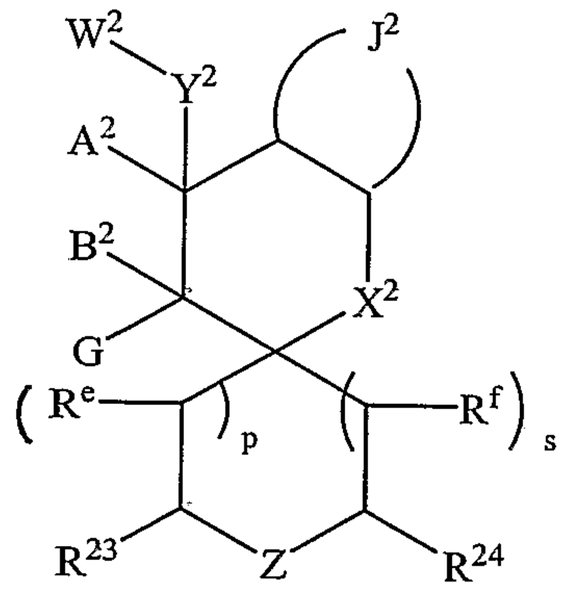
121. A method according to claim 120 wherein said motor disorder is tremors.

122. A method according to claim 121, further comprising the step of:

administering to said patient an effective amount of an antiParkinson's agent.

123. A method for treating a traumatic injury to the central nervous system, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)–, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

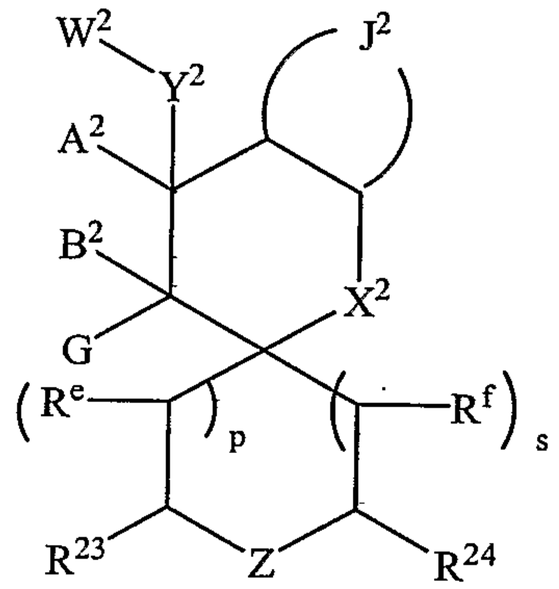
or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

124. A method according to claim 123,

wherein said traumatic injury is traumatic injury to the spinal cord or brain.

125. A method for preventing or treating stroke, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is –N(R^{25})-, -C(=O)-, -CH(OH)-, -CH(N(R^c)(R^d))-, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or –CH_2-;

G is H or alkyl;

X^2 is –C(R^c)(R^d)-, -O-, -S-, -S(=O)-, -S(=O)$_2$-, -C(=O)-, -CH(OH)-or –N(R^{26})-;

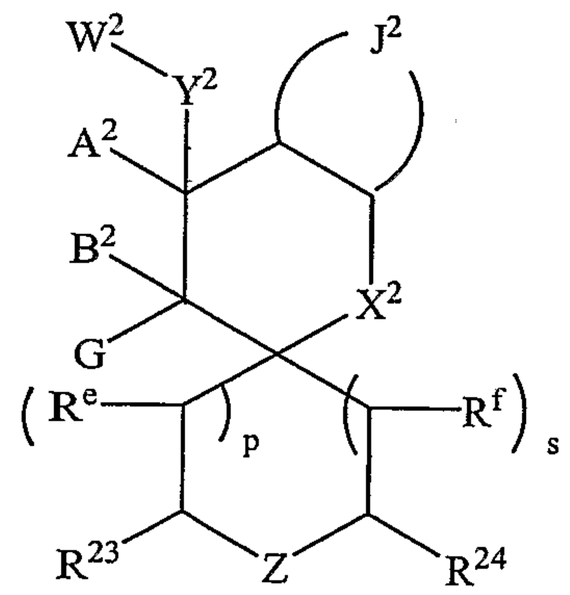
R^{26} is H, alkyl, cycloalkyl, -(CH_2)-alkenyl, -(CH_2)-alkynyl, aryl, -C(=O)R^d, or -S(=O)$_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

126. A method for preventing or treating cardiac arrhythmia, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

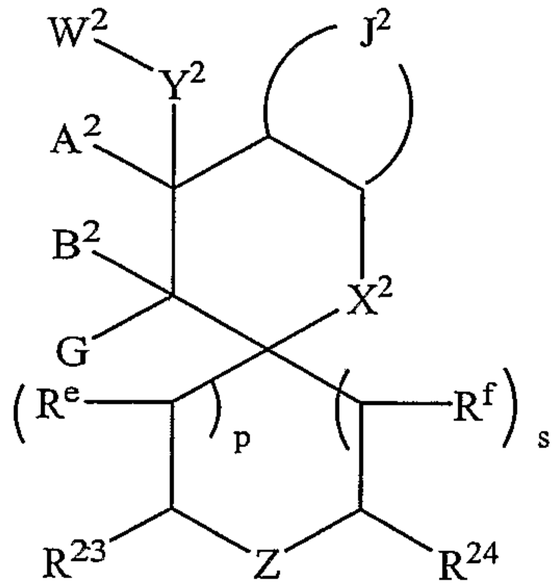
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

127. A method for preventing or treating glaucoma, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

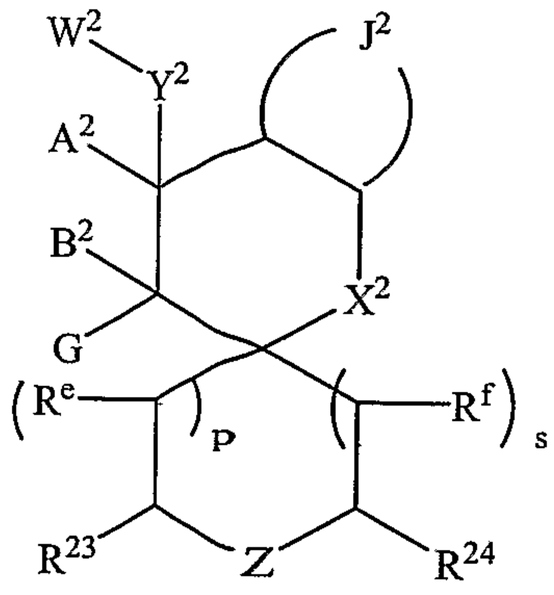
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

128. A method for preventing or treating sexual dysfunction, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

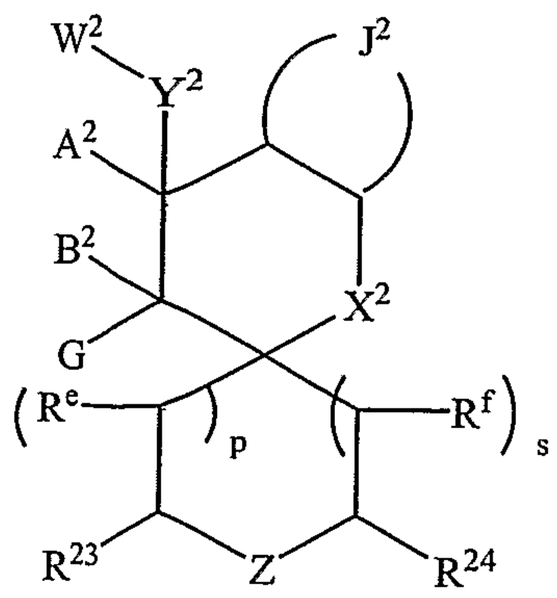
or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

129. A method according to claim 128,

wherein said sexual dysfunction is premature ejaculation.

130. A method for treating a condition selected from the group consisting of shock, brain edema, cerebral ischemia, cerebral deficits subsequent to cardiac bypass surgery and grafting, systemic lupus erythematosus, Hodgkin's disease, Sjogren's disease, epilepsy, and rejection in organ transplants and skin grafts, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

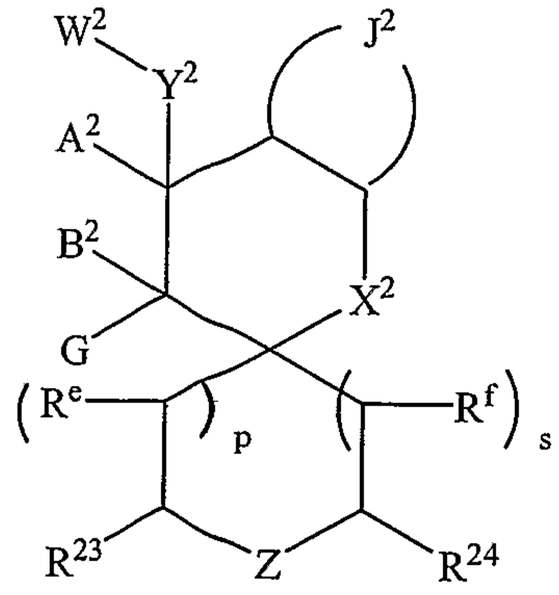
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)-$alkenyl, $-(CH_2)-$alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

131. A method for treating substance addiction, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

132. A method according to claim 131,

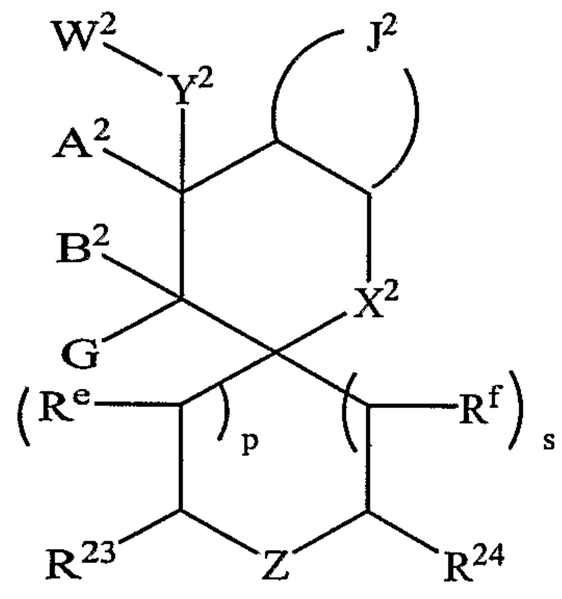
wherein said substance addiction is alcohol addiction, nicotine addiction, or drug addiction.

133. A method according to claim 132,

wherein said drug addiction is addiction to opioids.

134. A method for improving organ and cell survival, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

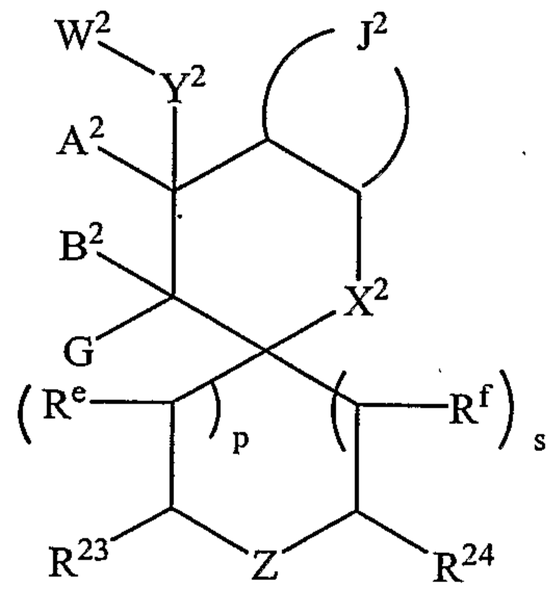
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

135. A method for providing cardioprotection following myocardial infarction, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

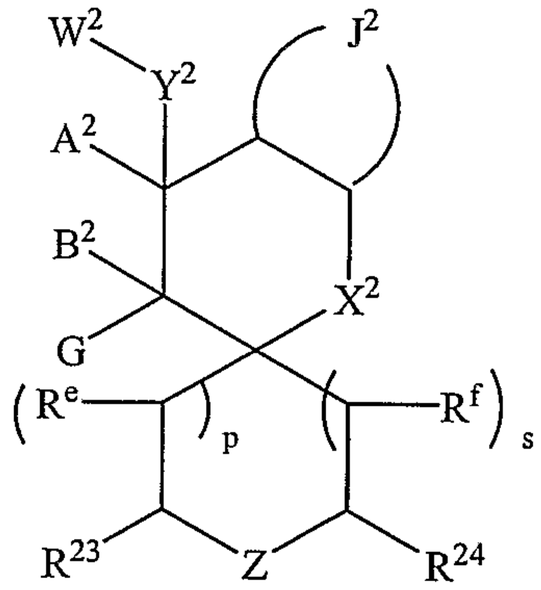
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

136. A method for reducing the need for anesthesia, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

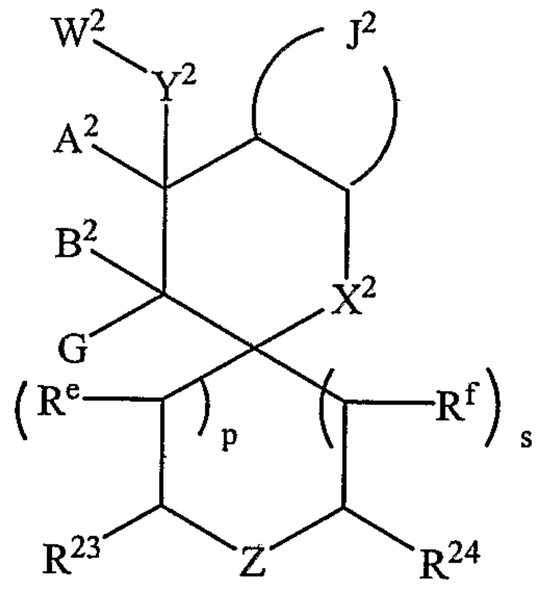
R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

137. A method of producing or maintaining an anesthetic state, comprising the step of:

administering to a patient in need thereof an effective amount of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, $-S(=O)-$, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

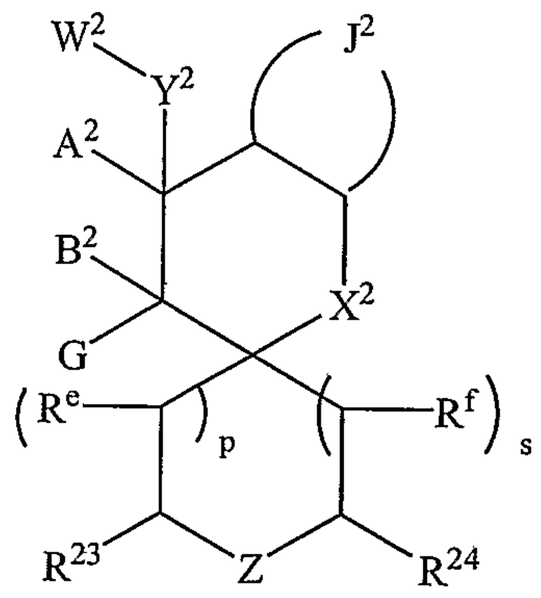
138. A method according to claim 137, further comprising the step of:

administering to said patient an anesthetic agent selected from the group consisting of an inhaled anesthetic, a hypnotic, an anxiolytic, a neuromuscular blocker, and an opioid.

139. A method according to claim 138,

wherein said compound and said anesthetic agent are co-administered.

140. A radio-labeled derivative of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, $-C(=O)-$, $-CH(OH)-$, $-CH(N(R^c)(R^d))-$, or $-O-$;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$, $-C(=O)-$, $-CH(OH)-$or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, -(CH_2)-alkenyl, -(CH_2)-alkynyl, aryl, -C(=O)R^d, or -S(=O)$_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

-C(=O)-H

-S-C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H,

-N(C_{1-4} alkyl)S(=O)$_2$-H,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

-NH_2,

-N=C(aryl)$_2$,

-N(H)C_{1-4} alkyl,

-N(C_{1-4} alkyl)$_2$,

-OS(=O)$_2$-C_{1-4} alkyl optionally substituted with one or more halogens,

-OS(=O)$_2$-C_{6-12} aryl optionally substituted with C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-N(C_{1-4} alkyl)S(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H, and

-N(C_{1-4} alkyl)S(=O)$_2$-H;

p and s are each 1,

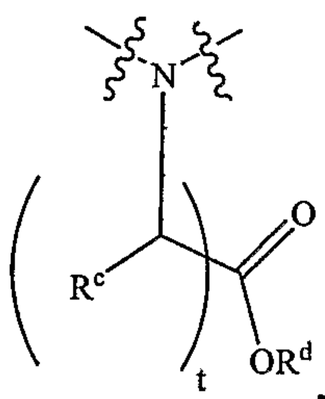
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



, wherein t is an integer from 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-S-C_{1-4} alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

$-NH_2$,

$-N(C_{1-4}$ alkyl$)_2$, and

pyrrolyl;

p and s are each 1,

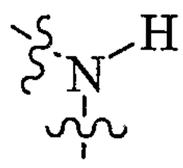
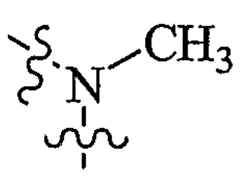
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:

 or  ; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached forms unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

$-S-C_{1-4}$ alkyl,

p and s are each 1,

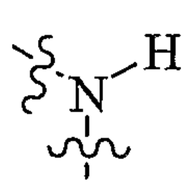
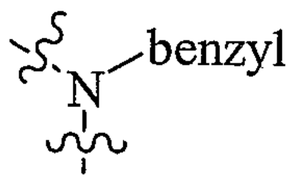
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

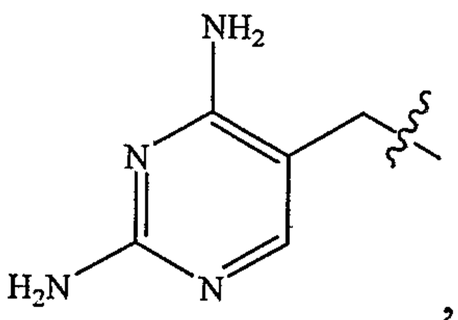
X^2 is –O-;

then Z is other than:


or

; and

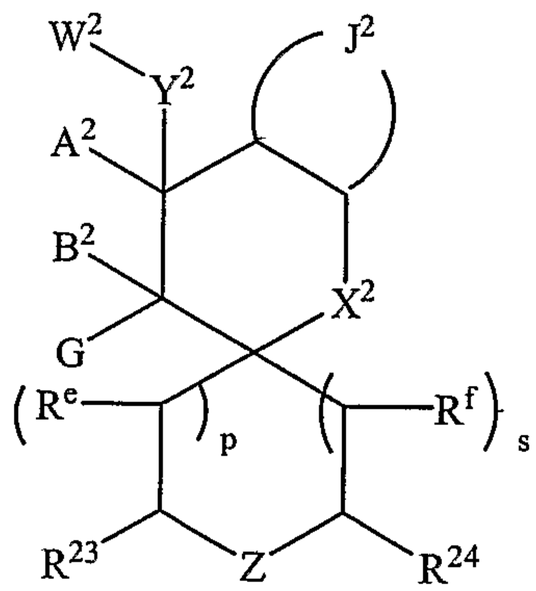
provided that when:

(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:


, then Z is other than $–N(R^{25})$- or -$CH(NH_2)$-;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

141. An isotopically-labeled derivative of a compound of formula IV:



IV ;

wherein:

Y^2 is a single bond or $-[C(R^c)(R^d)]_k-$;

each R^c, R^e, and R^f is independently H or alkyl;

each R^d is independently H, alkyl, or aryl;

W^2 is aryl, alkaryl, heterocycloalkylaryl, heteroaryl, alkylheteroaryl, heteroarylaryl, or alkylheteroarylaryl;

R^{23} and R^{24} are each independently H, alkyl, alkenyl, alkynyl, or aryl, or R^{23} and R^{24} when taken together with the atoms through which they are connected, form a 4- to 8-membered cycloalkyl or heterocycloalkyl ring;

Z is $-N(R^{25})-$, -C(=O)-, -CH(OH)-, $-CH(N(R^c)(R^d))-$, or –O-;

R^{25} is H, alkyl, alkenyl, alkynyl, cycloalkyl, alkylcycloalkyl, aralkyl, or heteroarylalkyl, or R^{23} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring, or R^{24} and R^{25} when taken together with the atoms through which they are connected, form a 4- to 8-membered heterocycloalkyl ring;

each k is independently 1, 2, or 3;

p is 0, 1, 2 or 3;

s is 0, 1, 2 or 3, provided that the sum of p and s is ≤ 4;

A^2 and B^2 are each independently H, fluoro, or alkyl, or together form a double bond or $-CH_2-$;

G is H or alkyl;

X^2 is $-C(R^c)(R^d)-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$, -C(=O)-, -CH(OH)-or $-N(R^{26})-$;

R^{26} is H, alkyl, cycloalkyl, $-(CH_2)$-alkenyl, $-(CH_2)$-alkynyl, aryl, $-C(=O)R^d$, or $-S(=O)_2R^d$; and

J^2 forms a 6- to 10-membered aryl or a 5- to 10-membered heteroaryl ring when taken together with the carbon atoms to which it is attached;

provided that when:

(a) J^2 taken together with the carbon atoms to which it is attached forms a 6- to 10-membered aryl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-SH,

-C(=O)-H

-S-C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H,

-N(C_{1-4} alkyl)S(=O)$_2$-H,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

cyano,

hydroxy,

C_{1-6} alkyl optionally substituted with one or more halogens,

C_{1-6} alkoxy optionally substituted with one or more halogens or with C_{3-6} cycloalkyl,

C_{2-6} alkenyloxy,

C_{2-6} alkynyloxy,

C_{3-6} cycloalkyloxy,

C_{6-12} aryloxy,

aralkoxy,

heteroaryloxy,

heteroaralkoxy,

heterocycloalkyl further substituted with alkoxy,

-SH,

-S-C_{1-4} alkyl,

-NH_2,

-N=C(aryl)$_2$,

-N(H)C_{1-4} alkyl,

-N(C_{1-4} alkyl)$_2$,

-OS(=O)$_2$-C_{1-4} alkyl optionally substituted with one or more halogens,

-OS(=O)$_2$-C_{6-12} aryl optionally substituted with C_{1-4} alkyl,

-NHS(=O)$_2$-C_{1-4} alkyl,

-N(C_{1-4} alkyl)S(=O)$_2$-C_{1-4} alkyl,

-NHS(=O)$_2$-H, and

-N(C_{1-4} alkyl)S(=O)$_2$-H;

p and s are each 1,

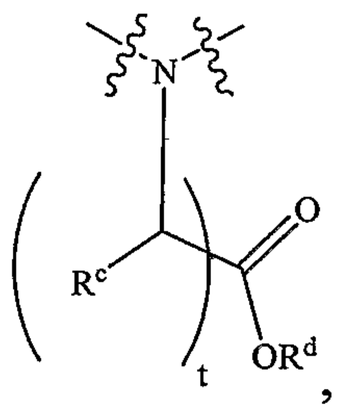
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:



, wherein t is an integer in the range of 1 to 20; and

provided that when:

(b) J^2 taken together with the carbon atoms to which it is attached forms a phenyl ring substituted with 0-3 groups selected from the group consisting of:

halogen,

hydroxy,

-S-C_{1-4} alkyl,

C_{1-4} alkyl, and

C_{1-4} alkoxy, the latter two optionally substituted with one or more halogens or with C_{1-4} alkoxy;

W^2 is unsubstituted naphthyl, or phenyl substituted with 0-3 groups selected from the group consisting of:

halogen,

C_{1-6} alkyl,

C_{1-6} alkoxy,

phenyl,

phenoxy,

1,3-benzodioxazolyl, or 2,2-difluoro-1,3-benzodioxazolyl fluoro,

-NH_2,

-N(C_{1-4} alkyl)$_2$, and

pyrrolyl;

p and s are each 1,

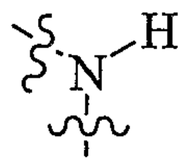
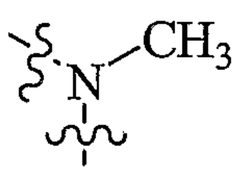
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

X^2 is –O-;

then Z is other than:

 or  ; and

provided that when:

(c) J^2 taken together with the carbon atoms to which it is attached forms unsubstituted phenyl,

W^2 is phenyl substituted with 0-3 groups selected from the group consisting of:

fluoro,

hydroxy,

C_{1-6} alkoxy optionally substituted with one or more fluoro,

C_{2-6} alkenyloxy, and

-S-C_{1-4} alkyl,

p and s are each 1,

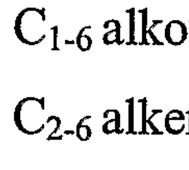
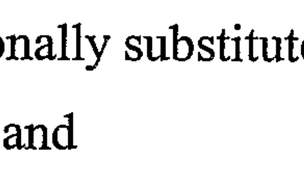
R^e, R^f, R^{23}, R^{24}, and G are each H,

A^2 and B^2 together form a double bond which incorporates the atoms to which they are attached,

Y^2 is a single bond; and

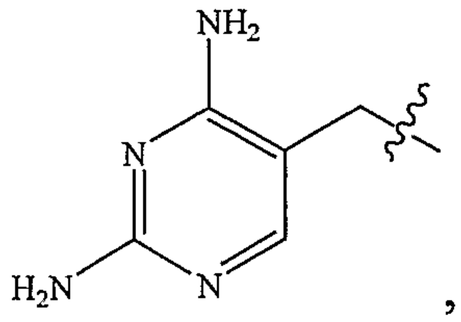
X^2 is –O-;

then Z is other than:

 or  ; and

provided that when:

(d) J^2 taken together with the carbon atoms to which it is attached forms a 6-membered aryl ring substituted with:



, then Z is other than –N(R^{25})- or -CH(NH_2)-;

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

142. A compound which is selected from the group consisting of:

4-[(4-methoxyphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(4-methylphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

4-phenyl-spiro[2H,1-benzopyran-2,4'-piperidine];

4-[(3-methoxyphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine]; and

4-[(2-methoxyphenyl]-spiro[2H,1-benzopyran-2,4'-piperidine];

or a stereoisomer, prodrug, pharmaceutically acceptable salt, hydrate, solvate, acid salt hydrate, or N-oxide thereof.

143. A compound according to claim 1, wherein J^2 forms a 6- to 10-membered aryl or a 5- or 6-membered heteroaryl ring when taken together with the carbon atoms to which it is attached.

144. A pharmaceutical composition according to claim 80 wherein said agent for the treatment of Parkinson's disease is selected from deprenyl, amantadine, levodopa and carbidopa.

145. A method of diagnostic imaging comprising administering to a patient a compound according to claim 140, and imaging the patient.

146. A method according to claim 145 wherein said imaging comprises positron emission tomography.

147. A method of diagnostic imaging comprising administering to a patient a compound according to claim 141, and imaging the patient.

148. A method according to claim 147 wherein said imaging comprises positron emission tomography.