

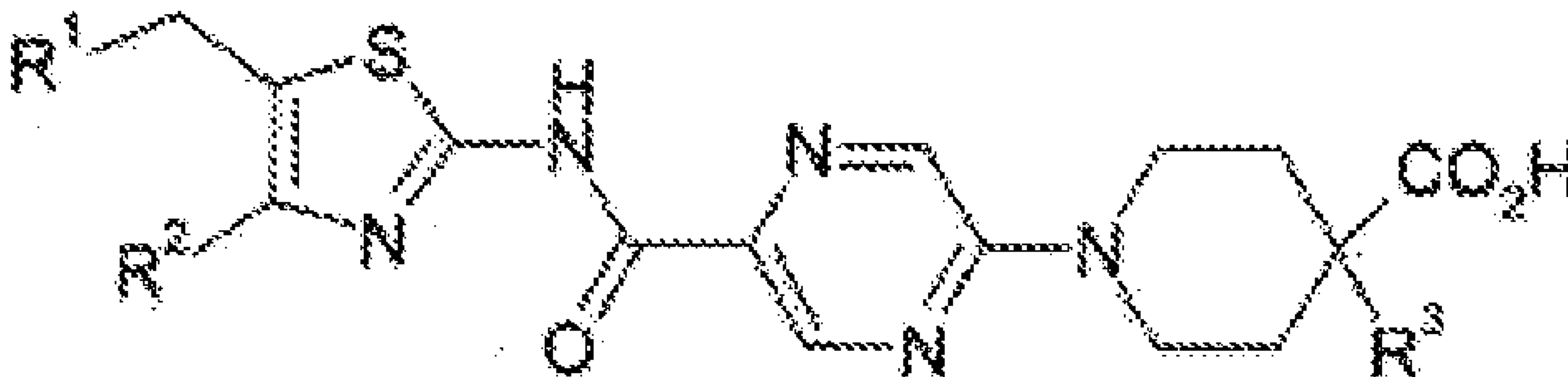


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(54) Titre : DERIVE DE 2-ACYLAMINOTHIAZOLE ET SEL DE CELUI-CI

(54) Title: 2-ACYLAMINOTHIAZOLE DERIVATIVE AND SALT THEREOF



(57) **Abrégé/Abstract:**

The present inventors achieved the present invention on the basis of the knowledge that a thiazole derivative with a pyrazine-2-carboxylamine substituent at the second carbon position is an excellent positive allosteric modulator of the muscarinic M3 receptor and is useful as a prophylactic and/or therapeutic agent against bladder/urinary tract disorders associated with bladder contractions induced by the muscarinic M3 receptor. A 2-acylaminothiazole derivative or a salt thereof according to the present invention can be used as a prophylactic and/or therapeutic agent against bladder/urinary tract disorders associated with bladder contractions induced by the muscarinic M3 receptor, including, for example, urinary disorders such as underactive bladder. (In the formula, R¹ is -(N(-R¹¹))(-R¹²) or an optionally substituted cyclic amine; R¹¹ is a C₁₋₆ alkyl; R¹² is an optionally substituted C₁₋₆ alkyl or an optionally substituted C₃₋₈ cycloalkyl; R² is an optionally substituted aryl, an optionally substituted monocyclic aromatic heterocycle, or an optionally substituted bicyclic aromatic heterocycle; and R³ is -H, -OH, -O-(C₁₋₆ alkyl), or a halogen.)

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Abstract

[Abstract]

[Problem]

5 A compound which is useful as an active ingredient of a pharmaceutical composition for treating storage dysfunctions, voiding dysfunctions, and lower urinary tract diseases is provided.

[Means for Solution]

10 The present inventors have found that a thiazole derivative having pyrazine-2-carbonylamino substituted at the 2-position is an excellent muscarinic M₃ receptor positive allosteric modulator, and is useful as an agent for preventing and/or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, thereby completing the present invention. The 2-acylaminothiazole derivative or a salt thereof of
15 the present invention can be used as an agent for preventing and/or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, for example, voiding dysfunctions such as underactive bladder.

[Selected Figure]

Nil

DESCRIPTION

Title of Invention: 2-ACYLAMINOTHIAZOLE DERIVATIVE OR SALT THEREOF

5 Technical Field

[0001]

The present invention relates to a 2-acylaminothiazole derivative or a salt thereof, which is useful as an active ingredient of a pharmaceutical composition, in particular, a pharmaceutical composition for treating bladder or urinary tract diseases, related to bladder
10 contraction by a muscarinic M₃ receptor.

Background Art

[0001]

Important roles of the lower urinary tract are urine storage and voiding, which are
15 regulated by a coordinated action of the bladder and the urethra. That is, during urine storage, the bladder smooth muscle is relaxed and the urethral sphincter is contracted, whereby a state of high urethral resistance is maintained and urinary continence is thus maintained. On the other hand, during voiding, while the bladder smooth muscle is contracted, the urethral smooth muscle is relaxed, and contraction of the external urethral
20 sphincter is also inhibited. Examples of disorders in the lower urinary tract include storage dysfunctions such as overactive bladder in which urine cannot be retained during urine storage and voiding dysfunctions in which urine cannot be drained sufficiently during voiding due to increase in the urethral resistance or decrease in the bladder contractile force. These two dysfunctions may develop simultaneously in some cases.

25 [0001]

Voiding dysfunctions are caused by a decrease in the bladder contractile force or an increase in urethral resistance during voiding, and lead to voiding difficulty, straining during voiding, attenuation of the urinary stream, extension of voiding time, an increase in residual urine, a decrease in voiding efficiency, or the like. A decrease in the bladder
30 contractile force during voiding is called underactive bladder, acontractile bladder, or the like. As a factor for decreasing the bladder contractile force during voiding, there are known increasing age, diabetes mellitus, benign prostatic hyperplasia, neurological diseases such as Parkinson's disease and multiple sclerosis, spinal cord injury, nerve damage caused by pelvic surgery, and the like (Reviews in Urology, 15: pp. 11-22 (2013)).

35 [0001]

As a mechanism that induces bladder contraction during voiding, involvement of muscarinic receptor stimulation is known. In other words, the pelvic nerve that is a parasympathetic nerve innervating the bladder is excited during voiding, and acetylcholine

is released from nerve terminals. The released acetylcholine binds to a muscarinic receptor in the bladder smooth muscle to cause contraction of the bladder smooth muscle (Journal of Pharmacological Sciences, 112: pp. 121-127 (2010)). The muscarinic receptors are currently divided into five subtypes, M₁, M₂, M₃, M₄, and M₅, and it is known that a subtype involved in contraction of the bladder smooth muscle is mainly M₃ (Pharmacological Reviews, 50: pp. 279-290 (1998), and The Journal of Neuroscience, 22: pp. 10627-10632 (2002)).

[0001]

As a therapeutic agent for a decrease in the bladder contractile force during voiding, bethanechol chloride which is a non-selective muscarinic receptor agonist or distigmine bromide which is a choline esterase inhibitor is known. However, it is known that these drugs have cholinergic side effects, such as diarrhea, abdominal pain, and sweating. Further, cholinergic crisis is sometimes occurred as a serious side effect, therefore carefulness is required for the use (UBRETID (registered trademark) tablet 5 mg package insert, Torii Pharmaceutical Co., Ltd., Besacolin (registered trademark) powder 5% package insert, Eisai Co., Ltd.).

On the other hand, as a cause of an increase in urethral resistance, a voiding dysfunction associated with benign prostatic hyperplasia is well-known, which is characterized by partial obstruction of the urethra due to nodular hypertrophy of the prostate tissues. Adrenergic α_1 receptor antagonists have now been used as therapeutic agents for the voiding dysfunction associated with benign prostatic hyperplasia (Pharmacology, 65: pp. 119-128 (2002)). On the other hand, the effectiveness of adrenergic α_1 receptor antagonists on voiding dysfunctions not associated with benign prostatic hyperplasia is unclear, as compared with the voiding dysfunction associated with benign prostatic hyperplasia (Journal of Pharmacological Sciences, 112: pp. 121-127 (2010)).

Further, in voiding dysfunctions caused by a decrease in the bladder contractile force or an increase in the urethral resistance, residual urine after voiding may be observed in some cases. Increased residual urine may cause a decrease in effective bladder capacity, and thus cause overactive bladder symptoms such as urinary frequency, or severe symptoms, such as hydronephrosis, in some cases.

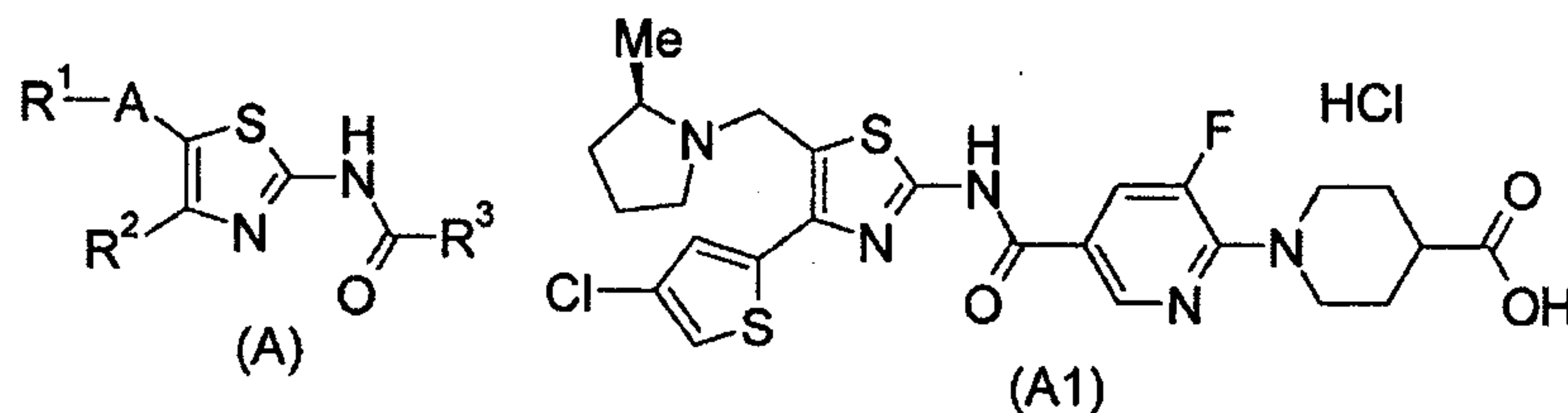
There is a demand for a therapeutic agent which is more effective on bladder or urinary tract diseases or symptoms thereof caused by a decrease in the bladder contractile force or an increase in the urethral resistance during voiding.

[0001]

In Patent Document 1, it is described that a compound represented by the following general formula (A), including a compound of the following formula A1 disclosed in Example 315, has a Ba/F3 cell proliferative activity through a human c-

myeloproliferative leukemia virus type P (c-Mpl) and has a thrombocyte increasing activity.

[Chem. 1]



5

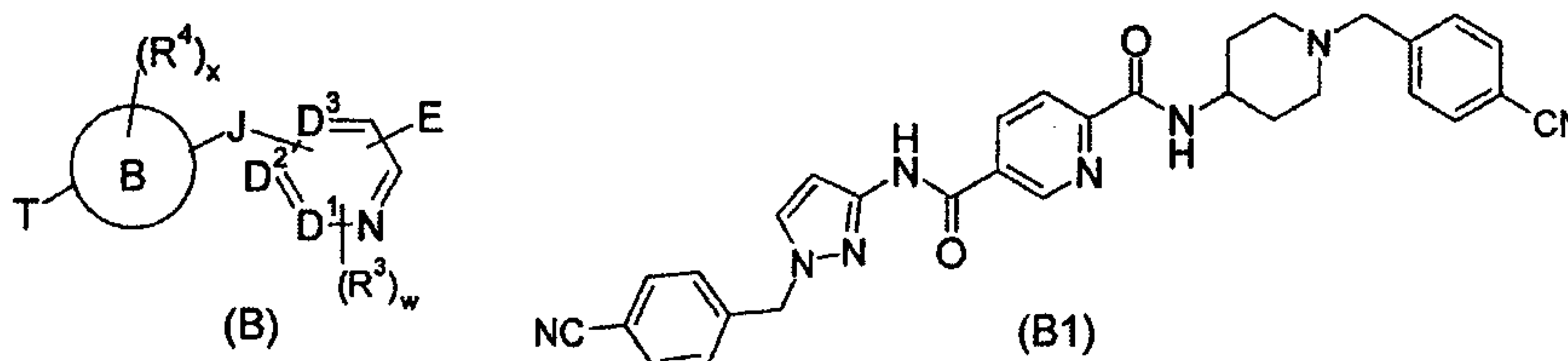
(in which R^3 represents an aromatic hetero ring which may be substituted. For the other symbols, refer to the patent publication.)

[0001]

In Patent Document 2, it is described that a compound represented by the following general formula (B), including a compound of the following formula B1 disclosed as the compound 38, has an activating effect on an AMPK pathway.

10

[Chem. 2]



15

(in which a ring B represents a heteroarylene or the like, J represents $-NR^{13}C(O)-$ or the like, D^1 , D^2 , and D^3 represent N, CH, or the like, and E represents $-NR^1R^2$ or the like. For the other symbols, refer to the patent publication.)

Related Art

20

Patent Document

[0001]

[Patent Document 1] Pamphlet of International publication WO 2005/007651

[Patent Document 2] Pamphlet of International publication WO 2012/016217

25

Disclosure of Invention

Problems to Be Solved by the Invention

[0001]

30

The present invention is to provide a compound which is useful as an active ingredient of a pharmaceutical composition, in particular, a pharmaceutical composition for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M_3 receptor.

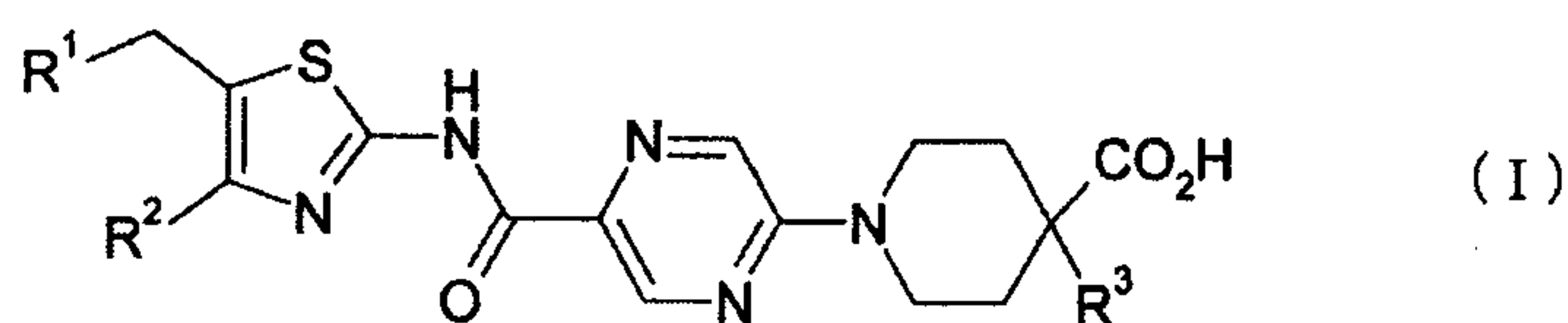
Means for Solving the Problems

[0001]

The present inventors have found that a thiazole derivative having pyrazine-2-
 5 carbonylamino substituted at the 2-position is an excellent muscarinic M₃ receptor positive
 allosteric modulator, and is useful as an agent for preventing and/or treating bladder or
 urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, thereby
 completing the present invention.

That is, the present invention relates to a compound of the formula (I) or a salt
 10 thereof as well as a pharmaceutical composition comprising a compound of the formula (I)
 or a salt thereof and an excipient:

[Chem. 3]



15 wherein

R¹ is -N(-R¹¹)(-R¹²), or cyclic amino which may be substituted;

R¹¹ is C₁₋₆ alkyl;

R¹² is C₁₋₆ alkyl which may be substituted, or C₃₋₈ cycloalkyl which may be
 substituted;

20 R² is aryl which may be substituted, a monocyclic aromatic hetero ring which may
 be substituted, or a bicyclic aromatic hetero ring which may be substituted; and

R³ is -H, -OH, -O-(C₁₋₆ alkyl), or halogen.

In addition, unless otherwise specified, when symbols in a certain chemical
 formula in the present specification are also used in another chemical formula, the same
 25 symbol represents the same meaning.

[0001]

Moreover, in Patent Document 1, there is no disclosure or suggestion of a specific
 compound that is the compound of the formula (A), in which R³ is pyrazinyl, and there is
 also no disclosure or suggestion of an action on a muscarinic receptor or an action on
 30 bladder or urinary tract diseases.

Further, in Patent Document 2, there is no disclosure of a specific compound that
 is the compound of the formula (B), in which a ring B is thiazole, and there is no disclosure
 or suggestion of an action on a muscarinic receptor or an action on bladder or urinary tract
 diseases.

35 [0001]

Furthermore, the present invention relates to a pharmaceutical composition, in particular, a pharmaceutical composition for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, comprising a compound of the formula (I) or a salt thereof. Further, the pharmaceutical composition
 5 includes an agent for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, comprising the compound of the formula (I) or a salt thereof.

In addition, the present invention relates to use of the compound of the formula (I) or a salt thereof for the manufacture of a pharmaceutical composition for preventing or
 10 treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor; use of the compound of the formula (I) or a salt thereof for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor; the compound of the formula (I) or a salt thereof for preventing or treating
 15 bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor; and a method for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, comprising administering to a subject an effective amount of the compound of the formula (I) or a salt thereof. In addition, the
 “subject” is a human or another mammal in need of such prevention or treatment, and in a certain embodiment, a human in need of such prevention or treatment.

20

Effects of the Invention

[0001]

The compound of the formula (I) or a salt thereof can be used as an agent for preventing and/or treating bladder or urinary tract diseases, related to bladder contraction
 25 by a muscarinic M₃ receptor, as a muscarinic M₃ receptor positive allosteric modulator.

Brief Description of Drawings

[0001]

FIG. 1 shows a powder X-ray diffraction pattern of the compound of Example 8.
 30 FIG. 2 shows a powder X-ray diffraction pattern of the compound of Example 206.
 FIG. 3 shows a powder X-ray diffraction pattern of the compound of Example 207.

Embodiments for Carrying Out the Invention

[0001]

35 Hereinafter, the present invention will be described in detail.

A positive allosteric modulator is a compound which binds to an allosteric site other than a ligand-binding site, mainly to cause a change in the structures of a receptor, thereby, has effects of increasing the affinity of an agonist to the receptor and changing the

signal level of the agonist. In the living body, the positive allosteric modulator itself does not exhibit an agonistic effect, and increases the effect of an endogenous agonist.

Examples of the advantage of the positive allosteric modulator over the agonist include (1) that since the positive allosteric modulator exhibits an enhancement in the endogenous
 5 agonist stimulation-dependently, the side effects can be avoided, (2) that since the positive allosteric modulator binds to a site other than the ligand-binding site, a high subtype selectivity can be obtained, and (3) that desensitization shown in an agonist is hardly occurred (Pharmacological Reviews, 63: pp. 59-126 (2011)).

[0001]

10 In the present specification, the muscarinic M₃ receptor positive allosteric modulator means a compound which enhances an effect by a muscarinic M₃ receptor in an agonist stimulation-dependent or nerve stimulation-dependent manner. Accordingly, the effect on increasing bladder contraction is expected only during voiding, and thus, it is thought that the muscarinic M₃ receptor positive allosteric modulator is useful as an agent
 15 for improving various symptoms accompanying voiding dysfunctions. Further, by an action specific to the voiding, it is expected that the cholinergic side effects known as bethanechol chloride or distigmine bromide can be avoided. Further, since the muscarinic M₃ receptor positive allosteric modulator increases the bladder contractile force during voiding, the effect on voiding dysfunctions those are caused by an increase in the urethral
 20 resistance can also be expected. The decrease in the residual urine by the improvement of voiding dysfunctions leads to an increase in the effective bladder capacity, and thus, improvement of urine storage functions and avoidance of renal disorders can be expected. As such, the muscarinic M₃ receptor positive allosteric modulator is expected to be useful as an agent for preventing and/or treating bladder or urinary tract diseases, related to
 25 bladder contraction by a muscarinic M₃ receptor. The present inventors have newly found a compound that acts as the modulator, thereby completing the present invention.

[0001]

In the present specification,

30 Examples of the “bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor” include voiding and storage dysfunctions in underactive bladder, hypotonic bladder, acontractile bladder, detrusor underactivity, neurogenic bladder, urethral relaxation failure, detrusor-external urethral sphincter dyssynergia, overactive bladder, urinary frequency, nocturia, urinary incontinence, benign prostatic hyperplasia, interstitial cystitis, chronic prostatitis, urethral calculus, or the like, and
 35 preferably voiding and storage dysfunctions in underactive bladder, hypotonic bladder, acontractile bladder, detrusor underactivity and neurogenic bladder.

The “alkyl” includes linear alkyl and branched alkyl. Accordingly, the “C₁₋₆ alkyl” is linear or branched alkyl having 1 to 6 carbon atom(s), and specific examples

thereof include methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl, n-pentyl, and n-hexyl. In a certain embodiment, the C₁₋₆ alkyl is methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, or tert-butyl.

5 The “cycloalkyl” is a saturated hydrocarbon ring group. Accordingly, the “C₃₋₈ cycloalkyl” is a saturated hydrocarbon ring group having 3 to 8 ring members, and specific examples thereof include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, and cyclooctyl. In a certain embodiment, the C₃₋₈ cycloalkyl is cyclopropyl, cyclobutyl, cyclopentyl, or cyclohexyl; and in another embodiment, cyclopropyl.

10 The “aryl” is a C₆₋₁₄ monocyclic to tricyclic aromatic hydrocarbon ring group, and specific examples thereof include phenyl, naphthyl, tetrahydronaphthyl, indanyl, and indenyl. In a certain embodiment, the aryl is phenyl.

[0001]

15 The “monocyclic aromatic hetero ring” is a monocyclic aromatic hetero ring group having 5 to 7 ring members, which has 1 to 4 hetero atom(s) selected from the group consisting of a nitrogen atom, an oxygen atom, and a sulfur atom as a ring-constituting atom. Specific examples thereof include pyrrolyl, pyrazolyl, imidazolyl, triazolyl, furanyl, thienyl, oxazolyl, oxadiazolyl, thiazolyl, thiadiazolyl, pyridyl, pyridazinyl, pyrimidinyl, and pyrazinyl. In a certain embodiment, the monocyclic aromatic hetero ring is thienyl or thiazolyl; and in another embodiment, thienyl.

20 The “bicyclic aromatic hetero ring” is a bicyclic aromatic hetero ring group, in which the monocyclic aromatic hetero ring is fused with a benzene ring or a monocyclic aromatic hetero ring, and includes its partially hydrogenated ring group. Specific examples thereof include indolyl, isoindolyl, indazolyl, benzotriazolyl, benzofuranyl, benzothienyl, benzoxazolyl, benzothiazolyl, quinolyl, isoquinolyl, cinnolinyl, quinazolinyl, 25 quinoxalinyl, naphthyridinyl, fropyrindyl, thienopyridyl, indolinyl, dihydrobenzofuranyl, dihydrobenzothienyl, dihydroquinolyl, tetrahydroquinolyl, dihydroisoquinolyl, tetrahydroisoquinolyl, dihydrofropyrindyl, and dihydrothienopyridyl. In a certain embodiment, the bicyclic aromatic hetero ring is dihydrobenzofuranyl.

[0001]

30 The “saturated hetero ring” is a 3- to 8-membered saturated ring group which has 1 to 4 hetero atom(s) selected from the group consisting of a nitrogen atom, an oxygen atom, and a sulfur atom as a ring-constituting atom, and may be bridged with lower alkylene, and its sulfur atom as a ring-constituting atom may be oxidized.

35 The “cyclic amino” is a group having a bond at a nitrogen atom constituting the ring of the saturated hetero rings above, and specific examples thereof include pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, azepan-1-yl, azocan-1-yl, morpholin-4-yl, thiomorpholin-4-yl, piperazin-1-yl, 1,4-diazepan-1-yl, 1,4-oxazepan-4-yl, and 1,4-thiazepan-4-yl. In a certain embodiment, the cyclic amino is pyrrolidin-1-yl, piperidin-1-

yl, azetidin-1-yl, or morpholin-4-yl; and in another embodiment, pyrrolidin-1-yl or piperidin-1-yl.

[0001]

The cyclic amino in R¹ may be combined with the cyclic amino to form a spiro ring. In this case, specific examples of the cyclic amino include 2-oxa-6-azaspiro[3.5]nonan-6-yl, 2,6-diazaspiro[3.5]nonan-6-yl, 2-thia-6-azaspiro[3.5]nonan-6-yl, 2-oxa-8-azaspiro[4.5]decan-8-yl, 6-oxa-9-azaspiro[4.5]decan-9-yl, 3-oxa-9-azaspiro[5.5]undecan-9-yl, and the like.

[0001]

The "halogen" means fluoro, chloro, bromo, or iodo. In a certain embodiment, it is fluoro, chloro, or bromo; and in another embodiment, fluoro or chloro.

[0001]

In the present specification, the expression "which may be substituted" means "which is not substituted" or "which is substituted with 1 to 5 substituent(s)". Further, if it has a plurality of substituents, the substituents may be the same as or different from each other.

[0001]

Examples of the substituent acceptable for the "cyclic amino which may be substituted", "C₁₋₆ alkyl which may be substituted", "C₃₋₈ cycloalkyl which may be substituted", "aryl which may be substituted", "monocyclic aromatic hetero ring which may be substituted", and "bicyclic aromatic hetero ring which may be substituted" include the substituents in the following Group G; and in another embodiment, the substituents described in (a) to (g) and (m) to (o) in the following Group G:

Group G

- (a) C₁₋₆ alkyl which may be substituted with at least one group selected from the group consisting of -OH, -O-(C₁₋₆ alkyl), -CN, -SO₂-C₁₋₆ alkyl, and halogen,
- (b) -OH,
- (c) -O-(C₁₋₆ alkyl which may be substituted with at least one group selected from the group consisting of -OH, -O-(C₁₋₆ alkyl), -CN, -SO₂-C₁₋₆ alkyl, and halogen),
- (d) C₃₋₈ cycloalkyl,
- (e) -O-(C₃₋₈ cycloalkyl),
- (f) halogen,
- (g) -CN,
- (h) -SO₂-C₁₋₆ alkyl,
- (i) -CO₂-C₁₋₆ alkyl and -COOH,
- (j) -CO-N(C₁₋₆ alkyl)₂, -CO-NH(C₁₋₆ alkyl), and -CONH₂,
- (k) -CO-C₁₋₆ alkyl,
- (l) -SO₂-N(C₁₋₆ alkyl)₂, -SO₂-NH(C₁₋₆ alkyl), and -SO₂NH₂,

(m) -N(C₁₋₆ alkyl)₂, -NH(C₁₋₆ alkyl), and, -NH₂,

(n) a saturated hetero ring, and

(o) an -O-saturated hetero ring.

Further, examples of the substituent in the “cyclic amino which may be substituted” include oxo (=O).

[0001]

The substituent acceptable in the “cyclic amino which may be substituted” in R¹ is, in a certain embodiment, the substituents shown in (a) to (d), (f) and (g) in the Group G; in another embodiment, a substituent shown in the following Group G1:

Group G1

C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -OH, -O-(C₁₋₆ alkyl), and halogen; -O-(C₁₋₆ alkyl); C₃₋₈ cycloalkyl; halogen; and -CN;

in another embodiment, C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -OH, -O-(C₁₋₆ alkyl), and halogen;

in still another embodiment, C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen;

in further still another embodiment, C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 -O-(C₁₋₆ alkyl) group(s);

in further still another embodiment, C₁₋₆ alkyl; and

in further still another embodiment, methyl or ethyl.

[0001]

The substituent acceptable for the “C₁₋₆ alkyl which may be substituted” in R¹² is, in a certain embodiment, the substituents shown in (b) to (o) in the Group G;

in another embodiment, C₃₋₈ cycloalkyl, -O-(C₁₋₆ alkyl), -O-(C₃₋₈ cycloalkyl), halogen, -CN, or cyclic amino; and

in still another embodiment, -O-(C₁₋₆ alkyl).

[0001]

The substituent acceptable for the “C₃₋₈ cycloalkyl which may be substituted” in R¹² is, in a certain embodiment, the substituents shown in (a) to (c), (f) and (g) in the Group G; and

in another embodiment, C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl).

[0001]

The substituent acceptable for the “aryl which may be substituted” in R² is, in a certain embodiment, the substituents shown in (a) to (c), (f), (g) and (m) to (o) in the Group G;

in another embodiment, the substituents shown in the following Group G2:

Group G2

C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s);
 -O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 substituent(s)
 5 selected from the group consisting of halogen and -O-(C₁₋₆ alkyl)); an -O-saturated hetero
 ring; halogen; -N(C₁₋₆ alkyl)₂; -NH(C₁₋₆ alkyl); -NH₂; and cyclic amino;

in still another embodiment, the substituents shown in the following Group G21:

Group G21

C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s);
 10 -O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 substituent(s)
 selected from the group consisting of halogen and -O-(C₁₋₆ alkyl)); an -O-saturated hetero
 ring; halogen; -N(C₁₋₆ alkyl)₂; and cyclic amino;

in further still another embodiment, the substituents shown in the following Group
 G22:

15 Group G22

C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -
 O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 substituent(s)
 selected from the group consisting of halogen and -O-(C₁₋₆ alkyl)); halogen; and -N(C₁₋₆
 alkyl)₂;

20 in further still another embodiment, the substituents shown in the following Group
 G23:

Group G23

C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -
 O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s));
 25 halogen; and -N(C₁₋₆ alkyl)₂;

in further still another embodiment, the substituents shown in the following Group
 G24:

Group G24

C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -
 30 O-(C₁₋₆ alkyl); and halogen;

in further still another embodiment, the substituents shown in the following Group
 G25:

Group G25

C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s);
 35 and -O-(C₁₋₆ alkyl); and

in further still another embodiment, trifluoromethyl and methoxy.

[0001]

The substituent acceptable for the “monocyclic aromatic hetero ring which may be substituted” and “bicyclic aromatic hetero ring which may be substituted” in R^2 is, in a certain embodiment, the substituents shown in (a) to (c), (f), (g) and (m) to (o) in the Group G;

5 in another embodiment, the substituents shown in the following Group G3:

Group G3

C_{1-6} alkyl which may be substituted with the same or different 1 to 5 halogen(s); -O-(C_{1-6} alkyl which may be substituted with the same or different 1 to 5 halogen(s)); halogen; -N(C_{1-6} alkyl)₂; -NH(C_{1-6} alkyl); -NH₂; and cyclic amino;

10 in still another embodiment, the substituents shown in the following Group G31:

Group G31

C_{1-6} alkyl which may be substituted with the same or different 1 to 5 halogen(s); -O-(C_{1-6} alkyl which may be substituted with the same or different 1 to 5 halogen(s)); and halogen;

15 in further still another embodiment, the substituents shown in the following Group G32:

Group G32

C_{1-6} alkyl which may be substituted with the same or different 1 to 5 halogen(s); and halogen;

20 in further still another embodiment, halogen; and

in further still another embodiment, chloro.

[0001]

Certain embodiments of the compound of the formula (I) or a salt thereof are shown below.

25 (1) The compound or a salt thereof, in which R^1 is cyclic amino which may be substituted with 1 to 5 substituent(s) selected from the Group G and oxo, or R^1 is -N(- R^{11})(- R^{12});

30 in another embodiment, the compound or a salt thereof, in which R^1 is cyclic amino selected from the group consisting of pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, and morpholin-4-yl, or -N(- R^{11})(- R^{12}), and the cyclic amino may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G1,

R^{11} is C_{1-6} alkyl, and

R^{12} is C_{1-6} alkyl which may be substituted with -O-(C_{1-6} alkyl), or C_{3-8} cycloalkyl which may be substituted with C_{1-6} alkyl substituted with -O-(C_{1-6} alkyl);

35 in still another embodiment, the compound or a salt thereof, in which R^1 is cyclic amino selected from the group consisting of pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, and morpholin-4-yl, or -N(- R^{11})(- R^{12}), and the cyclic amino may be substituted with C_{1-6}

alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen,

R¹¹ is C₁₋₆ alkyl, and

R¹² is C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl); and

5 in further still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, or -N(-R¹¹)(-R¹²), and the cyclic amino may be substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen,

10 R¹¹ is C₁₋₆ alkyl, and

R¹² is C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl).

[0001]

(1-1) The compound or a salt thereof, in which R¹ is cyclic amino which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G and
15 oxo;

in another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G1;

20 in still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, and morpholin-4-yl, and the cyclic amino may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G;

25 in further still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, and morpholin-4-yl, and the cyclic amino may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G1;

30 in further still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, and morpholin-4-yl, and the cyclic amino may be substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen;

35 in further still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the cyclic amino is substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen;

in further still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and

the cyclic amino is substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 -O-(C₁₋₆ alkyl) group(s);

in further still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and
5 the cyclic amino is substituted with C₁₋₆ alkyl; and

in further still another embodiment, the compound or a salt thereof, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the cyclic amino is substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of methyl and ethyl.

10 [0001]

(1-2) The compound or a salt thereof, in which R¹ is -N(-R¹¹)(-R¹²) and R¹¹ is methyl, ethyl, n-propyl, or isobutyl.

(1-3) The compound or a salt thereof, in which R¹ is -N(-R¹¹)(-R¹²), and R¹² is C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl), or C₃₋₈ cycloalkyl which may be
15 substituted with C₁₋₆ alkyl substituted with -O-(C₁₋₆ alkyl);

in another embodiment, the compound or a salt thereof, in which R¹ is -N(-R¹¹)(-R¹²) and R¹² is C₁₋₆ alkyl substituted with -O-(C₁₋₆ alkyl); and

in still another embodiment, the compound or a salt thereof, in which R¹ is -N(-R¹¹)(-R¹²) and R¹² is 2-methoxyethyl.

20 [0001]

(1-4) The compound or a salt thereof, which is any combination of the embodiments described in (1-2) and (1-3) above.

[0001]

(2) The compound or a salt thereof, in which R² is aryl which may be substituted
25 with the same or different 1 to 5 substituent(s) selected from the Group G, a monocyclic aromatic hetero ring which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G, or a bicyclic aromatic hetero ring which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G;

in another embodiment, the compound or a salt thereof, in which R² is phenyl
30 which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G, thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G, thiazolyl which may be substituted with the same or different 1 to 2 substituent(s) selected from the Group G, or 2,3-dihydro-1-benzofuranyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G;

35 in still another embodiment, the compound or a salt thereof, in which R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G2, thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G3, thiazolyl which may be substituted with the same or different

1 to 2 substituent(s) selected from the Group G3, or 2,3-dihydrobenzofuranyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G3;

in further still another embodiment, the compound or a salt thereof, in which R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G21 and the thienyl may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G32;

in further still another embodiment, the compound or a salt thereof, in which R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G22 and the thienyl may be substituted with the same or different 1 to 3 halogen(s);

in further still another embodiment, the compound or a salt thereof, in which R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G24 and the thienyl may be substituted with the same or different 1 to 3 halogen(s);

in further still another embodiment, the compound or a salt thereof, in which R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G25 and the thienyl may be substituted with the same or different 1 to 3 halogen(s); and

in further still another embodiment, the compound or a salt thereof, in which R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 2 substituent(s) selected from the group consisting of trifluoromethyl and methoxy, and the thienyl may be substituted with one chloro.

[0001]

(2-1) The compound or a salt thereof, in which R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G;

in another embodiment, the compound or a salt thereof, in which R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G2;

in still another embodiment, the compound or a salt thereof, in which R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G21;

in further still another embodiment, the compound or a salt thereof, in which R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G22;

in further still another embodiment, the compound or a salt thereof, in which R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G23;

in further still another embodiment, the compound or a salt thereof, in which R^2 is phenyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G24;

5 in further still another embodiment, the compound or a salt thereof, in which R^2 is phenyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G25; and

in further still another embodiment, the compound or a salt thereof, in which R^2 is phenyl which may be substituted with the same or different 1 to 2 substituent(s) selected from the group consisting of trifluoromethyl and methoxy.

10 (2-2) The compound or a salt thereof, in which R^2 is thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G;

in another embodiment, the compound or a salt thereof, in which R^2 is thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G3;

15 in still another embodiment, the compound or a salt thereof, in which R^2 is thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G31;

in further still another embodiment, the compound or a salt thereof, in which R^2 is thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G32;

in further still another embodiment, the compound or a salt thereof, in which R^2 is thienyl which may be substituted with the same or different 1 to 3 halogen(s); and

in further still another embodiment, the compound or a salt thereof, in which R^2 is thienyl which may be substituted with one chloro.

25 [0001]

(3) The compound or a salt thereof, in which R^3 is -H, -OH, methoxy, or fluoro;

in another embodiment, the compound or a salt thereof, in which R^3 is -H, -OH, or fluoro; and

30 in further still another embodiment, the compound or a salt thereof, in which R^3 is -H.

[0001]

(4) The compound or a salt thereof, which is a combination of any embodiment described in (1), (1-1), or (1-4) above and any embodiment described in (2), (2-1), or (2-2) above and any embodiment described in (3) above.

35 [0001]

(4-1) The compound or a salt thereof, in which R^1 is cyclic amino selected from the group consisting of pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, and morpholin-4-yl,

or -N(-R¹¹)(-R¹²), and the cyclic amino may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G1,

R¹¹ is C₁₋₆ alkyl,

5 R¹² is C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl), or C₃₋₈ cycloalkyl which may be substituted with C₁₋₆ alkyl substituted with -O-(C₁₋₆ alkyl), and

R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G2, thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G3, thiazolyl which may be substituted with the same or different 1 to 2 substituent(s) selected from the Group G3, or
10 2,3-dihydrobenzofuranyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G3, and

R³ is -H, -OH, methoxy, or fluoro.

[0001]

(4-2) The compound or a salt thereof as described in (4-1) above, in which R² is
15 phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G21 and the thienyl may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G32.

[0001]

(4-3) The compound or a salt thereof as described in (4-2) above, in which R¹ is
20 cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, or -N(-R¹¹)(-R¹²), and the cyclic amino may be substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen,

R¹² is C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl),

25 R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G22 and the thienyl may be substituted with the same or different 1 to 3 halogen(s), and

R³ is -H, -OH, or fluoro.

[0001]

30 (4-4) The compound or a salt thereof as described in (4-3) above, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the cyclic amino is substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 -O-(C₁₋₆ alkyl) group(s), and

R² is phenyl or thienyl, in which the phenyl may be substituted with the same or
35 different 1 to 3 substituent(s) selected from the Group G24 and the thienyl may be substituted with the same or different 1 to 3 halogen(s), and

R³ is -H.

[0001]

(4-5) The compound or a salt thereof as described in (4-4) above, in which R^1 is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the cyclic amino is substituted with C_{1-6} alkyl, and

5 R^2 is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G25 and the thienyl may be substituted with the same or different 1 to 3 halogen(s).

[0001]

(4-6) The compound or a salt thereof as described in (4-5) above, in which R^1 is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and
10 the cyclic amino is substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of methyl and ethyl, and

R^2 is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 2 substituent(s) selected from the group consisting of trifluoromethyl and methoxy, and the thienyl may be substituted with one chloro.

15 [0001]

(4-7) The compound or a salt thereof as described in (4-6) above, in which R^2 is phenyl which may be substituted with the same or different 1 to 2 substituent(s) selected from the group consisting of trifluoromethyl and methoxy.

[0001]

20 (4-8) The compound or a salt thereof as described in (4-6) above, in which R^2 is thienyl which may be substituted with one chloro.

[0001]

(4-9) The compound or a salt thereof, in which R^1 is cyclic amino which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G and
25 oxo,

R^2 is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G, thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the Group G, thiazolyl which may be substituted with the same or different 1 to 2 substituent(s) selected from the Group G, or
30 2,3-dihydro-1-benzofuranyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G, and

R^3 is -H, -OH, methoxy, or fluoro.

[0001]

(4-10) The compound or a salt thereof as described in (4-9) above, in which R^2 is
35 phenyl which may be substituted with 1 to 5 substituent(s) selected from the Group G.

[0001]

(4-11) The compound or a salt thereof as described in (4-9) above, in which R^2 is thienyl which may be substituted with 1 to 3 substituent(s) selected from the Group G.

[0001]

(4-12) The compound or a salt thereof as described in (4-10) above, in which R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the cyclic amino is substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen,

R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G23, and

R³ is -H.

[0001]

Specific examples of the compound included in the present invention include the following compounds or salts thereof:

1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-propoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-{5-[(4-[3-methoxy-5-(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpiperidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-(5-{[4-(4-chloro-2-thienyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid,

1-{5-[(4-[4-isopropoxy-3-(trifluoromethyl)phenyl]-5-{[(2R)-2-propylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-(5-{[4-(3-chloro-5-fluoro-4-methoxyphenyl)-5-{[(2S)-2-(ethoxymethyl)pyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid,

1-{5-[(5-{[(2S)-2-(ethoxymethyl)pyrrolidin-1-yl]methyl}-4-[3-fluoro-4-methoxy-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-(5-{[4-(3,5-dichloro-4-methoxyphenyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid,

1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[3-fluoro-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-{5-[(4-[4-methoxy-3-(trifluoromethyl)phenyl]-5-{[(2R)-2-propylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-[5-({5-[(2-isopropylpyrrolidin-1-yl)methyl]-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl} carbamoyl)pyrazin-2-yl]piperidine-4-carboxylic acid,

1-(5-{[4-(4-chloro-2-thienyl)-5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid, and

1-{5-[(4-[4-ethoxy-3-(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid.

[0001]

In another embodiment, specific examples of the compound included in the present invention include the following compounds or salts thereof:

1-{5-[(4-[3-methoxy-5-(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpiperidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-(5-{[4-(4-chloro-2-thienyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid,

1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[3-fluoro-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid, and

1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid.

[0001]

The compound of the formula (I) may exist in the form of tautomers or geometrical isomers depending on the kind of substituents. In the present specification, the compound of the formula (I) shall be described in only one isomer form, yet the present invention includes any other isomers, in their isolated form, or as mixtures thereof.

In addition, the compound of the formula (I) may have asymmetric carbon atoms or axial asymmetries in some cases, and therefore, optical isomers may exist based thereon. The present invention includes isolated forms of optical isomers of the compound of the formula (I) or any mixture thereof.

[0001]

Moreover, the present invention also includes a pharmaceutically acceptable prodrug of the compound of the formula (I). The pharmaceutically acceptable prodrug is a compound having a group that can be converted into an amino group, a hydroxyl group, a carboxyl group, or the like through solvolysis or under physiological conditions.

Examples of the group forming the prodrug include the groups described in Prog. Med., 5, 2157-2161 (1985) and "Pharmaceutical Research and Development" (Hirokawa Publishing Company, 1990), Vol. 7, Molecular Design, 163-198.

[0001]

Moreover, the salt of the compound of the formula (I) is a pharmaceutically acceptable salt of the compound of the formula (I) and may form an acid addition salt or a salt with a base depending on the kind of substituents. Specific examples thereof include acid addition salts with inorganic acids such as hydrochloric acid, hydrobromic acid, hydroiodic acid, sulfuric acid, nitric acid, and phosphoric acid, and with organic acids such as formic acid, acetic acid, propionic acid, oxalic acid, malonic acid, succinic acid, fumaric acid, maleic acid, lactic acid, malic acid, mandelic acid, tartaric acid, dibenzoyltartaric acid, ditoluoyltartaric acid, citric acid, methanesulfonic acid, ethanesulfonic acid, benzenesulfonic acid, p-toluenesulfonic acid, aspartic acid, and glutamic acid, and salts with inorganic bases such as sodium, potassium, magnesium, calcium, and aluminum, or organic bases such as methylamine, ethylamine, ethanolamine, lysine, and ornithine, salts with various amino acids or amino acid derivatives such as acetylleucine, ammonium salts, and the like.

[0001]

Furthermore, the present invention also includes various hydrates or solvates, and polymorphic crystalline substances of the compound of the formula (I) or a salt thereof. In addition, the present invention also includes compounds labeled with various radioactive or non-radioactive isotopes.

[0001]

(Preparation Methods)

The compound of the formula (I) and salts thereof can be prepared using the characteristics based on the basic structure or the type of substituents thereof and by applying various known synthesis methods. During the preparation, replacing the relevant functional group with a suitable protective group (a group that can be easily converted into the relevant functional group) at the stage from starting material to an intermediate may be effective depending on the type of the functional group in the production technology in some cases. The protective group for such a functional group may include, for example, the protective groups described in "Greene's Protective Groups in Organic Synthesis (4th edition, 2006)", P. G. M. Wuts and T. W. Greene, and one of these may be selected and used as necessary depending on the reaction conditions. In this kind of method, a desired compound can be obtained by introducing the protective group, by carrying out the reaction and by eliminating the protective group as necessary.

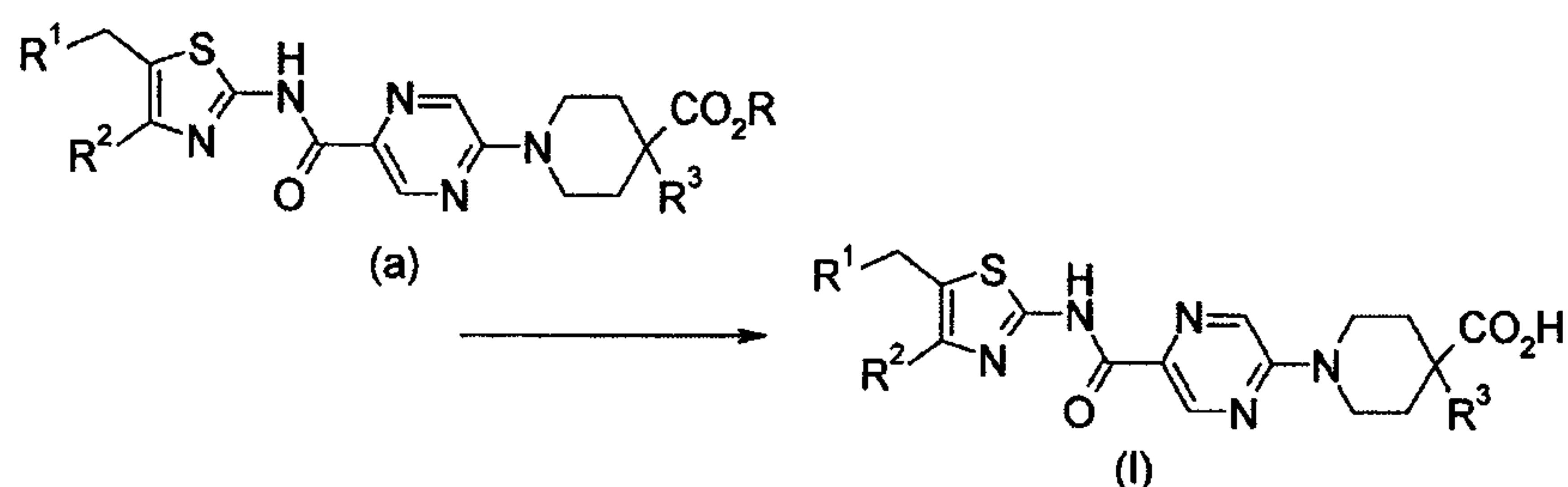
In addition, prodrugs of the compound of the formula (I) can be prepared by introducing a specific group or by carrying out the reaction using the obtained compound of the formula (I) at the stage from a starting material to an intermediate, just as in the case of the above-mentioned protective group. The reaction can be carried out using methods known to a person skilled in the art, such as ordinary esterification, amidation, dehydration, and the like.

Hereinbelow, representative preparation methods for the compound of the formula (I) will be described. Each production process may also be carried out with reference to the References appended in the present description. Further, the preparation methods of the present invention are not limited to the examples as shown below.

5

[0001]

[Chem. 4]



(in which R represents lower alkyl or benzyl, the same shall apply hereinafter.)

10

The present reaction is a method in which a compound of the formula (a) is deprotected to prepare the compound of the formula (I) which is the compound of the present invention.

The present reaction is carried out by using the compound of the formula (a) and a deprotecting reagent in equivalent amounts, or either thereof in an excess amount, and stirring the mixture in a solvent which is inert to the reaction or in the absence of a solvent, in a range from cooling to heating to reflux, usually for 0.1 hours to 5 days.

15

Alternatively, in the case where R is benzyl, the present reaction may also be carried out by subjecting the compound of the formula (a) to a hydrogenation reaction, using a metal catalyst under a hydrogen atmosphere. Examples of the solvent herein used are not particularly limited, but include alcohols such as methanol, ethanol, n-propanol, or the like, dimethylformamide (DMF), tetrahydrofuran and the like. Further, a mixed solvent of the solvent with water may be suitable for the reaction in some cases. Examples of the deprotecting reagent are not particularly limited, but include bases such as an aqueous sodium hydroxide solution, an aqueous potassium hydroxide solution or the like, and acids such as hydrochloric acid, trifluoroacetic acid, or the like. In addition, examples of the metal catalyst that can be used for the hydrogenation condition include palladium-supported carbon, palladium hydroxide, and the like.

20

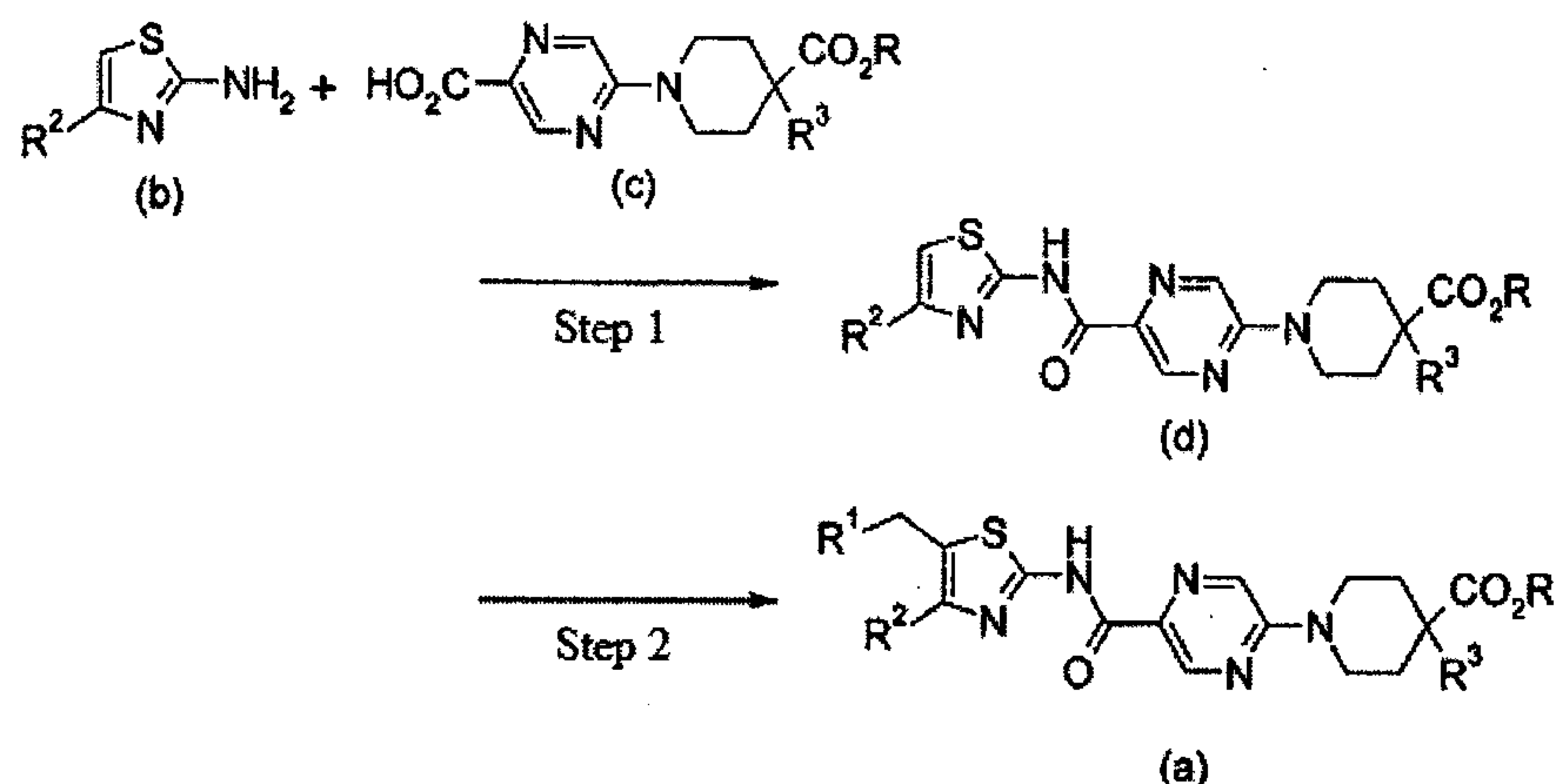
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[0001]

(Starting Material Synthesis 1-1)

30

[Chem. 5]



[0001]

(Step 1)

The present step is a step in which a compound of the formula (b) and a compound
 5 of the formula (c) are subjected to an amidation reaction to obtain a compound of the formula (d).

In this reaction, the compound of the formula (b) and the compound of the formula
 (c) are used in equivalent amounts, or either thereof in an excess amount, and their mixture
 is stirred in a range from cooling to heating, preferably at a temperature from -20°C to
 10 150°C, usually for 0.1 hours to 5 days, in a solvent which is inert to the reaction, in the
 presence of a condensing reagent. Examples of the solvent herein used are not
 particularly limited, but include aromatic hydrocarbons such as benzene, toluene, xylene,
 or the like, halogenated hydrocarbons such as dichloromethane, 1,2-dichloroethane,
 chloroform, or the like, ethers such as diethyl ether, tetrahydrofuran, dioxane,
 15 dimethoxyethane, cyclopentylmethyl ether, or the like, N,N-dimethylformamide,
 dimethylsulfoxide (DMSO), ethyl acetate, acetonitrile, or water, and any mixture thereof.
 Examples of condensing reagent include, but are not limited to, 1-(3-
 dimethylaminopropyl)-3-ethylcarbodiimide, dicyclohexylcarbodiimide, 1,1'-
 carbonyldiimidazole, diphenylphosphoryl azide, phosphorous oxychloride, and O-
 20 (benzotriazol-1-yl)-N,N,N',N'-tetramethyluronium tetrafluoroborate. It may be
 preferable in some cases for the reaction to use an additive (for example, 1-
 hydroxybenzotriazole). It may be advantageous in some cases for smooth progress of the
 reaction to carry out the reaction in the presence of organic bases such as triethylamine,
 N,N-diisopropylethylamine, N-methylmorpholine, or the like, or inorganic bases such as
 25 potassium carbonate, sodium carbonate, potassium hydroxide, or the like. In addition, it
 may be advantageous in some cases for the smooth progress of the reaction to heat the
 reaction mixture under irradiation with microwaves.

Furthermore, it is also possible to use a method in which a carboxylic acid (c) is
 converted to a reactive derivative and afterward reacted with an amine (b). Examples of

the reactive derivative of the carboxylic acid include acid halides that can be obtained by the reaction with a halogenating reagent such as phosphorus oxychloride, thionyl chloride, or the like, mixed acid anhydrides obtained by the reaction with isobutyl chloroformate, or the like, and active esters obtained by condensation with 1-hydroxybenzotriazole or the like. The reaction of these reactive derivatives with the compound (b) can be carried out in a range from cooling to heating, and preferably from -20°C to 60°C, in a solvent which is inert to the reaction, such as halogenated hydrocarbons, aromatic hydrocarbons, ethers, and the like.

[Documents]

“Organic Functional Group Preparations”, S. R. Sandler and W. Karo, 2nd edition, Vol. 1, Academic Press Inc., 1991

The Chemical Society of Japan, “Courses in Experimental Chemistry (5th edition)” Vol. 16 (2005) (Maruzen)

[0001]

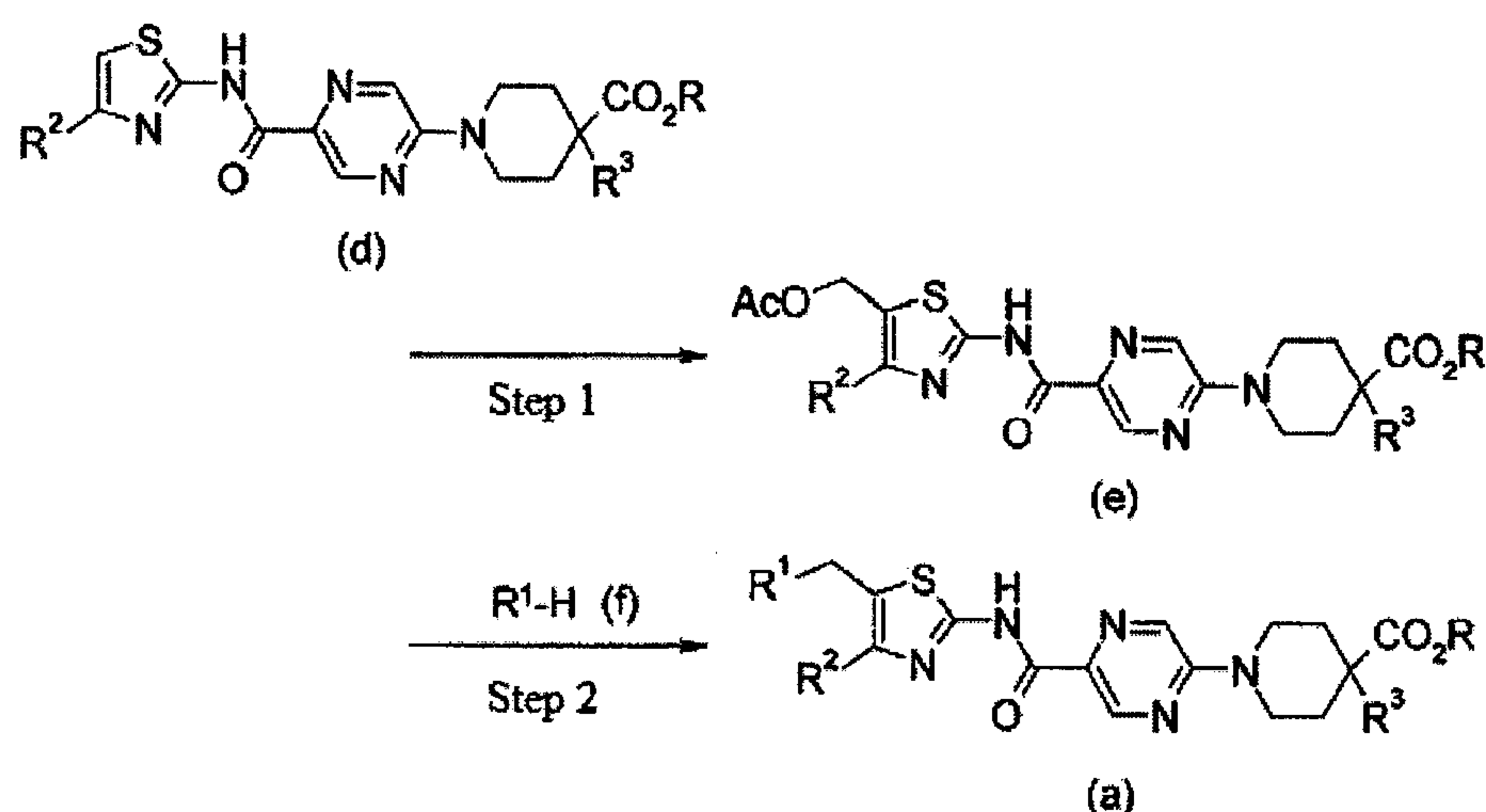
(Step 2)

The present step is a step in which an aminomethyl group is introduced into the 5-position of thiazole of a compound of the formula (d) using a Mannich reaction to prepare the compound of the formula (a). The method shown in Albertson, N. F.: Journal of American Chemistry 1948, 70, 669., or Bhargava, P. N.; Sharma, S. C.; Bulletin of the Chemical Society of Japan 1965, 38, 909., or a method analogous thereto can be employed.

[0001]

(Starting Material Synthesis 1-2)

[Chem. 6]



25

[0001]

(Step 1)

The present step is a step in which an acetoxymethyl group is introduced into the 5-position of thiazole of a compound of the formula (d) to prepare a compound of the formula (e). The compound of the formula (d) is subjected to a reaction with an aqueous formaldehyde solution or paraformaldehyde in an acetic acid solvent, in a range from room temperature to heating, or in a range of room temperature to refluxing. Further, the reaction may also be carried out by adding acetic acid to a solvent which is inert to the reaction, such as halogenated hydrocarbons, aromatic hydrocarbons, ethers, or the like, instead of the acetic acid solvent. Further, the reaction may also be carried out by further adding acetic anhydride.

[0001]

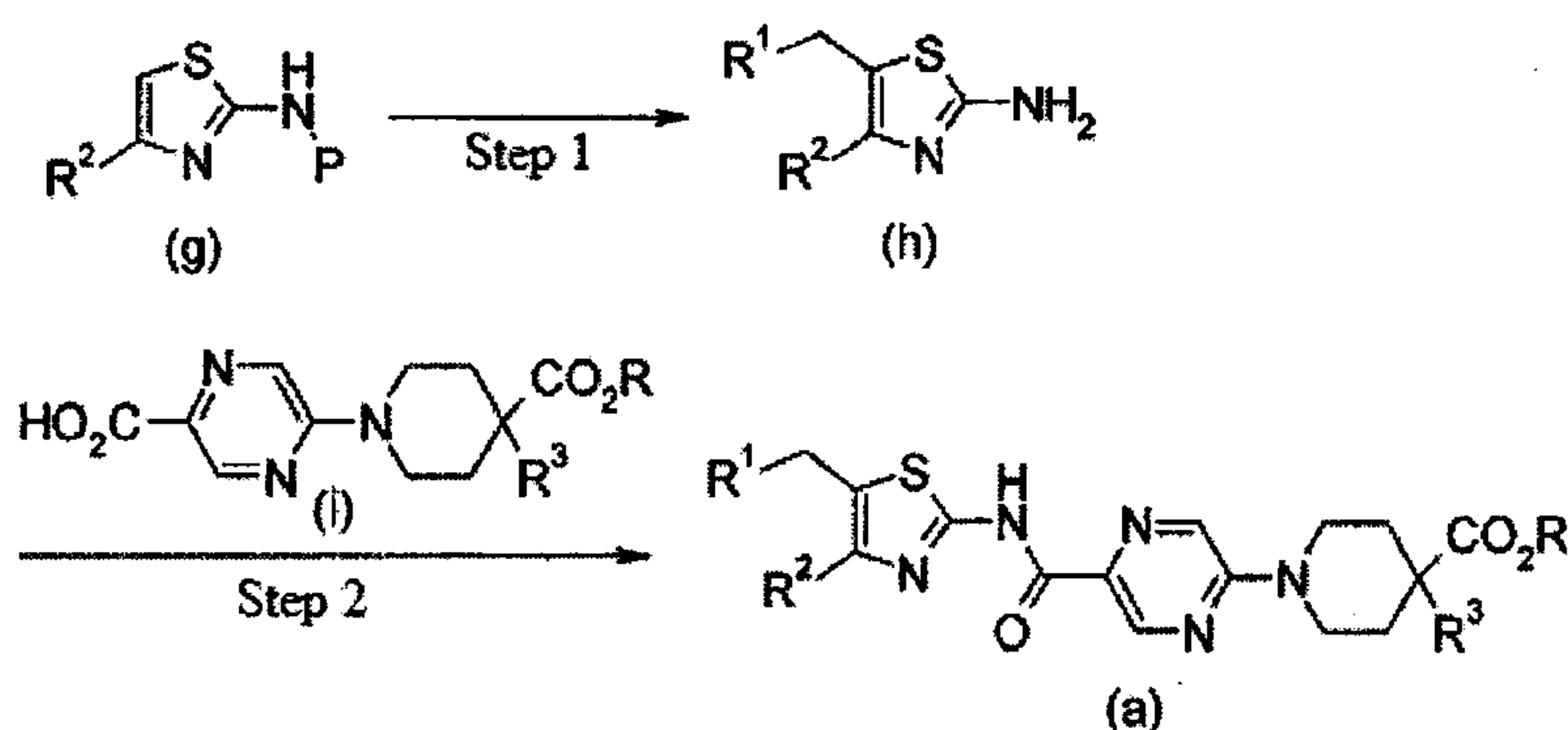
(Step 2)

The present step is a step in which under a basic condition, the compound of the formula (e) is subjected to a nucleophilic substitution reaction with a compound of the formula (f) to prepare the compound of the formula (a). The nucleophilic substitution reaction can be carried out by subjecting the compound of the formula (e) to a reaction with the compound of the formula (f) in an organic solvent which is inert to the reaction, such as halogenated hydrocarbons, aromatic hydrocarbons, ethers, esters, acetonitrile, DMF, DMSO, or the like, in the presence of organic bases such as triethylamine, diisopropylethylamine, or the like and/or inorganic bases such as potassium carbonate, sodium carbonate, cesium carbonate, sodium hydrogen carbonate, or the like. Further, in order to accelerate the reaction, a catalyst such as dimethylaminopyridine may also be added. In addition, instead of the organic bases and/or inorganic bases, the compound of the formula (f) may be used in an excess amount. The reaction can be carried out in a range from cooling to room temperature, in a range from room temperature to heating, or in a range from room temperature to refluxing.

[0001]

(Starting Material Synthesis 2)

[Chem. 7]



(in which P represents a protective group, for example, an acetyl group.)

(Step 1)

The present step is a step in which the compound of the formula (g) is subjected to a deprotection reaction after the Mannich reaction to prepare a compound of the formula (h). The Mannich reaction is the same as Step 2 of Starting Material Synthesis 1-1. The subsequent deprotection of P which is a protective group of the amino group can be carried out with reference to "Protective Groups in Organic Synthesis", Greene and Wuts, 4th edition, John Wiley & Sons Inc, 2006 as described above.

[0001]

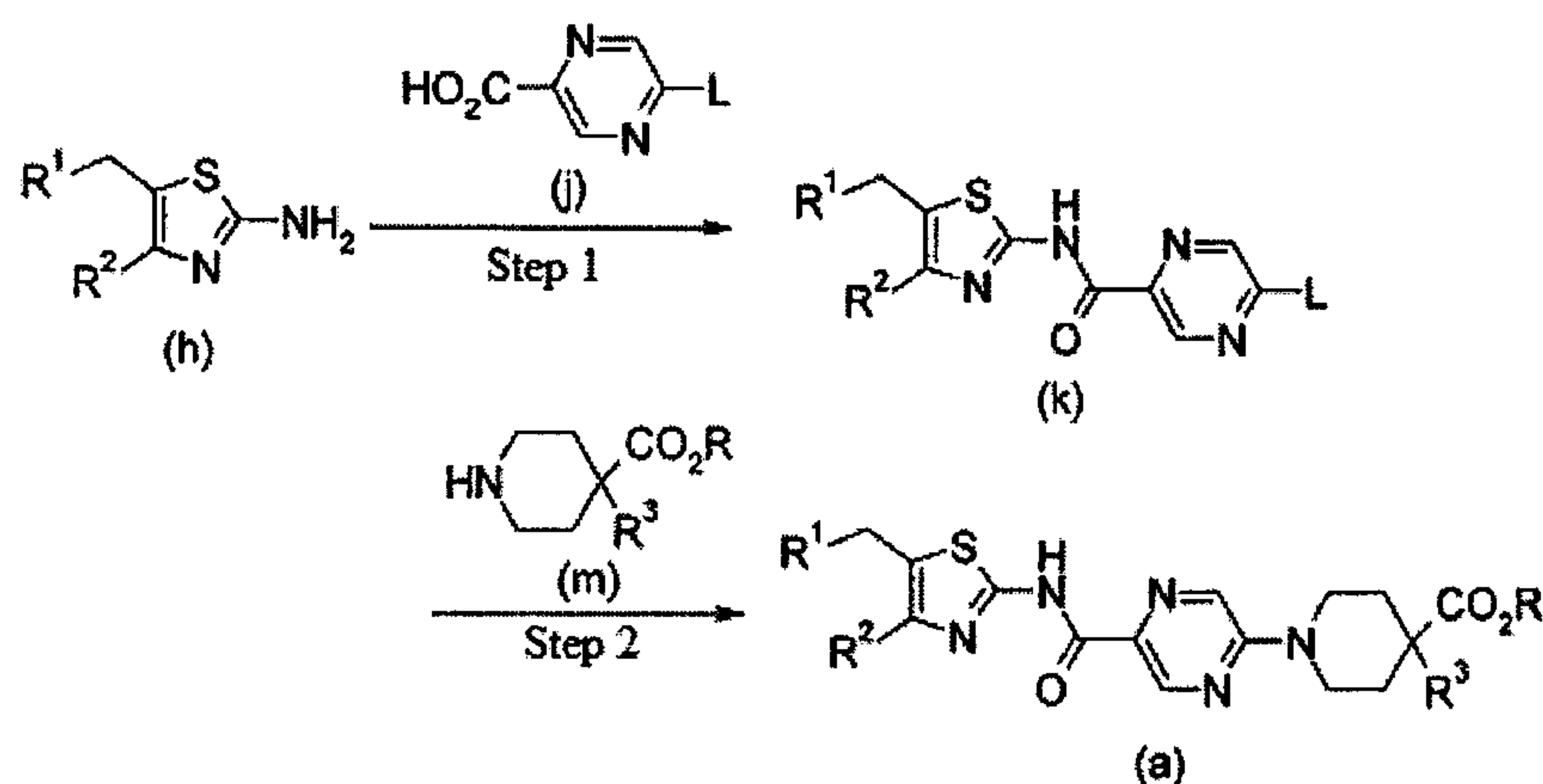
(Step 2)

The present step is a step in which the compound of the formula (h) and a compound of the formula (i) are subjected to an amidation reaction to prepare the compound of the formula (a). The reaction conditions are the same as in Step 1 of Starting Material Synthesis 1-1.

[0001]

(Starting Material Synthesis 3)

[Chem. 8]



(in which L represents a leaving group, for example, chloro.).

[0001]

(Step 1)

The present step is a method in which the compound of the formula (h) and a compound of the formula (j) are subjected to an amidation reaction to prepare a compound of the formula (k). The reaction conditions are the same as in Step 1 of Starting Material Synthesis 1-1.

[0001]

(Step 2)

The present step is a step in which the compound of the formula (k) is reacted with a compound of the formula (m) to prepare the compound of the formula (a).

In this reaction, the compound (k) and a compound (m) are used in equivalent amounts, or either thereof in an excess amount, and their mixture is stirred in a range from cooling to heating to reflux, preferably at a temperature from 0°C to 80°C, usually for 0.1 hours to 5 days, in a solvent which is inert to the reaction or in the absence of a solvent.

- 5 Examples of the solvent herein used are not particularly limited, but include aromatic hydrocarbons such as benzene, toluene, xylene, or the like, ethers such as diethyl ether, tetrahydrofuran, dioxane, dimethoxyethane, or the like, halogenated hydrocarbons such as dichloromethane, 1,2-dichloroethane, chloroform, or the like, N,N-dimethylformamide, dimethylsulfoxide, ethyl acetate, acetonitrile, N-methylpyrrolidone and a mixture thereof.
- 10 It may be advantageous in some cases for smooth progress of the reaction to carry out the reaction in the presence of organic bases such as triethylamine, N,N-diisopropylethylamine, N-methylmorpholine, or the like, or inorganic bases such as potassium carbonate, sodium carbonate, potassium hydroxide, or the like.

[Documents]

- 15 “Organic Functional Group Preparations”, S. R. Sandler and W. Karo, 2nd edition, Vol. 1, Academic Press Inc., 1991
- The Chemical Society of Japan, “Courses in Experimental Chemistry (5th edition)” Vol. 14 (2005) (Maruzen)

[0001]

- 20 The compounds of the formula (I) can be isolated and purified as free compounds, salts, hydrates, solvates, or crystal polymorph substances thereof. Salts of the compound of the formula (I) can be prepared by conventional salt forming reactions.

- Isolation and purification are carried out by employing ordinary chemical operations such as extraction, fractional crystallization, and various types of fractional
- 25 chromatography.

- Various isomers can be prepared by selecting appropriate starting compounds or by separation using differences in physicochemical properties between the isomers. For example, optical isomers can be obtained by means of a general optical resolution method for racemic products (for example, fractional crystallization for inducing diastereomer salts
- 30 with optically active bases or acids, and chromatography using a chiral column or the like), and further, the isomers can also be prepared from an appropriate optically active starting compound.

[0001]

- Pharmacological activities of the compound of the formula (I) were confirmed in
- 35 the following tests.

Test Example 1: Evaluation of Muscarinic M₃ Receptor Positive Allosteric Modulator Activity

a) Construction of Human Muscarinic M₃ Receptor Expression Vector

A human muscarinic M₃ receptor gene (GenBank Accession No. NM_000740.2) was introduced into an expression vector pcDNA3.1TM (Life Technologies).

b) Construction of Cell Stably Expressing Human Muscarinic M₃ Receptor

The human muscarinic M₃ receptor expression vector was introduced into a CHO-K1 cell (ATCC No. CCL-61). The introduction was carried out by using a Lipofectamine (registered trademark) 2000 reagent (Life Technologies) which is a gene introduction reagent, according to instructions attached. The cells were cultured in an alpha Modified Eagle Minimum Essential Medium (α-MEM) containing 2 mM glutamic acid, 10% fetal bovine serum, and 2.0 mg/mL Geneticin (registered trademark) (Life Technologies) for 4 weeks to acquire a drug-resistant clone.

c) Measurement of Intracellular Ca²⁺ Concentration

On the day before the experiment, the cells obtained in b) above were suspended in an α-MEM containing 2 mM glutamic acid, 10% fetal bovine serum, and 0.2 mg/mL Geneticin (registered trademark), dispensed into a 384-well plate (Lot number 355962, BD Biosciences) to 1.2 to 1.5 × 10⁴ cells/well, and cultured at 37°C and 5% CO₂ overnight. The culture medium was replaced with a loading buffer (Assay Buffer (Hanks Balanced Salt Solution (HBSS), 1 g/L BSA, 20 mM HEPES (pH 7.5), and 2.5 mM Probenecid) containing 3.1 μM Fluo 4-AM (Dojindo Laboratories)), and left at room temperature for about 2 hours. Thereafter, the cells were washed with a plate washer ELx405TM (BIO-TEK Instruments) in which the assay buffer had been set, and placed in an intracellular Ca²⁺ concentration measuring system (FLIPR^{tetra} (registered trademark), Molecular Devices). A test substance (final concentration of 1 μM or 10 μM) and carbachol (Sigma, final concentration of 0.0024 nM to 100 μM) each of which had been dissolved in the assay buffer in advance were placed in a FLIPR^{tetra} (registered trademark). In the device, the test substances were added to the cells, then carbachol was added to the cells about 5 minutes after adding the test substances, and increases in the intracellular Ca²⁺ concentration by carbachol were measured (excitation wavelength of 470 nm to 495 nm and fluorescent wavelength of 515 nm to 575 nm).

For the activity of the muscarinic M₃ receptor positive allosteric modulator, a shift toward a lower concentration side of a carbachol concentration-response curve by the test substance was used as an index. That is, the minimum value of the carbachol response and the maximum value of the carbachol response from the concentration-response curve of carbachol were set to 0% and 100%, respectively. By a logistic regression method, the concentration of carbachol showing a 50% response was calculated as an EC₅₀ value, and the activity was determined by dividing the EC₅₀ value of carbachol in the absence of the test substance by the EC₅₀ value in the presence of the test substance. For example, when the EC₅₀ value of carbachol in the absence of the test substance is 0.1 μM and the EC₅₀ value of carbachol in the presence of the test substance is 0.01 μM, the value becomes 10,

indicating that the test substance has a 10-fold shift toward a lower concentration side in the carbachol concentration response curve. In the table after described, the values in the case where the test substances were added at a final concentration of 10 μ M are shown in the section of 10 μ M (-fold shift), and the values in the case where the test substances were added at a final concentration of 1 μ M are shown in the section of 1 μ M (-fold shift).

[0001]

Test Example 2: Evaluation of Human c-Mpl-Introduced Ba/F3 Cell Proliferative Activity

The human c-Mpl-introduced Ba/F3 cell proliferative activity was measured by the following method.

As a positive control, 1-(5-{[4-(4-chloro-2-thienyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}-3-fluoropyridin-2-yl)piperidine-4-carboxylic acid hydrochloride, which is disclosed as Example 315 in Patent Document 1 and represented by the formula A1, was used. It is known that the compound has a good human c-Mpl-introduced Ba/F3 cell proliferative activity as disclosed in Table 1 of Patent Document 1.

a) Construction of Human c-Mpl Receptor Expression Vector

A human c-mpl receptor gene (GenBank Accession No. M90102.1) was introduced into an expression vector pEF-BOS (Nucleic Acids Res. 18, 5322, 1990).

b) Construction of Cell Stably Expressing Human c-Mpl Receptor

A human c-Mpl receptor expression vector was introduced into a Ba/F3 cell (RIKEN BRC: RCB0805). For the introduction, an electroporation method was used. pEF-BOS-c-mpl (10 μ g), pSV2bsr (1 μ g, Kaken Pharmaceutical Co., Ltd.) and 1×10^7 Ba/F3 cells were put into a cuvette having a gap width of 0.4 cm, and electroporated under the conditions of 1.5 kV (25 μ F) by a Gene Pulser (registered trademark) (BioRad). The cells were cultured in an RPMI-1640 culture medium containing 0.5% WEHI conditioned media (BD Biosciences) and 10% fetal bovine serum for 3 days, and then cultured in an RPMI-1640 culture medium, to which 10 μ g/mL blasticidin had been further added, for 30 days to acquire a drug-resistant clone.

c) Measurement of Cell Proliferative Activity

The cells obtained in b) above was cultured in an RPMI-1640 culture medium containing 0.5% WEHI conditioned media, 10% fetal bovine serum, and used. On the day before the experiment, test substances (final concentration of 100 nM to 10 μ M) which had been dissolved in a culture medium for assay (RPMI-1640 culture medium containing 10% fetal bovine serum) were added to a 384-well plate (Lot No.781185, Greiner Bio-One). The cells in the culture medium that had been replaced with a culture medium for assay were dispensed into a 384-well plate, to which the test substances had been added in advance, to 1×10^4 cells/well, and cultured at 37°C and 5% CO₂ overnight. On the

experiment day, a solution of a Cell Counting Kit (Dojindo Laboratories) was added to each well of the 384-well plate and cultured at 37°C and 5% CO₂ for about 5 hours. Thereafter, the absorbance (absorption wavelength of 450 nm) of each well was measured using Safire²™ (TECAN) and used as the index of the number of cells. Further, as a
 5 negative control, a well in which the test substance had been not added was prepared.

The absorbance of the well without the test substance was set to 0%, and the absorbance in the case where the positive control was added at a final concentration of 1 μM was set to 100%. From the absorbance in the case where the test substance had been added, a cell proliferation rate (%) was calculated. From the obtained results, the test
 10 substance concentration showing 30% proliferation was calculated as an EC₃₀ value by a logistic regression method.

[0001]

The muscarinic M₃ receptor positive allosteric modulator activity (-fold shift) and the human c-Mpl-introduced Ba/F3 cell proliferative activity (EC₃₀ value, nM) of several
 15 Example compounds of the present invention are shown in combination in Table 1. Further, Ex represents Example No. as denoted after (this shall apply hereinafter).

[0001]

[Table 1]

Ex.	Test Example 1		Test Example 2
	10 μ M (-fold shift)	1 μ M (-fold shift)	EC ₃₀ (nM)
1	187	11	>10000
2	253	12	>10000
3	260	19	4800
4	186	31	350
11	91	15	>10000
19	151	10	>10000
20	361	15	>10000
21	116	14	>10000
27	340	26	>10000
38	126	14	>10000
69	114	10	>10000
84	184	17	>10000
92	131	11	>10000
115	245	10	>10000
125	128	20	>10000
128	533	64	8400
129	464	109	770
133	209	36	1100
142	110	15	380
146	201	18	820
150	213	17	>10000
152	251	24	580
156	269	19	>10000
158	128	9	>10000
179	373	34	>10000
188	246	12	>10000
196	186	38	380
197	100	20	1800
200	97	10	>10000
203	203	16	>10000
204	207	25	>10000

[0001]

In Test Example 1, for many Example compounds which had been subjected to the present test, the carbachol concentration response curve had an approximately 100-fold or more shift toward a lower concentration side when the compounds were added at a concentration of 10 μ M, and the carbachol concentration response curve had an approximately 10-fold or more shift toward a lower concentration side when the compounds were added at a concentration of 1 μ M. Further, it was confirmed that several Example compounds alone did not cause a change in the intracellular Ca²⁺ concentrations,

therefore it was confirmed that these compounds do not have a muscarinic M₃ receptor agonistic activity.

[0001]

And, in Test Example 2, it was confirmed that a number of Example compounds
5 which had been subjected to the present test had no or weak human c-Mpl-introduced Ba/F3 cell proliferative activity. In a certain embodiment, the compound of the present invention is a compound having an EC₃₀ value of the human c-Mpl-introduced Ba/F3 cell proliferative activity of 0.3 μM or more, preferably 1 μM or more, and further preferably 10 μM or more.

10 [0001]

Test Example 3: Effects on Transmural Electrical Field Stimulation-Induced Contraction of Isolated Rat Bladder

As an effect on the nerve stimulation-dependent bladder contraction in vitro, the effect of the Example compound of the present invention in the transmural electrical field
15 stimulation-induced contraction of isolated rat bladder was measured by the following method. That is, from the bladder isolated from a Sprague-Dawley (SD) female rat (Japan SLC, Inc.), a longitudinal bladder strip having a width of about 2 mm and a length of about 10 mm was prepared. The prepared bladder strip was suspended in an organ bath filled with 10 mL of a Krebs-Henseleit solution. The Krebs-Henseleit solution was
20 bubbled with 95% O₂ and 5% CO₂, and kept at 37°C. After stabilization at an initial tension of 1 g, contraction was induced twice with 60 mM KCl. The strip was washed with the Krebs-Henseleit solution and stabilized, and then contraction was induced with transmural electrical field stimulation at 20 V (stimulation frequency of 8 Hz, pulse width of 0.3 msec, and stimulation time of 10 seconds) by an electrical stimulation device (Nihon
25 Kohden Corporation). At an interval of 2 minutes, transmural electrical field stimulation was repeated and the voltage was adjusted to make the contractile amplitude about 50% of the contractile response by 20 V. After stabilization of the contraction by the transmural electrical field stimulation, 10 μL of the test substance (final concentrations of 3 μM, 10 μM, and 30 μM), which had been dissolved in 100% dimethylsulfoxide in advance was
30 added. The test substance was cumulatively administered at the next concentration after the contractile response at a lower concentration had been stabilized. The responses were put into a personal computer through PowerLab (registered trademark) (AD Instruments), and analyzed with LabChart (registered trademark) (AD Instruments). The area under the response of each contractile response (area under curve, AUC) was calculated and the
35 value before the treatment with the test substance was set to 100%. Based on this, the enhancement rate of the isolated bladder contraction (% of pre) after the treatment with the test substance was calculated.

[0001]

The enhancement rates of the isolated bladder contraction due to several 10 μ M Example compounds which are the compounds of the formula (I) are shown in Table 2.

And, all of the Example compounds which had been subjected to the present test did not cause contraction in the absence of the electrical field stimulation, therefore it was confirmed that the compound alone did not exhibit a bladder contractile effect.

[0001]

[Table 2]

Ex.	Enhancement rate of isolated bladder contraction (% of pre)
1	132
4	180
19	124
69	152
84	140
92	132
115	121
156	135
158	125
179	120
188	128
196	125

[0001]

As seen from above, it was confirmed that the Example compounds which had been subjected to the present test do not exhibit a contractile effect in the isolated rat bladder when used alone, and have an activity for enhancing the transmural electrical field stimulation-induced contraction.

[0001]

Test Example 4: Effect on Pelvic Nerve Electrical Stimulation-Induced Elevation of Intravesical Pressure in Anesthetized Rats

As an effect on the nerve stimulation-dependent bladder contraction in vivo, the effect of the Example compound of the present invention in the pelvic nerve electrical stimulation-induced elevation of the intravesical pressure in rats was measured by the following method. That is, using SD female rats (Japan SLC, Inc.), the lower abdomen was incised in the midline under anesthesia with pentobarbital (50 mg/kg ip). The ureter on both sides was ligated and cut, and then a cannula for measuring the intravesical pressure (PE-50) was inserted into the bladder from the external urethral orifice and fixed by a clip. About 200 μ L of physiological saline was injected through the cannula inserted into the bladder, the other side was then connected to a pressure transducer, and the intravesical pressure was measured. Under observation using a stereomicroscope, the pelvic nerve near the bladder was isolated and an electrode (Unique Medical) for nerve stimulation was placed. The abdominal cavity was filled with mineral oil (MP

BIOMEDICALS). After the surgery, a stabilization period was applied, and an elevation of the intravesical pressure was induced by the electrical stimulation of the pelvic nerve (stimulation frequency of 8 Hz, pulse width of 0.3 msec, and stimulation time of 10 seconds) using an electrical stimulation device (Nihon Kohden Corporation). While
 5 adjusting the voltage, electrical stimulation was repeated at an interval of 2 minutes, and the voltage was adjusted to make the elevation of the intravesical pressure about 50% to 70% of that with stimulation at 10 V. Thereafter, the electrical stimulation at an interval of 10 minutes was repeated. After the elevation of the intravesical pressure by electrical stimulation was stabilized three times or more, the test substance (dose of 3 mg/kg) was
 10 administered at a volume of 1 mL/kg from a catheter placed in the vein and the effect of the test substance on the elevation of the intravesical pressure was measured for 1 hour. The test substance was dissolved in water containing 10% dimethylsulfoxide and 10% Cremophor.

The responses were put into a personal computer through PowerLab (registered
 15 trademark) (AD Instruments), and analyzed with LabChart (registered trademark). The AUC of each elevation of the intravesical pressure was calculated. The average value of three values before the treatment with the test substance was set to 100%, and the elevation rate of the intravesical pressure (% of pre) after the treatment with the test substance was calculated. The maximum effect during the one-hour period after the administration of
 20 the compound was considered as the effect of the test substance.

[0080]

The elevation rates of the intravesical pressure (% of pre) when several Example compounds which are the compounds of the formula (I) were administered at 3 mg/kg are shown in Table 3.

25 [0081]

[Table 3]

Ex.	Elevation rate of intravesical pressure (% of pre)
4	184
115	131
156	130

[0082]

In addition, all of the Example compounds which had been evaluated in the
 30 present test did not cause an elevation of the intravesical pressure when electrical stimulation was not applied, therefore it was confirmed that the compound alone did not exhibit an elevating effect on the intravesical pressure.

[0083]

As seen from above, it was confirmed that the Example compounds which are
 35 shown in Table 3 do not exhibit an elevating effect on the intravesical pressure when used

alone, but have an enhancing effect on the pelvic nerve electrical stimulation-induced elevation of the intravesical pressure in the anesthetized rat.

[0084]

As seen from the results of each test above, it was confirmed that the compound of the formula (I) has a muscarinic M₃ receptor positive allosteric modulator activity and enhances the bladder contraction in vitro in a nerve stimulation-dependent manner and enhances an elevation of the intravesical pressure in vivo in a nerve stimulation-dependent manner. Accordingly, the compound of the formula (I) can be used for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, in particular, voiding dysfunctions or storage dysfunctions in bladder or urinary tract diseases. For example, the compound of the formula (I) can be used for preventing or treating voiding dysfunctions or storage dysfunctions in underactive bladder, hypotonic bladder, acontractile bladder, detrusor underactivity, neurogenic bladder, urethral relaxation failure, detrusor-external urethral sphincter dyssynergia, overactive bladder, urinary frequency, nocturia, urinary incontinence, benign prostatic hyperplasia, interstitial cystitis, chronic prostatitis, urethral calculus, or the like. In particular, the compound of the formula (I) can be used for preventing or treating voiding dysfunctions or storage dysfunctions in underactive bladder, hypotonic bladder, acontractile bladder, detrusor underactivity, and neurogenic bladder.

Further, the compound of the formula (I) does not exhibit an agonistic effect on a muscarinic M₃ receptor when used alone, and has an effect on enhancing the nerve stimulation-dependent bladder contraction, thus avoiding the cholinergic side effects as reported in the existing drugs. Therefore, the compound of the formula (I) can be a therapeutic agent having superior safety.

[0085]

Pharmaceutical compositions containing one or more kinds of the compound of the formula (I) or a salt thereof as an active ingredient can be prepared using excipients that are usually used in the art, that is, excipients for pharmaceutical preparation, carriers for pharmaceutical preparation, and the like according to the methods usually used.

Administration can be accomplished either by oral administration via tablets, pills, capsules, granules, powders, solutions, and the like, or parenteral administration, such as injections such as intraarticular, intravenous, and intramuscular injections, suppositories, transdermal solutions, ointments, transdermal patches, transmucosal solutions, transmucosal patches, inhalers, and the like.

[0086]

Solid compositions for oral administration are used in the form of tablets, powders, granules, or the like. In such solid compositions, one or more active ingredient(s) are mixed with at least one inactive excipient. In a conventional method, the composition

may contain inactive additives, such as lubricants, disintegrating agents, stabilizers, or solubilization assisting agents. If necessary, tablets or pills may be coated with sugar or s gastric- or enteric-soluble substance films.

5 Liquid compositions for oral administration include pharmaceutically acceptable emulsions, solutions, suspensions, syrups, elixirs, or the like, and also include generally used inert diluents, for example, purified water or ethanol. In addition to the inert diluent, liquid compositions may also contain auxiliary agents, such as solubilization assisting agents, moistening agents, and suspending agents, sweeteners, flavors, aromatics, or antiseptics.

10 [0087]

15 Injections for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, or emulsions. Aqueous solvents include, for example, distilled water for injection or physiological saline. Examples of non-aqueous solvents include alcohols such as ethanol. Such compositions may further contain tonicity agents, antiseptics, moistening agents, emulsifying agents, dispersing agents, stabilizers, or solubilization assisting agents. These are sterilized, for example, by filtration through bacteria retaining filter, blendings of bactericide, or irradiation. In addition, these can also be used by preparing sterile solid compositions, and dissolving or suspending in sterile water or sterile solvents for injection prior to use.

20 [0088]

Agents for external use includes ointments, plasters, creams, jellies, poultices, sprays, lotions, and the like. The agents contain generally used ointment bases, lotion bases, aqueous or non-aqueous solutions, suspensions, emulsions, and the like.

[0089]

25 As transmucosal agents such as inhalers, transnasal agents, and the like, those in the form of a solid, liquid, or semi-solid state are used, and can be prepared in accordance with conventionally known methods. For example, known excipients, and furthermore pH adjusting agents, antiseptics, surfactants, lubricants, stabilizers, thickening agents, or the like may be appropriately added thereto. For their administration, appropriate devices
30 for inhalation or blowing can be used. For example, a compound may be administered alone or as a powder of formulated mixture, or as a solution or suspension in combination with pharmaceutically acceptable carriers, using a known device or sprayer, such as a measured administration inhalation device, and the like. Dry powder inhalers or the like may be for single or multiple administration use, and dry powder or powder-containing
35 capsules may be used. Alternatively, these may be a pressurized aerosol spray which uses appropriate ejection agents, for example, a suitable gas such as chlorofluoroalkane, carbon dioxide, and the like.

[0090]

For oral administration, a daily dose is generally from about 0.001 to 100 mg/kg, preferably from 0.1 to 30 mg/kg, and more preferably from 0.1 to 10 mg/kg, per body weight, administered in one portion or in 2 to 4 separate portions. In the case of intravenous administration, a daily dose is suitably administered from about 0.0001 to 10 mg/kg per body weight, once a day or two or more times a day. In addition, a transmucosal agent is administered at a dose from about 0.001 to 100 mg/kg per body weight, once a day or two or more times a day. Doses are appropriately determined according to the individual according to the symptoms, age, gender, and the like.

[0091]

Although varying depending on administration routes, formulations, administration sites, or the types of excipients or additives, the pharmaceutical composition of the present invention contains 0.01 to 100% by weight, and in a certain embodiment, 0.01 to 50% by weight of one or more kinds of the compound of the formula (I) or a salt thereof, which is an active ingredient.

[0092]

The compound of the formula (I) can be used in combination with various agents for treating or preventing the diseases for which the compound of the formula (I) is considered to be effective, as described above. The combined preparation may be administered simultaneously, or separately and continuously, or at a desired time interval. The preparations to be administered simultaneously may be a mixture, or may be prepared individually.

[Examples]

[0093]

Hereinbelow, the preparation methods for the compound of the formula (I) will be described in more detail with reference to Examples. The present invention is not limited to the compounds described in Examples as described below. Further, the production processes for the starting compounds will be described in Preparation Examples. Further, the preparation methods for the compound of the formula (I) are not limited to the preparation methods in specific Examples shown below, and the compound of the formula (I) can be prepared according to a combination of these preparation methods or methods apparent to those skilled in the art.

[0094]

Further, in the present specification, nomenclature software such as ACD/Name (registered trademark, Advanced Chemistry Development, Inc.) may be used in some cases for the nomenclature of the compounds.

[0095]

Moreover, the following abbreviations may be used in some cases in Examples, Preparation Examples, and Tables as described later.

PEx: Preparation Example number, Ex: Example number, PSyn: Preparation Example No. prepared by the same method, Syn: Example No. prepared by the same method, No.: Compound No., Str: Chemical structural formula (Me: methyl, Et: ethyl, nPr: n-propyl, iPr: isopropyl, cPr: cyclopropyl, nBu: n-butyl, iBu: isobutyl, Boc: tert-butyloxycarbonyl, Ac: acetyl, Z: benzyloxycarbonyl, and Ts: 4-methylphenylsulfonyl), DATA: Physicochemical data, ESI+: m/z values in mass spectroscopy (Ionization ESI, representing $[M+H]^+$ unless restricted), ESI-: m/z values in mass spectroscopy (Ionization ESI, representing $[M-H]^-$ unless restricted), APCI/ESI+: APCI/ESI-MS (Atmospheric chemical ionization APCI, APCI/ESI represents simultaneous measurement of APCI and ESI, representing $[M+H]^+$ unless limited), EI: m/z values in mass spectroscopy (Ionization EI, representing $[M]^+$ unless restricted), CI+: m/z values in mass spectroscopy (Ionization CI, representing $[M+H]^+$ unless restricted), m.p.: melting point, NMR (DMSO-d₆): δ (ppm) of peak in ¹H NMR in DMSO-d₆, s: singlet (spectrum), d: doublet (spectrum), t: triplet (spectrum), q: quartet (spectrum), br: broad line (spectrum) (for example, brs), and m: multiplet (spectrum). Further, in the structural formula, HCl denotes that the compound is monohydrochloride, 2HCl denotes that the compound is dihydrochloride, and 3HCl denotes that the compound is trihydrochloride.

[0096]

Furthermore, for convenience, the concentration mol/L is expressed as M. For example, a 1 M aqueous sodium hydroxide solution means a 1 mol/L aqueous sodium hydroxide solution.

[0097]

Further, the on-set temperatures of the DSC curve obtained by measurement under the following conditions are described as melting points in Tables below.

The DSC measurement was carried out using TA Instruments DSC Q20, under the conditions of a measurement temperature range from room temperature to 300°C, a temperature elevating rate of 10°C/min, a nitrogen flow rate of 50 mL/min, with an aluminum sample pan.

[0098]

The powder X-ray diffraction was measured using RINT-TTRII under the conditions of a tube of Cu, a tube current of 300 mA, a tube voltage of 50 kV, a sampling width of 0.020°, a scanning speed of 4°/min, a wavelength of 1.54056 angstroms, and a measurement diffraction angle (2 θ) of 2.5° to 40°.

Furthermore, for the powder X-ray diffraction spectrum, crystal lattice spacings or overall patterns are important in identity certification of crystals in the nature of the data. The diffraction angle and the diffraction intensity may vary more or less depending on the orientation of the crystal growth, the particle size, or the measurement conditions, and thus, the values should not be strictly interpreted.

[0099]

Preparation Example 1

To a solution of 1-[4-hydroxy-3-(trifluoromethyl)phenyl]ethanone (1 g) in acetonitrile (10 mL) were added 1-bromopropane (0.90 mL), potassium carbonate (1.7 g), and tetrabutylammonium iodide (180 mg), followed by stirring at room temperature overnight. The insoluble materials were separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[4-propoxy-3-(trifluoromethyl)phenyl]ethanone (1.16 g) as an oily substance.

[0100]

Preparation Example 2

A mixture of 1-[4-hydroxy-3-(trifluoromethyl)phenyl]ethanone (1 g), iodoethane (1.19 mL), cesium carbonate (1.92 g), and N,N-dimethylformamide (15 mL) was stirred at 60°C for 3 hours. The reaction mixture was cooled to room temperature and water was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous sodium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[4-ethoxy-3-(trifluoromethyl)phenyl]ethanone (1.1 g) as a solid.

[0101]

Preparation Example 3

To a solution of 1-[4-hydroxy-3-(trifluoromethyl)phenyl]ethanone (1 g) in tetrahydrofuran (10 mL) were added 2-propanol (0.46 mL), a 40% diethylazodicarboxylate solution in toluene (2.3 mL), and triphenyl phosphine (1.55 g), followed by stirring at room temperature overnight. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[4-isopropoxy-3-(trifluoromethyl)phenyl]ethanone (1.05 g) as an oily substance.

[0102]

Preparation Example 4

Under an argon atmosphere, zinc powder (1.86 g), cobalt (II) bromide (520 mg), and acetonitrile (20 mL) were mixed, and trifluoroacetic acid (0.14 mL) was added thereto, followed by stirring at room temperature for 15 minutes. To the reaction mixture were added a 1-bromo-3-methoxy-5-(trifluoromethoxy)benzene (4.61 g) in acetonitrile (10 mL) solution and acetic anhydride (1.93 mL), followed by stirring at room temperature for 5 hours. To the reaction mixture was added 1 M hydrochloric acid, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble

materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[3-methoxy-5-(trifluoromethoxy)phenyl]ethanone (2.29 g) as an oily substance.

5 [0103]

Preparation Example 5

1-[4-Methoxy-3-(trifluoromethyl)phenyl]ethanone (15 g) and tetrahydrofuran (270 mL) were mixed, and phenyltrimethylammonium tribromide (28.42 g) was added thereto, followed by stirring at room temperature for 30 minutes. The precipitated insoluble materials were separated by filtration and the filtrate was concentrated under reduced pressure. The obtained residue and ethanol (260 mL) were mixed, and thiourea (6.81 g) was added thereto, followed by stirring at 80°C for 3 hours. The reaction mixture was cooled to room temperature, and water, a 1 M aqueous sodium hydroxide solution, and ethyl acetate was added thereto. The organic layer was washed with a 1 M aqueous sodium hydroxide solution, water, and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (16.18 g) as a solid.

20 [0104]

Preparation Example 6

5-Chloropyrazine-2-carboxylic acid (3.00 g), N,N-dimethylformamide (30 mL), ethyl piperidine-4-carboxylate (5.83 mL), and diisopropylethylamine (6.50 mL) were mixed, followed by stirring at 80°C overnight. The reaction mixture was cooled to room temperature and ethyl acetate was added thereto. The mixture was washed with an aqueous citric acid solution, water, and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The obtained solid was washed with diisopropyl ether and dried to obtain 5-[4-(ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (3.96 g) as a solid.

30 [0105]

Preparation Example 7

To a mixture of 4-[4-propoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (1.27 g), 5-[4-(ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (1.29 g), and pyridine (20 mL) was added dropwise phosphorous oxychloride (0.44 mL) at -10°C, followed by stirring at the same temperature for 1 hour. To the reaction mixture were added ethyl acetate and an aqueous citric acid solution, and the insoluble materials were dissolved therein. Then, silica gel was added thereto, followed by stirring. The

insoluble materials were separated by filtration and the aqueous layer of the filtrate was separated, followed by extraction with ethyl acetate. The organic layer was combined and basic silica gel was added thereto, followed by stirring. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. To the residue was added diisopropyl ether, followed by stirring, and the solid was collected by filtration and dried to obtain ethyl 1-[5-({4-[4-propoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (1.38 g) as a solid.

[0106]

Preparation Example 8

Under an argon atmosphere, to a solution of 1-tert-butyl 3-ethyl-3-methylpiperidine-1,3,3-tricarboxylate (2.35 g) in tetrahydrofuran (28 mL) was added a 3 M lithium borohydride/tetrahydrofuran solution (19.87 mL) at an internal temperature of -5°C or lower, followed by stirring for 30 minutes, and then stirring at 60°C for 20 hours. The reaction mixture was ice-cooled, and a saturated aqueous ammonium chloride solution was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (chloroform-methanol) to obtain tert-butyl 3,3-bis(hydroxymethyl)piperidine-1-carboxylate (1.22 g).

[0107]

Preparation Example 9

4-[3-Methoxy-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (500 mg), tetrahydrofuran (10 mL), 5-[4-(ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (560 mg), O-(benzotriazol-1-yl)-N,N,N',N'-tetramethyluronium tetrafluoroborate (645 mg), and diisopropylethylamine (0.69 mL) were mixed, followed by stirring at 145°C for 30 minutes under irradiation with microwaves. The reaction mixture was cooled to room temperature and ethyl acetate was added thereto. The mixture was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) and the obtained solid was washed with diisopropyl ether and dried to obtain ethyl 1-[5-({4-[3-methoxy-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (704 mg) as a solid.

[0108]

Preparation Example 10

5-{[(2R)-2-Methylpyrrolidin-1-yl]methyl}-4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-amine (1.75 g), 5-chloropyrazine-2-carboxylic

acid (1.13 g), N-[(1Z)-1-cyano-2-ethoxy-2-oxoethylidene]amino}oxy)(morpholin-4-yl)methylene]-N-methylmethanaminium hexafluorophosphate (3.1 g), dioxane (20 mL), and diisopropylethylamine (2.43 mL) were mixed, followed by stirring at room temperature for 1 hour, and to the reaction mixture was added ethyl acetate. The mixture
 5 was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 5-chloro-N-(5-[(2R)-2-methylpyrrolidin-1-yl]methyl)-4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-yl)pyrazine-2-carboxamide (1.71 g).
 10

[0109]

Preparation Example 11

5-Chloropyrazine-2-carboxylic acid (15.0 g) and ethyl acetate (200 mL) were mixed, and thionyl chloride (30 mL) and N,N-dimethylformamide (0.28 mL) were added
 15 thereto, followed by stirring at 55°C to 60°C for 1 hour. The reaction mixture was concentrated under reduced pressure, and an operation of adding toluene to the residue and concentrating the mixture was carried out twice.

4-[4-Methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (19.96 g) and cyclopentylmethyl ether (200 mL) were mixed, and to the mixture was added dropwise a
 20 solution of the residue obtained above in cyclopentylmethyl ether (40 mL) at 10°C or lower, and the reaction mixture was warmed to room temperature and stirred for 5 hours. The reaction mixture was ice-cooled and water (600 mL) was added dropwise thereto at 15°C or lower, followed by stirring at room temperature overnight. The precipitated solid was collected by filtration, washed with methyl ethyl ketone, and then dried to obtain 5-
 25 chloro-N-{4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}pyrazine-2-carboxamide (29 g) as a solid.

[0110]

Preparation Example 12

5-[4-(Ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (895 mg), N,N-dimethylformamide (10 mL), O-(7-azabenzotriazol-1-yl)-N,N,N',N'-tetramethyluronium tetrafluoroborate (1.34 g), and diisopropylethylamine (1.10 mL) were mixed, followed by
 30 stirring for 10 minutes. Under a nitrogen atmosphere, 4-[3,5-bis(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (1.0 g) and N,N-dimethylformamide (10 mL) were mixed, and sodium hydride (154 mg) was added thereto under ice-cooling, followed by stirring for 10 minutes. Then, the reaction mixture that had been prepared in advance was added thereto, followed
 35 by heating at 80°C and stirring for 30 minutes. The reaction mixture was heated to 120°C and further stirred for 1 hour. Then, 4-[3,5-bis(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (0.72 g) was added thereto, followed by further stirring at the same temperature for

2 hours. The reaction mixture was cooled to room temperature and ethyl acetate was added thereto. The mixture was washed with water, a saturated aqueous sodium hydrogen carbonate solution, and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (chloroform-ethyl acetate). To the obtained residue was added diisopropyl ether, and the obtained solid was collected by filtration and dried to obtain ethyl 1-[5-({4-[3,5-bis(trifluoromethyl)phenyl]-1,3-thiazol-2-yl} carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (167 mg) as a solid.

[0111]

Preparation Example 13

4-[4-Chloro-3-(trifluoromethyl)phenyl]-5-[(3-methoxy-3-methylpiperidin-1-yl)methyl]-1,3-thiazol-2-amine (80 mg), 5-[4-(ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (64 mg), N-[(1Z)-1-cyano-2-ethoxy-2-oxoethylidene]amino}oxy)(morpholin-4-yl)methylene]-N-methylmethanaminium hexafluorophosphate (101 mg), diisopropylethylamine (0.082 mL), and dioxane (1.2 mL) were mixed, followed by stirring at 80°C for 30 minutes under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure and the residue was purified by basic silica gel column chromatography (chloroform-hexane) and basic silica gel column chromatography (ethyl acetate-hexane). The obtained solid was washed with ethyl acetate-hexane and dried to obtain ethyl 1-[5-({4-[4-chloro-3-(trifluoromethyl)phenyl]-5-[(3-methoxy-3-methylpiperidin-1-yl)methyl]-1,3-thiazol-2-yl} carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (71 mg) as a solid.

[0112]

Preparation Example 14

4-[3-Methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-amine (500 mg), N,N-dimethylformamide (10 mL), 5-[4-(ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (764 mg), N-[(1Z)-1-cyano-2-ethoxy-2-oxoethylidene]amino}oxy)(morpholin-4-yl)methylene]-N-methylmethanaminium hexafluorophosphate (1.17 g), and diisopropylethylamine (0.94 mL) were mixed, followed by stirring at 150°C for 30 minutes under irradiation with microwaves. The reaction mixture was cooled to room temperature and ethyl acetate was added thereto. The mixture was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate), and the obtained residue was washed with diisopropyl ether and dried to obtain ethyl 1-[5-({4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-yl} carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (476 mg) as a solid.

[0113]

Preparation Example 15

4-[4-Chloro-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (748 mg), 5-[4-(ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (500 mg), N,N-dimethylformamide (10 mL), O-(7-azabenzotriazol-1-yl)-N,N,N',N'-tetramethyluronium tetrafluoroborate (1.02 g), and diisopropylethylamine (0.93 mL) were mixed, followed by stirring at 100°C overnight. The reaction mixture was cooled to room temperature and ethyl acetate was added thereto. The mixture was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (chloroform-ethyl acetate), and the obtained residue was washed with diisopropyl ether and dried to obtain ethyl 1-[5-({4-[4-chloro-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (294 mg) as a solid.

[0114]

Preparation Example 16

4-[3-Methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-amine (5.68 g), pyridine (17 mL), and acetic anhydride (7.8 mL) were mixed, followed by stirring at 60°C for 1 hour. The reaction mixture was cooled to room temperature and ethyl acetate was added thereto. The mixture was washed with water, 1 M hydrochloric acid, and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The obtained solid was washed with diisopropyl ether and dried to obtain N-{4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-yl}acetamide (6.21 g) as a solid.

[0115]

Preparation Example 17

To ethyl 1-[5-({4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (2.0 g) were added acetic acid (50 mL) and a 36% aqueous formaldehyde solution (1.5 mL), followed by stirring at 100°C for 1.5 hours. To the reaction mixture was added acetic anhydride (0.71 mL), followed by further stirring at the same temperature for 1.5 hours. Then, acetic anhydride (0.71 mL) was added thereto again, followed by stirring for 0.5 hours. The reaction mixture was concentrated under reduced pressure, and to the residue was added ethanol, followed by stirring. The precipitated solid was collected by filtration and dried to obtain ethyl 1-[5-({5-(acetoxymethyl)-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (1.77 g) as a solid.

[0116]

Preparation Example 18

Ethyl 1-[5-({4-[3-methoxy-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (1.87 g), acetic acid (8 mL), a 36% aqueous formaldehyde solution (2.69 mL), and acetic anhydride (3.30 mL) were mixed, followed by stirring at 150°C for 30 minutes under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure, and to the residue was added water and a saturated aqueous sodium hydrogen carbonate solution, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (chloroform-ethyl acetate) and the obtained solid was washed with diisopropyl ether, and dried to obtain ethyl 1-[5-({5-(acetoxymethyl)-4-[3-methoxy-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (705 mg) as a solid.

[0117]

Preparation Example 19

To ethyl 1-[5-({4-[4-propoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (1.38 g) were added acetic acid (35 mL), acetic anhydride (1.2 mL), and a 36% aqueous formaldehyde solution (0.98 mL), followed by stirring at 100°C for 3 hours. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (chloroform-ethyl acetate). The obtained residue was dissolved in pyridine (14 mL), and acetic anhydride (1.4 mL) was added thereto, followed by stirring at room temperature for 2 hours. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (chloroform-ethyl acetate). The obtained solid was stirred in an ethyl acetate-diisopropyl ether mixed solvent, collected by filtration, and dried to obtain ethyl 1-[5-({5-(acetoxymethyl)-4-[4-propoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (771 mg) as a solid.

[0118]

Preparation Example 20

Ethyl 1-[5-({4-[4-chloro-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (1.15 g), acetic acid (12.0 mL), a 36% aqueous formaldehyde solution (2.0 mL), and acetic anhydride (2.5 mL) were mixed, followed by stirring at 150°C for 1 hour under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure, and to the residue were added pyridine (8 mL) and acetic anhydride (2.5 mL), followed by stirring at room temperature for 1 hour. The reaction mixture was concentrated under reduced pressure, and to the residue was

added water, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The obtained solid was washed with a chloroform-ethyl acetate mixed solvent and dried to obtain ethyl 1-[5-({5-(acetoxymethyl)-4-[4-chloro-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl} carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (564 mg) as a solid.

[0119]

Preparation Example 21

5-Chloro-N-{4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}pyrazine-2-carboxamide (4.27 g), acetic acid (50 mL), a 36% aqueous formaldehyde solution (4.0 mL), and (2R)-2-ethylpyrrolidine hydrochloride (7.0 g) were mixed and stirred at 90°C for 1 hour, and dichloroethane (50 mL) was then added thereto, followed by stirring overnight. The reaction mixture was cooled to room temperature and concentrated under reduced pressure, and to the obtained residue was added ethyl acetate. The mixture was washed with a 1 M aqueous sodium hydroxide solution, water, and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. To the obtained residue was added ethyl acetate, and the insoluble materials were separated by filtration. The filtrate was then concentrated under reduced pressure and the residue was purified by basic silica gel column chromatography (hexane-ethyl acetate). The obtained solid was washed with hexane and dried to obtain 5-chloro-N-(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)pyrazine-2-carboxamide (954 mg) as a solid.

[0120]

Preparation Example 22

Ethyl 1-[5-({4-[4-(dimethylamino)-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl} carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (200 mg), acetic acid (3 mL), a 36% aqueous formaldehyde solution (0.14 mL), and (2R)-2-methylpyrrolidine L-(+)-tartrate (425 mg) were mixed, followed by stirring at 110°C for 30 minutes under irradiation with microwaves. The reaction mixture was neutralized by the addition of a saturated aqueous sodium hydrogen carbonate solution, followed by extraction with ethyl acetate. The organic layer was washed with a 1 M aqueous sodium hydroxide solution and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain ethyl 1-{5-[(4-[4-(dimethylamino)-3-

(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylate (110 mg) as a solid.

[0121]

Preparation Example 23

5 Ethyl 1-[5-({5-(acetoxymethyl)-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (2.5 g), (2R)-2-ethylpyrrolidine hydrochloride (690 mg), diisopropylethylamine (1.42 mL), and N,N-dimethylformamide (25 mL) were mixed, followed by stirring at 90°C for 1 hour. The reaction mixture was diluted with ethyl acetate, washed with water, and dried over
10 anhydrous sodium sulfate. The insoluble materials were then filtered and the filtrate was concentrated under reduced pressure. The residue was purified by basic silica gel column chromatography (chloroform-ethyl acetate) to obtain ethyl 1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylate (2.28 g).

15 [0122]

Preparation Example 24

To a solution of ethyl 1-[5-({5-(acetoxymethyl)-4-[4-chloro-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (160 mg) in tetrahydrofuran (1.6 mL) were added (2R)-2-methylpyrrolidine hydrochloride
20 (64 mg) and diisopropylethylamine (0.18 mL), followed by stirring at 150°C for 1 hour under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain ethyl 1-{5-[(4-[4-chloro-3-(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-
25 carboxylate (117 mg) as an oily substance.

[0123]

Preparation Example 25

To a solution of benzyl (2S)-2-(2-methoxypropan-2-yl)pyrrolidine-1-carboxylate (650 mg) in ethanol (6.5 mL) was added 10% palladium-supported carbon (50% wet, 150
30 mg), followed by stirring at room temperature for 1 hour at 1 atm under a hydrogen atmosphere. The insoluble materials were separated by filtration, and to the filtrate was added a 4 M hydrogen chloride/dioxane solution (2 mL), followed by concentration under reduced pressure. The residue was dried overnight to obtain (2S)-2-(2-methoxypropan-2-yl)pyrrolidine hydrochloride (438 mg) as a solid.

35 [0124]

Preparation Example 26

To a solution of tert-butyl (2R)-2-ethylpyrrolidine-1-carboxylate (3.41 g) in dioxane (25 mL) was added a 4 M hydrogen chloride/dioxane solution (25 mL), followed

by stirring at room temperature for 1 hour. The reaction mixture was concentrated under reduced pressure, and to the residue was added diethyl ether, followed by stirring. The precipitated solid was collected by filtration and dried to obtain (2R)-2-ethylpyrrolidine hydrochloride (2.1 g) as a solid.

5 [0125]

Preparation Example 27

N-(5-{[(2R)-2-Methylpyrrolidin-1-yl]methyl}-4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-yl)acetamide (3.05 g), ethanol (20 mL), and a 6 M aqueous sodium hydroxide solution (12 mL) were mixed, followed by stirring at 120°C for 10 15 minutes under irradiation with microwaves. To the reaction mixture was added water, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by basic silica gel column 15 chromatography (hexane-ethyl acetate) to obtain 5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-amine (1.75 g) as an oily substance.

[0126]

Preparation Example 28

20 To a mixture of 2-(2,5-dimethyl-1H-pyrrol-1-yl)-4-[3-methoxy-4-(trifluoromethyl)phenyl]-1,3-thiazole (280 mg), ethanol (2.5 mL) and water (0.84 mL) were added hydroxylamine hydrochloride (828 mg) and triethylamine (0.55 mL), followed by stirring at 130°C for 30 minutes under irradiation with microwaves. Ethanol was evaporated under reduced pressure and to the residue was added water, followed by 25 extraction with chloroform. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) and purified by silica gel column chromatography (chloroform-methanol) to obtain 30 4-[3-methoxy-4-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (113 mg) as a solid.

[0127]

Preparation Example 29

Under an argon atmosphere, to a solution of tert-butyl 3,3-bis(hydroxymethyl)piperidine-1-carboxylate (0.9 g) in tetrahydrofuran (18 mL) was added 35 a 2.69 M n-butyllithium/tetrahydrofuran solution (1.39 mL) at -5°C or lower, followed by stirring for 20 minutes. To the reaction mixture was added dropwise a solution of toluenesulfonyl chloride (0.7 g) in tetrahydrofuran (4.5 mL) at -5°C or lower, followed by stirring for 40 minutes. To the resulted mixture was added a 2.69 M n-

butyllithium/tetrahydrofuran solution (1.43 mL), followed by stirring for 30 minutes, then heating to 60°C, and further stirring for 1 hour. The reaction mixture was ice-cooled, and a saturated aqueous ammonium chloride solution was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain tert-butyl 2-oxa-6-azaspiro[3.5]nonane-6-carboxylate (436 mg).

[0128]

10 Preparation Example 30

To a solution of (3R)-tetrahydrofuran-3-ol (1.0 g) in N-methylpyrrolidone (20 mL) was added a 60% oil dispersion of sodium hydride (430 mg) under ice-cooling, followed by stirring at the same temperature for 10 minutes. To the reaction mixture was added dropwise a solution of 1-[4-fluoro-3-(trifluoromethyl)phenyl]ethanone (2.0 g) in N-methylpyrrolidone (10 mL), and the mixture was stirred for 1 hour under ice-cooling. To the reaction mixture was added water, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-{4-[(3R)-tetrahydrofuran-3-yloxy]-3-(trifluoromethyl)phenyl}ethanone (1.84 g) as an oily substance.

[0129]

Preparation Example 31

25 A mixture of 1-[4-fluoro-3-(trifluoromethyl)phenyl]ethanone (2.0 g), pyrrolidine (10 mL), potassium carbonate (2.0 g), and acetonitrile (3.0 mL) was stirred at 80°C for 2 hours. The reaction mixture was cooled to room temperature and water was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[4-(pyrrolidin-1-yl)-3-(trifluoromethyl)phenyl]ethanone (2.5 g) as an oily substance.

[0130]

35 Preparation Example 32

To a solution of 2-(2,5-dimethyl-1H-pyrrol-1-yl)-4-[3-fluoro-4-(trifluoromethyl)phenyl]-1,3-thiazole (300 mg) in tetrahydrofuran (2.4 mL) was added sodium methoxide (60 mg), followed by stirring at 100°C for 30 minutes under irradiation

with microwaves. To the reaction mixture was added sodium methoxide (90 mg), followed by stirring at 130°C for 1 hour under irradiation with microwaves. Then sodium methoxide (150 mg) was added thereto, followed by stirring at 150°C for 30 minutes under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 2-(2, 5-dimethyl-1H-pyrrol-1-yl)-4-[3-methoxy-4-(trifluoromethyl)phenyl]-1,3-thiazole (289 mg) as an oily substance.

[0131]

Preparation Example 33

4-(5-Chloro-3-thienyl)-1,3-thiazol-2-amine (4.30 g), dichloromethane (80 mL) and diisopropylethylamine (4.2 mL) were mixed, and trifluoroacetic anhydride (4.2 mL) was added thereto under ice-cooling, followed by warming to room temperature and stirring for 1 hour. The reaction mixture was diluted with chloroform, washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate), and the obtained solid was washed with hexane and dried to obtain N-[4-(5-chloro-3-thienyl)-1,3-thiazol-2-yl]-2,2,2-trifluoroacetamide (5.56 g) as a solid.

[0132]

Preparation Example 34

To a solution of 4-[3-fluoro-4-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (600 mg) in toluene (3.6 mL) were added hexane-2,5-dione (0.32 mL) and p-toluenesulfonic acid (44 mg), followed by stirring at 170°C for 30 minutes under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure, and to the residue was added a saturated aqueous sodium hydrogen carbonate solution, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 2-(2,5-dimethyl-1H-pyrrol-1-yl)-4-[3-fluoro-4-(trifluoromethyl)phenyl]-1,3-thiazole (634 mg) as a solid.

[0133]

Preparation Example 35

To a solution of (2-methylpyrrolidin-2-yl)methanol (300 mg) in tetrahydrofuran (3 mL) was added a solution of di-tert-butyl dicarbonate (0.85 g) in tetrahydrofuran (1.5 mL) at room temperature, followed by stirring at room temperature for 3 days. Then, to the reaction mixture was added a 1 M aqueous sodium hydroxide solution (1.8 mL), followed by stirring at room temperature for 2 hours. To the reaction mixture was added water,

followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain tert-butyl 2-(hydroxymethyl)-2-methylpyrrolidine-1-carboxylate (396 mg) as an oily substance.

[0134]

Preparation Example 36

To a solution of 2-[(2S)-pyrrolidin-2-yl]propan-2-ol hydrochloride (1.0 g) in dichloroethane (15 mL) was added triethylamine (2.52 mL), followed by water-cooling. Benzyl chlorocarbonate (1.29 mL) was added thereto, followed by warming to room temperature and stirring for 2 hours. The reaction mixture was concentrated under reduced pressure, and to the residue was added water, followed by extraction with ethyl acetate. The organic layer was dried over anhydrous magnesium sulfate, the insoluble materials were then separated by filtration, and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain benzyl (2S)-2-(2-hydroxypropan-2-yl)pyrrolidine-1-carboxylate (1.01 g) as an oily substance.

[0135]

Preparation Example 37

N-[4-(5-Chloro-3-thienyl)-1,3-thiazol-2-yl]-2,2,2-trifluoroacetamide (5.56 g), (2R)-2-methylpyrrolidine (3.36 g), acetic acid (60 mL), and a 36% aqueous formaldehyde solution (2.75 mL) were mixed, followed by stirring at 60°C for 1 hour. The reaction mixture was concentrated under reduced pressure and the residue was diluted with ethyl acetate, washed with a saturated aqueous sodium hydrogen carbonate solution and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The obtained residue, ethanol (60 mL), and a 6 M aqueous sodium hydroxide solution (15 mL) were mixed, followed by stirring at 90°C for 2 hours. The reaction mixture was cooled to room temperature and water was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by basic silica gel column chromatography (hexane-ethyl acetate) to obtain 4-(5-chloro-3-thienyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-amine (2.28 g).

[0136]

Preparation Example 38

1-[4-Hydroxy-3-(trifluoromethyl)phenyl]ethanone (3.0 g), N,N-dimethylformamide (36 mL), and water (3.6 mL) were mixed, and sodium chloro(difluoro)acetate (5.76 g) and cesium carbonate (7.2 g) were added thereto, followed by stirring at 100°C for 3 hours. To the reaction mixture was added water, followed by
 5 extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[4-(difluoromethoxy)-3-(trifluoromethyl)phenyl]ethanone (3.80 g) as an oily substance. 1-[4-(Difluoromethoxy)-3-(trifluoromethyl)phenyl]ethanone (3.80 g) and tetrahydrofuran (50
 10 mL) were mixed, and phenyltrimethylammonium tribromide (5.66 g) was added thereto, followed by stirring at room temperature for 45 minutes. The precipitated insoluble materials were separated by filtration and the filtrate was concentrated under reduced pressure. The residue and ethanol (50 mL) were mixed, and thiourea (1.47 g) was added thereto followed by stirring at 80°C for 2 hours. The reaction mixture was cooled to
 15 room temperature, and water (30 mL) and a 1 M aqueous sodium hydroxide solution (30 mL) were added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. To the residue was added diisopropyl
 20 ether, the mixture was concentrated under reduced pressure, and then diisopropyl ether and hexane were further added thereto. The resulting solid was collected by filtration and dried to obtain 4-[4-(difluoromethoxy)-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-amine (3.48 g) as a solid.

[0137]

25 Preparation Example 39

3-Bromo-5-(trifluoromethoxy)phenol (4.84 g), N,N-dimethylformamide (50 mL), potassium carbonate (3.12 g), and methyl iodide (2.35 mL) were mixed, followed by stirring at room temperature for 2 hours. To the reaction mixture was added water, followed by extraction with ethyl acetate. The organic layer was washed with water and a
 30 saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-bromo-3-methoxy-5-(trifluoromethoxy)benzene (4.61 g) as an oily substance.

35 [0138]

Preparation Example 40

To a mixture of benzyl (2S)-2-(2-hydroxypropan-2-yl)pyrrolidine-1-carboxylate (1.0 g), Proton Sponge (registered trademark) (2.44 g), and dichloromethane (15 mL) was

added trimethyloxonium tetrafluoroborate (1.77 g) under ice-cooling, followed by warming to room temperature and stirring overnight. The insoluble materials were separated by filtration, and to the filtrate were added water and a 10% aqueous citric acid solution, followed by extraction with chloroform. The organic layer was dried over anhydrous magnesium sulfate and the insoluble materials were then separated by filtration. The filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain benzyl (2S)-2-(2-methoxypropan-2-yl)pyrrolidine-1-carboxylate (664 mg) as an oily substance.

[0139]

10 Preparation Example 41

To a solution of diisopropylamine (5.05 mL) in tetrahydrofuran (30 mL) was added a 2.66 M n-butyllithium/hexane solution (12.86 mL) at -78°C under an argon atmosphere, followed by stirring for 15 minutes. To the reaction mixture was added dropwise a solution of 1-tert-butyl 3-ethyl piperidine-1,3-dicarboxylate (4.0 g) in tetrahydrofuran (20 mL) over 10 minutes, followed by stirring for 30 minutes. To the reaction mixture was added dropwise a solution of methyl iodide (1.455 mL) in tetrahydrofuran (10 mL) over 10 minutes, and the obtained mixture was warmed to 0°C for 1 hour, followed by stirring at the same temperature for 30 minutes, then further warming to room temperature, and stirring for 3 hours. To the reaction mixture was added a saturated aqueous ammonium chloride solution, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-tert-butyl 3-ethyl 3-methylpiperidine-1,3-dicarboxylate (3.29 g) as an oily substance.

[0140]

Preparation Example 42

Under an argon atmosphere, a mixture of a 55% oil dispersion of sodium hydride (126 mg) and tetrahydrofuran (3 mL) was water-cooled, and a solution of tert-butyl 3-(hydroxymethyl)-3-methylpiperidine-1-carboxylate (442 mg) in tetrahydrofuran (2 mL) was added thereto, followed by stirring at room temperature for 5 minutes and then stirring at 60°C for 30 minutes. The reaction mixture was ice-cooled, and methyl iodide (0.3 mL) was added thereto, followed by warming to room temperature and stirring for 1.5 hours. To the reaction mixture was added a saturated aqueous ammonium chloride solution, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography

(hexane-ethyl acetate) to obtain tert-butyl 3-(methoxymethyl)-3-methylpiperidine-1-carboxylate (414 mg) as an oily substance.

[0141]

Preparation Example 43

5 N-{4-[3-Fluoro-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}acetamide (2.84 g), acetic acid (20 mL), a 36% aqueous formaldehyde solution (3.6 mL), and acetic anhydride (4.40 mL) were mixed, followed by stirring at 170°C for 30 minutes under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure, and the obtained solid was washed with methanol and dried to obtain a white solid. The obtained
10 solid, N-methylpyrrolidone (20 mL), (2R)-2-methylpyrrolidine (608 mg), and diisopropylethylamine (2.45 mL) were mixed, followed by stirring at 100°C for 30 minutes. The reaction mixture was cooled to room temperature and water was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate.
15 The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain N-(4-[3-fluoro-5-(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl)acetamide (1.38 g) as a solid.

[0142]

20 Preparation Example 44

3-Bromo-1,1,1-trifluoroacetone (3.0 g), ethyl amino(thio)acetate (2.10 g), and ethanol (45 mL) were mixed, followed by heating to reflux for 15 hours. The reaction mixture was cooled to room temperature and concentrated under reduced pressure. To the residue was added a saturated aqueous sodium hydrogen carbonate solution (50 mL), and
25 water (50 mL) was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain ethyl 4-(trifluoromethyl)-1,3-thiazole-2-carboxylate (2.19 g) as an oily substance. To a solution
30 of ethyl 4-(trifluoromethyl)-1,3-thiazole-2-carboxylate (2.07 g) in ethanol (50 mL) was added a 1 M aqueous sodium hydroxide solution (30 mL), followed by stirring at 50°C for 30 minutes. The reaction mixture was cooled to room temperature, and 1 M hydrochloric acid (30 mL) and water (100 mL) were added thereto, followed by extraction with a
35 chloroform-isopropanol mixed solvent. The organic layer was dried over anhydrous magnesium sulfate, the insoluble materials were separated by filtration and the filtrate was concentrated under reduced pressure to obtain a solid. To the obtained solid was added

hexane, the solvent was removed by decantation, and the solid was then dried to obtain 4-(trifluoromethyl)-1,3-thiazole-2-carboxylic acid (832 mg) as a solid.

[0143]

Preparation Example 45

5 To 4-(trifluoromethyl)-1,3-thiazole-2-carboxylic acid (790 mg) were added thionyl chloride (4.0 mL), dichloromethane (6 mL), and N,N-dimethylformamide (1 droplet), followed by stirring at 40°C for 2 hours. The reaction mixture was concentrated under reduced pressure, azeotropic distilled with toluene twice, and then dried under reduced pressure. To a mixture of magnesium chloride (382 mg) and toluene (12 mL) were added
10 dimethyl malonate (0.55 mL) and triethylamine (1.3 mL), and the mixture was stirred at room temperature for 1.5 hours. To the reaction mixture was added dropwise a solution of the previously obtained residue in toluene (3 mL), followed by stirring at room temperature for 16 hours. To the reaction mixture was slowly added 6 M hydrochloric acid (5 mL), and then water (30 mL) was added thereto, followed by extraction with ethyl
15 acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was dissolved in dimethyl disulfoxide (4 mL) and water (0.4 mL), followed by stirring at 160°C for 2 hours. The reaction mixture was cooled to room temperature, and
20 then water (30 mL) was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[4-(trifluoromethyl)-1,3-thiazol-2-yl]ethanone (498 mg) as an oily substance.

[0144]

Preparation Example 46

To a solution of tert-butyl (2S)-2-(hydroxymethyl)pyrrolidine-1-carboxylate (17 g), triethylamine (17.66 mL), and 1-methyl-1H-imidazole (10.05 mL) in dichloromethane
30 (255 mL) was added p-toluenesulfonyl chloride (17.71 g) under ice-cooling, followed by stirring at the same temperature for 1 hour. To the reaction mixture was added water, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous sodium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated
35 under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain tert-butyl (2S)-2-([(4-methylphenyl)sulfonyl]oxy)methylpyrrolidine-1-carboxylate (29.51 g) as an oily substance.

[0145]

Preparation Example 47

To a mixture of copper (I) iodide (9.4 g) and diethyl ether (180 mL) was added dropwise an about 1 M methyllithium/diethyl ether solution (100 mL) at an internal
 5 temperature of 0°C to 5°C over 30 minutes, followed by stirring for 15 minutes after the dropwise addition. To the reaction mixture was added a solution of tert-butyl (2S)-2-
 ({[(4-methylphenyl)sulfonyl]oxy}methyl)pyrrolidine-1-carboxylate (7.0 g) in dichloromethane (30 mL), and the solution was kept at an internal temperature of 5°C or lower and added dropwise over 20 minutes, followed by stirring at room temperature for
 10 2.5 hours. To the reaction mixture was added dropwise a saturated aqueous ammonium chloride solution, followed by extraction with ethyl acetate. The organic layer was dried over anhydrous sodium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain tert-butyl (2R)-2-
 15 ethylpyrrolidine-1-carboxylate (3.52 g) as an oily substance.

[0146]

Preparation Example 48

Under an argon atmosphere, to a solution of diisopropylamine (10.09 mL) in tetrahydrofuran (60 mL) was added a 2.69 M n-butyllithium/hexane solution (25.43 mL) at
 20 -78°C, followed by stirring at the same temperature for 15 minutes, then warming to -20°C, and stirring for 30 minutes. The reaction mixture was cooled to -78°C again, and a solution of 1-tert-butyl 3-ethyl piperidine-1,3-dicarboxylate (8.0 g) in tetrahydrofuran (20 mL) was added dropwise thereto over 20 minutes, followed by warming to -20°C and stirring for 30 minutes. The obtained mixture was cooled to -78°C, and a solution of
 25 methyl chlorocarbonate (5.98 mL) in tetrahydrofuran (16 mL) was added dropwise thereto over 15 minutes, followed by warming to room temperature and then stirring for 2 hours. To the reaction mixture was added dropwise a saturated aqueous ammonium chloride solution, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate.
 30 The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-tert-butyl 3-ethyl 3-methyl piperidine-1,3,3-tricarboxylate (5.63 g) as an oily substance.

[0147]

35 Preparation Example 92

To a mixture of 5-chloro-N-{4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}pyrazine-2-carboxamide (29 g) and N-methylpyrrolidone (150 mL) were added diisopropylethylamine (18 mL) and ethyl piperidine-4-carboxylate (14 mL), followed by

stirring at room temperature for 2 hours. The reaction mixture was ice-cooled and water was added thereto, followed by stirring at room temperature for 1 hour. The solid was collected by filtration and dried to obtain ethyl 1-[5-({4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (36.85 g) as a solid.

[0148]

Preparation Example 209

A mixture of 1-[4-fluoro-3-(trifluoromethyl)phenyl]ethanone (3.75 g) and dimethylamine (2 M tetrahydrofuran solution, 22.3 mL) was stirred at 110°C for 30 minutes under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (hexane-ethyl acetate). To the obtained compound was added dimethylamine (2 M tetrahydrofuran solution, 15 mL), followed by stirring at 130°C for 1 hour under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain 1-[4-(dimethylamino)-3-(trifluoromethyl)phenyl]ethanone (2.89 g).

[0149]

In the similar manner as the methods of Preparation Examples 1 to 48, 92, and 209, the compounds of Preparation Example 49 to 91, 93 to 208 and 210 to 212 in Tables below were prepared. The structures, the physicochemical data, and the preparation methods of the compounds of Preparation Examples are shown in Tables 4 to 36.

[0150]

Example 1

To a solution of ethyl 1-{5-[(5-[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-propoxy-3-(trifluoromethyl)phenyl]-1,3 thiazol-2-yl]carbamoyl}pyrazin-2-yl}piperidine-4-carboxylate (159 mg) in dioxane (2 mL) was added a 1 M aqueous sodium hydroxide solution (2 mL), followed by stirring at 60°C for 30 minutes. The reaction mixture was cooled to room temperature, neutralized by the addition of 1 M hydrochloric acid, extracted with chloroform, and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (chloroform-methanol) to obtain a pale yellow solid.

The obtained solid was dissolved in dioxane (2 mL), a 4 M hydrogen chloride/dioxane solution (0.25 mL) was added thereto, and the precipitated solid was stirred in acetonitrile, then collected by filtration, and dried to obtain 1-{5-[(5-[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-propoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl}piperidine-4-carboxylic acid dihydrochloride (132 mg) as a solid.

[0151]

Example 2

Ethyl 1-[5-({5-(acetoxymethyl)-4-[3-methoxy-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (100 mg), N,N-dimethylformamide (2 mL), (2R)-2-methylpiperidine hydrochloride (45 mg), and diisopropylethylamine (0.115 mL) were mixed, followed by stirring at 100°C for 1 hour. The reaction mixture was cooled to room temperature and diluted with ethyl acetate. The obtained mixture was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by basic silica gel column chromatography (hexane-ethyl acetate). The obtained residue was mixed with ethanol (2 mL) and tetrahydrofuran (1 mL), and a 1 M aqueous sodium hydroxide solution (0.83 mL) was added thereto, followed by stirring at 50°C for 20 minutes. The reaction mixture was cooled to room temperature, and 1 M hydrochloric acid (0.83 mL) and water were added thereto, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was mixed with ethyl acetate, and a 4 M hydrogen chloride/ethyl acetate solution (0.3 mL) was added thereto, followed by concentration under reduced pressure. The obtained solid was washed with ethyl acetate and dried to obtain 1-{5-[(4-[3-methoxy-5-(trifluoromethyl)phenyl]-5-{{(2R)-2-methylpiperidin-1-yl}methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid dihydrochloride (56 mg) as a solid.

[0152]

Example 3

5-Chloro-N-(5-{{(2R)-2-methylpyrrolidin-1-yl}methyl}-4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-yl)pyrazine-2-carboxamide (170 mg), N-methylpyrrolidone (3 mL), ethyl 4-fluoropiperidine-4-carboxylate (120 mg), and diisopropylethylamine (0.23 mL) were mixed, followed by stirring at 70°C for 1 hour. The reaction mixture was cooled to room temperature and diluted with ethyl acetate. The mixture was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate). The obtained residue was mixed with ethanol (4 mL) and tetrahydrofuran (2 mL), and a 1 M aqueous sodium hydroxide solution (1.7 mL) was added thereto, followed by stirring at 50°C for 20 minutes. The reaction mixture was cooled to room temperature and 1 M hydrochloric acid (1.7 mL) and water was added thereto, followed by extraction

with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was mixed with ethyl acetate, and a 4 M hydrogen chloride/ethyl acetate solution (0.5 mL) was added thereto, followed by concentration under reduced pressure. The obtained solid was washed with ethyl acetate and dried to obtain 4-fluoro-1-{5-[(5-[(2R)-2-methylpyrrolidin-1-yl]methyl)-4-[3-methyl-5-(trifluoromethoxy)phenyl]-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid dihydrochloride (116 mg) as a solid.

10 [0153]

Example 4

Ethyl 1-(5-{[4-(4-chloro-2-thienyl)-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylate (26.27 g), acetic acid (545 mL), a 36% aqueous formaldehyde solution (16.98 mL), and (2R)-2-methylpyrrolidine L-(+)-tartrate (51.71 g) were mixed, followed by stirring at 110°C for 2 hours. The reaction mixture was cooled to room temperature and concentrated under reduced pressure, and the residue was diluted with ethyl acetate. The mixture was washed with an aqueous sodium hydrogen carbonate solution and a saturated aqueous sodium chloride solution, and dried over anhydrous sodium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by basic silica gel column chromatography (hexane-ethyl acetate).

The obtained residue was mixed with ethanol (450 mL), and a 1 M aqueous sodium hydroxide solution (150 mL) was added thereto, followed by stirring at 70°C for 1 hour. The reaction mixture was cooled to room temperature, and water and 1 M hydrochloric acid (150 mL) were added thereto. The precipitated solid was collected by filtration, washed with water, and dried under reduced pressure. The obtained solid was mixed with ethyl acetate, and an excess amount of a 4 M hydrogen chloride/ethyl acetate solution was added thereto, followed by stirring at room temperature for 1 hour. The solid was collected by filtration and dried to obtain 1-(5-{[4-(4-chloro-2-thienyl)-5-[(2R)-2-methylpyrrolidin-1-yl]methyl]-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid dihydrochloride (23 g) as a solid.

30 [0154]

Example 5

4-(5-Chloro-3-thienyl)-5-[(2R)-2-methylpyrrolidin-1-yl]methyl-1,3-thiazol-2-amine (300 mg) and dichloromethane (6 mL) were mixed, and 5-[4-(ethoxycarbonyl)piperidin-1-yl]pyrazine-2-carboxylic acid (347 mg), N-[3-(dimethylamino)propyl]-N'-ethylcarbodiimide hydrochloride (240 mg), and 4-(dimethylamino)pyridine (35 mg) were added thereto, followed by stirring at 40°C for 1

hour. The reaction mixture was cooled to room temperature and diluted with ethyl acetate. The mixture was washed with water and a saturated aqueous sodium chloride solution, dried over anhydrous magnesium sulfate, and then filtered, and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) and purified by basic silica gel column chromatography (hexane-ethyl acetate). The obtained residue was mixed with ethanol (4 mL) and tetrahydrofuran (2 mL), and a 1 M aqueous sodium hydroxide solution (3 mL) was added thereto, followed by stirring at 50°C for 30 minutes. The reaction mixture was cooled to room temperature, and water and 1 M hydrochloric acid (3 mL) was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The obtained solid was washed with diisopropyl ether. The obtained solid was mixed with ethyl acetate, and a 4 M hydrogen chloride/ethyl acetate solution (1 mL) was added thereto, followed by concentration under reduced pressure. The obtained solid was washed with ethyl acetate and dried to obtain 1-[5-{[4-{5-chloro-3-thienyl}-5-[(2R)-2-methylpyrrolidin-1-yl]methyl]-1,3-thiazol-2-yl}carbamoyl]pyrazin-2-yl]piperidine-4-carboxylic acid dihydrochloride (143 mg) as a solid.

[0155]

Example 6

Ethyl 1-[5-({4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (1.45 g), acetic acid (10 mL), a 36% aqueous formaldehyde solution (1.50 mL), and acetic anhydride (1.8 mL) were mixed, followed by stirring at 170°C for 30 minutes under irradiation with microwaves. The reaction mixture was concentrated under reduced pressure, and to the residue were added water and a saturated aqueous sodium hydrogen carbonate solution, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (chloroform-ethyl acetate). The obtained residue was mixed with N,N-dimethylformamide (15 mL), N-(2-methoxyethyl)-2-methylpropane-1-amine hydrochloride (685 mg), and diisopropylethylamine (1.4 mL), followed by stirring at 100°C for 1 hour. The reaction mixture was cooled to room temperature and ethyl acetate was added thereto. The mixture was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) and the obtained solid

was washed with diisopropyl ether. The obtained solid was mixed with ethanol (5 mL), and a 1 M aqueous sodium hydroxide solution (2.8 mL) was added thereto, followed by stirring at 60°C for 15 minutes. The reaction mixture was cooled to room temperature, and water and 1 M hydrochloric acid (2.8 mL) was added thereto, followed by extraction
 5 with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The obtained solid was washed with diisopropyl ether and dried to obtain 1-{5-
 [(5-{[isobutyl(2-methoxyethyl)amino]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-
 10 1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid (224 mg) as a solid.
 [0156]

Example 7

To a solution of tert-butyl 2-oxa-6-azaspiro[3,5]nonane-6-carboxylate (110 mg) in dichloromethane (1.1 mL) was added trifluoroacetic acid (0.30 mL) under ice-cooling,
 15 followed by warming to room temperature and stirring for 2 hours. The reaction mixture was concentrated under reduced pressure to obtain a 2-oxa-6-azaspiro[3,5]nonane trifluoroacetate. The obtained 2-oxa-6-azaspiro[3,5]nonane trifluoroacetate was used in the next step without further purification.

To a solution of ethyl 1-[5-({5-(acetoxymethyl)-4-[4-methoxy-3-
 20 (trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (118 mg) in N,N-dimethylformamide (2.4 mL) were added diisopropylethylamine (0.33 mL) and the 2-oxa-6-azaspiro[3,5]nonane trifluoroacetate synthesized above, followed by stirring at 100°C for 1.5 hours. The reaction mixture was concentrated under reduced pressure, and to the residue was added water. The resulting solid was collected by
 25 filtration, dried, and then purified by basic silica gel column chromatography (hexane-ethyl acetate). To a solution of the obtained residue (66 mg) in ethanol (2 mL) was added a 1 M aqueous sodium hydroxide solution (0.29 mL), followed by stirring at 60°C for 1 hour. The reaction mixture was neutralized by the addition of 1 M hydrochloric acid, and water, a saturated aqueous sodium chloride solution, and chloroform were added thereto, and the
 30 organic layer was separated using a phase separator (International Sorbent Technology), and concentrated under reduced pressure. The residue was purified by silica gel column chromatography (chloroform-methanol), and the obtained solid was washed with ethanol and dried to obtain 1-[5-({4-[4-methoxy-3-(trifluoromethyl)phenyl]-5-(2-oxa-6-
 azaspiro[3,5]non-6-ylmethyl)-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-
 35 carboxylic acid (52 mg) as a solid.

[0157]

Example 8

To a mixture of ethyl 1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylate (21.6 g) and ethanol (216 mL) was added a 1 M aqueous sodium hydroxide solution (74 mL), followed by stirring at 50°C to 55°C for 1.5 hours. To the reaction mixture was further added a 1 M aqueous sodium hydroxide solution (36 mL), followed by stirring at the same temperature for 2 hours. To the reaction mixture was added acetic acid (6.5 mL) at the same temperature, and the pH of the mixture was adjusted to 5 to 6. Water (106 mL) was added thereto, followed by stirring at 55°C overnight. The mixture was cooled to room temperature and the solid was collected by filtration.

The obtained solid and ethanol (80 mL) were mixed and dissolved under heating to reflux. After cooling to room temperature, the precipitated solid was collected by filtration and ethanol (80 mL) was added thereto again, followed by heating to reflux for 1 hour and then cooling to room temperature. The precipitated solid was collected by filtration and dried to obtain 1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid (12.78 g) as crystals.

The crystals obtained in Example 8 had peaks around 2θ (°) 5.0, 7.1, 10.0, 11.0, 11.8, 12.0, 15.6, 17.1, 20.4, 23.1, 24.9, and 26.8 in powder X-ray diffraction.

[0158]

Example 103

To a mixture of ethyl 1-[5-({5-acetoxymethyl)-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl]pyrazin-2-yl]piperidine-4-carboxylate (110 mg) and N,N-dimethylformamide (2.2 mL) were added (3-methylpiperidin-3-yl)methanol hydrochloride (65 mg) and diisopropylethylamine (0.16 mL), followed by stirring at 100°C for 1.5 hours. The reaction mixture was concentrated under reduced pressure and the residue was purified by silica gel column chromatography (hexane-ethyl acetate). The obtained compound was mixed with ethanol (1.8 mL), and a 1 M aqueous sodium hydroxide solution (0.35 mL) was added thereto, followed by stirring at 60°C for 1 hour. The reaction mixture was neutralized by the addition of 1 M hydrochloric acid and concentrated under reduced pressure. To the residue were added water and chloroform, and the organic layer was separated using a phase separator (International Sorbent Technology) and concentrated under reduced pressure. The obtained solid was washed with ethanol/diisopropyl ether, collected by filtration, and dried to obtain 1-{5-[(5-{[3-(hydroxymethyl)-3-methylpiperidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid (36 mg).

[0159]

Example 107

A mixture of ethyl 1-[5-({5-(acetoxymethyl)-4-[4-(morpholin-4-yl)-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl}carbamoyl)pyrazin-2-yl]piperidine-4-carboxylate (300 mg), (2R)-2-propylpyrrolidine hydrochloride (150 mg), diisopropylethylamine (0.40 mL), and N,N-dimethylformamide (5.0 mL) was stirred at 100°C for 2 hours. The reaction mixture was cooled to room temperature and water was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate) to obtain a solid (200 mg). The obtained compound was mixed with tetrahydrofuran (5 mL) and ethanol (5 mL), and a 1 M aqueous sodium hydroxide solution were added thereto, followed by stirring at 60°C for 1 hour. The reaction mixture was cooled to room temperature and concentrated under reduced pressure. The residue was purified by ODS silica gel column chromatography (acetonitrile-water). The obtained solid was mixed with hexane (20 mL), and the solid was collected by filtration and dried to obtain sodium 1-{5-[(4-[4-(morpholin-4-yl)-3-(trifluoromethyl)phenyl]-5-[(2R)-2-propylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylate (190 mg).

[0160]

Example 141

Ethyl 1-(5-{[4-(4-chloro-2-thienyl)-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylate (200 mg), acetic acid (4 mL), a 36% aqueous formaldehyde solution (0.113 mL) and 2-ethylpyrrolidine (208 mg) were mixed, followed by stirring at 90°C for 3 hours. The reaction mixture was cooled to room temperature and concentrated under reduced pressure. The residue was diluted with ethyl acetate, and washed with a 1 M aqueous sodium hydroxide solution, water, and a saturated aqueous sodium chloride solution. The organic layer was dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The residue was purified by silica gel column chromatography (hexane-ethyl acetate). The obtained compound and ethanol (4 mL) were mixed, and tetrahydrofuran (2 mL) and a 1 M aqueous sodium hydroxide solution (2.10 mL) were added thereto, followed by stirring at 50°C for 20 minutes. The reaction mixture was cooled to room temperature, and water and 1 M hydrochloric acid (2.10 mL) was added thereto, followed by extraction with ethyl acetate. The organic layer was washed with water and a saturated aqueous sodium chloride solution, and dried over anhydrous magnesium sulfate. The insoluble materials were then separated by filtration and the filtrate was concentrated under reduced pressure. The obtained solid was washed with diisopropyl ether, collected by filtration, and dried to obtain 1-[5-({4-(4-chloro-2-thienyl)-5-[(2-ethylpyrrolidin-1-

yl)methyl]-1,3-thiazol-2-yl} carbamoyl]pyrazin-2-yl]piperidine-4-carboxylic acid (129 mg).

[0161]

Example 206

5 To a mixture of ethyl 1-(5-{[4-(4-chloro-2-thienyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylate (695 mg), ethanol (5 mL), and tetrahydrofuran (5 mL) was added a 1 M aqueous sodium hydroxide solution (5 mL), followed by stirring at 50°C for 30 minutes. To the reaction mixture was added acetic acid (0.29 mL), followed by concentration under reduced pressure and then
10 addition of water (5 mL). The mixture was stirred at 50°C for 3 hours, then cooled to room temperature, and stirred overnight, and the precipitated solid was then collected by filtration. The obtained solid and ethanol (4 mL) were mixed, followed by stirring at 80°C for 30 minutes. The mixture was cooled to room temperature, followed by stirring for 18 hours. The solid was collected by filtration and dried to obtain crystals of 1-(5-{[4-
15 (4-chloro-2-thienyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid (567 mg).

The crystals obtained in Example 206 had peaks around 2θ (°) 4.8, 6.6, 9.1, 10.3, 13.3, 14.5, 15.7, 17.2, 18.3, 19.0, 24.7, and 26.0 in powder X-ray diffraction.

[0162]

20 Example 207

To a mixture of ethyl 1-{5-[(4-[3-methoxy-5-(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpiperidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylate (987 mg) and ethanol (5 mL) was added a 1 M aqueous sodium hydroxide solution (5 mL), followed by stirring at 50°C for 30 minutes. To the reaction mixture
25 were added acetic acid (0.29 mL) and water. The mixture was stirred at 50°C for 3 hours, then cooled to room temperature, and stirred overnight, and the precipitated solid was collected by filtration. The obtained solid and ethanol (4 mL) were mixed, followed by stirring at 80°C for 3 hours. The mixture was cooled to room temperature and stirred for 3 days. The precipitated solid was collected by filtration to obtain crystals of 1-{5-[(4-[3-
30 methoxy-5-(trifluoromethyl)phenyl]-5-{[(2R)-2-methylpiperidin-1-yl]methyl}-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid (275 mg).

The crystals obtained in Example 207 had peaks around 2θ (°) 4.7, 7.5, 9.6, 10.4, 13.7, 16.9, 17.1, 18.0, 18.3, 19.2, 20.1, and 25.9 in powder X-ray diffraction.

[0163]

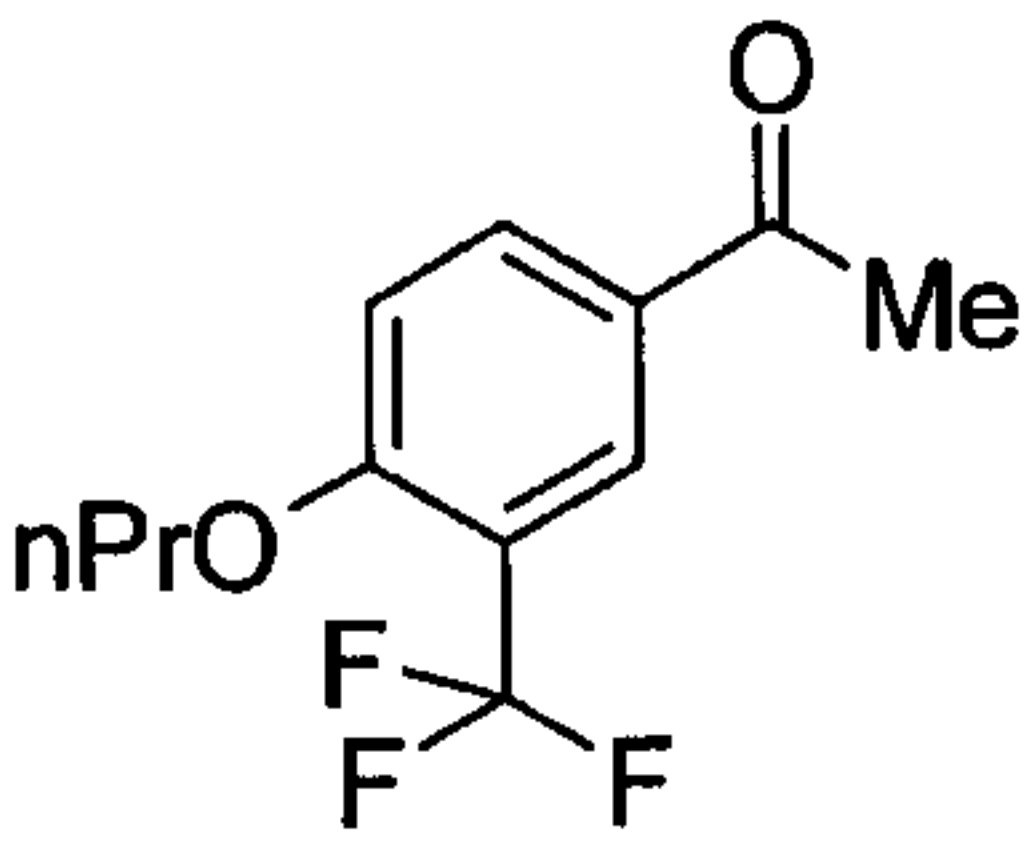
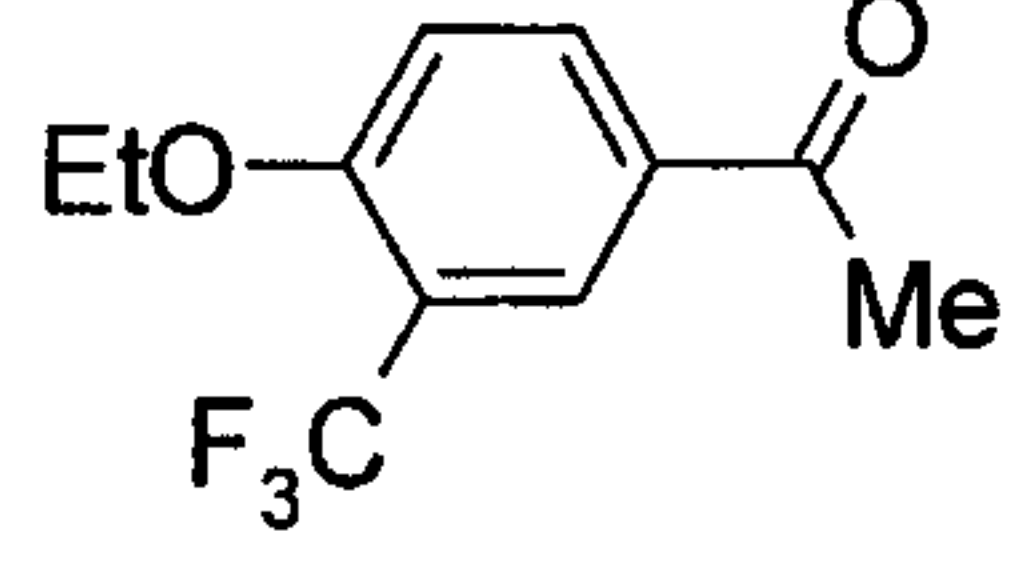
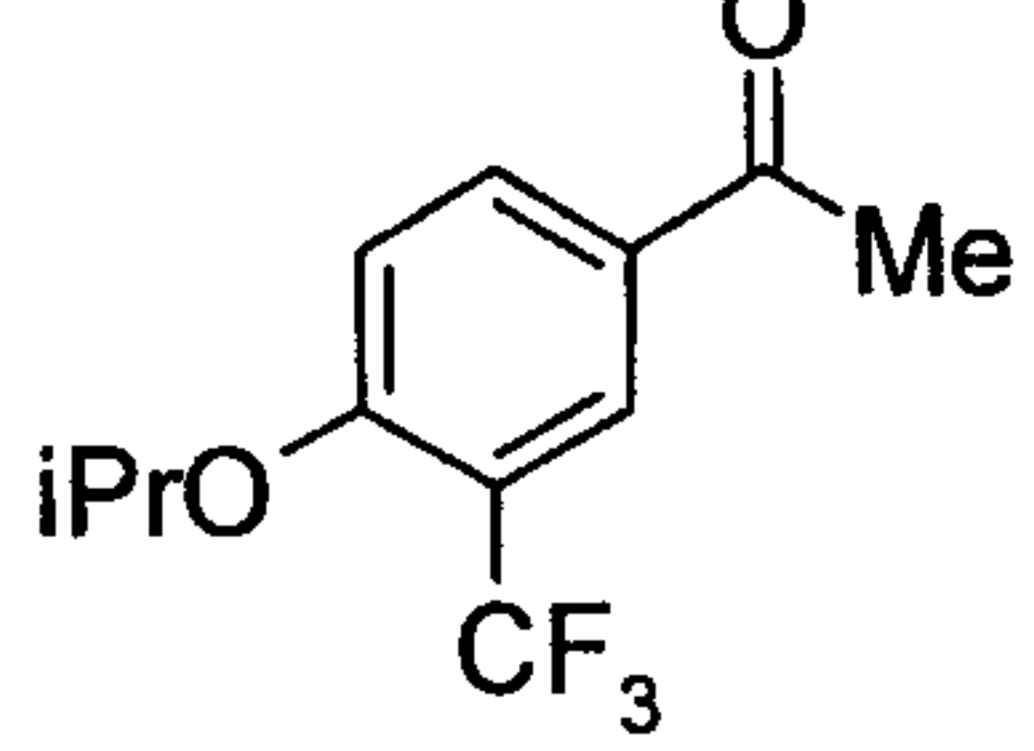
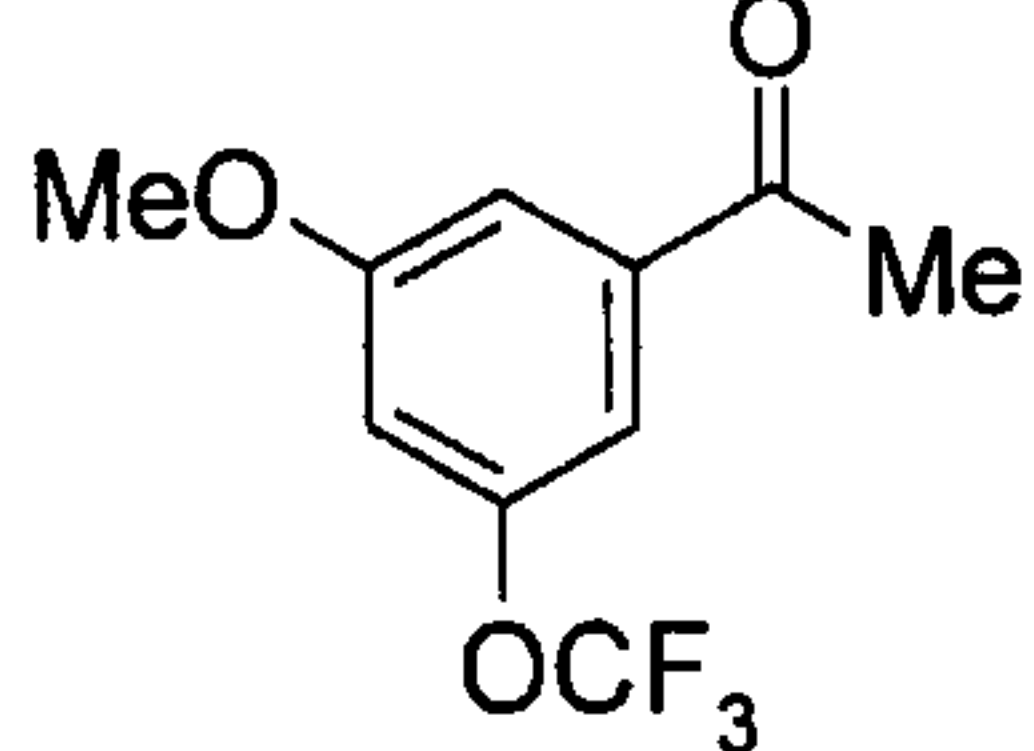
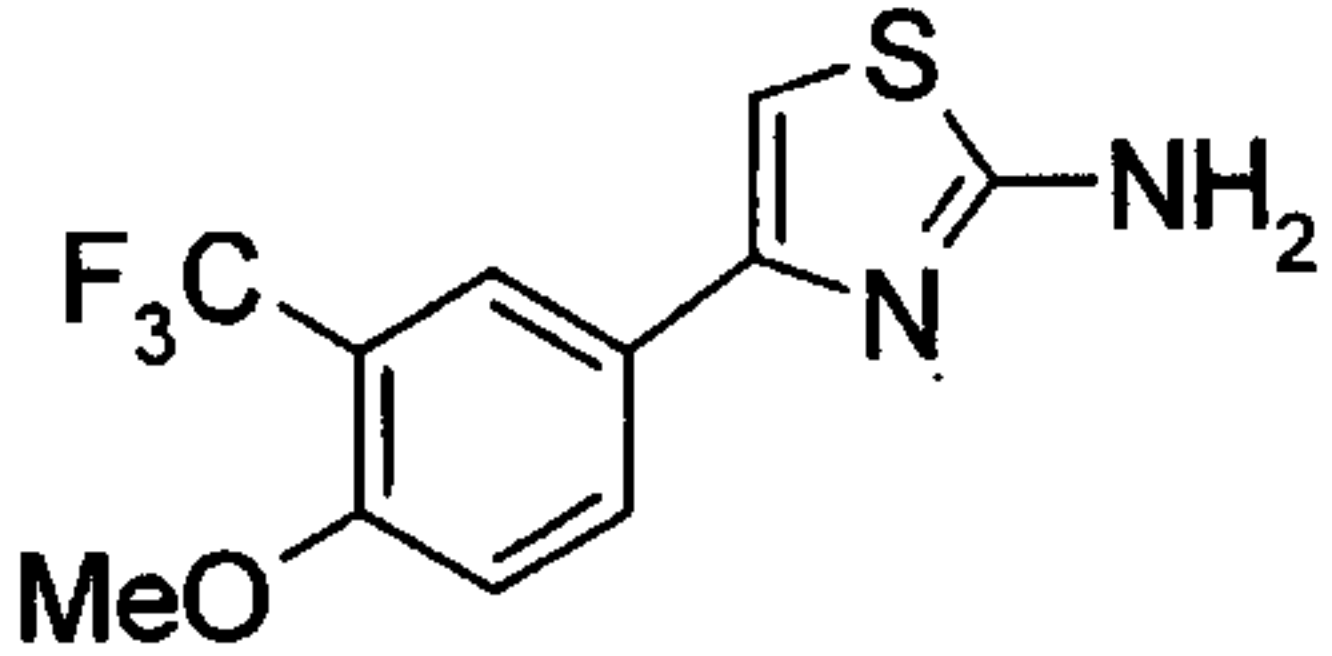
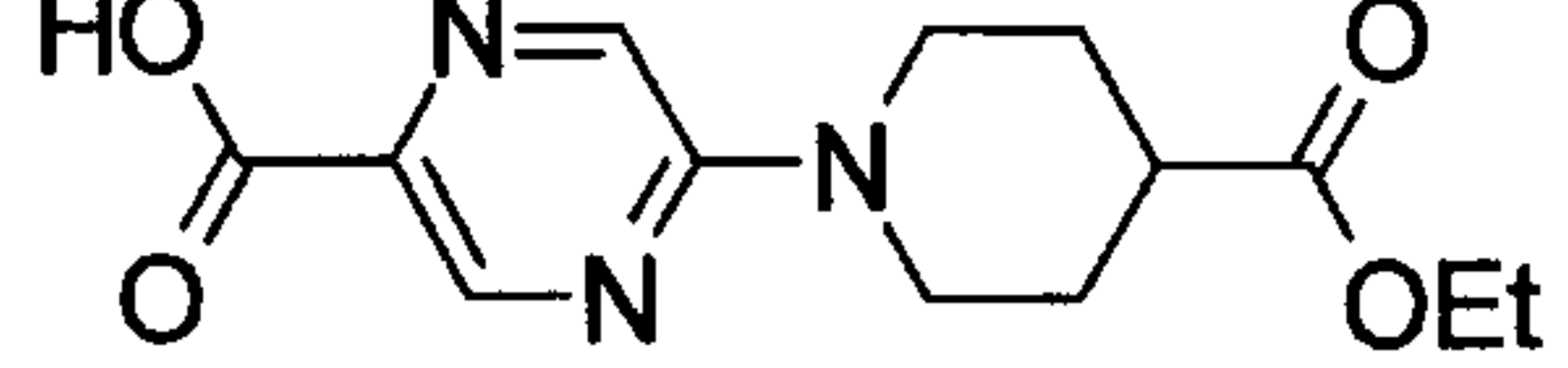
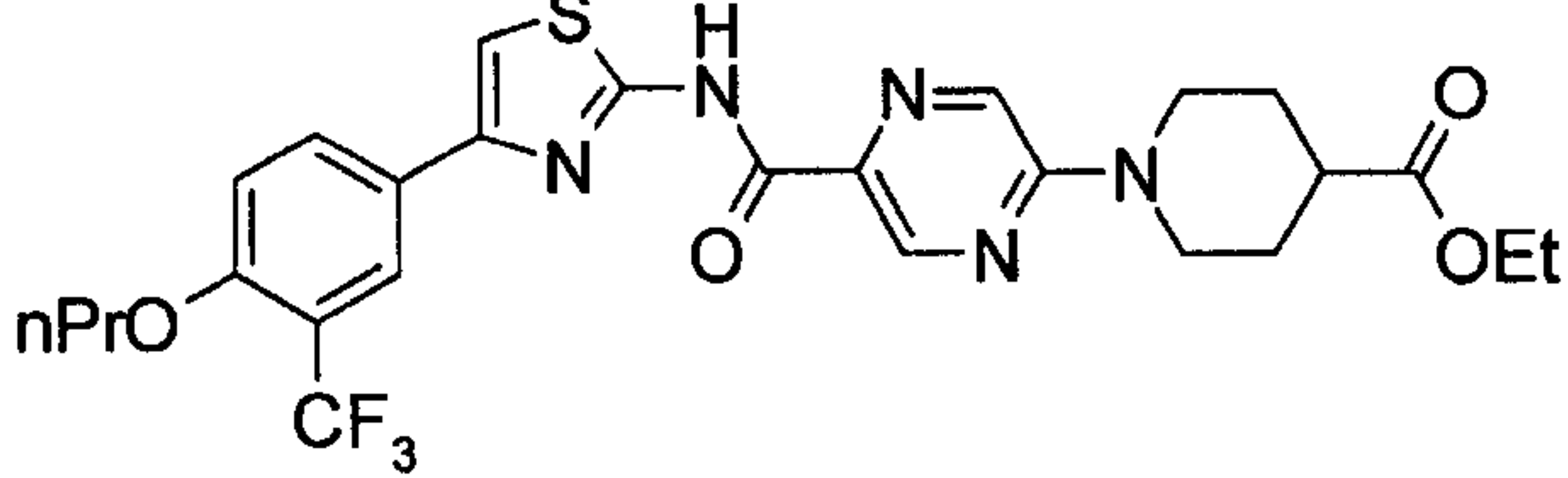
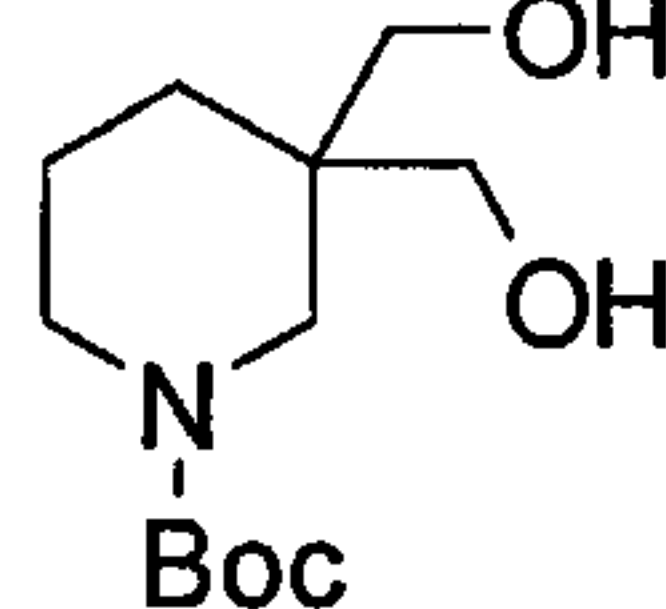
35 In the similar manner as the methods of Examples 1 to 8, the compounds of Example 9 to 205 in Tables below were prepared. For the compounds of Examples, the structures are shown in Tables 37 to 81, and the physicochemical data and the preparation methods are shown in Tables 82 to 97.

[0164]

Furthermore, the structures of the other compounds of the formula (I) are shown in Tables 98 to 113. These can be easily prepared by the preparation the methods described in the Preparation Examples and the Examples above, the methods apparent to those
5 skilled in the art, or modified methods thereof.

[0165]

[Table 4]

PEX	PSyn	Str	DATA
1	1		ESI+: 247
2	2		ESI+: 233
3	3		ESI+: 247
4	4		ESI+: 235
5	5		ESI+: 275
6	6		ESI-: 278
7	7		ESI+: 564
8	8		ESI+: 246

[0166]

[Table 5]

PEx	PSyn	Str	DATA
9	9		ESI+: 536
10	10		ESI+: 512
11	11		ESI+: 415
12	12		ESI+: 574
13	13		ESI+: 681
14	14		ESI+: 536

[0167]

[Table 6]

PEx	PSyn	Str	DATA
15	15		ESI+: 540
16	16		ESI+: 317
17	17		ESI+: 608
18	18		ESI+: 608
19	19		ESI+: 636
20	20		ESI+: 612, 614

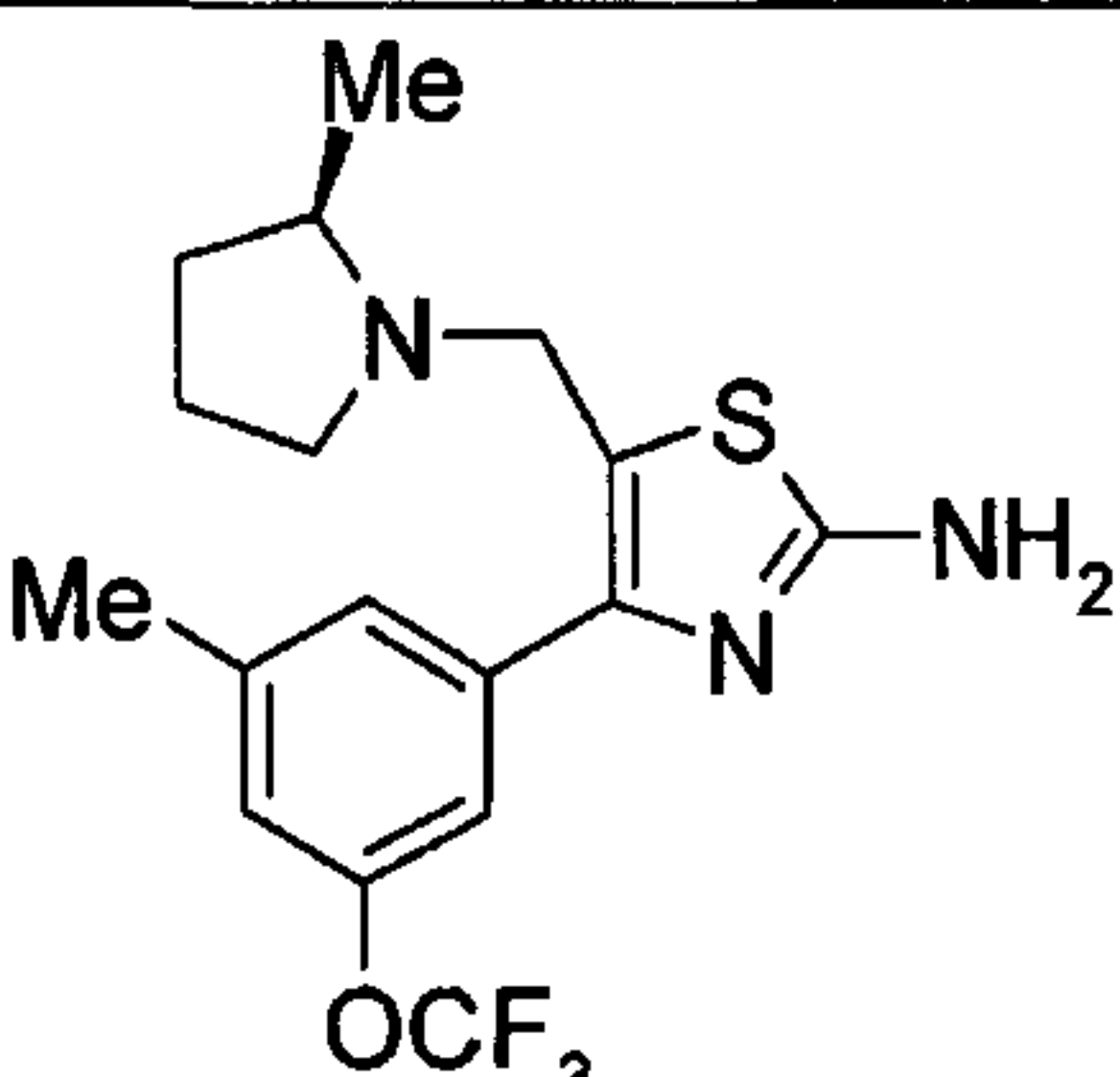
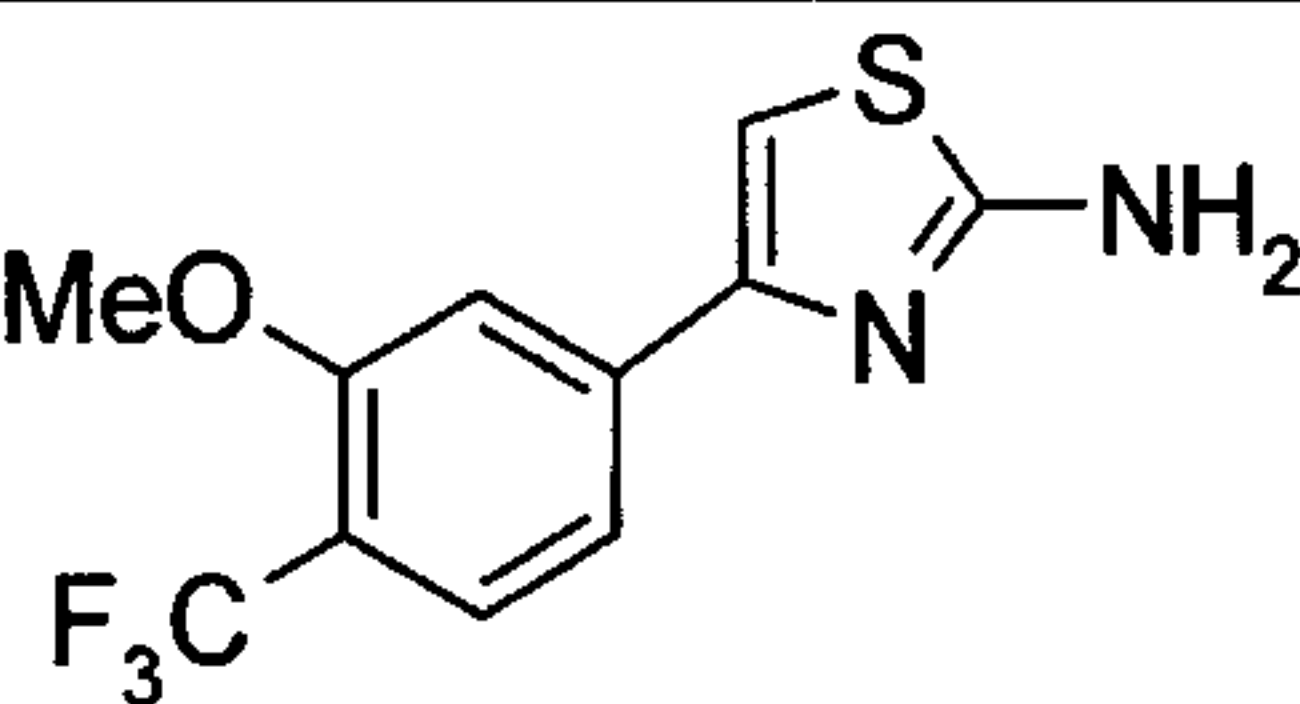
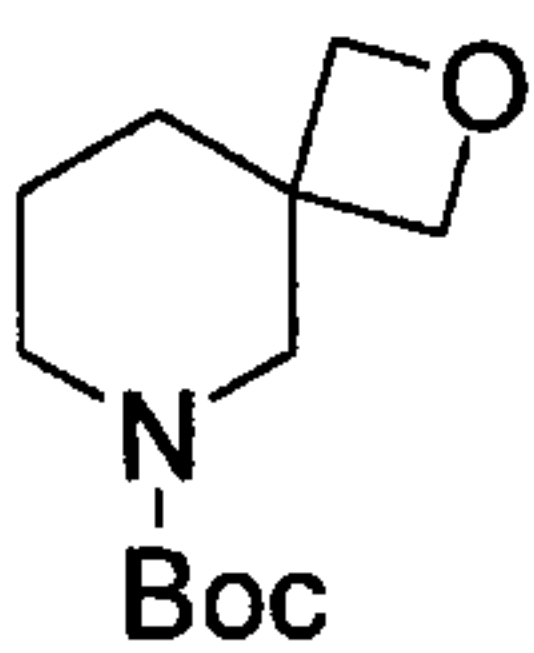
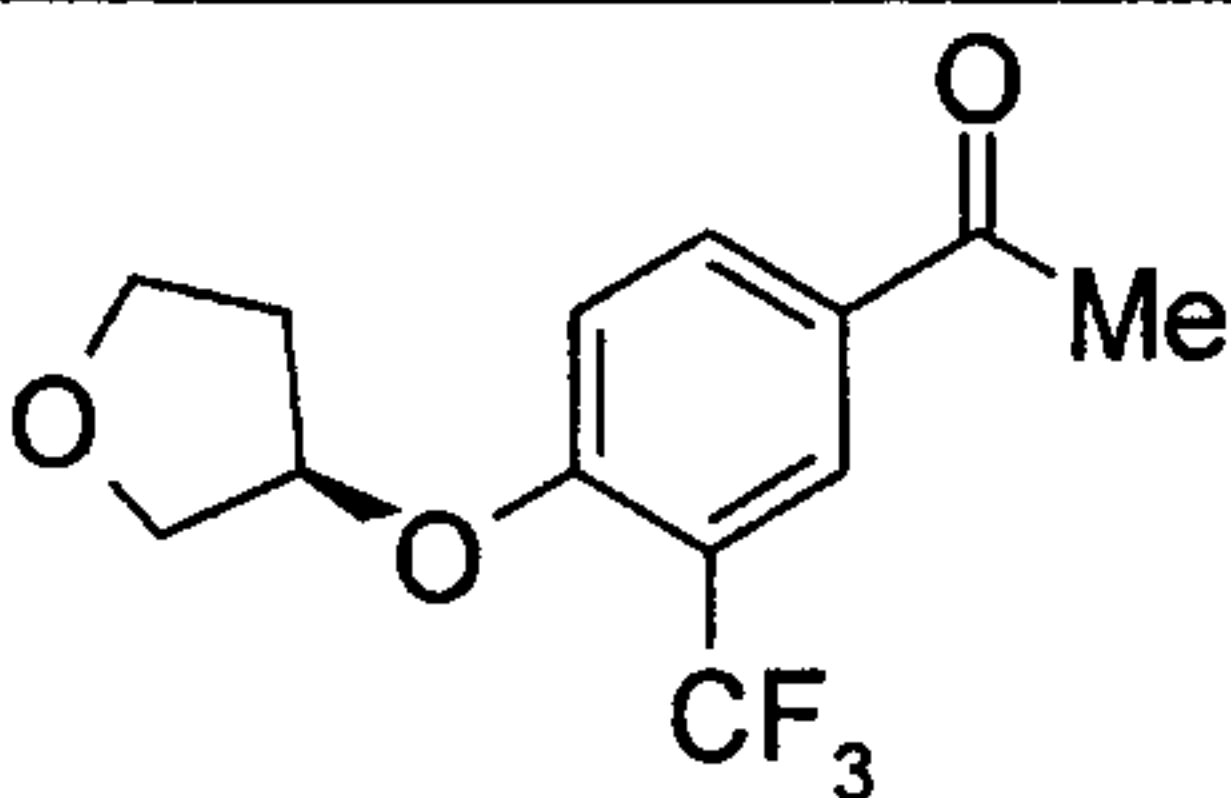
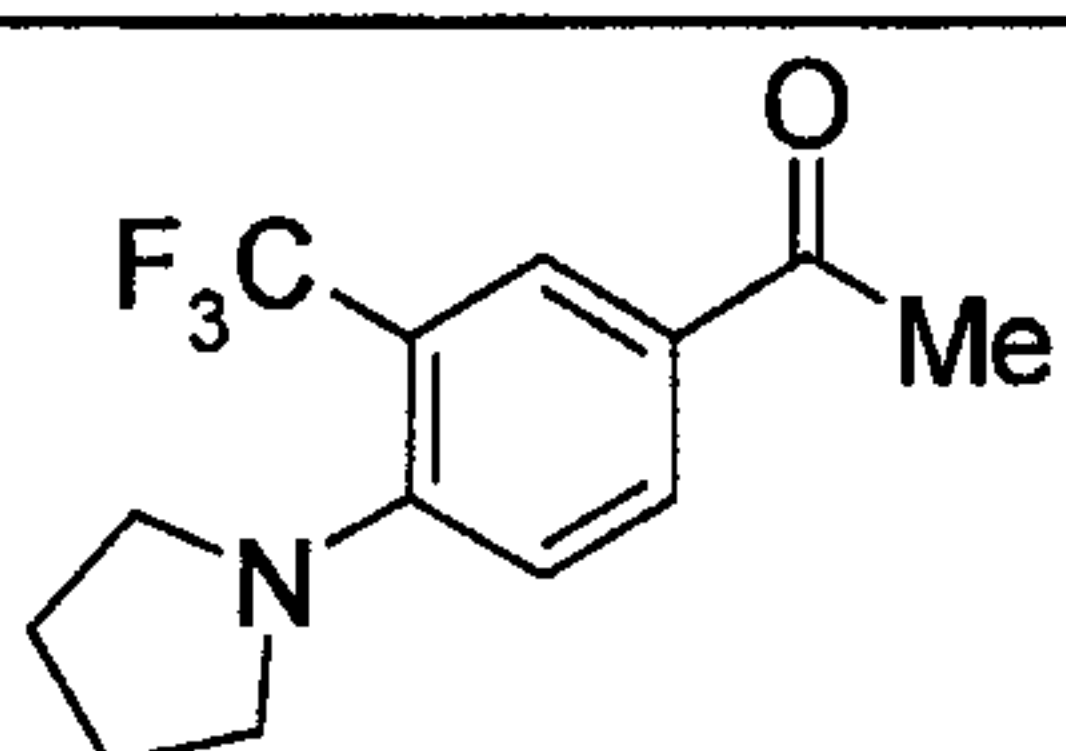
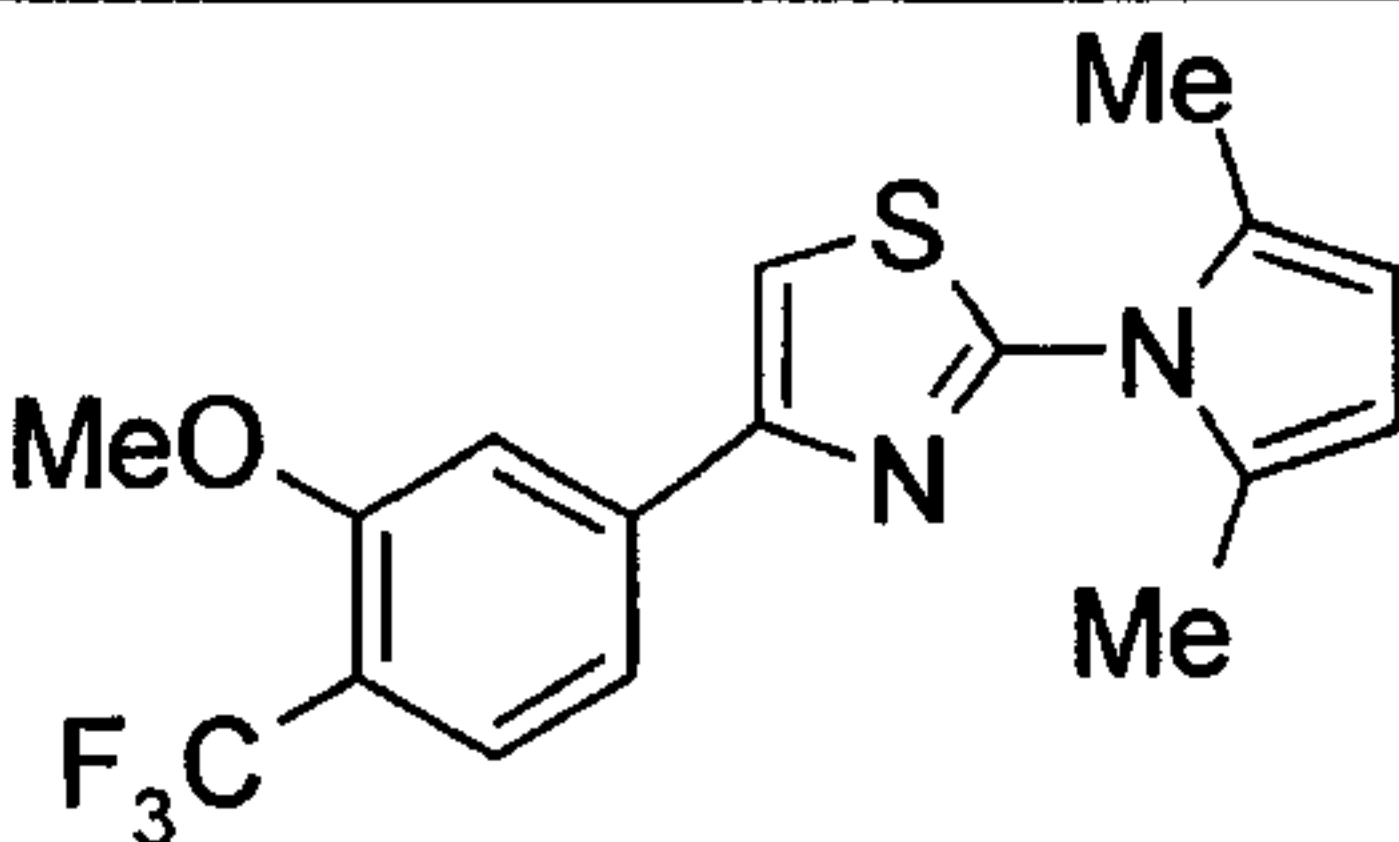
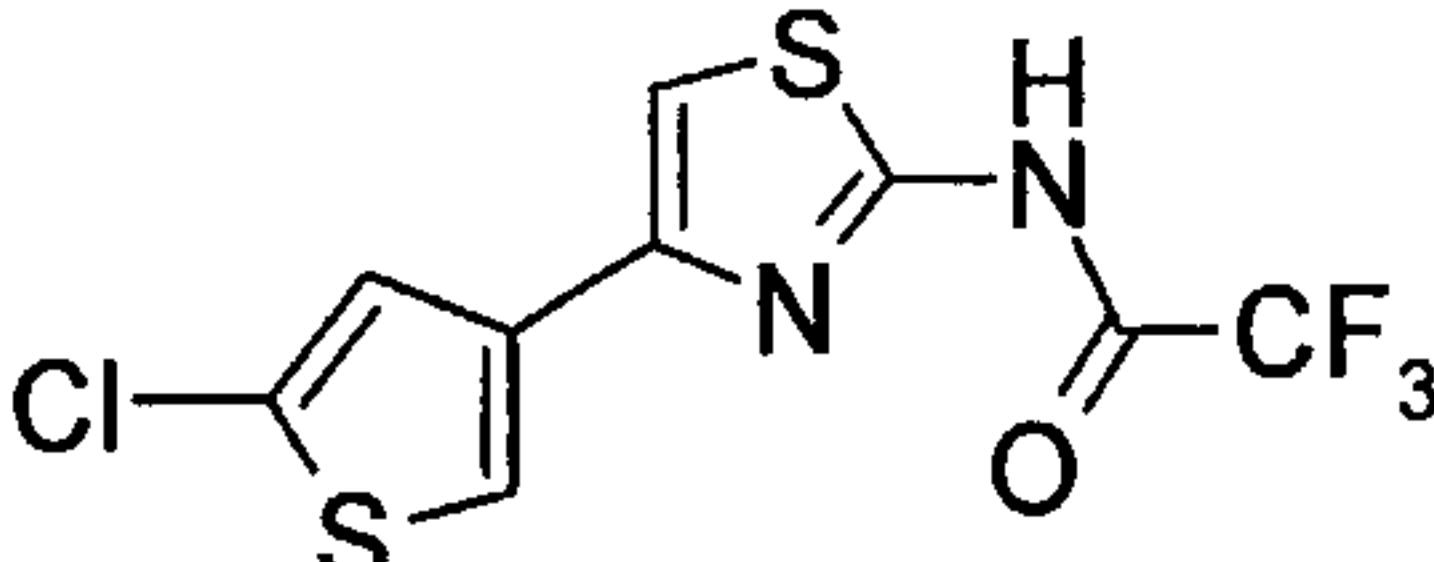
[0168]

[Table 7]

PEX	PSyn	Str	DATA
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22	22		ESI+: 646
23	23		ESI+: 647
24	24		ESI+: 637 , 639
25	25		ESI+: 144
26	26		ESI+: 100

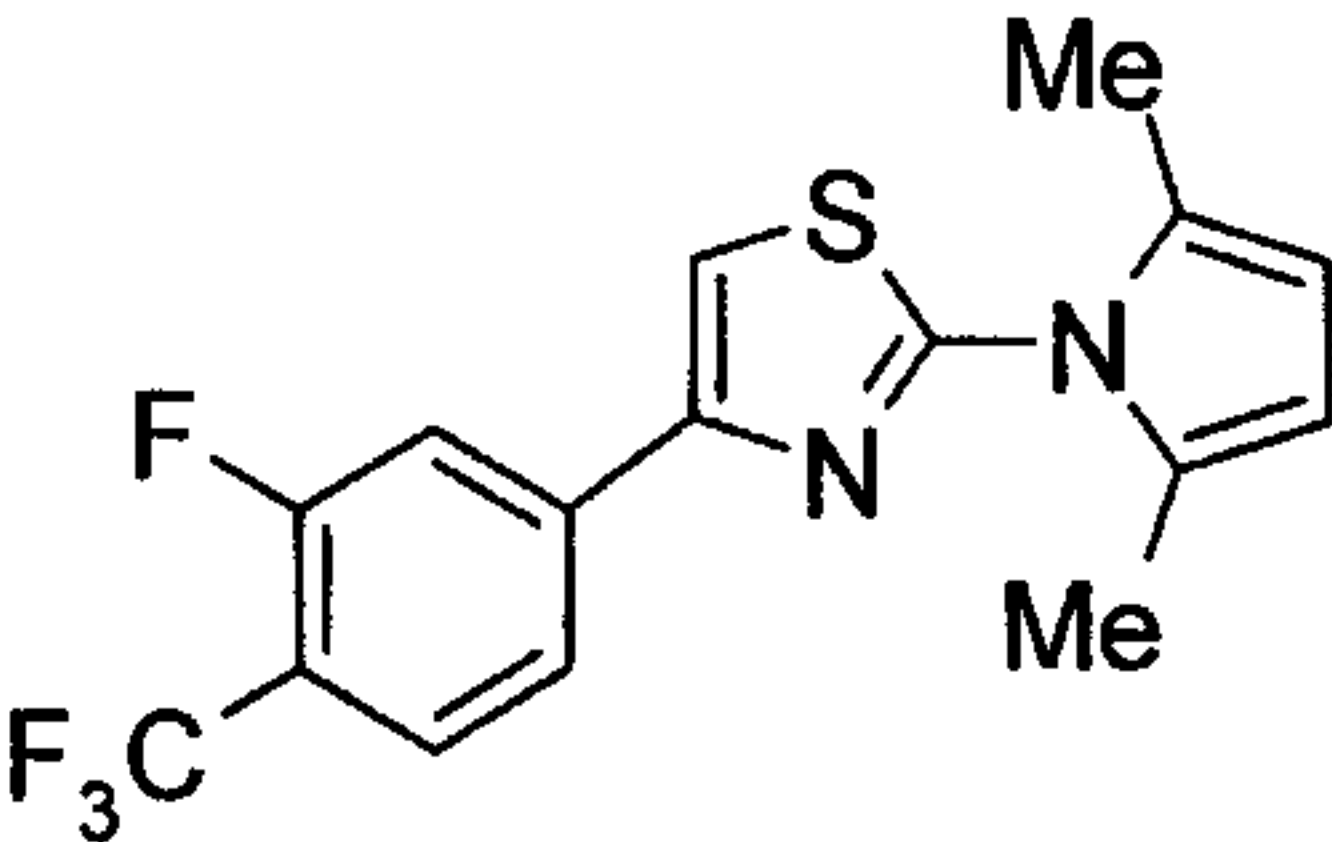
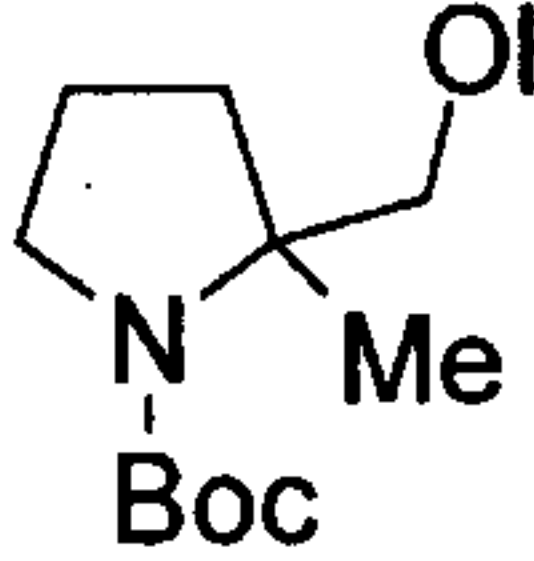
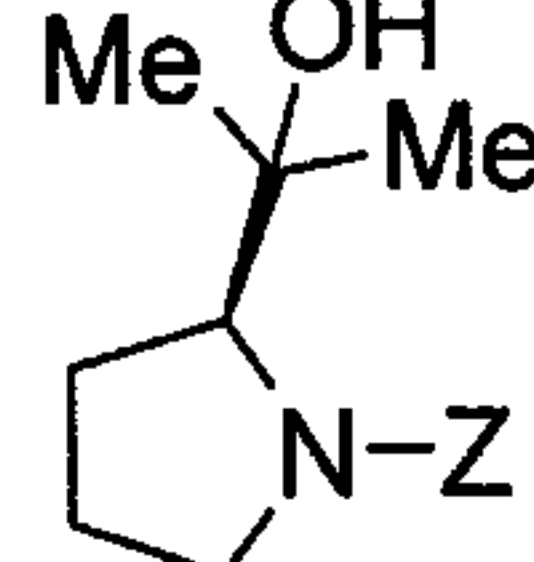
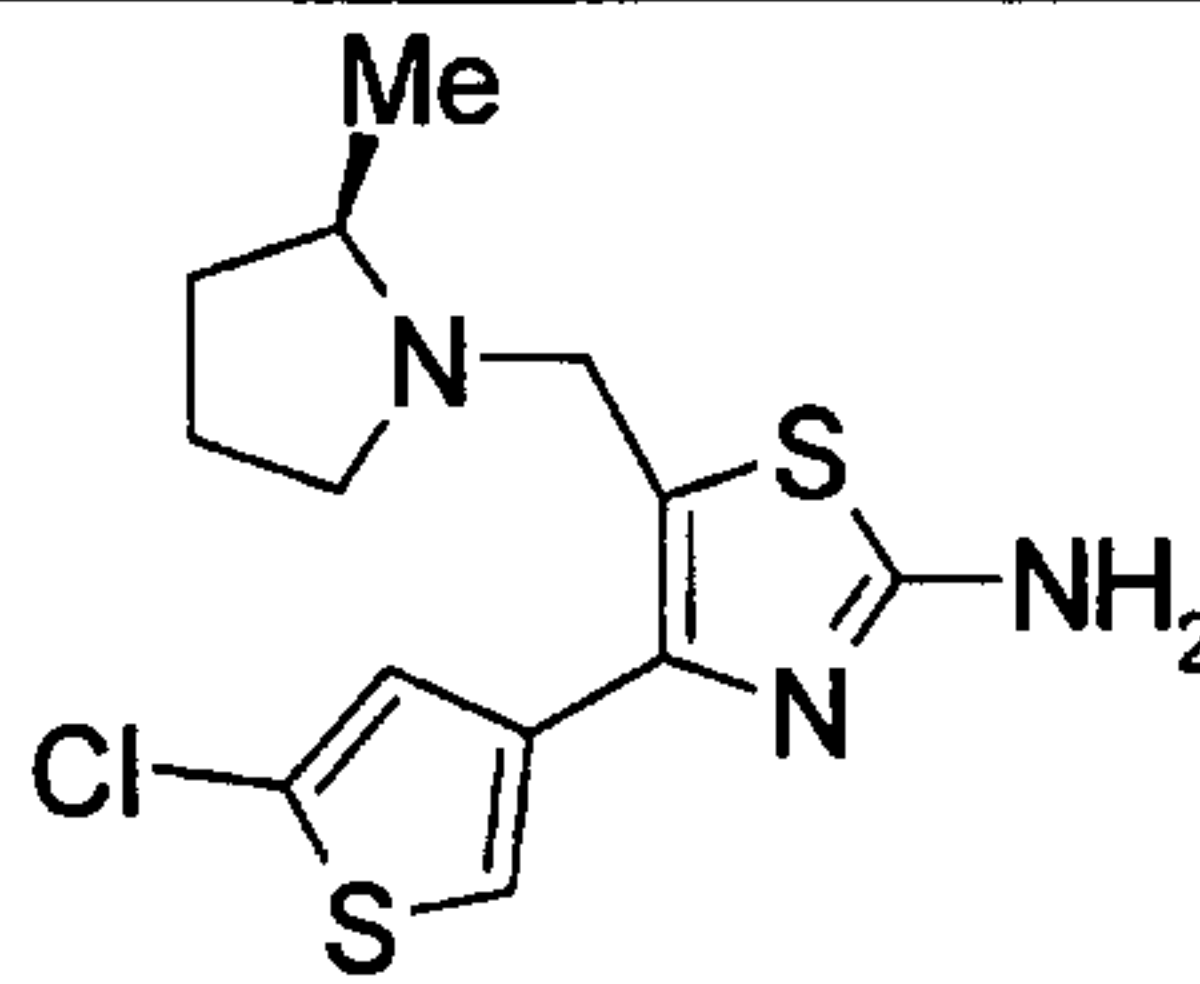
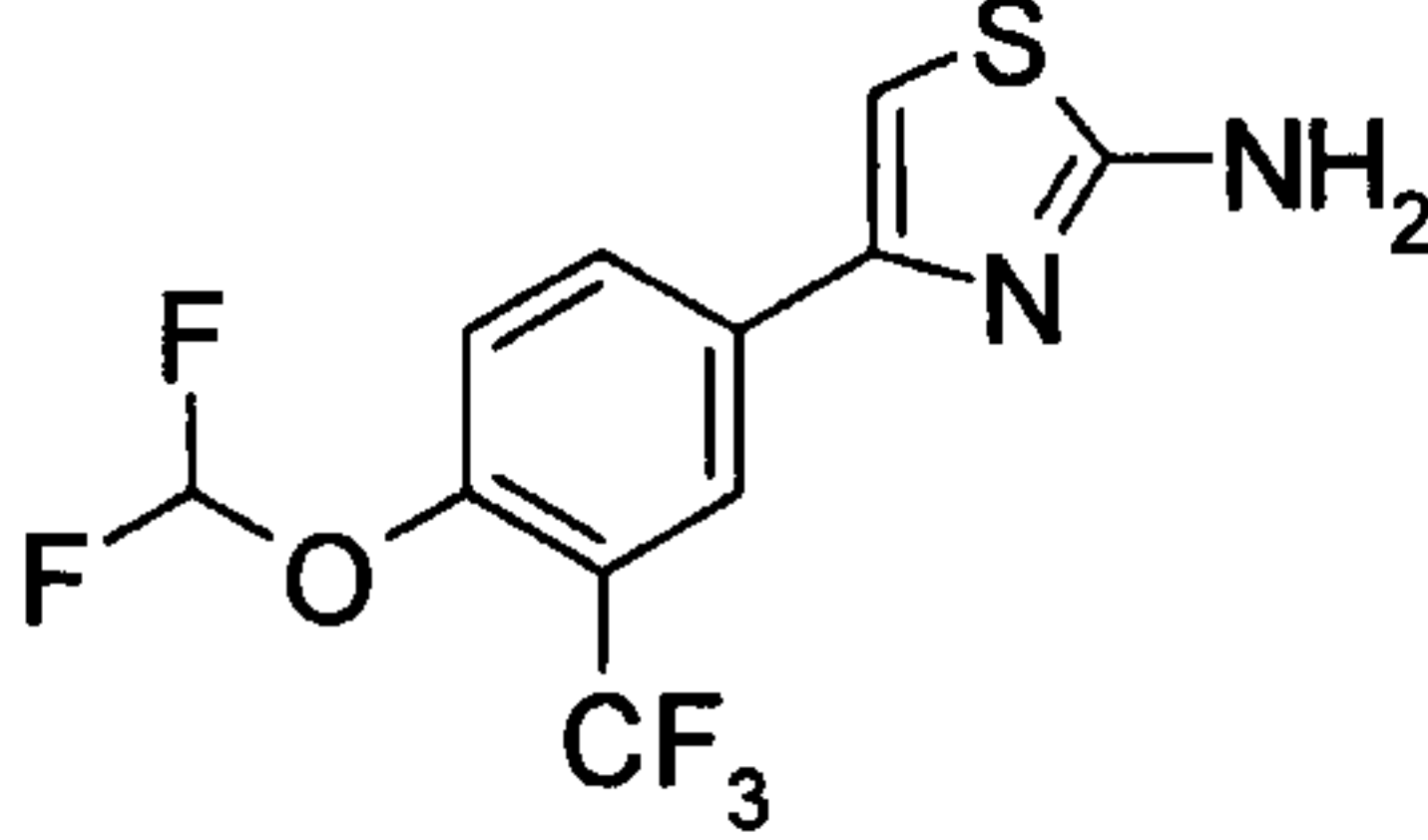
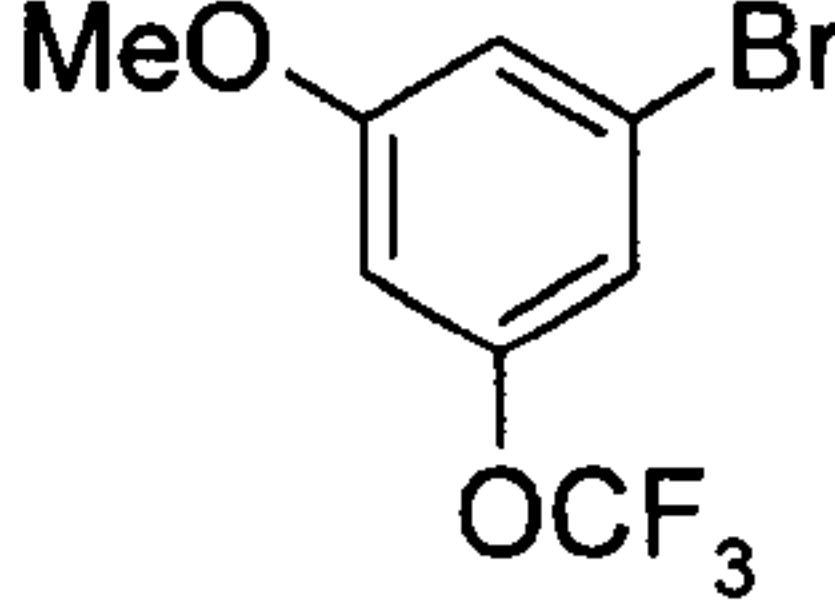
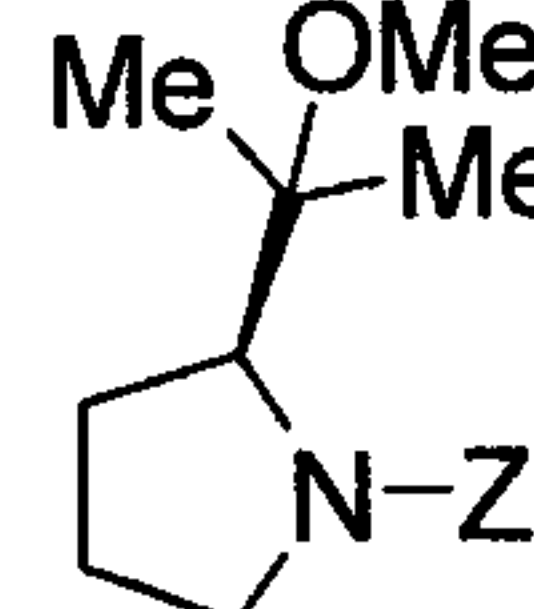
[0169]

[Table 8]

PEx	PSyn	Str	DATA
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29	29		ESI+: 228
30	30		EI: 274
31	31		ESI+: 258
32	32		ESI+: 353
33	33		ESI+: 313

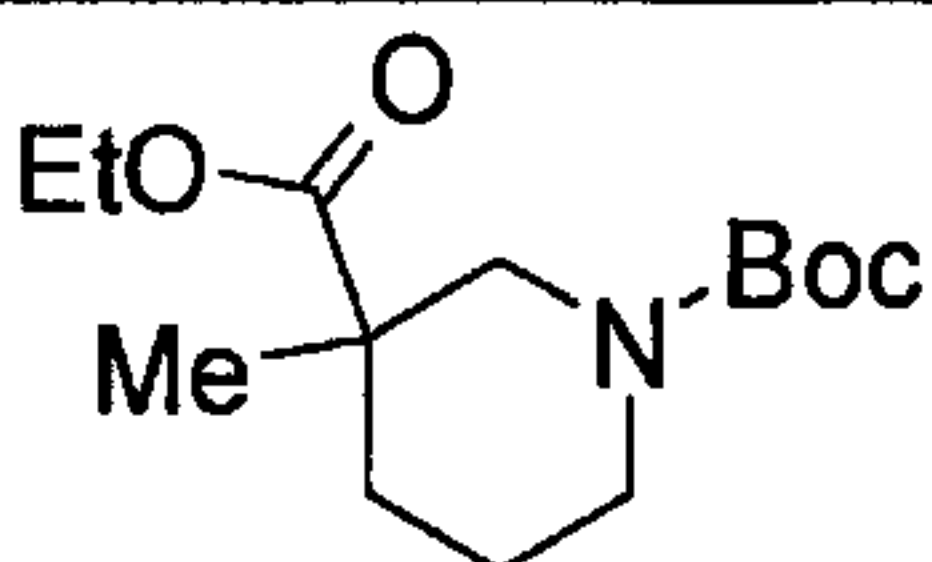
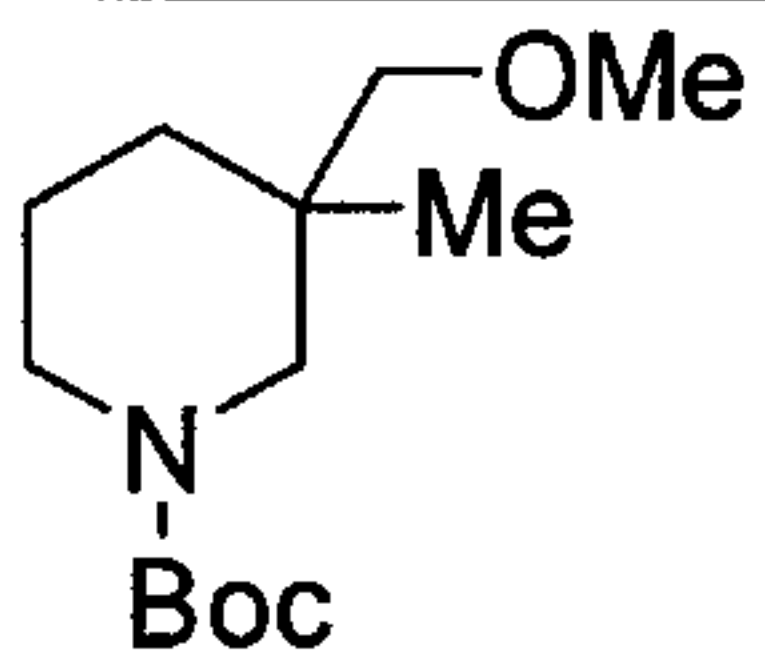
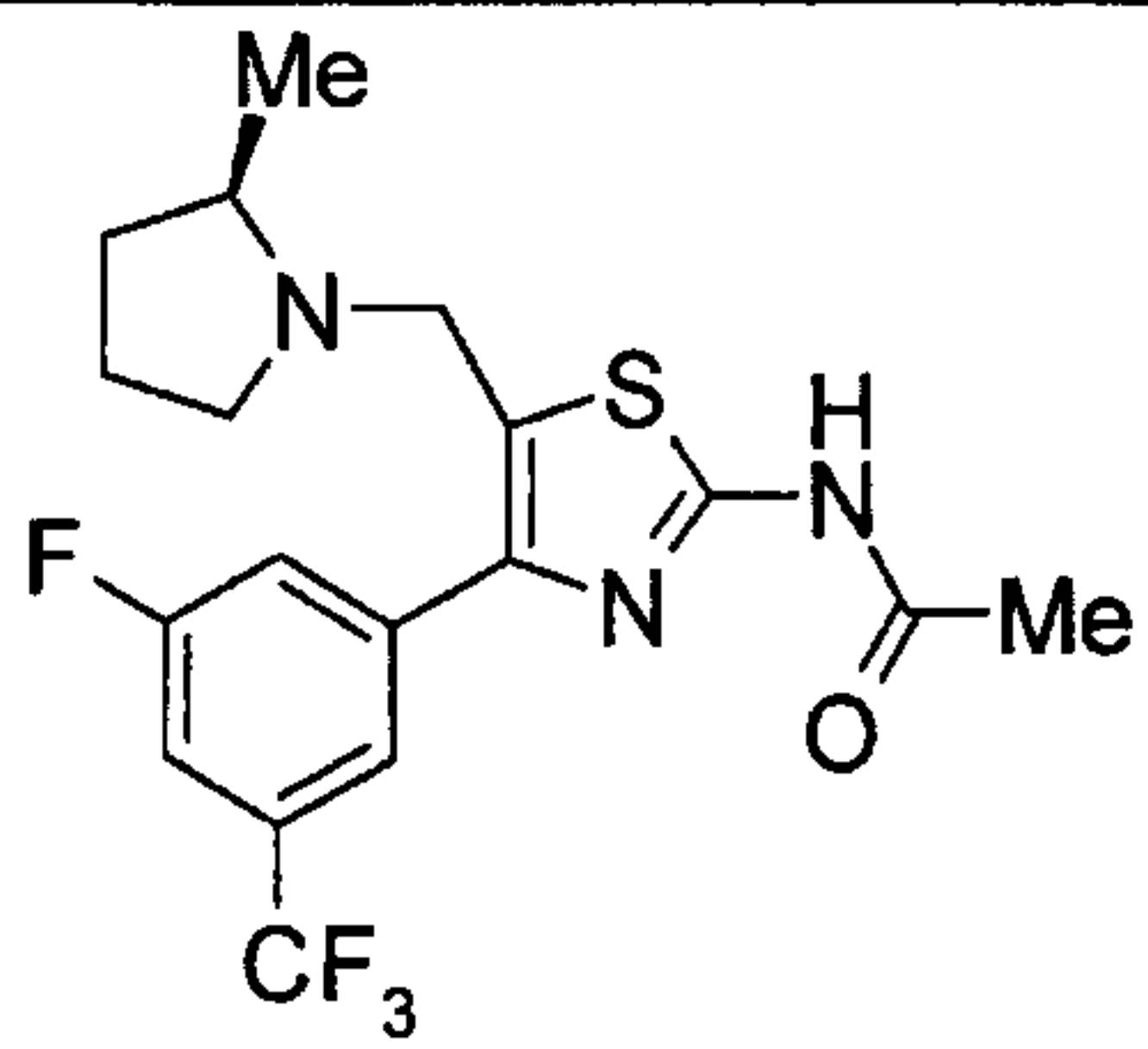
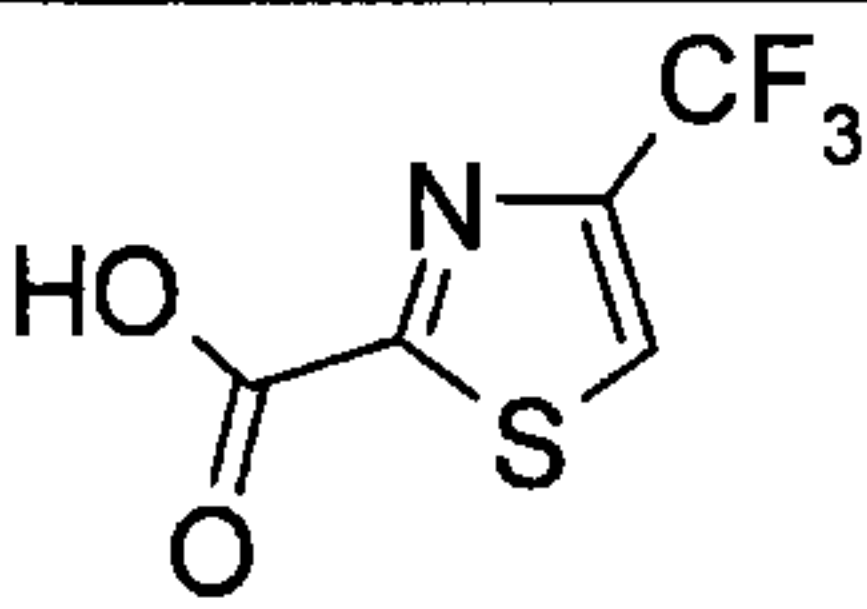
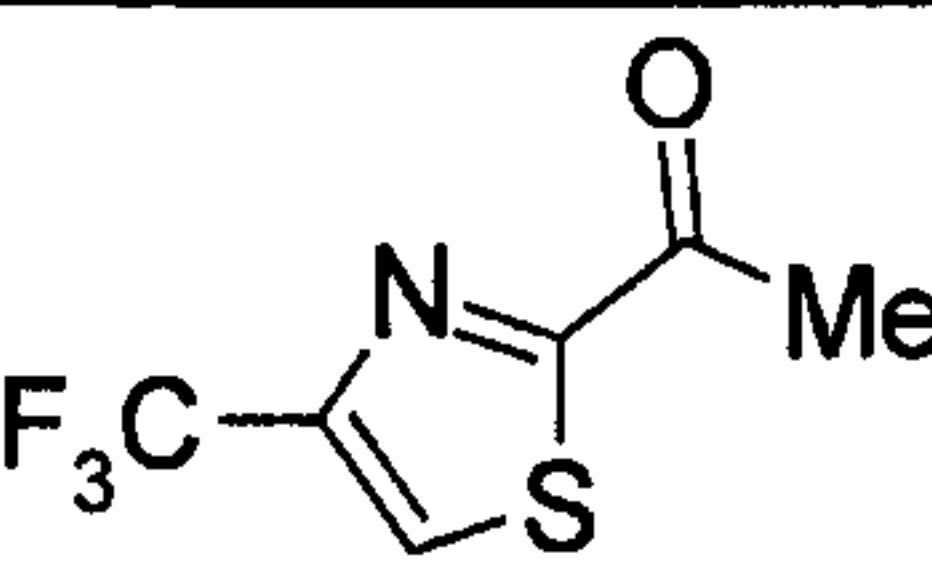
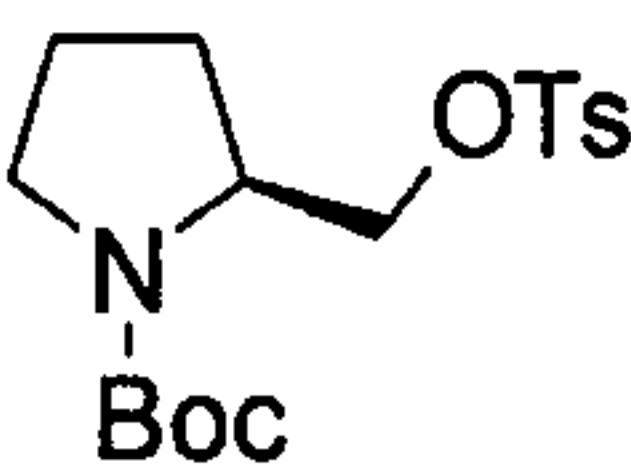
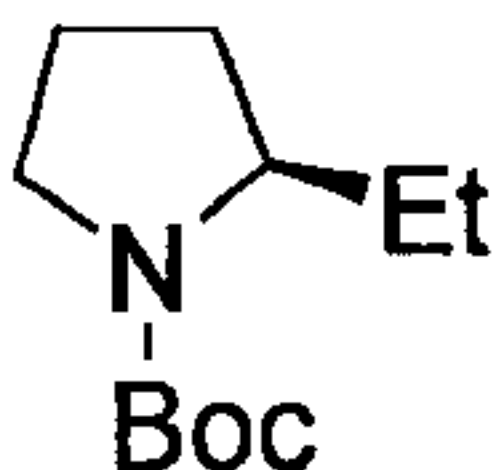
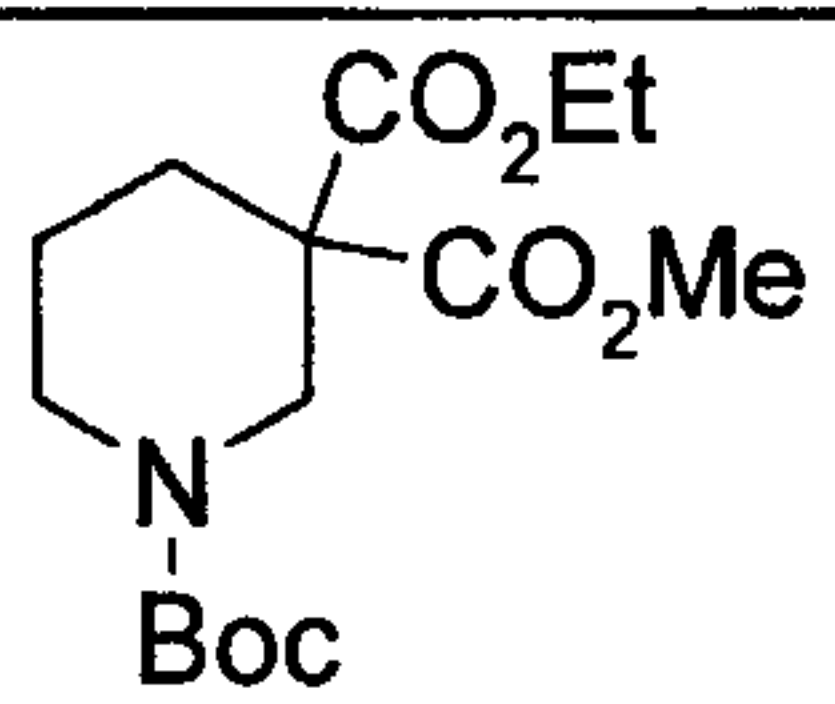
[0170]

[Table 9]

PEX	PSyn	Str	DATA
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35	35		ESI+: 216
36	36		ESI+: 264
37	37		ESI+: 314
38	38		ESI-: 309
39	39		NMR-DMSO-d6: 3.82 (3H, s), 6.97-7.00 (1H, m), 7.18-7.21 (1H, m), 7.23-7.26 (1H, m)
40	40		ESI+: 278

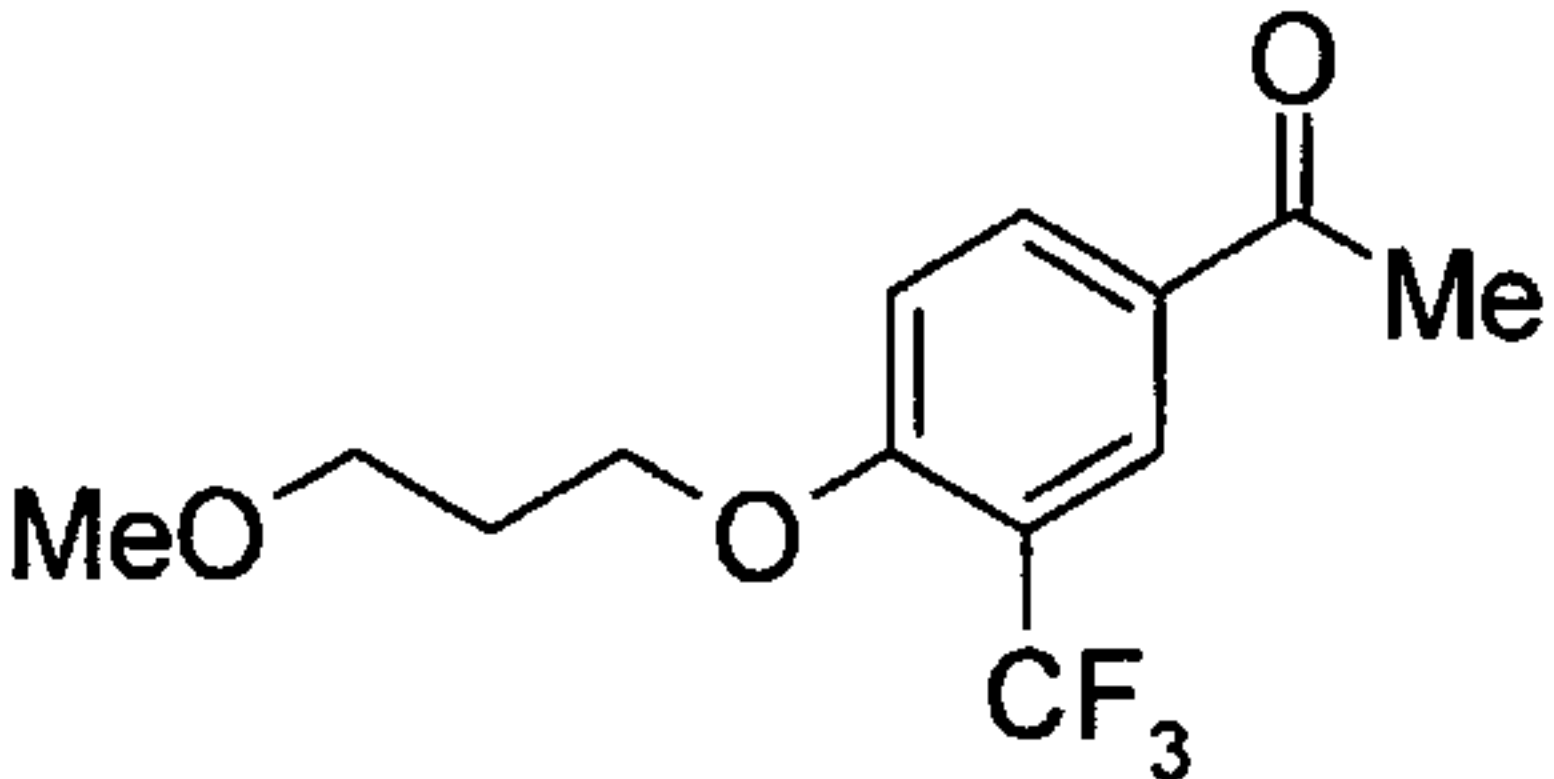
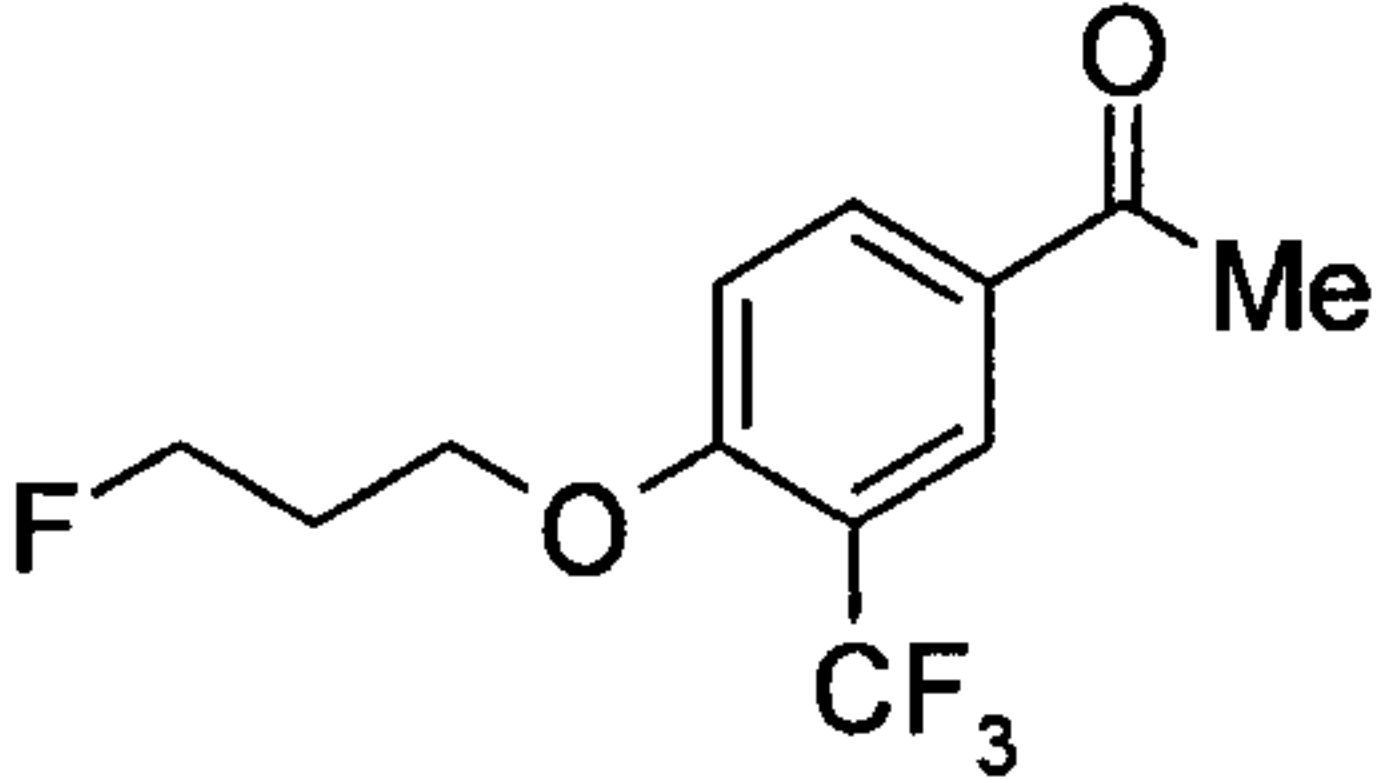
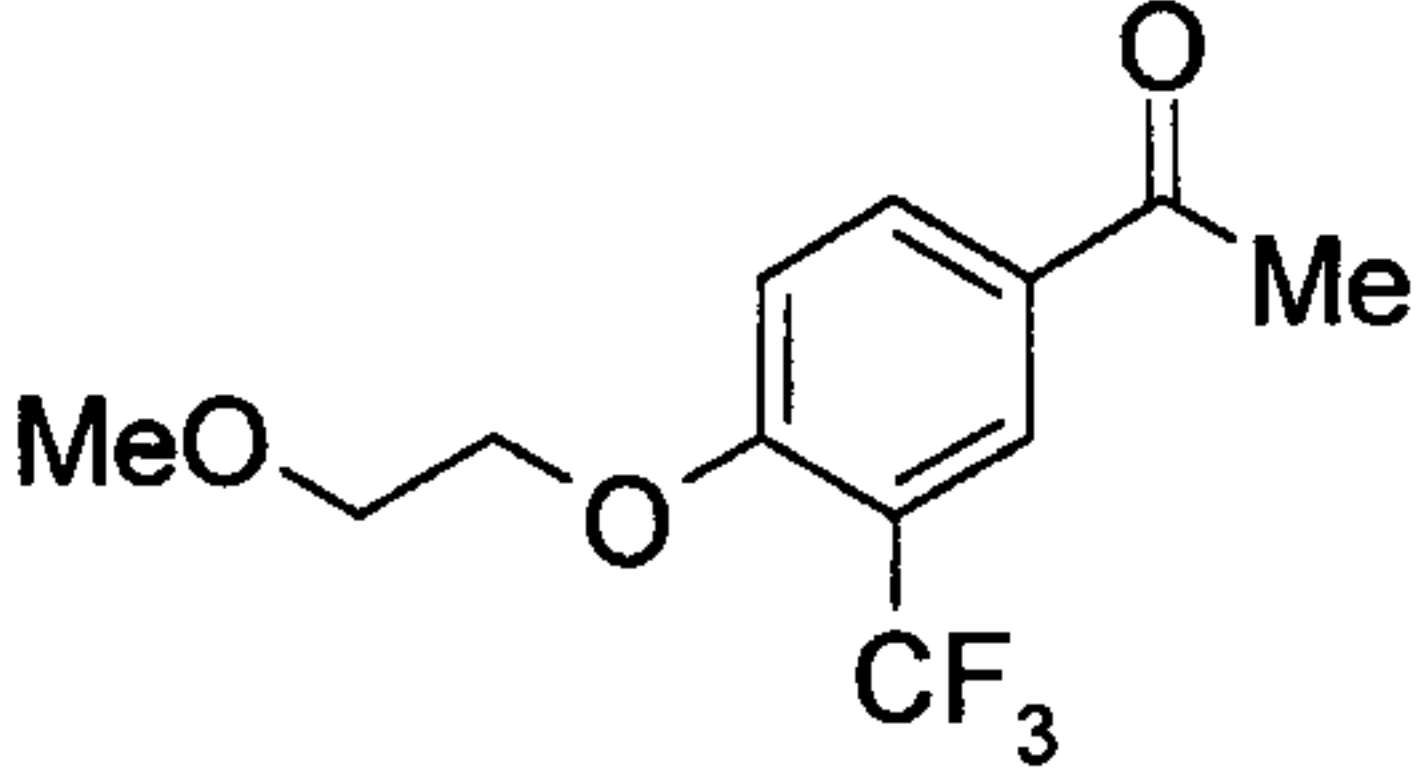
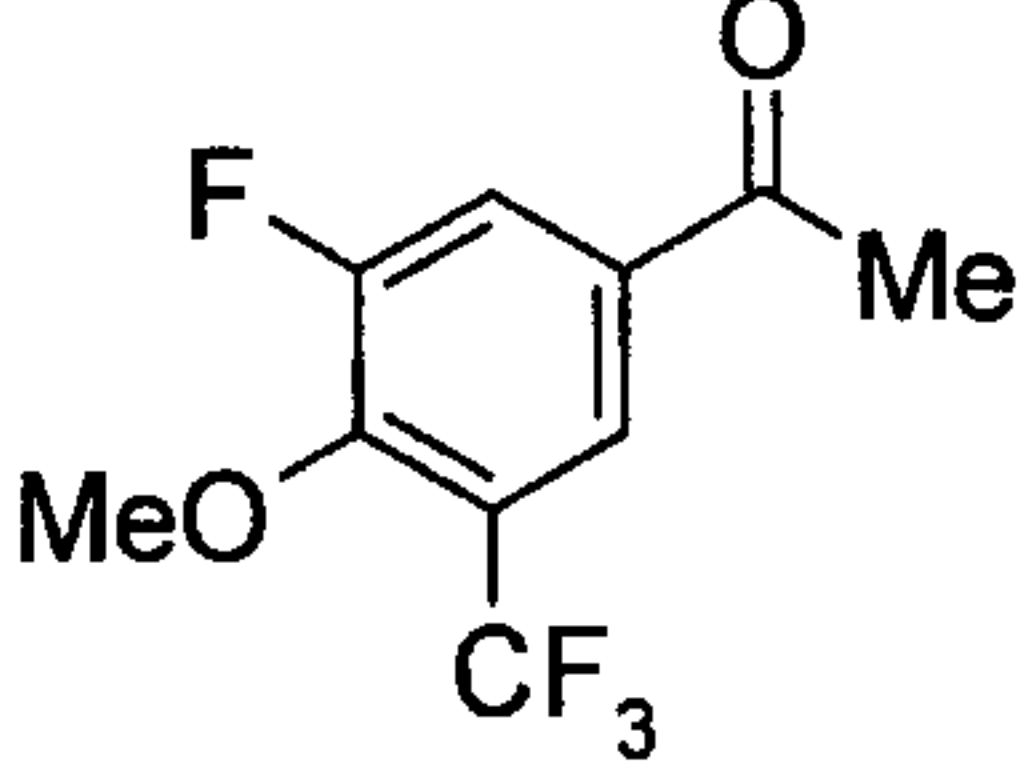
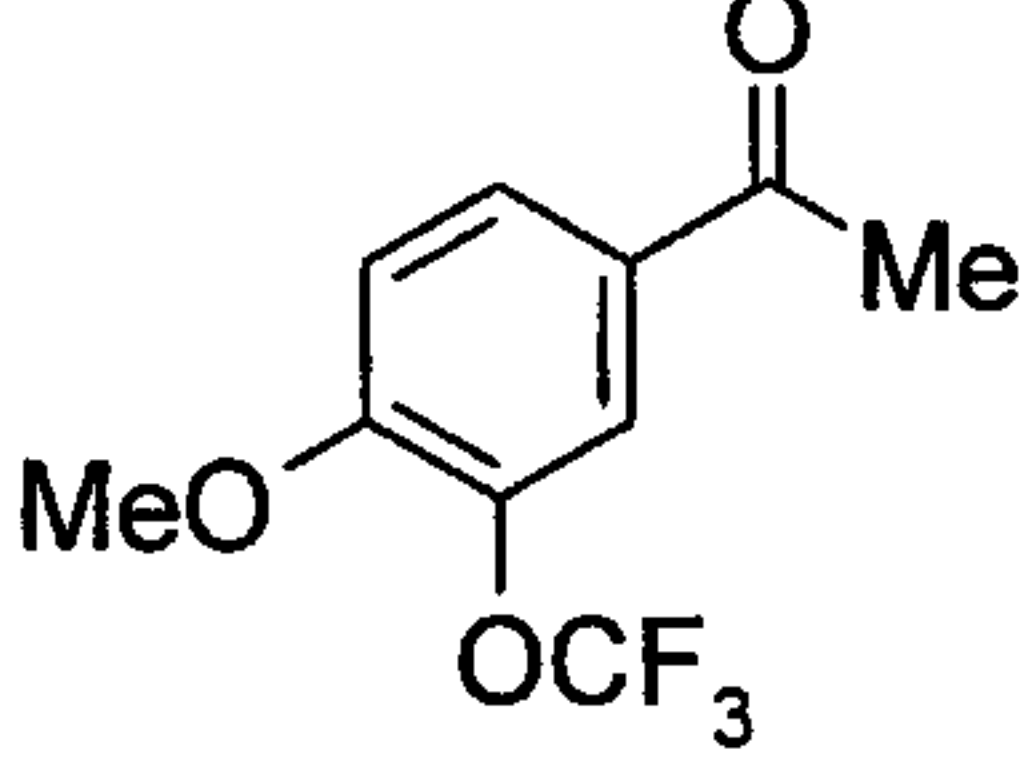
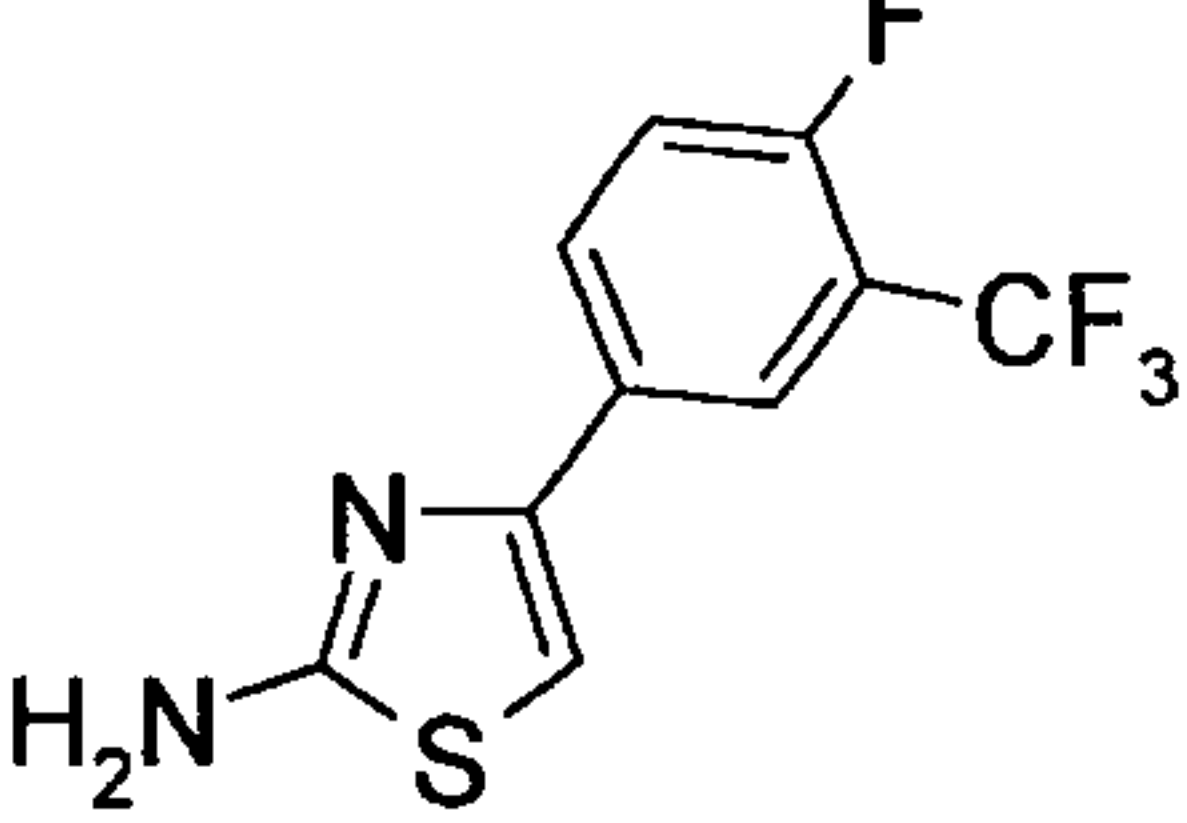
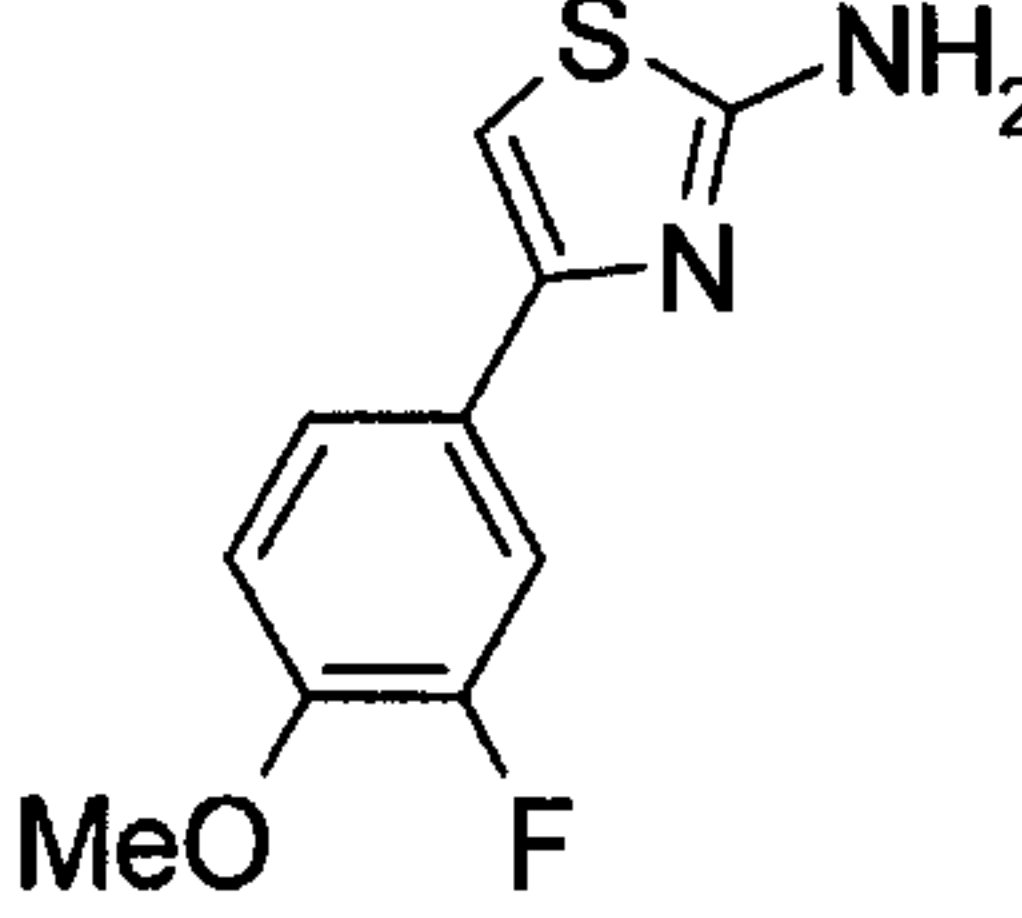
[0171]

[Table 10]

PEx	PSyn	Str	DATA
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42	42		ESI+: 244
43	43		ESI+: 402
44	44		ESI-: 196
45	45		EI: 195
46	46		ESI+: 378 [M+Na]+
47	47		ESI+: 200
48	48		ESI+: 316

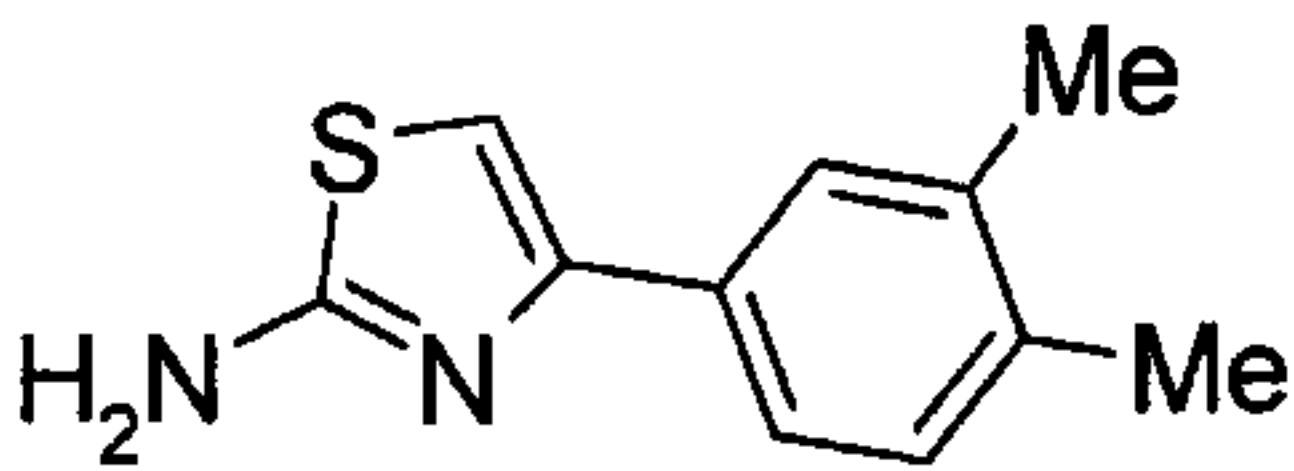
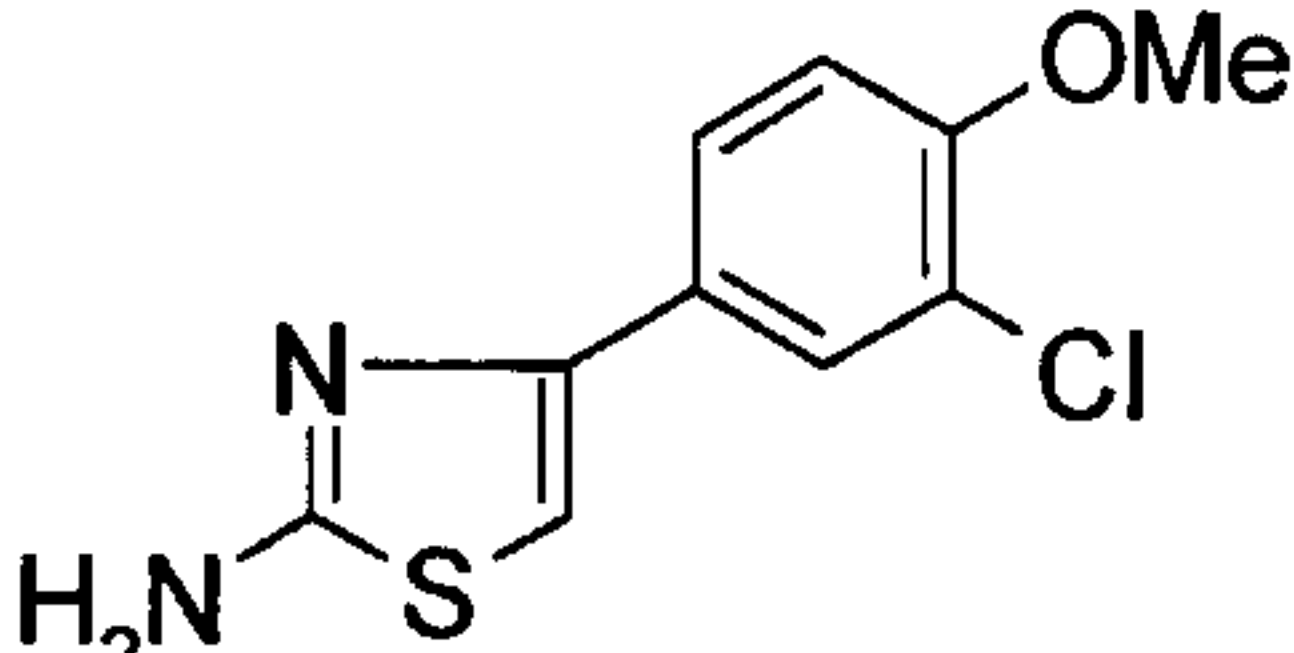
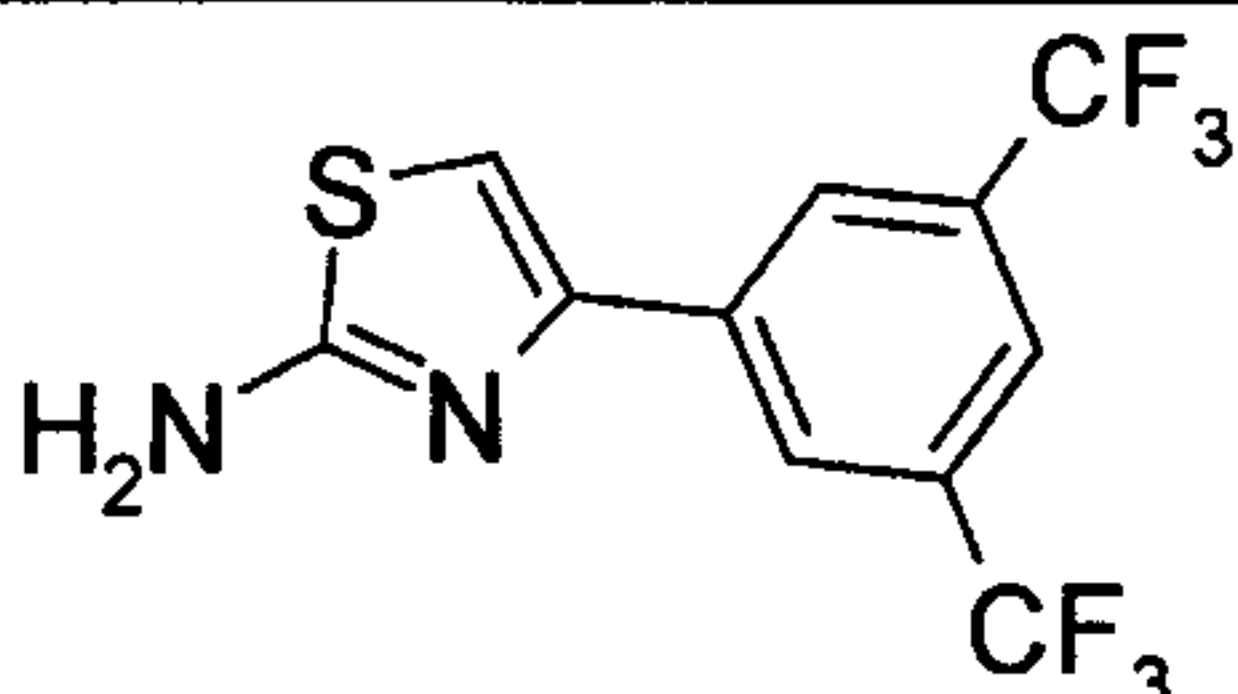
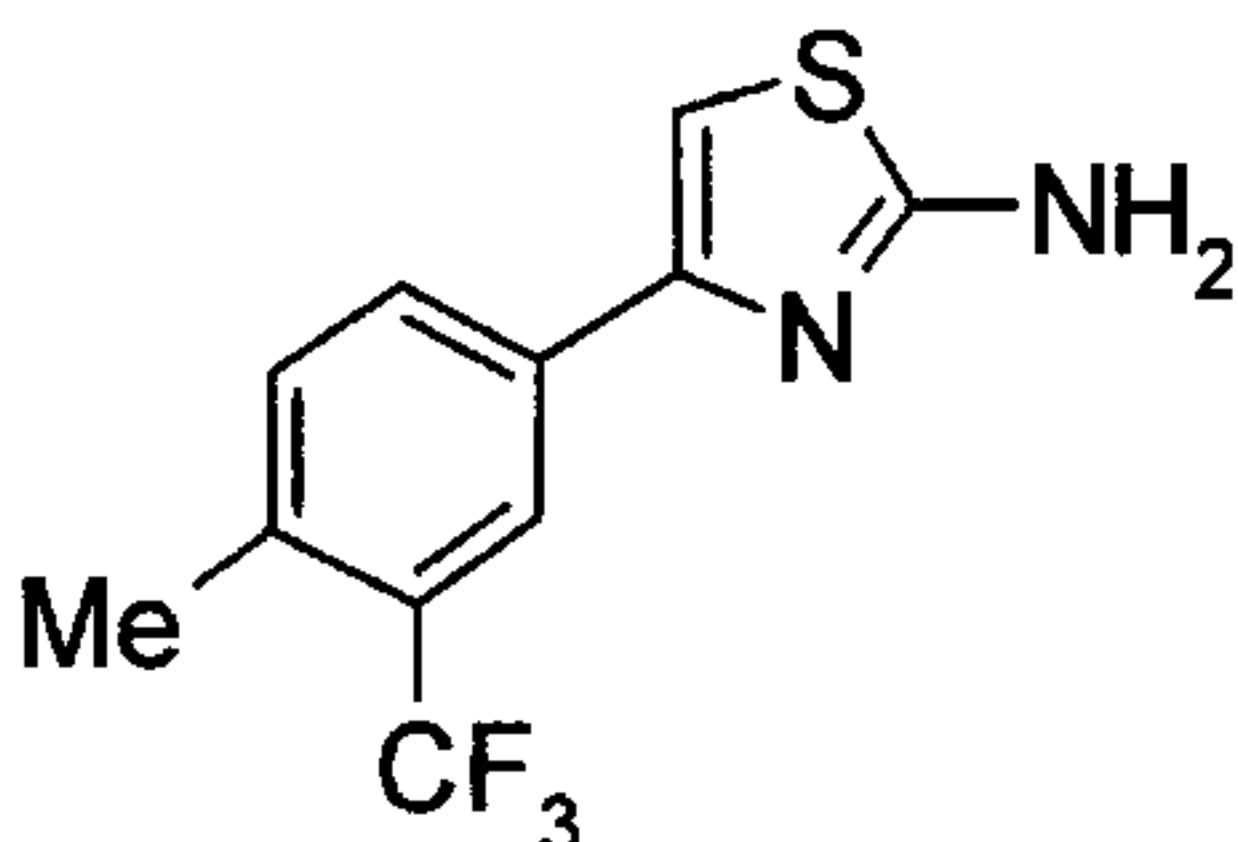
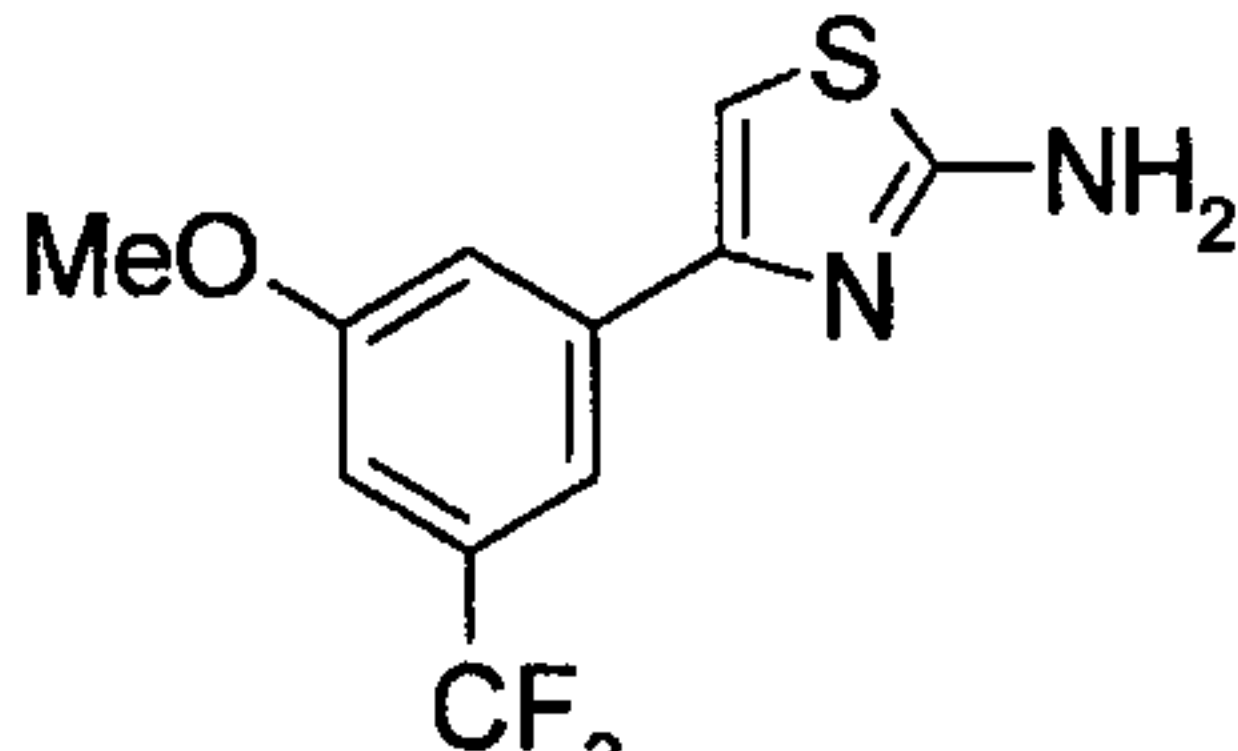
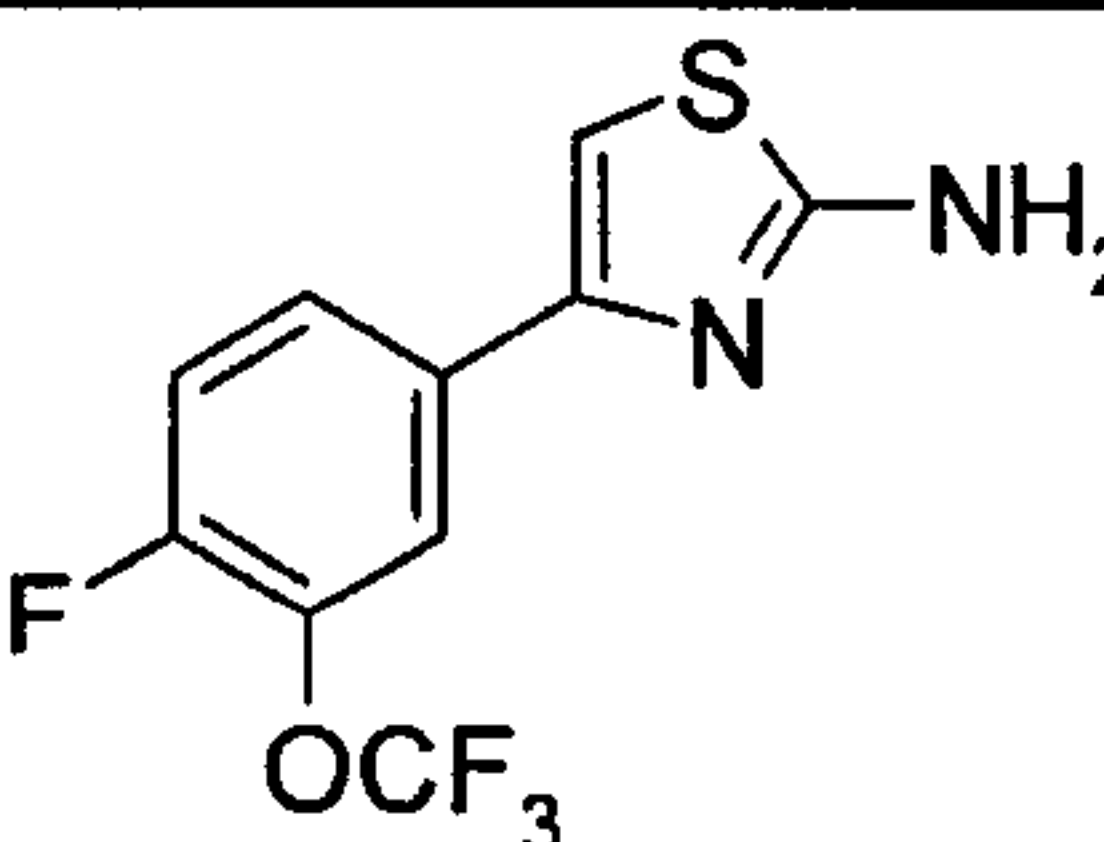
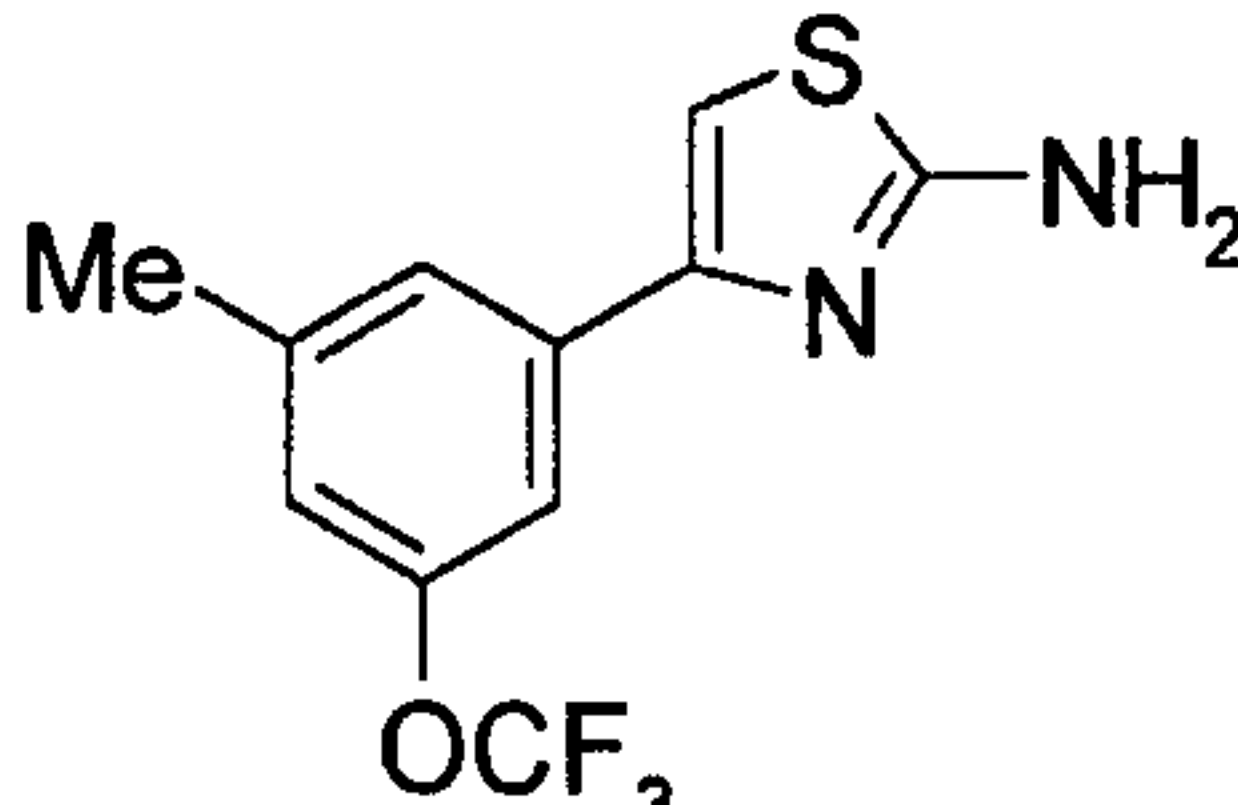
[0172]

[Table 11]

PEX	PSyn	Str	DATA
49	1		ESI+: 277
50	3		ESI+: 265
51	3		ESI+: 263
52	4		ESI+: 237
53	4		ESI+: 235
54	5		ESI+: 263
55	5		ESI+: 225

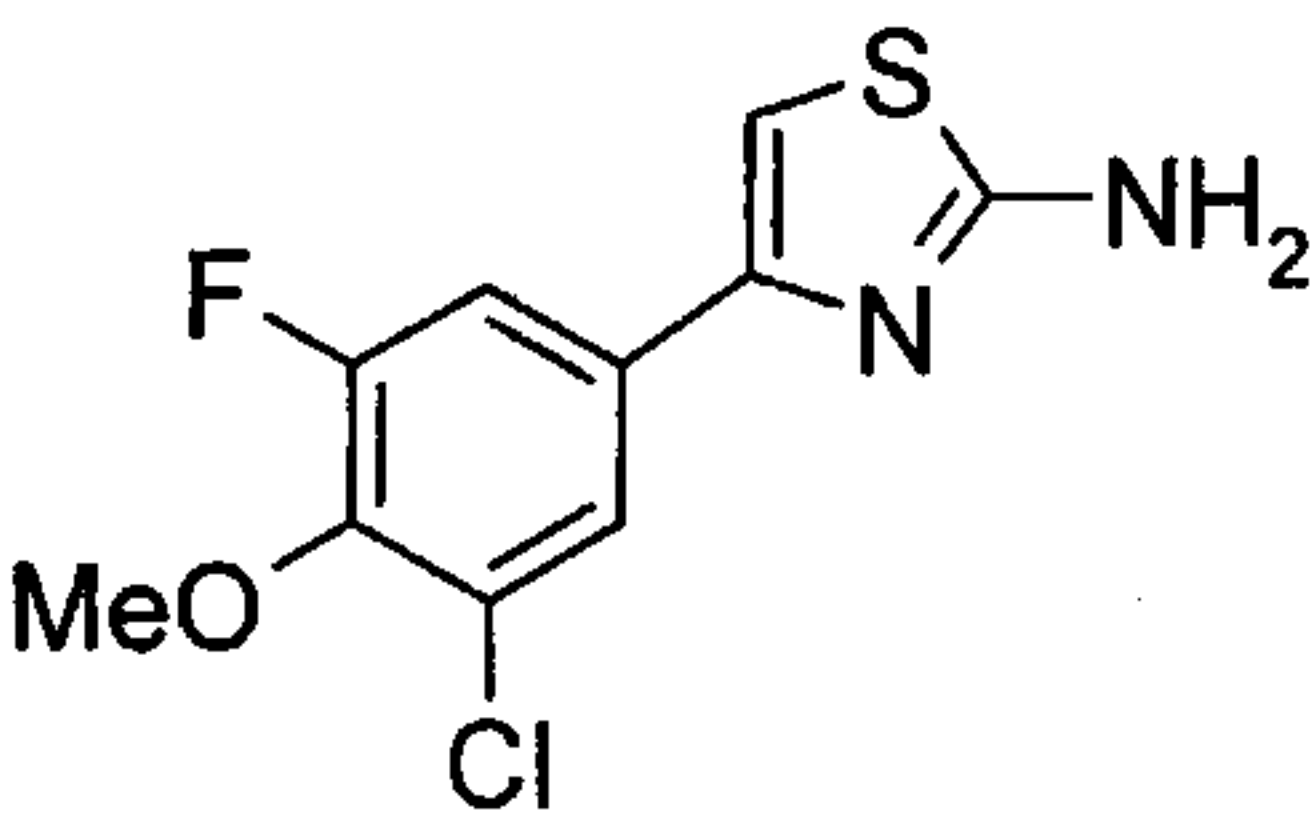
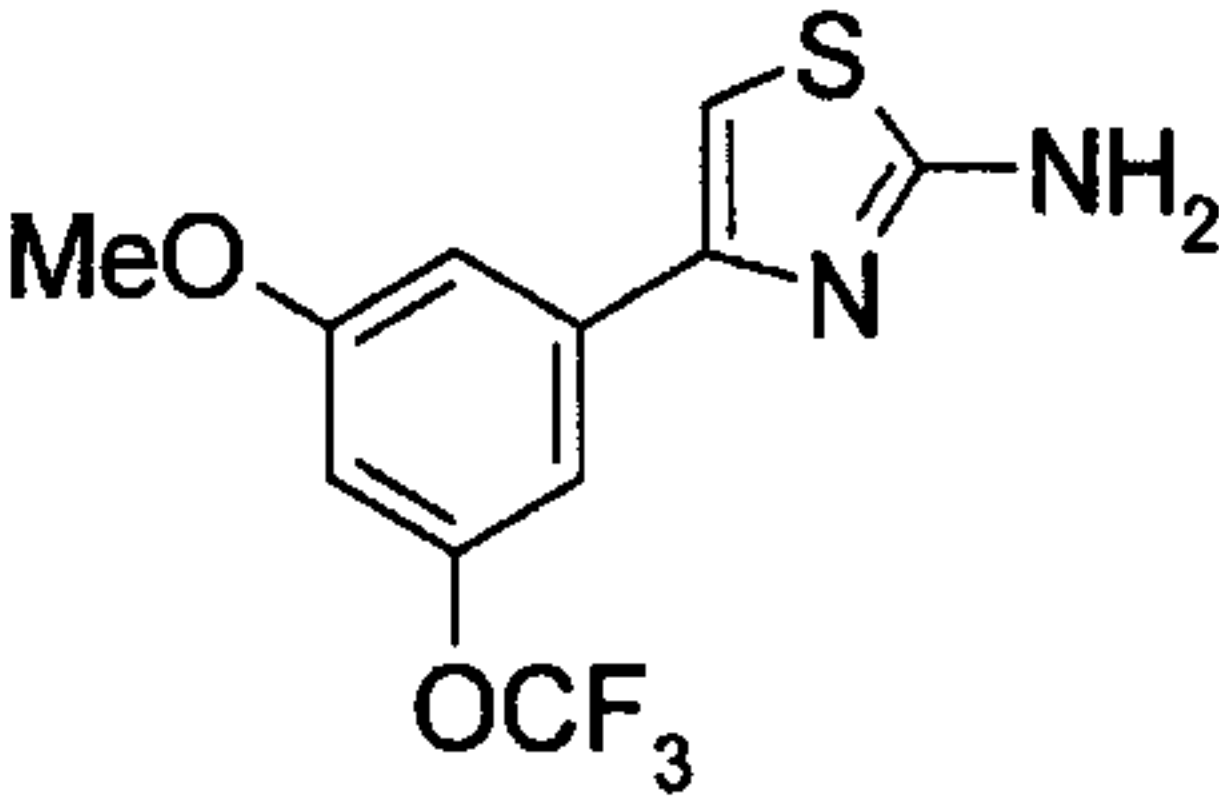
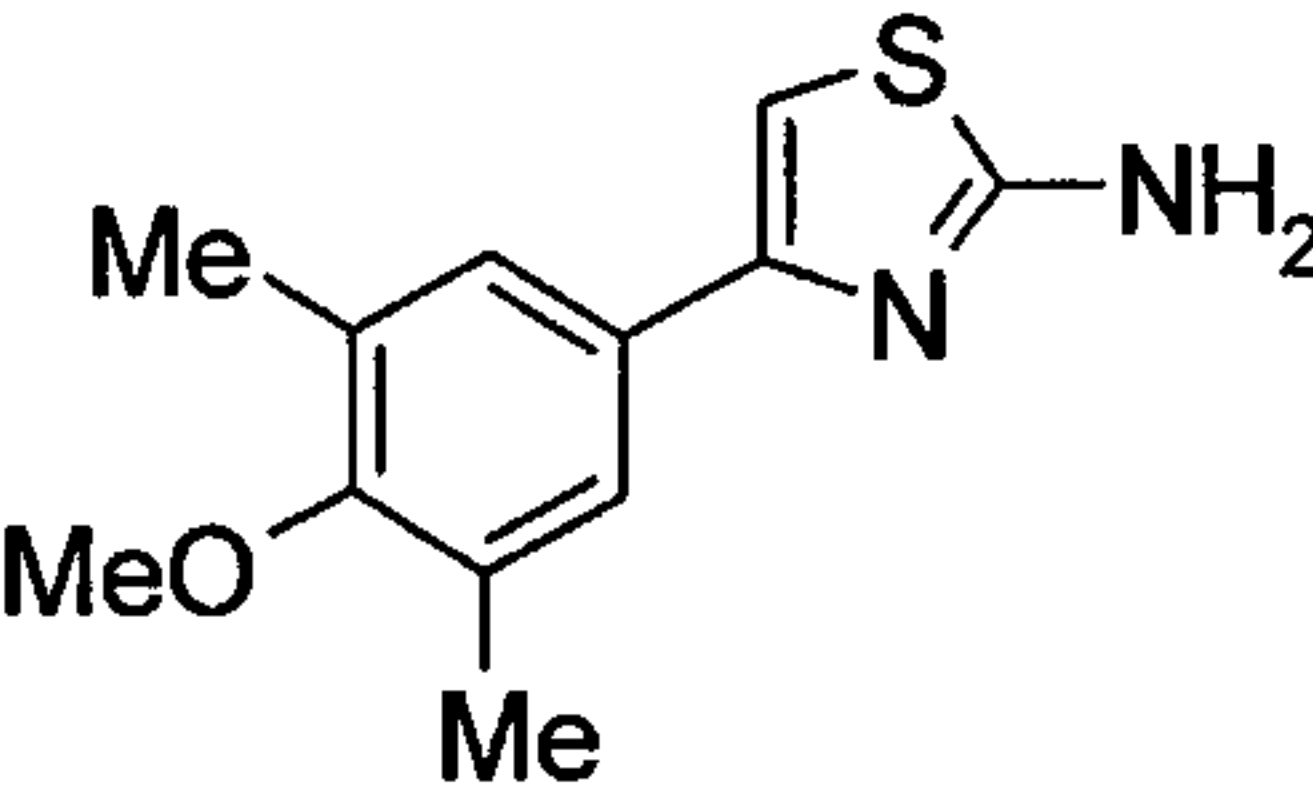
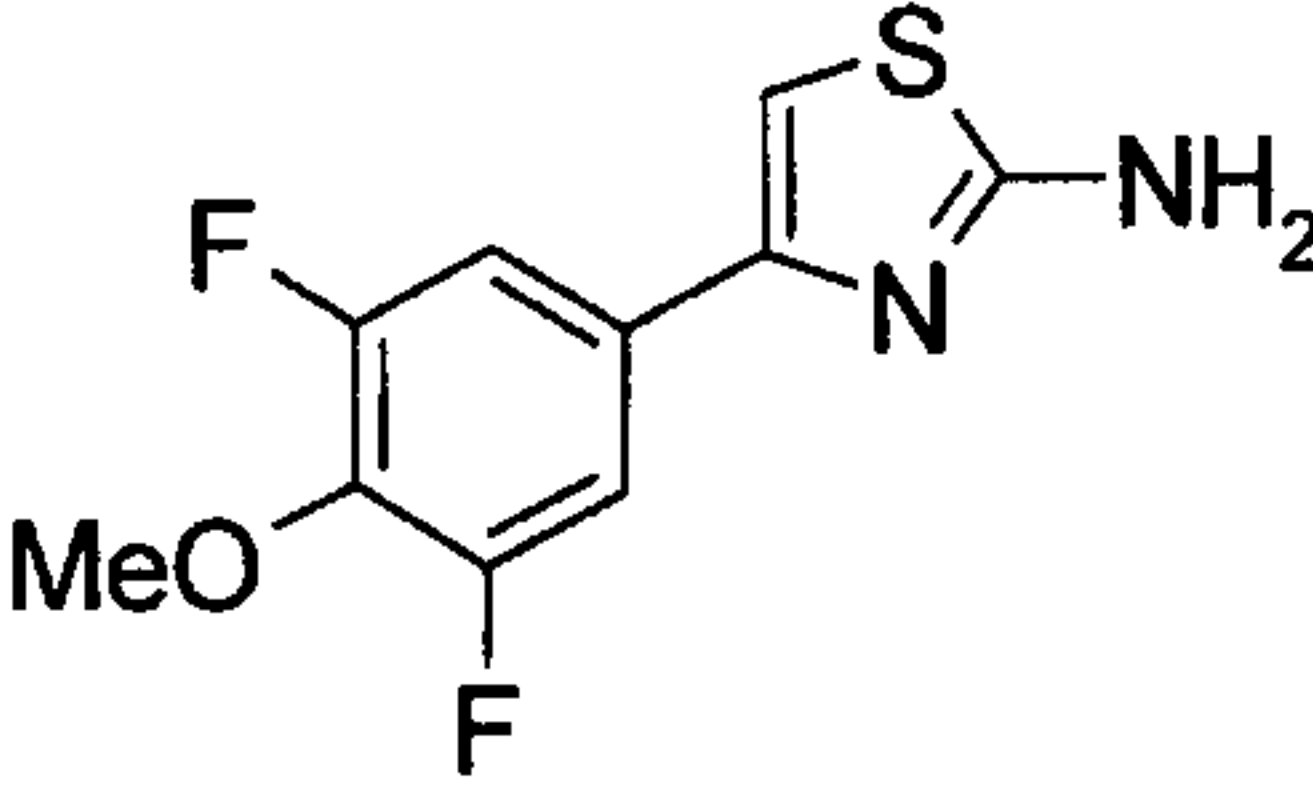
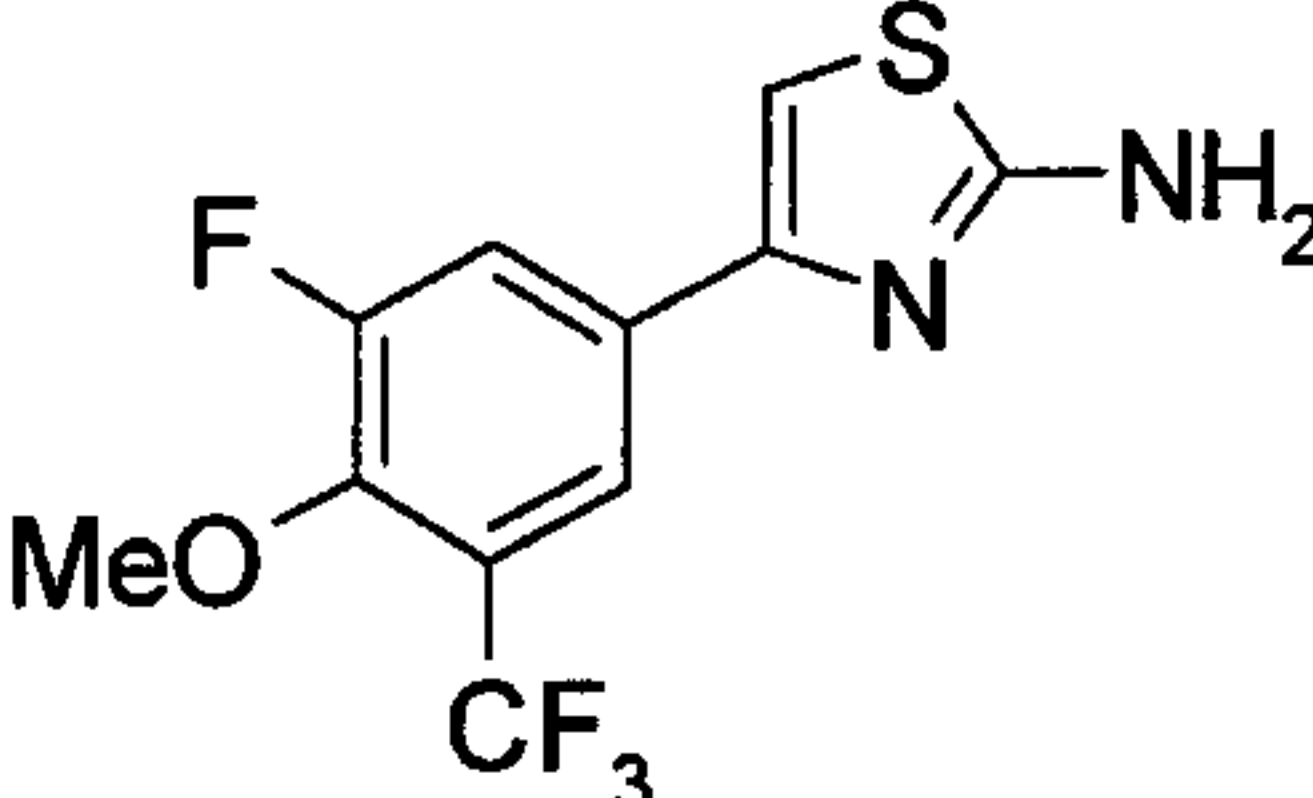
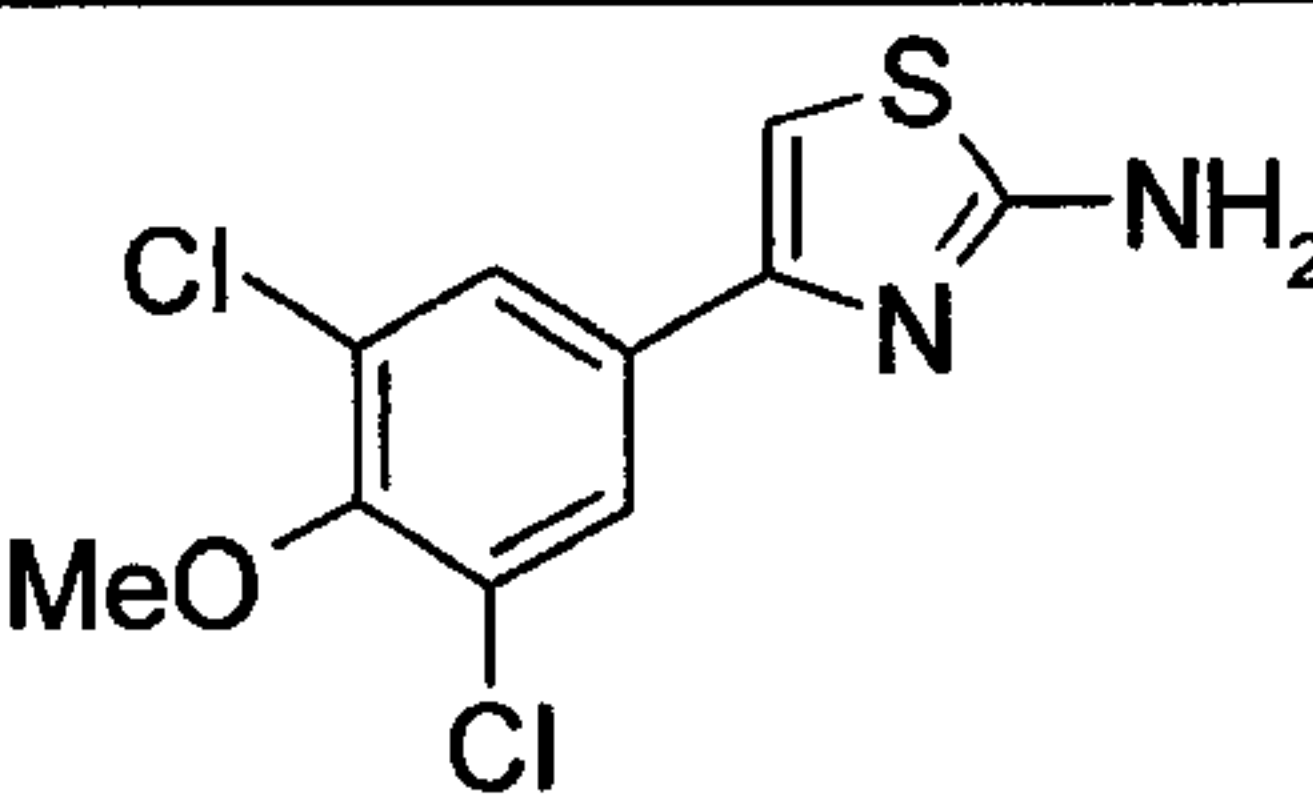
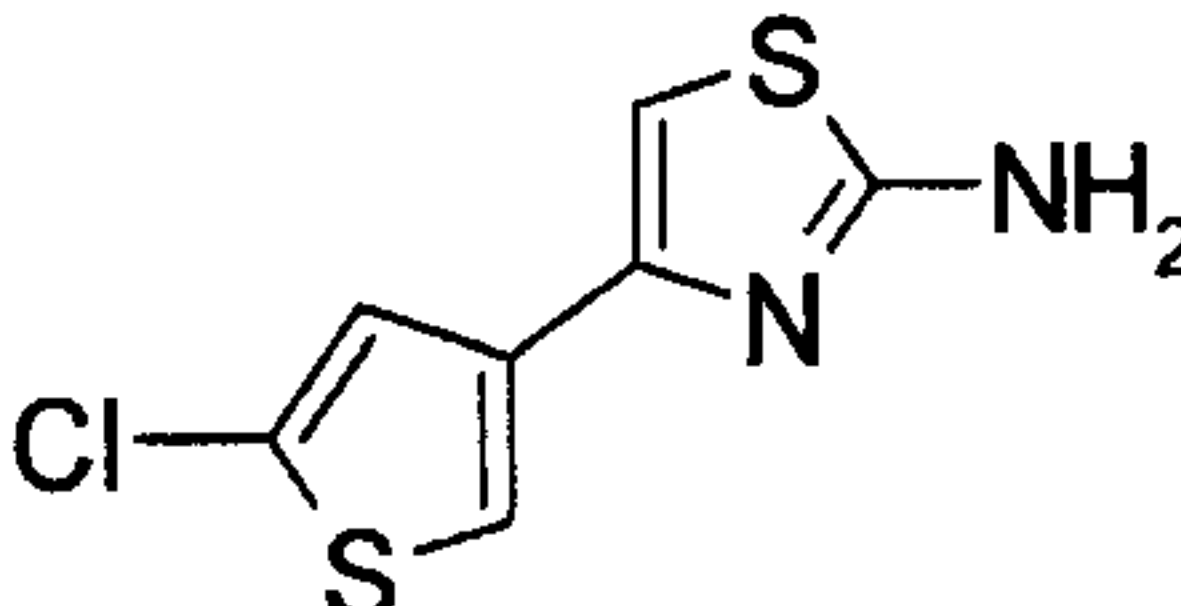
[0173]

[Table 12]

PEx	PSyn	Str	DATA
56	5		ESI+: 205
57	5		ESI+: 241
58	5		ESI+: 313
59	5		ESI+: 259
60	5		ESI+: 275
61	5		ESI+: 279
62	5		ESI+: 275

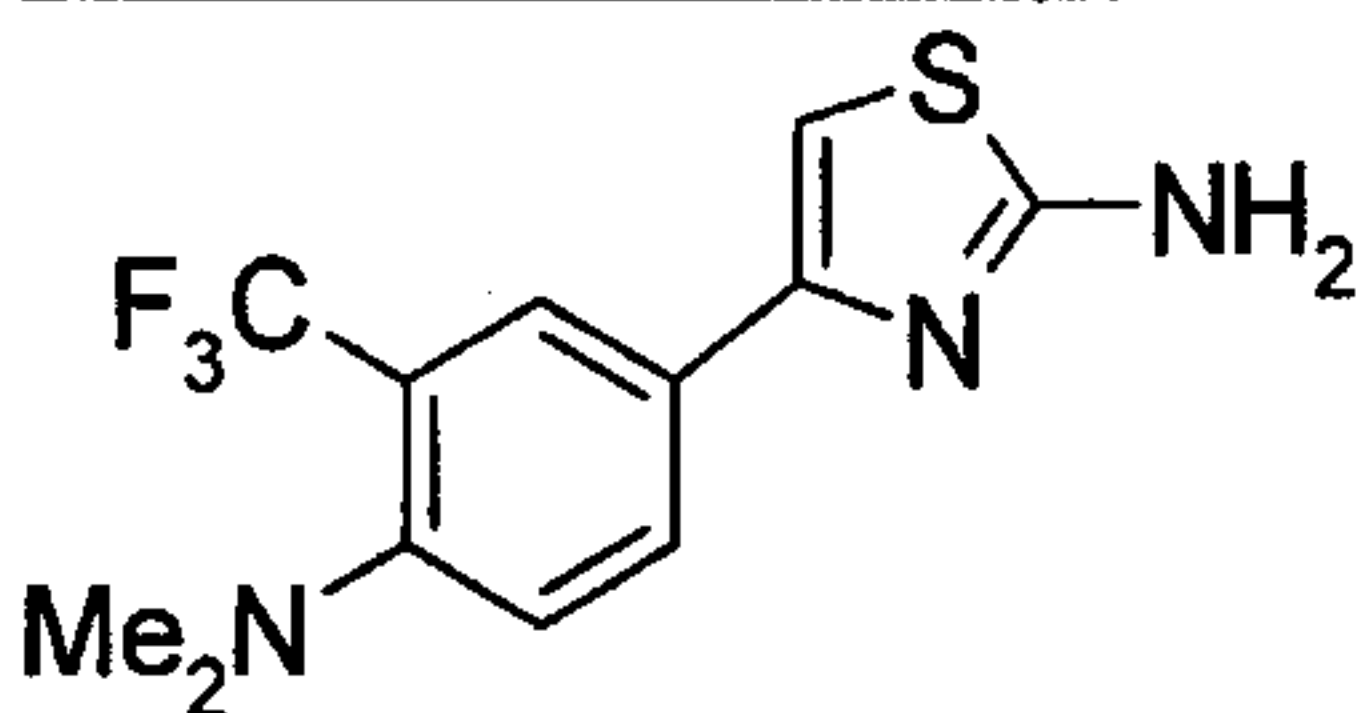
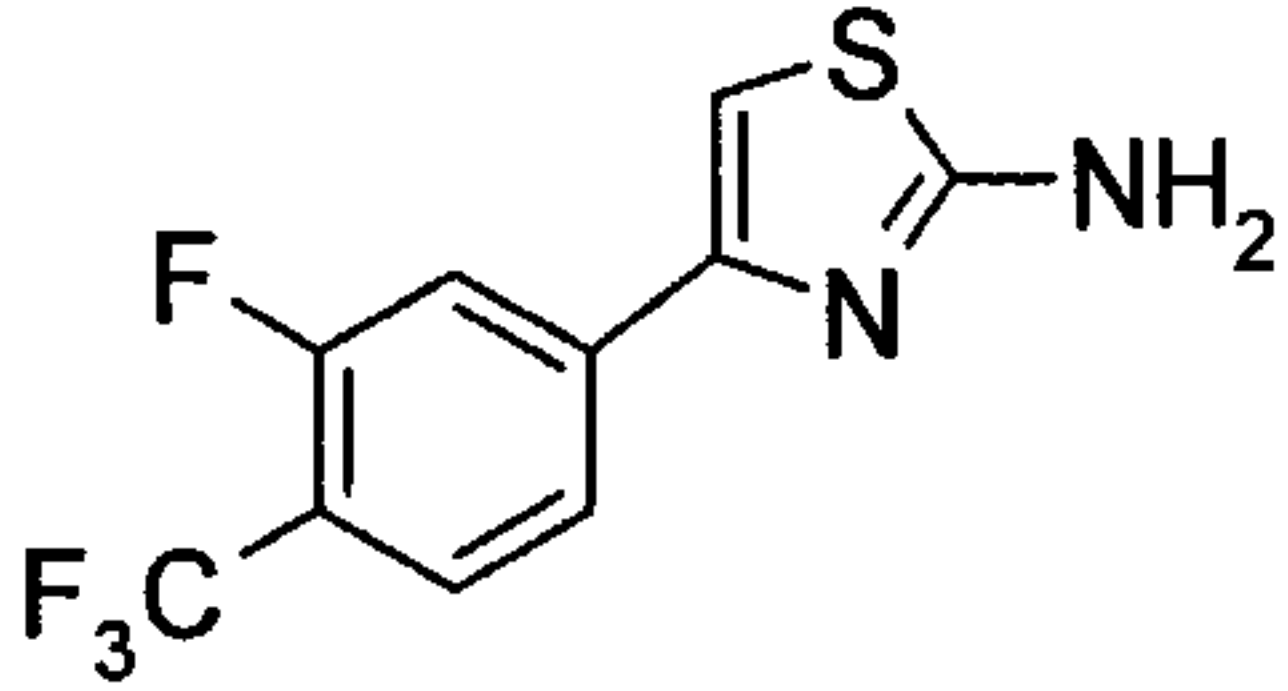
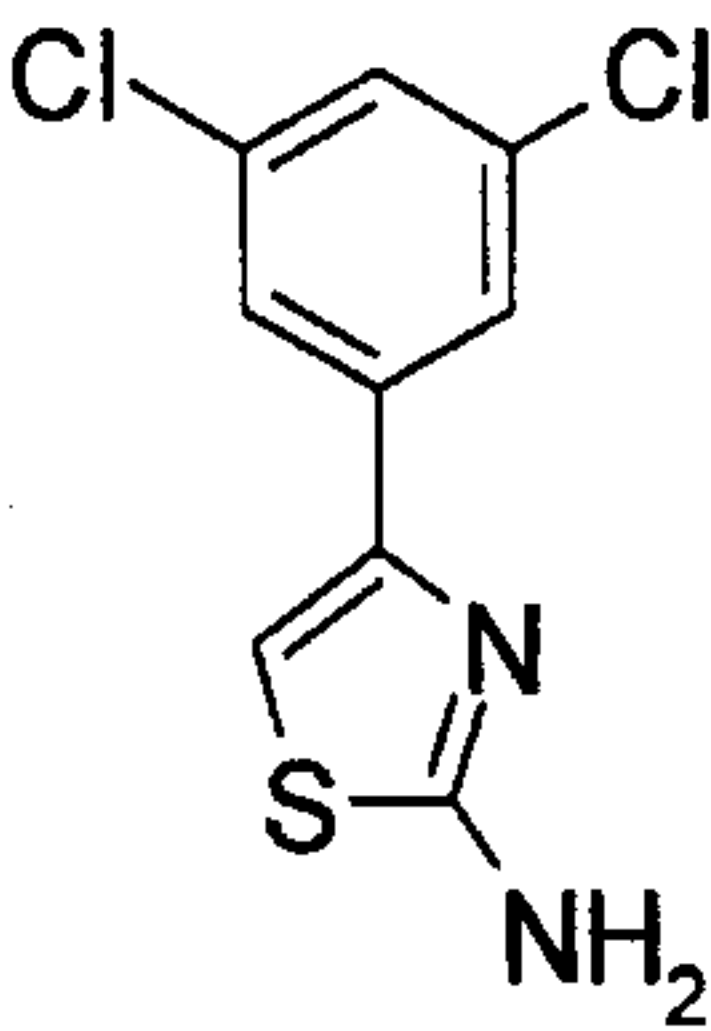
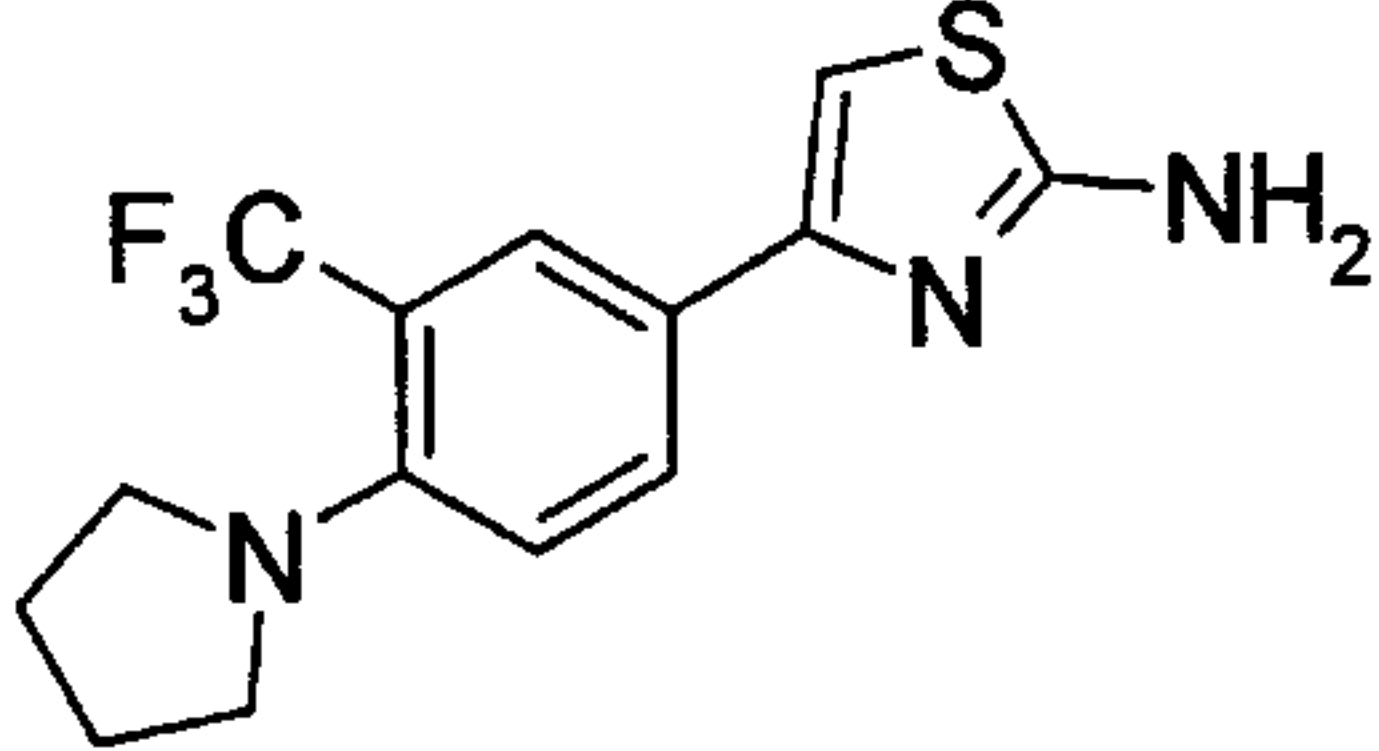
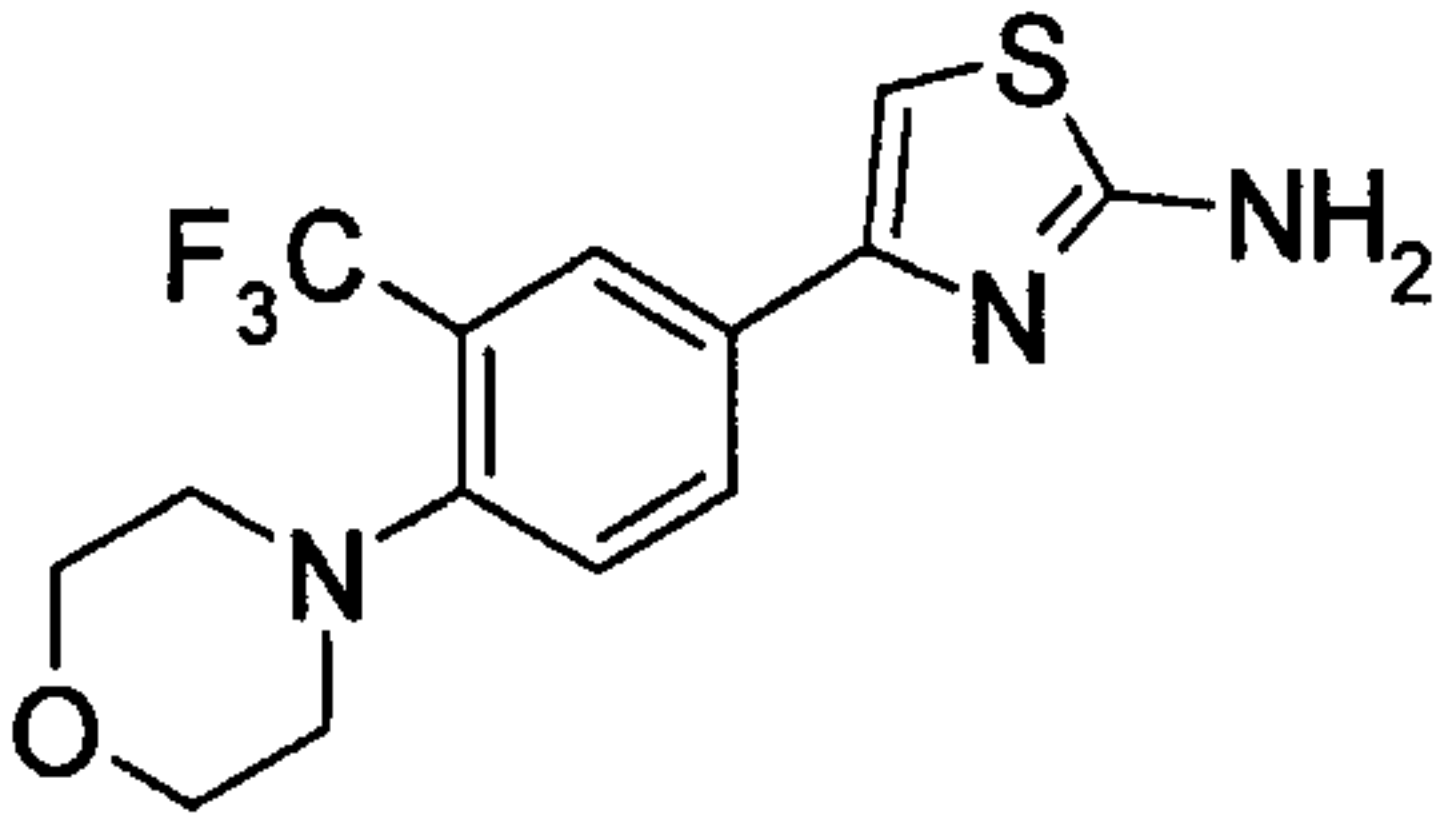
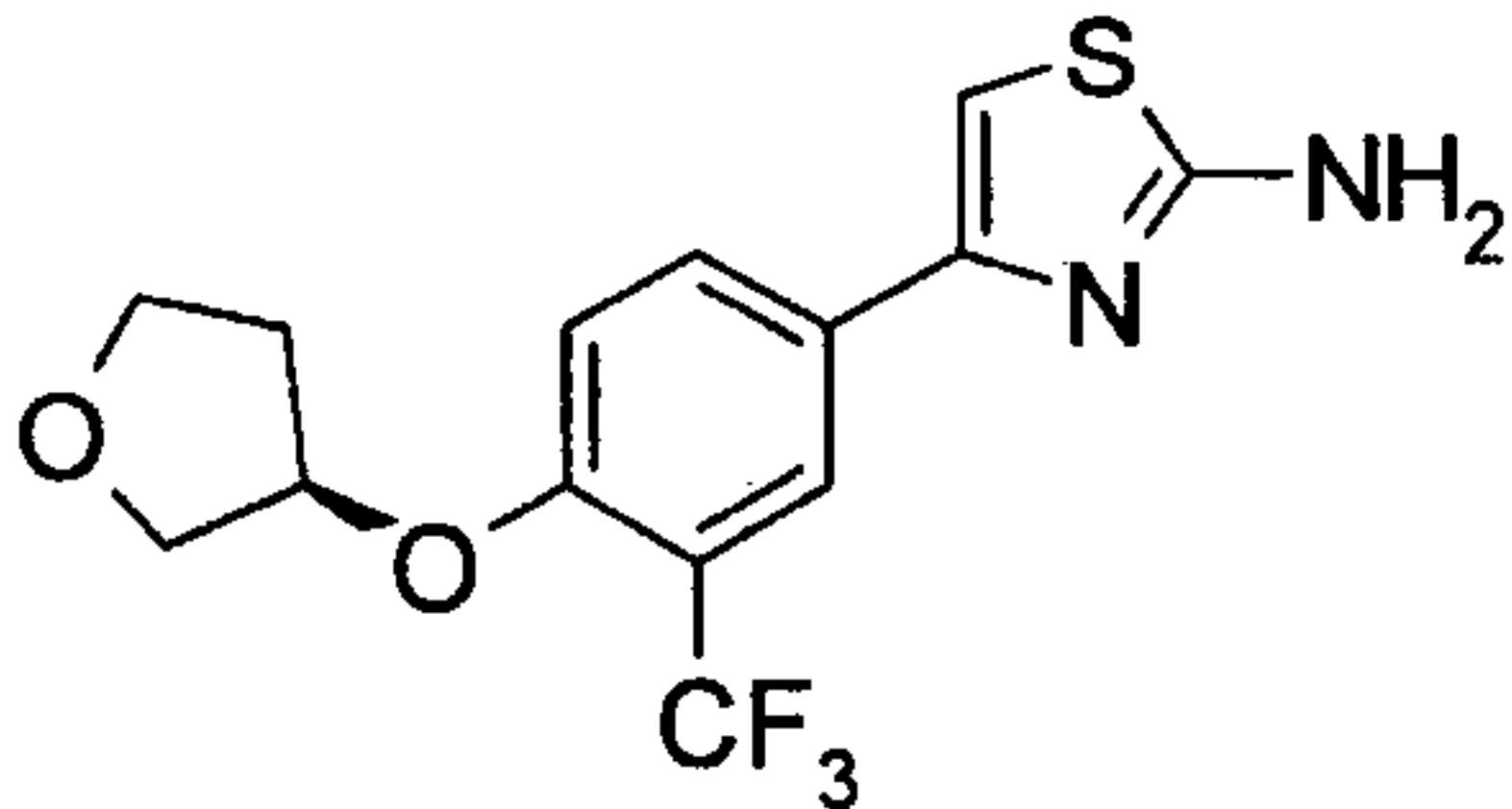
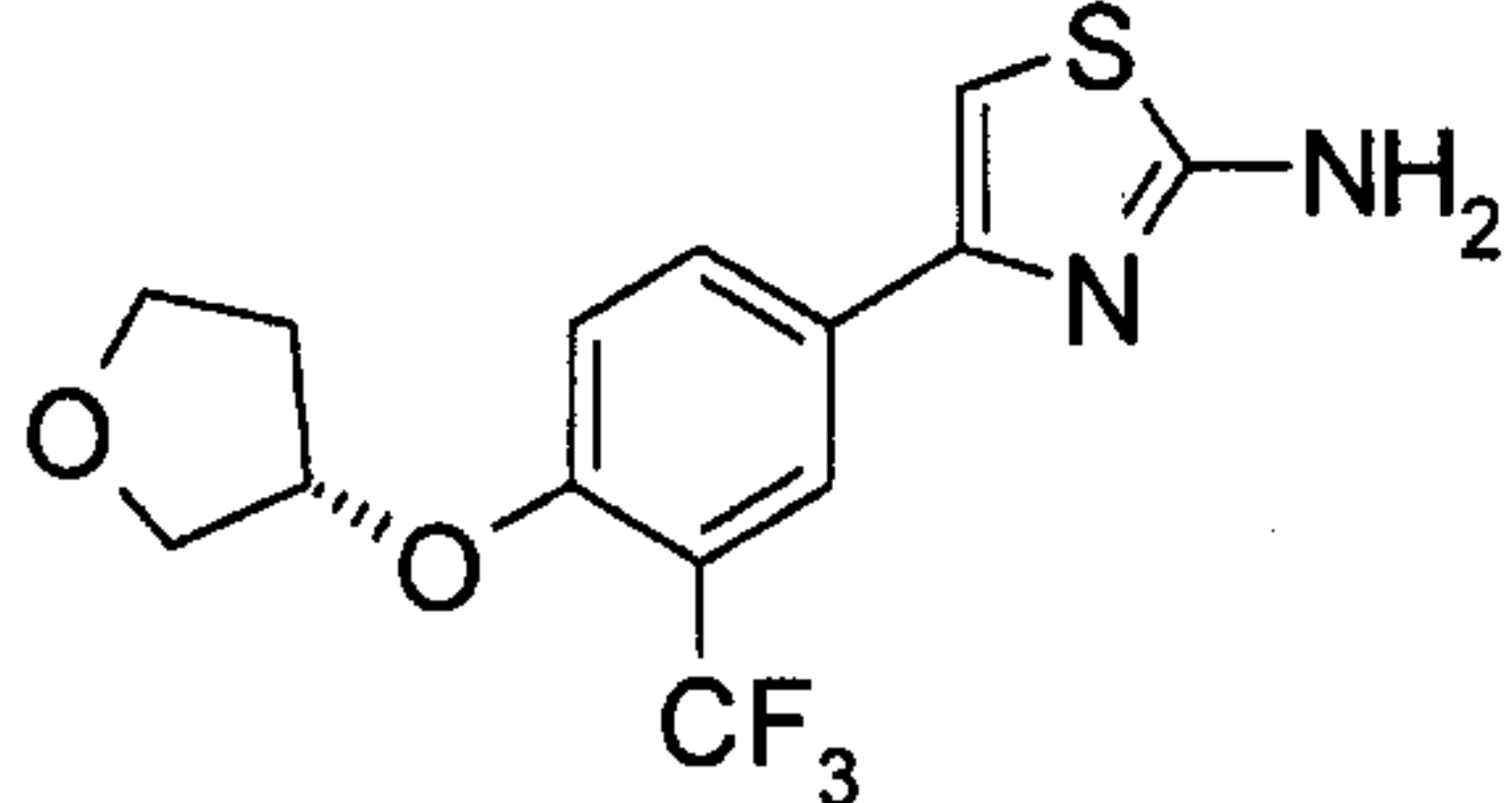
[0174]

[Table 13]

PEX	PSyn	Str	DATA
63	5		ESI+: 259
64	5		ESI+: 291
65	5		ESI+: 235
66	5		ESI+: 243
67	5		ESI+: 293
68	5		ESI+: 275
69	5		ESI+: 217

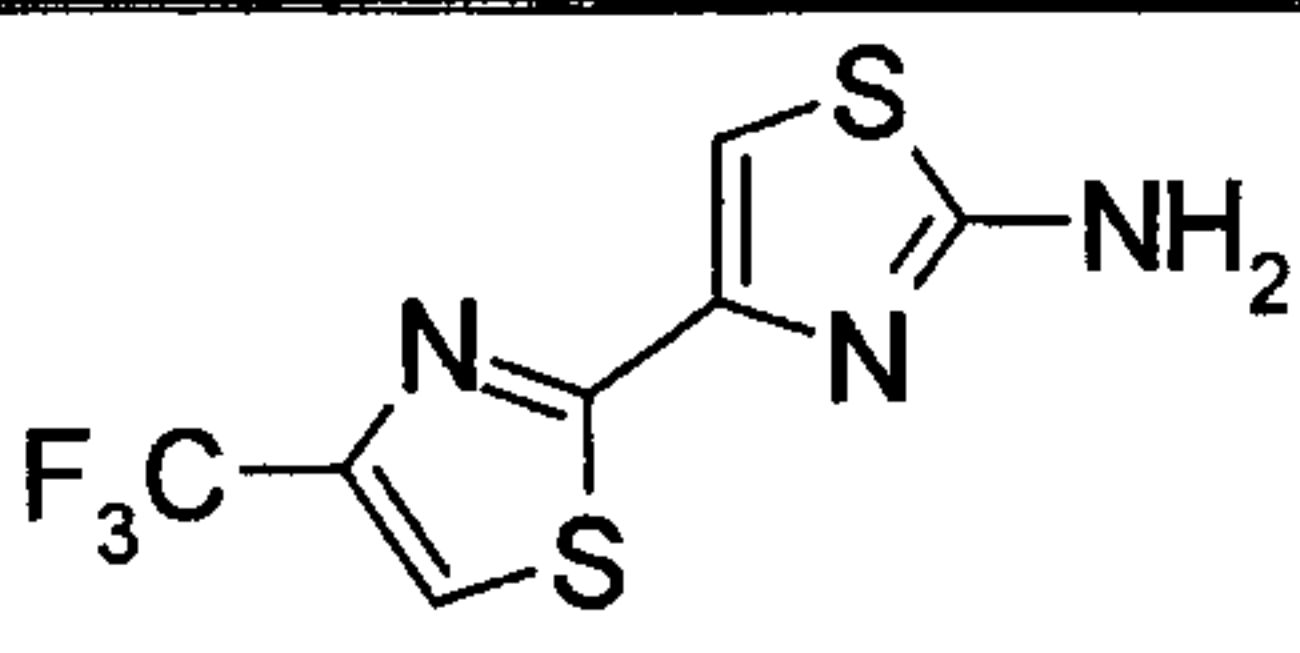
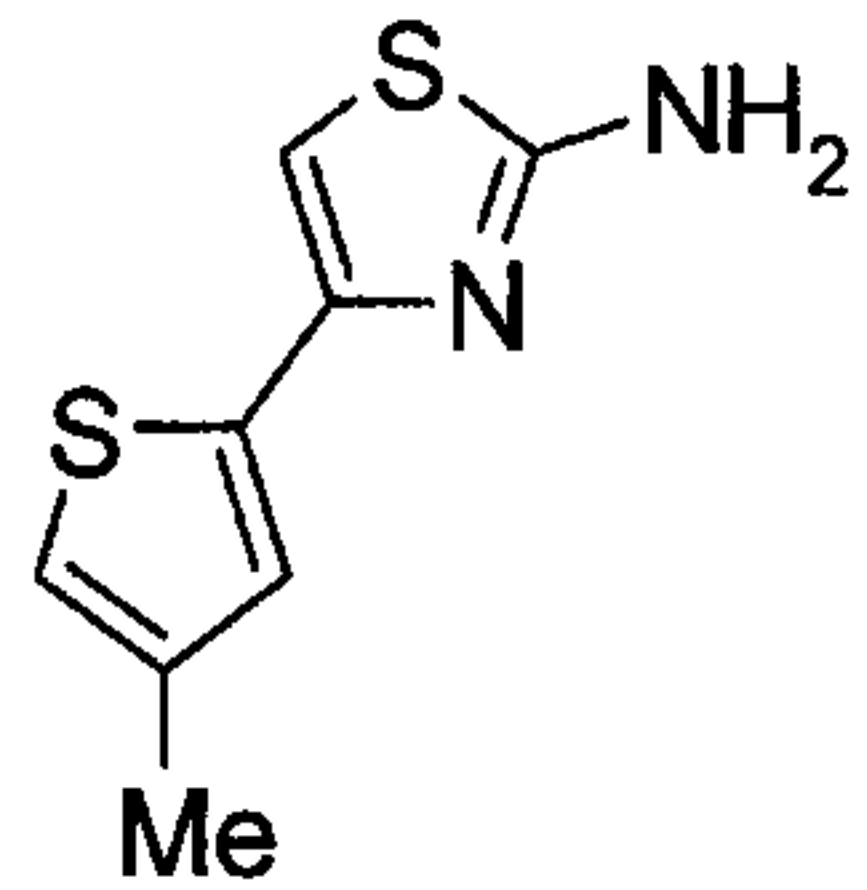
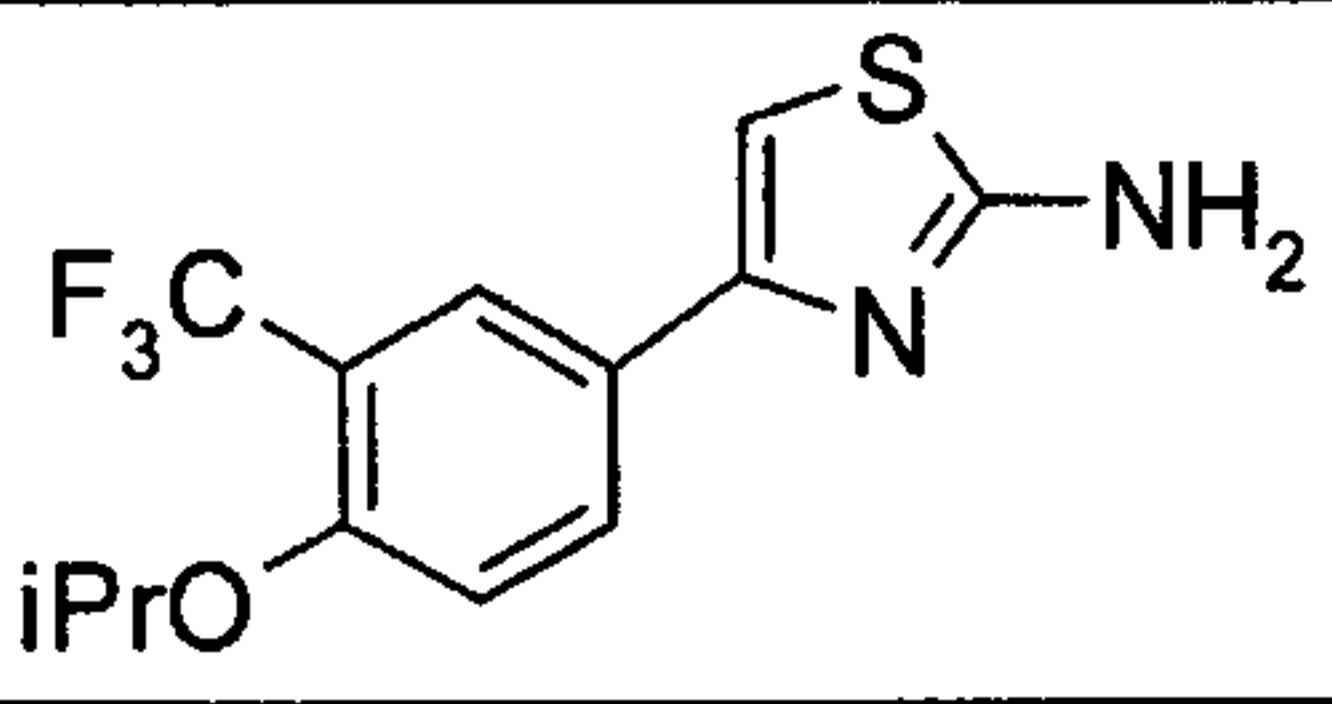
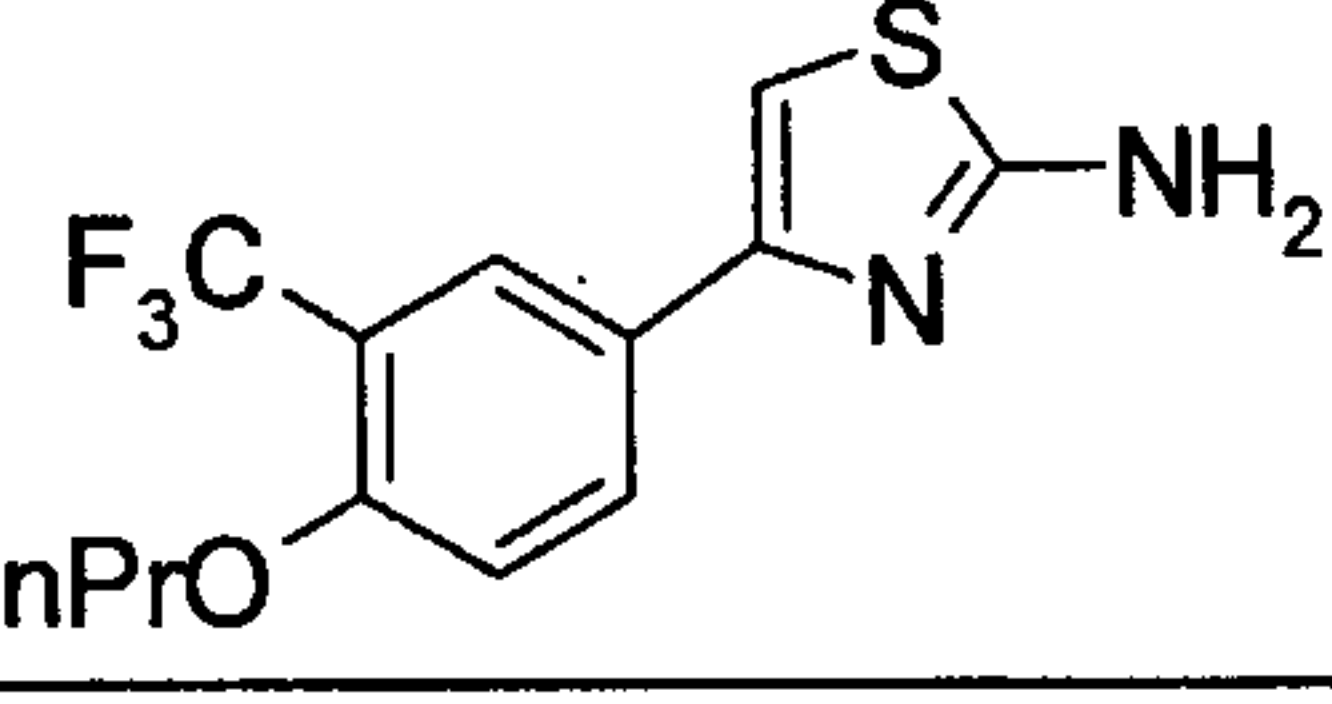
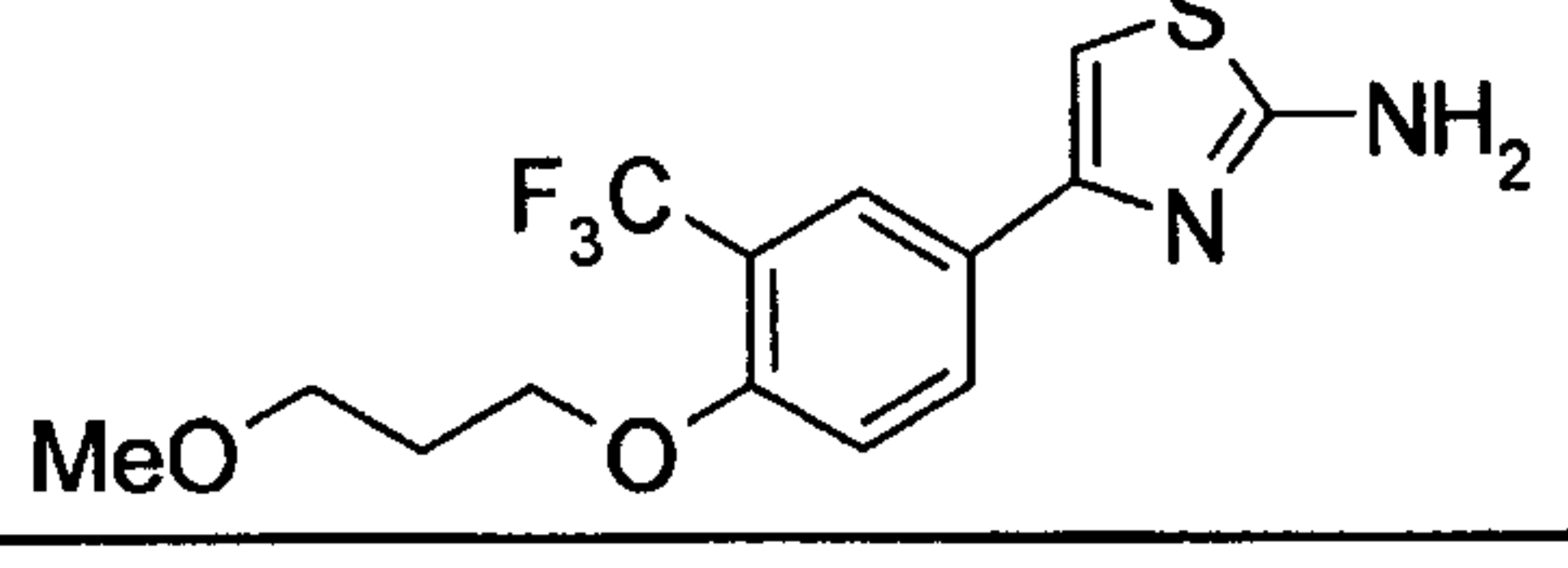
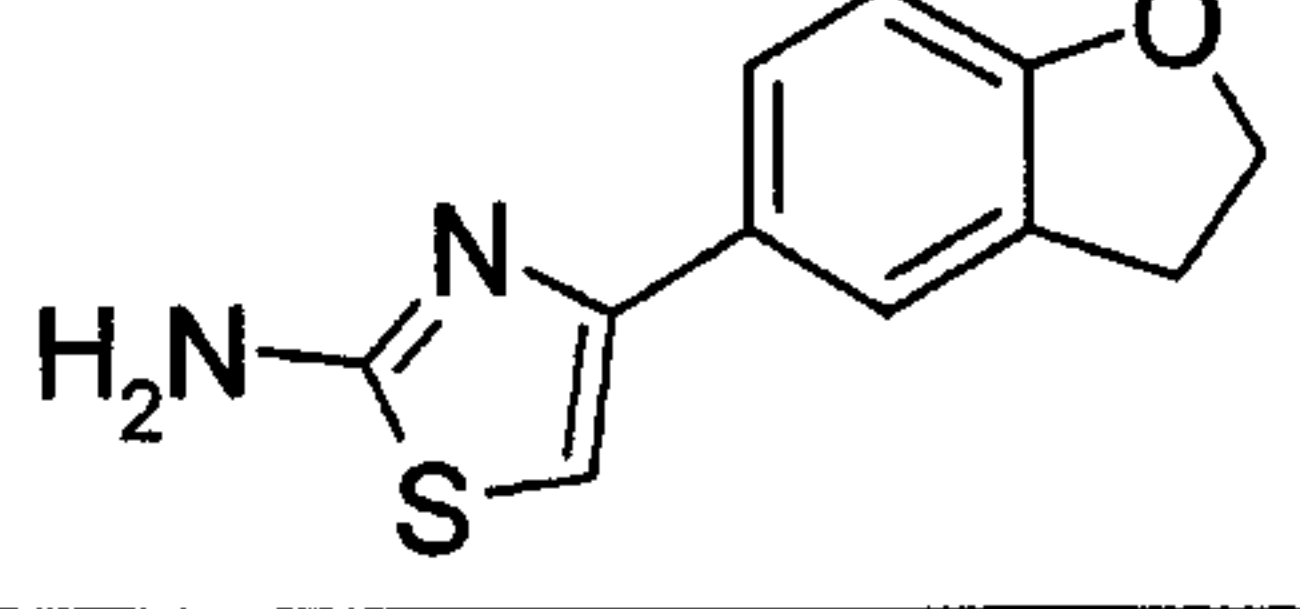
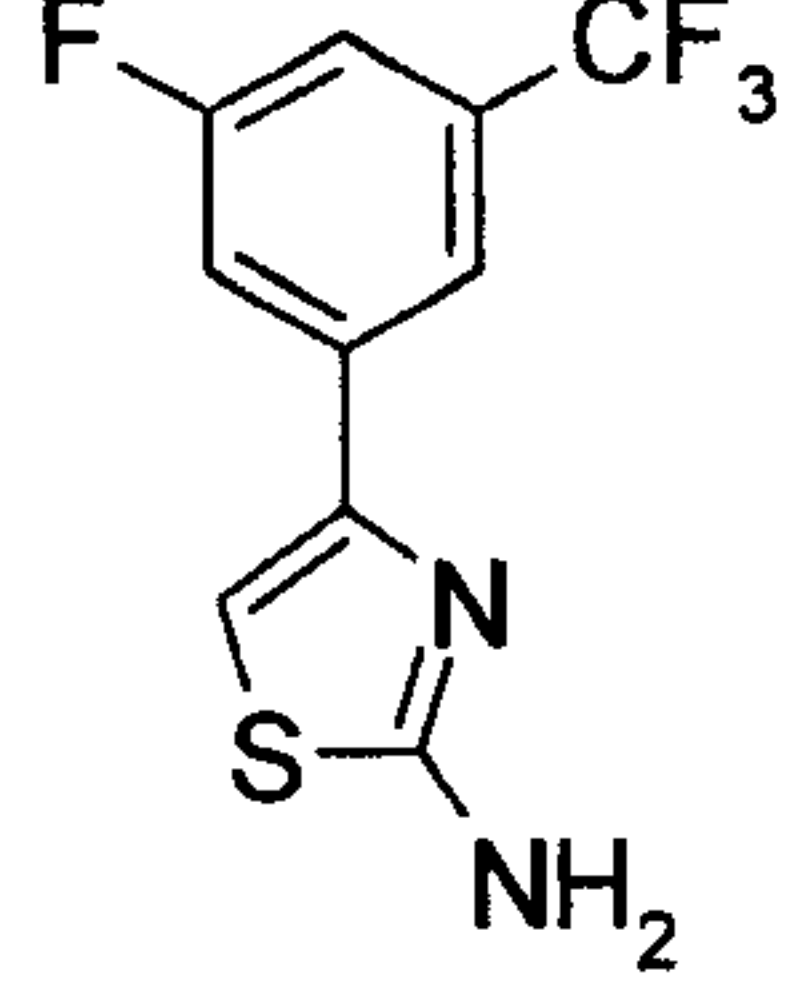
[0175]

[Table 14]

PEx	PSyn	Str	DATA
70	5		ESI+: 288
71	5		ESI+: 263
72	5		ESI+: 245 , 247
73	5		ESI+: 314
74	5		ESI+: 330
75	5		ESI+: 331
76	5		ESI+: 331

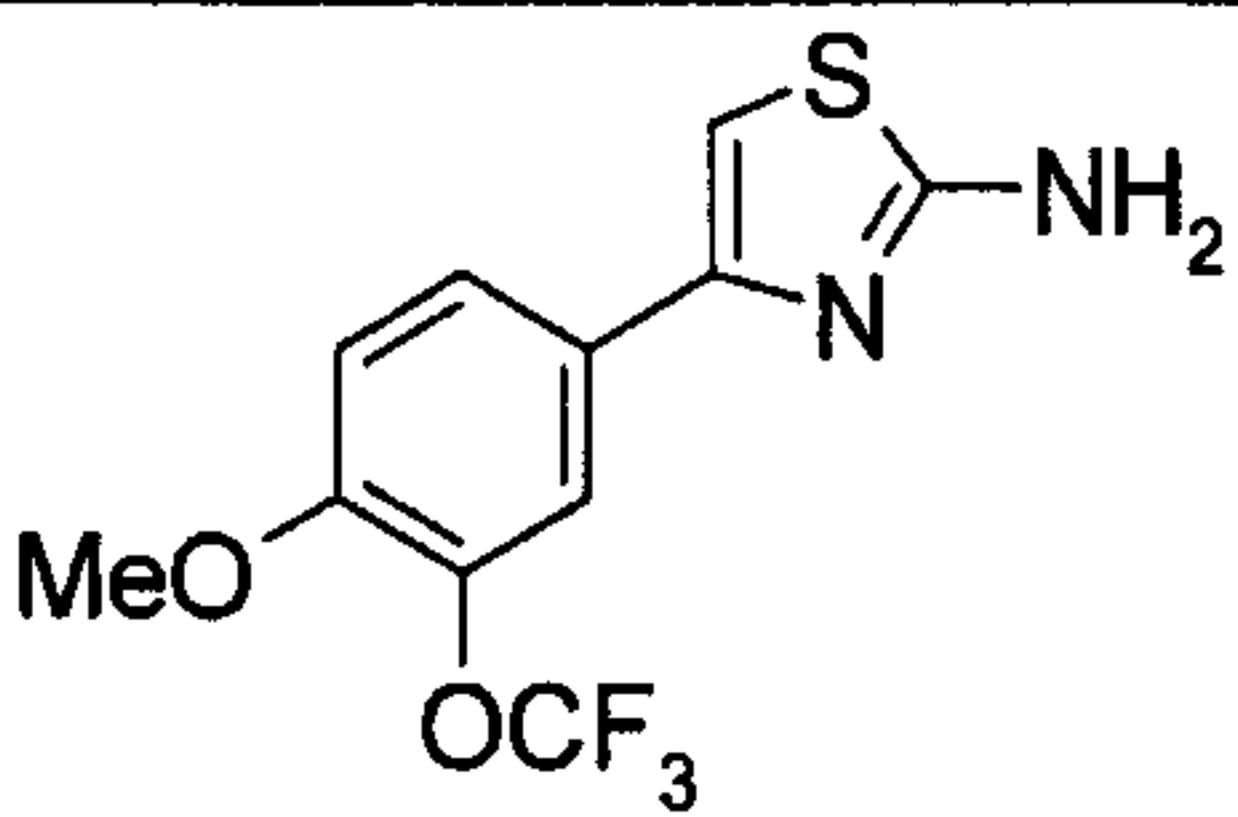
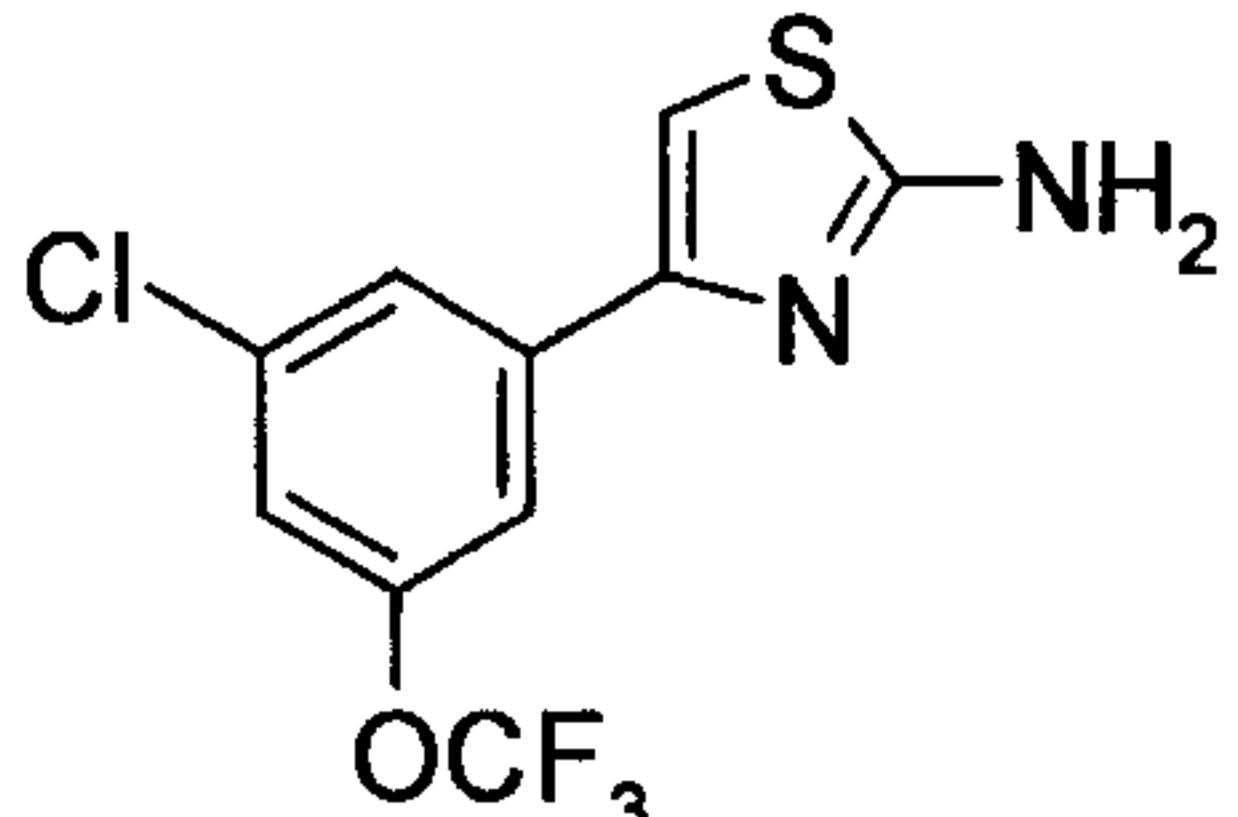
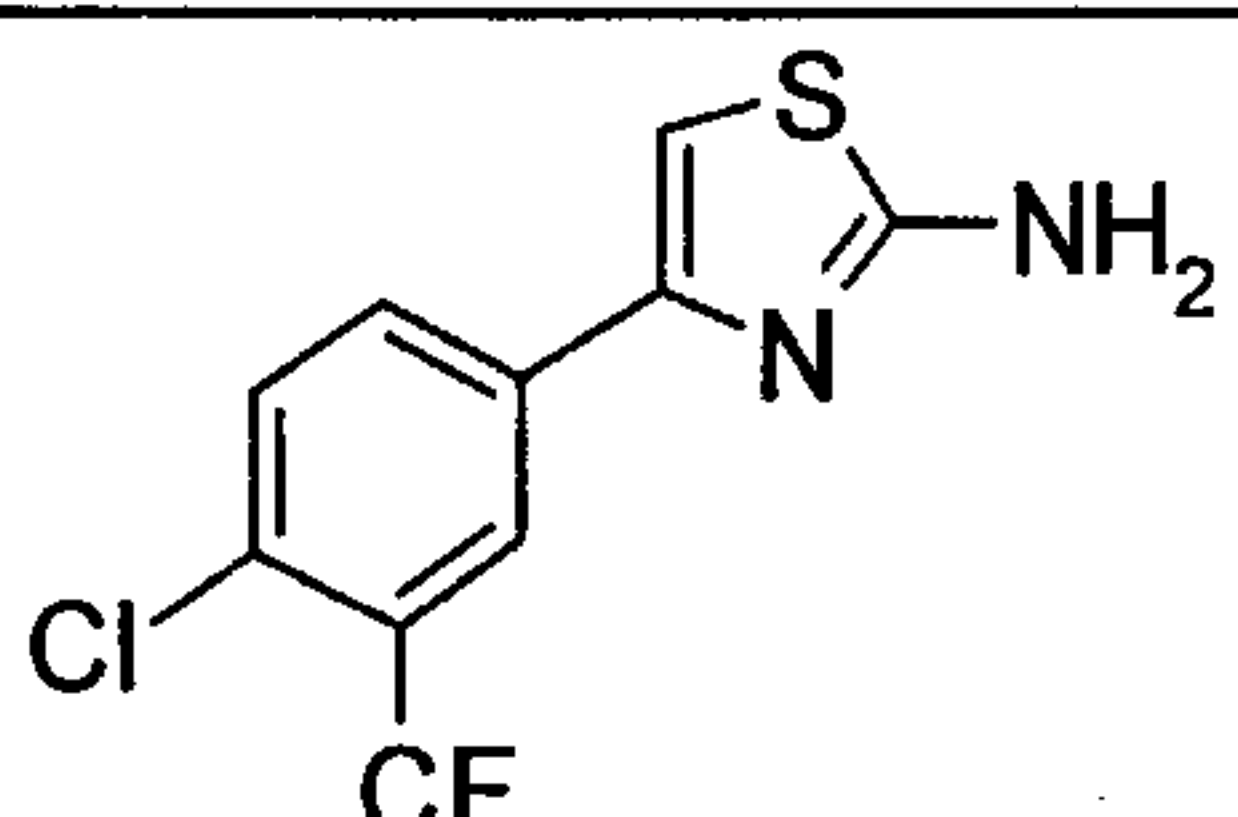
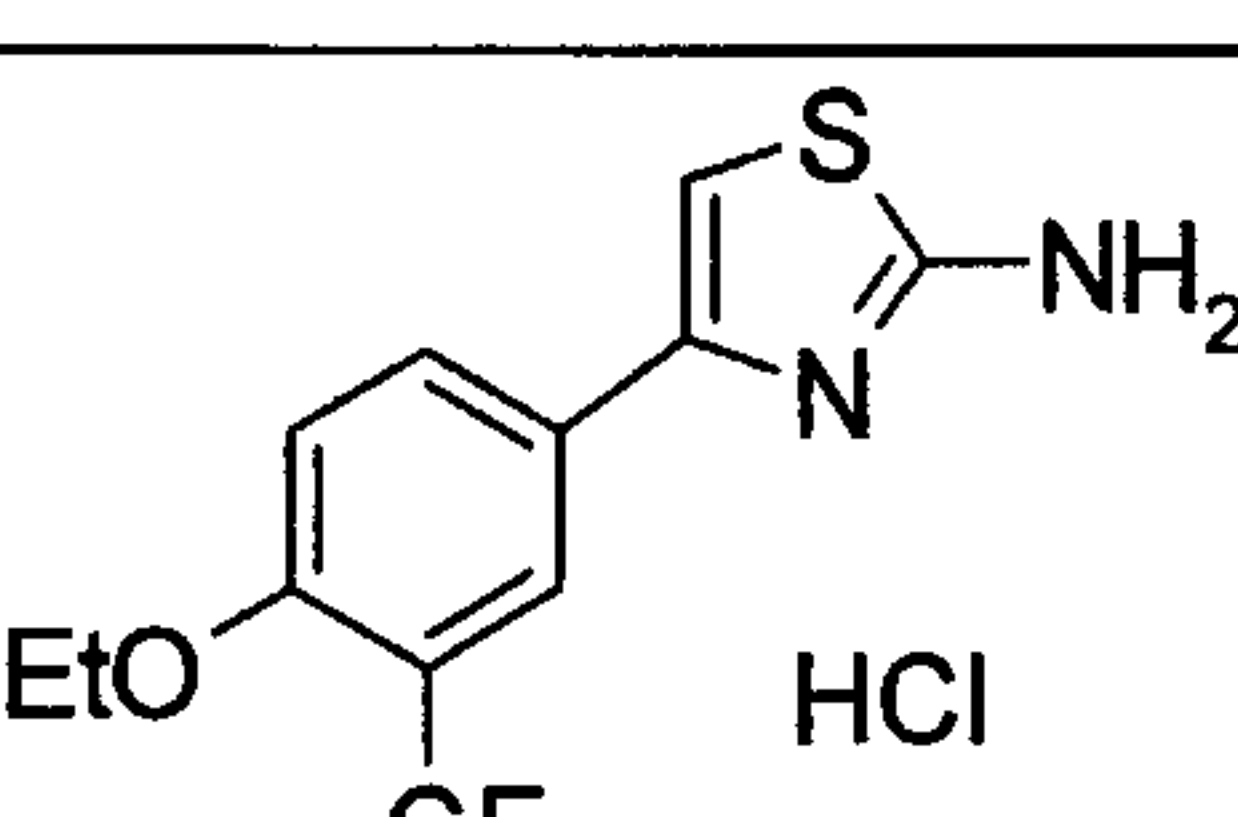
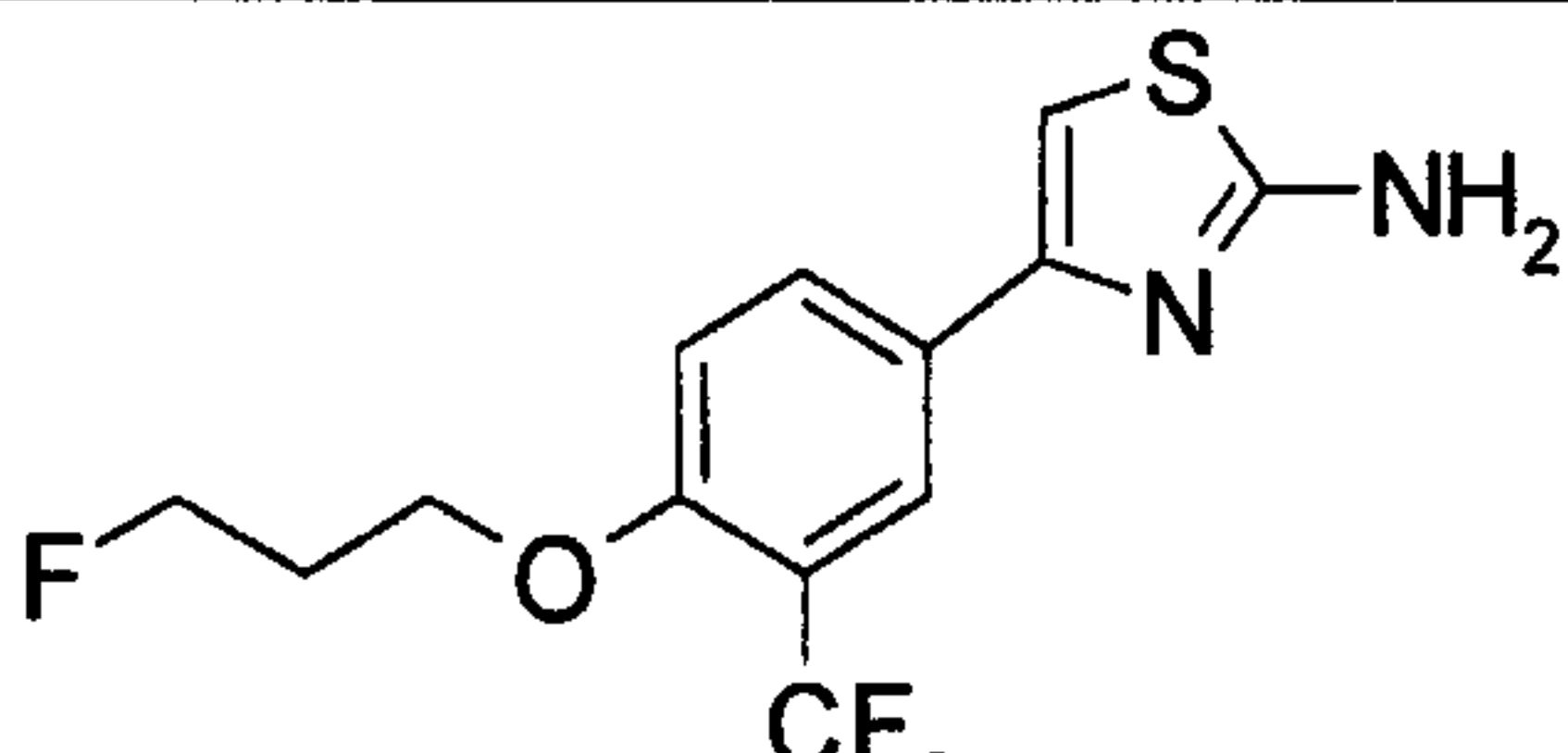
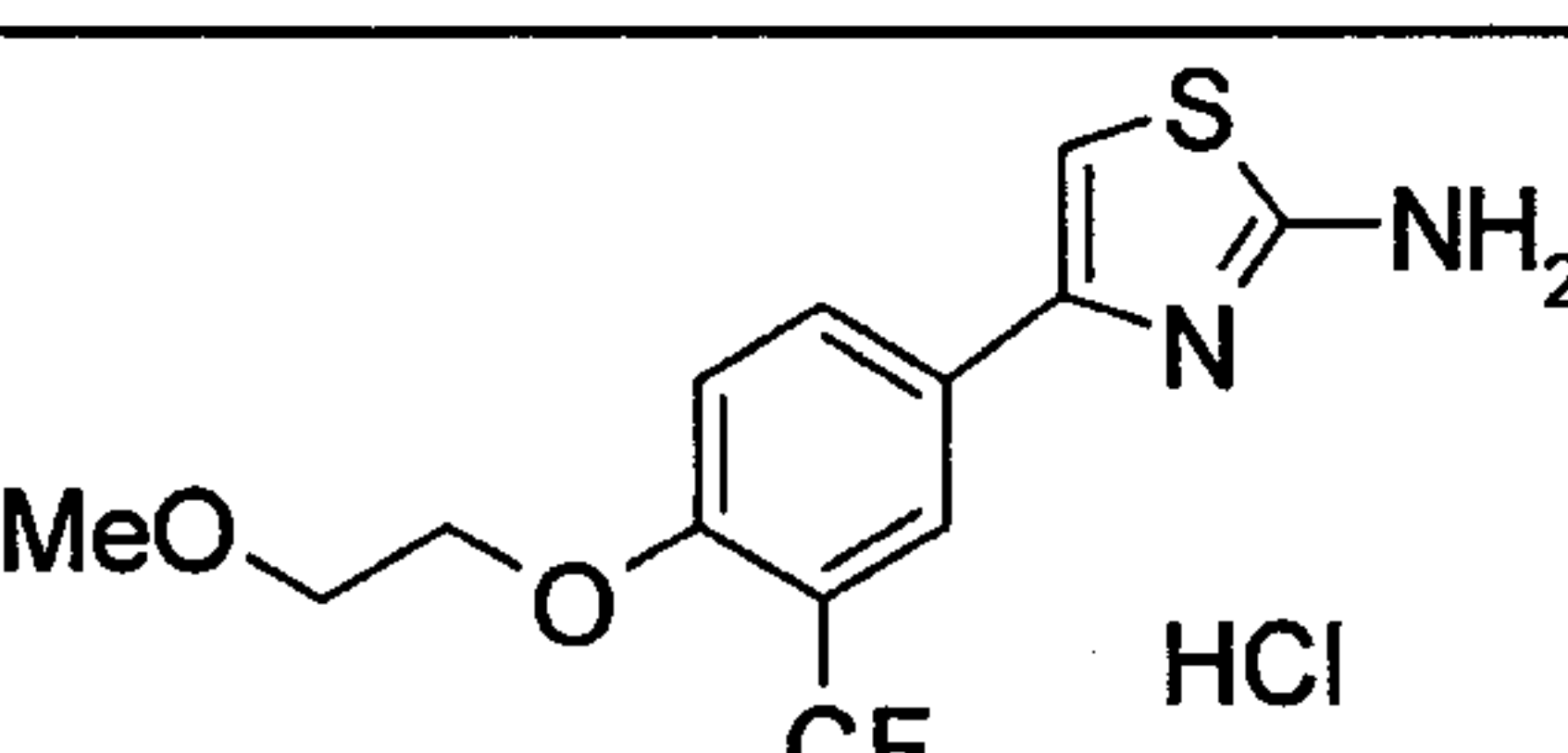
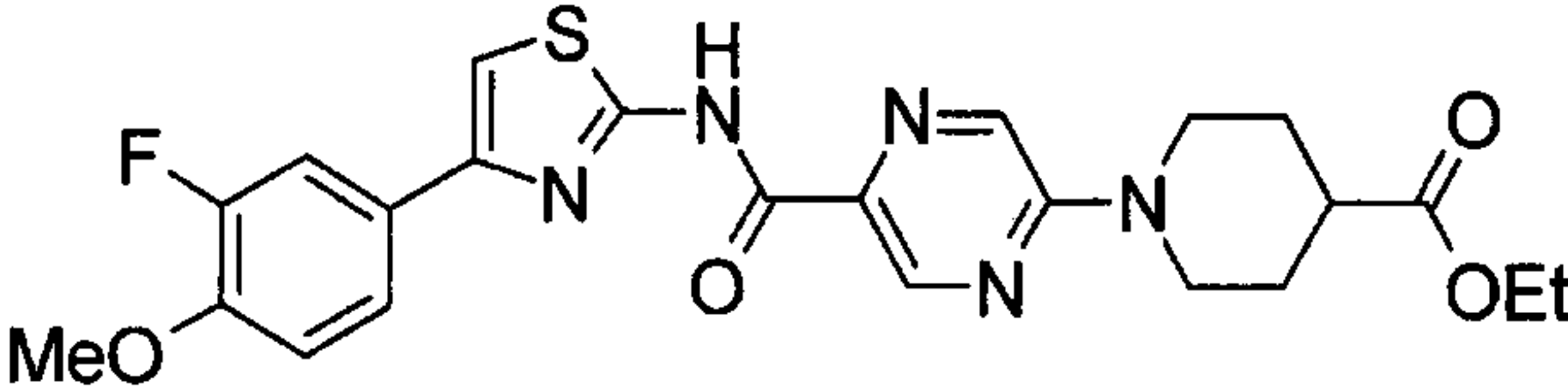
[0176]

[Table 15]

PEX	PSyn	Str	DATA
77	5		ESI+: 252
78	5		ESI+: 197
79	5		ESI+: 303
80	5		ESI+: 303
81	5		ESI+: 333
82	5		ESI+: 219
83	5		ESI+: 263

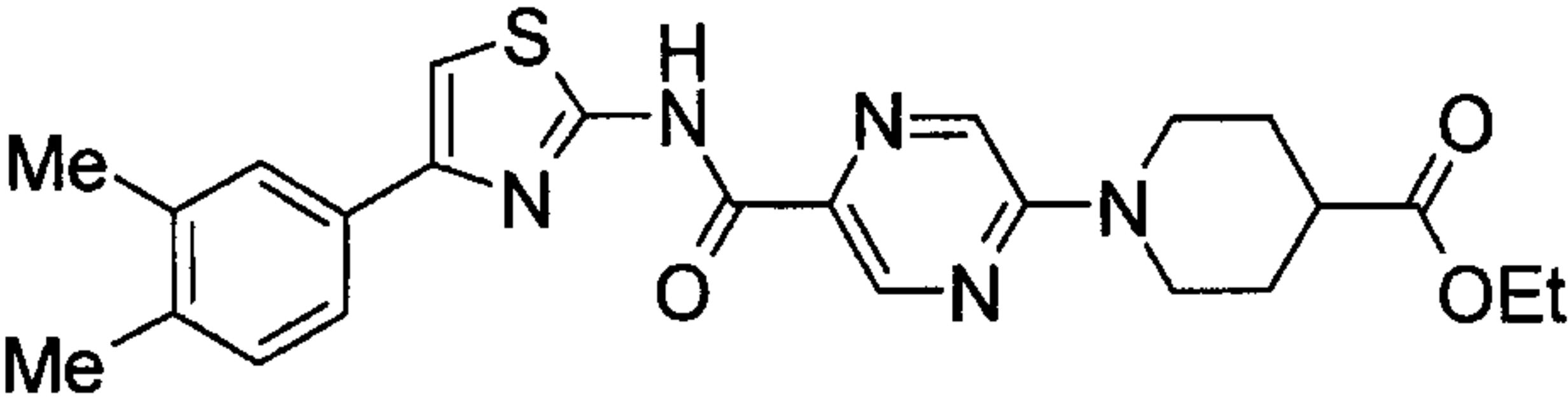
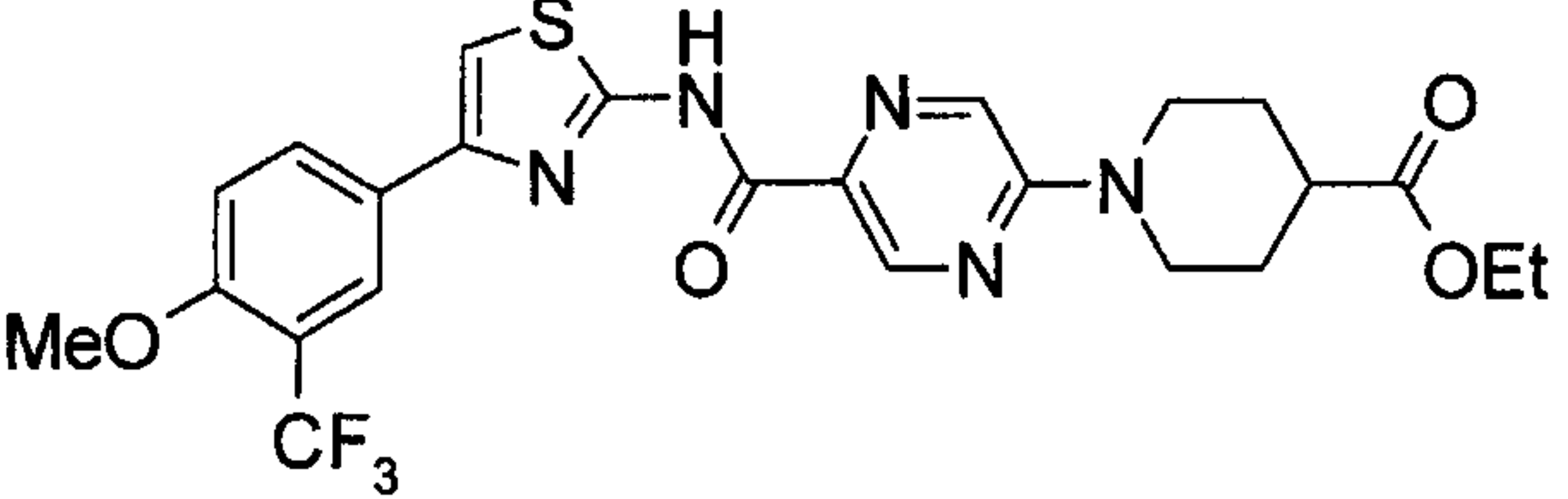
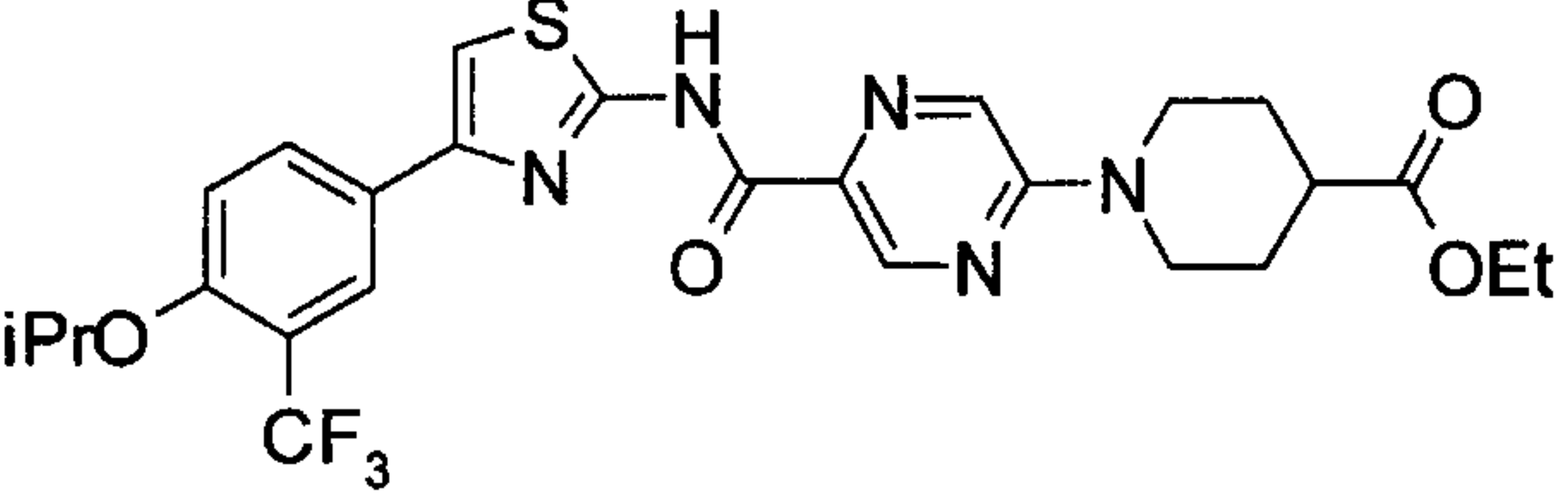
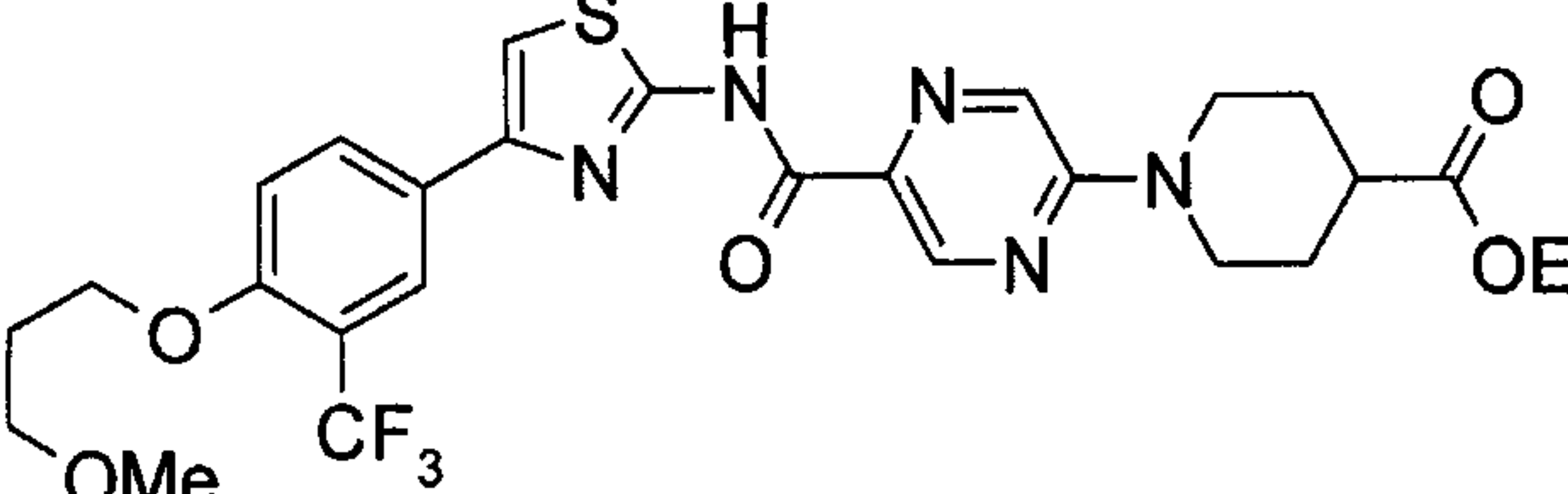
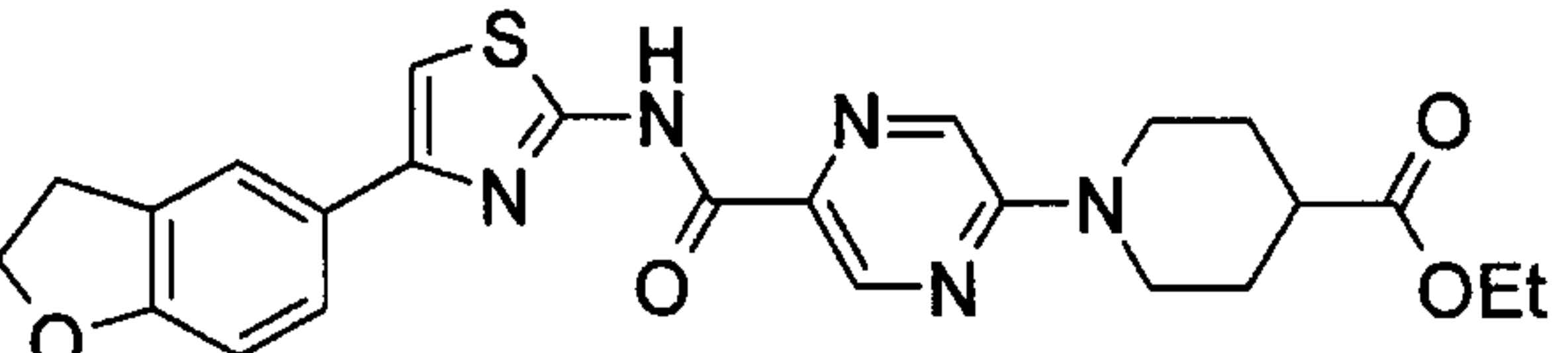
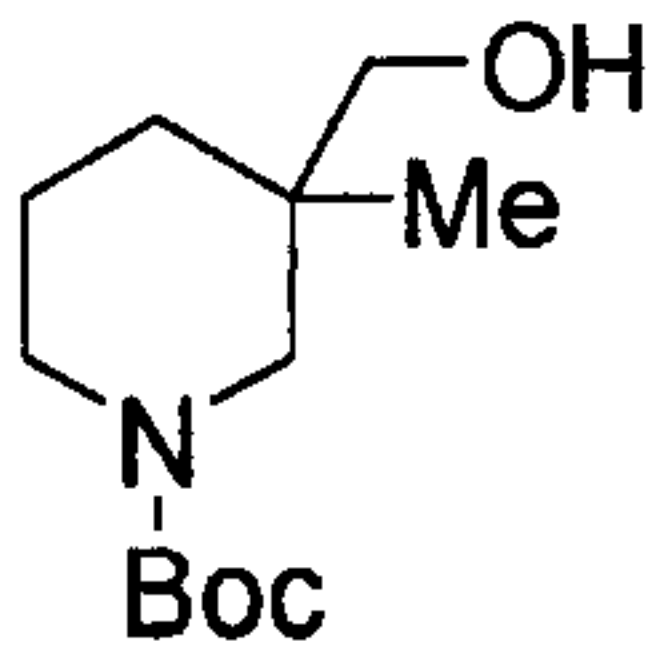
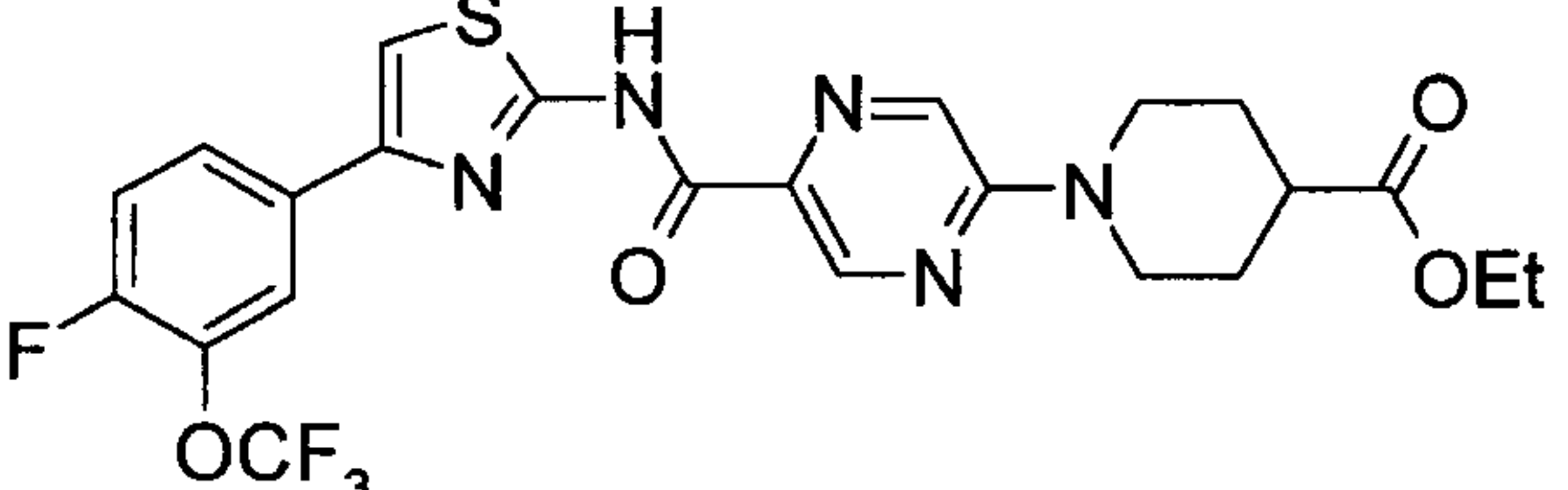
[0177]

[Table 16]

PEx	PSyn	Str	DATA
84	5	 <chem>COc1ccc(cc1OC(F)(F)F)-c2cc[nH]c2N</chem>	ESI+: 291
85	5	 <chem>Clc1ccc(cc1OC(F)(F)F)-c2cc[nH]c2N</chem>	ESI+: 295
86	5	 <chem>Clc1ccc(cc1C(F)(F)F)-c2cc[nH]c2N</chem>	ESI+: 279 , 281
87	5	 <chem>CCOc1ccc(cc1C(F)(F)F)-c2cc[nH]c2N</chem> HCl	ESI+: 289
88	5	 <chem>FOCCCOc1ccc(cc1C(F)(F)F)-c2cc[nH]c2N</chem>	ESI+: 321
89	5	 <chem>COCCOc1ccc(cc1C(F)(F)F)-c2cc[nH]c2N</chem> HCl	ESI+: 319
90	7	 <chem>COc1ccc(cc1F)-c2cc[nH]c2N3C(=O)N=C(N3C(=O)N4CCN(CC4)CC(=O)OCC)C5=CN=CN=C5</chem>	ESI+: 486

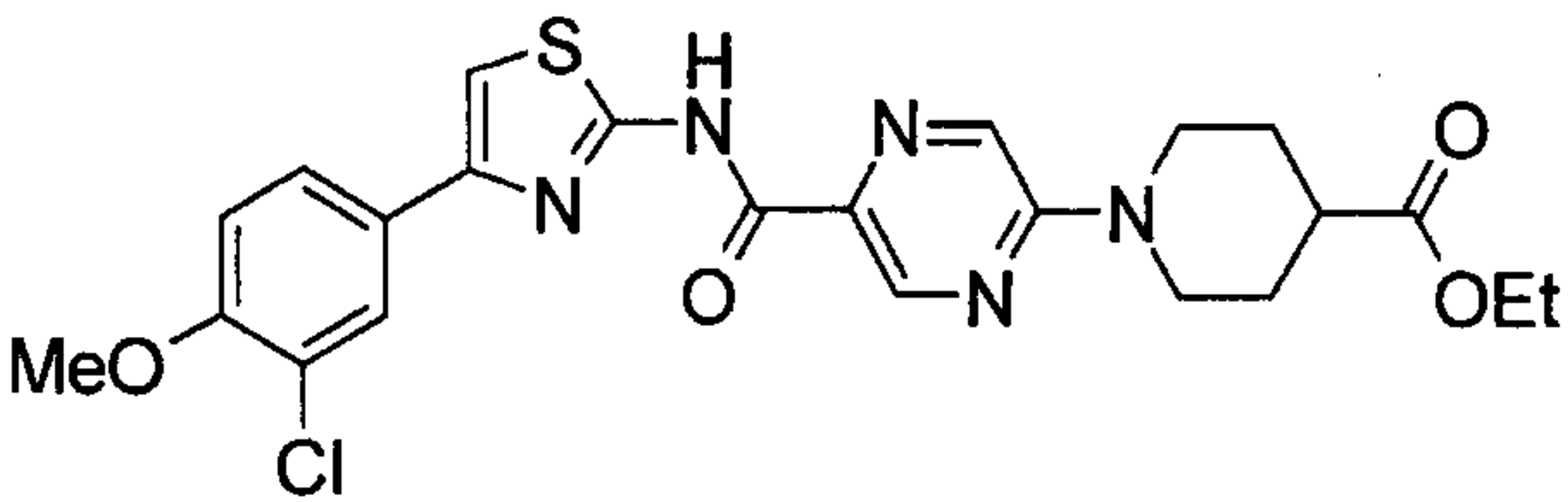
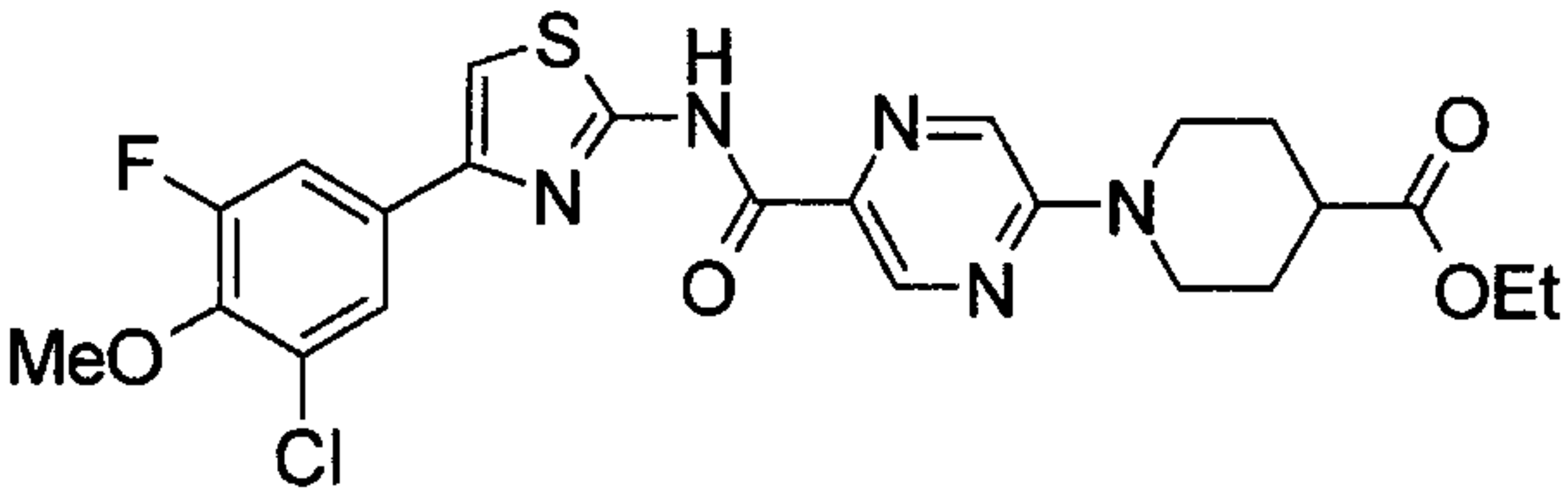
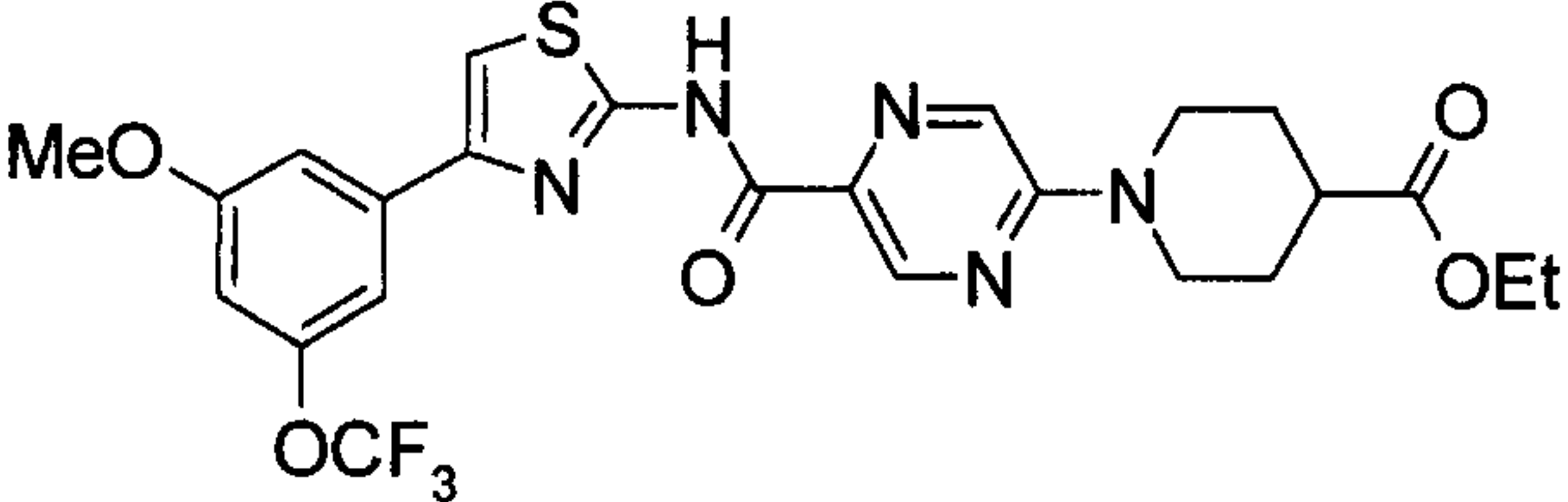
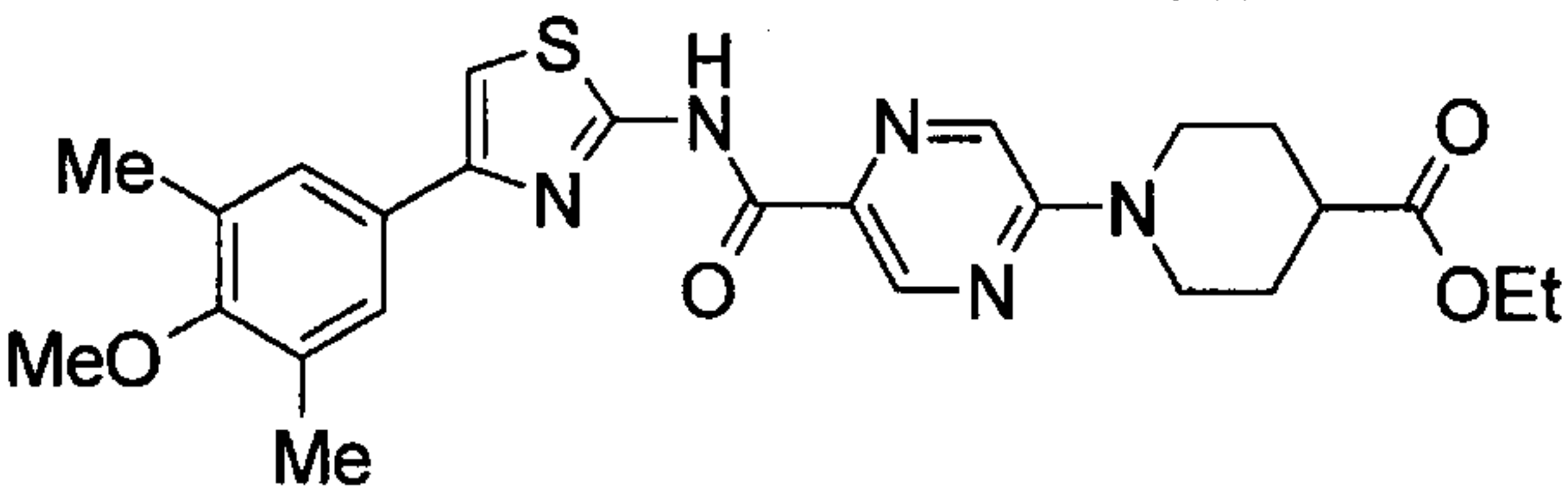
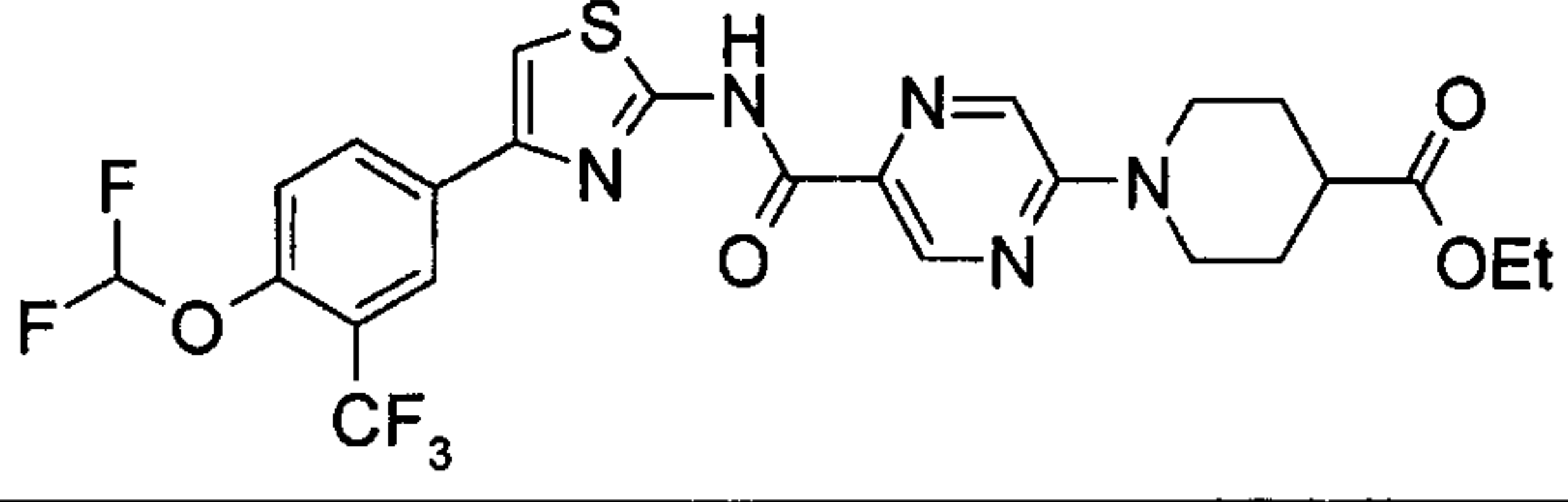
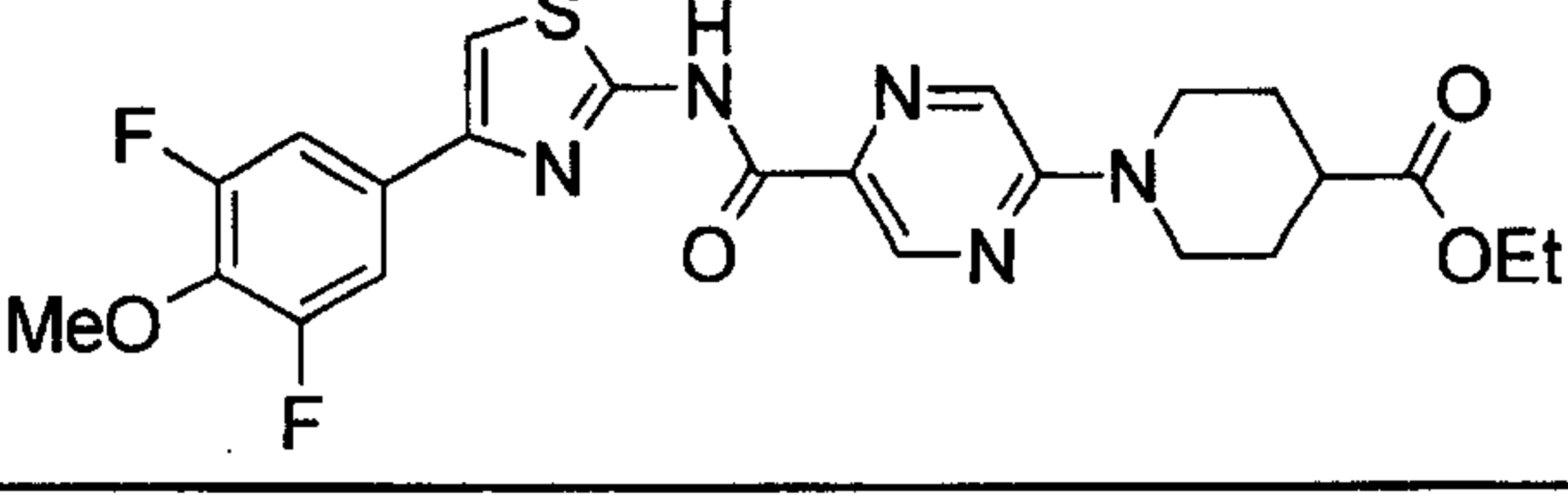
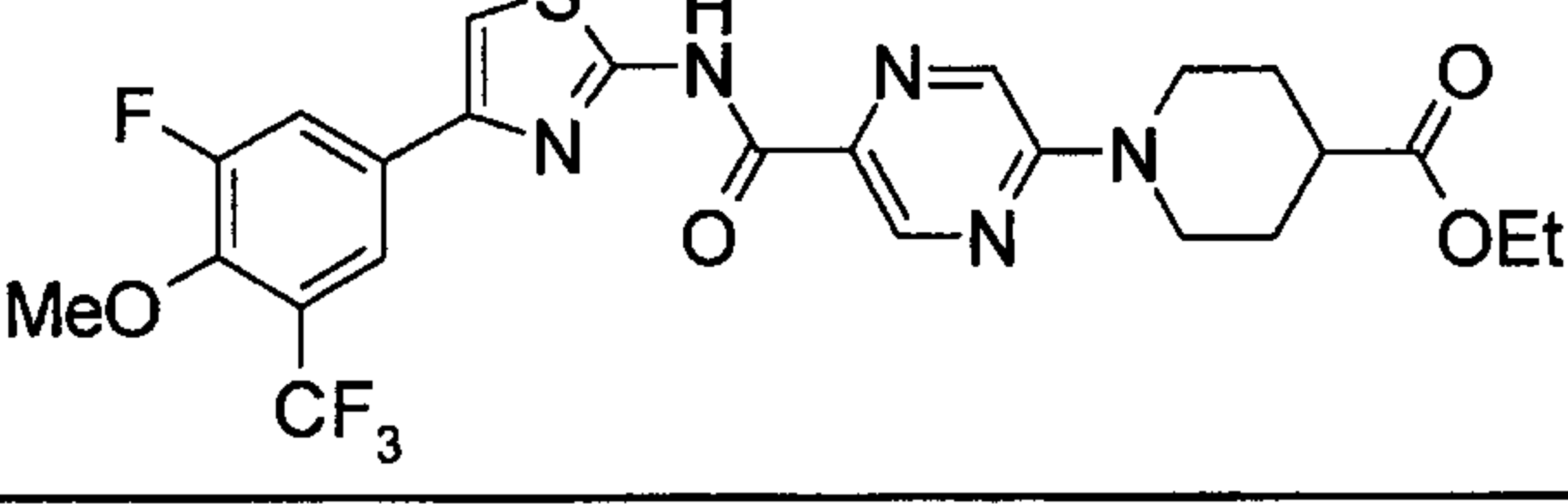
[0178]

[Table 17]

PEX	PSyn	Str	DATA
91	7		ESI+: 466
92	92		ESI+: 536
93	7		ESI+: 564
94	7		ESI+: 594
95	7		ESI+: 480
96	8		ESI+: 230
97	9		ESI+: 540

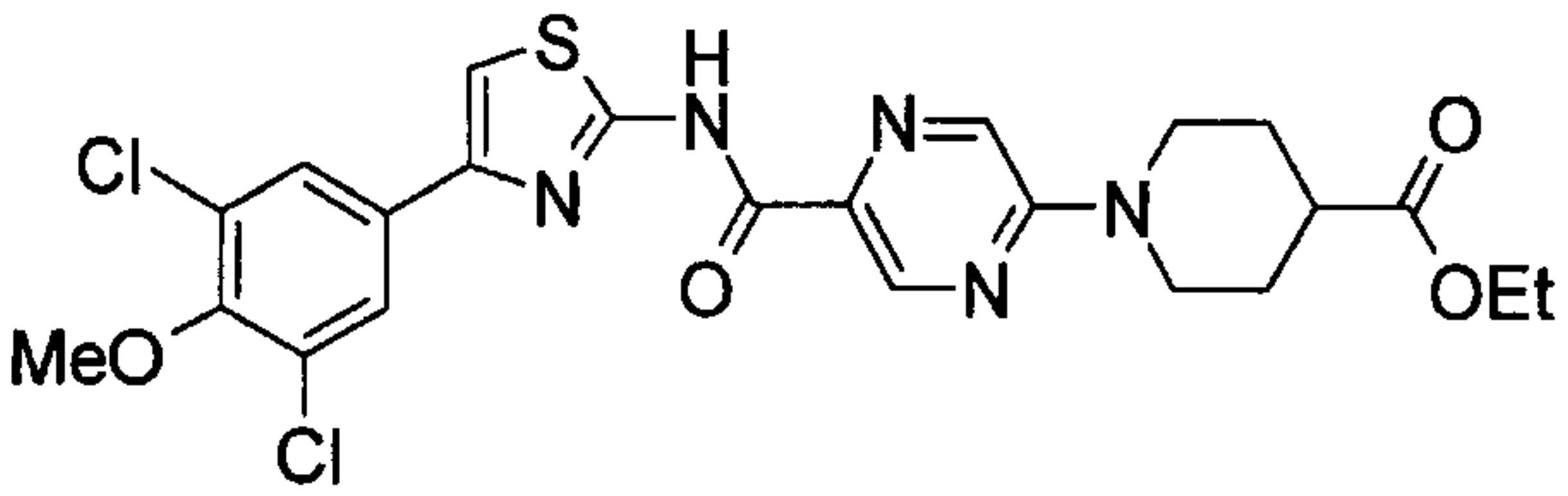
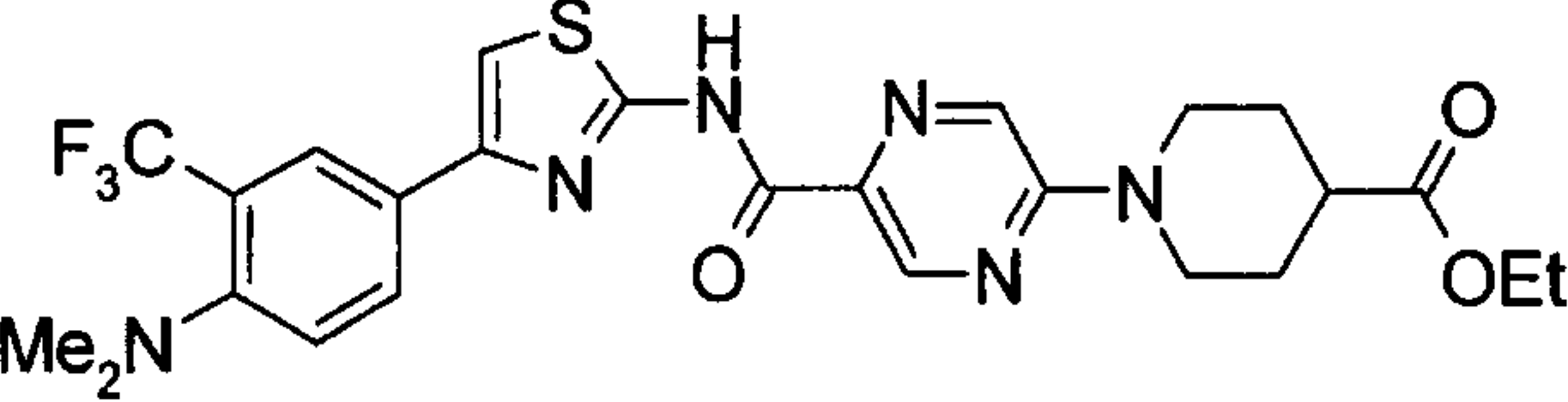
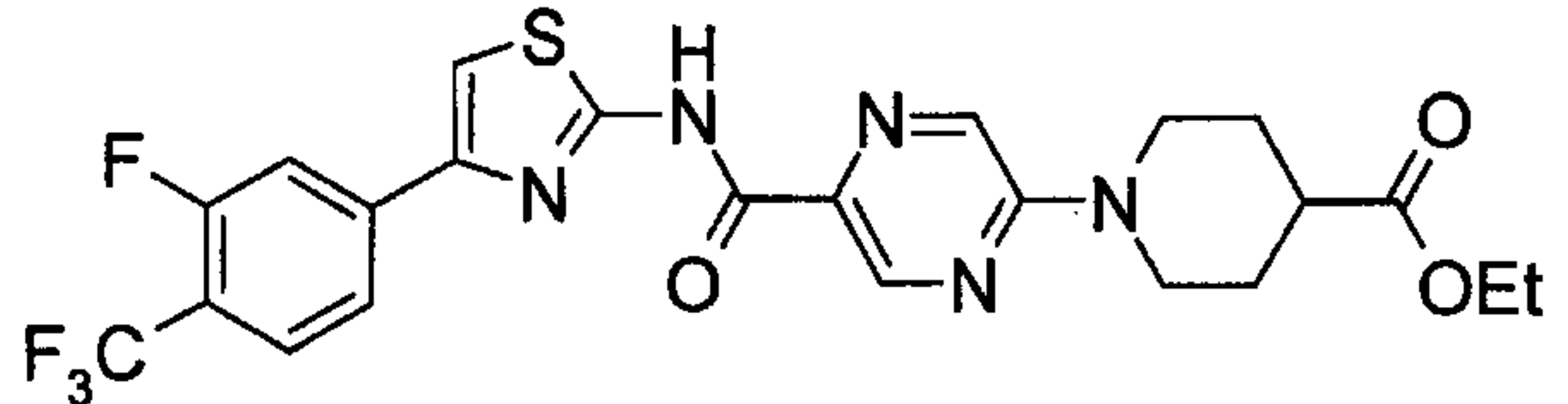
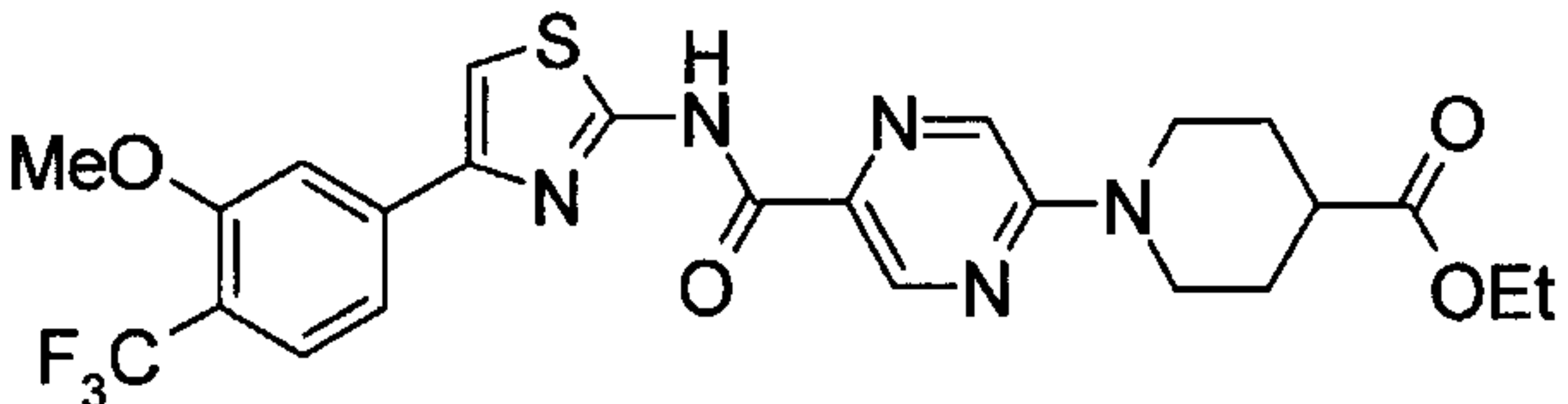
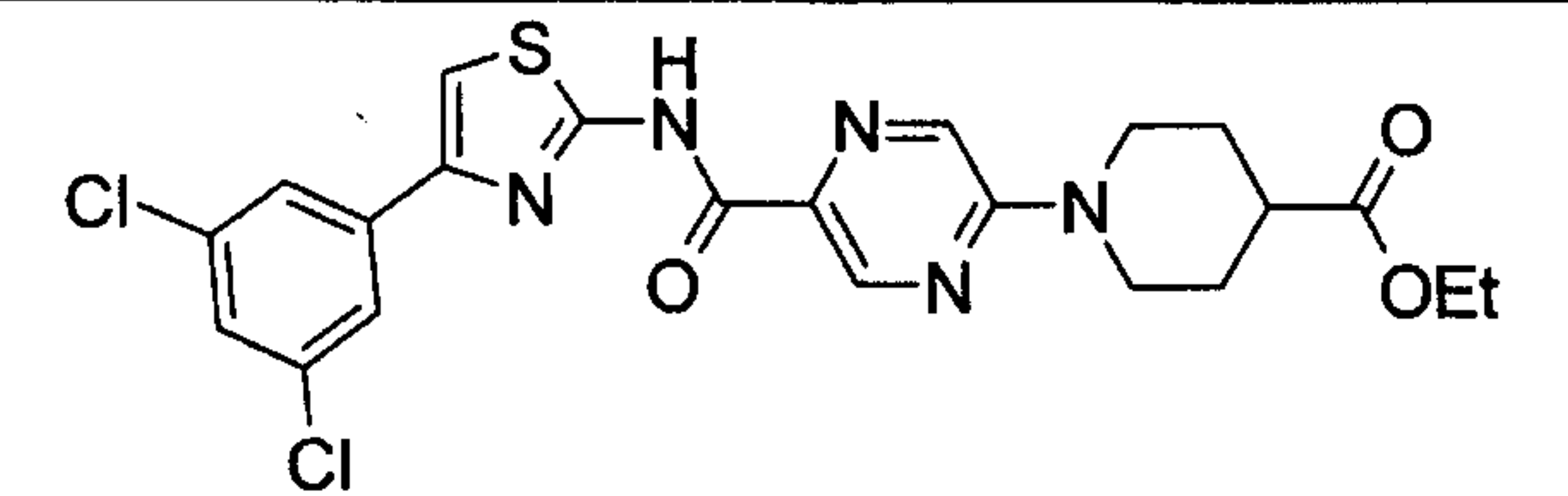
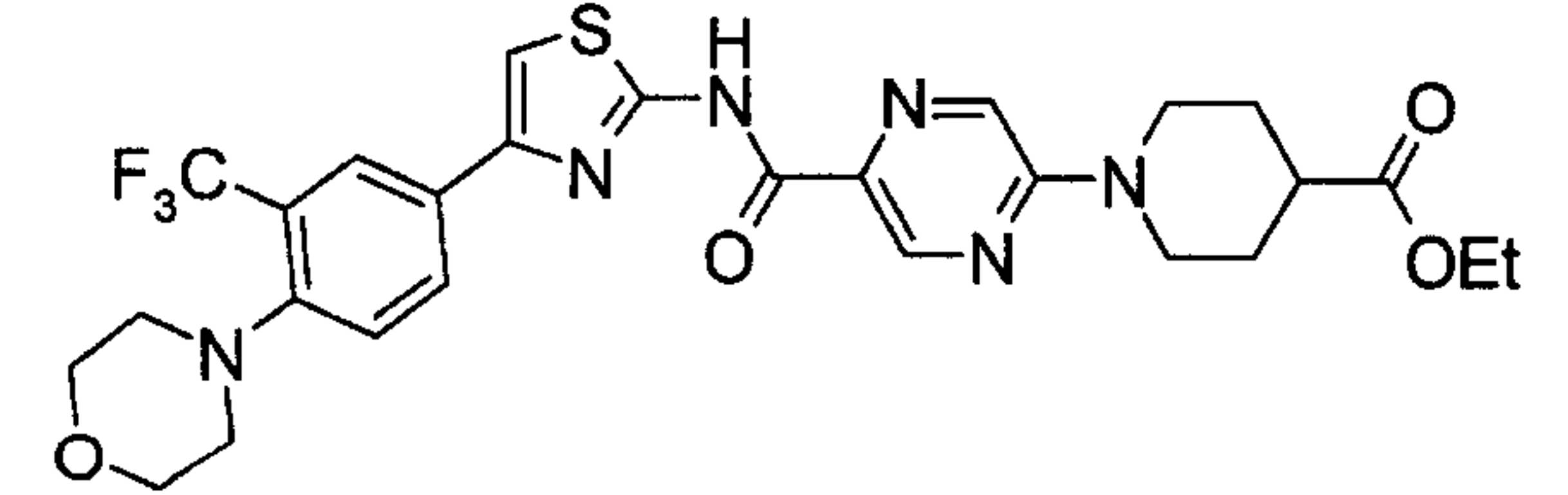
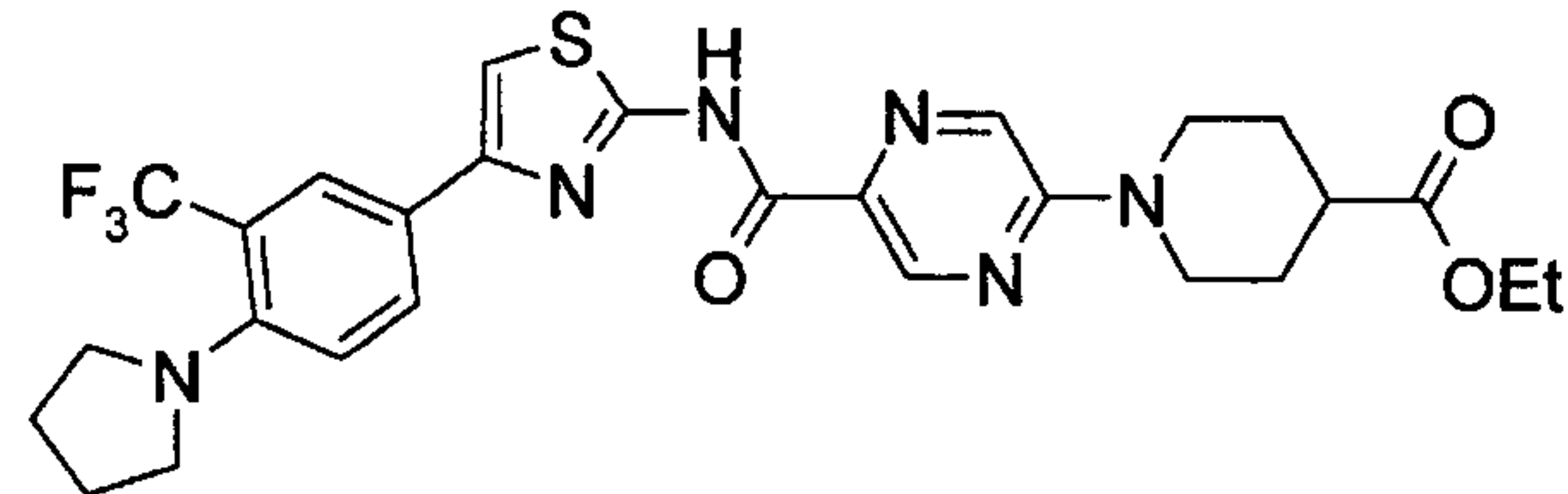
[0179]

[Table 18]

PEX	PSyn	Str	DATA
98	9		ESI+: 502
99	9		ESI+: 520
100	9		ESI+: 552
101	9		ESI+: 496
102	9		ESI+: 572
103	9		ESI+: 504
104	9		ESI+: 554

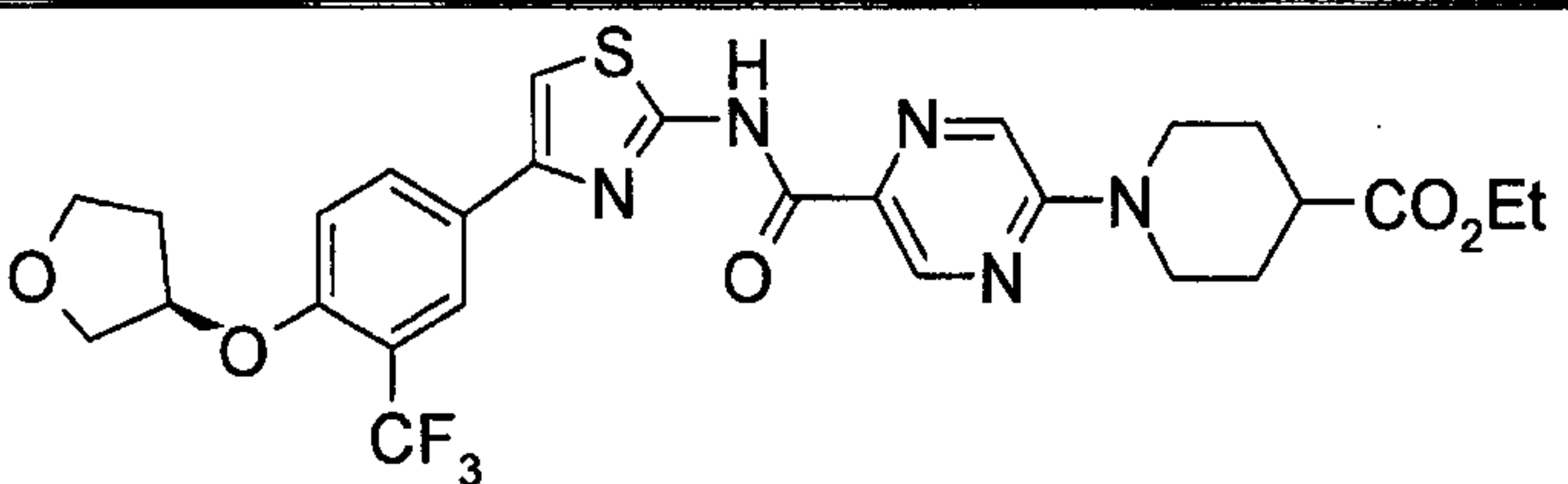
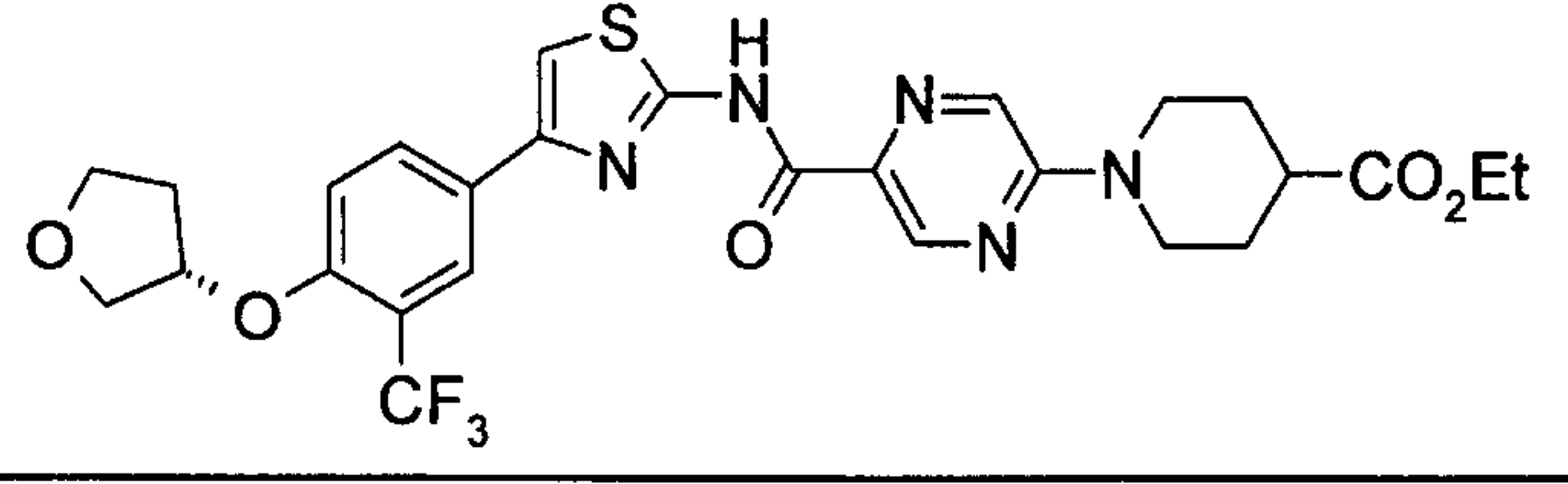
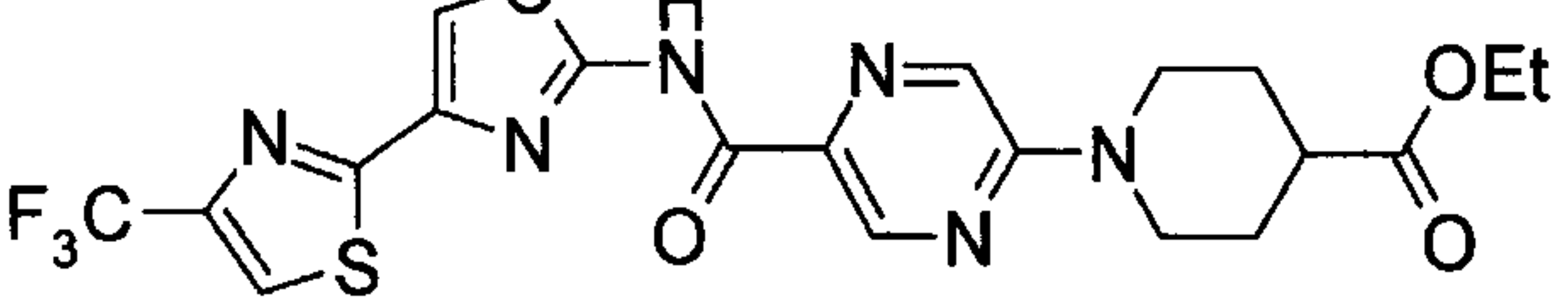
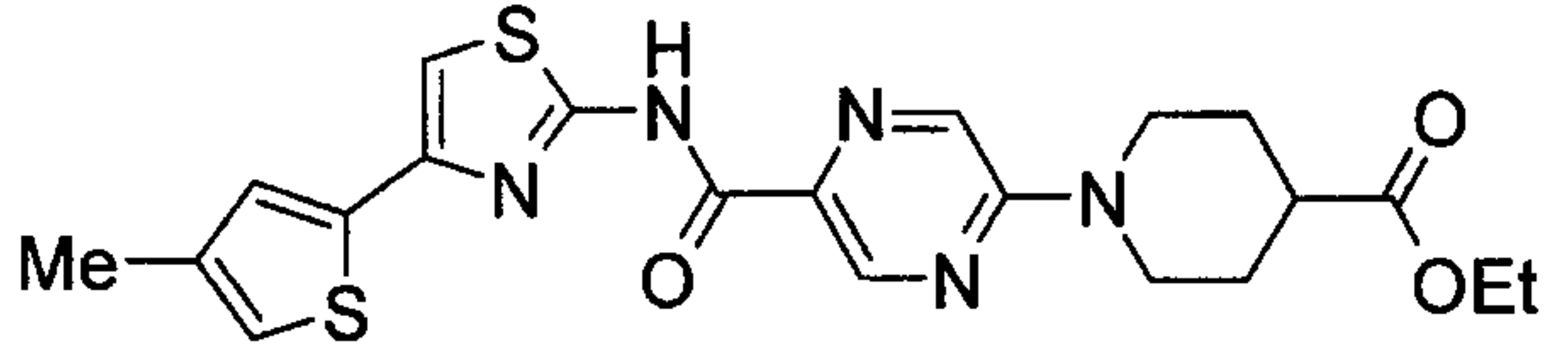
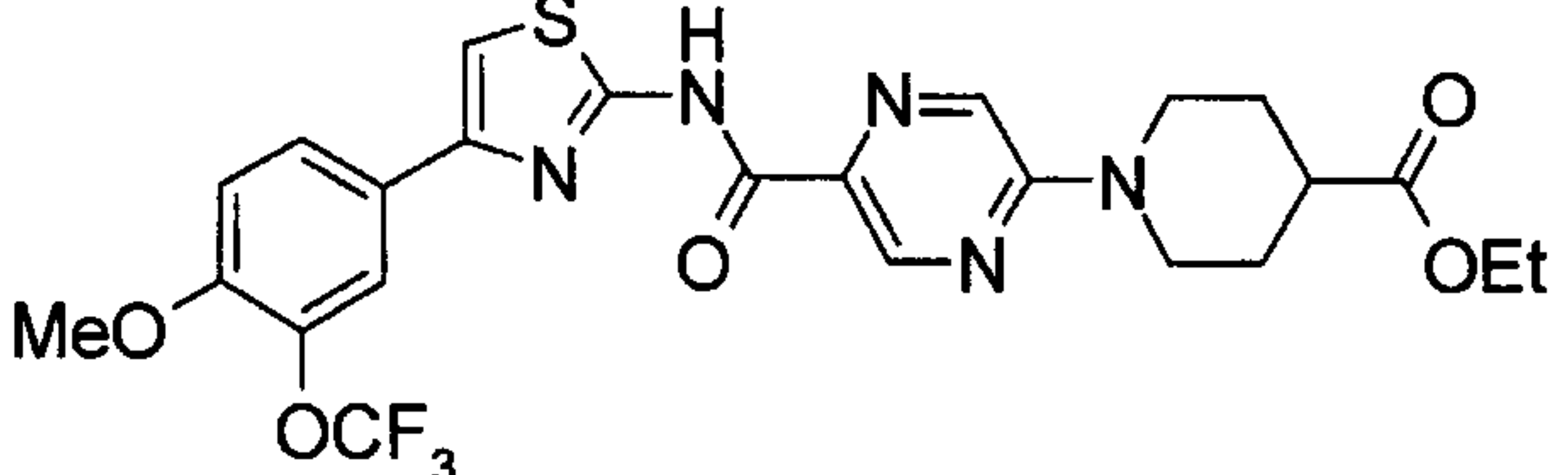
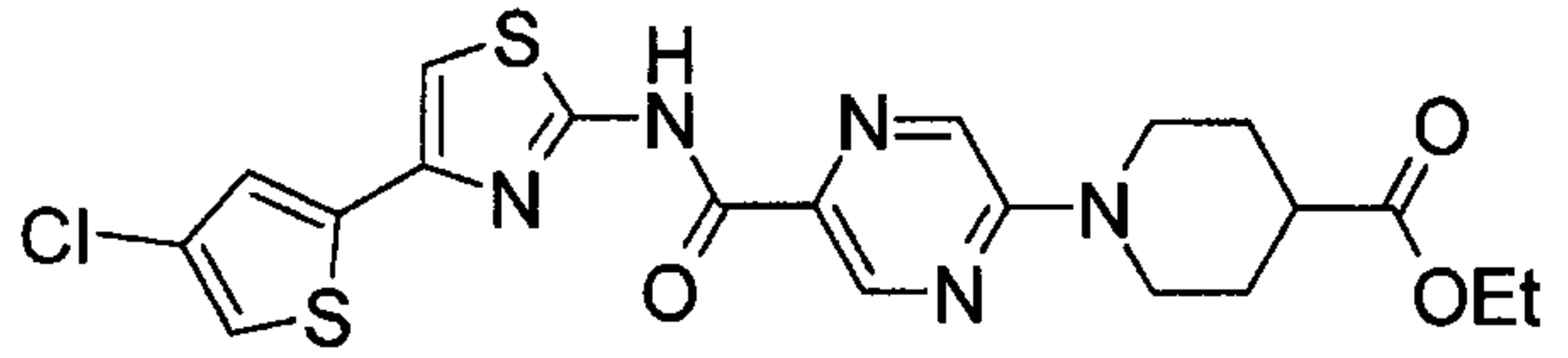
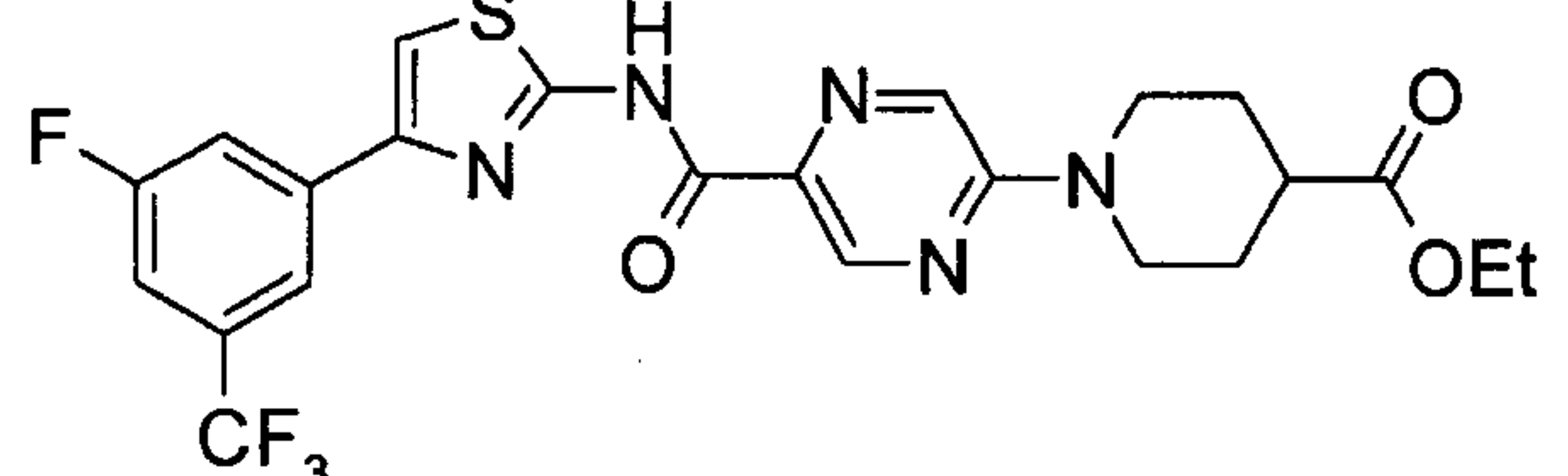
[0180]

[Table 19]

PEx	PSyn	Str	DATA
105	9		ESI+: 536
106	9		ESI+: 549
107	9		ESI+: 524
108	9		ESI+: 536
109	9		ESI+: 506 , 508
110	9		ESI+: 591
111	9		ESI+: 575

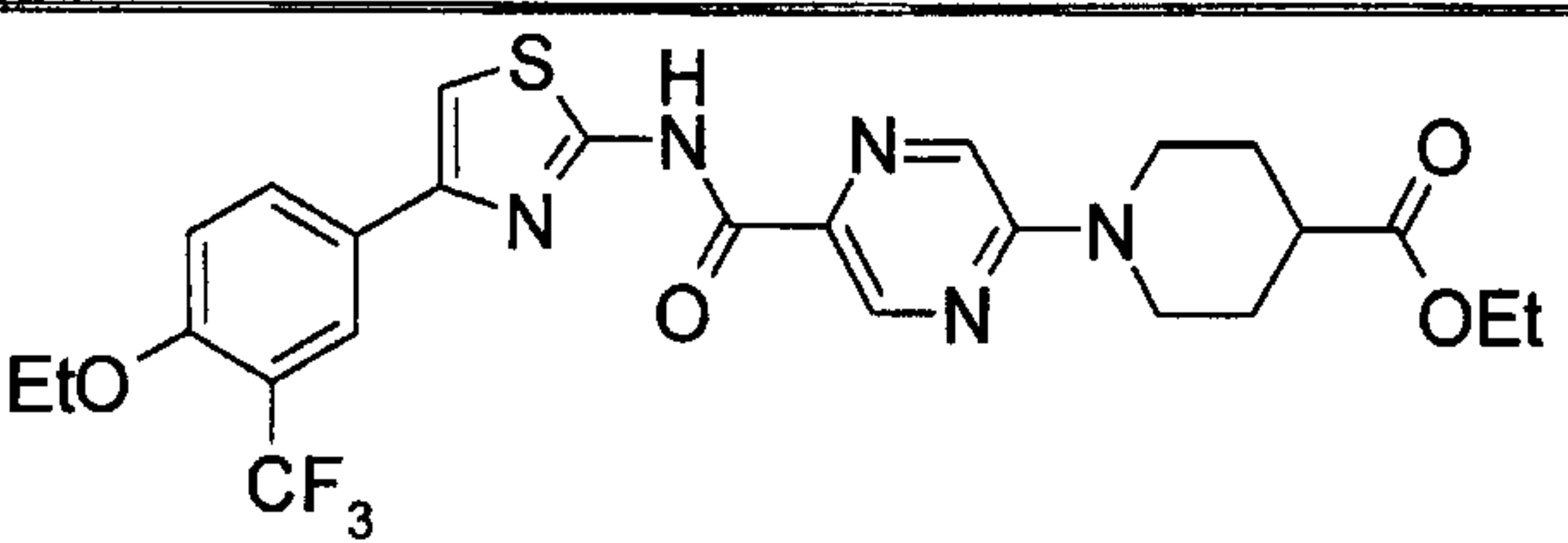
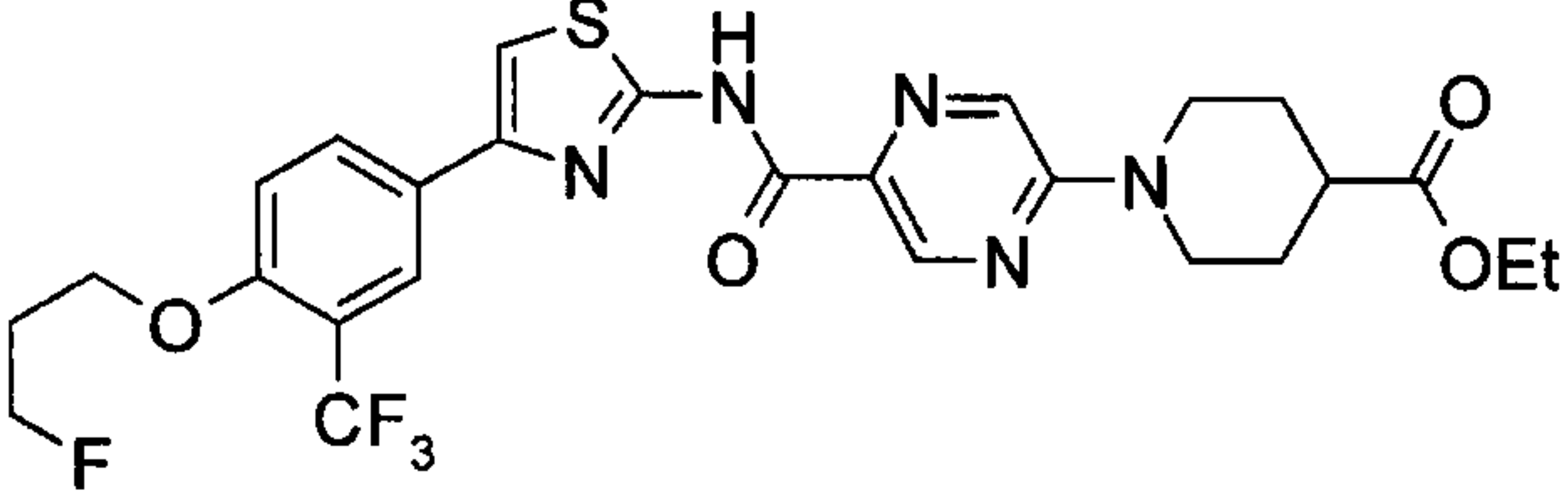
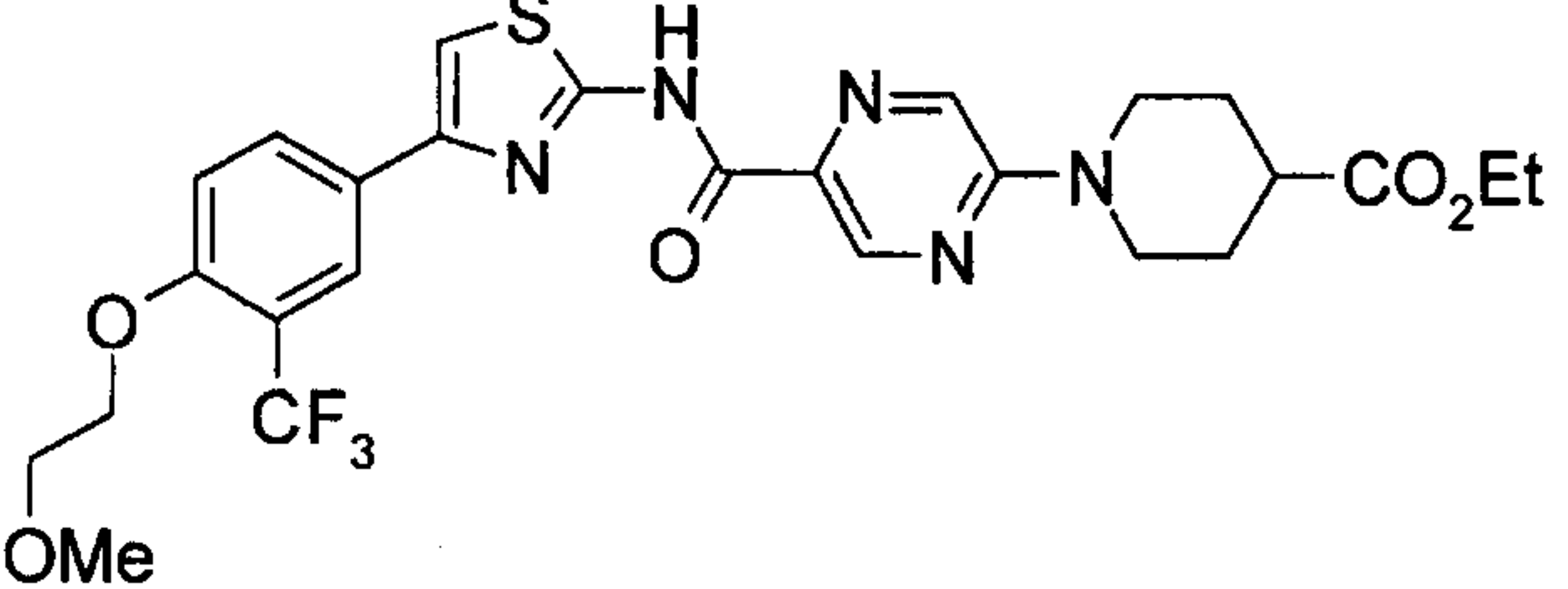
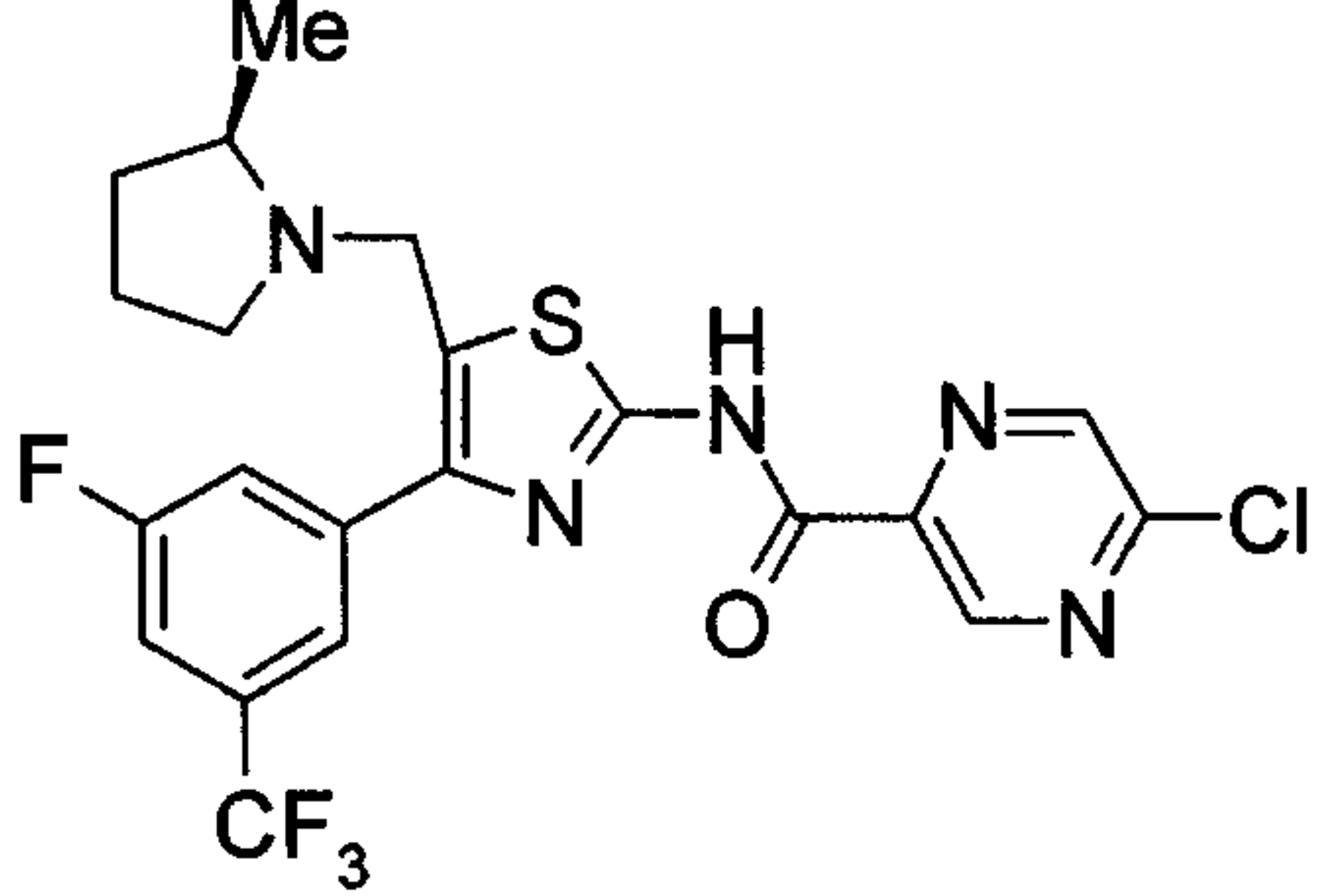
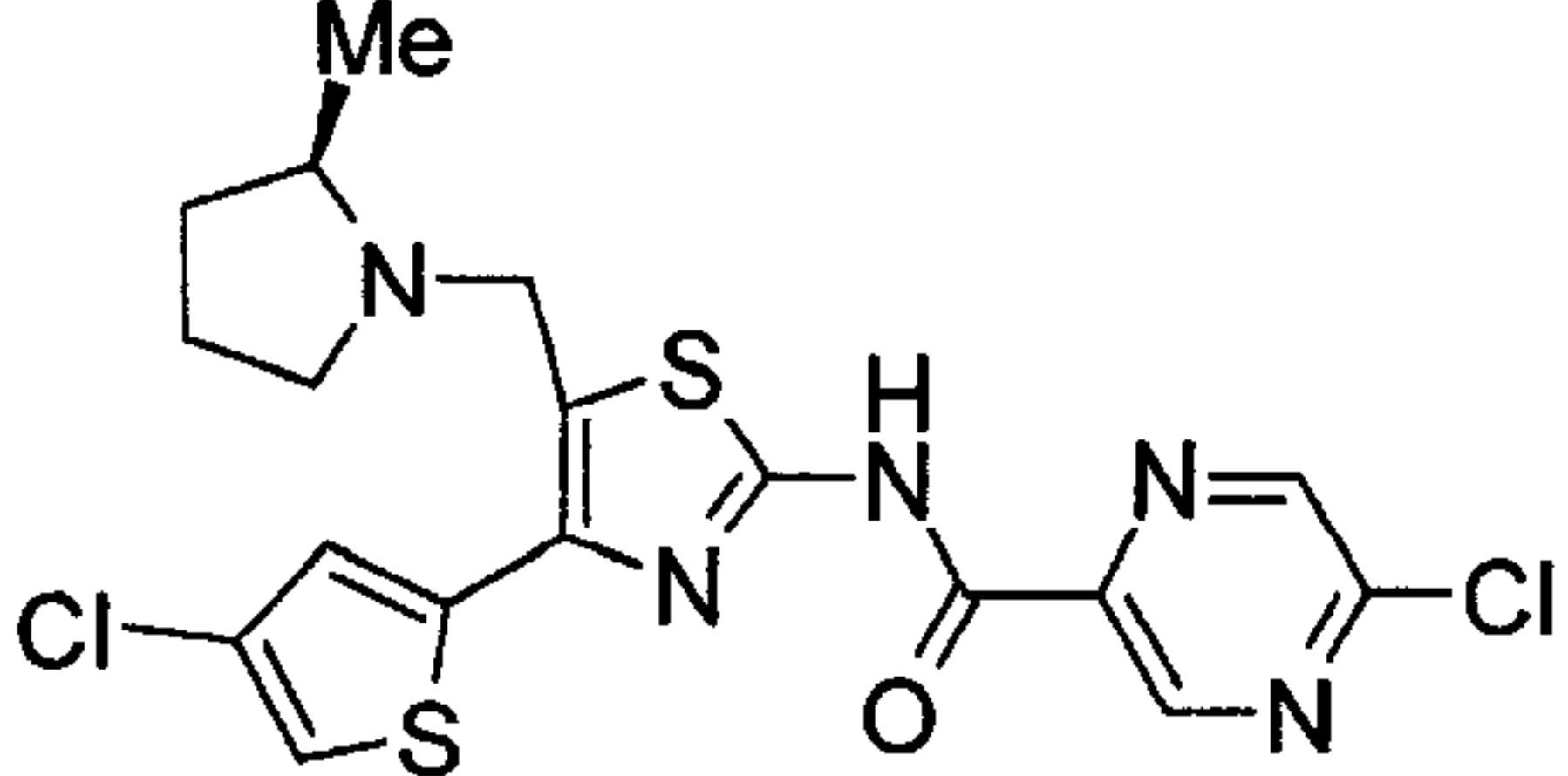
[0181]

[Table 20]

PEX	PSyn	Str	DATA
112	9		ESI+: 592
113	9		ESI+: 592
114	9		ESI+: 513
115	9		ESI+: 458
116	9		ESI+: 552
117	9		ESI+: 478 , 480
118	9		ESI+: 524

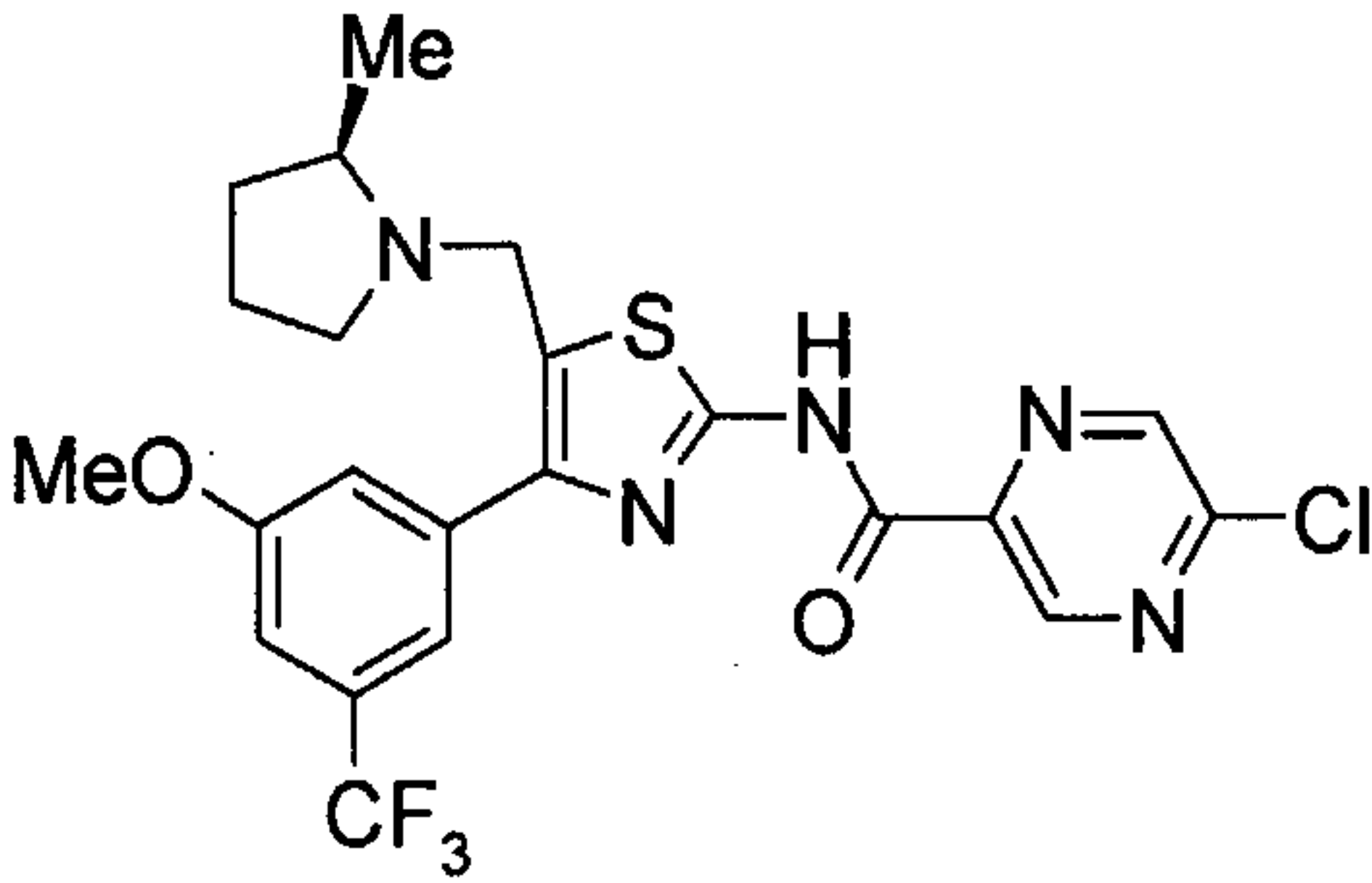
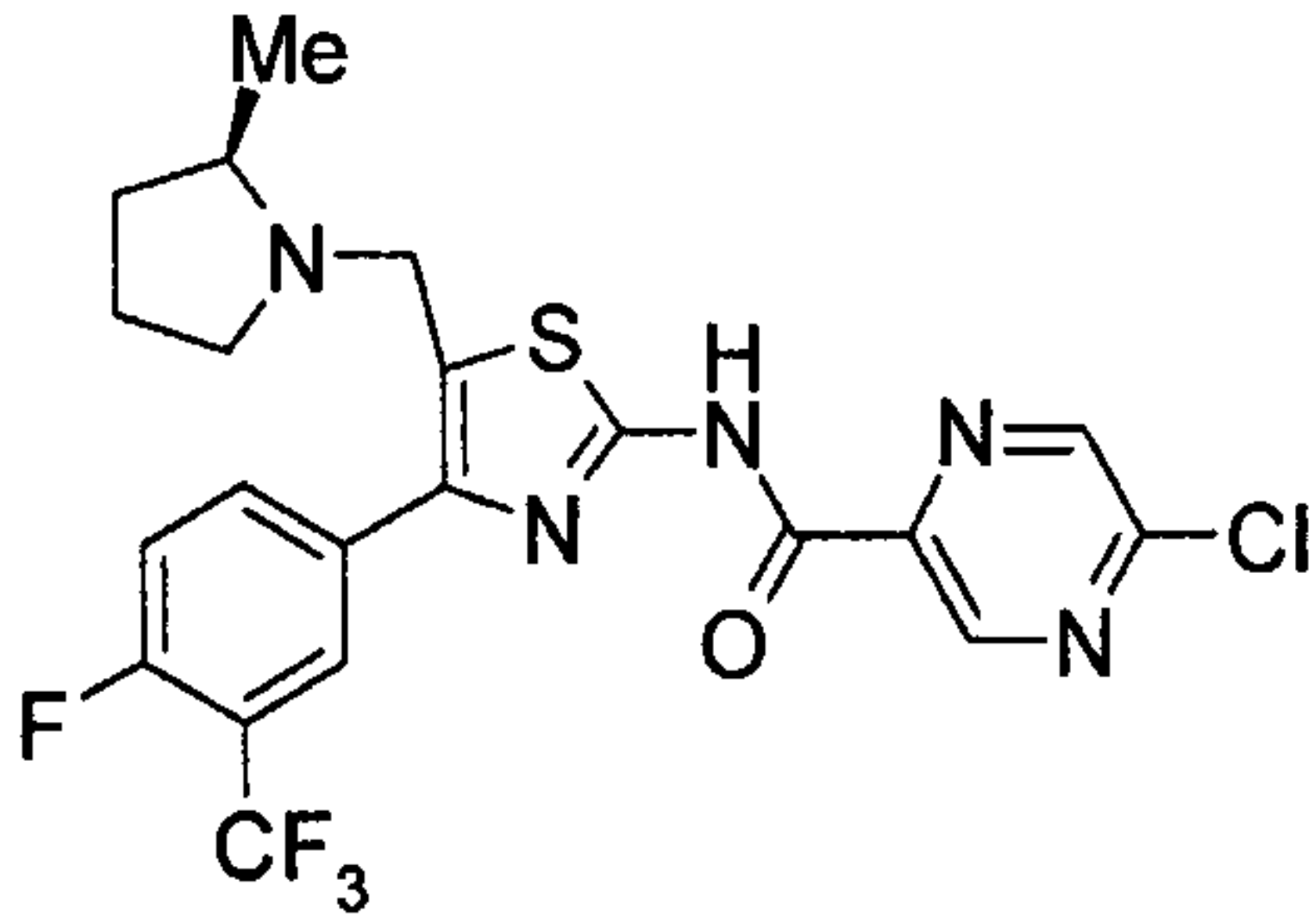
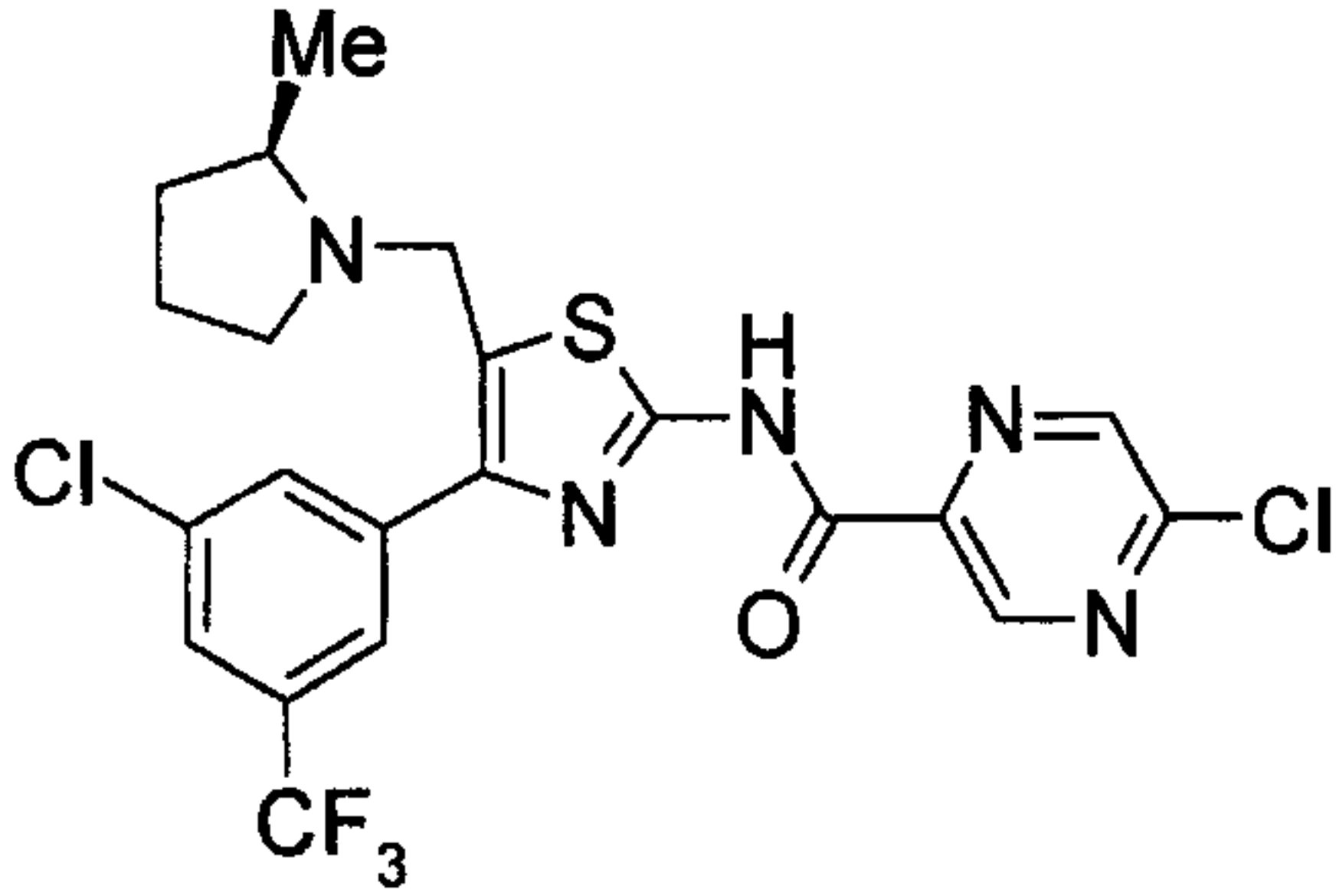
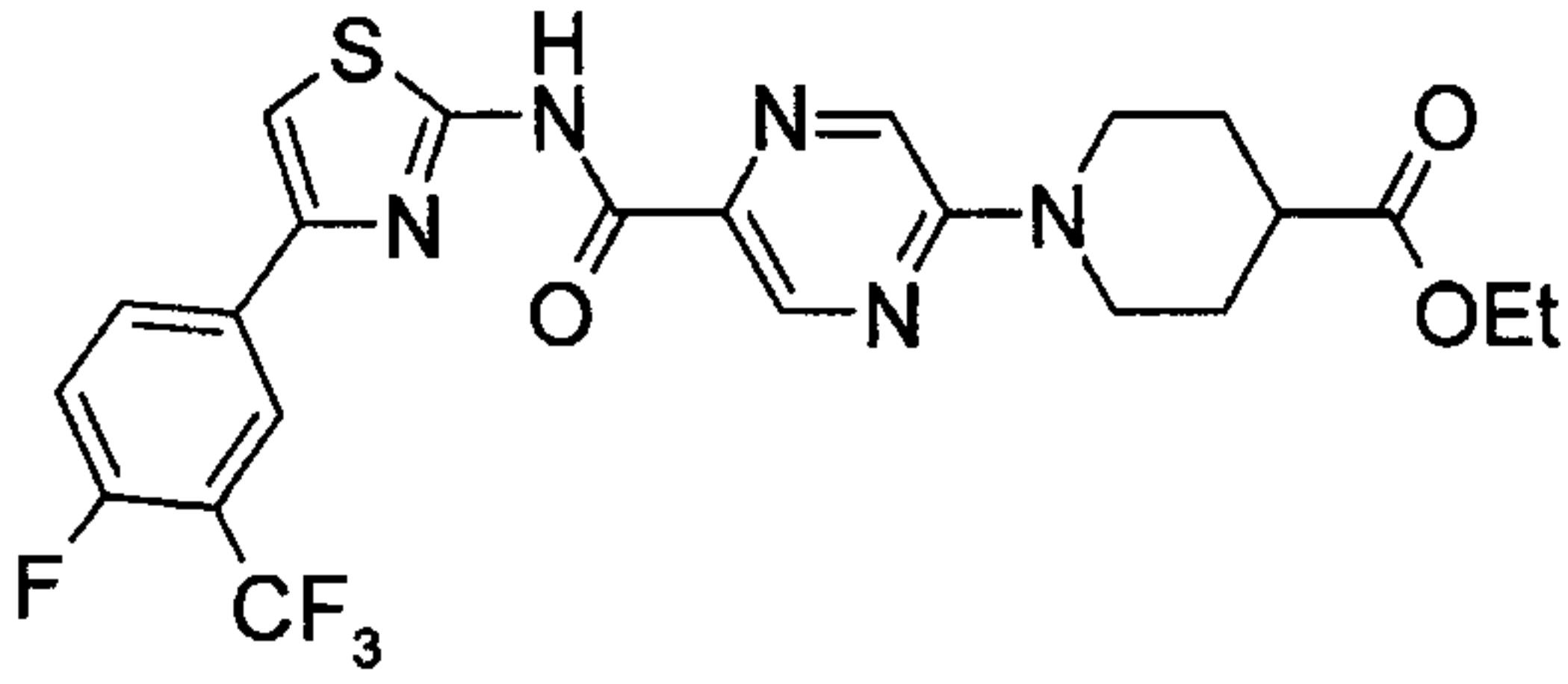
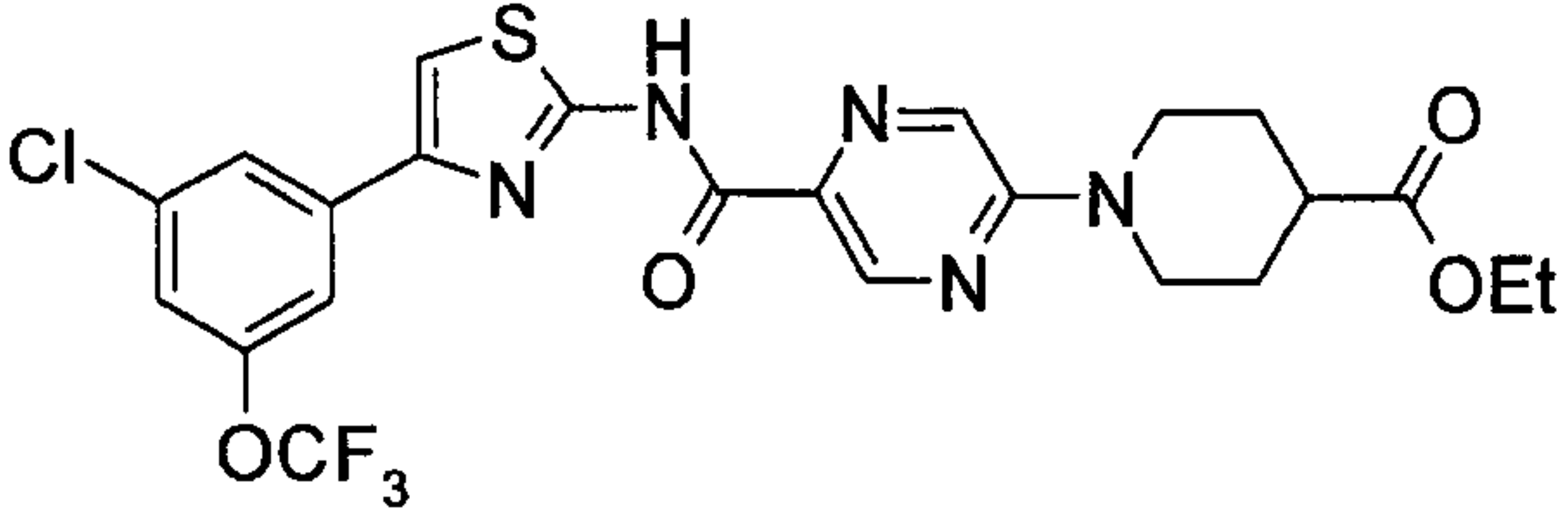
[0182]

[Table 21]

PEx	PSyn	Str	DATA
119	9		ESI+: 550
120	9		ESI+: 582
121	9		ESI+: 580
122	10		ESI+: 500
123	10		ESI+: 454

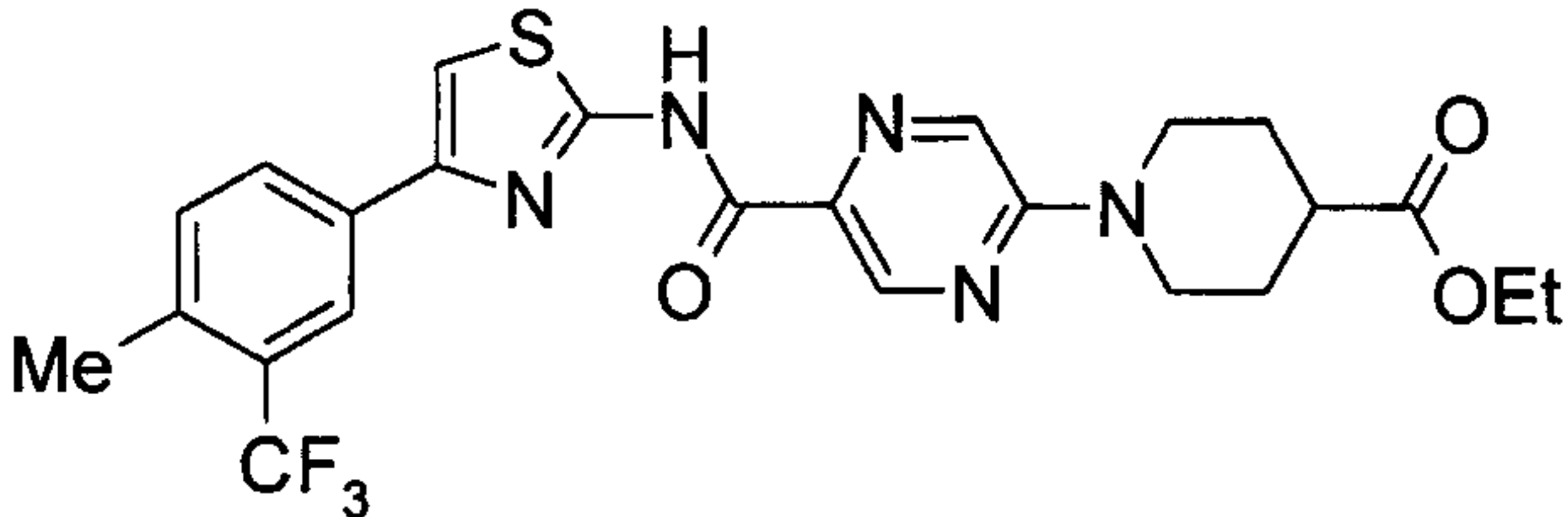
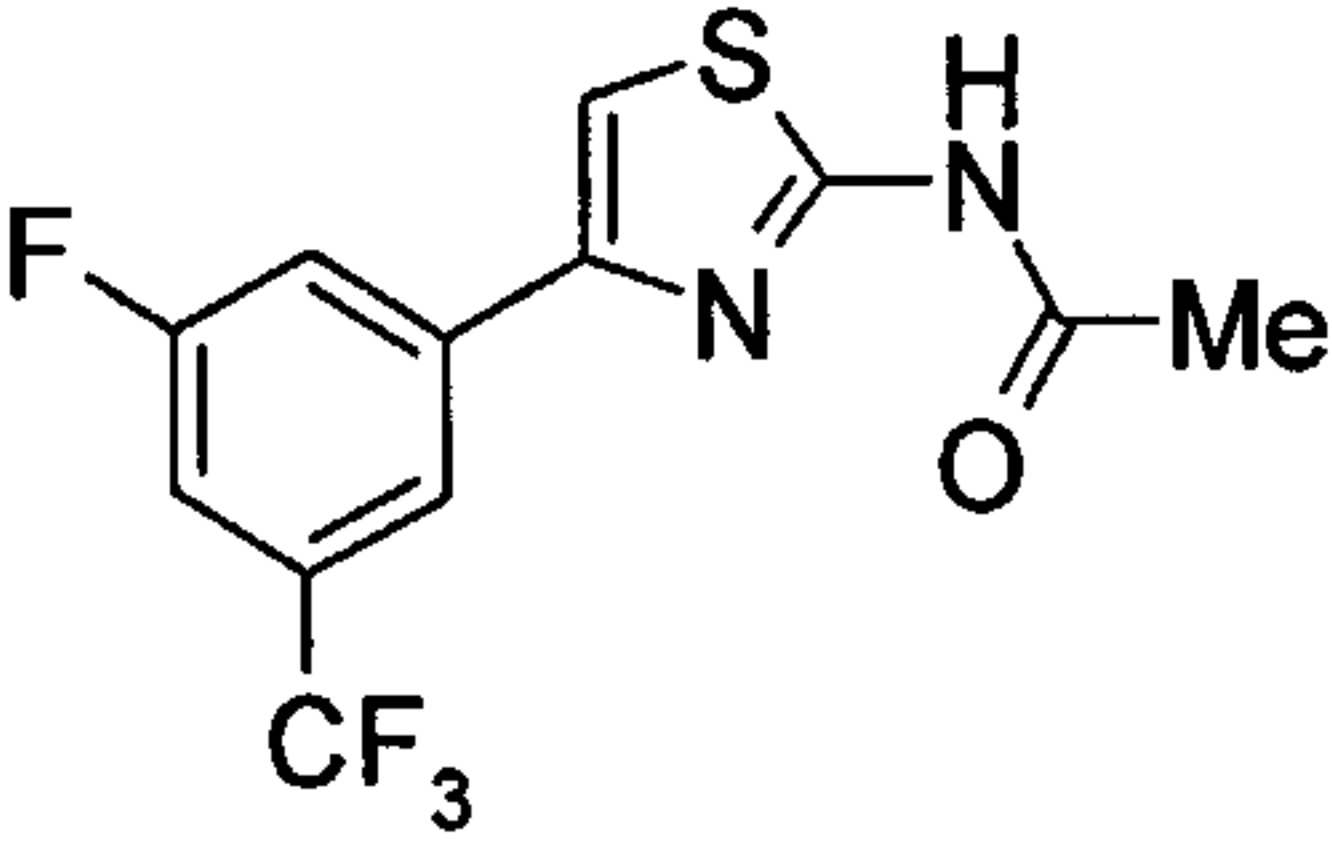
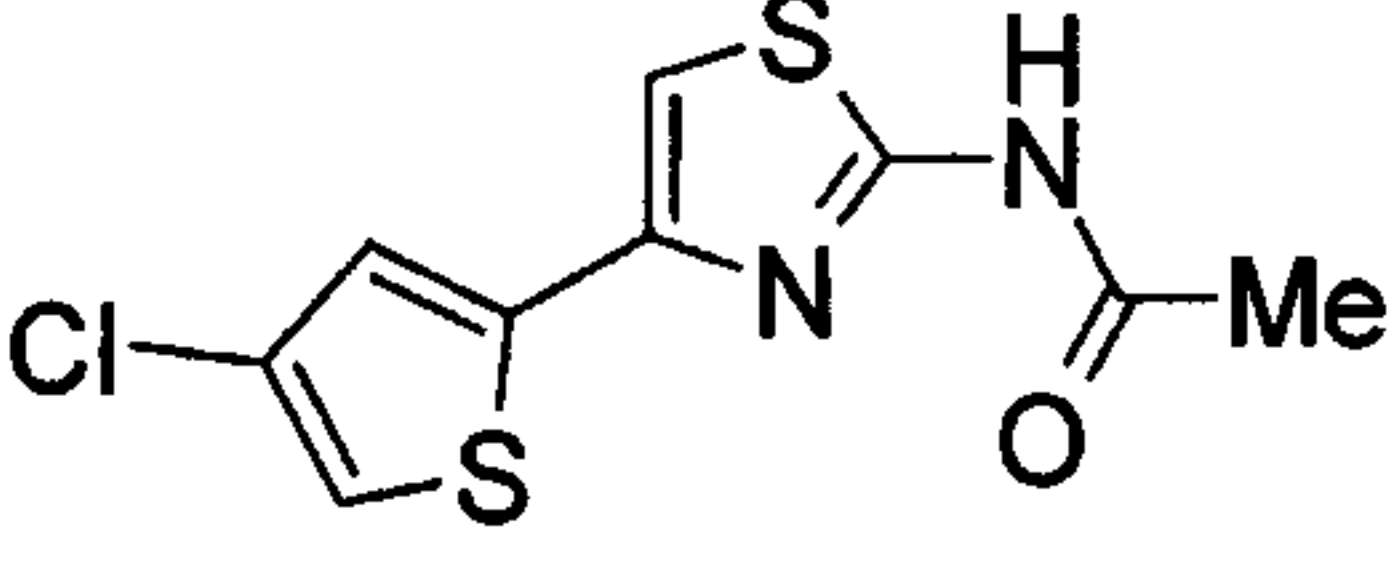
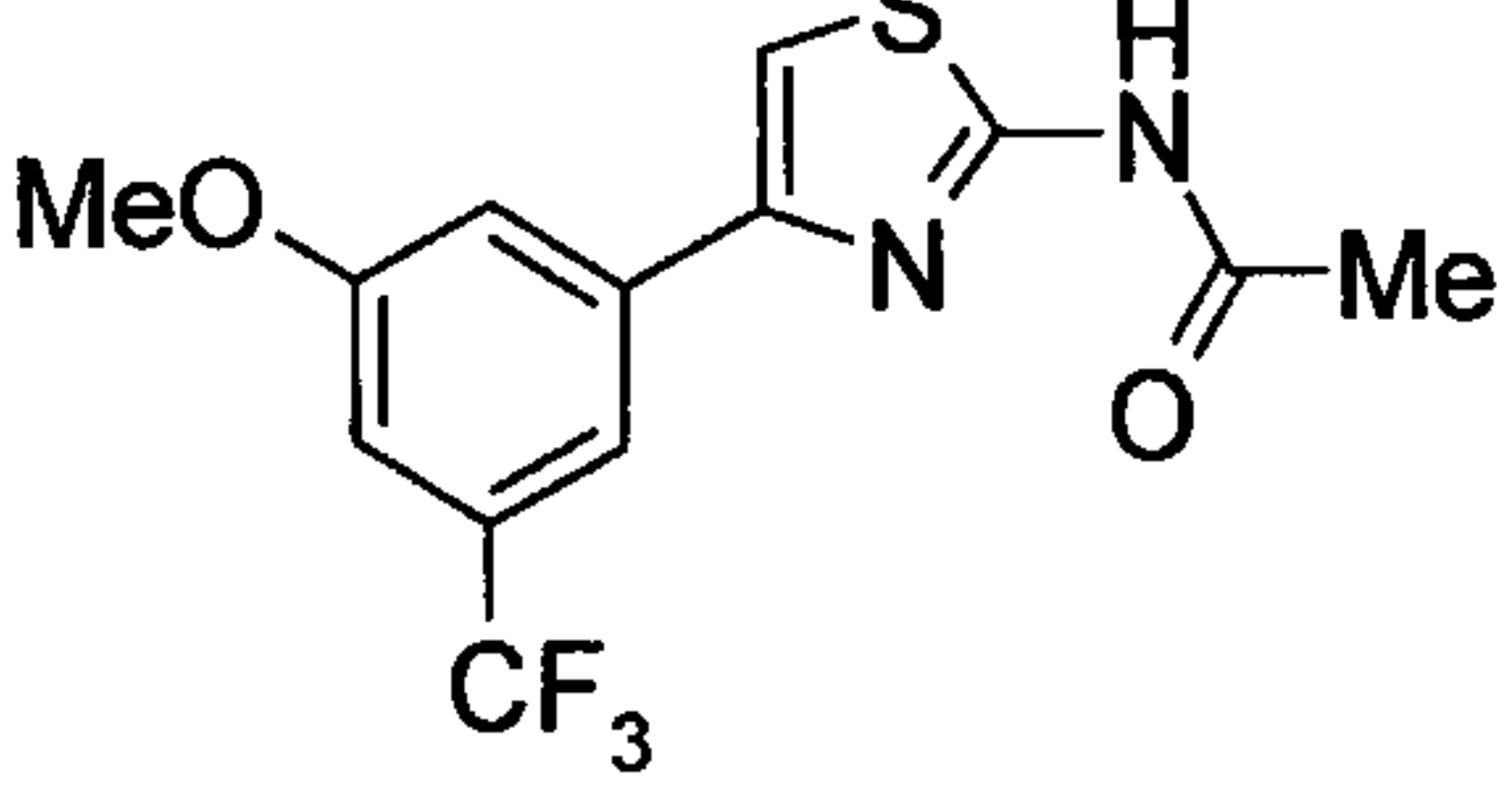
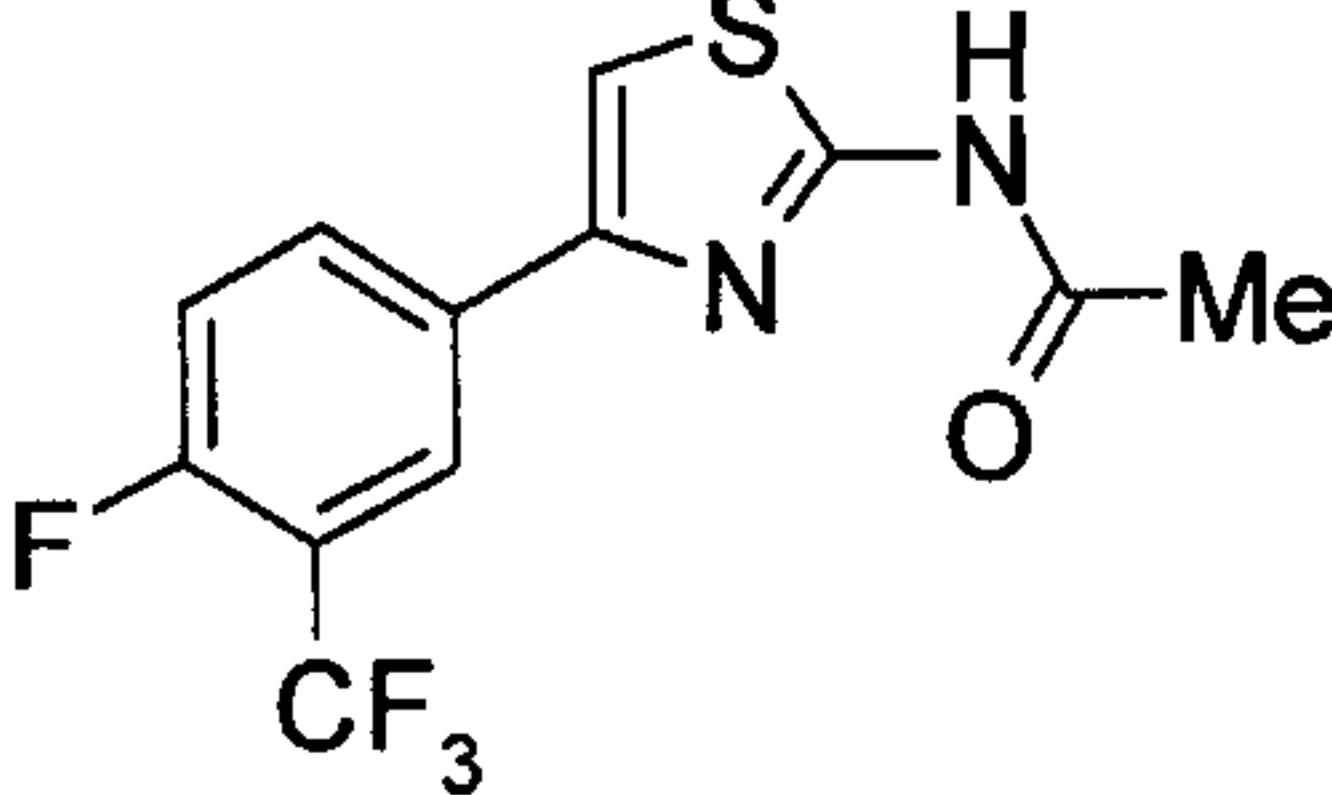
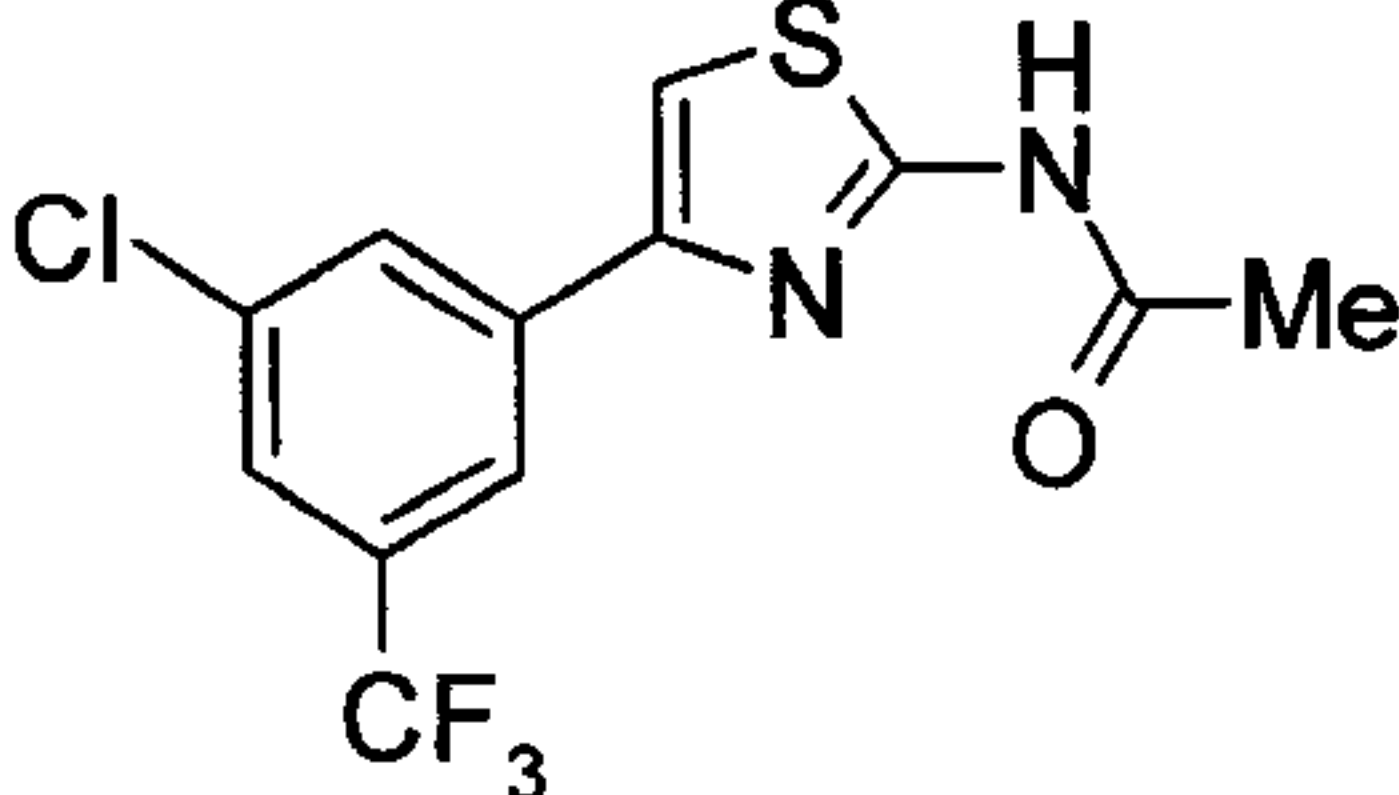
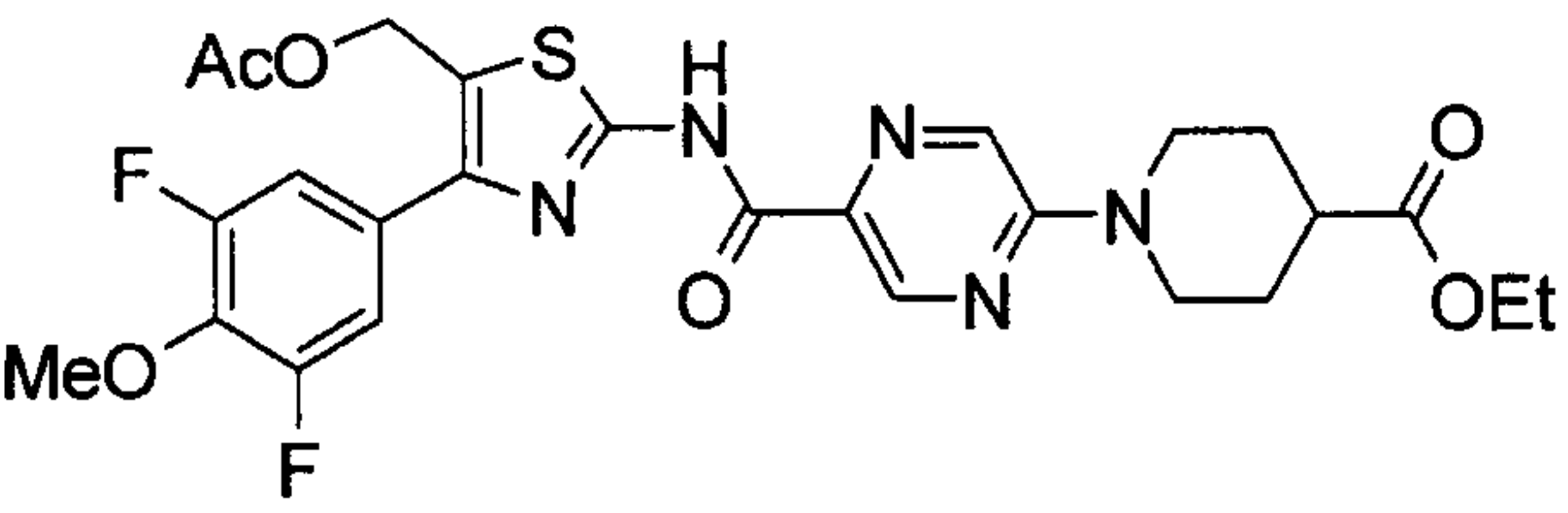
[0183]

[Table 22]

PEX	PSyn	Str	DATA
124	10		ESI+: 512
125	10		ESI+: 500
126	10		ESI+: 516, 518
127	14		ESI+: 524
128	15		ESI+: 556

[0184]

[Table 23]

PEx	PSyn	Str	DATA
129	15		ESI+: 520
130	16		ESI+: 305
131	16		ESI+: 259
132	16		ESI+: 317
133	16		ESI+: 305
134	16		ESI+: 321
135	17		ESI+: 576

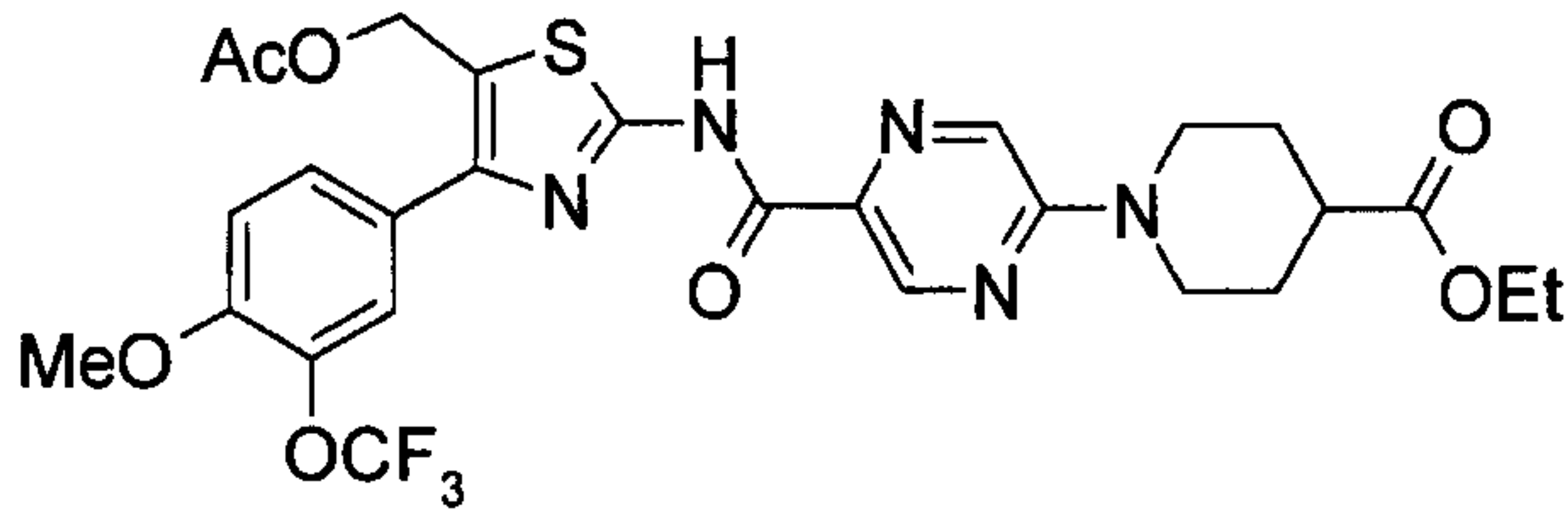
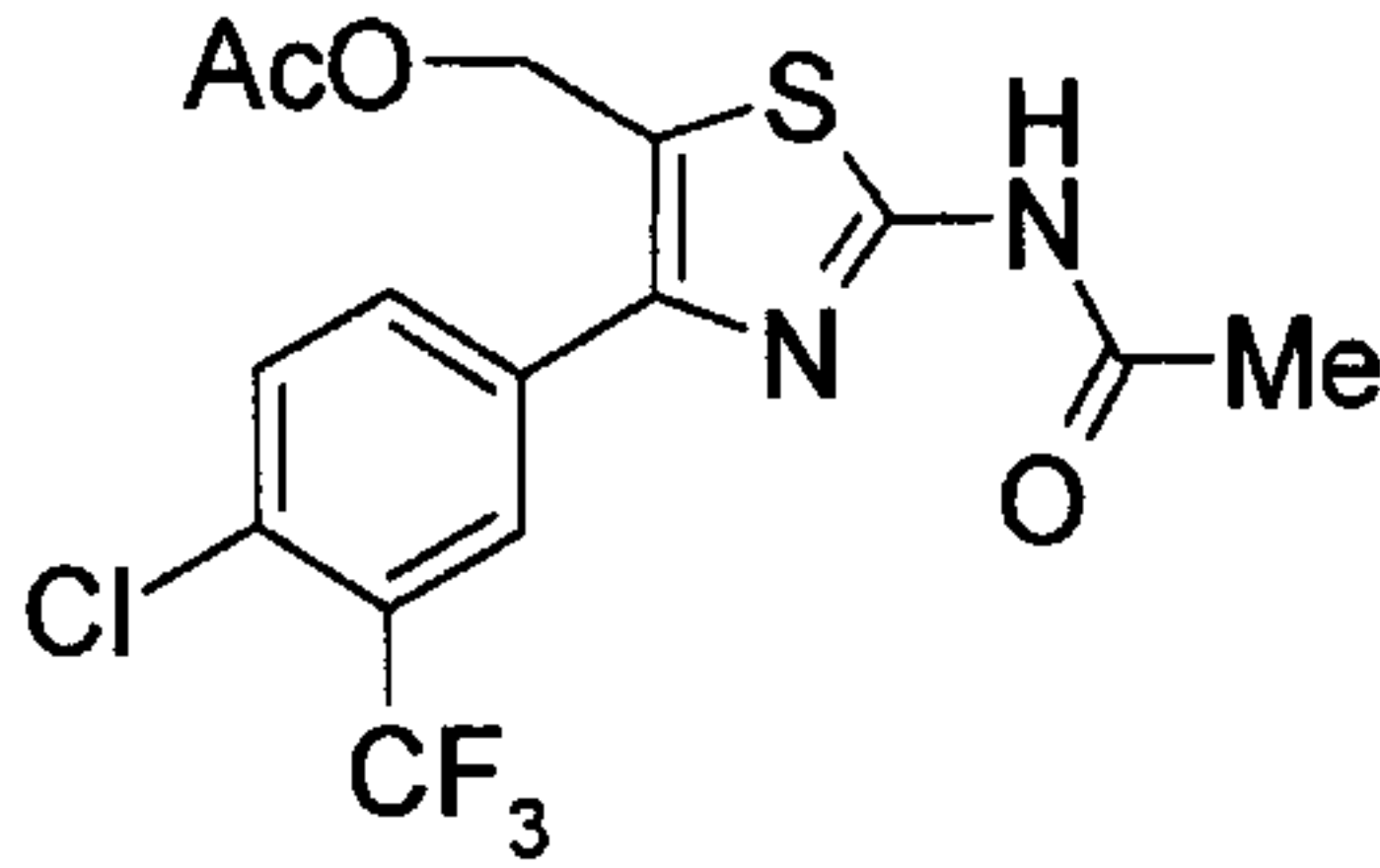
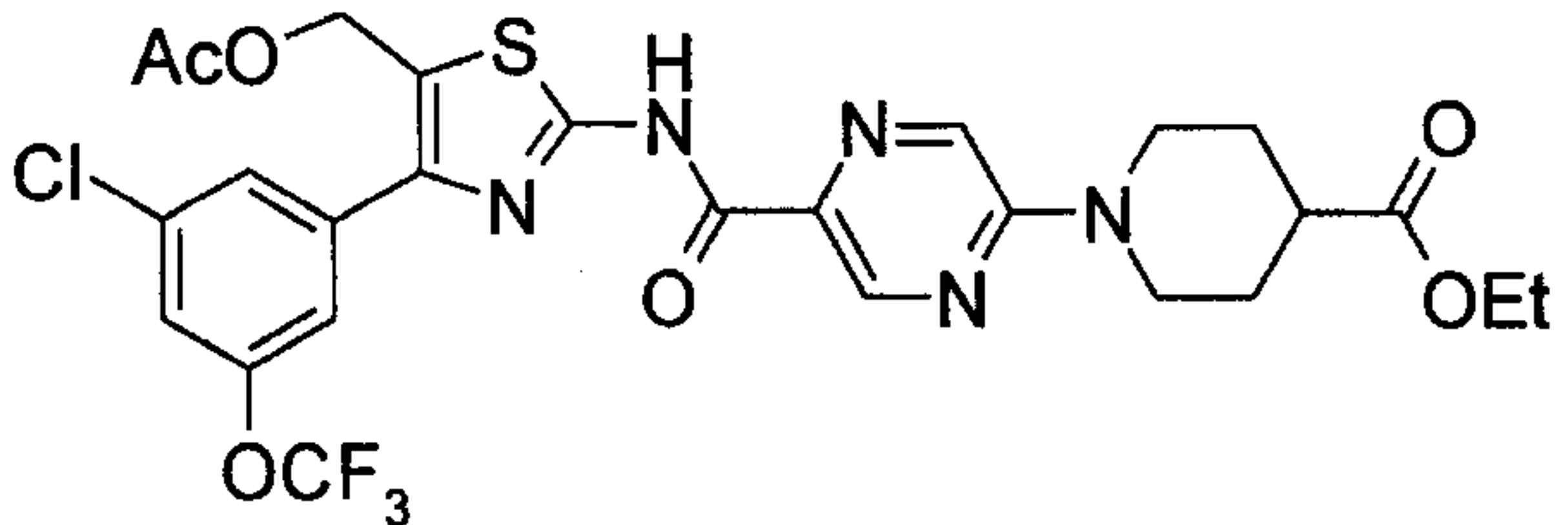
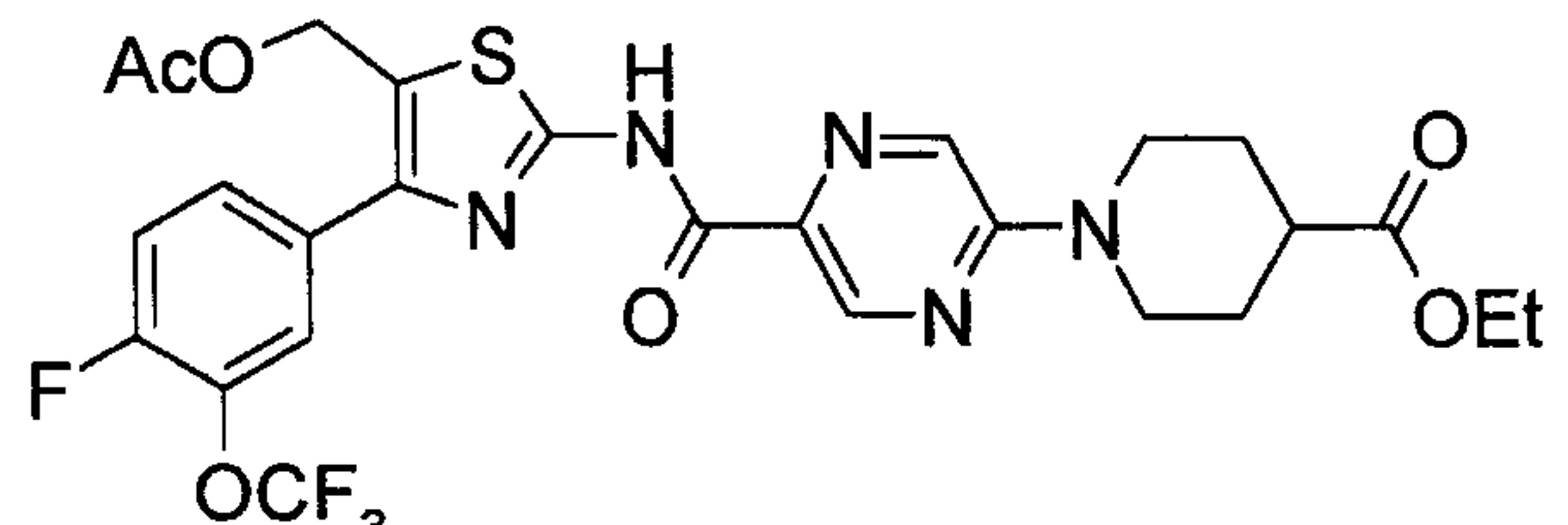
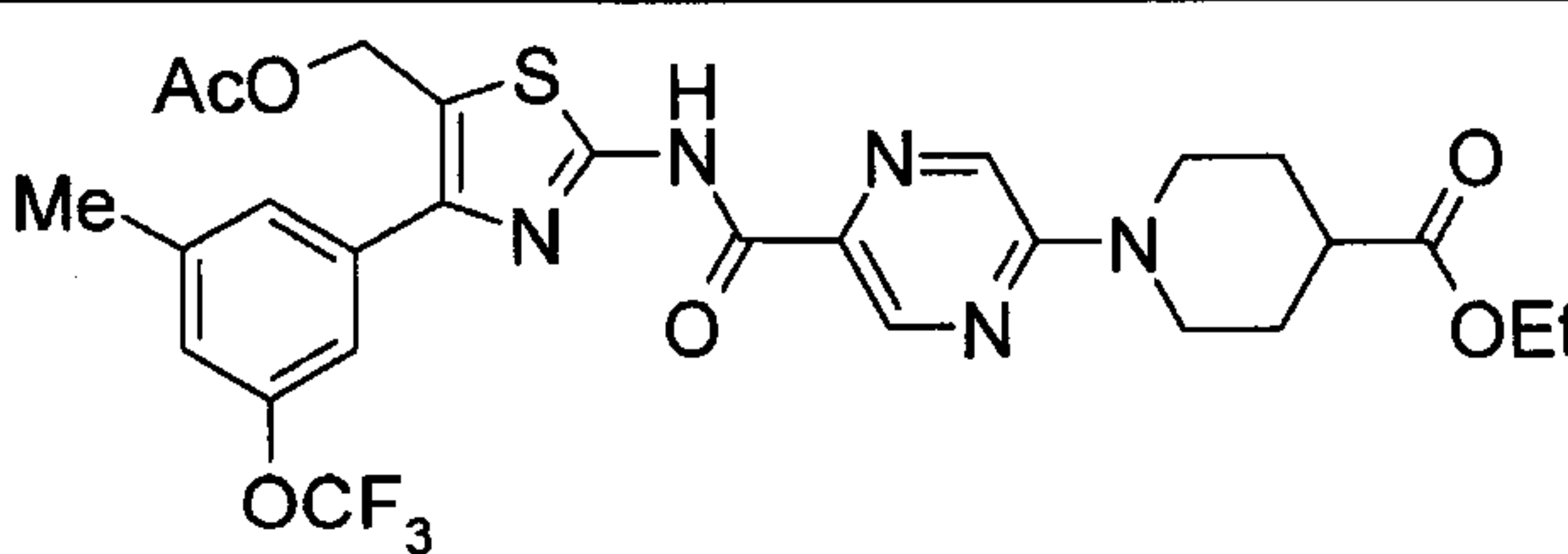
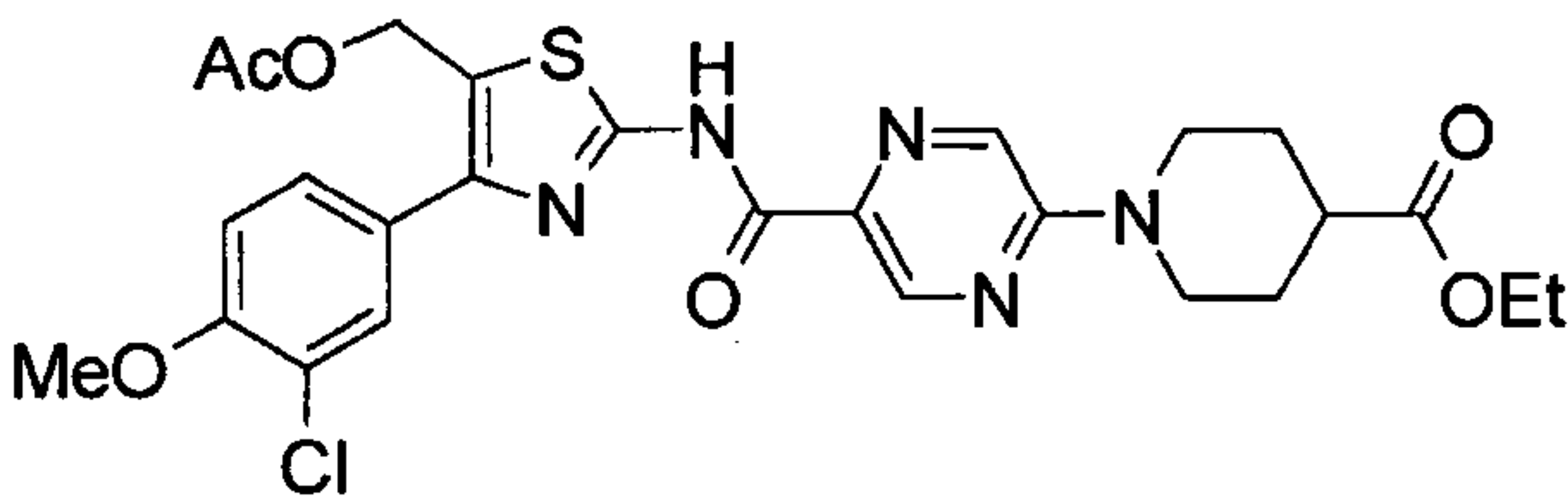
[0185]

[Table 24]

PEx	PSyn	Str	DATA
136	17		ESI+: 647
137	17		ESI+: 664
138	17		ESI+: 664
139	17		ESI+: 636
140	17		ESI+: 666
141	17		ESI+: 552

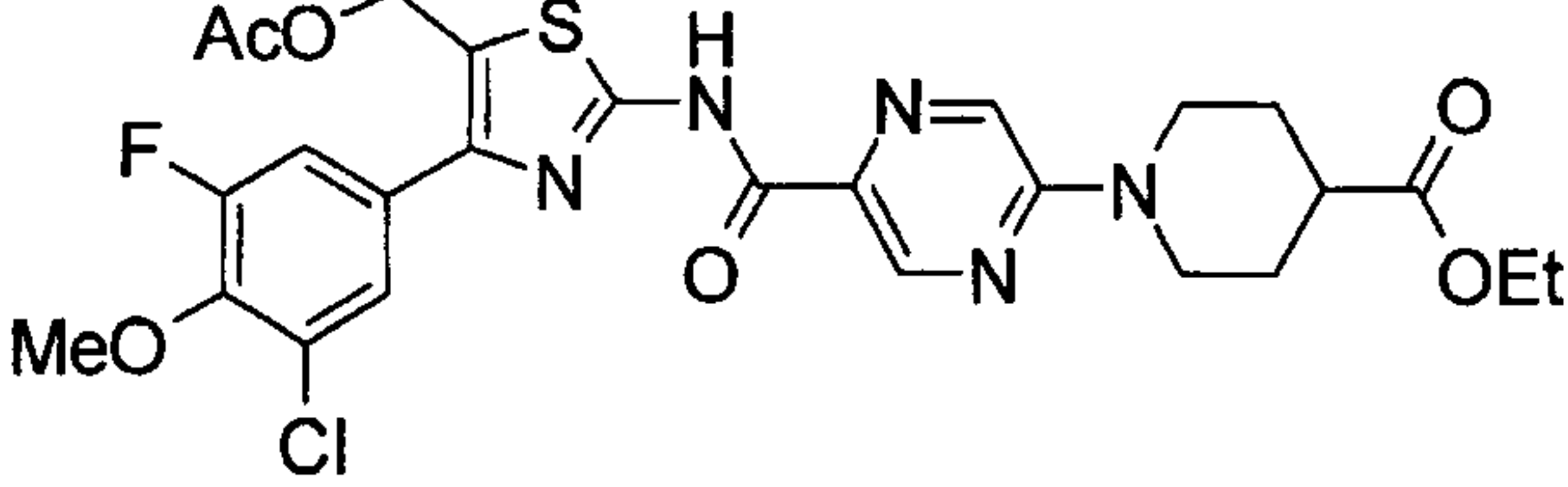
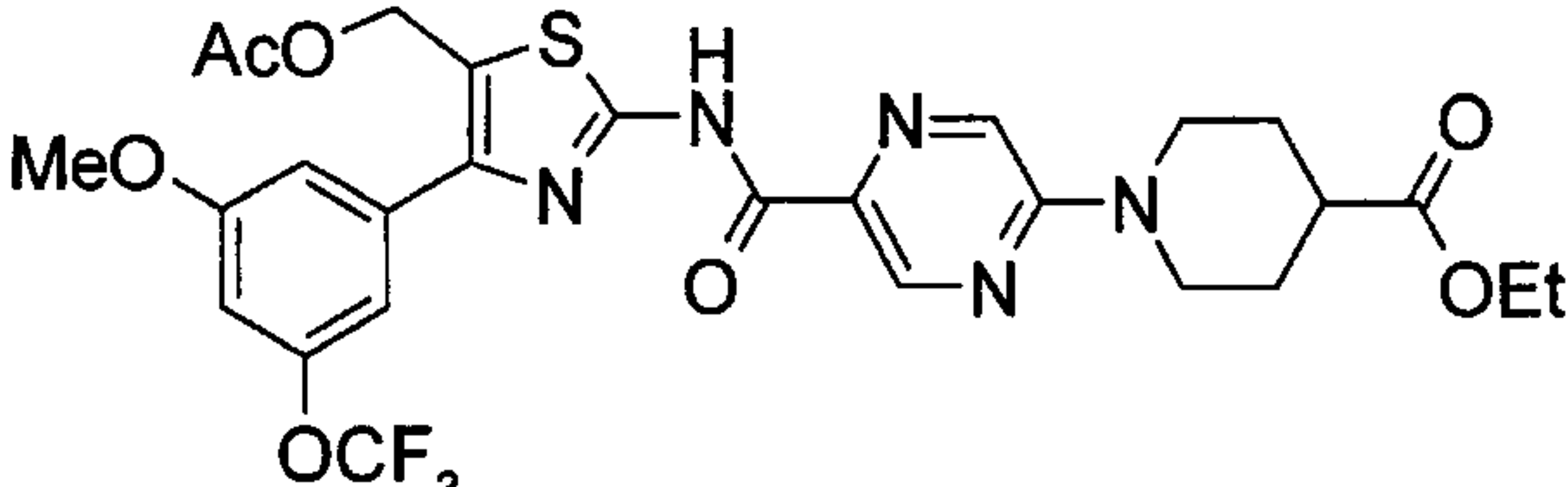
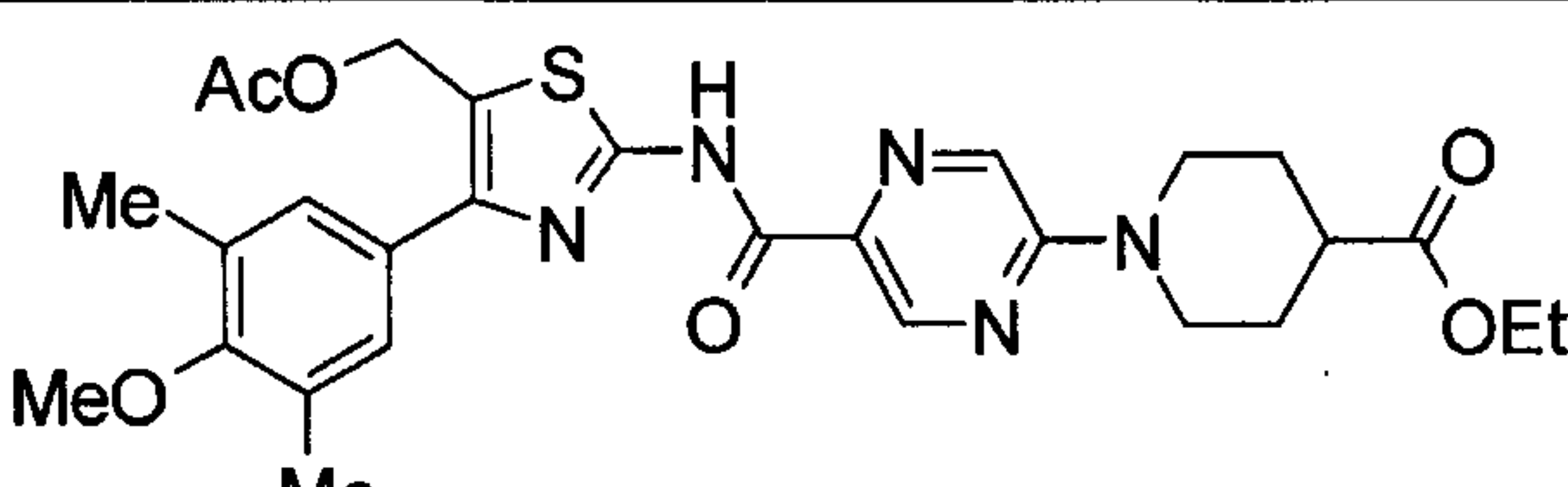
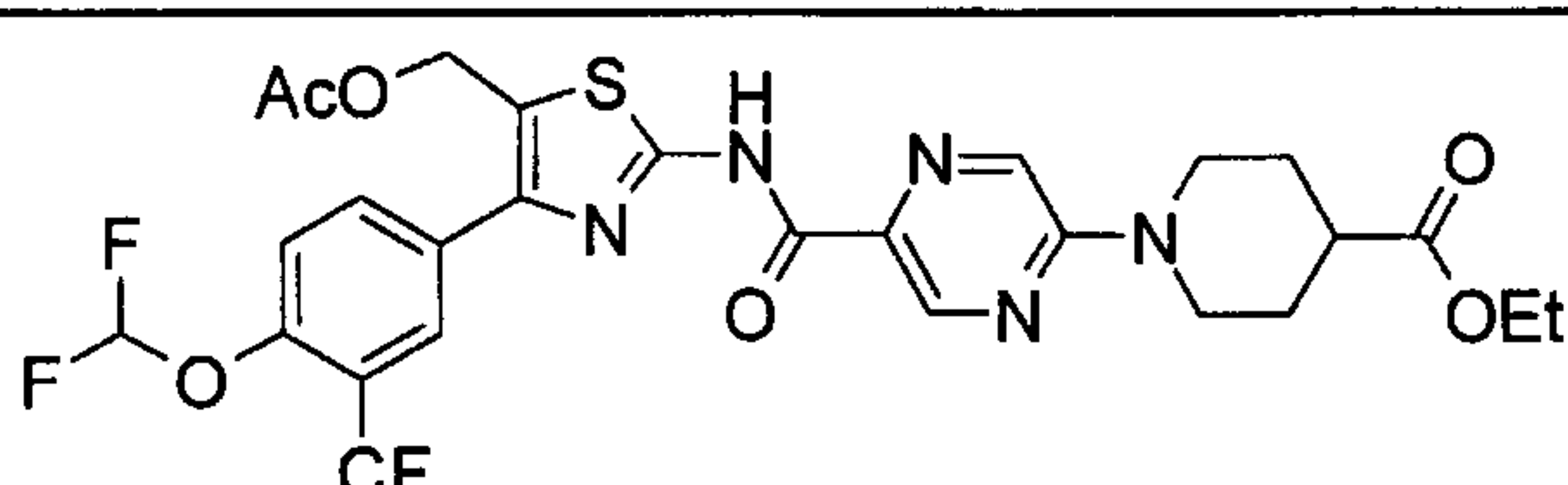
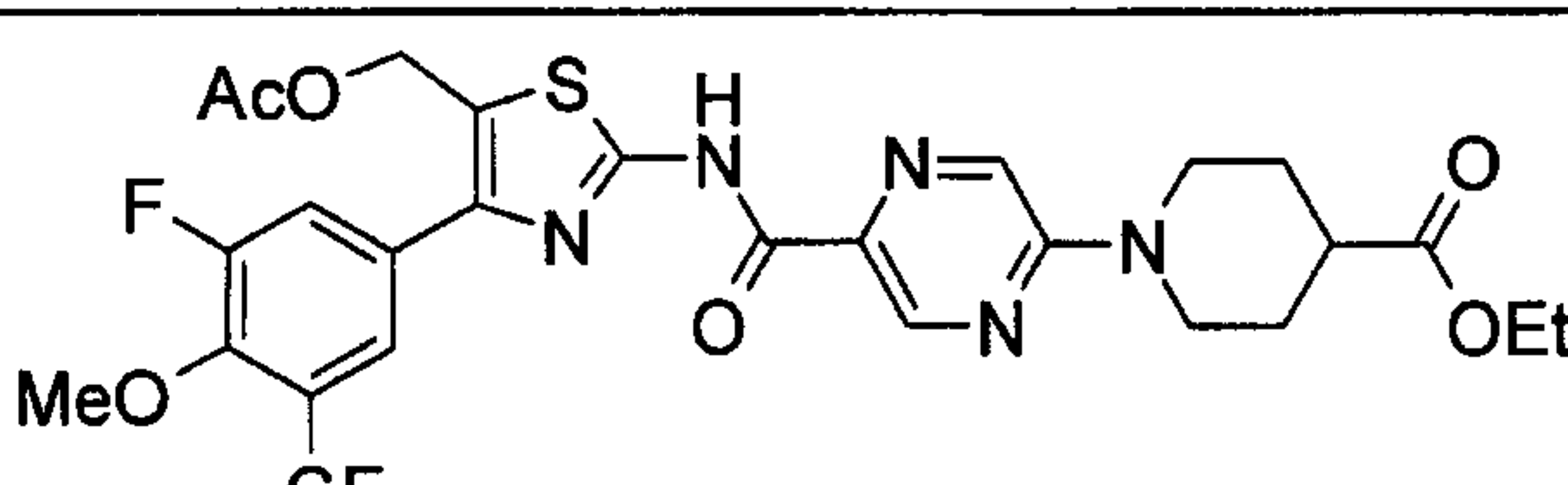
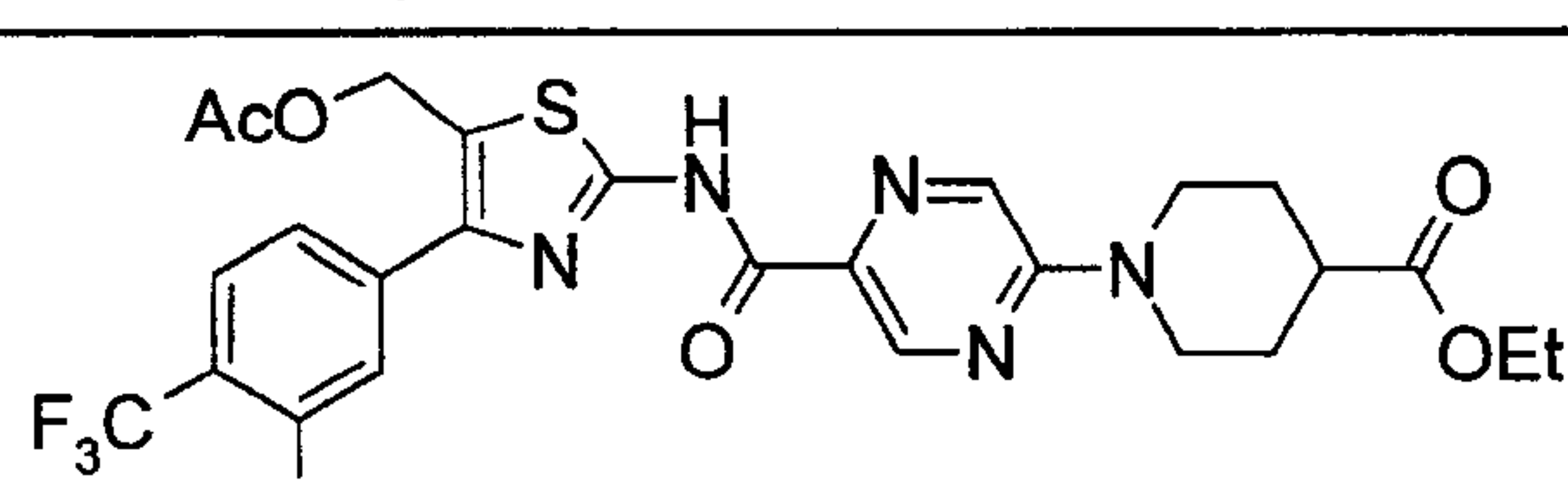
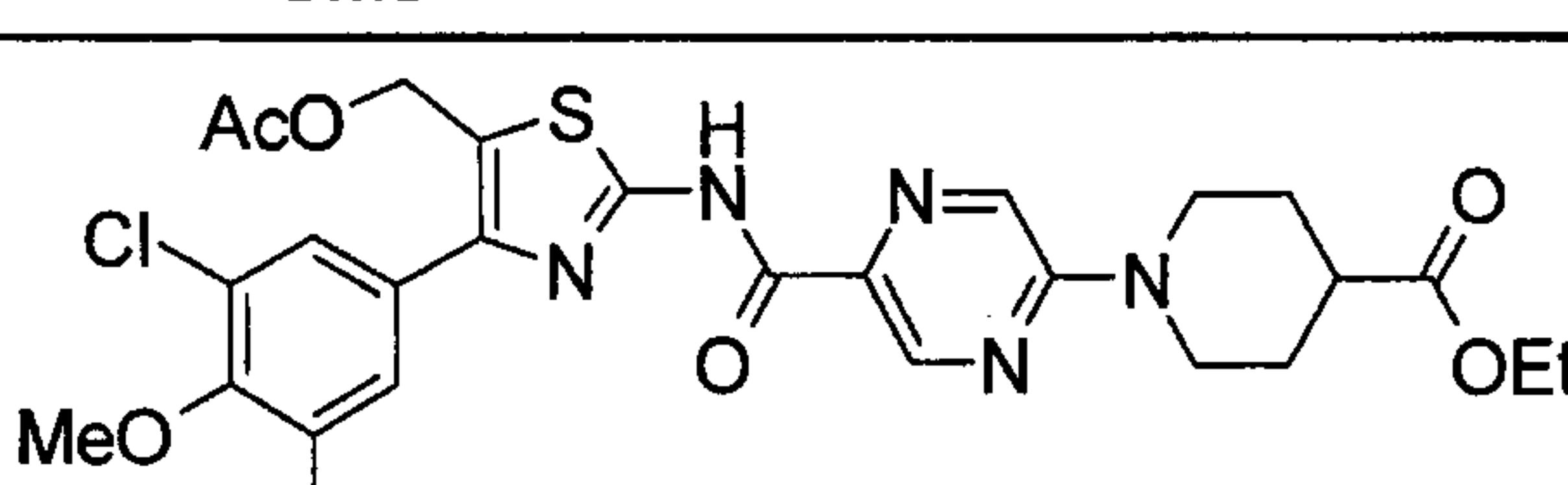
[0186]

[Table 25]

PEx	PSyn	Str	DATA
142	17		ESI+: 624
143	18		ESI+: 393
144	18		ESI+: 628
145	18		ESI+: 612
146	18		ESI+: 608
147	18		ESI+: 574

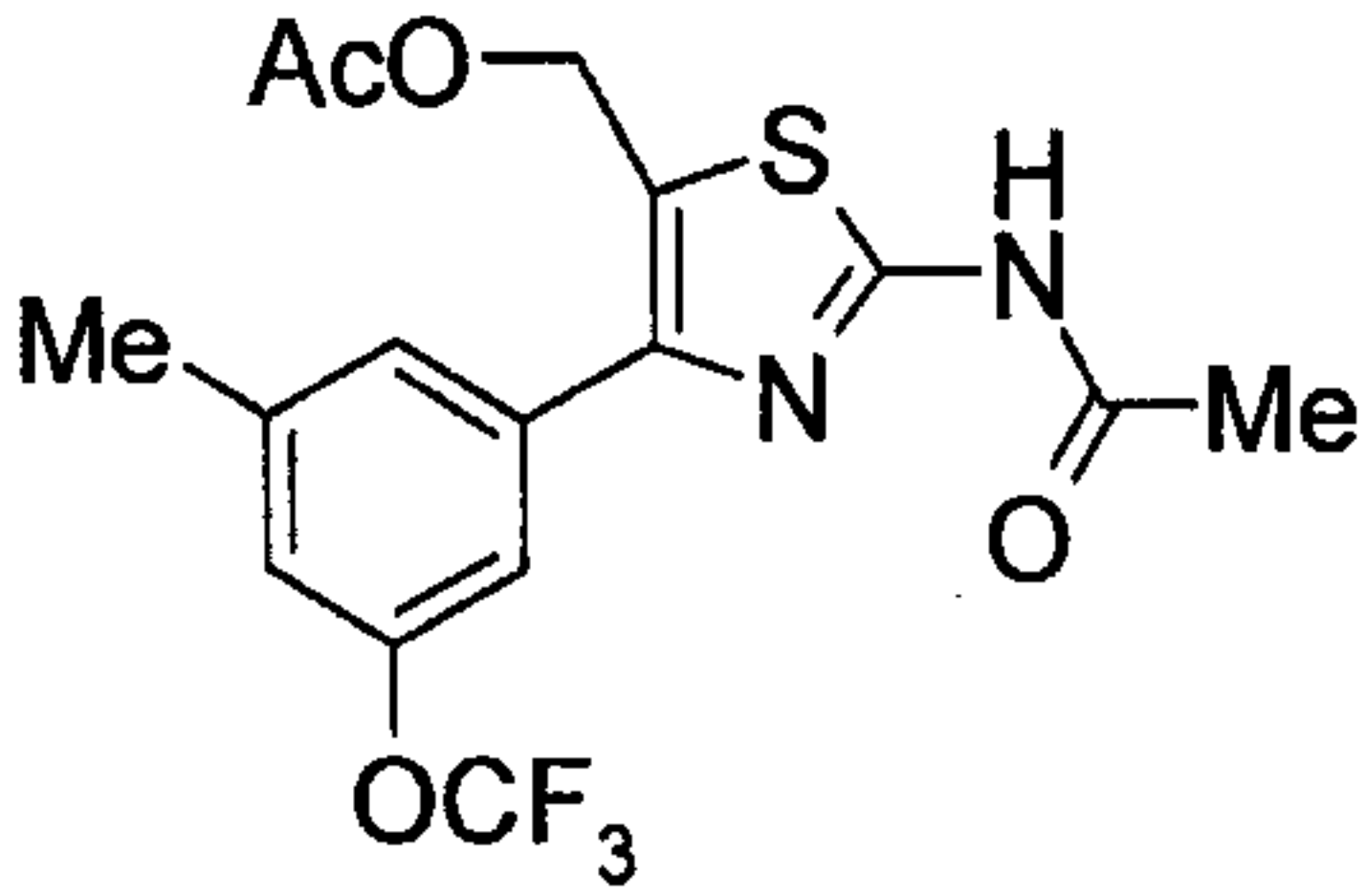
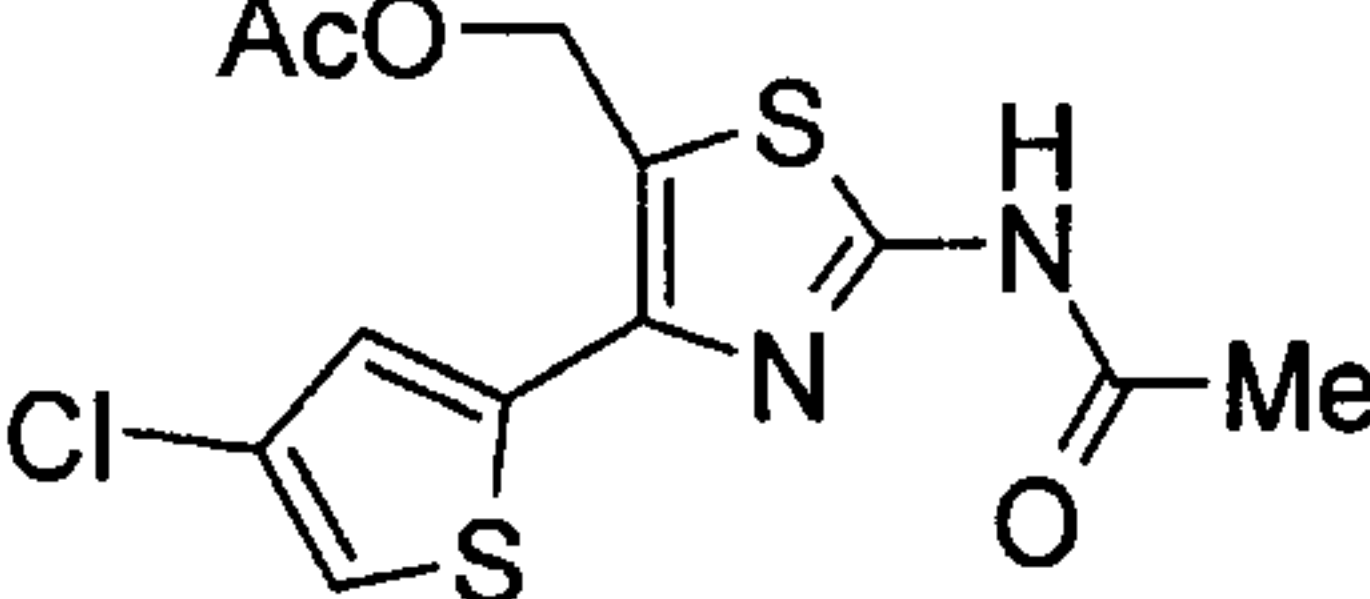
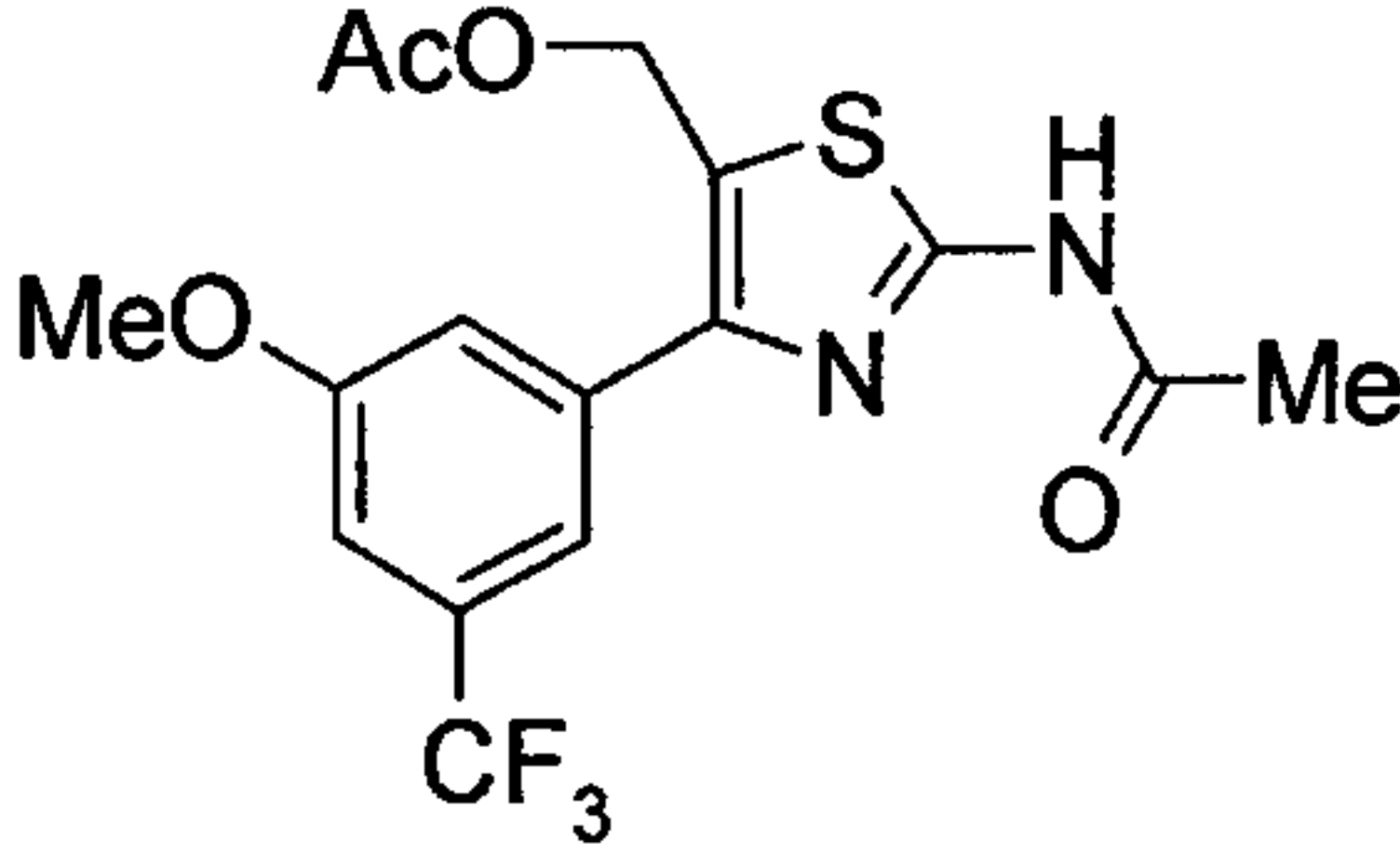
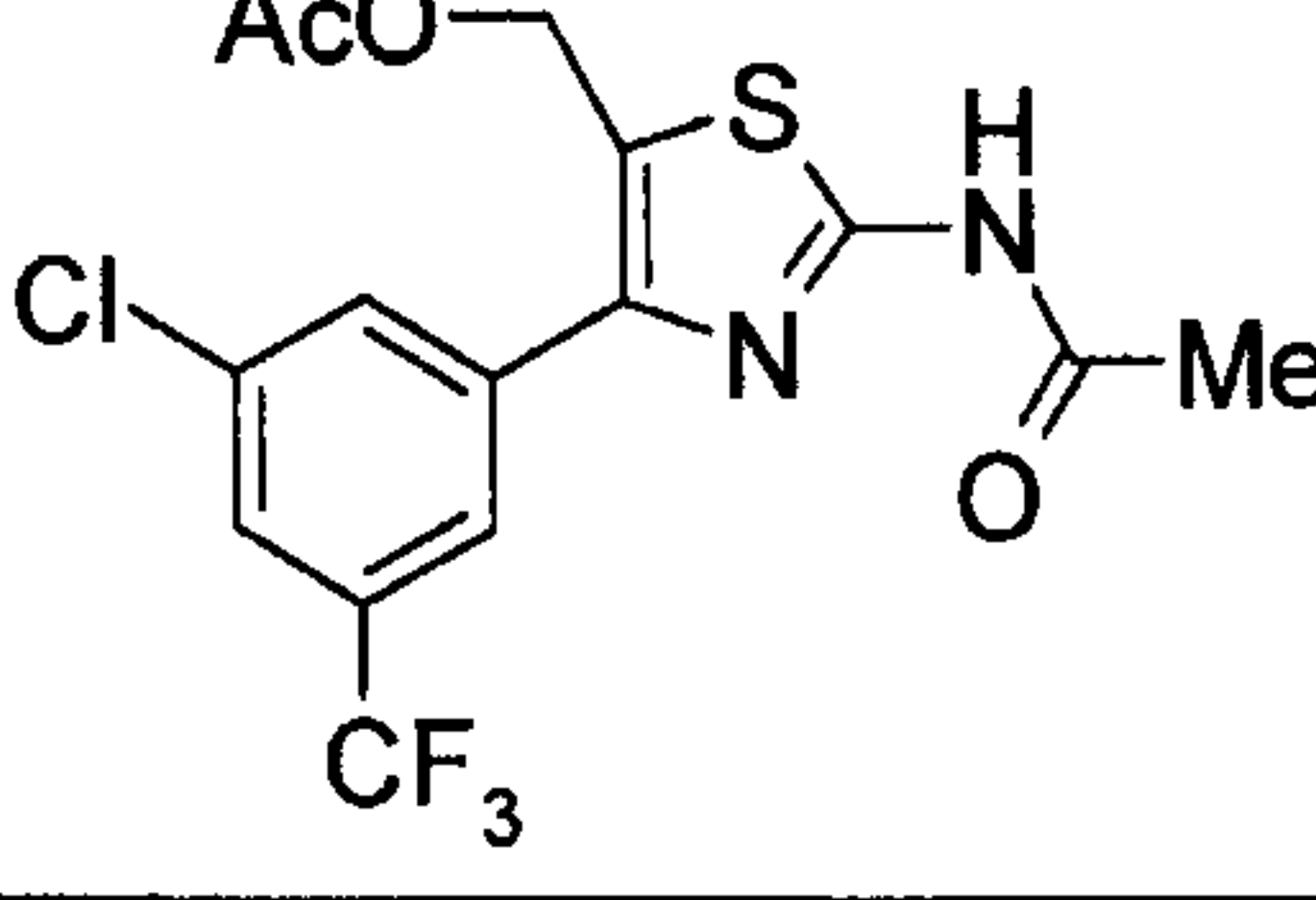
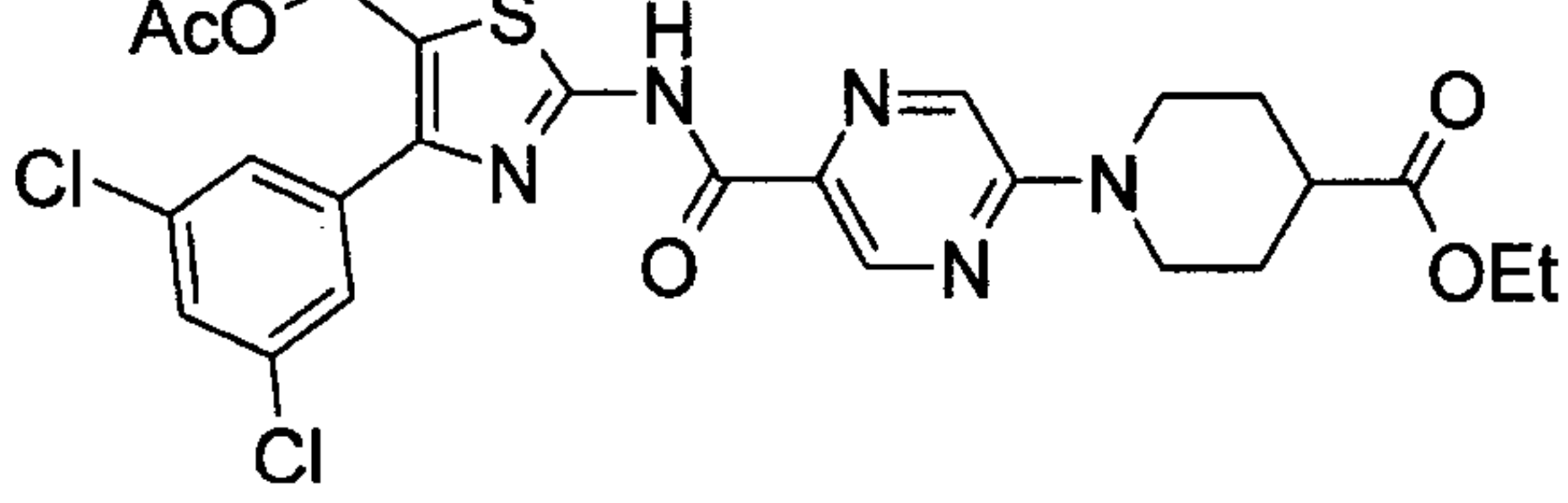
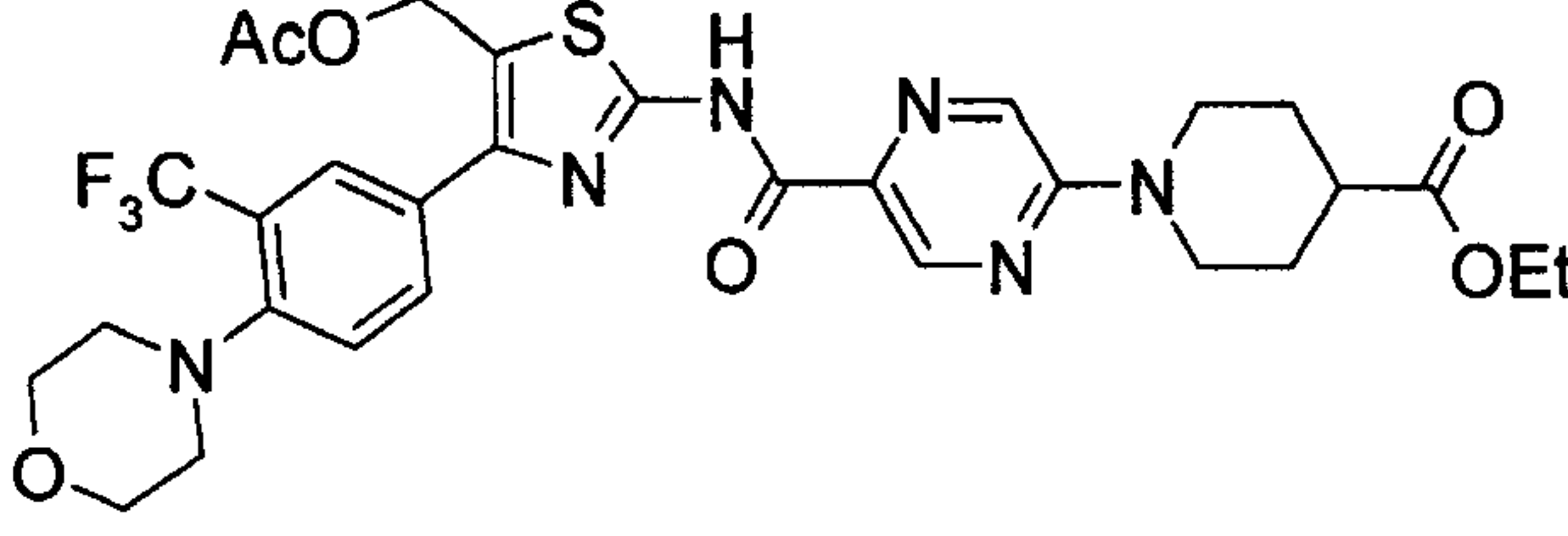
[0187]

[Table 26]

PEx	PSyn	Str	DATA
148	18		ESI+: 592
149	18		ESI+: 624
150	18		APCI/ESI+: 568
151	18		ESI+: 644
152	18		ESI+: 626
153	18		ESI+: 608
154	18		ESI+: 608

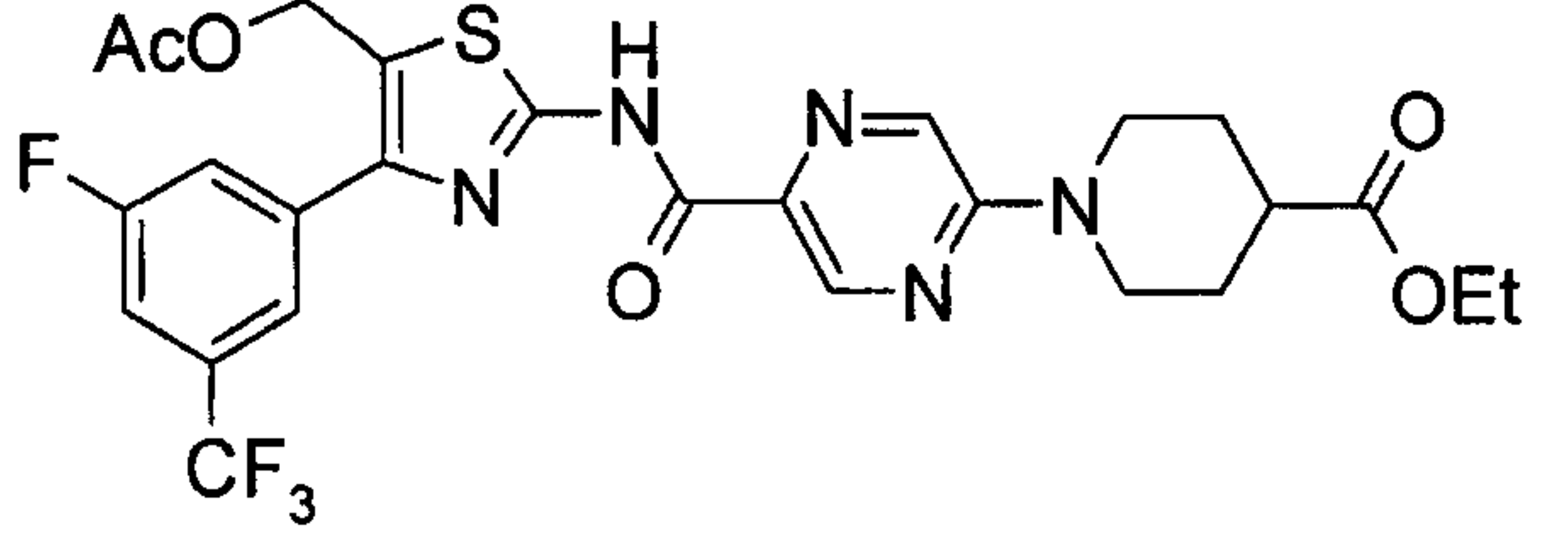
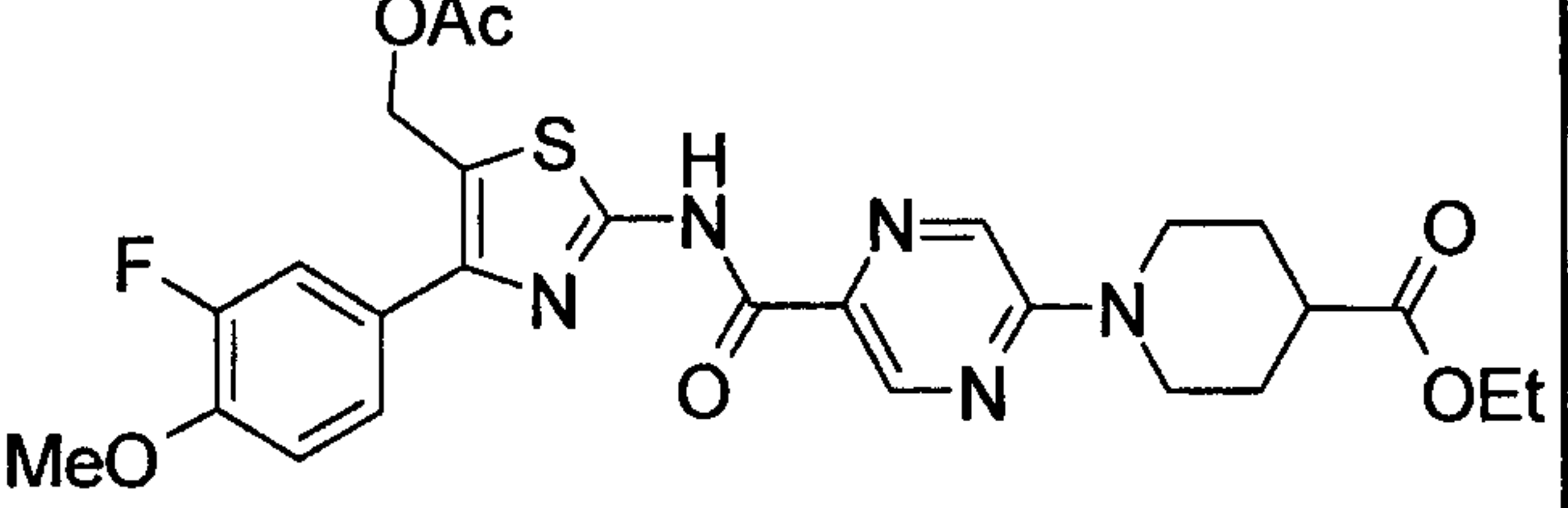
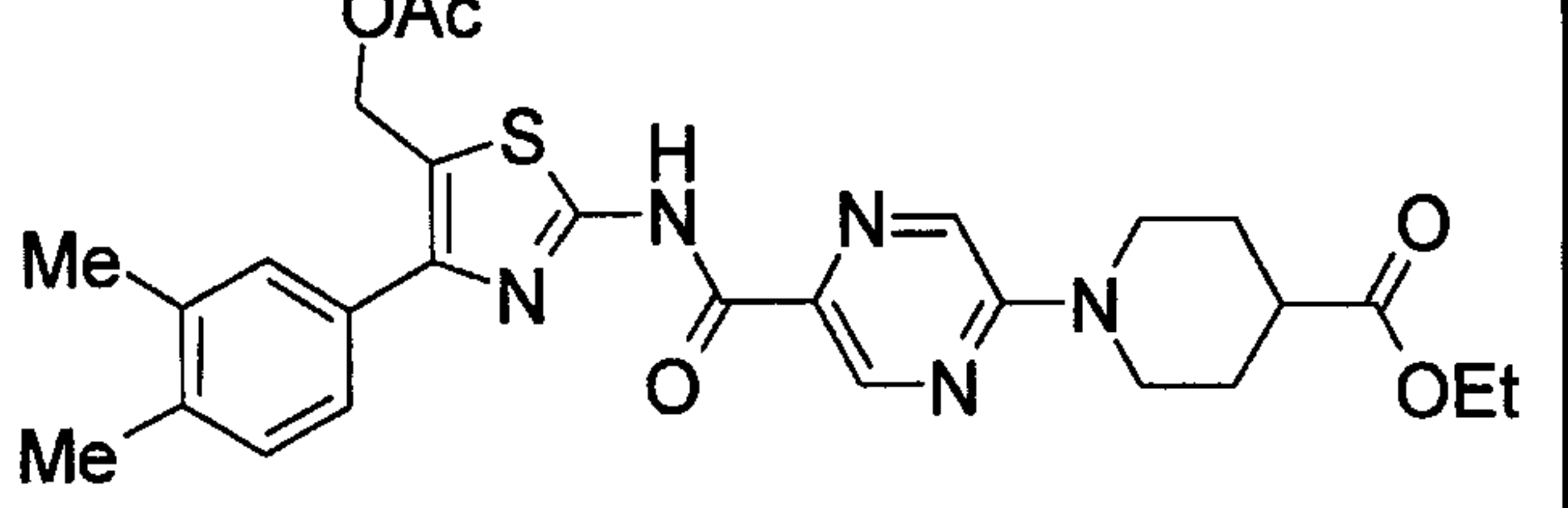
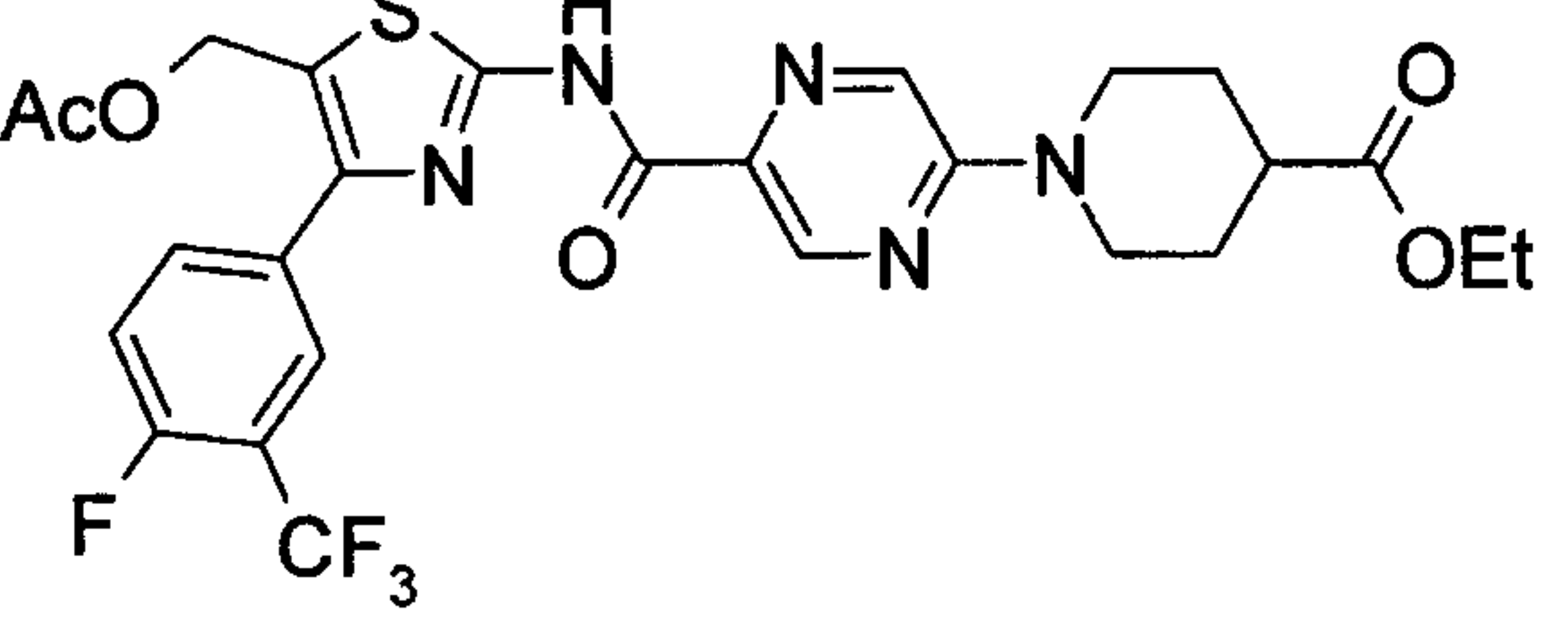
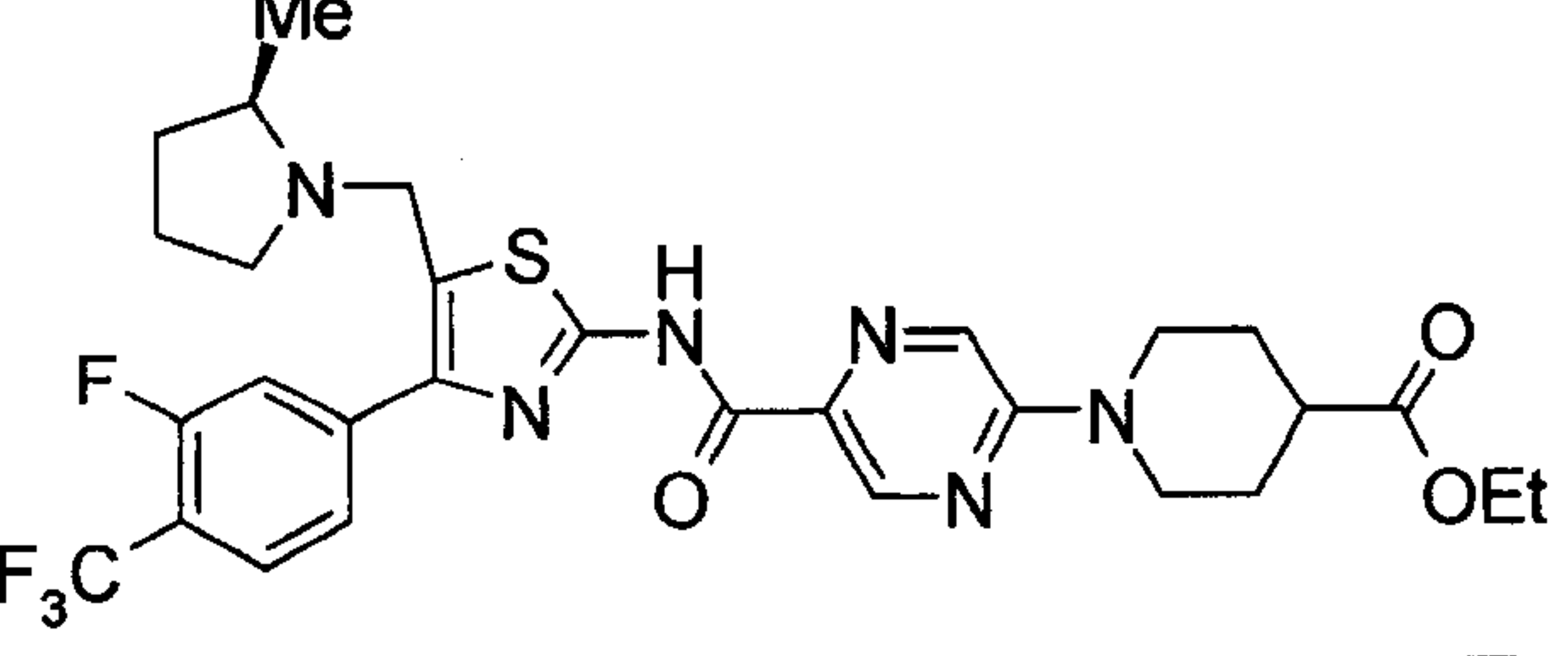
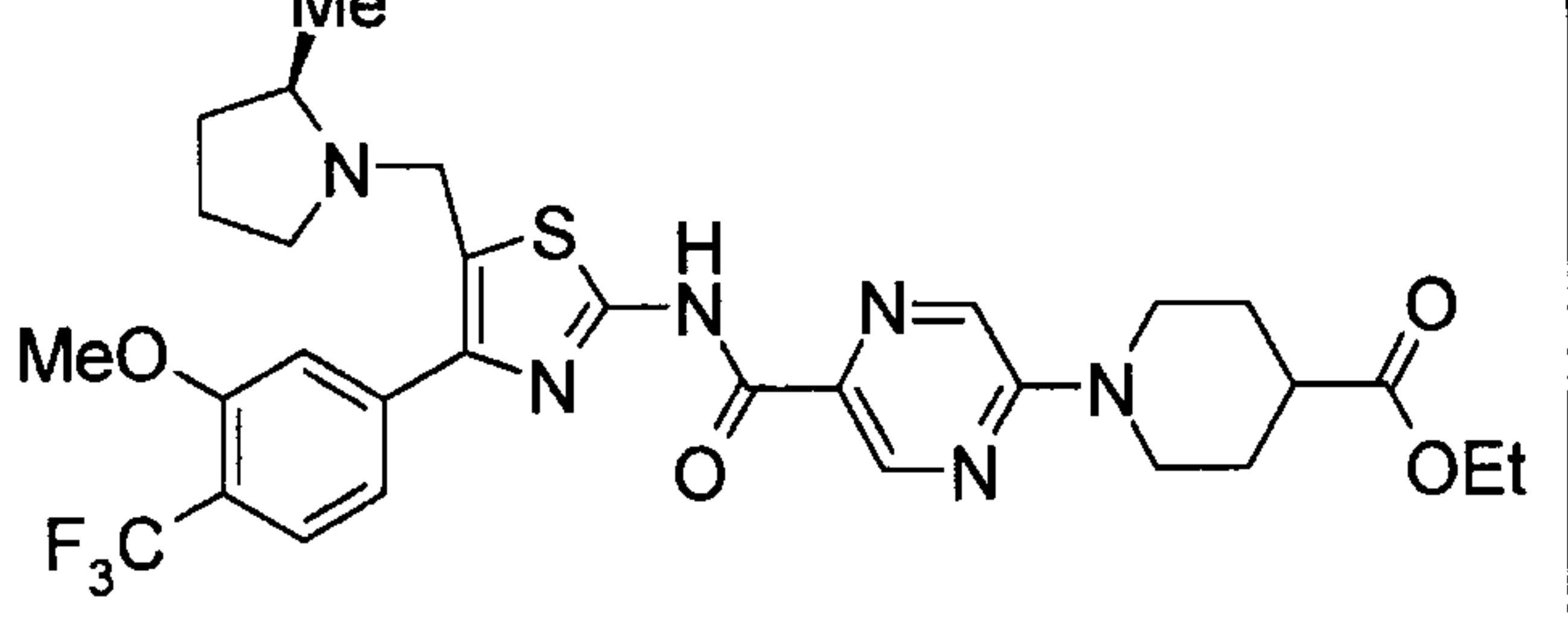
[0188]

[Table 27]

PEX	PSyn	Str	DATA
155	18		ESI+: 389
156	18		ESI+: 331
157	18		ESI+: 389
158	18		ESI+: 393 , 395
159	18		ESI+: 578 , 580
160	18		ESI+: 663

[0189]

[Table 28]

PEx	PSyn	Str	DATA
161	18		ESI+: 596
162	19		APCI/ESI+: 558
163	19		ESI+: 538
164	20		ESI+: 596
165	22		ESI+: 621
166	22		ESI+: 633

[0190]

[Table 29]

PEX	PSyn	Str	DATA
167	23		ESI+: 414
168	23		ESI+: 356
169	23		ESI+: 414
170	23		ESI+: 462
171	23		ESI+: 418 , 420

[0191]

[Table 30]

PEx	PSyn	Str	DATA
172	23		ESI+: 675
173	23		ESI+: 689
174	23		ESI+: 675
175	23		ESI+: 689
176	23		ESI+: 675

[0192]

[Table 31]

PEX	PSyn	Str	DATA
177	23		ESI+: 689
178	23		ESI+: 689
179	23		ESI+: 705
180	23		ESI+: 719
181	23		ESI+: 705

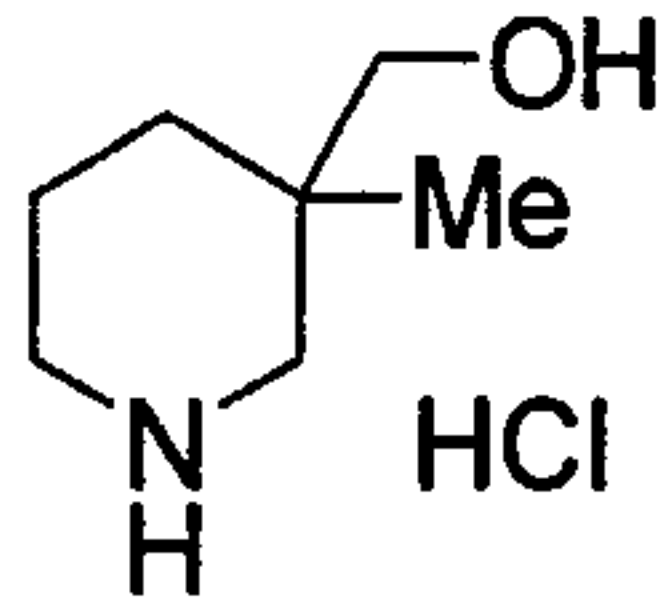
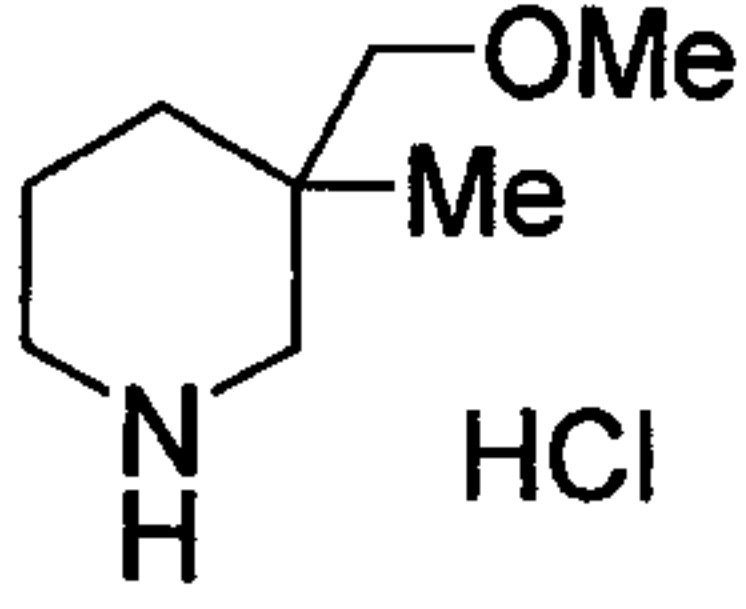
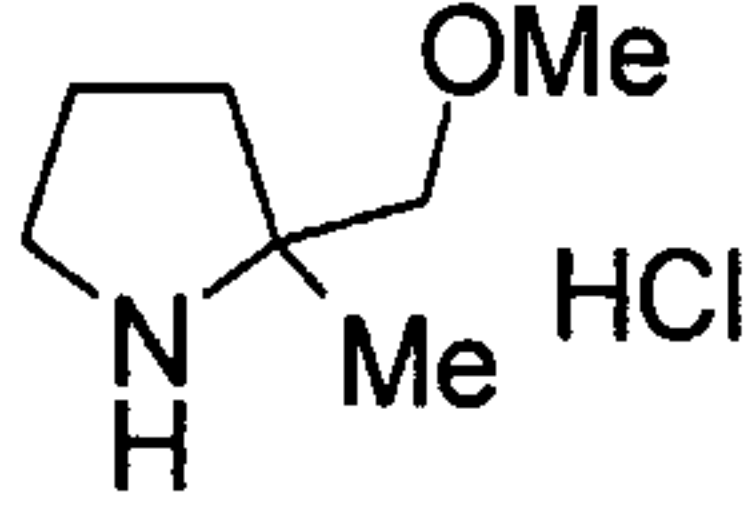
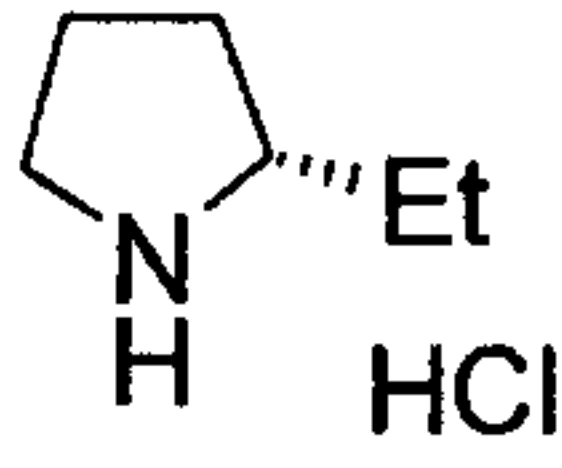
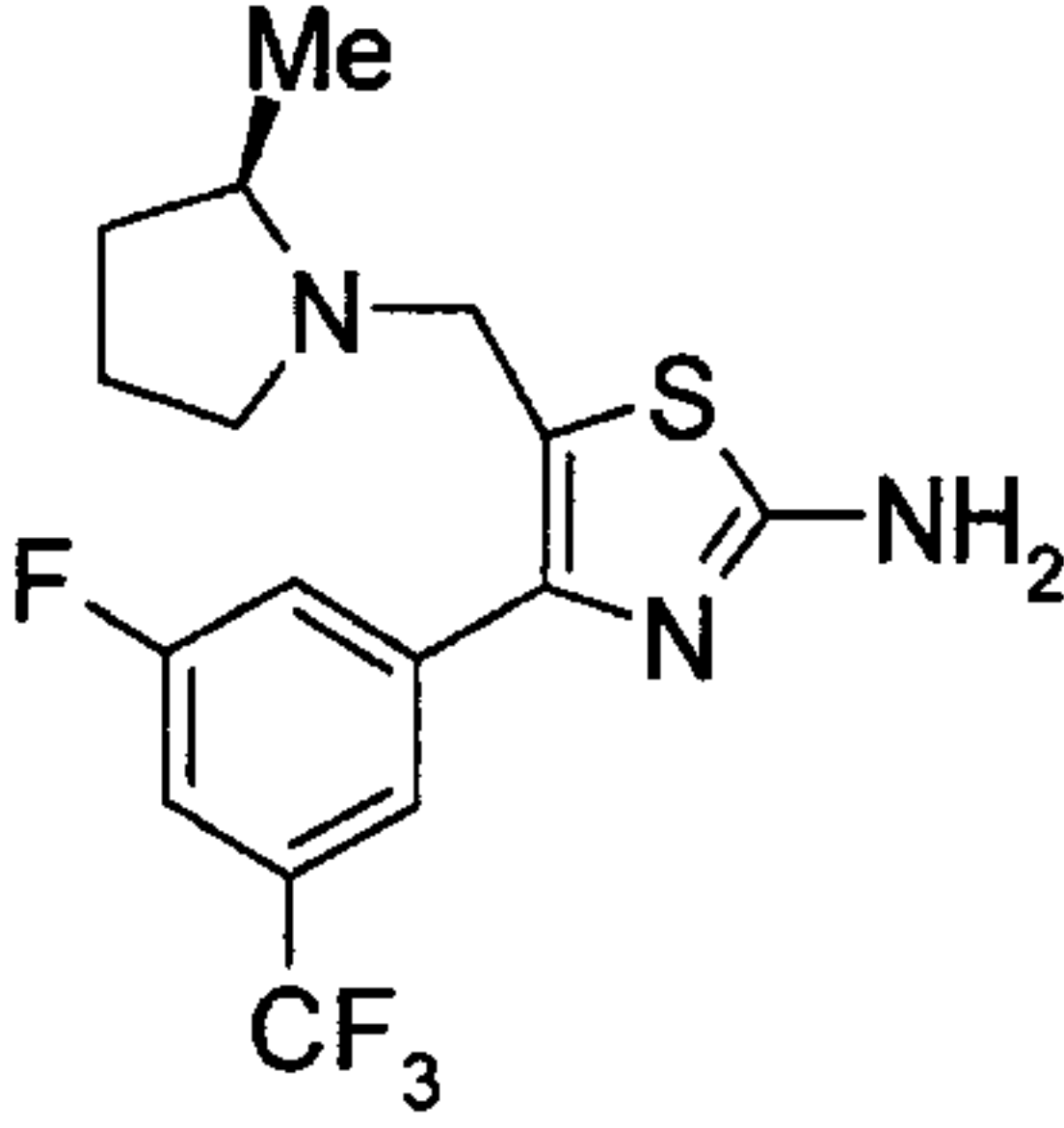
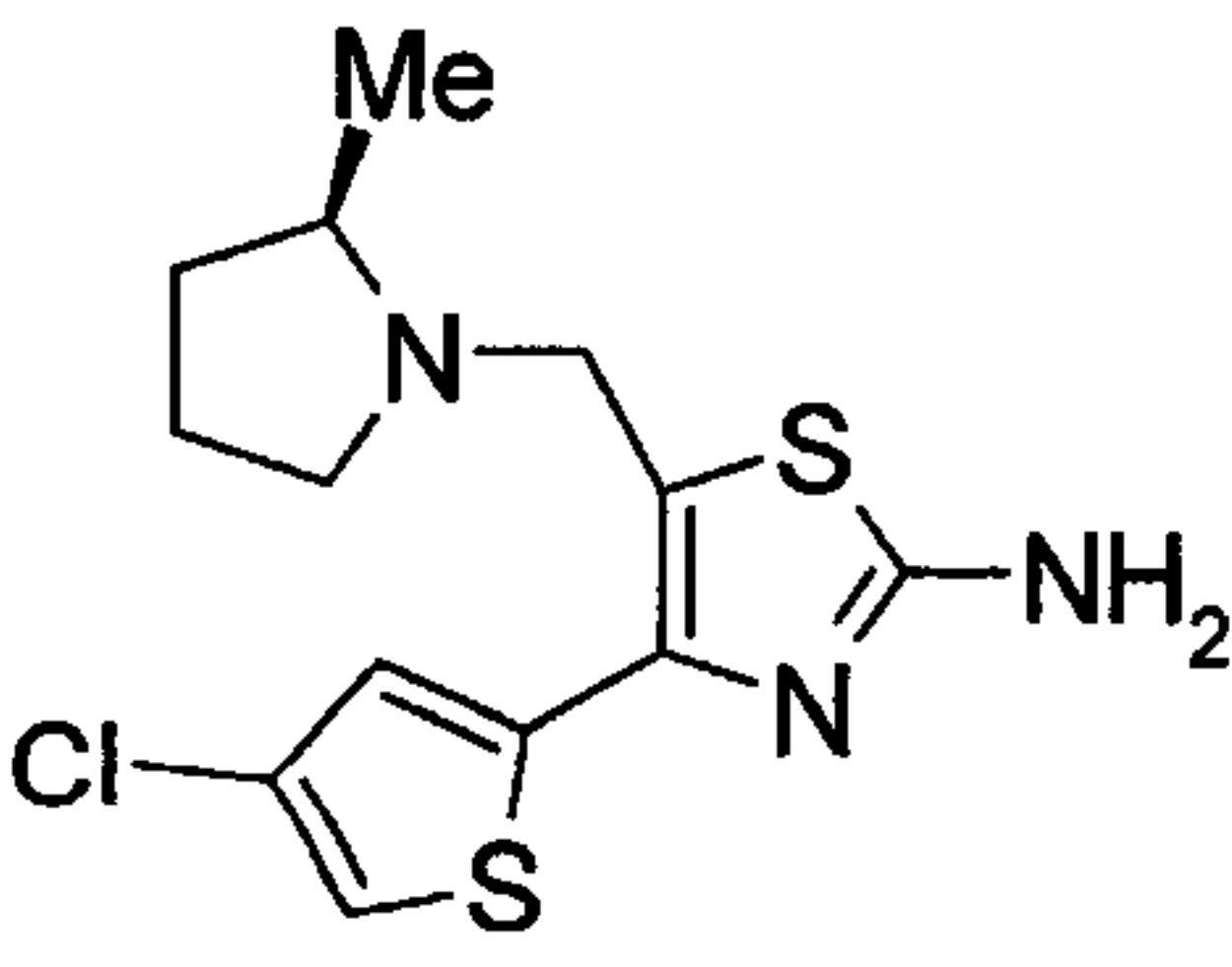
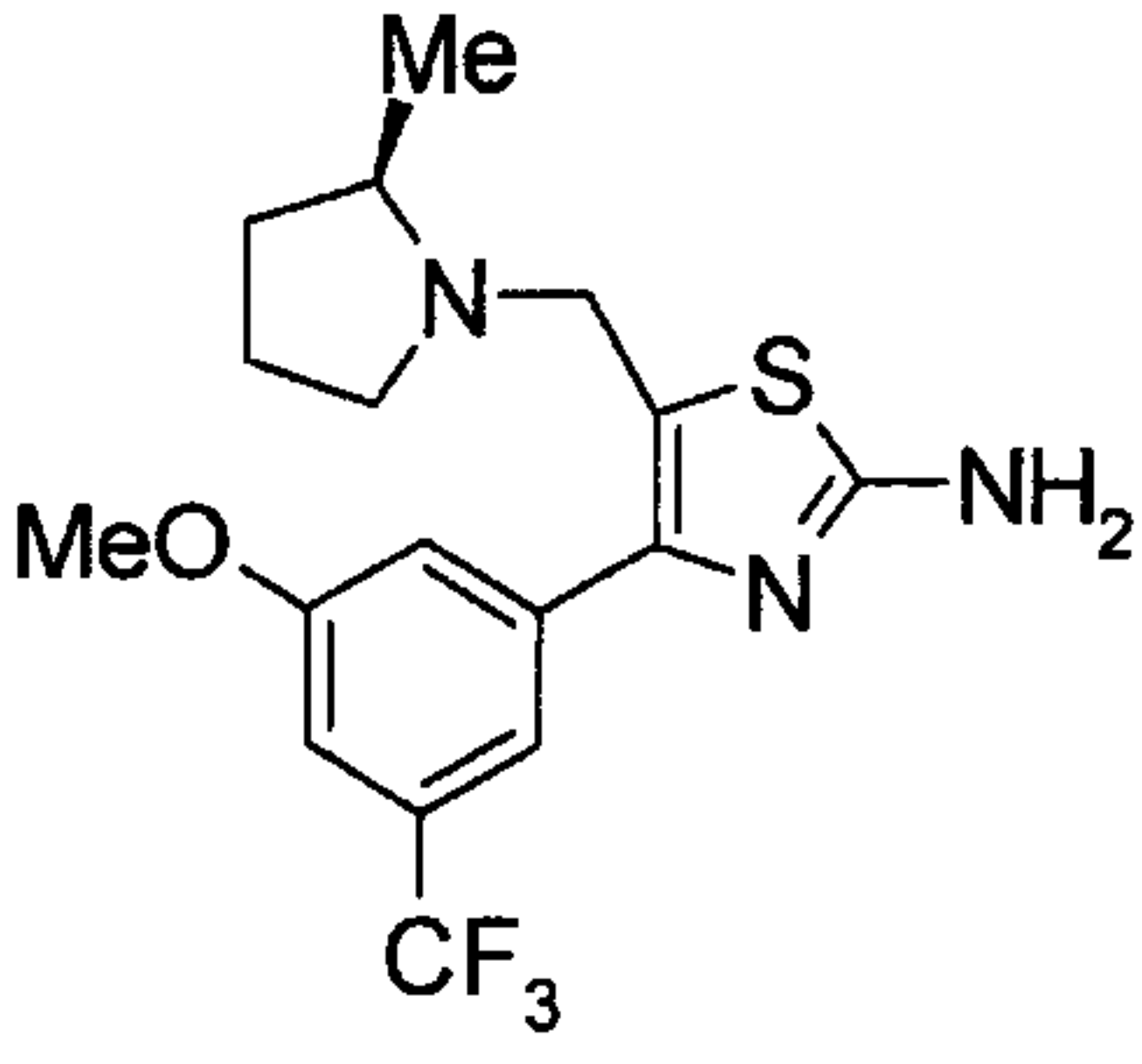
[0193]

[Table 32]

PEx	PSyn	Str	DATA
182	23		ESI+: 719
183	23		ESI+: 591
184	23		ESI+: 605
185	23		ESI+: 647
186	24		ESI+: 669 , 671
187	24		ESI+: 677

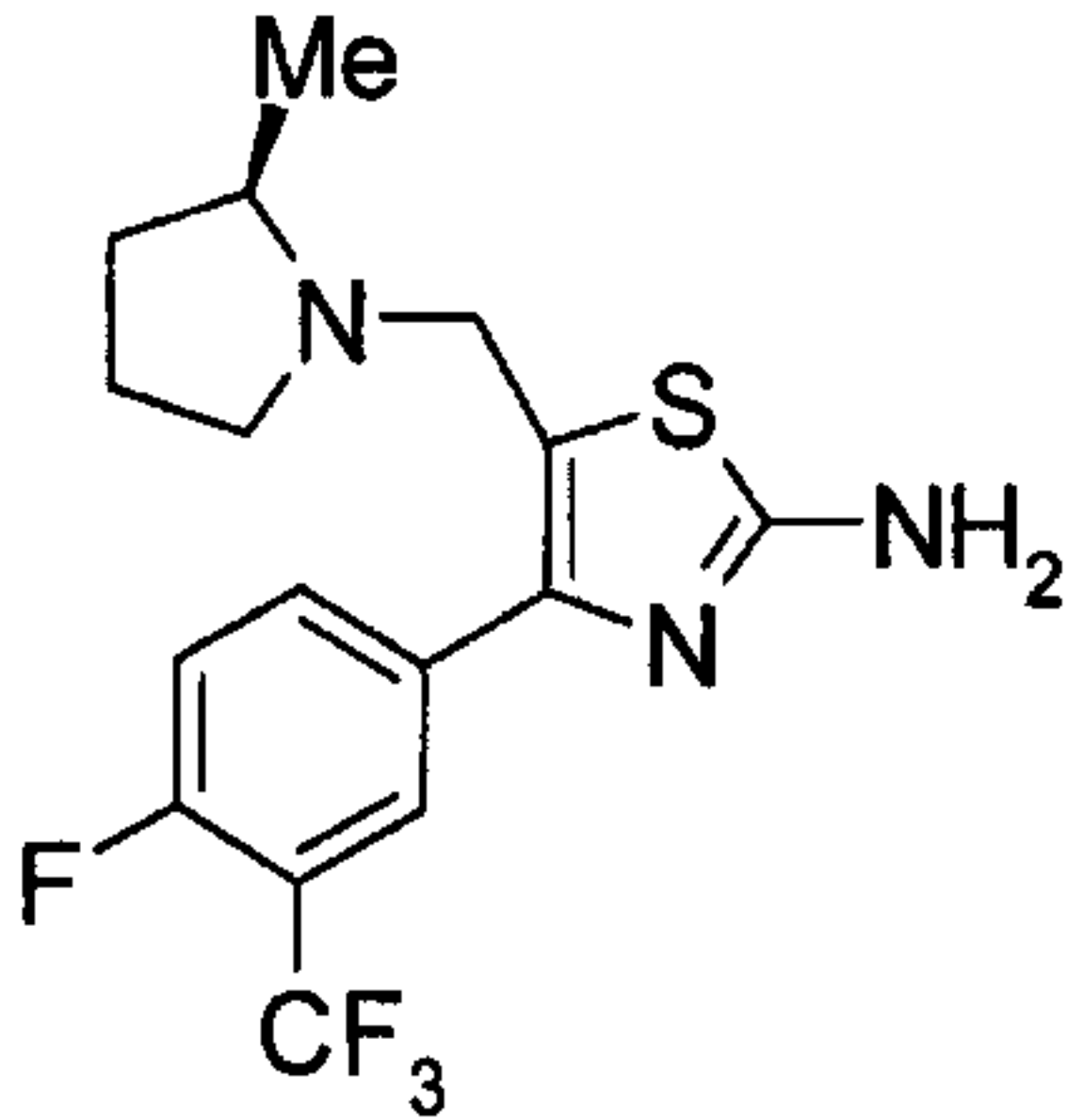
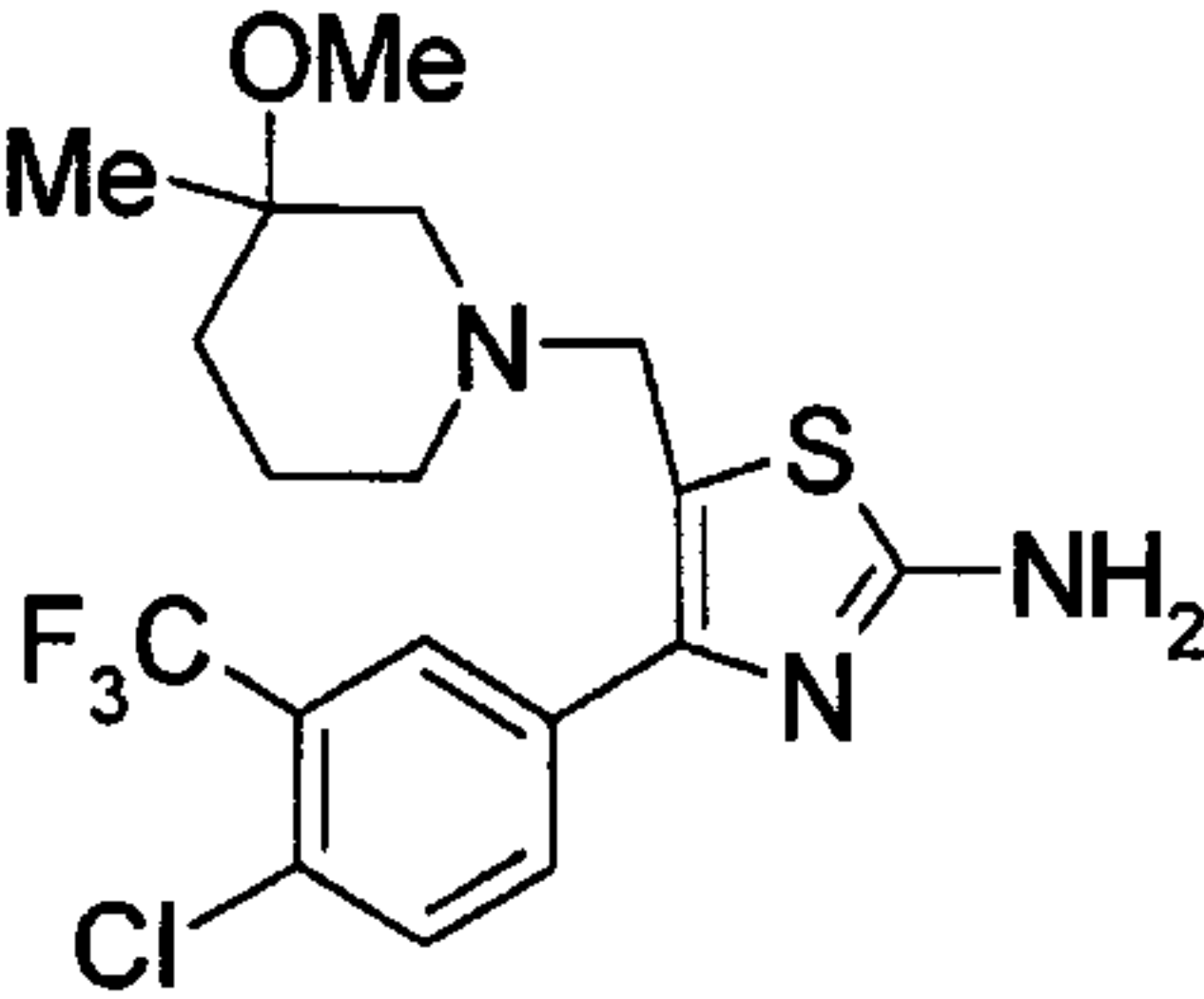
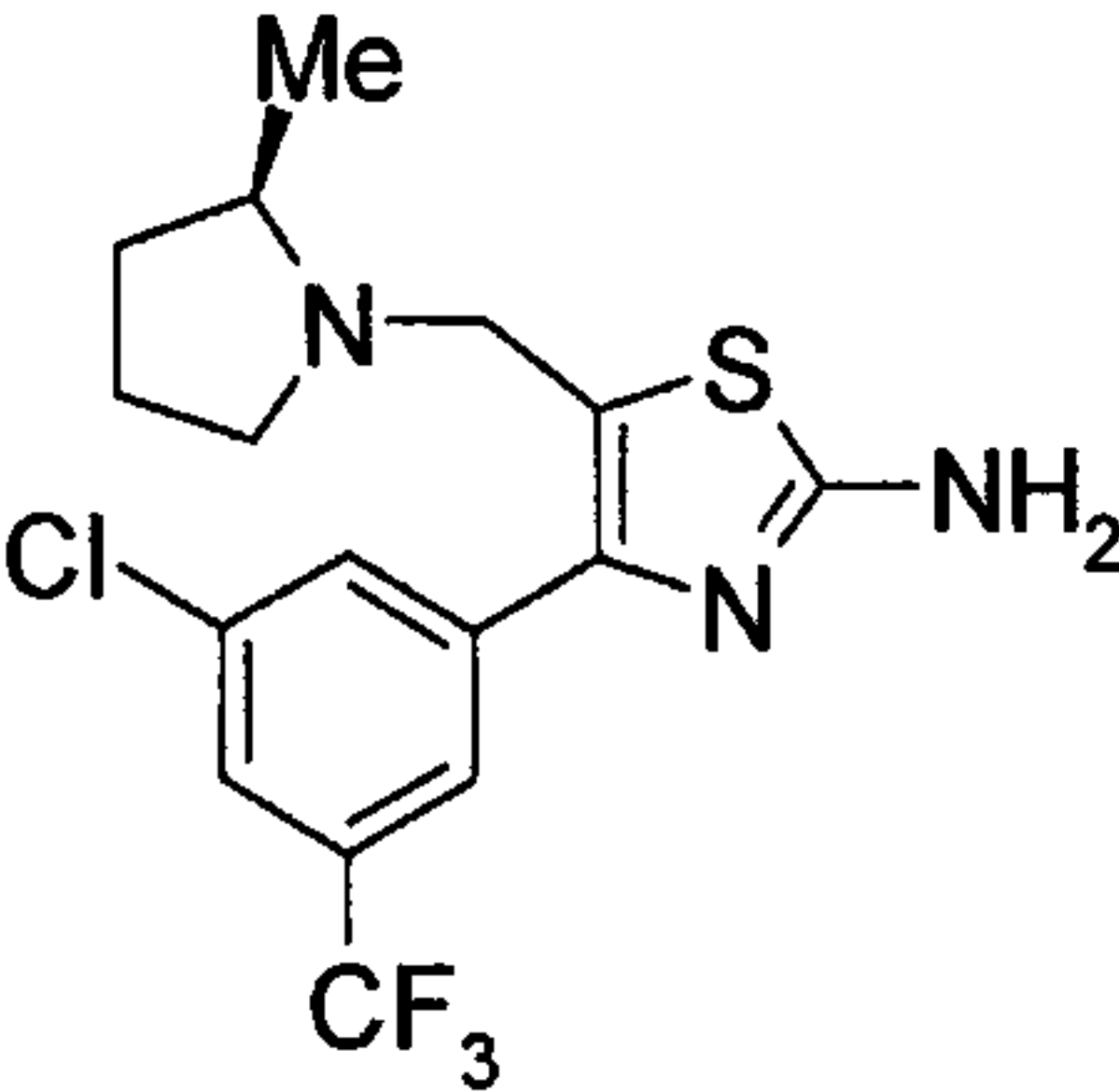
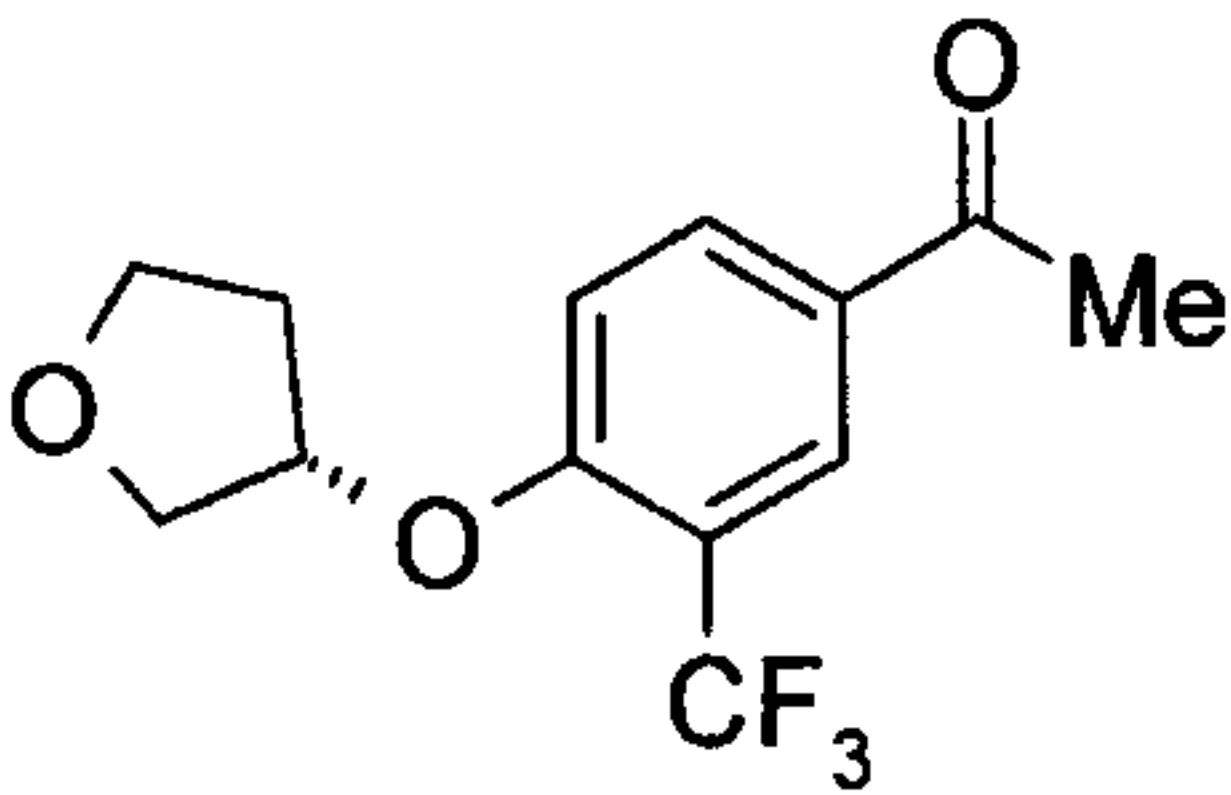
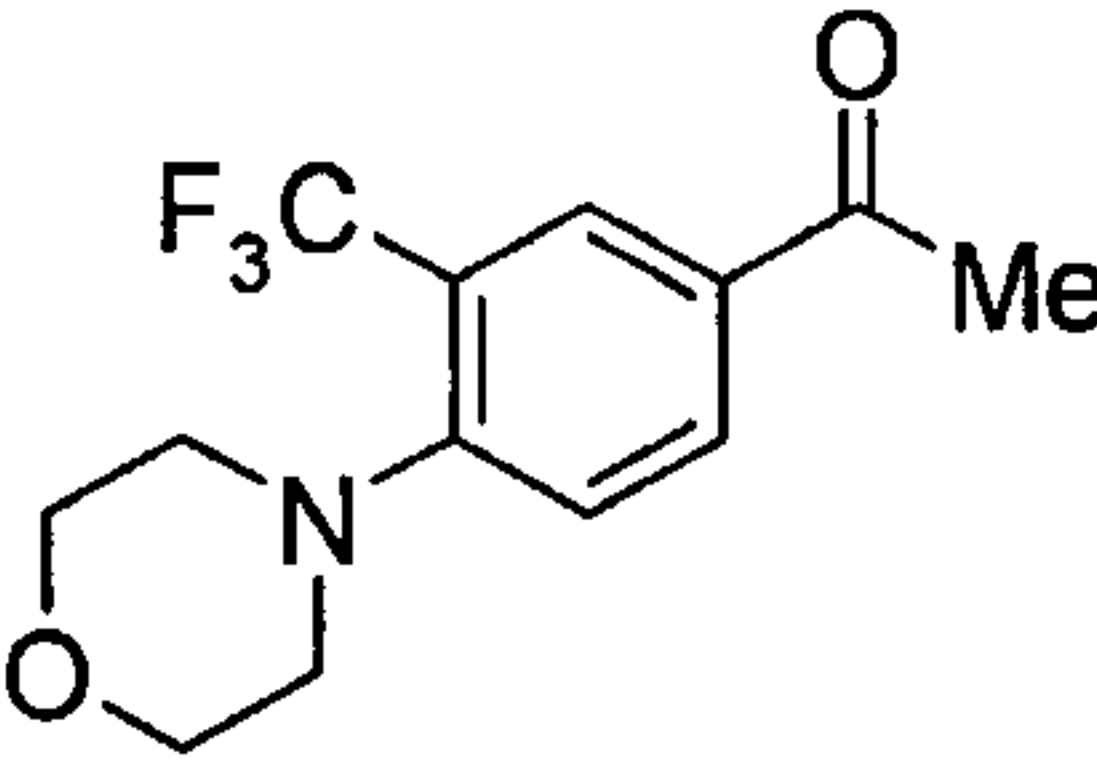
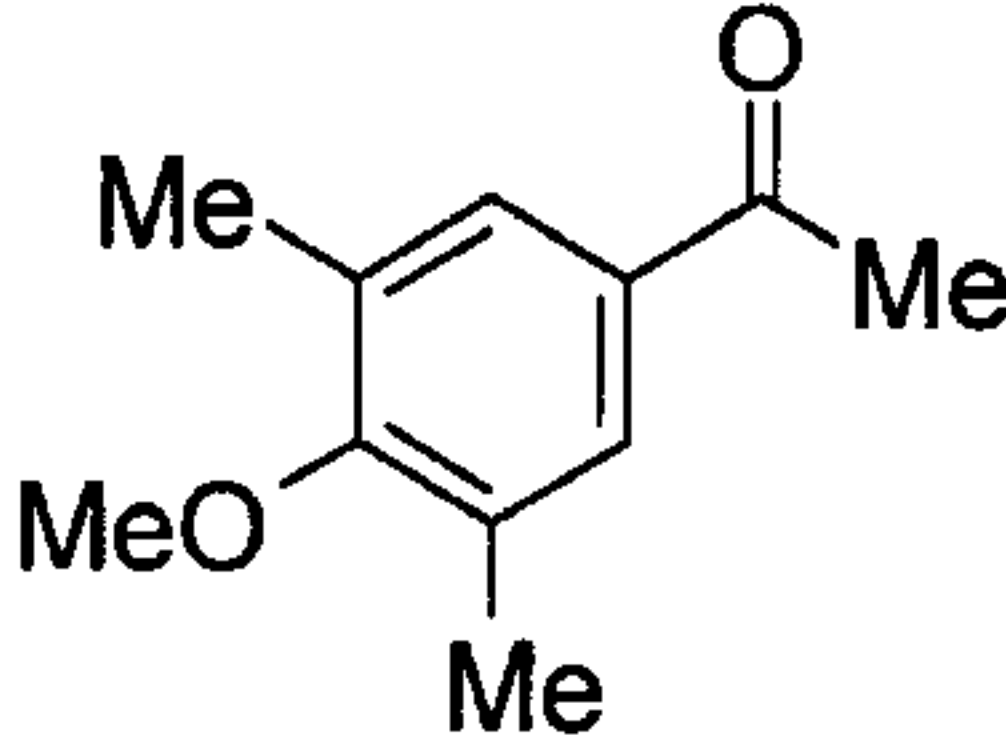
[0194]

[Table 33]

PEx	PSyn	Str	DATA
188	26		ESI+: 130
189	26		ESI+: 144
190	26		ESI+: 130
191	26		ESI+: 100
192	27		ESI+: 360
193	27		ESI-: 312
194	27		ESI+: 372

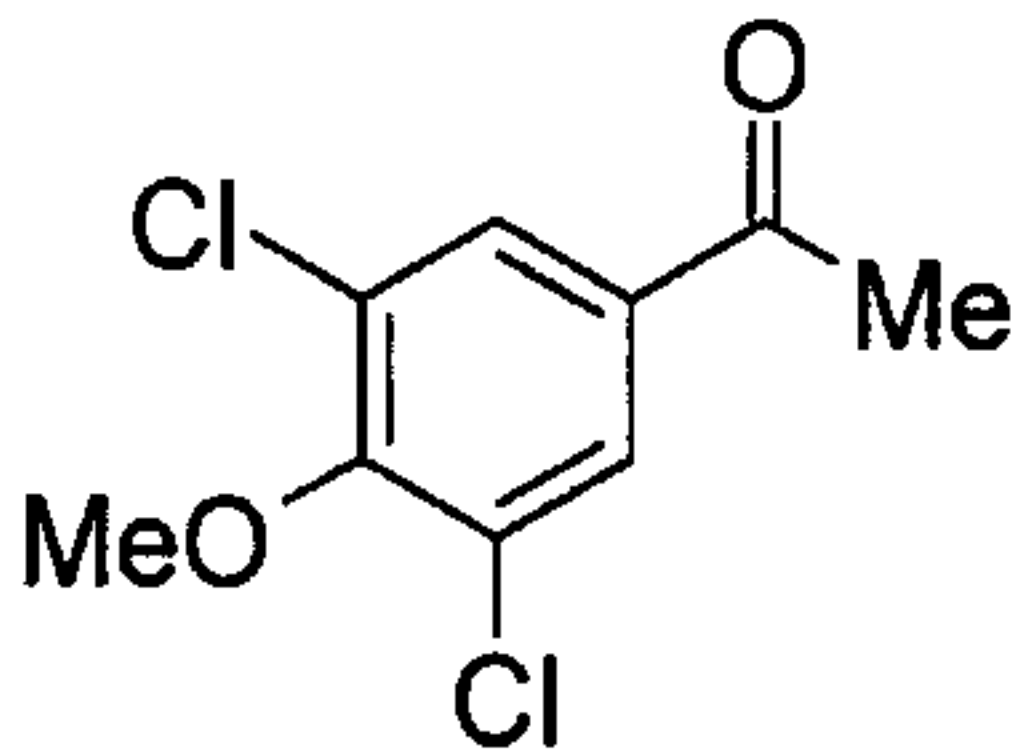
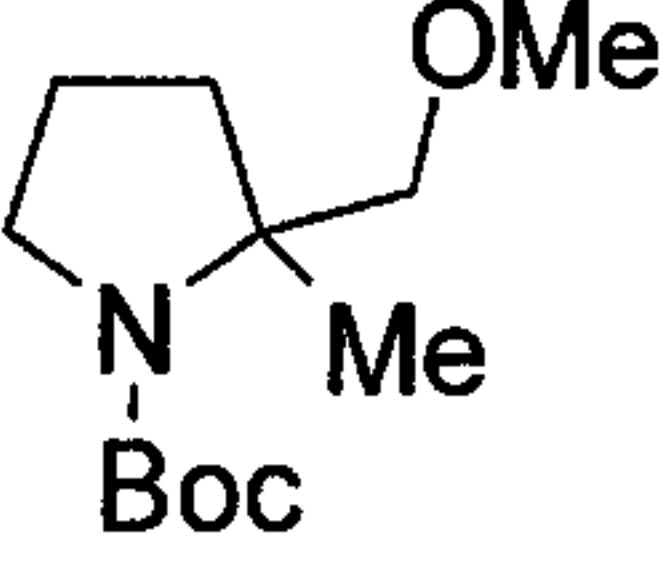
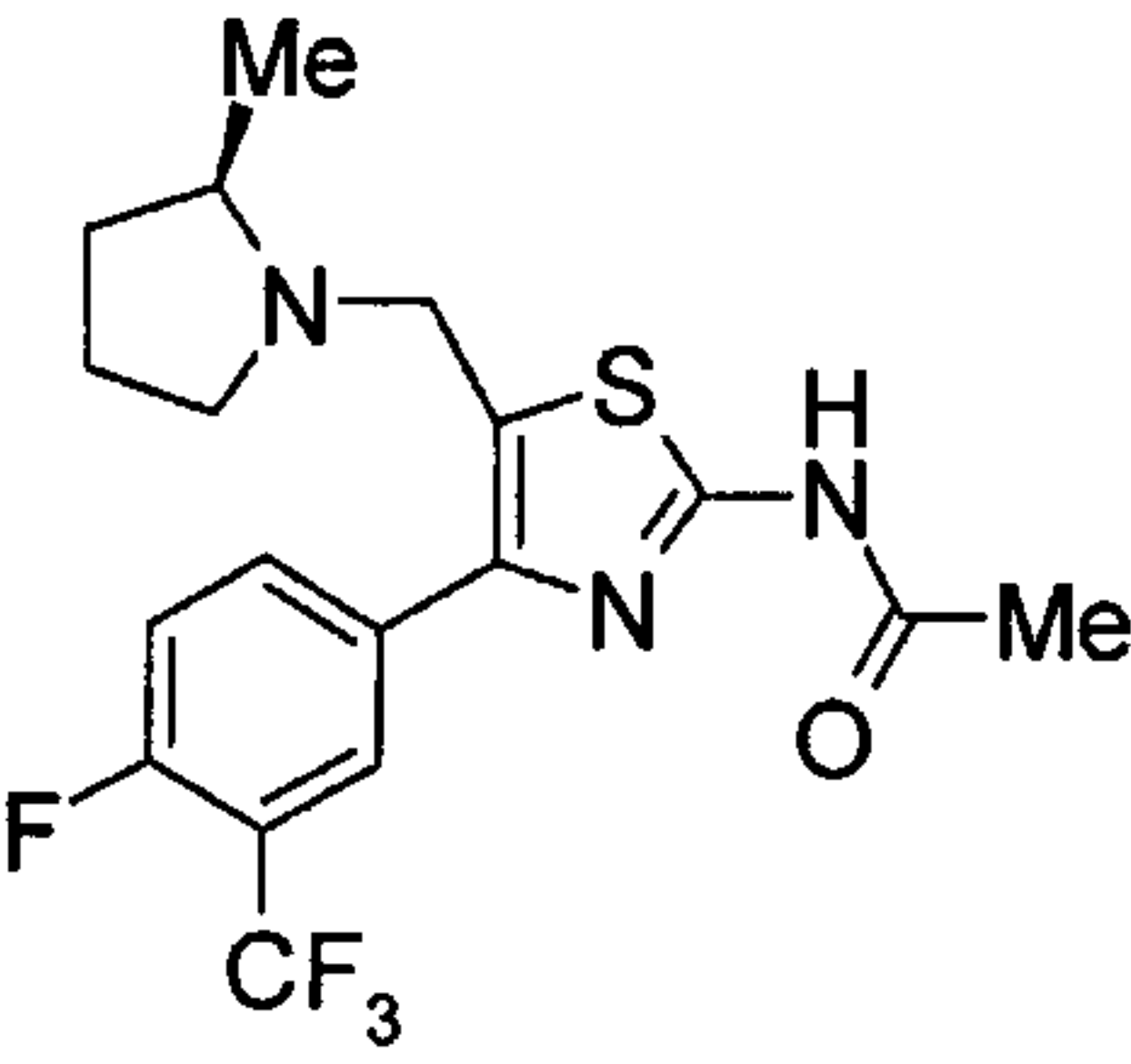
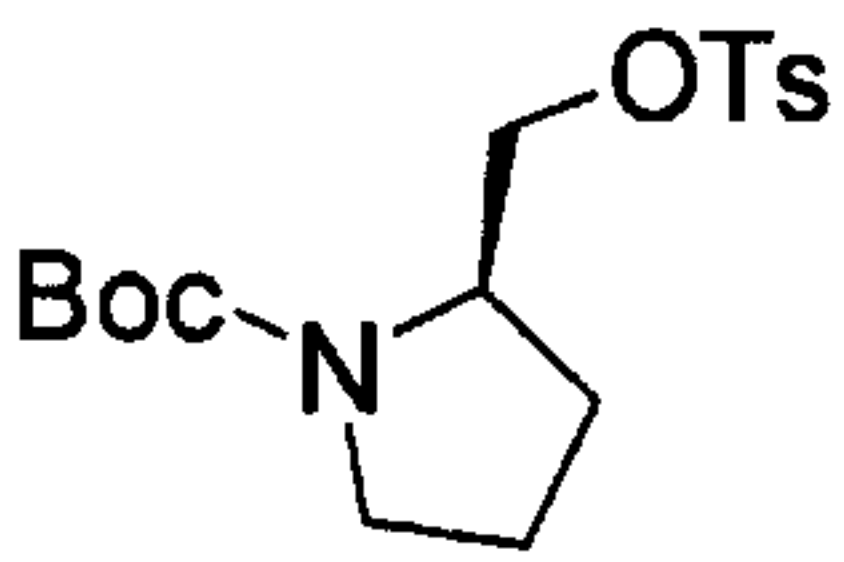
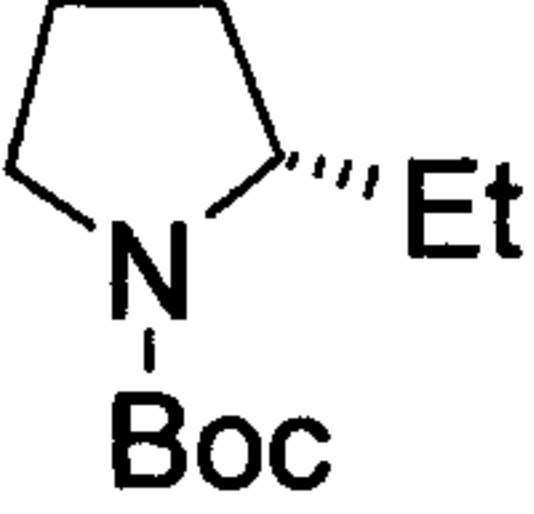
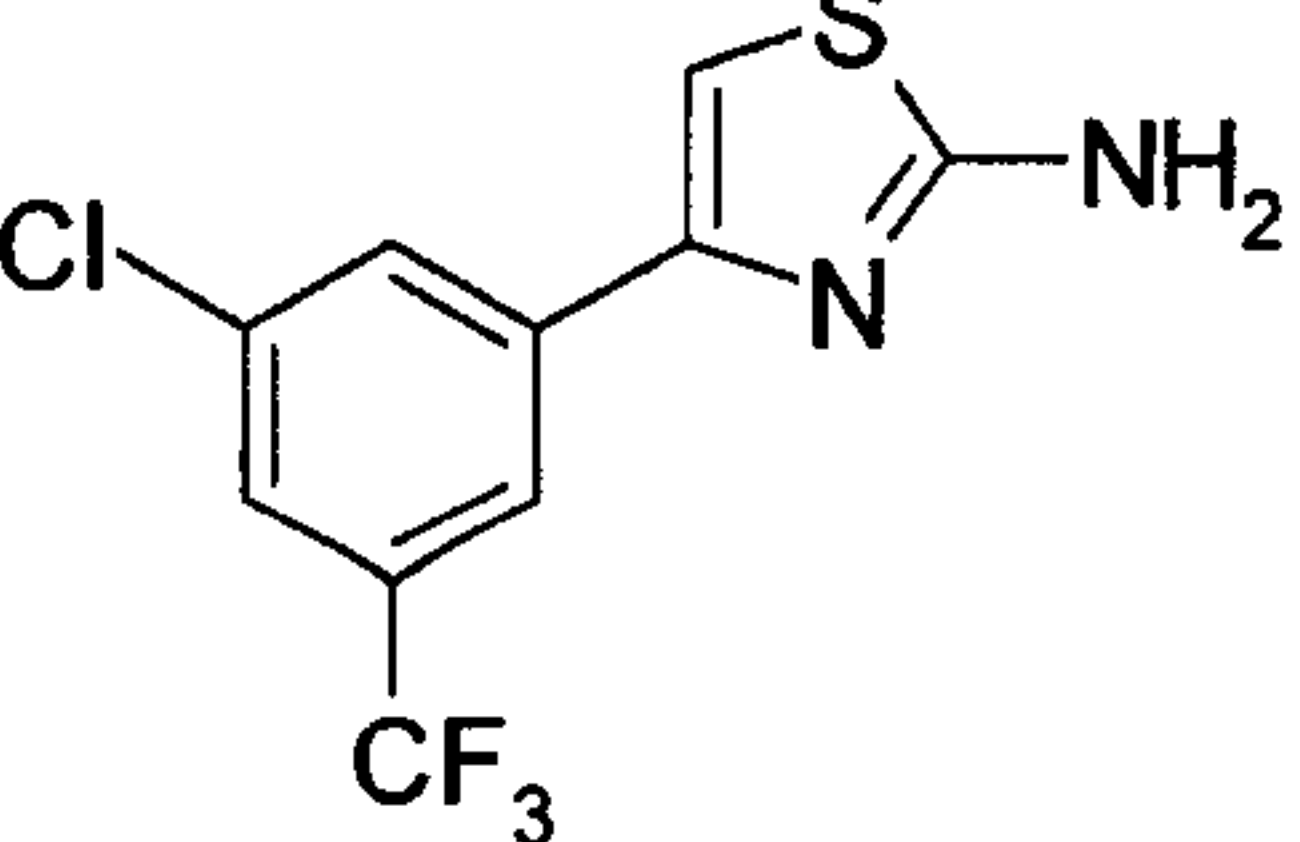
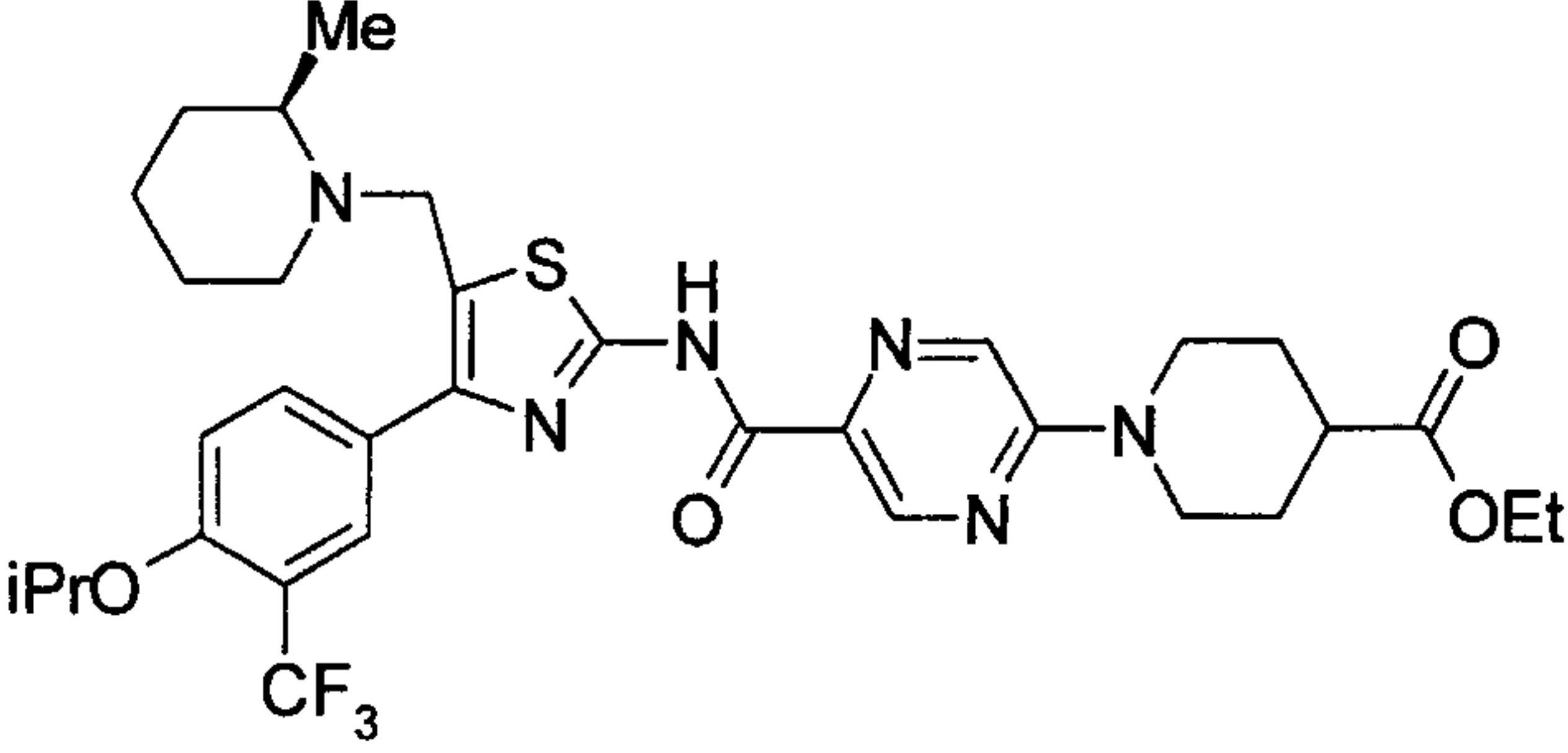
[0195]

[Table 34]

PEx	PSyn	Str	DATA
195	27		ESI+: 360
196	27		ESI+: 420
197	27		ESI+: 376 , 378
198	30		EI: 274
199	31		ESI+: 274
200	39		ESI+: 179

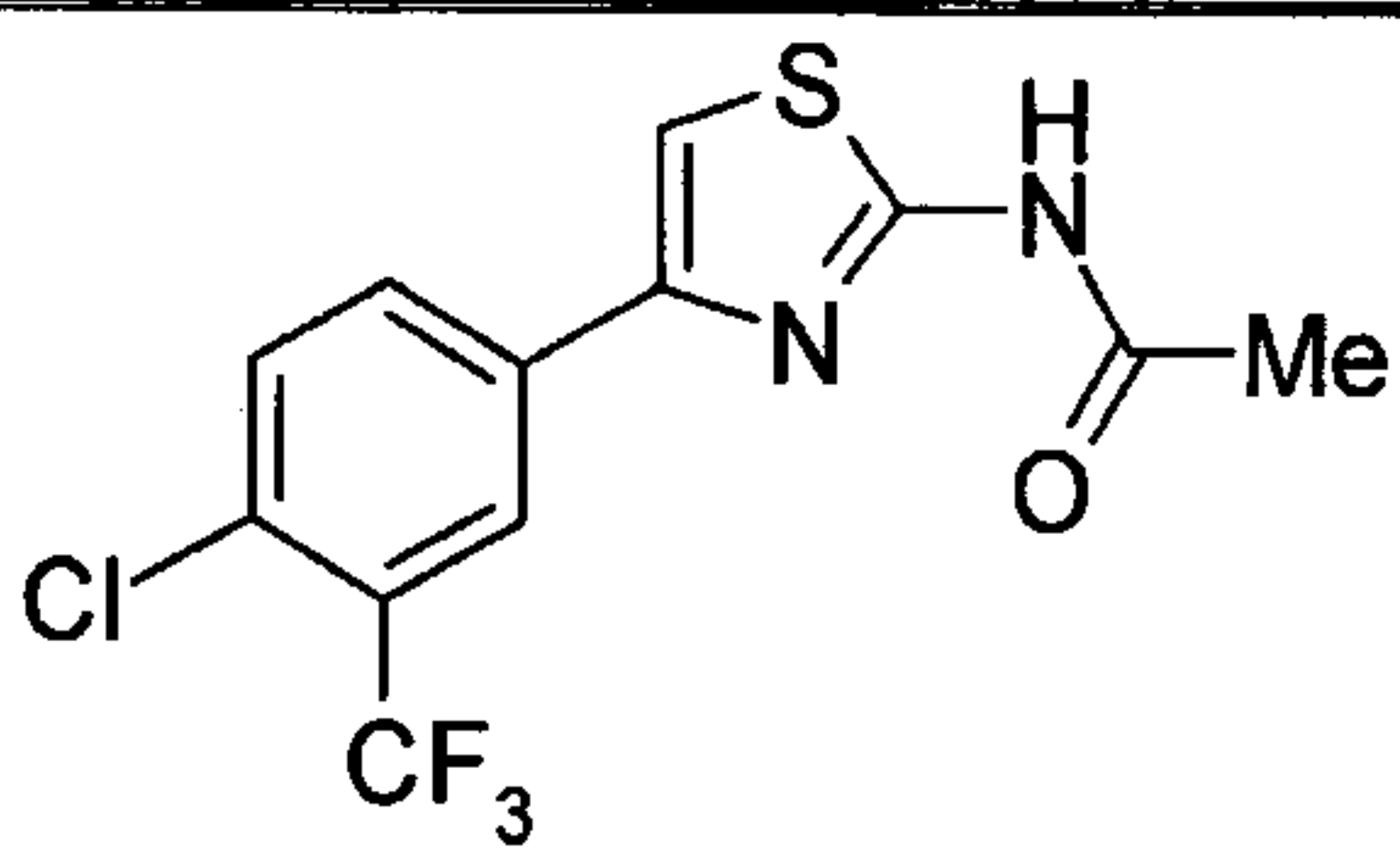
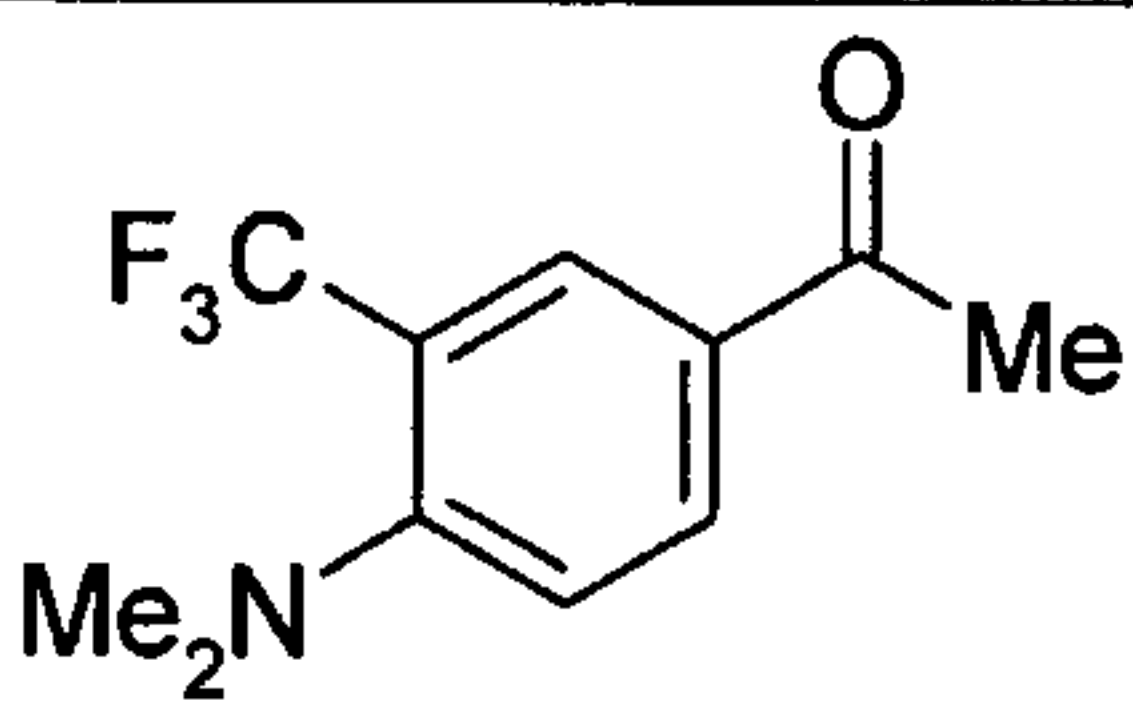
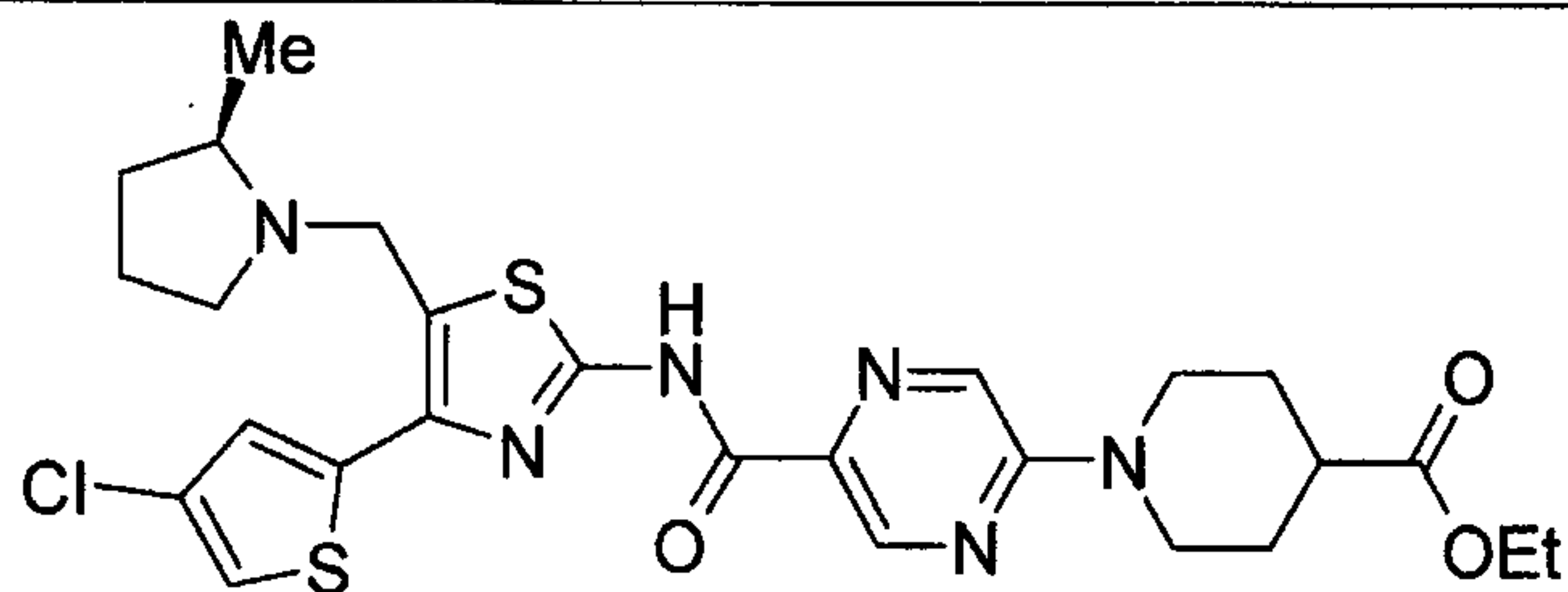
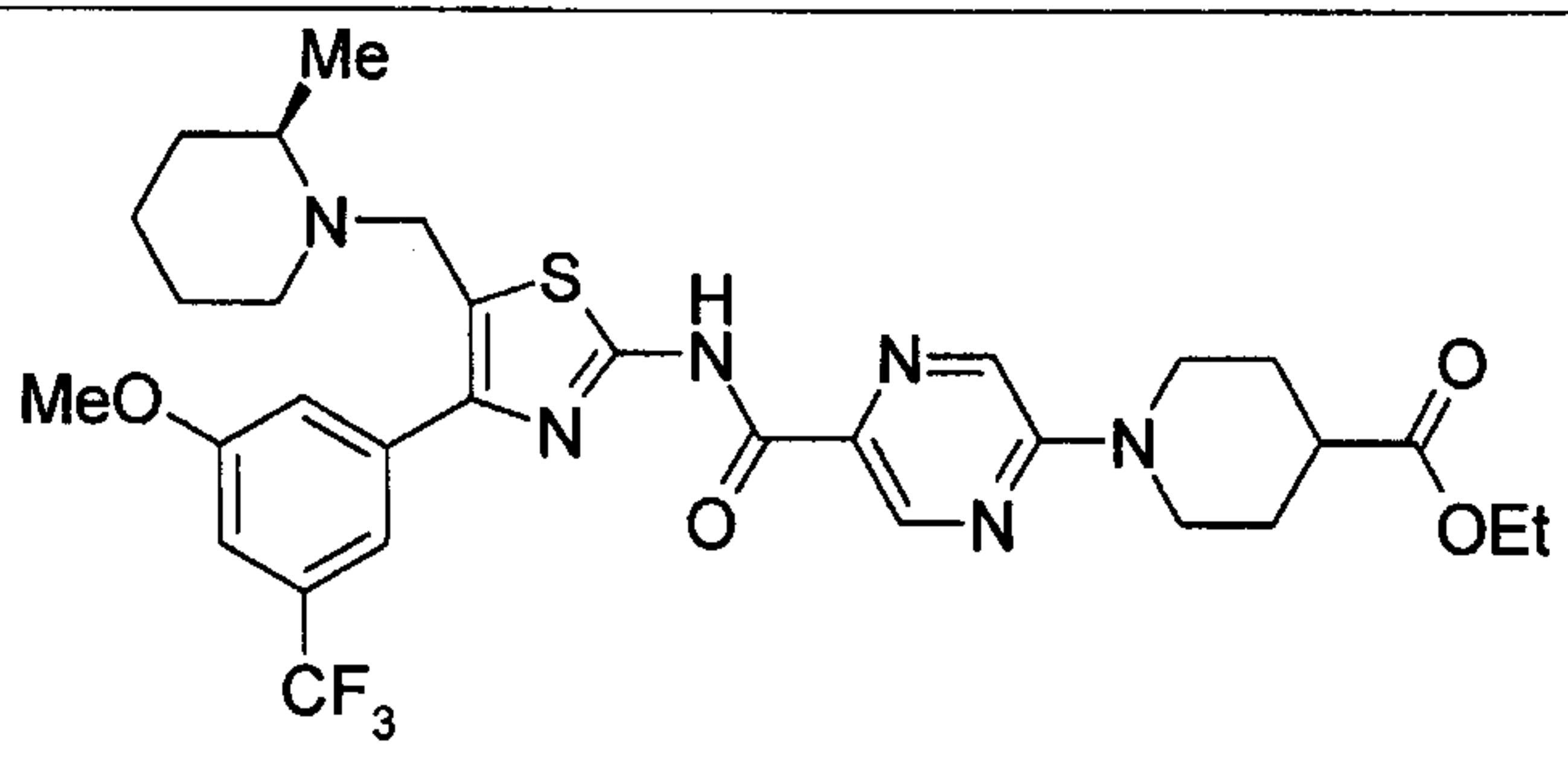
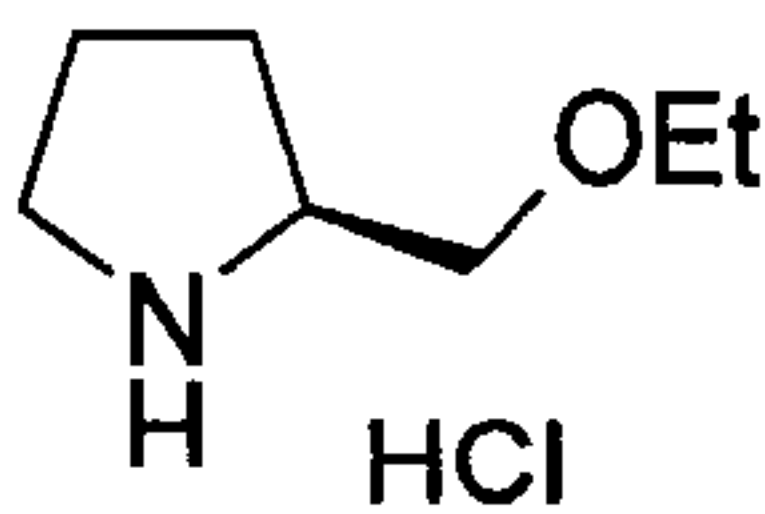
[0196]

[Table 35]

PEX	PSyn	Str	DATA
201	39		ESI+: 219
202	40		ESI+: 230
203	43		ESI+: 402
204	46		ESI+: 356
205	47		CI+: 200
206	5		ESI+: 279
207	23		ESI+: 675

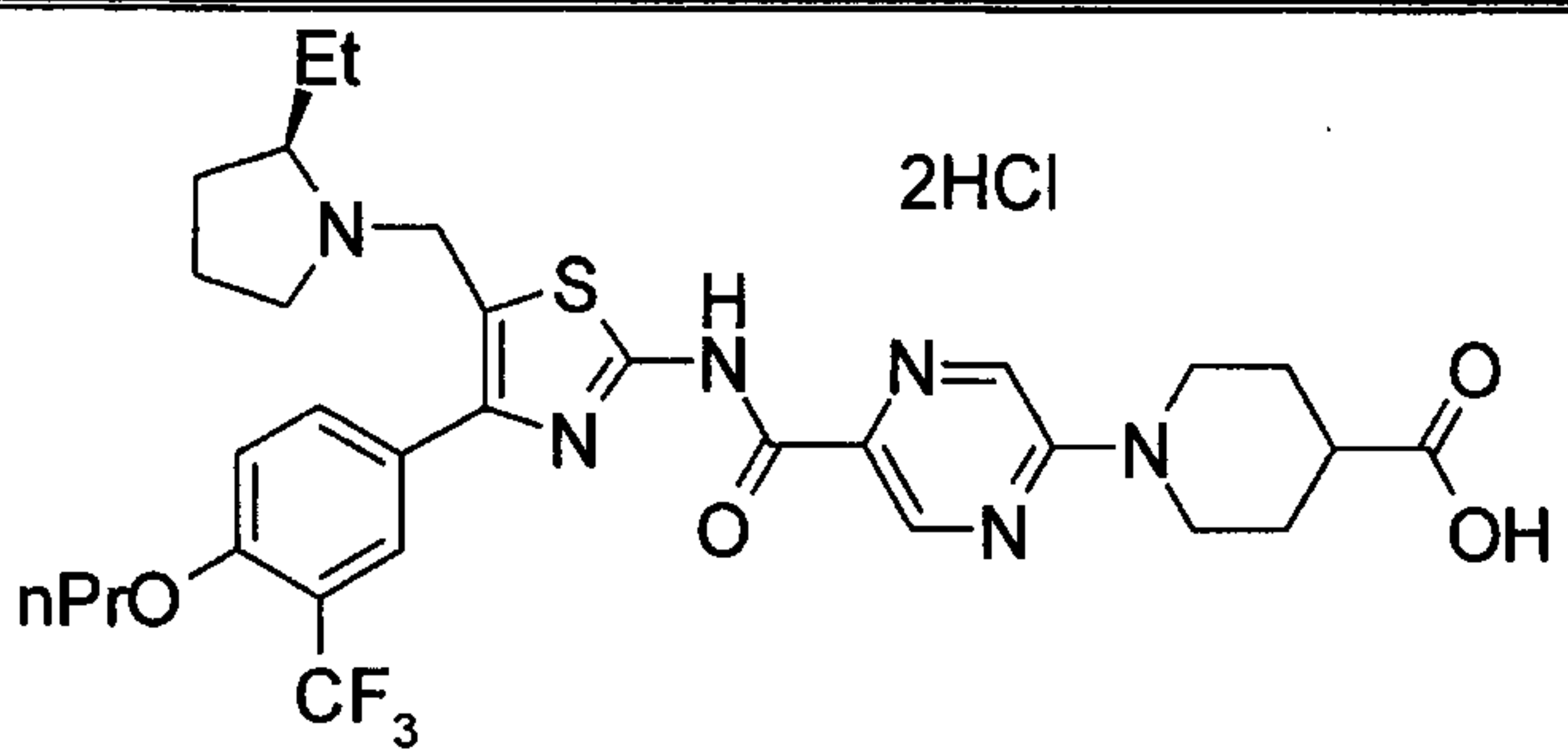
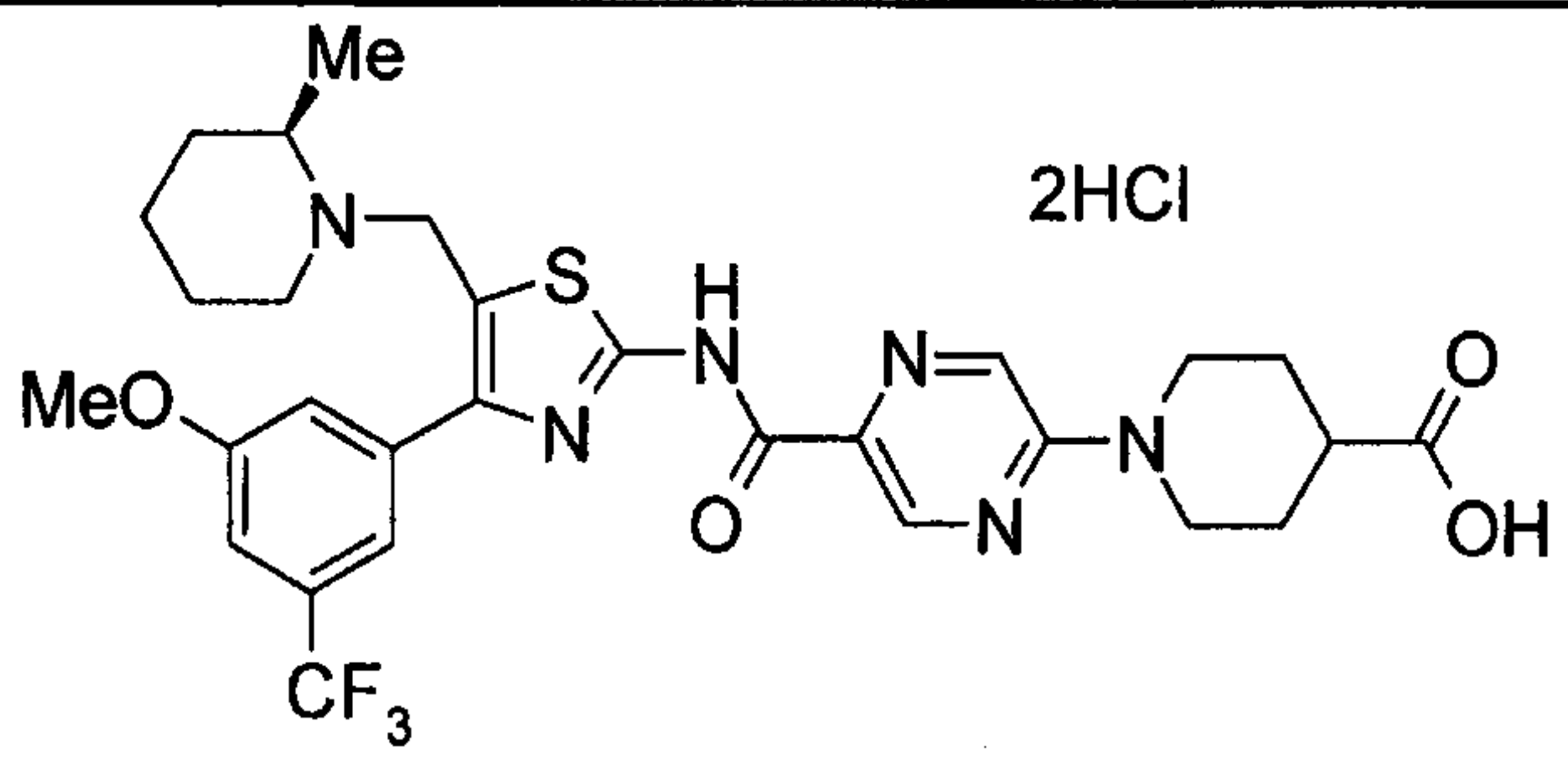
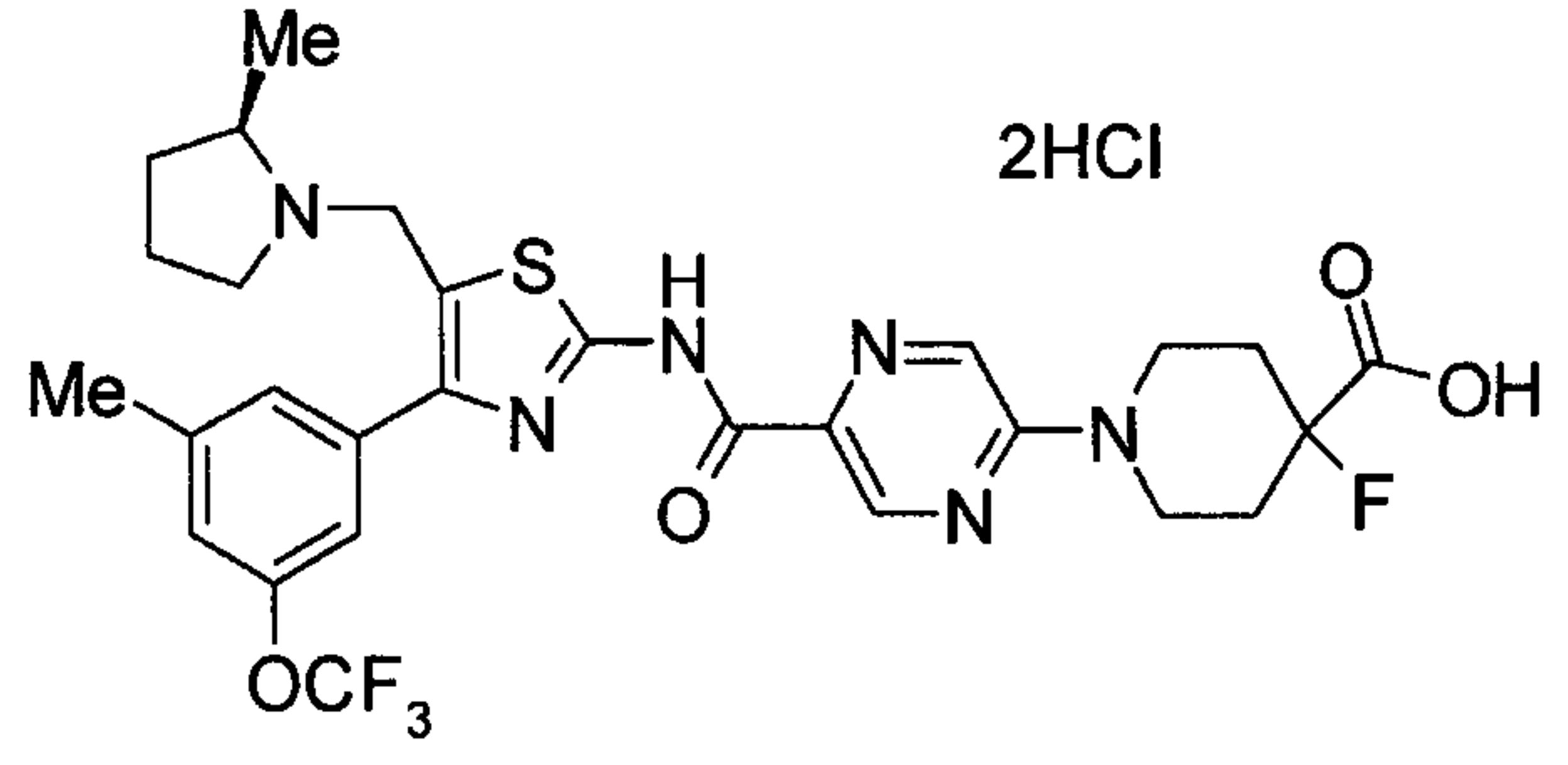
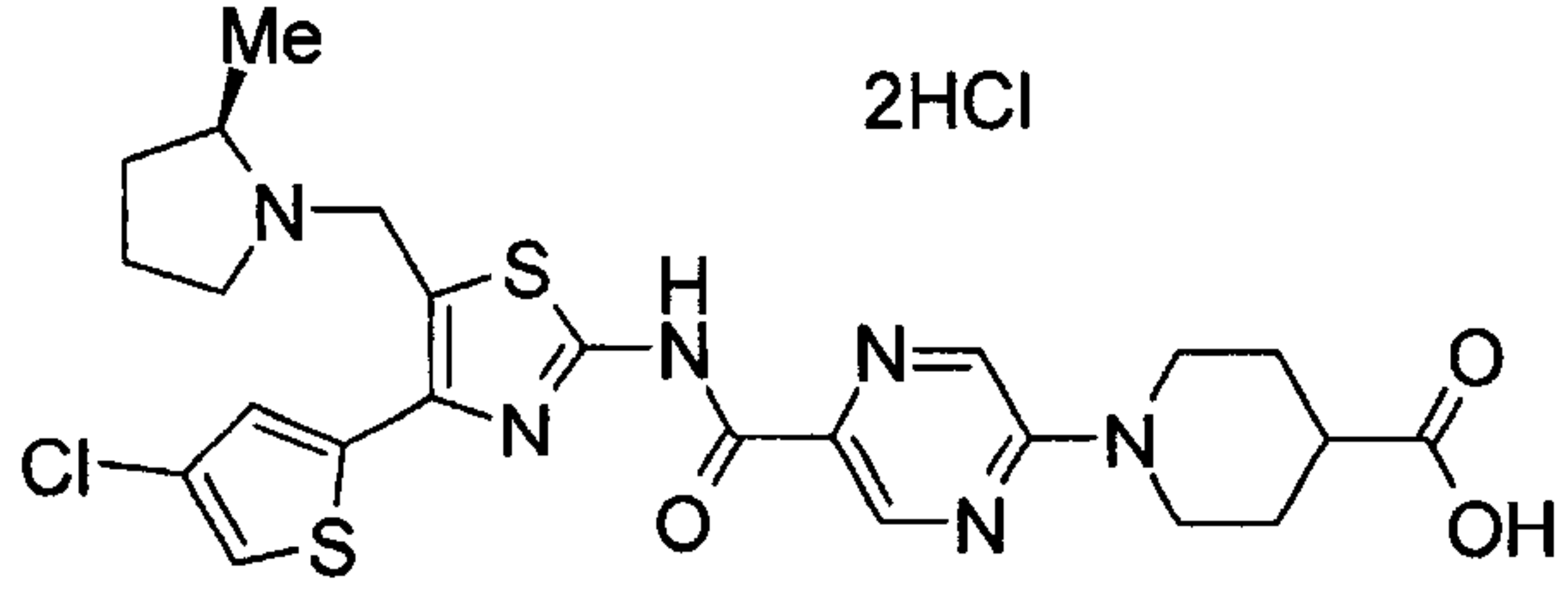
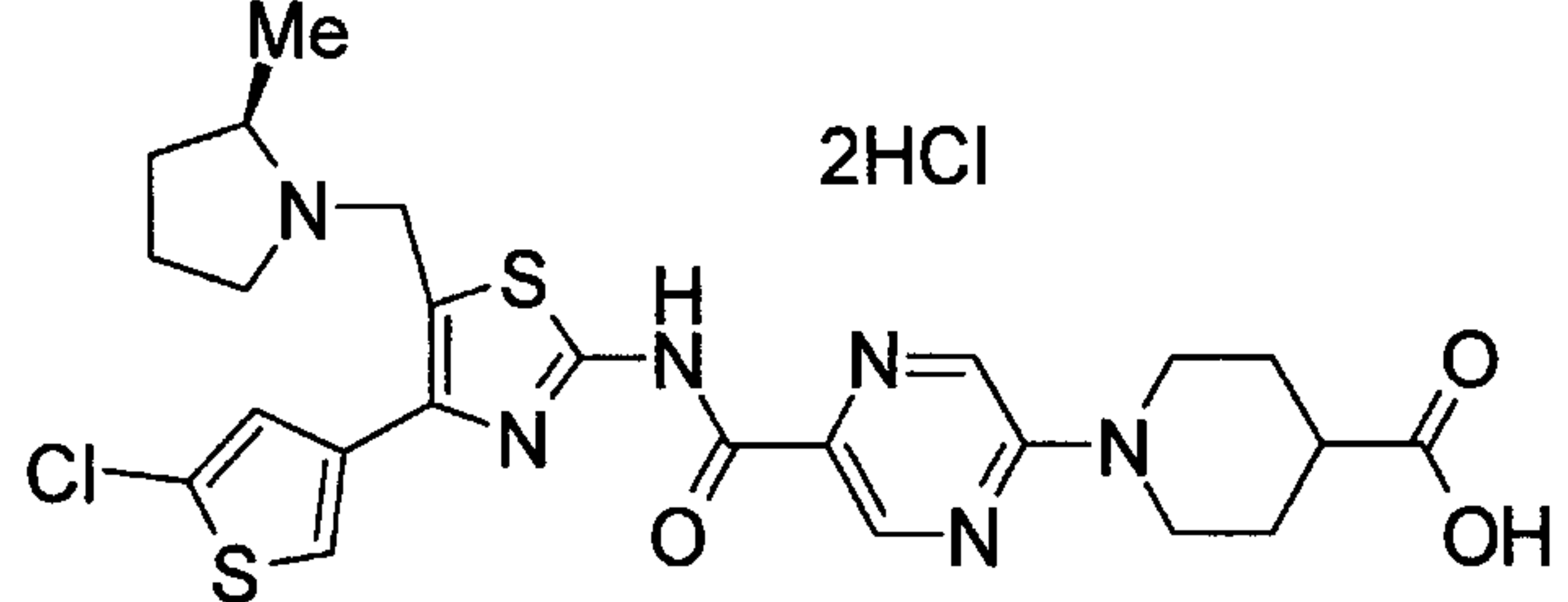
[0197]

[Table 36]

PEX	PSyn	Str	DATA
208	16		ESI+: 321
209	209		ESI+: 232
210	21		ESI-: 573, 575
211	23		ESI+: 647
212	26		ESI+: 130

[0198]

[Table 37]

Ex	Str
1	
2	
3	
4	
5	

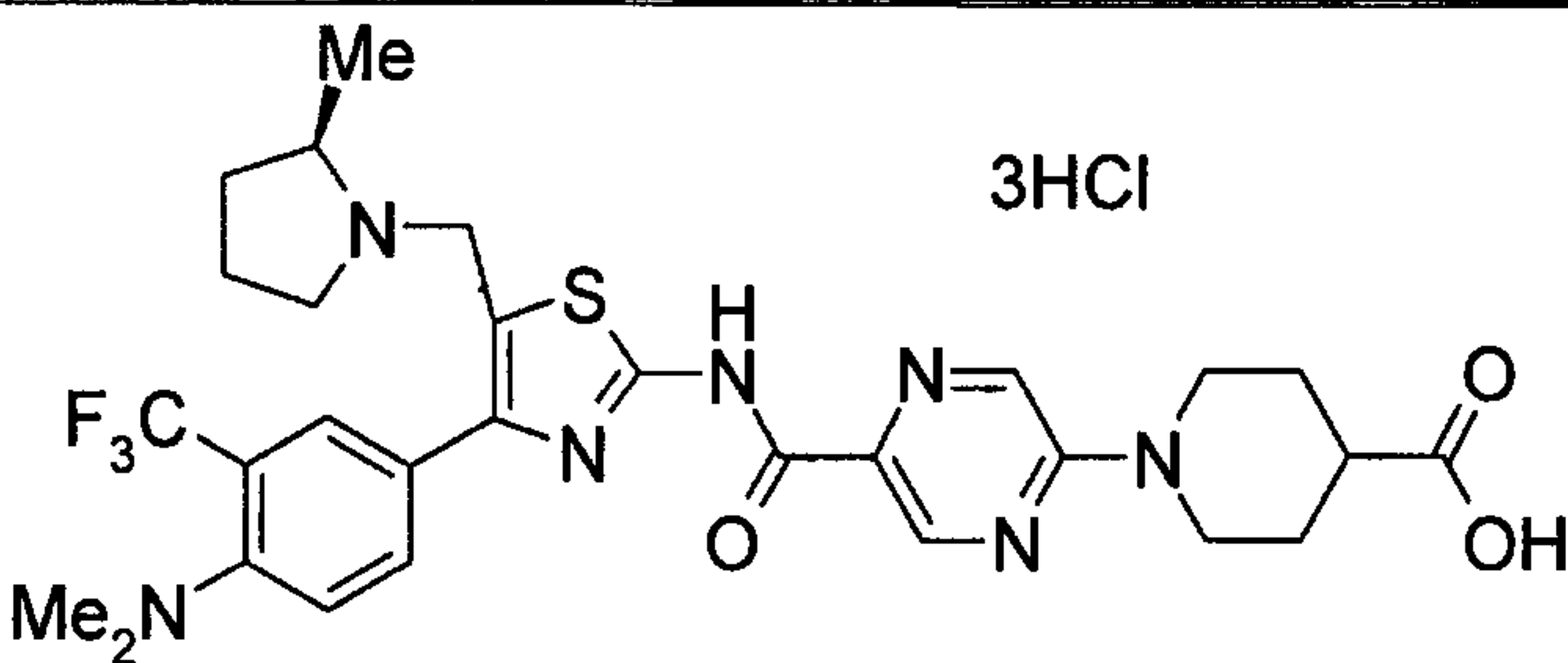
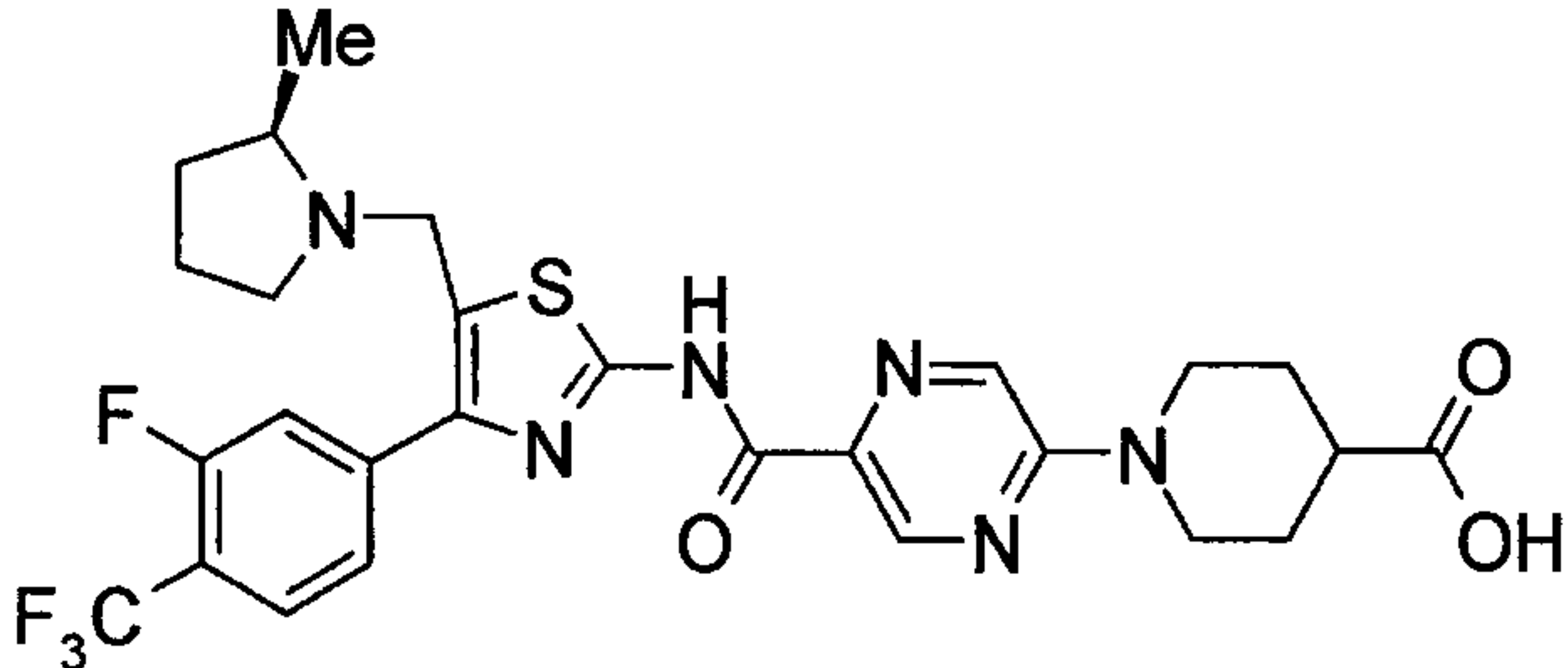
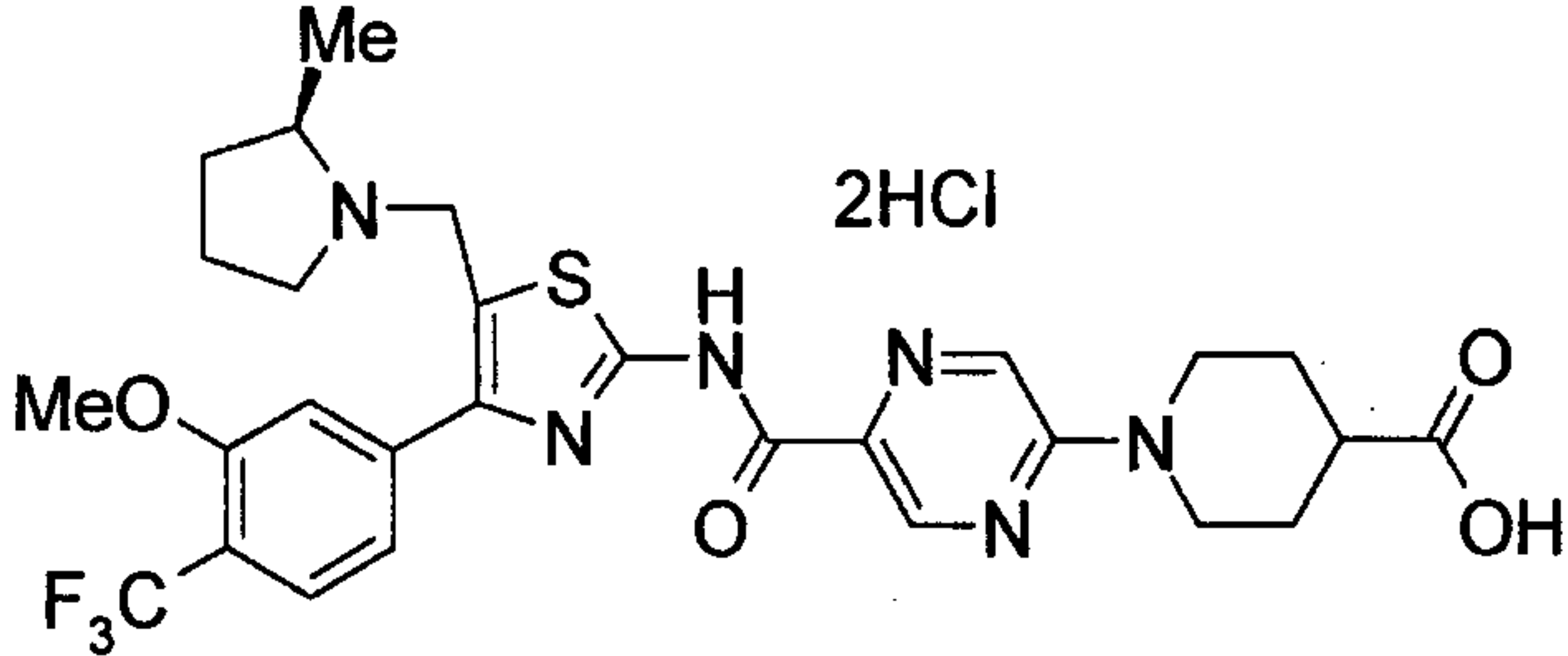
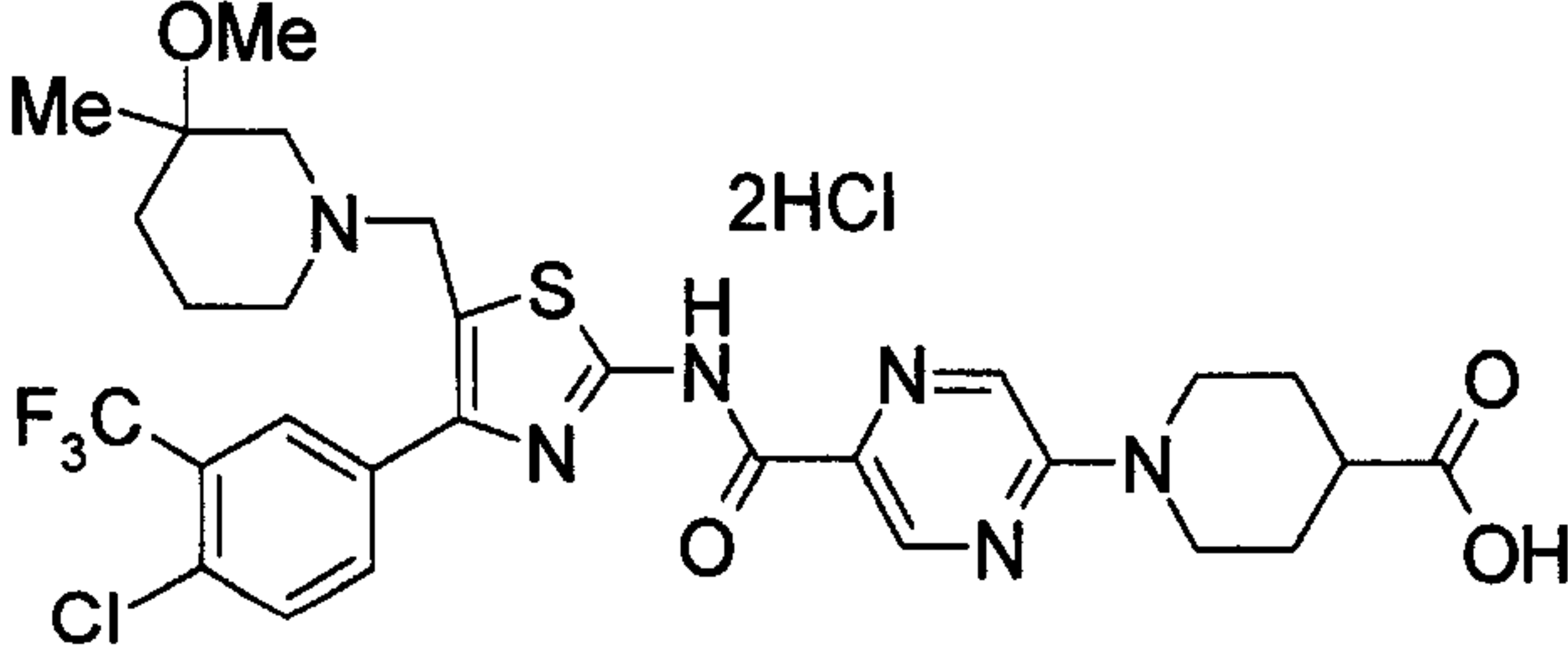
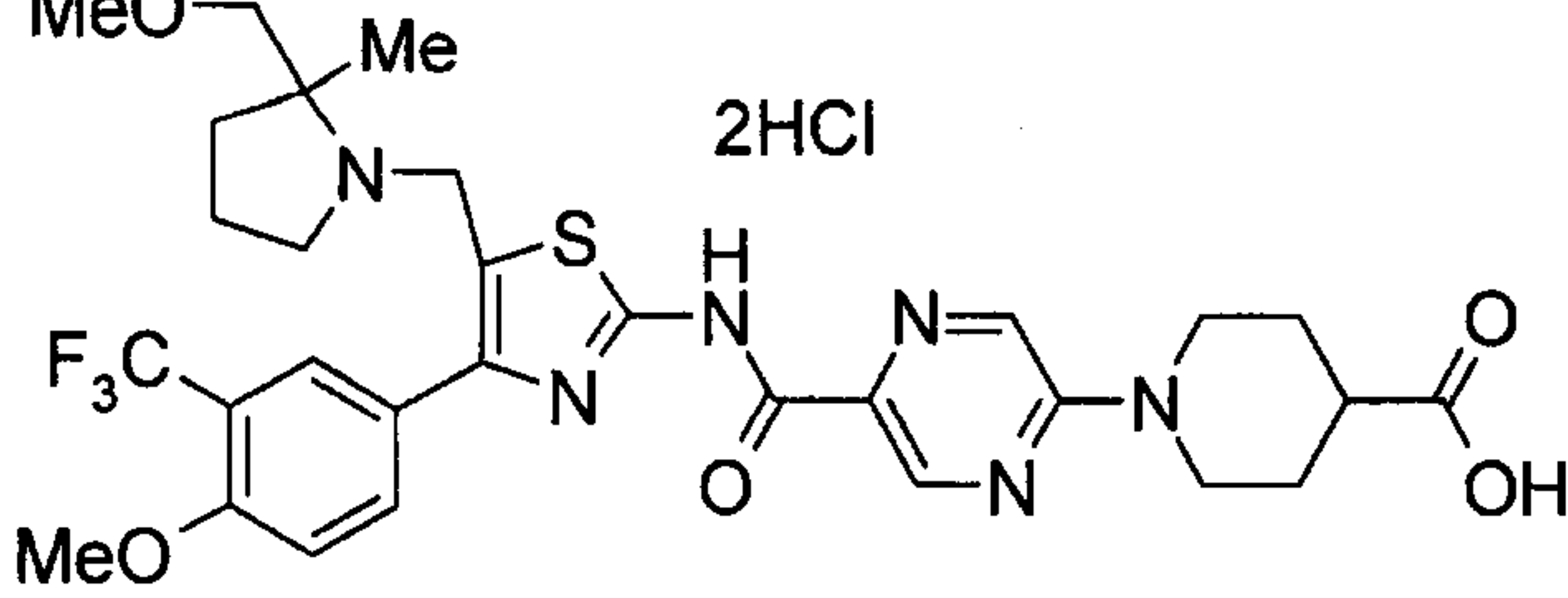
[0199]

[Table 38]

Ex	Str
6	
7	
8	
9	
10	

[0200]

[Table 39]

Ex	Str
11	
12	
13	
14	
15	

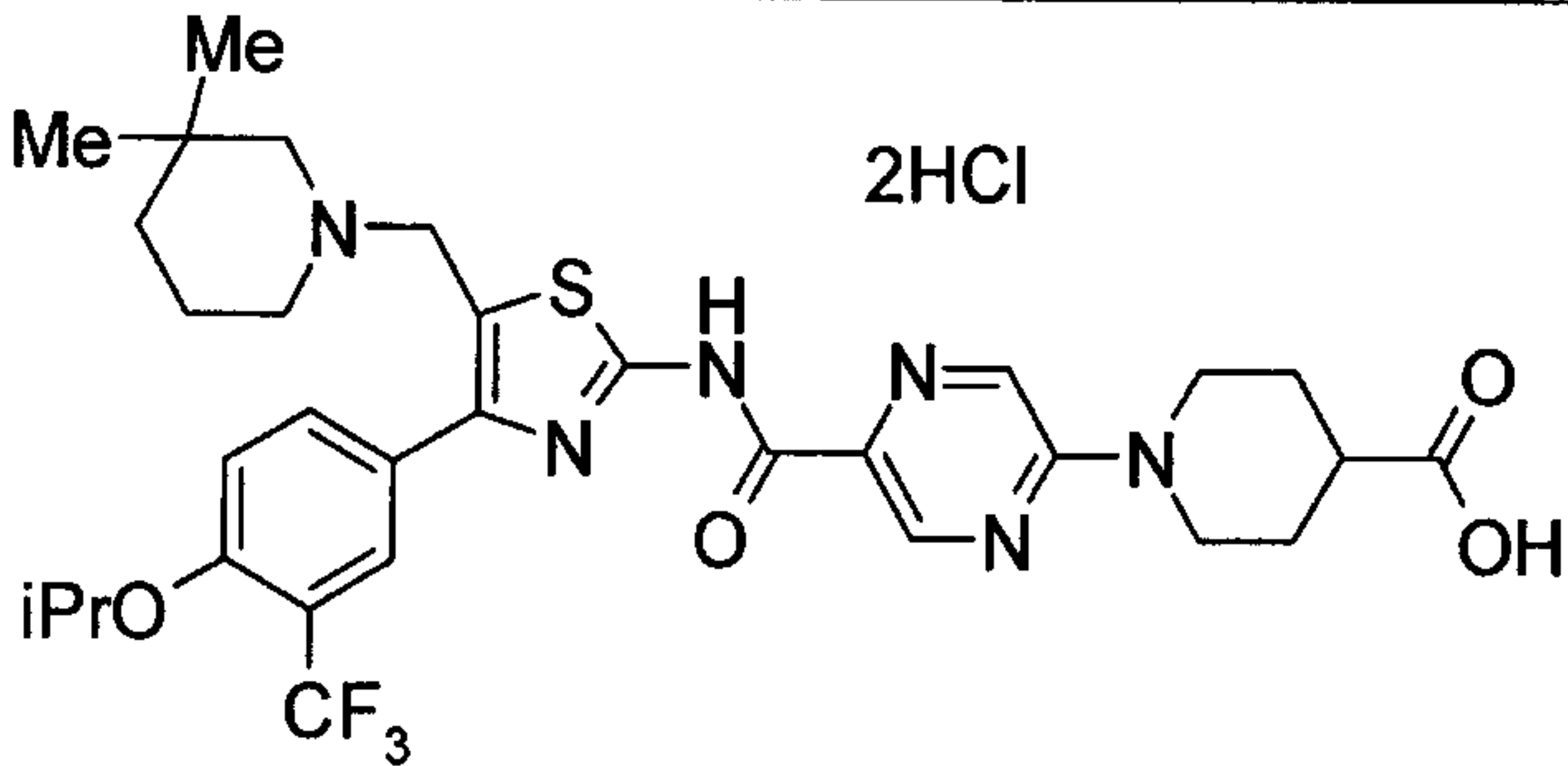
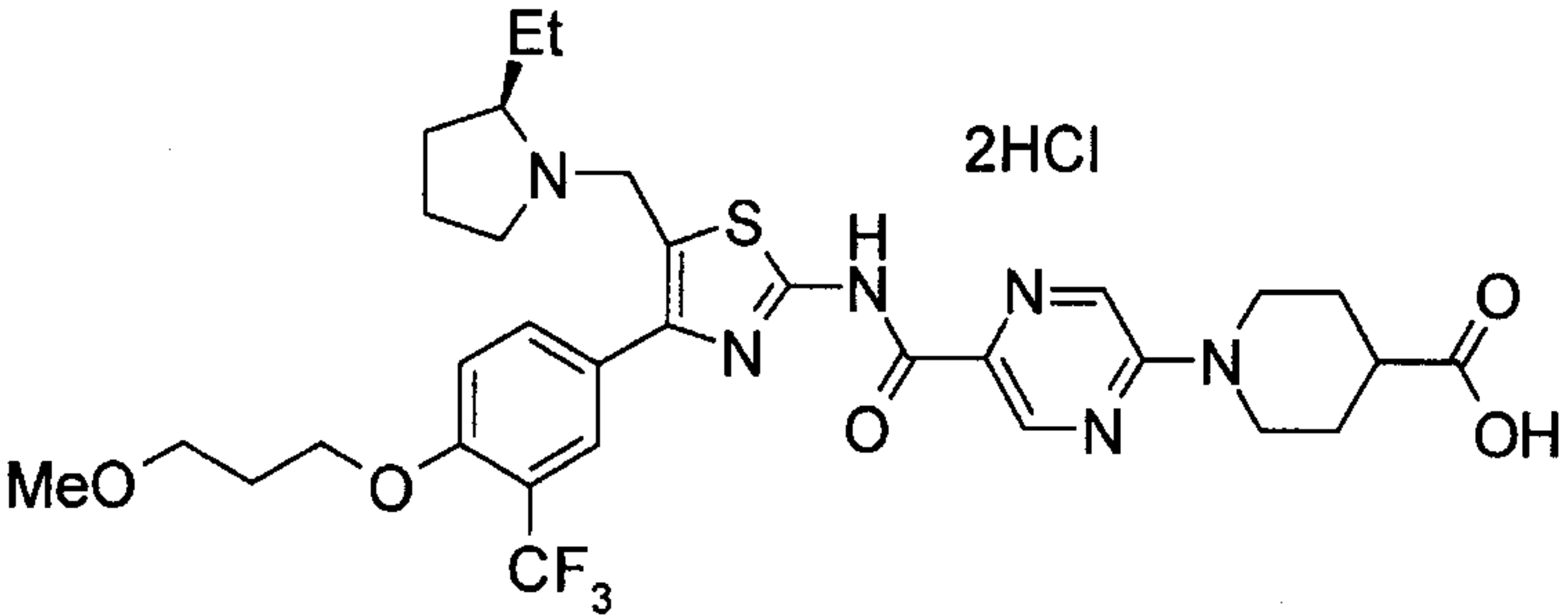
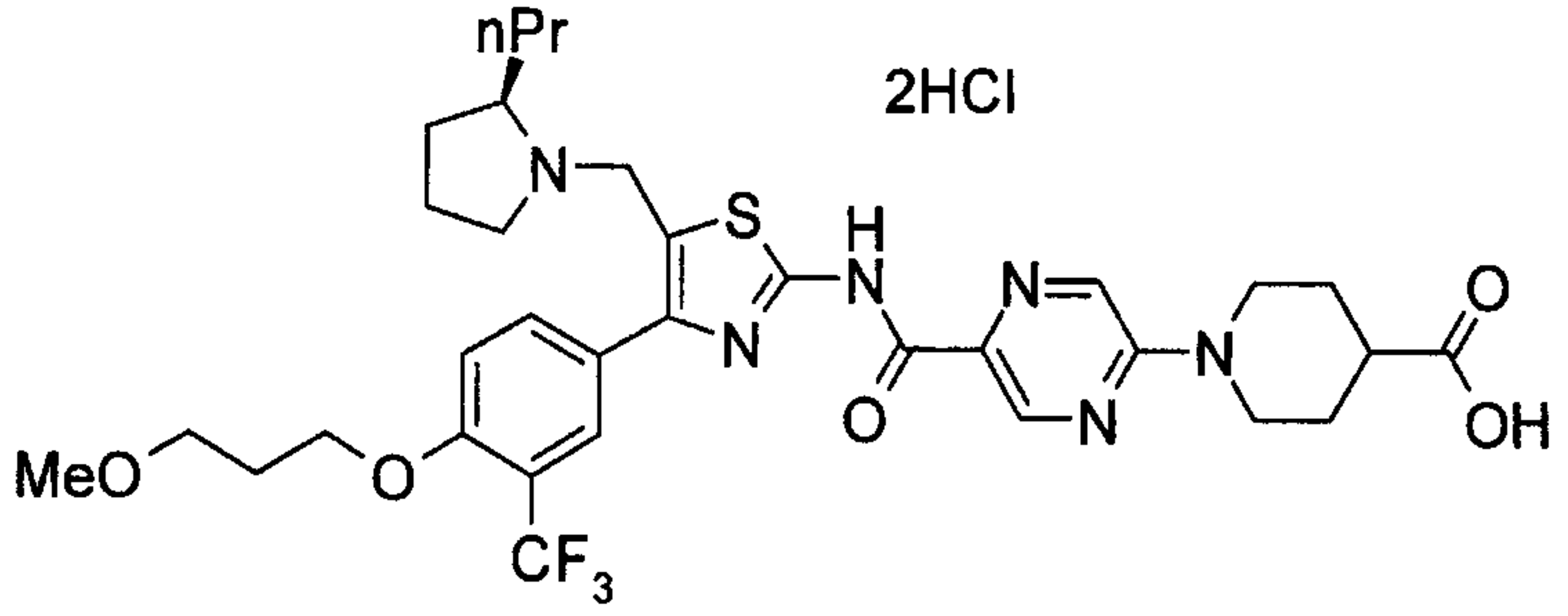
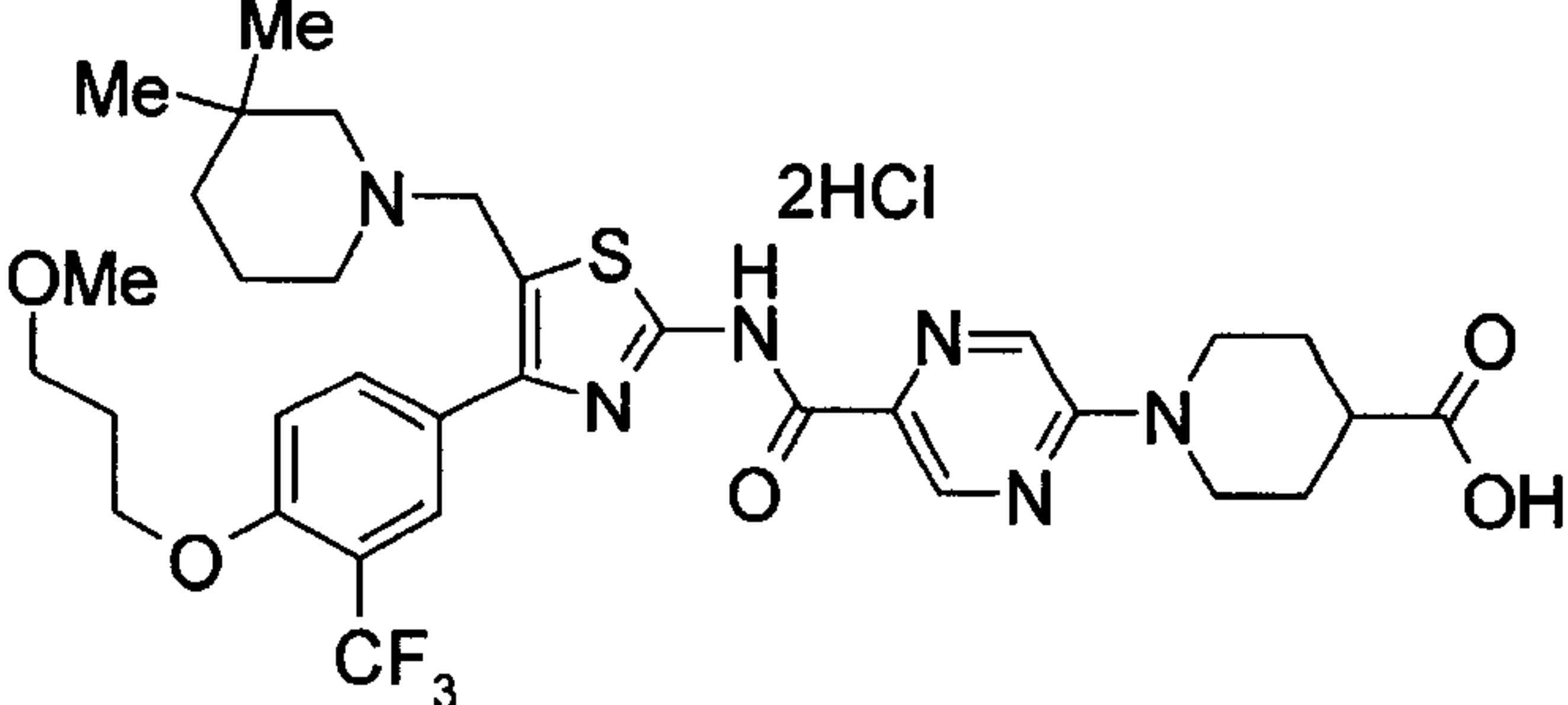
[0201]

[Table 40]

Ex	Str
16	Chemical structure 16: A thiazine derivative with a 4-(4-(3-fluoropropoxy)-3-(trifluoromethyl)phenyl)-2-(n-propylmethyl)thiazine-5-carboxamide group and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(n-propylmethyl)thiazine-5-carboxamide group, and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(n-propylmethyl)thiazine-5-carboxamide group. The structure is shown as a dicationic salt with 2HCl.
17	Chemical structure 17: A thiazine derivative with a 4-(4-(3-isopropoxy)-3-(trifluoromethyl)phenyl)-2-(methylmethyl)thiazine-5-carboxamide group and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(methylmethyl)thiazine-5-carboxamide group, and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(methylmethyl)thiazine-5-carboxamide group. The structure is shown as a dicationic salt with 2HCl.
18	Chemical structure 18: A thiazine derivative with a 4-(4-(3-isopropoxy)-3-(trifluoromethyl)phenyl)-2-(ethylmethyl)thiazine-5-carboxamide group and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(ethylmethyl)thiazine-5-carboxamide group, and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(ethylmethyl)thiazine-5-carboxamide group. The structure is shown as a dicationic salt with 2HCl.
19	Chemical structure 19: A thiazine derivative with a 4-(4-(3-isopropoxy)-3-(trifluoromethyl)phenyl)-2-(n-propylmethyl)thiazine-5-carboxamide group and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(n-propylmethyl)thiazine-5-carboxamide group, and a 4-(4-(3-(trifluoromethyl)-4-isopropoxyphenyl)-2-(n-propylmethyl)thiazine-5-carboxamide group. The structure is shown as a dicationic salt with 2HCl.

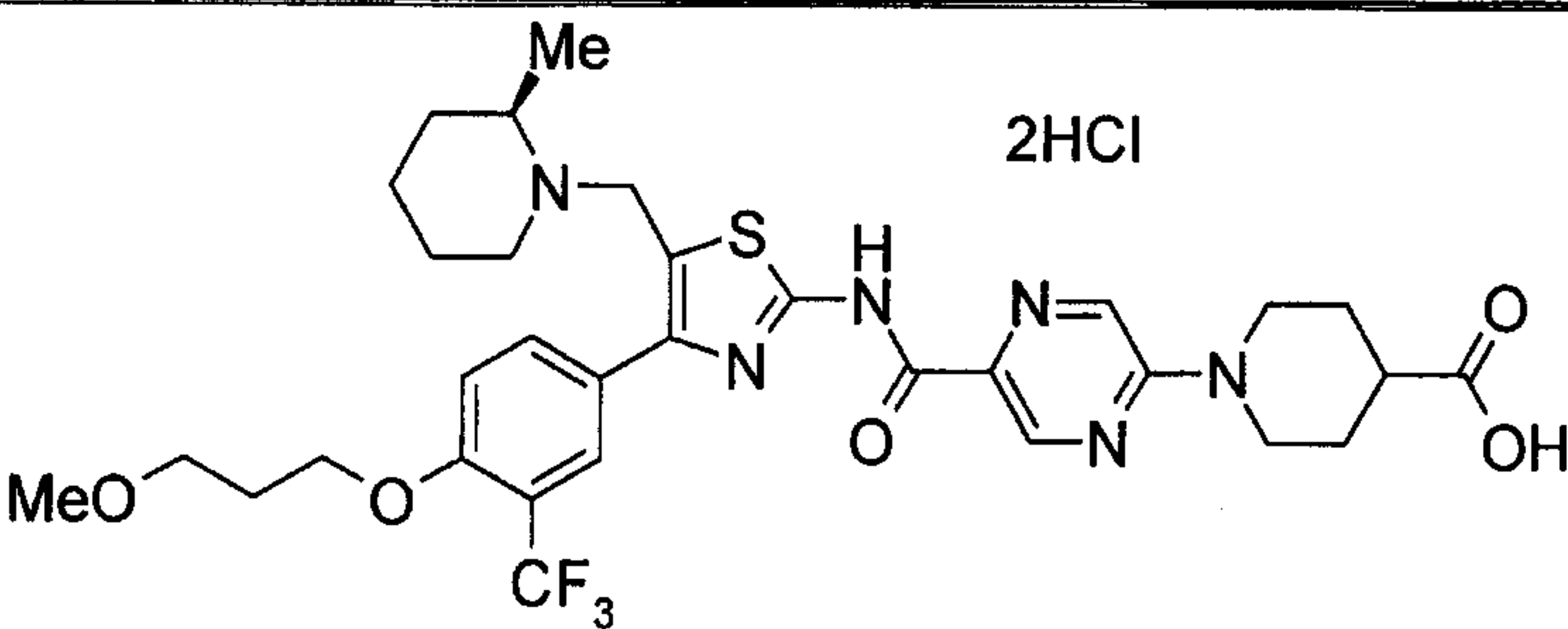
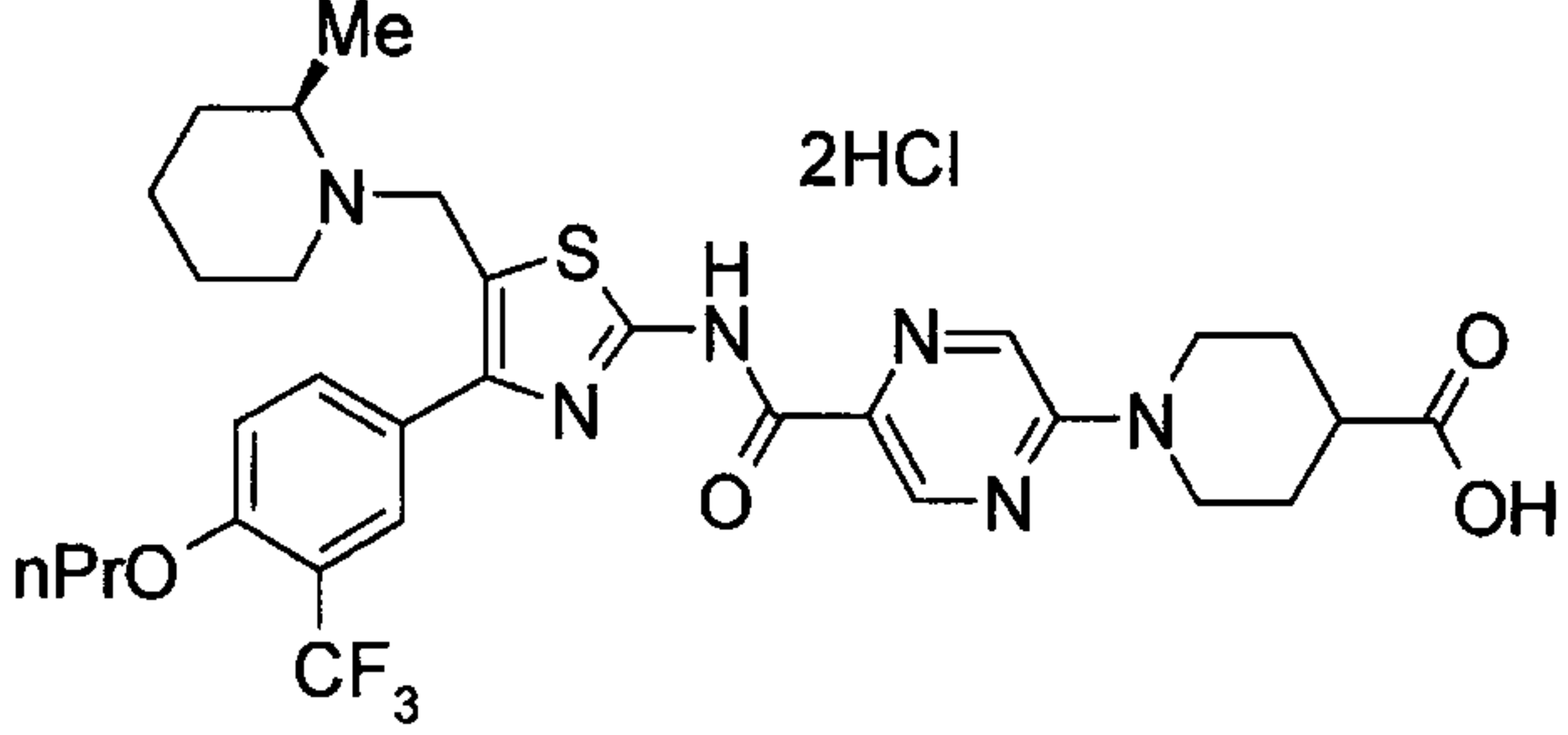
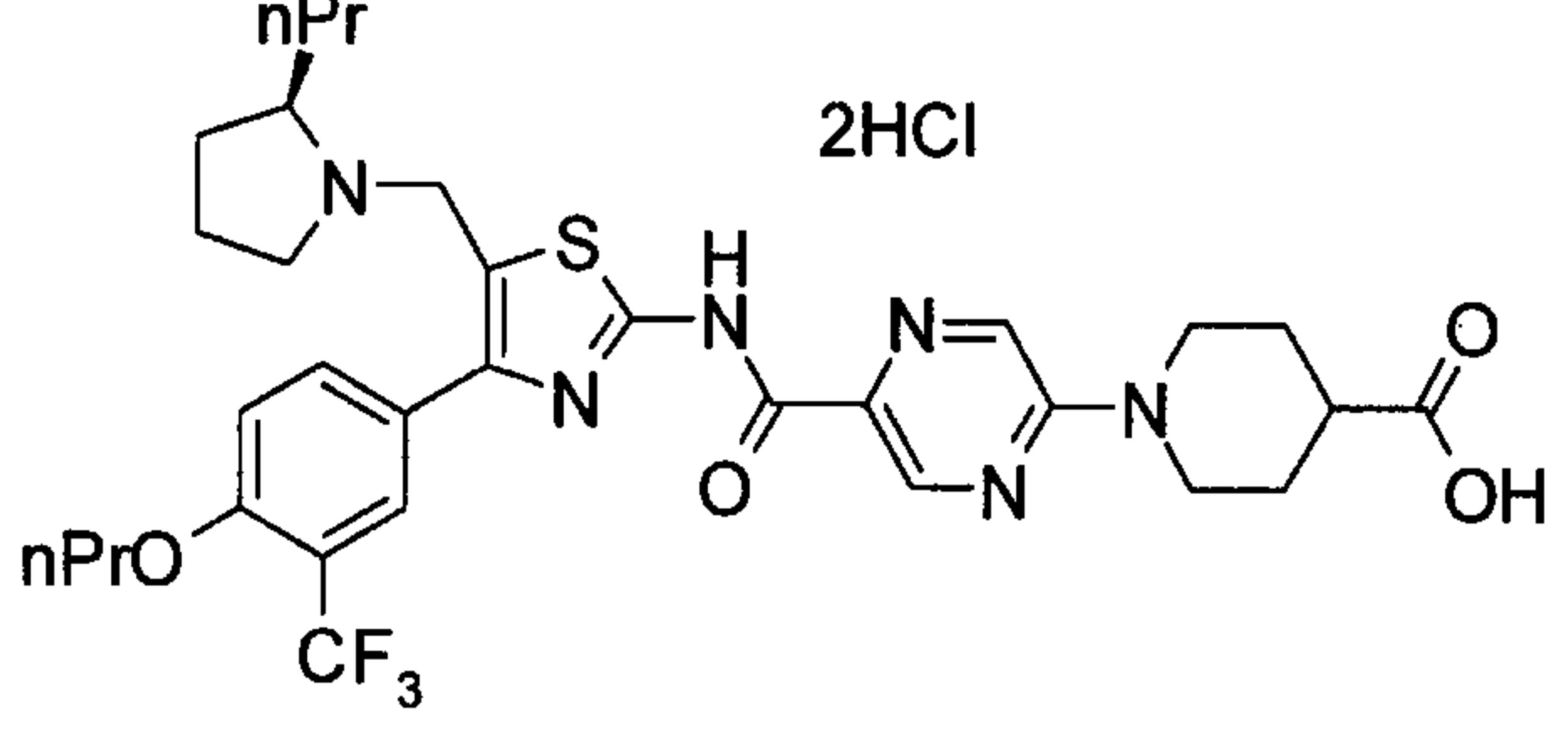
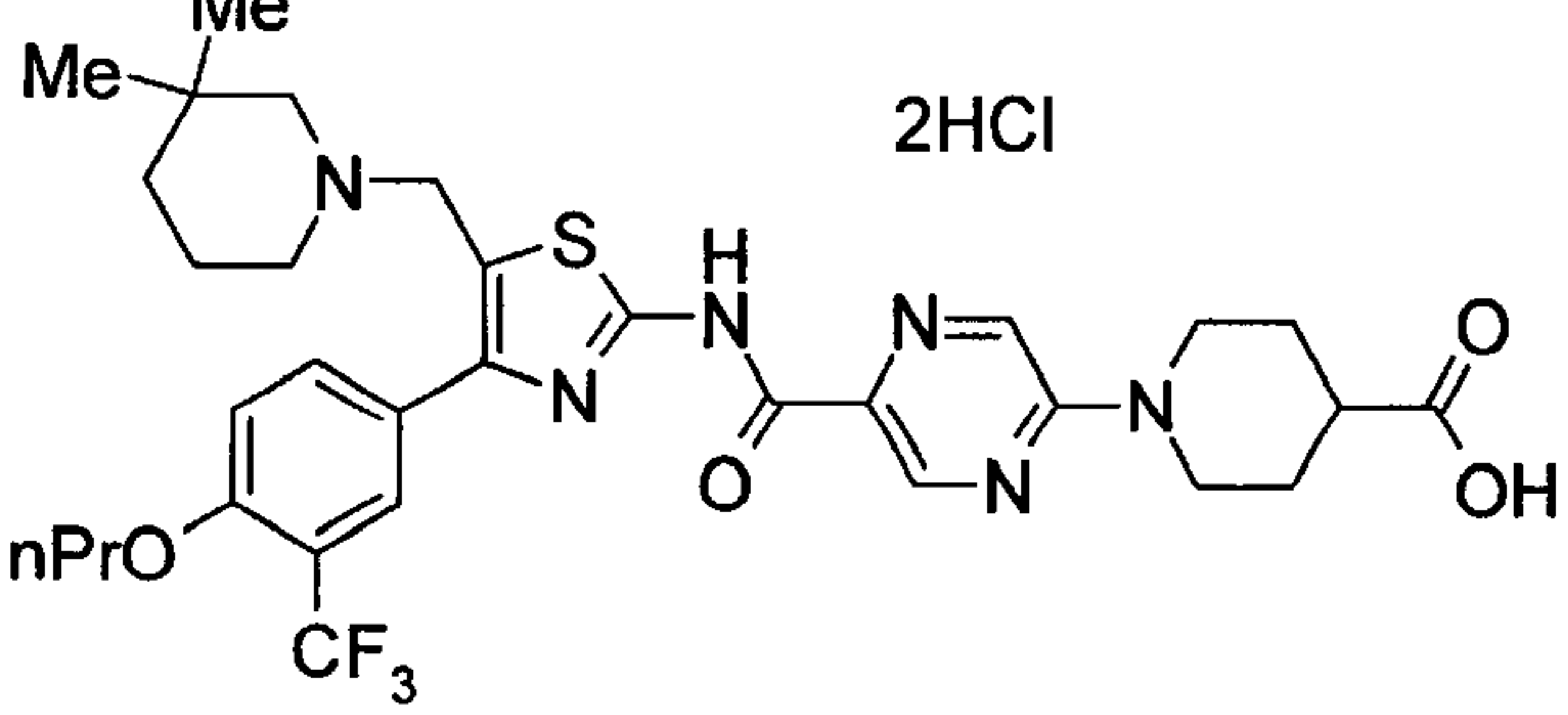
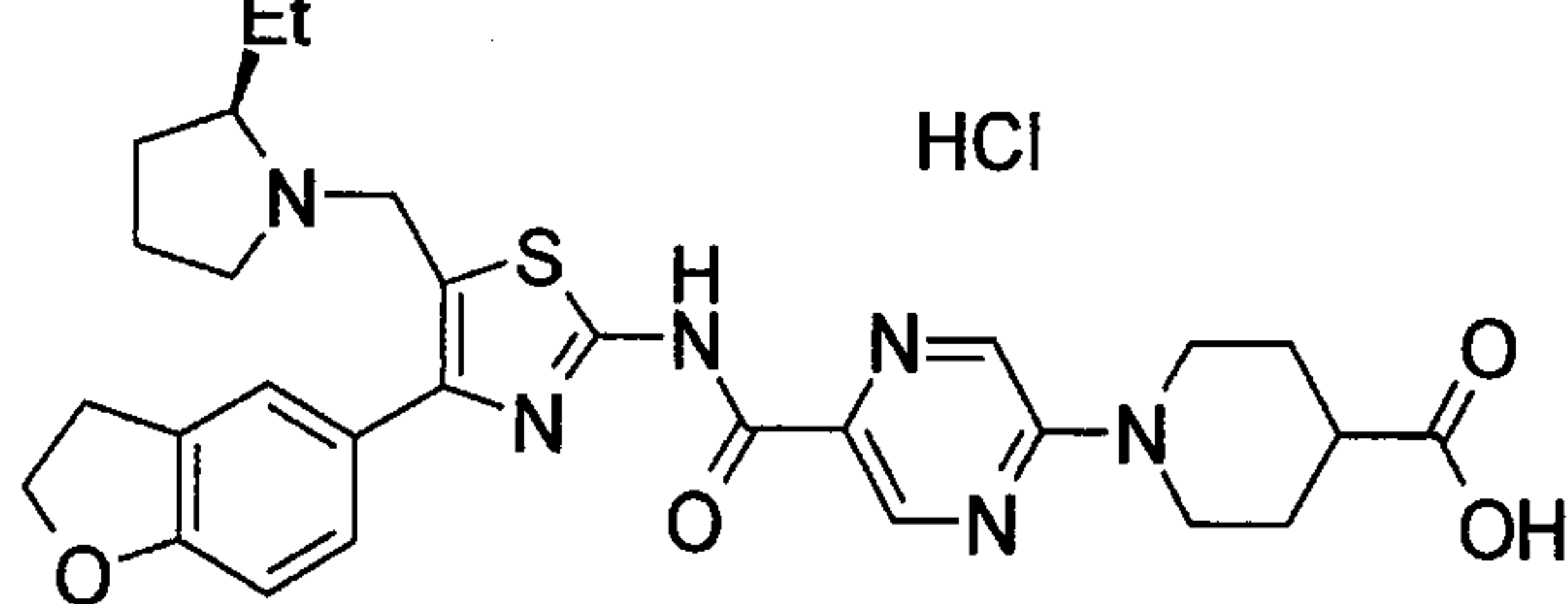
[0202]

[Table 41]

Ex	Str
20	
21	
22	
23	

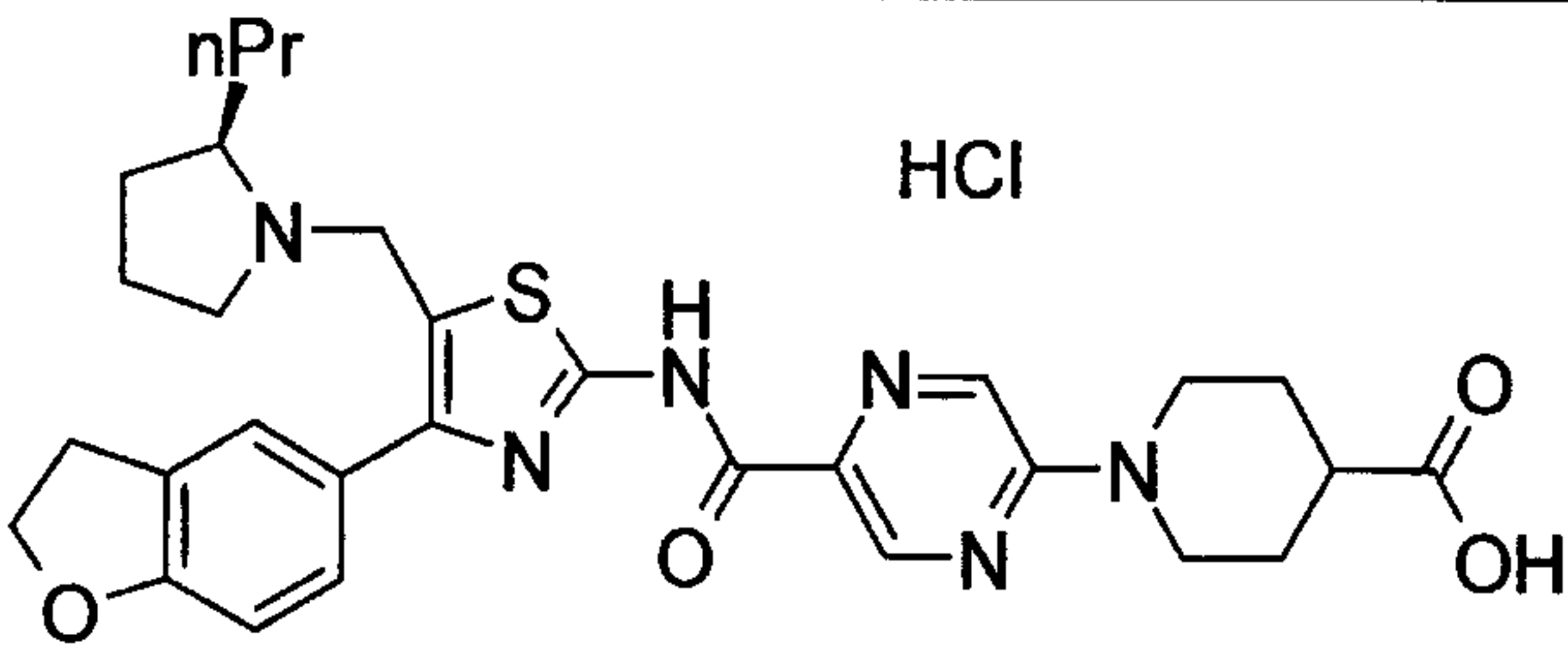
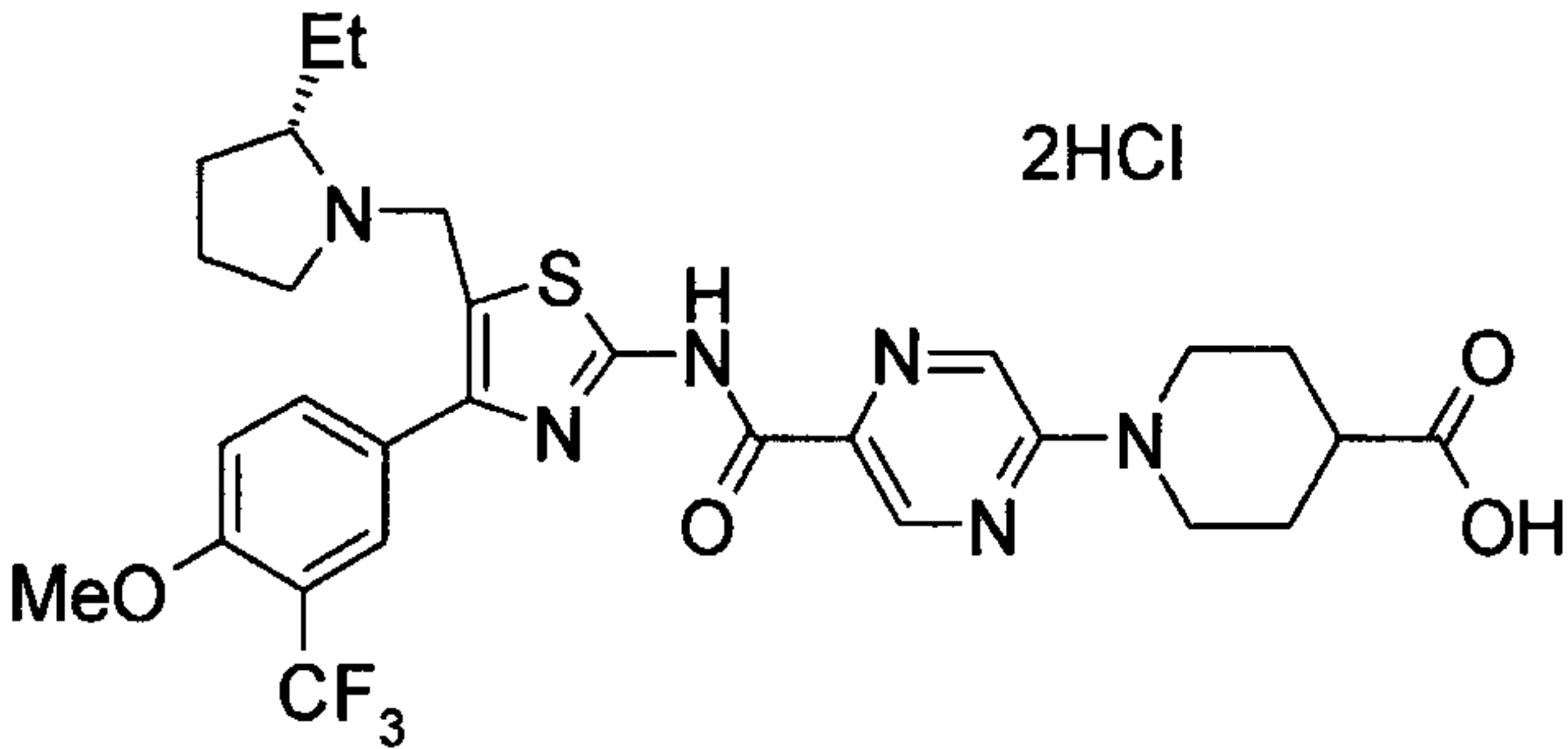
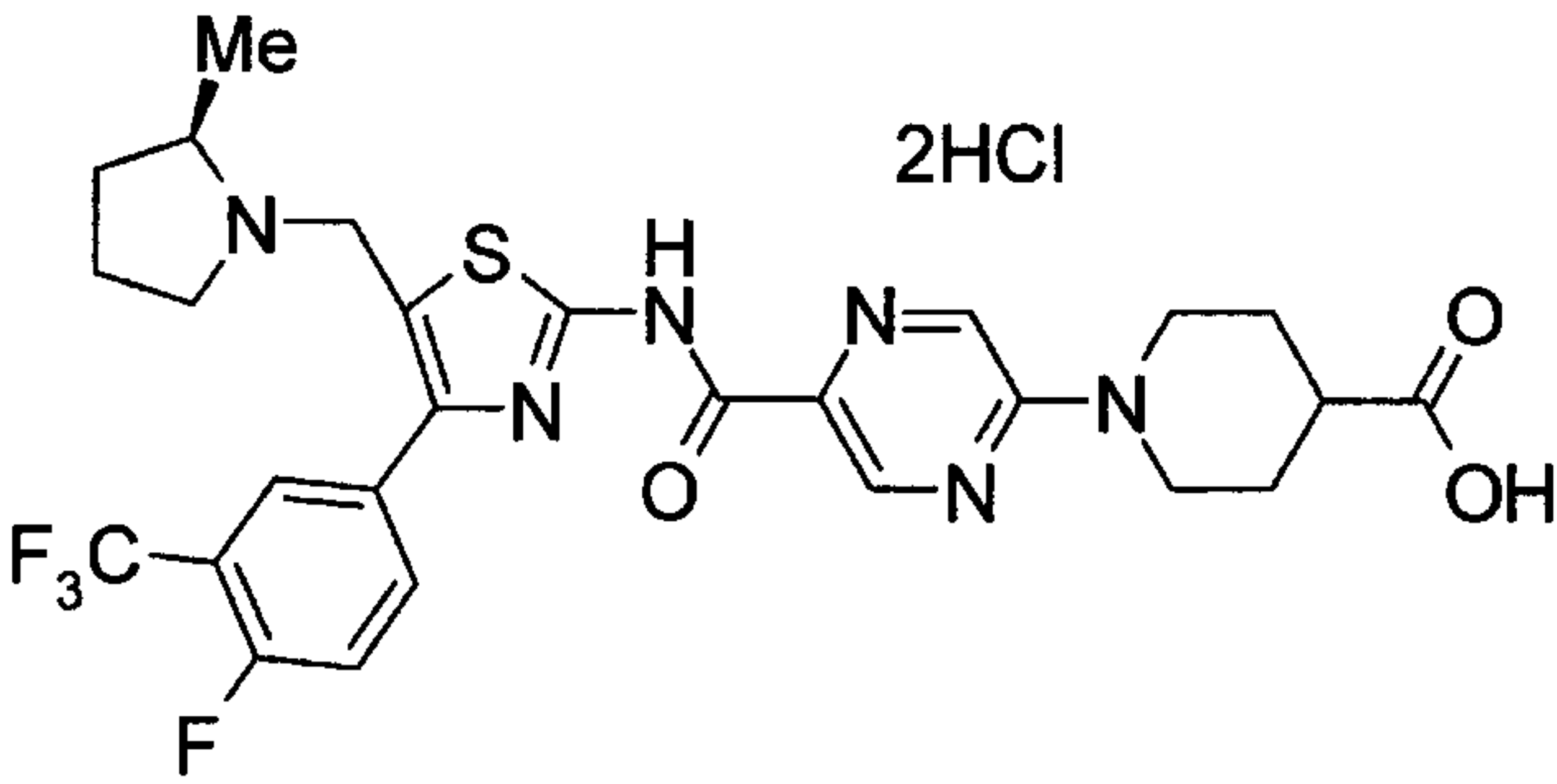
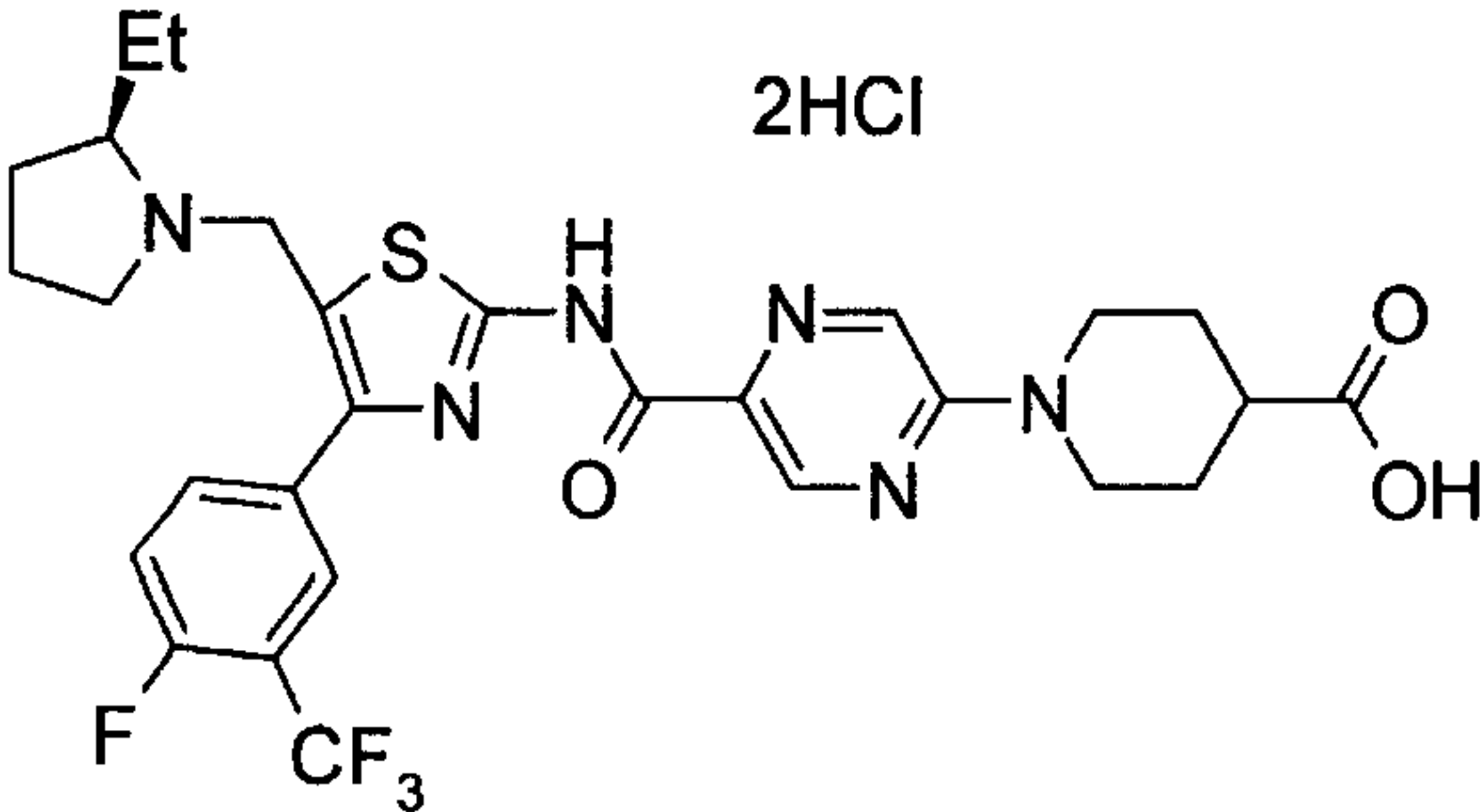
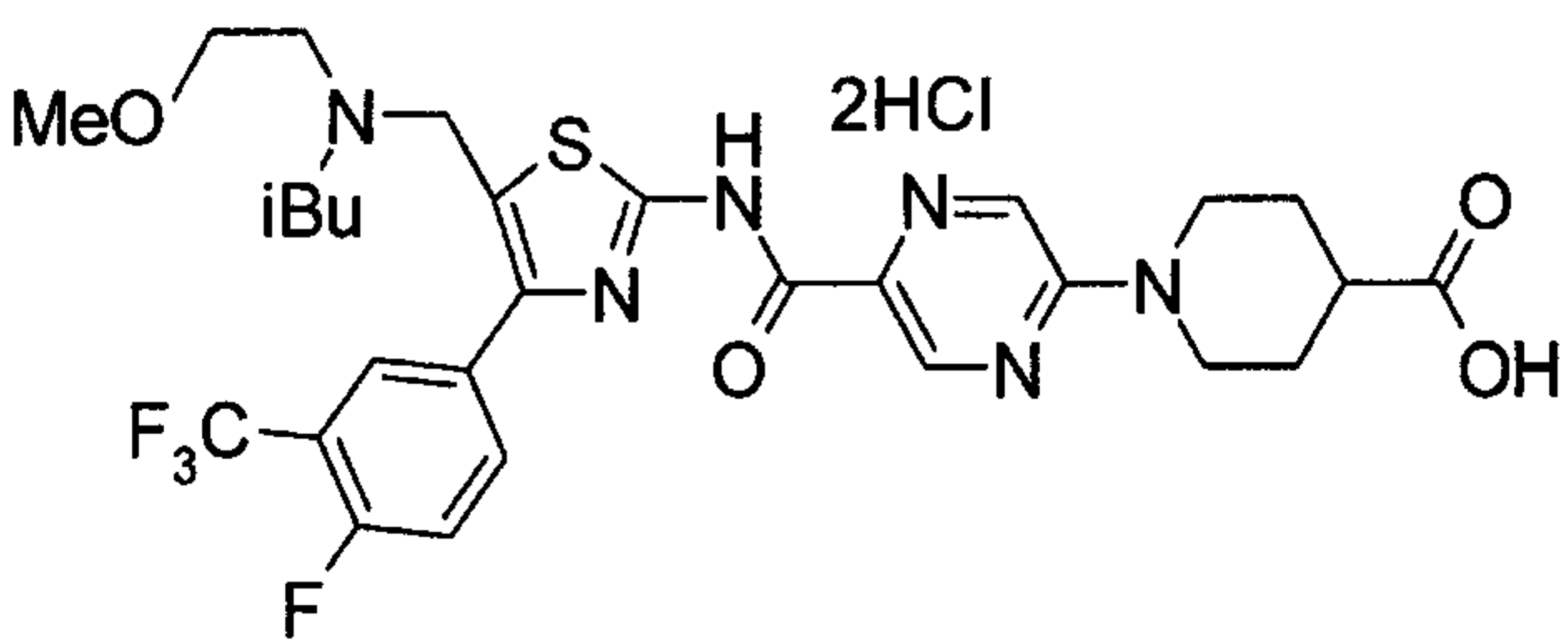
[0203]

[Table 42]

Ex	Str
24	
25	
26	
27	
28	

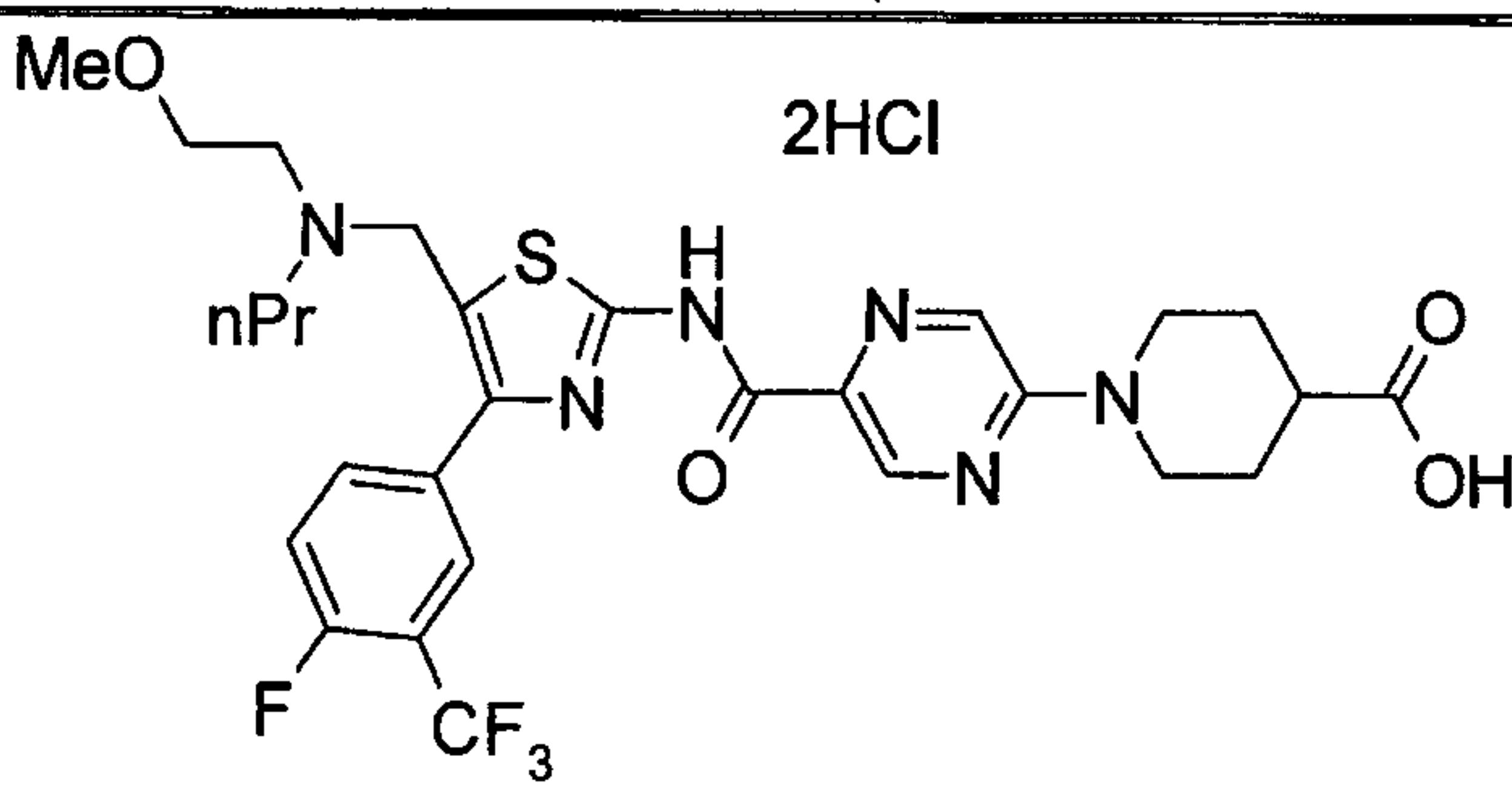
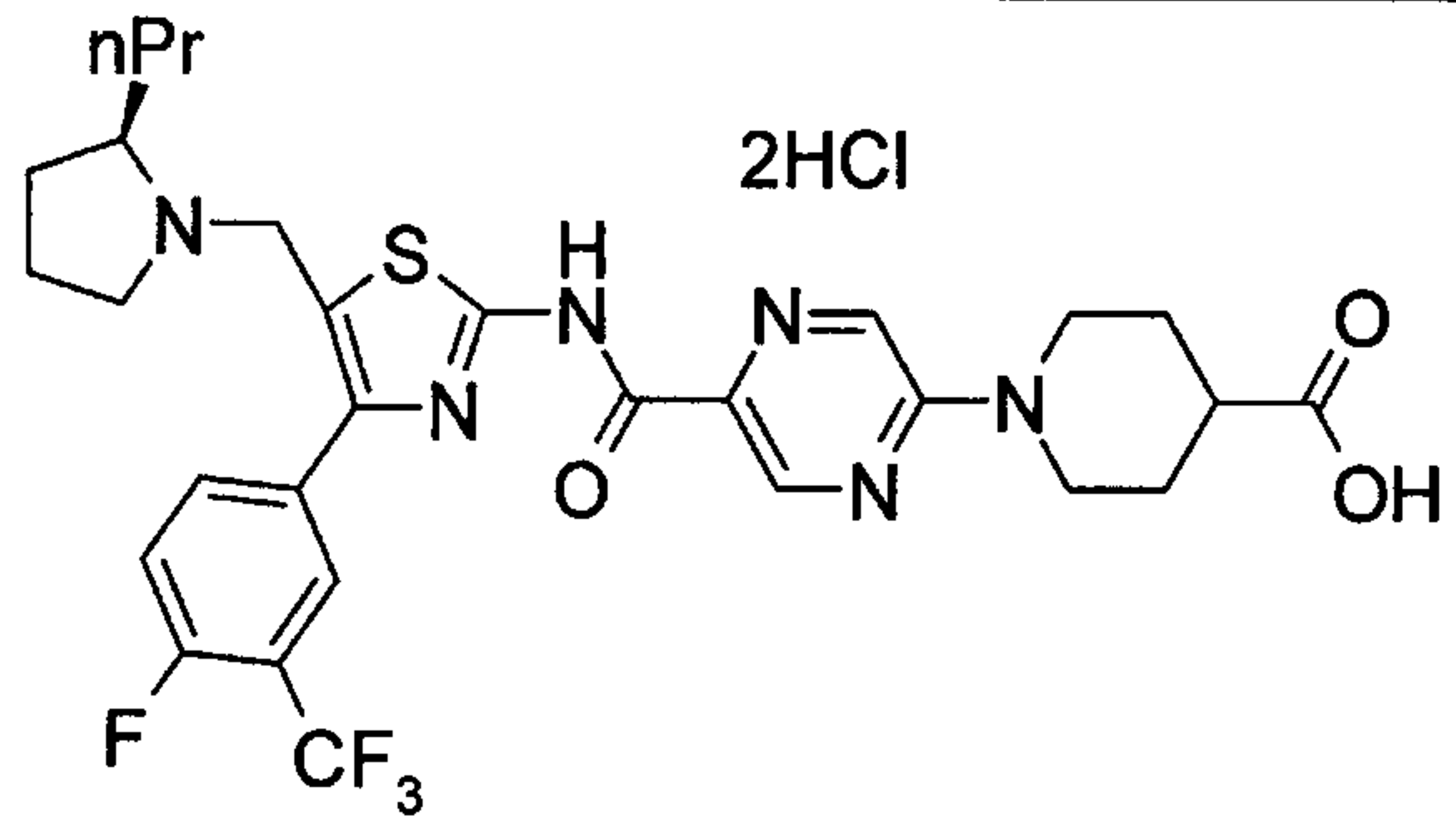
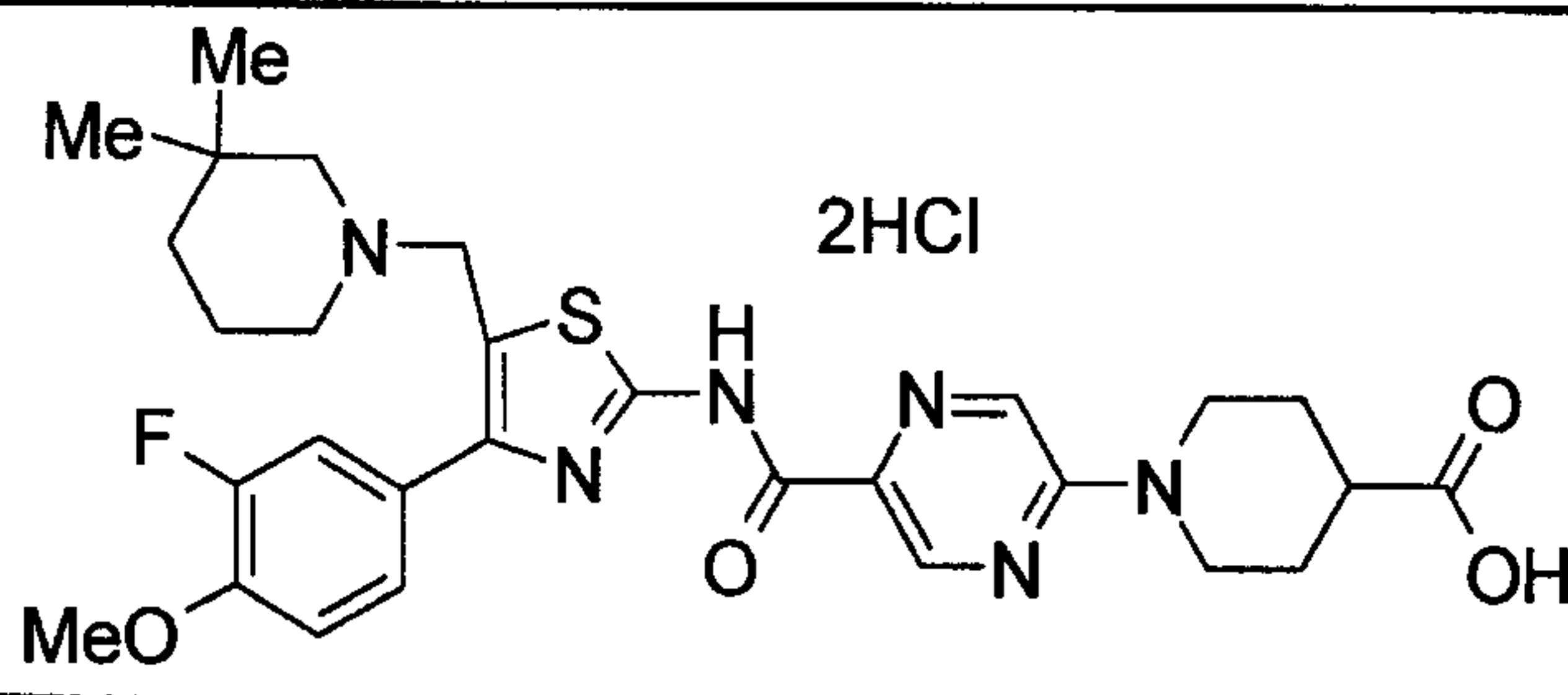
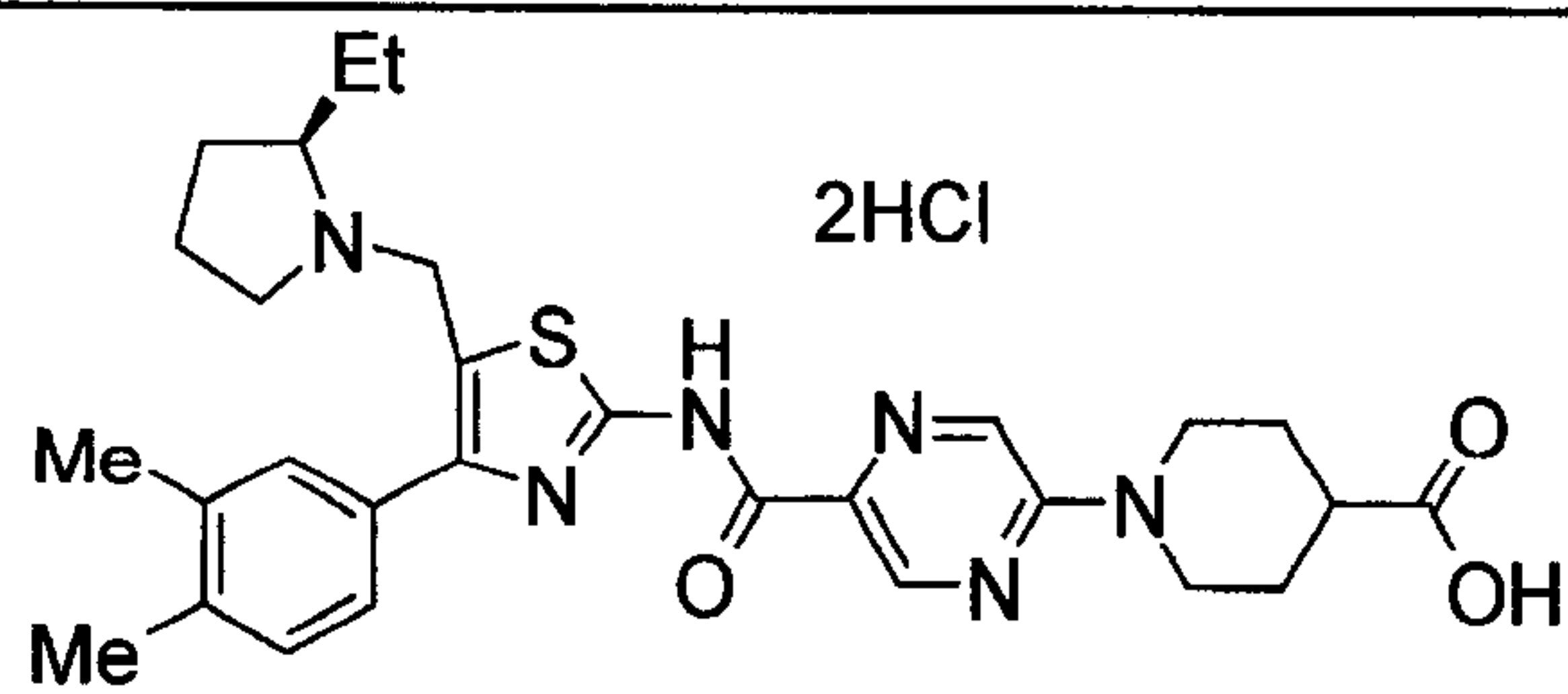
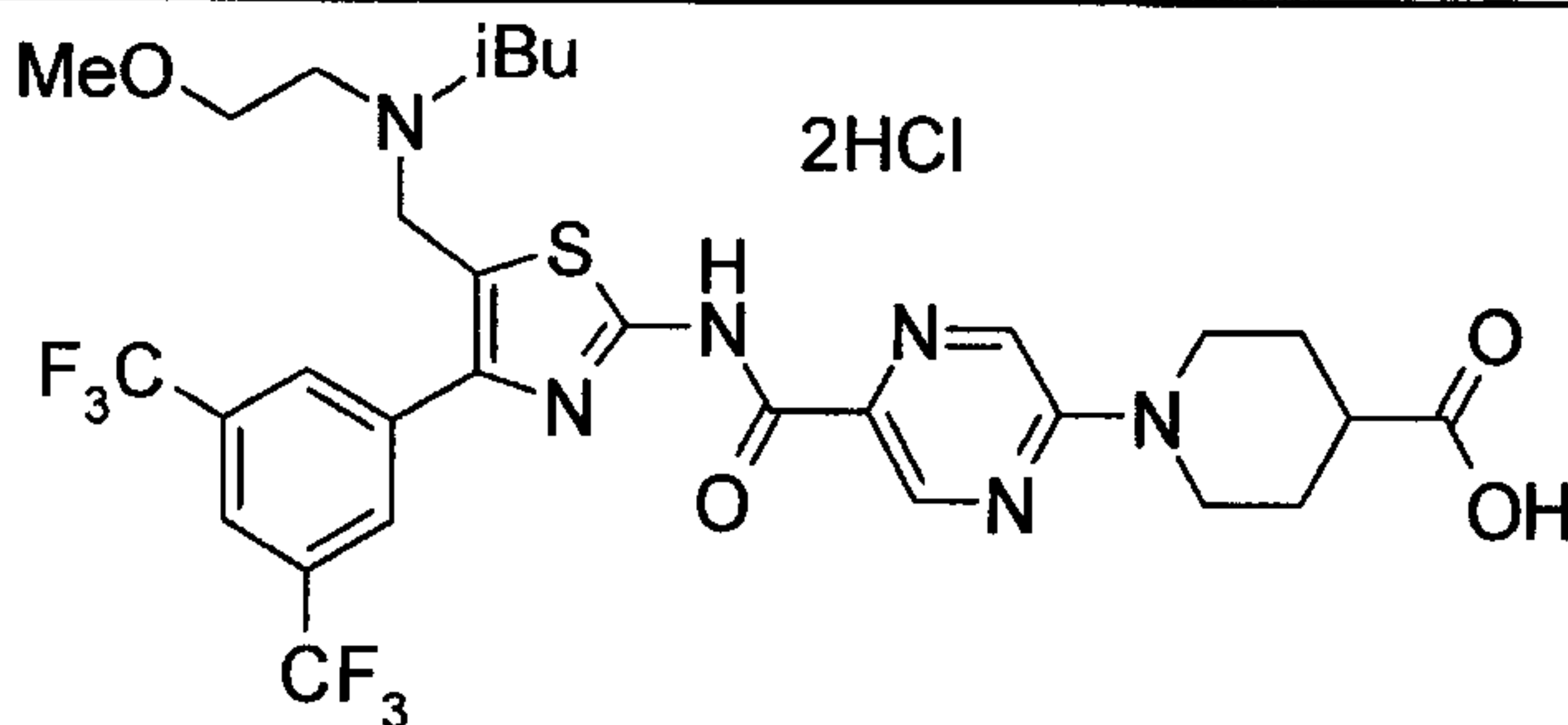
[0204]

[Table 43]

Ex	Str
29	 HCl
30	 2HCl
31	 2HCl
32	 2HCl
33	 2HCl

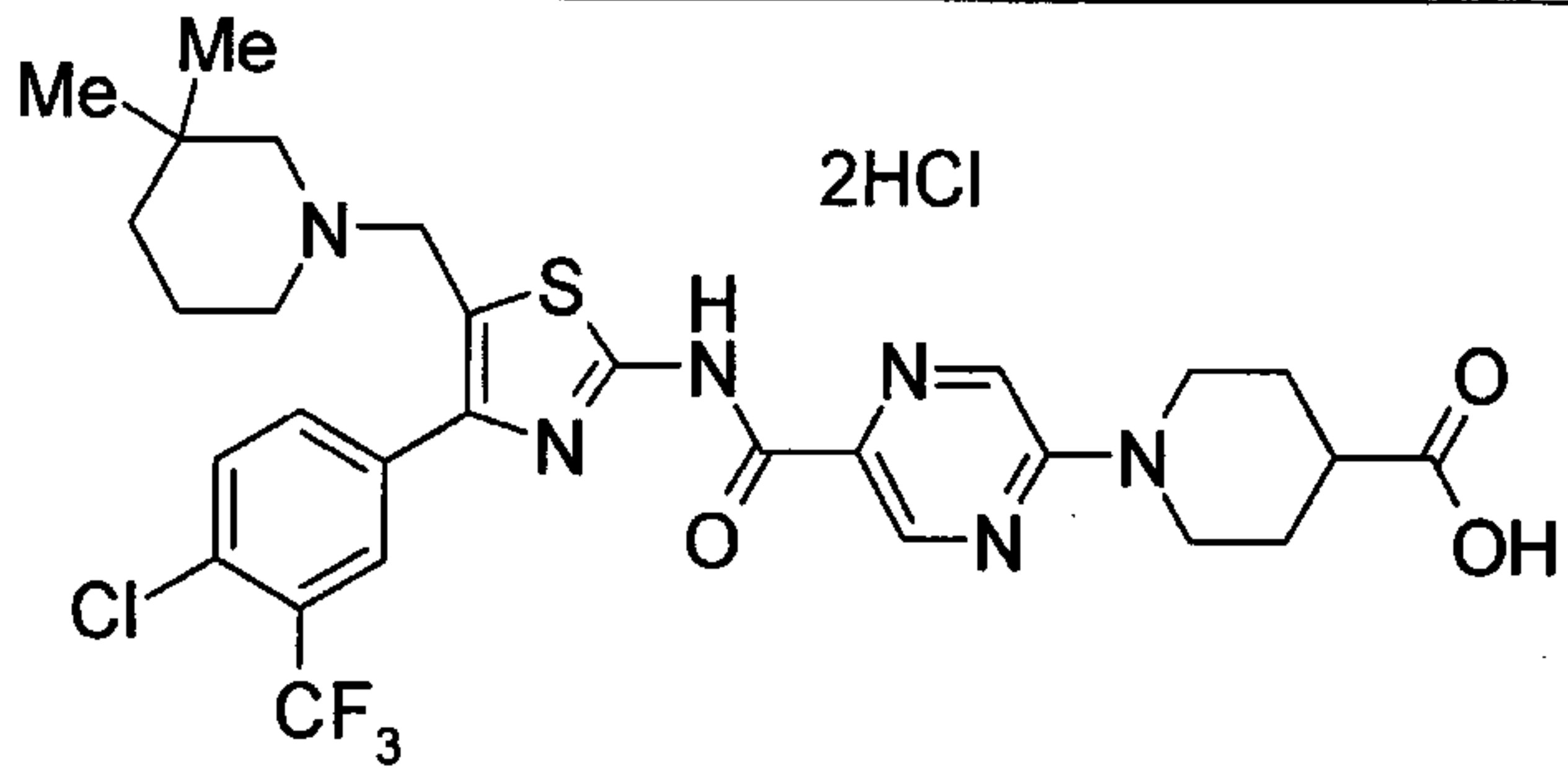
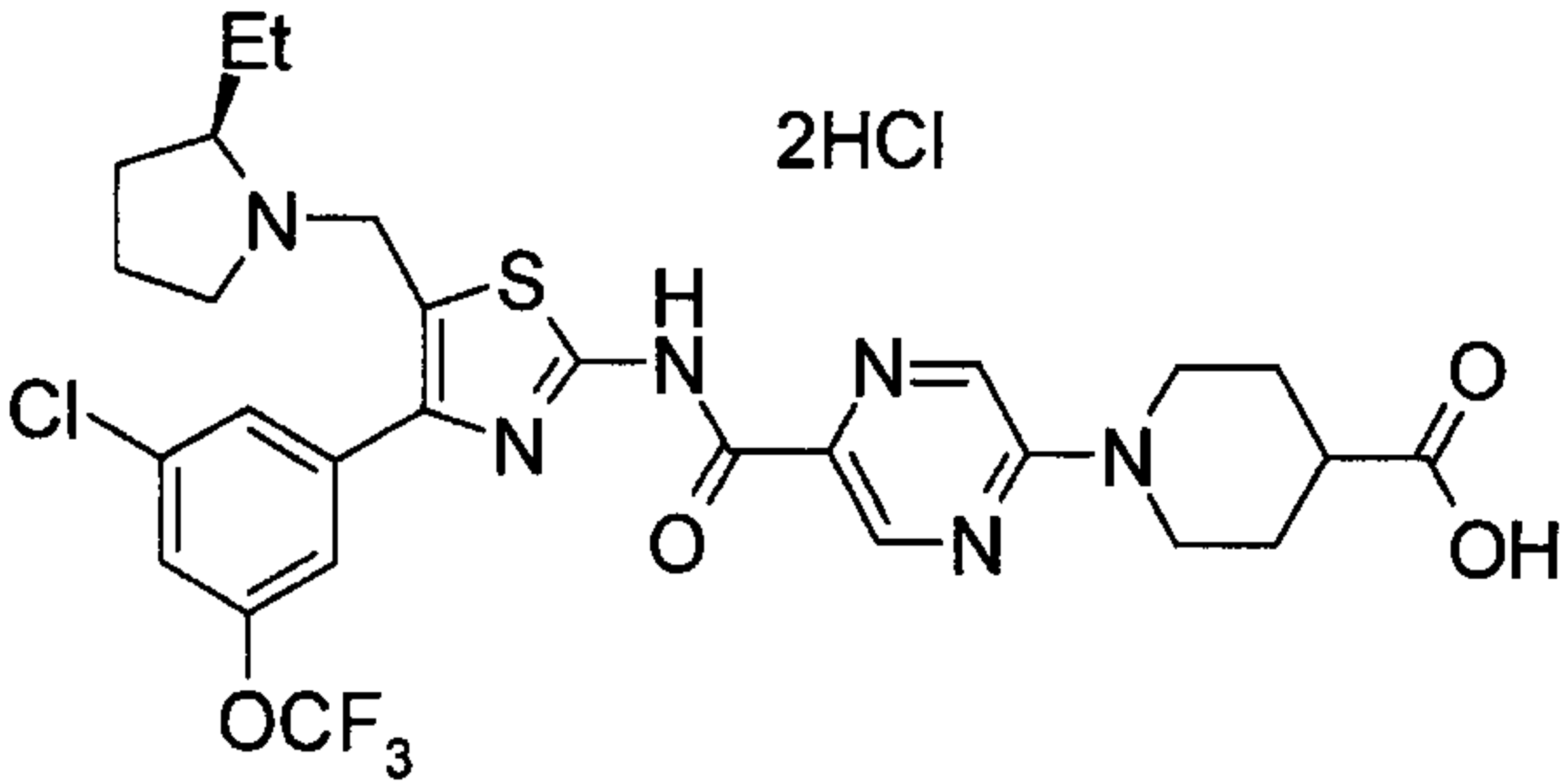
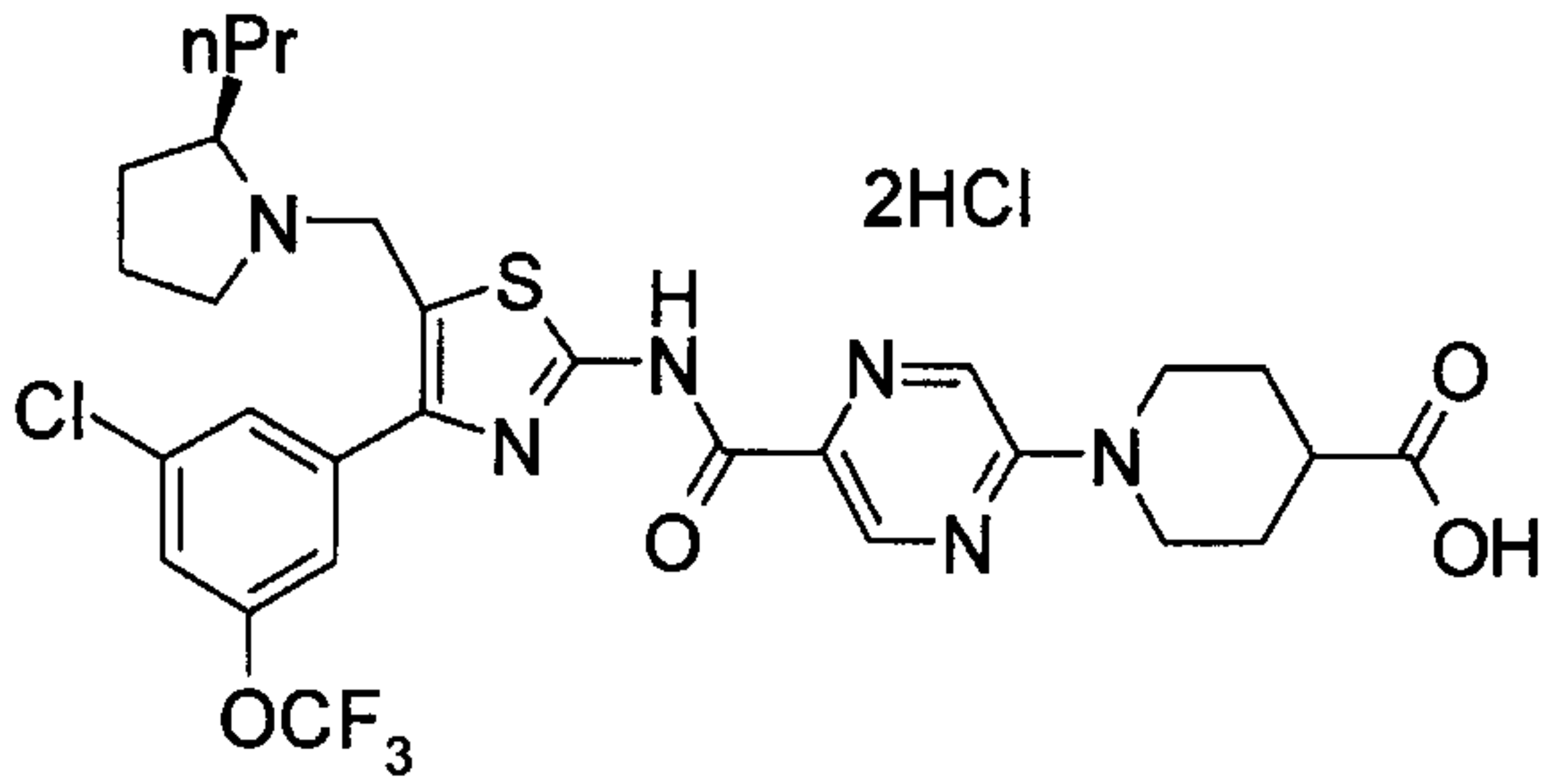
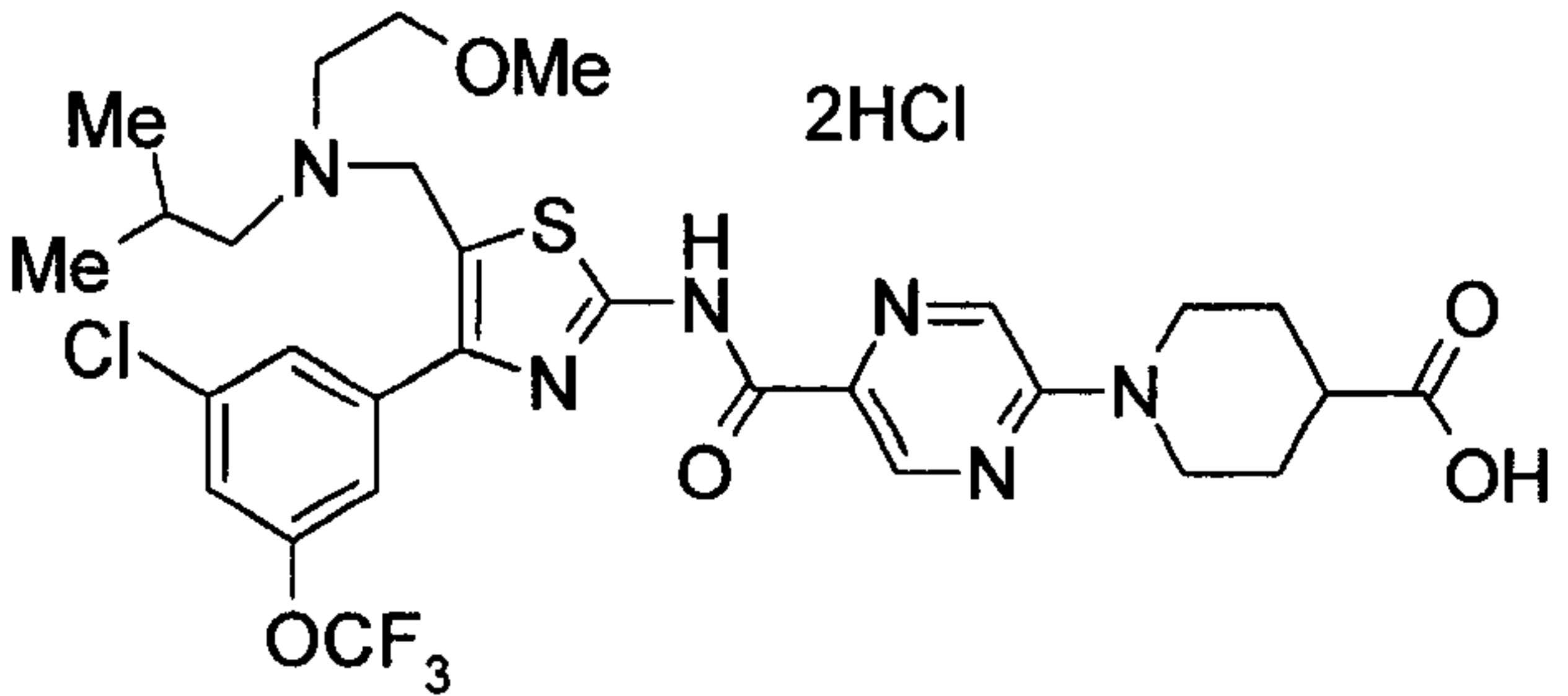
[0205]

[Table 44]

Ex	Str
34	
35	
36	
37	
38	

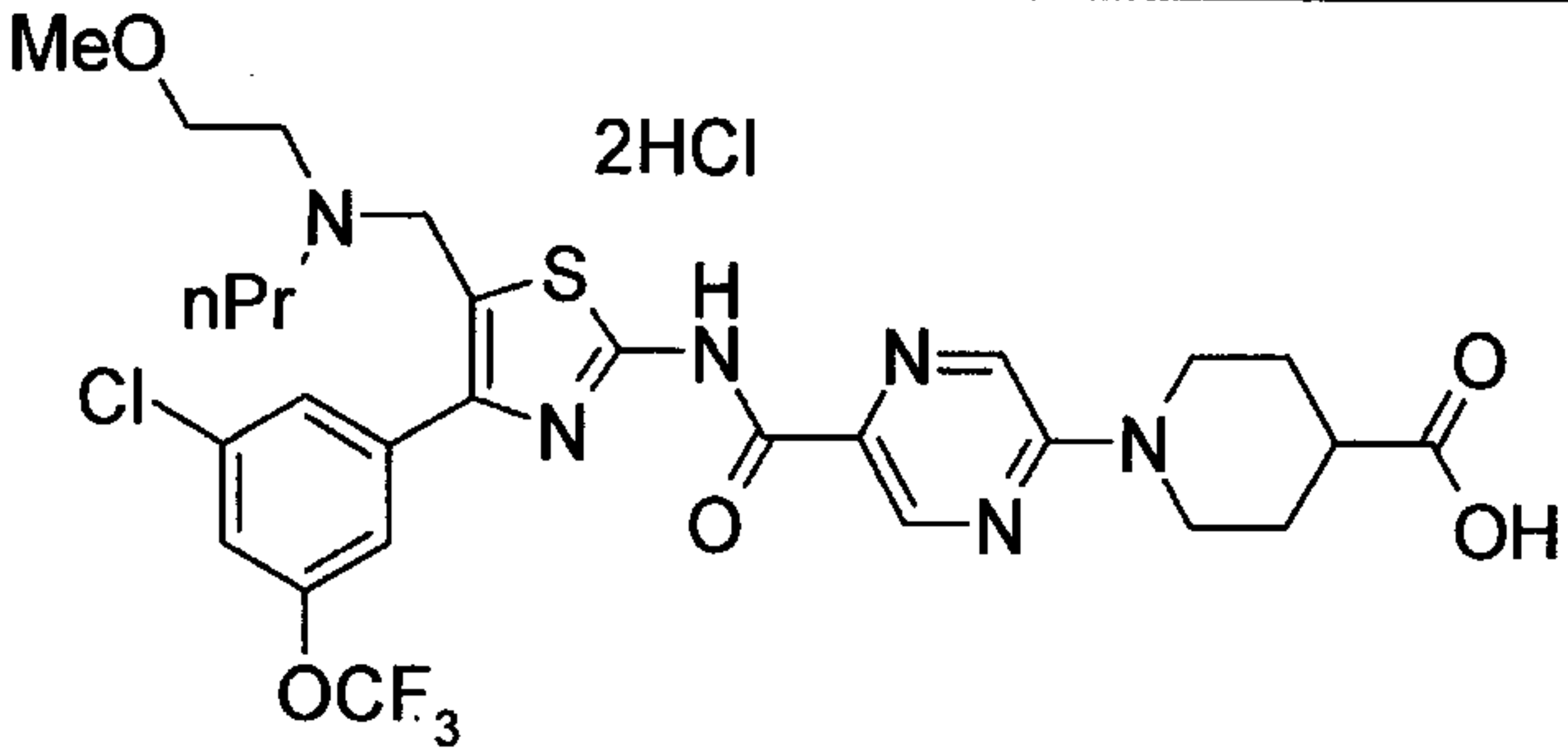
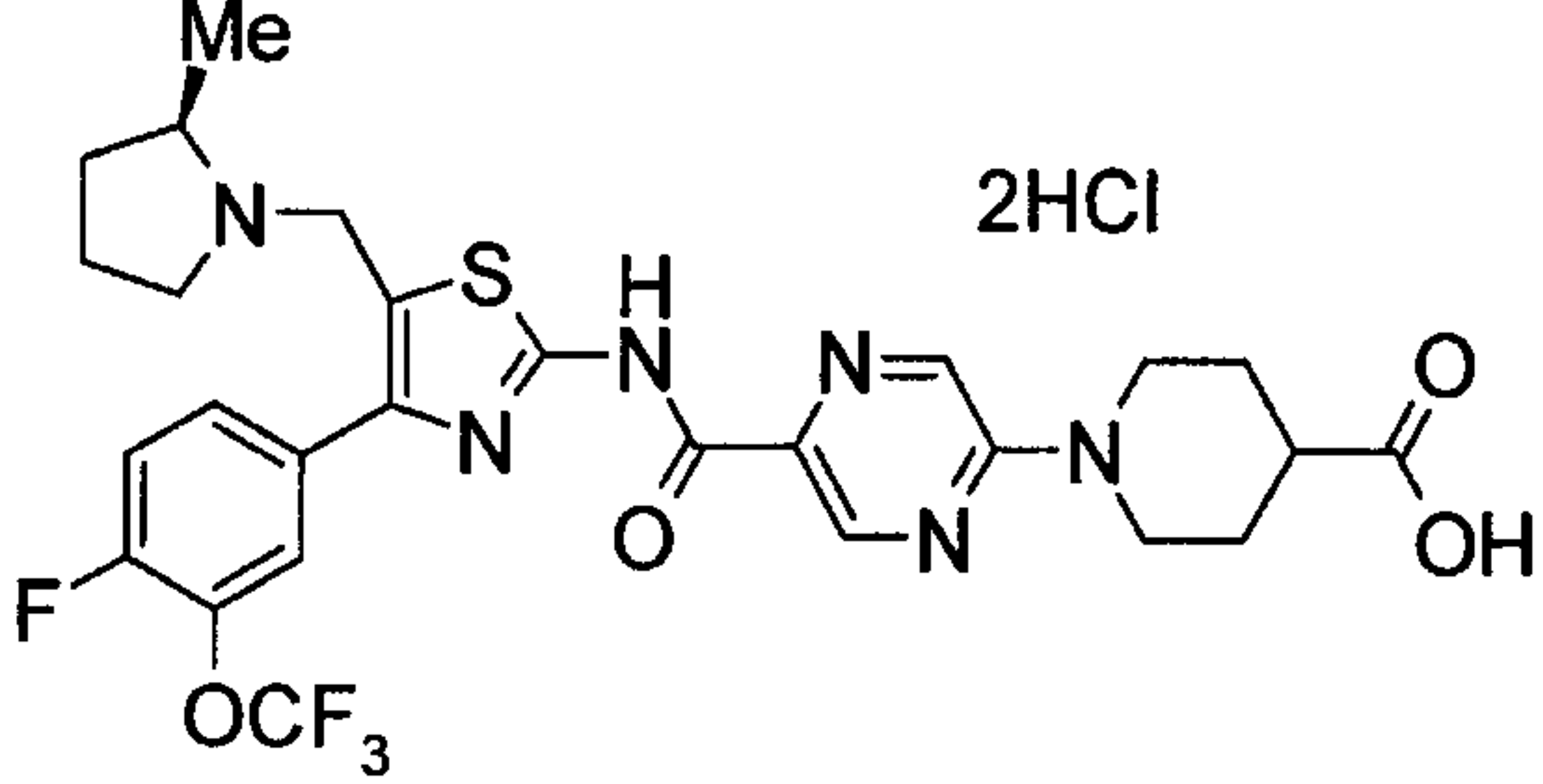
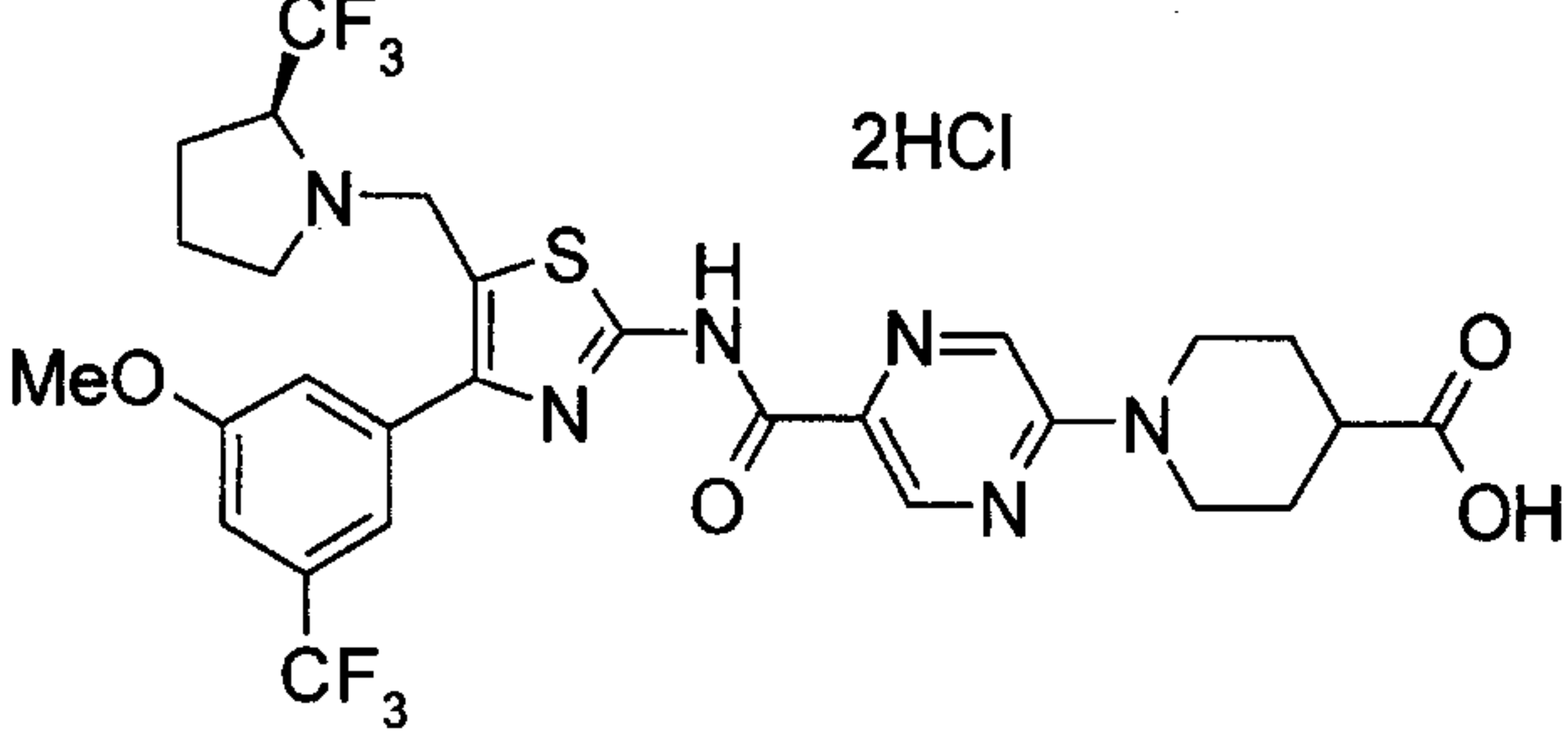
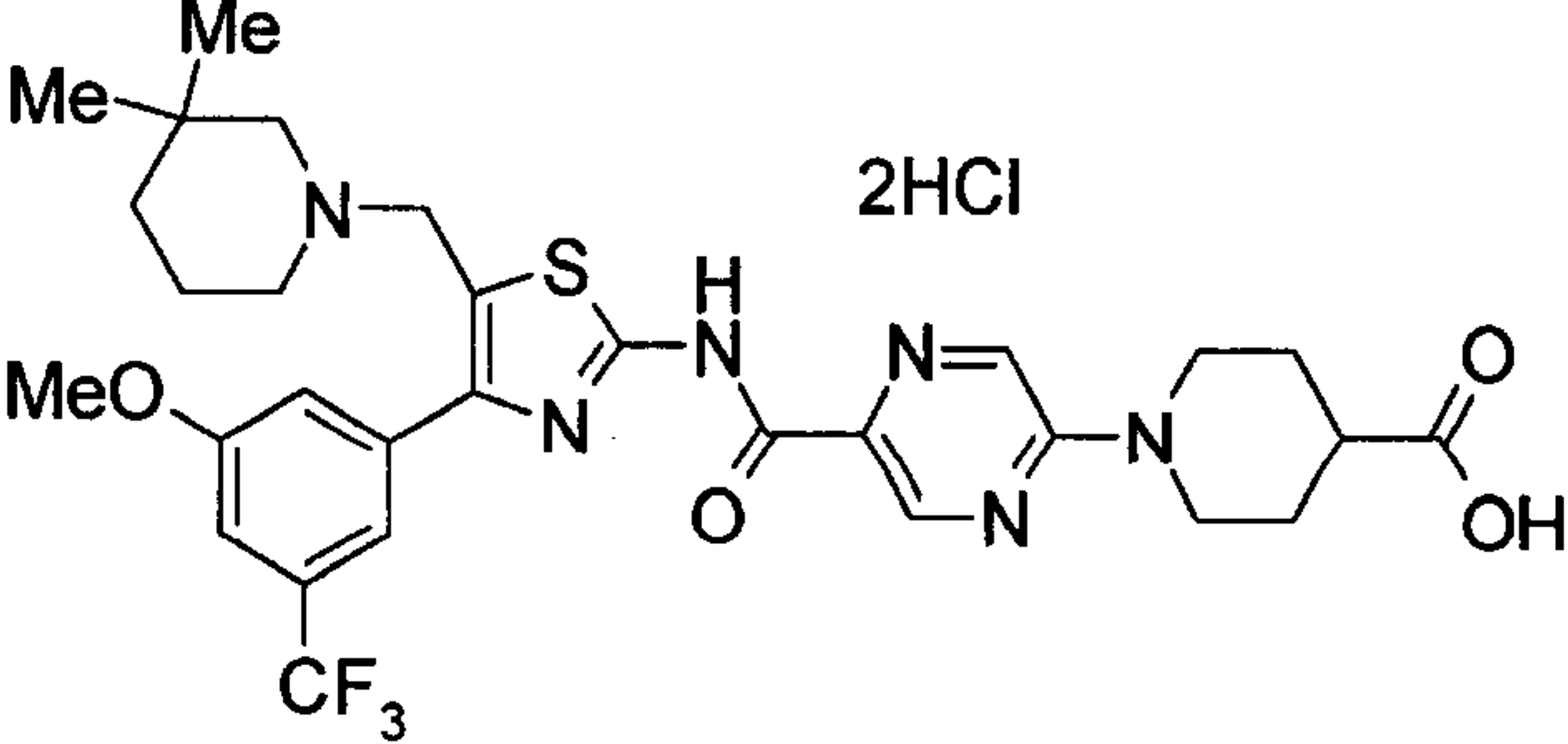
[0206]

[Table 45]

Ex	Str
39	
40	
41	
42	

[0207]

[Table 46]

Ex	Str
43	
44	
45	
46	

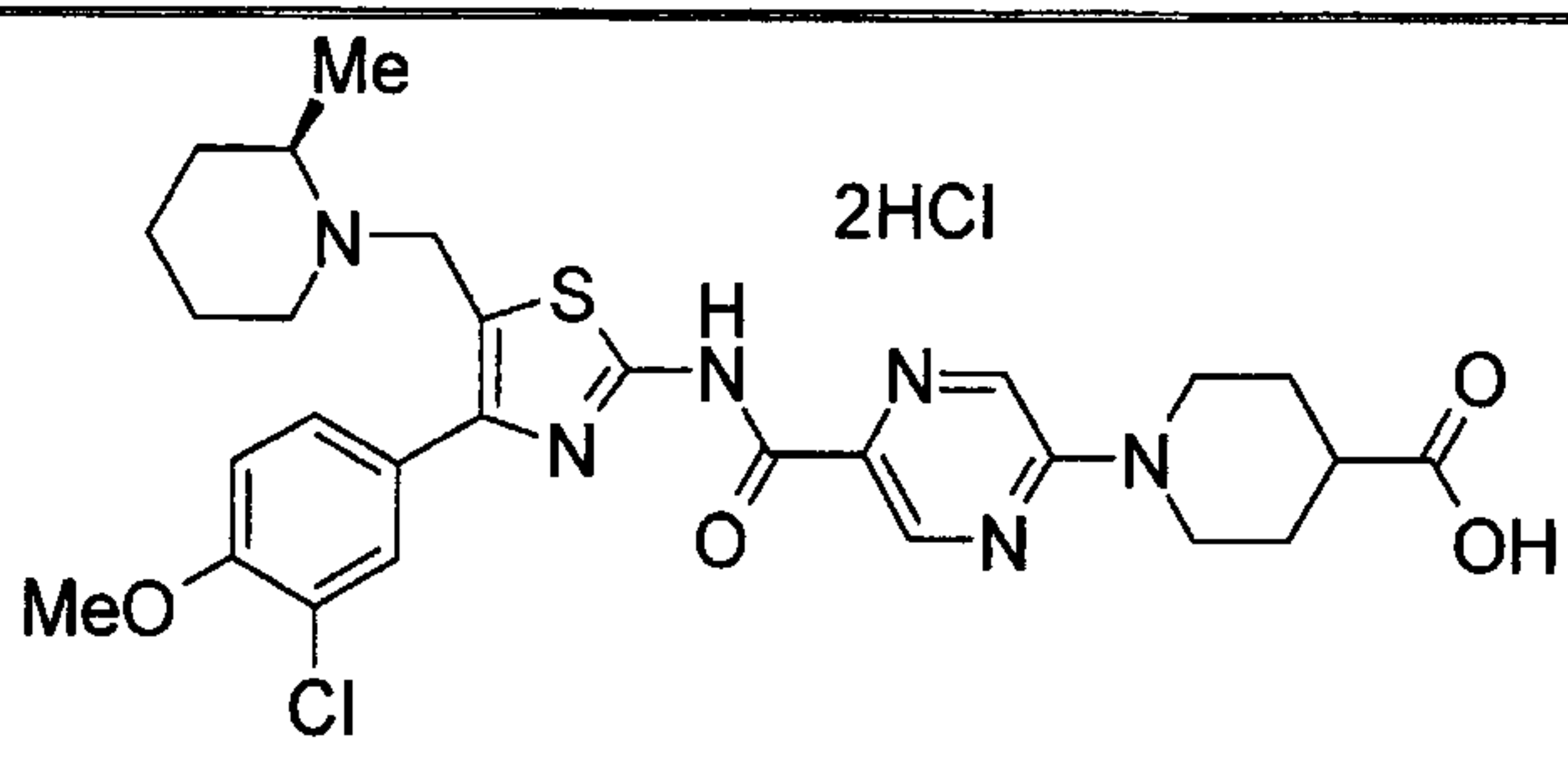
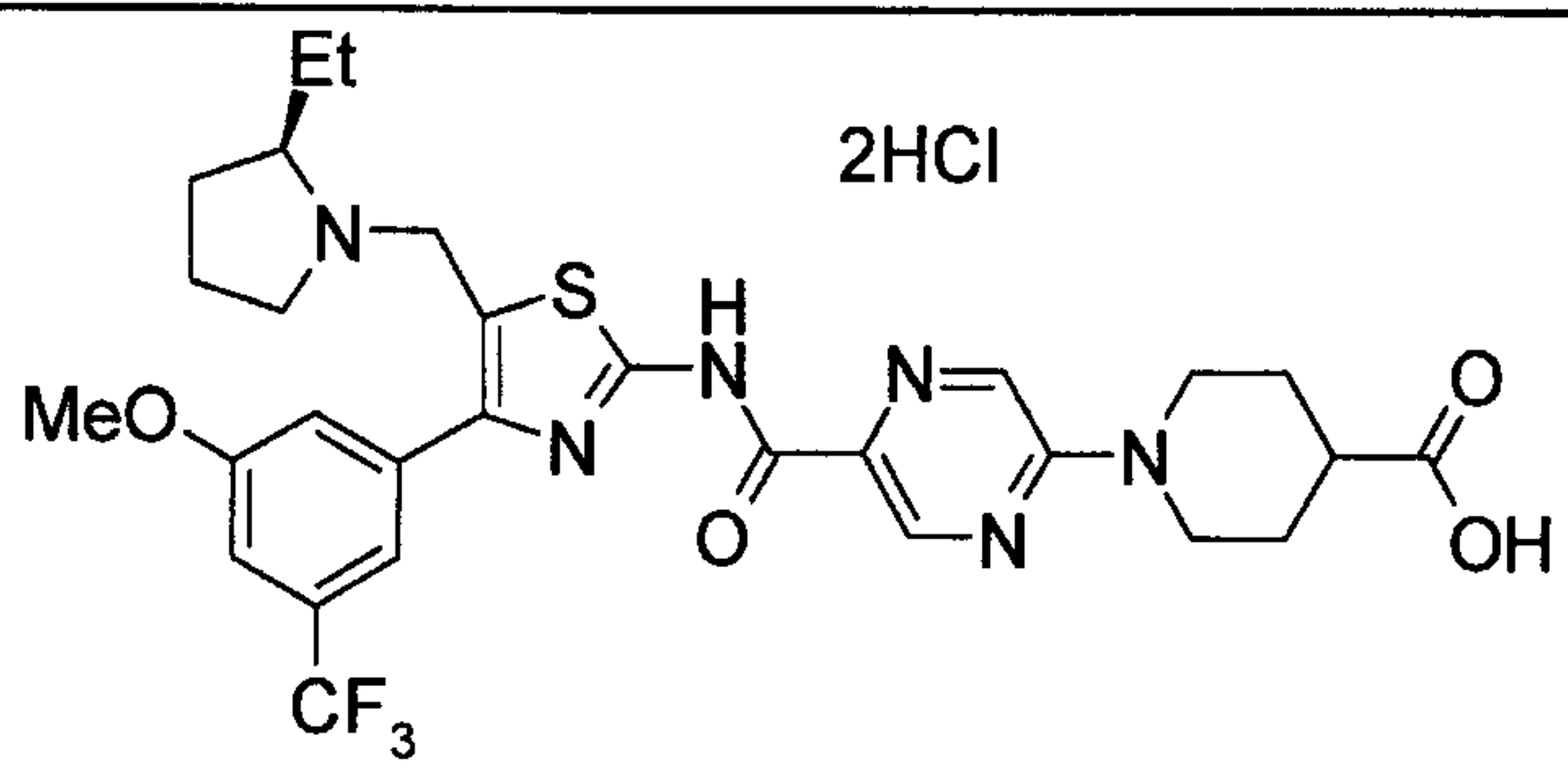
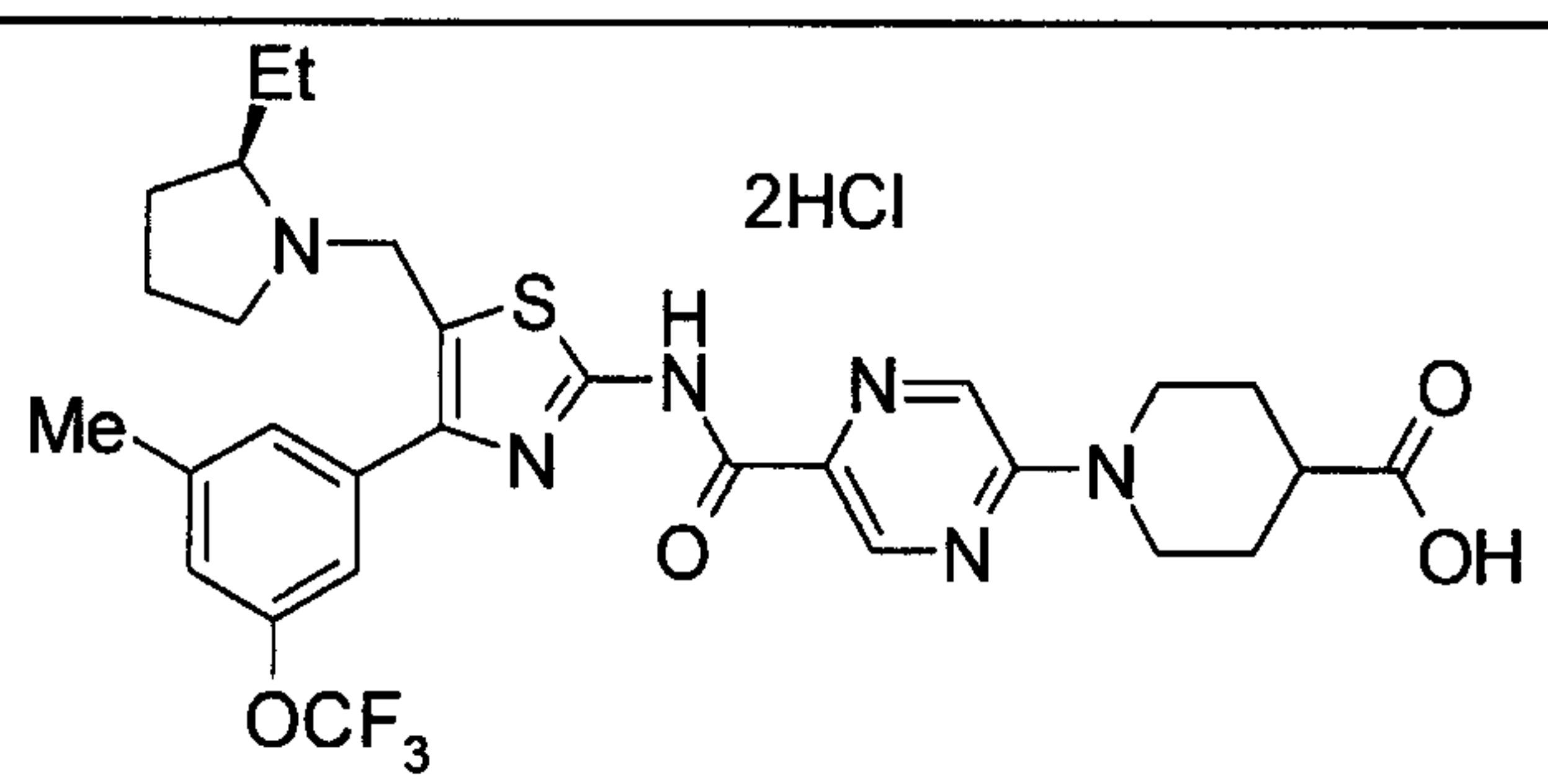
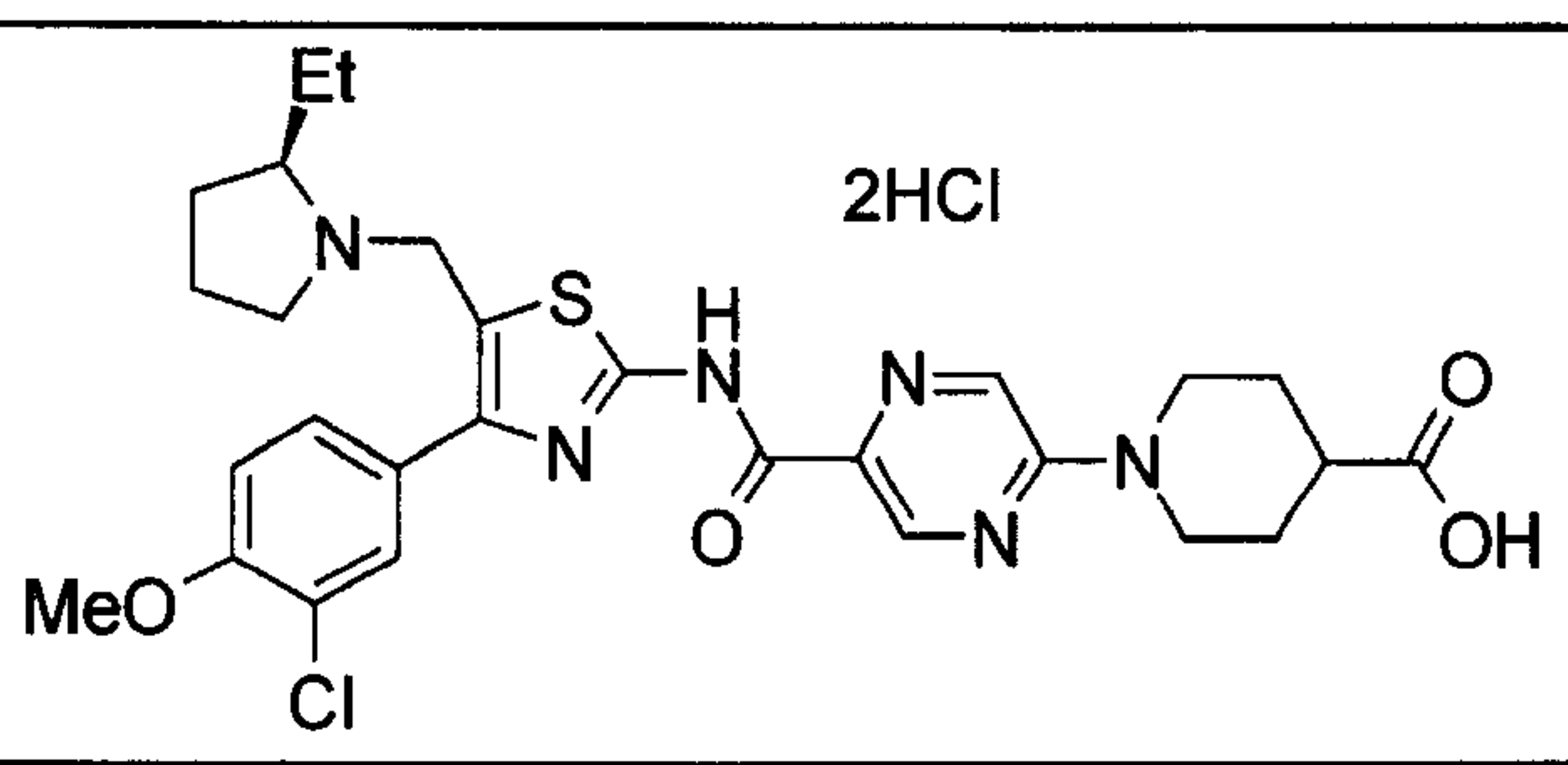
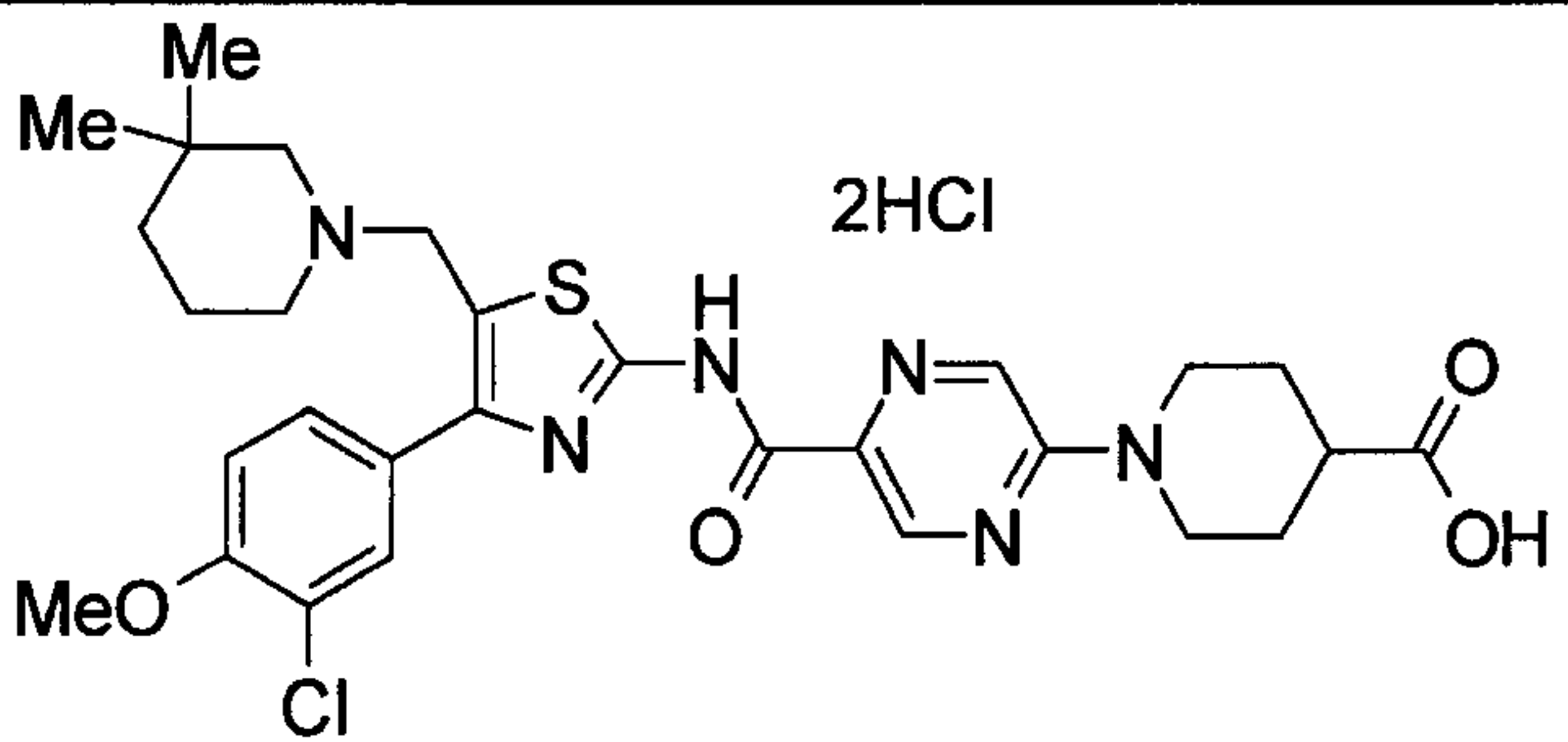
[0208]

[Table 47]

[illegible]

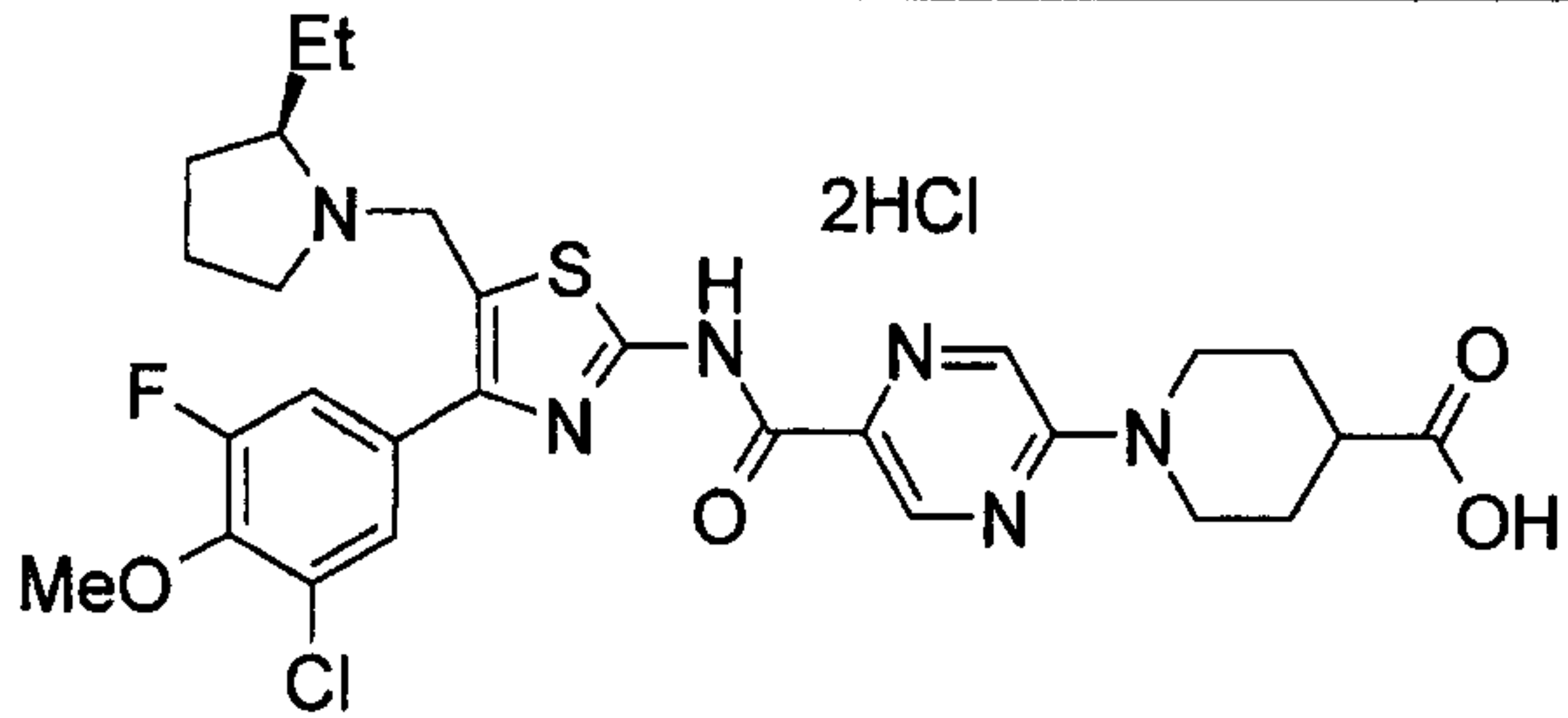
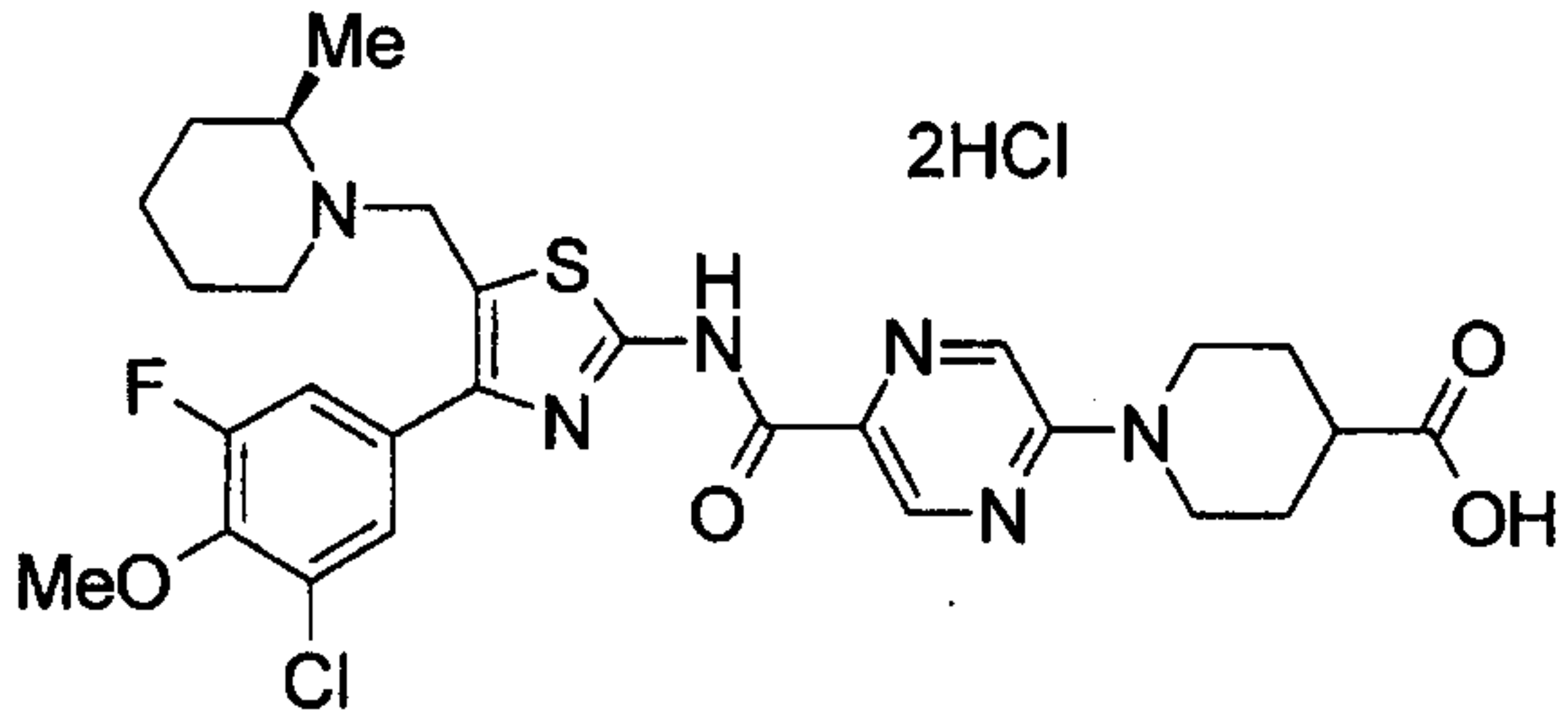
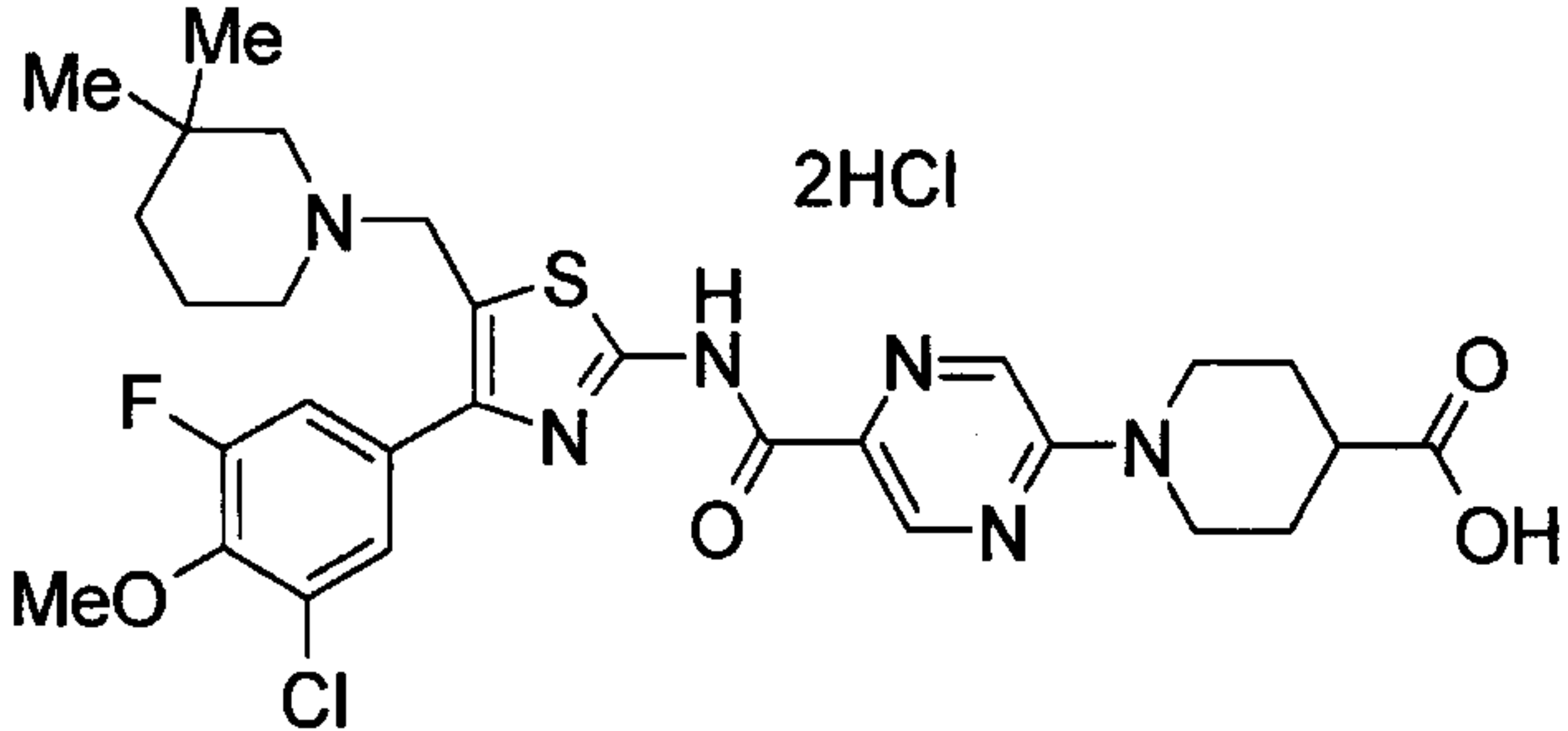
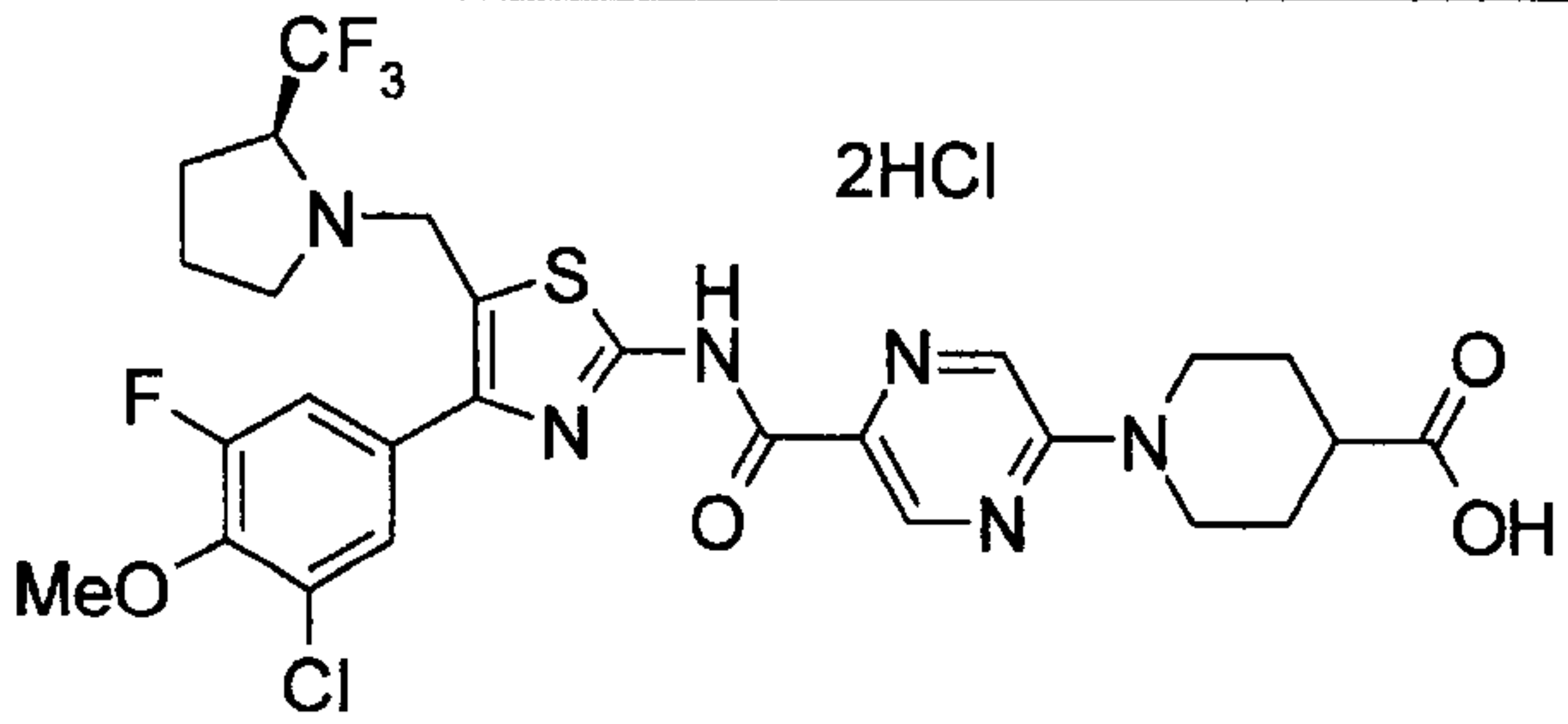
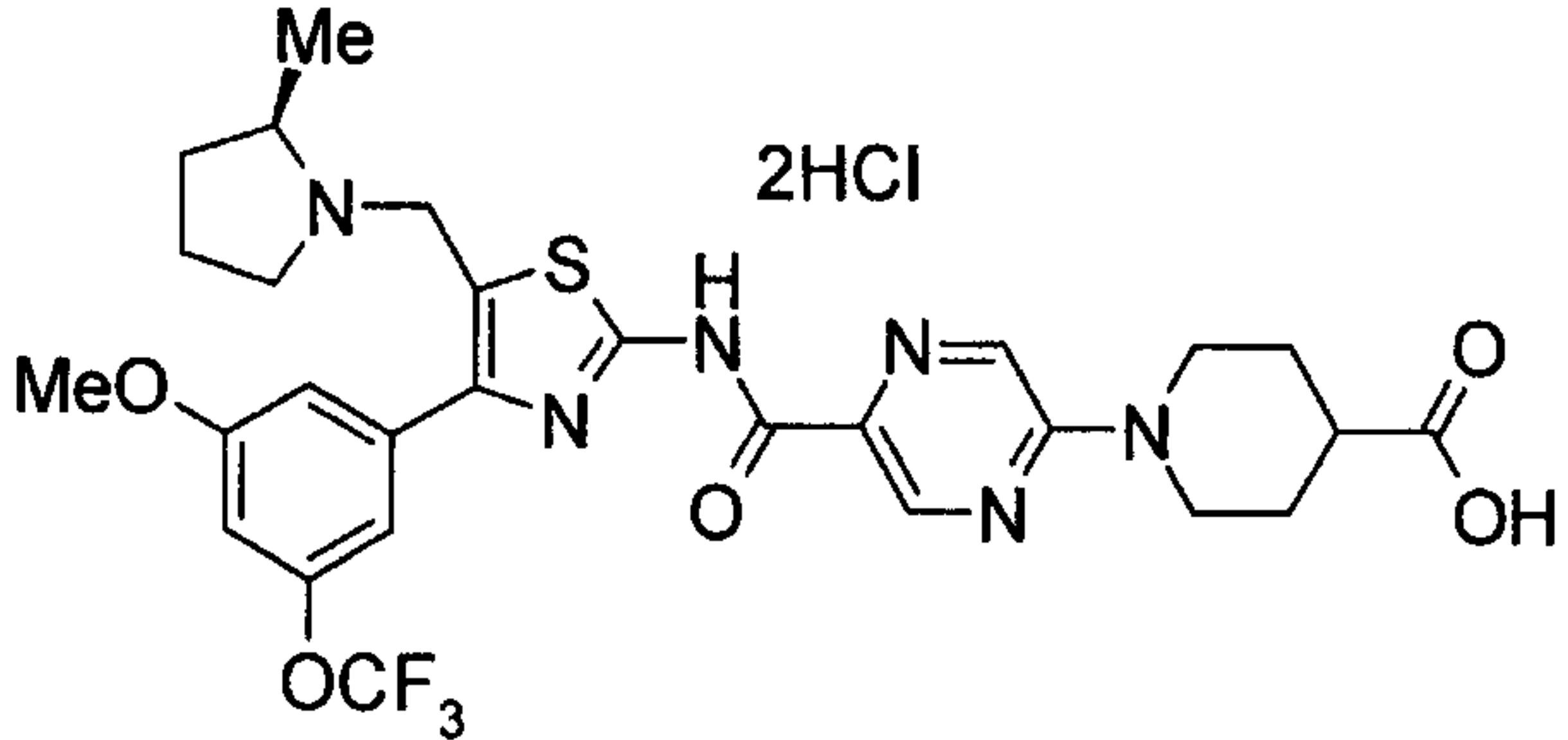
[0209]

[Table 48]

Ex	Str
52	
53	
54	
55	
56	

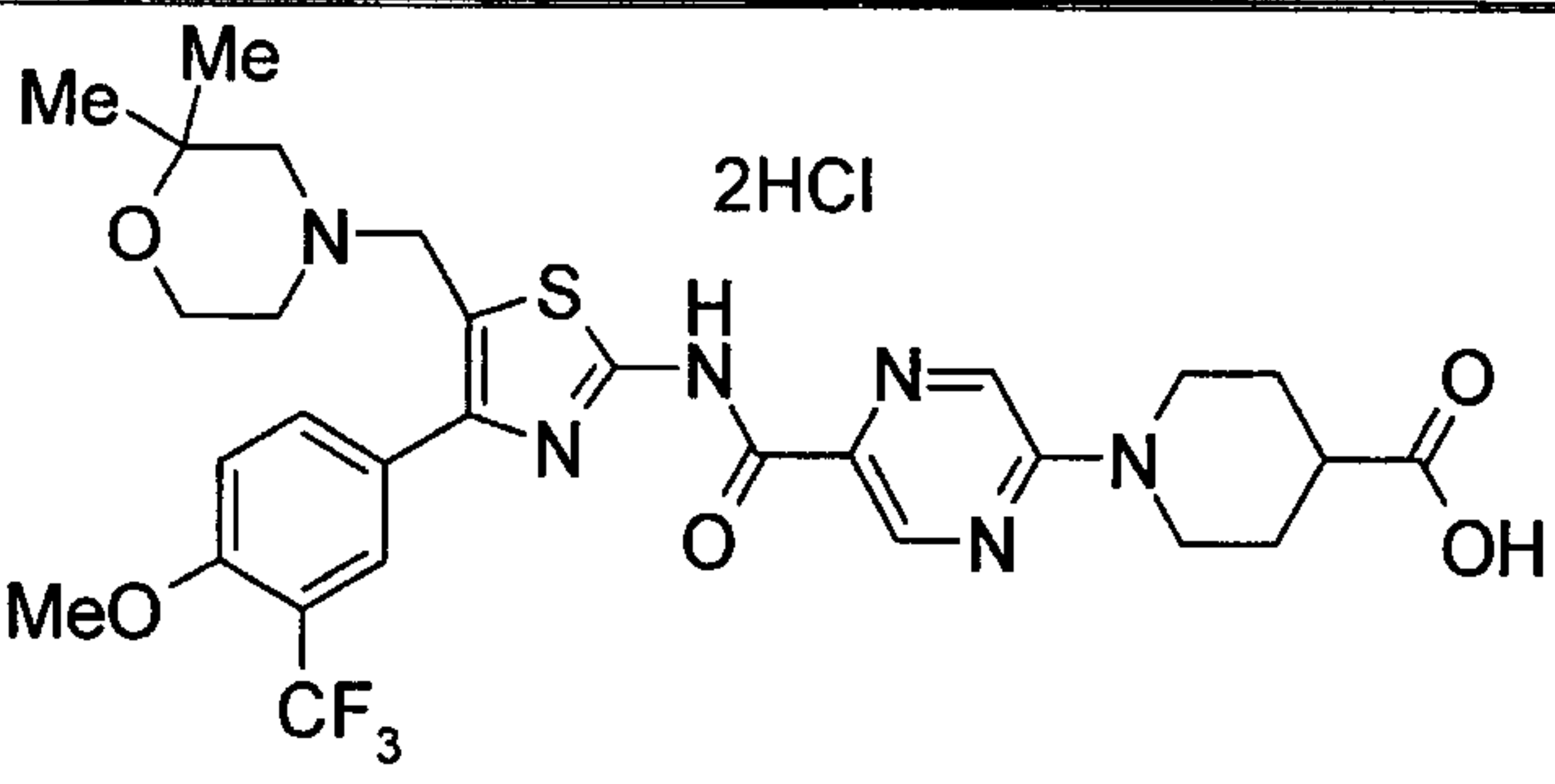
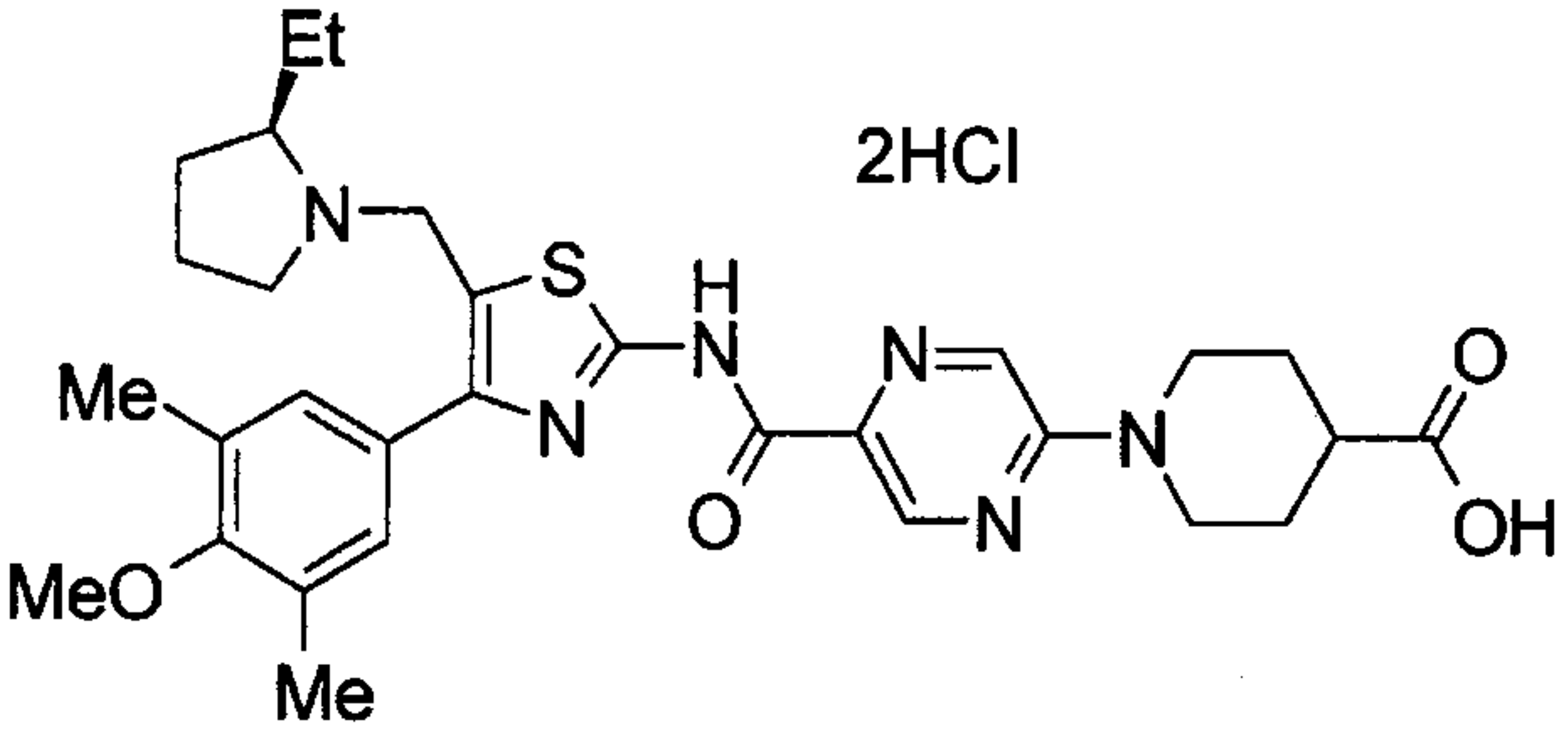
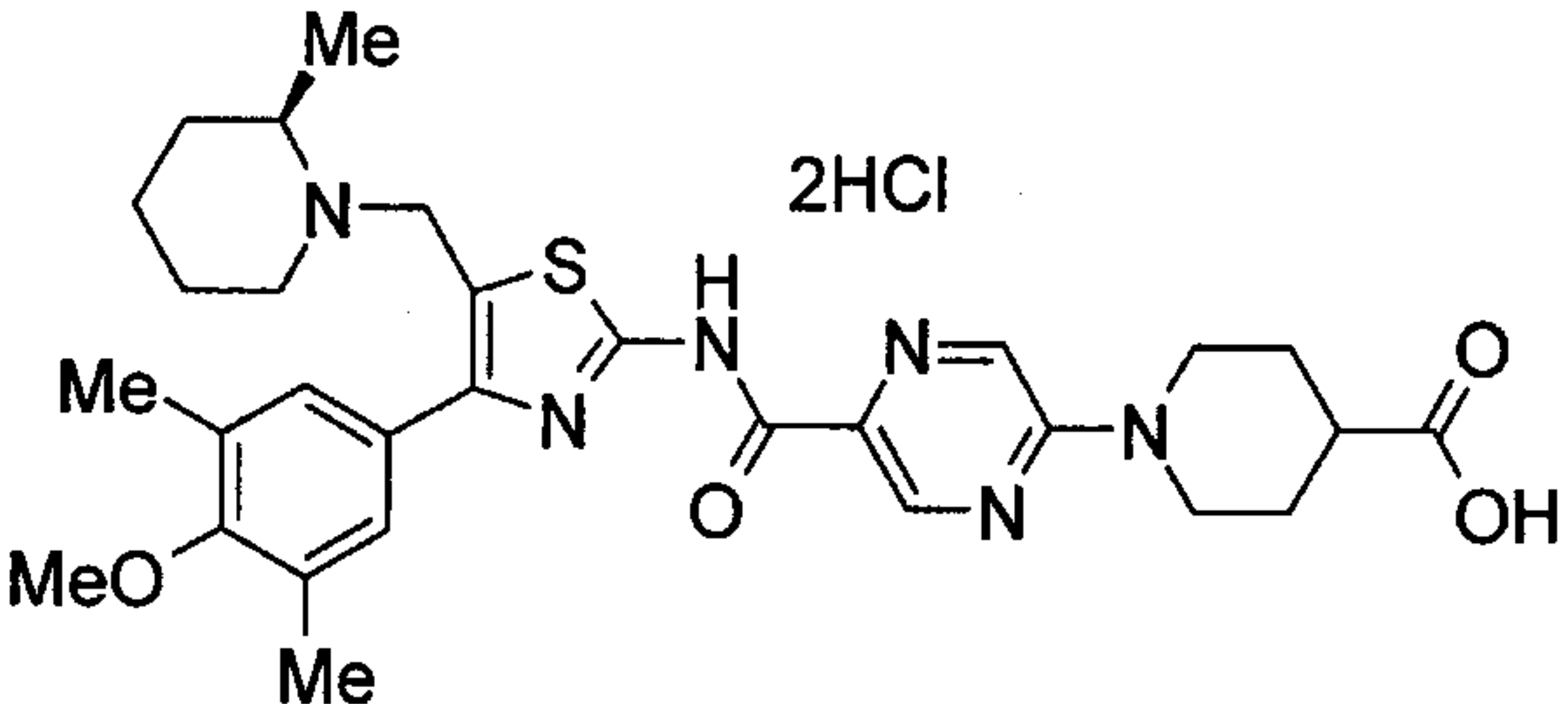
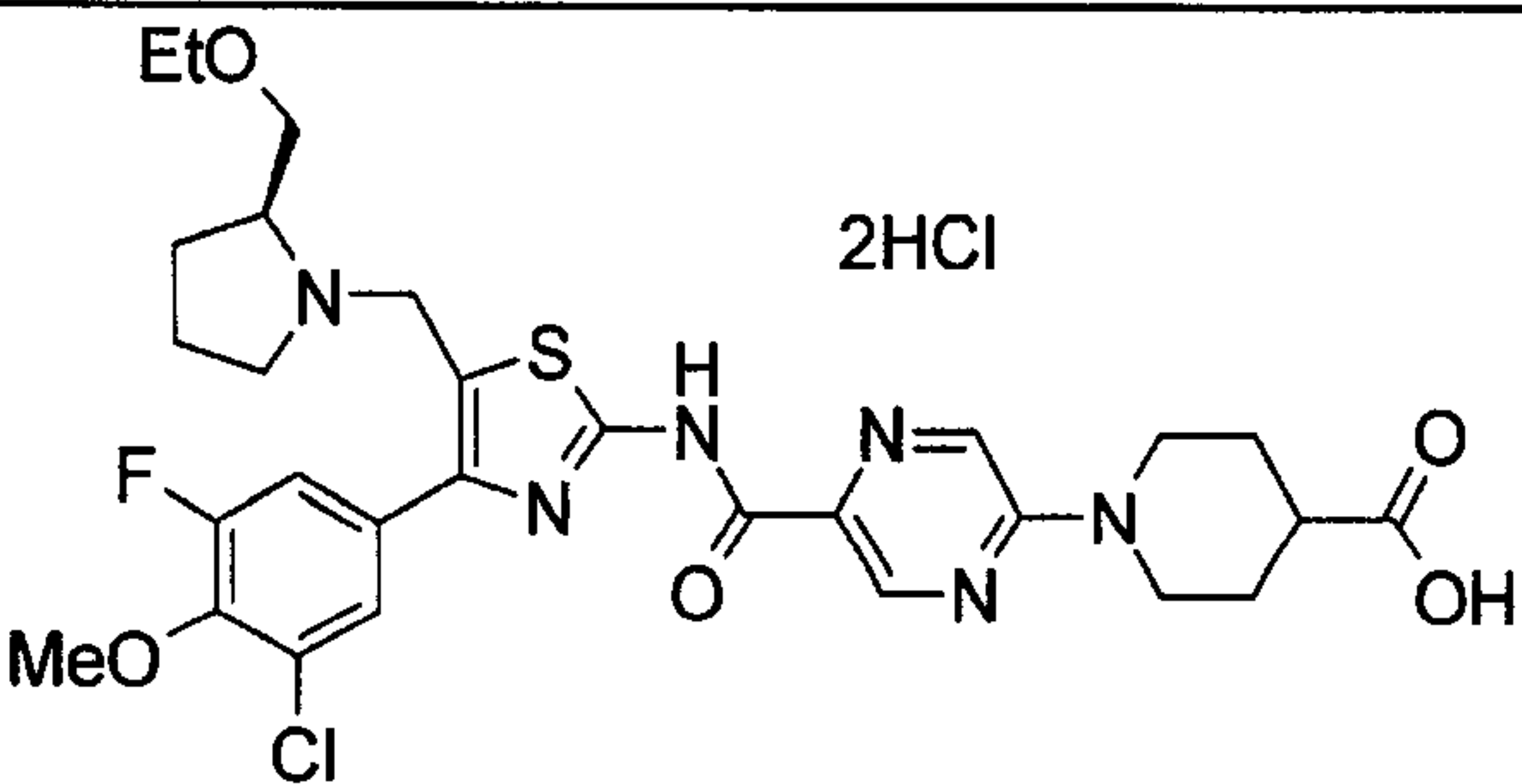
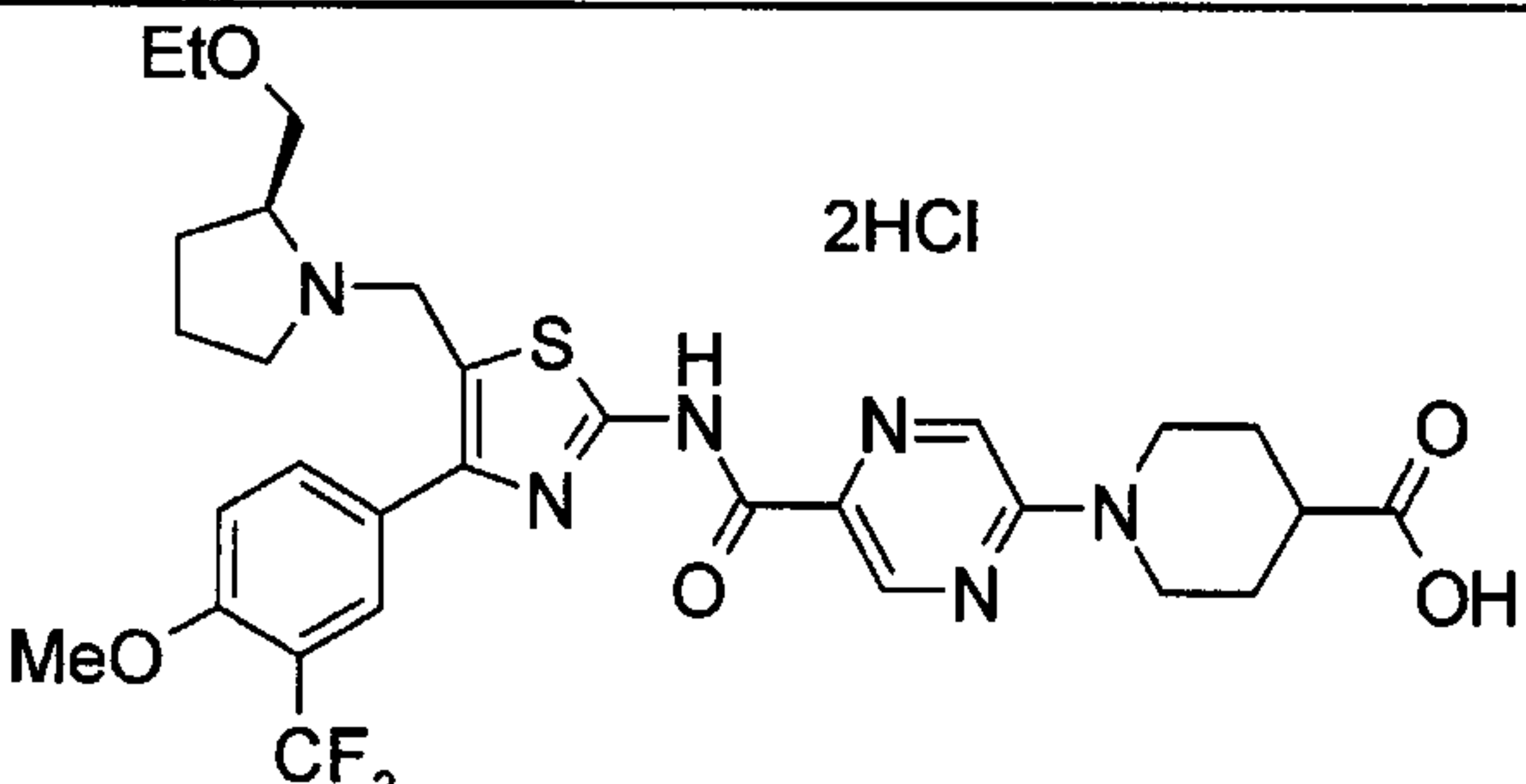
[0210]

[Table 49]

Ex	Str
57	
58	
59	
60	
61	

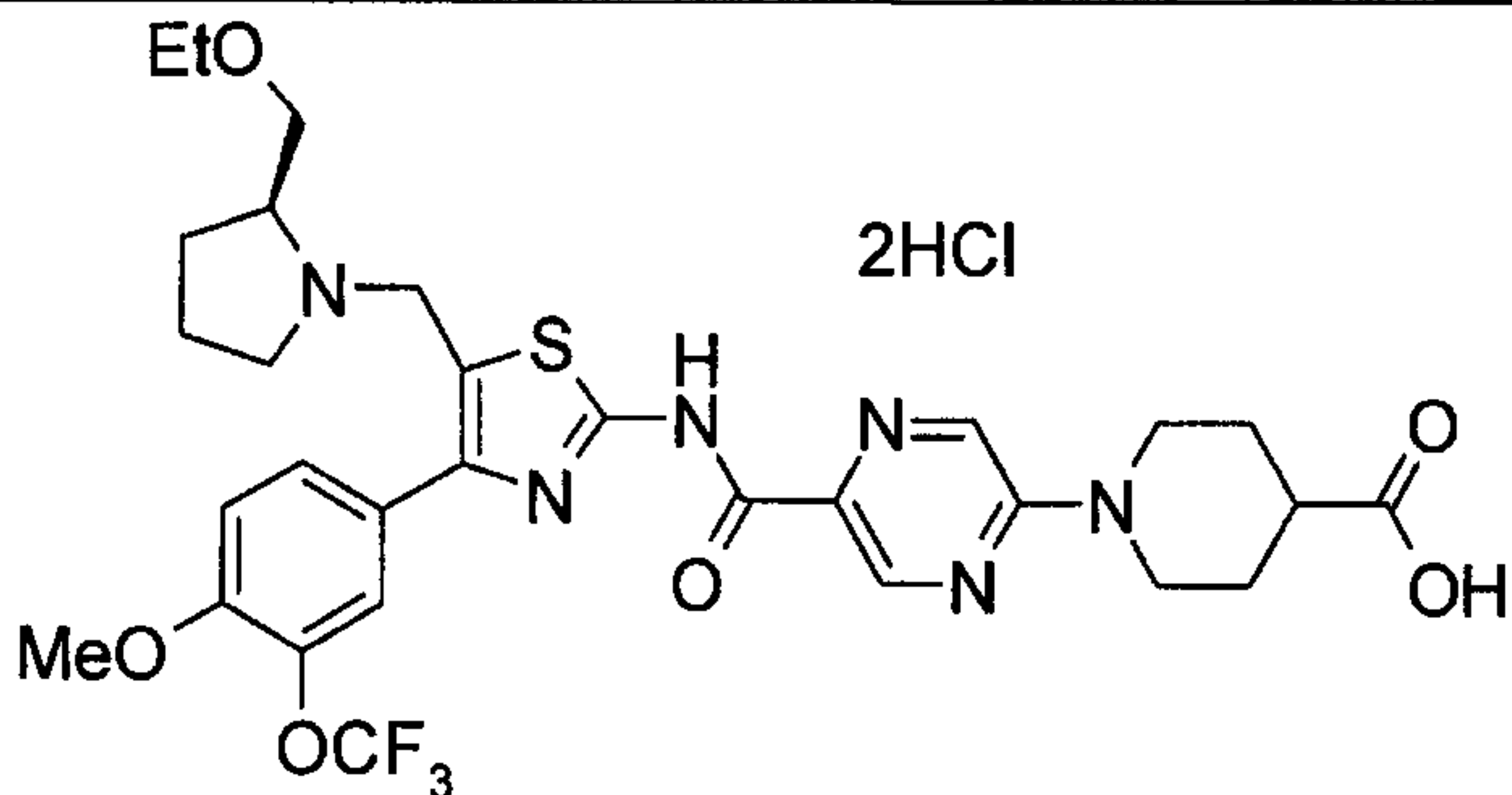
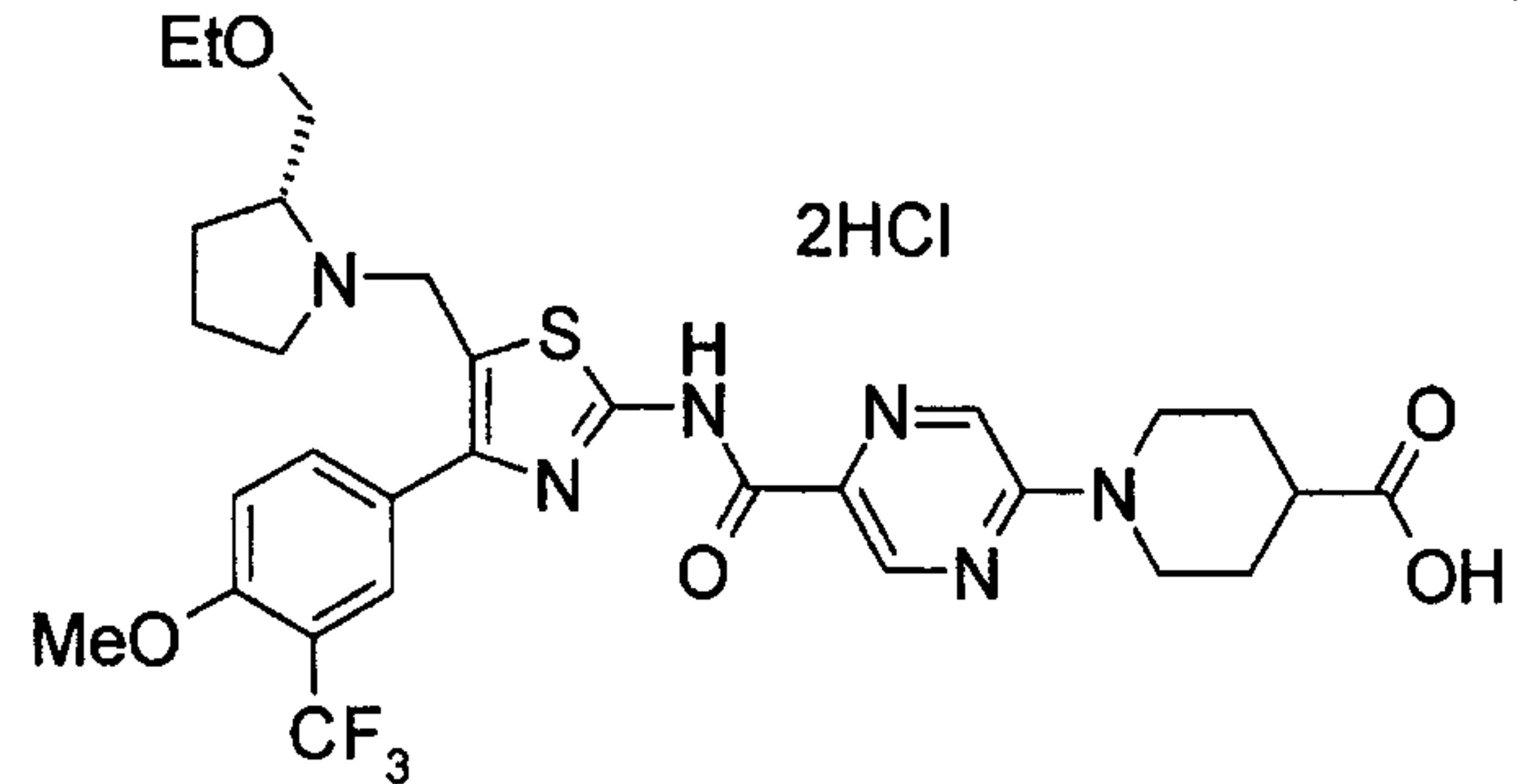
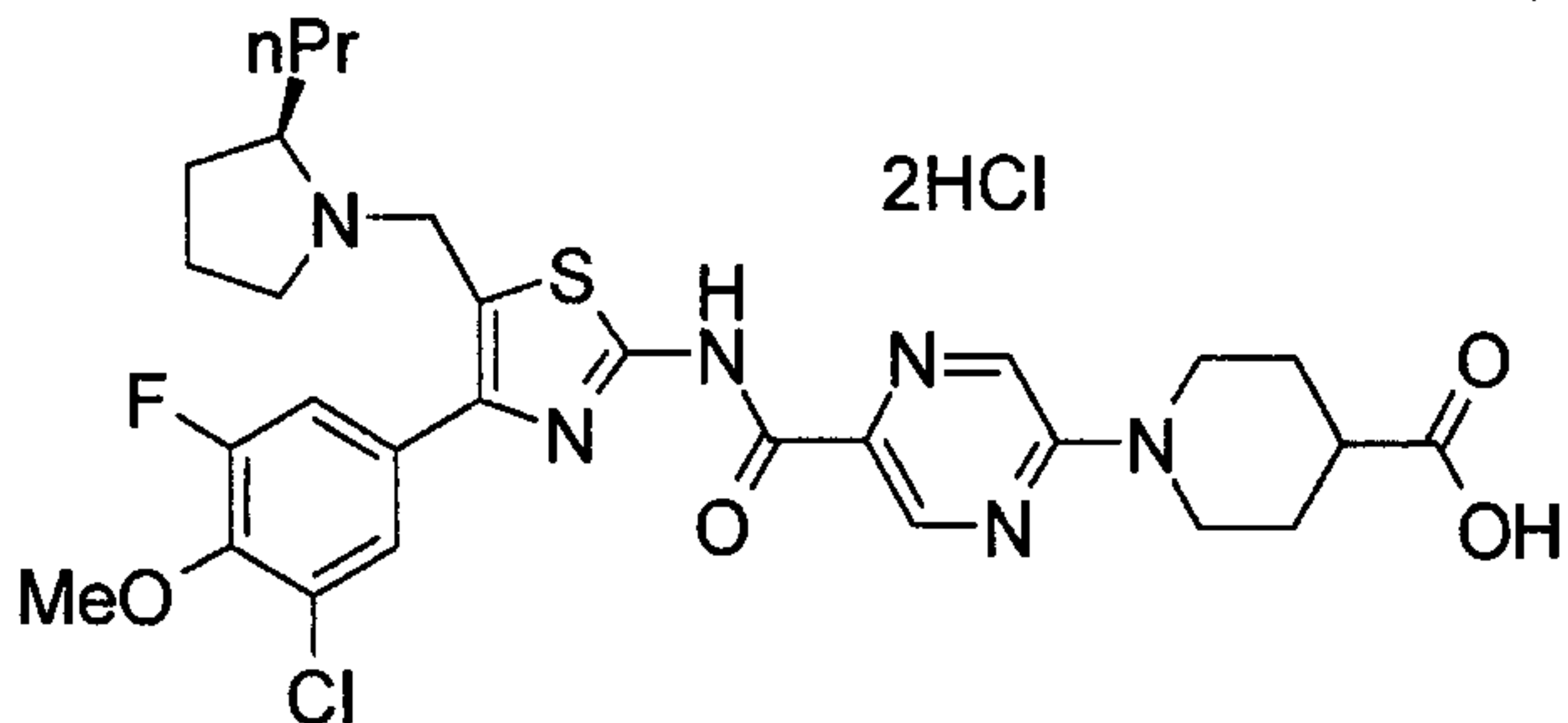
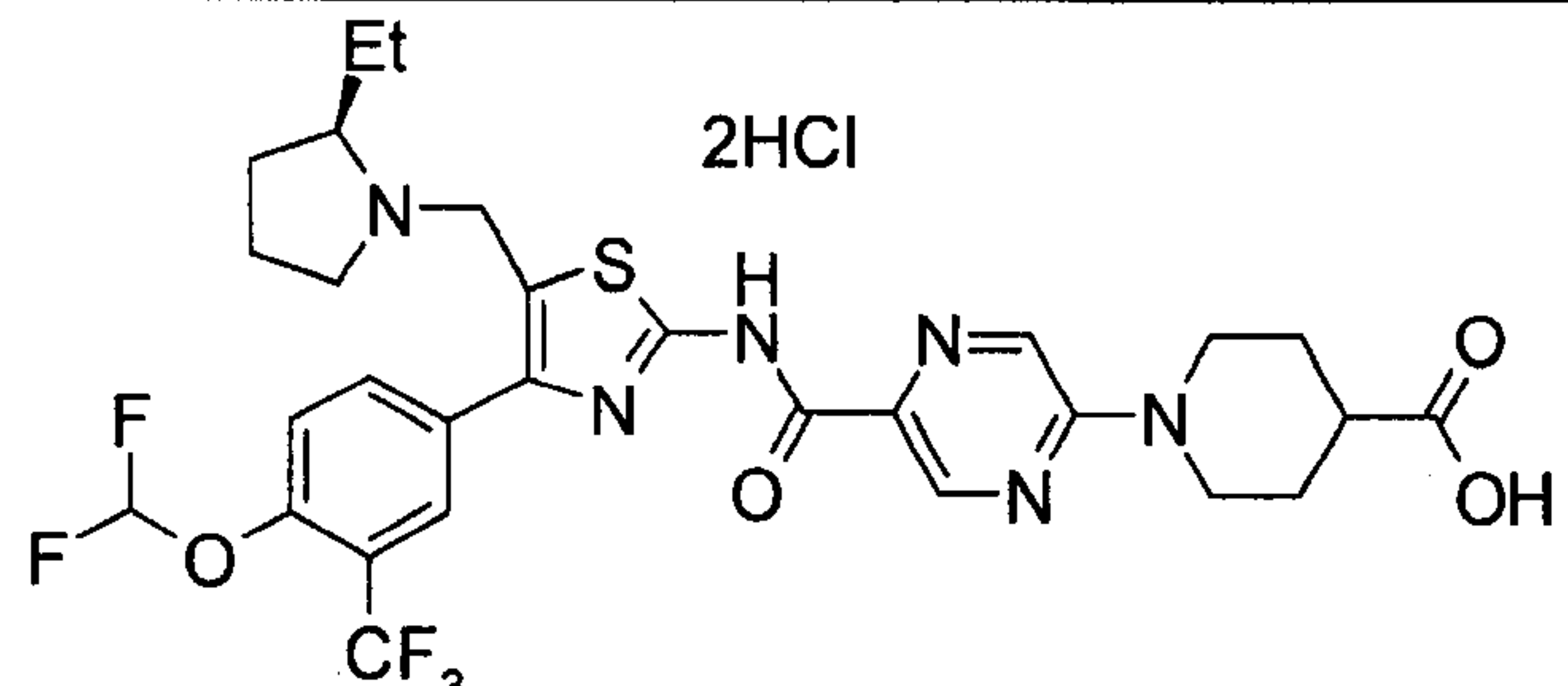
[0212]

[Table 51]

Ex	Str
66	
67	
68	
69	
70	

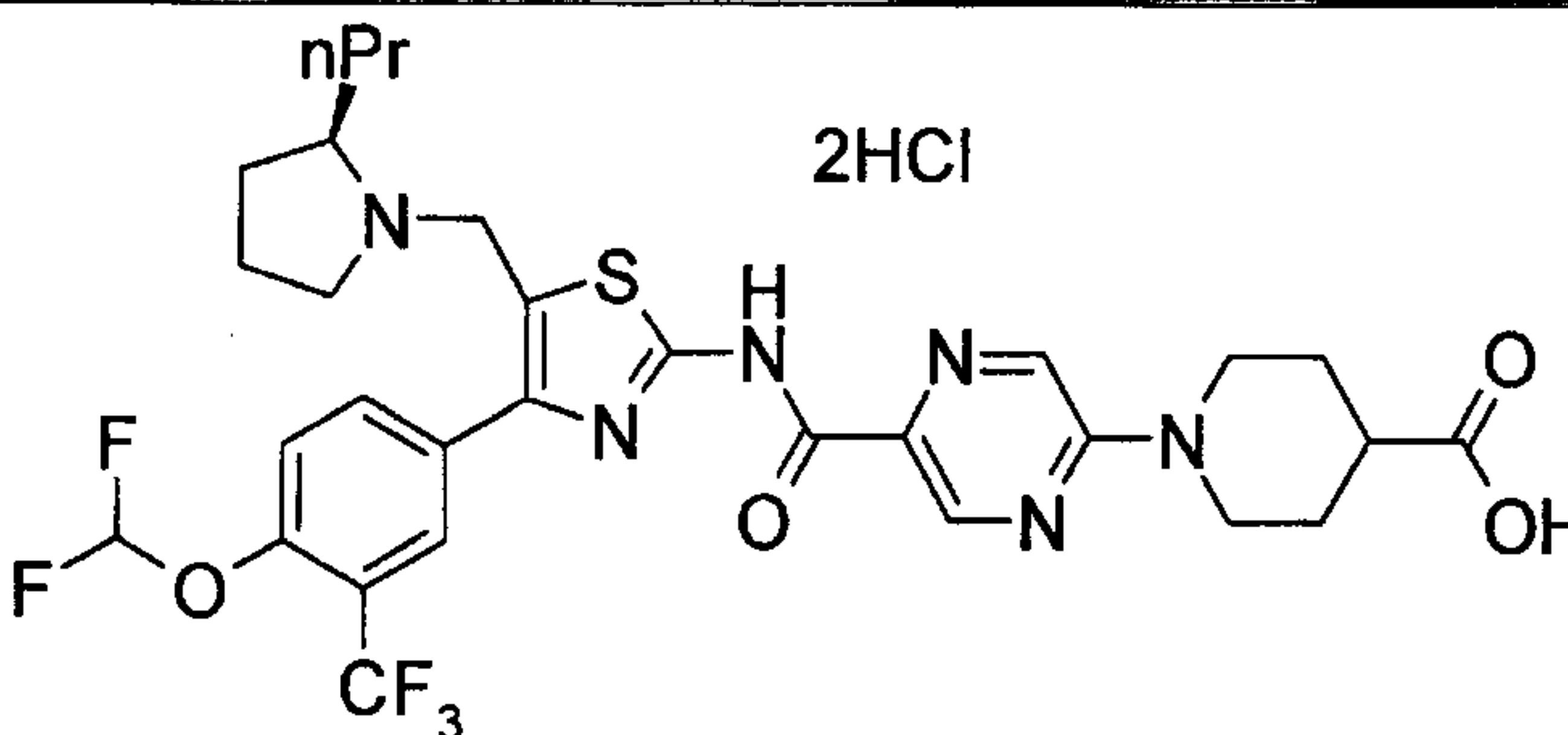
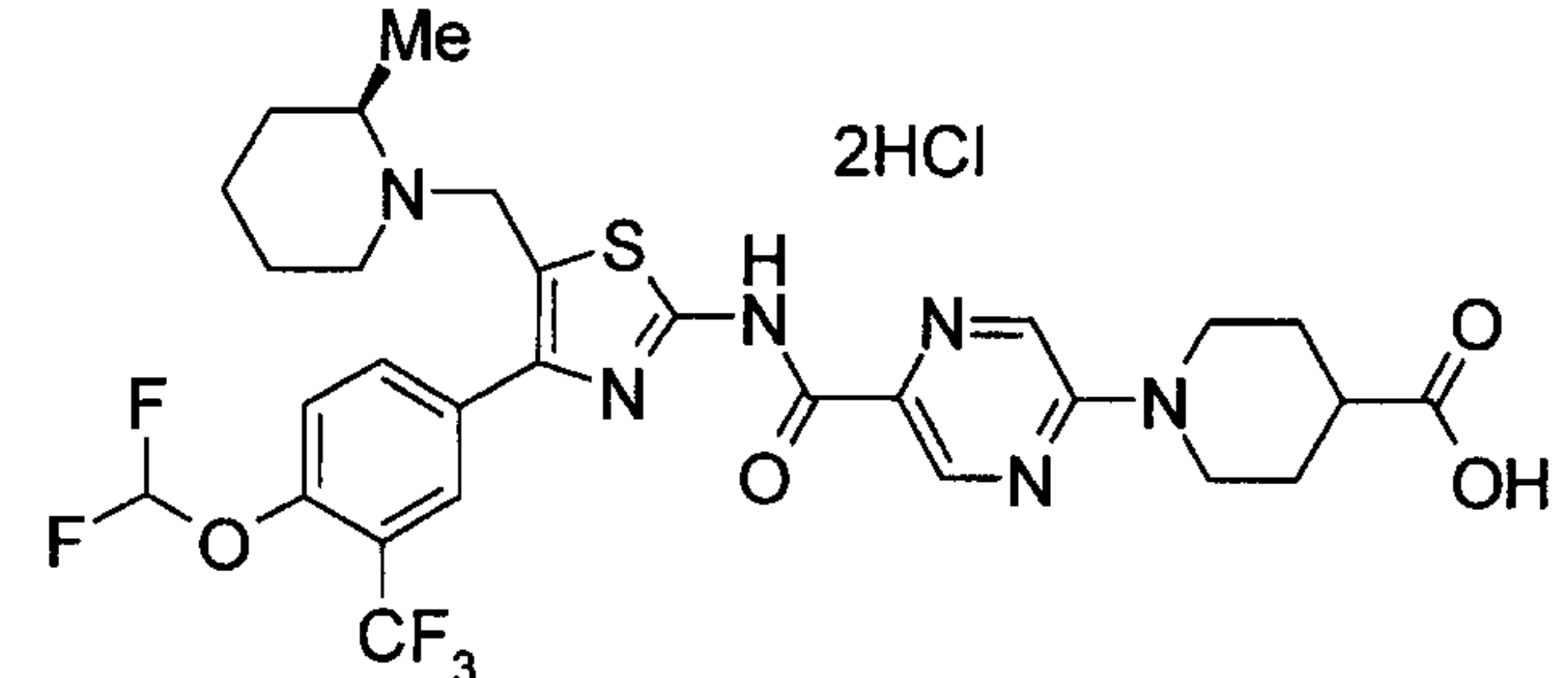
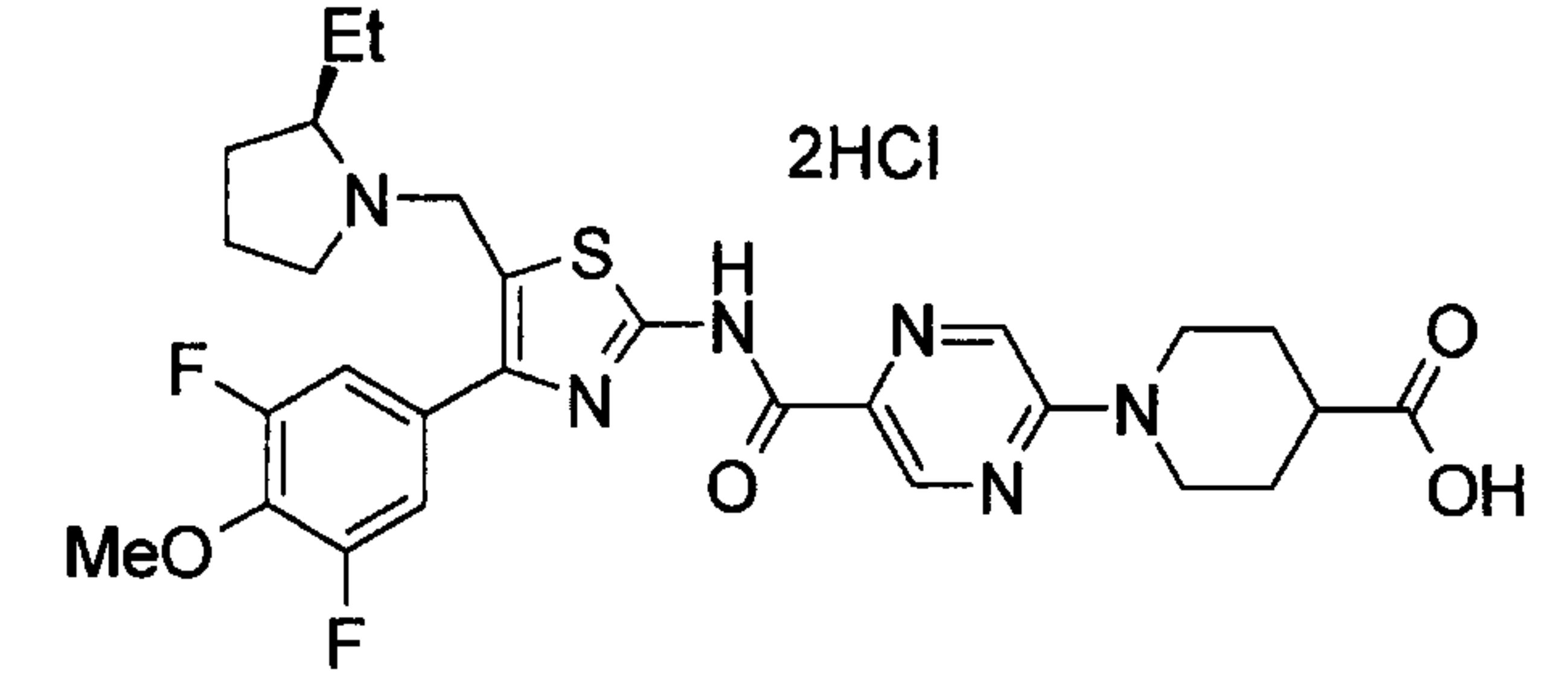
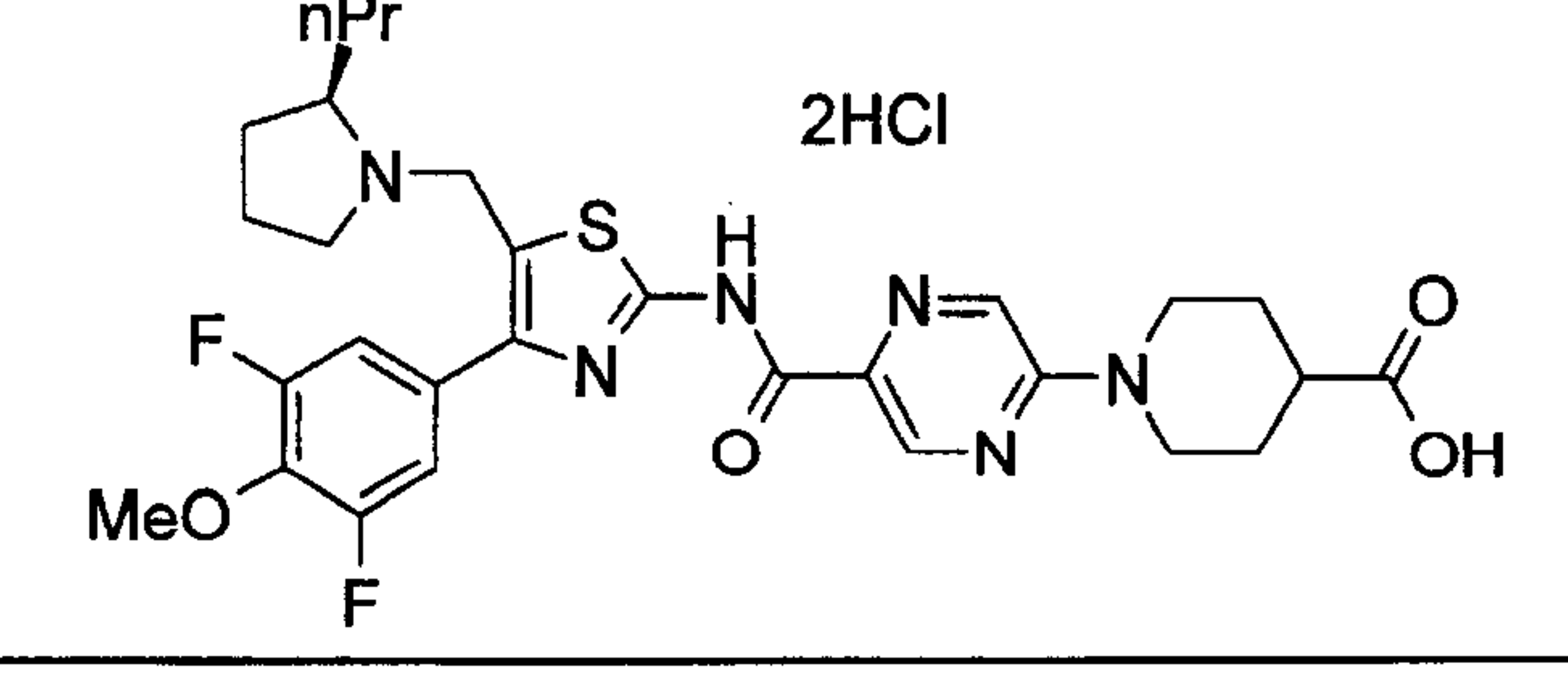
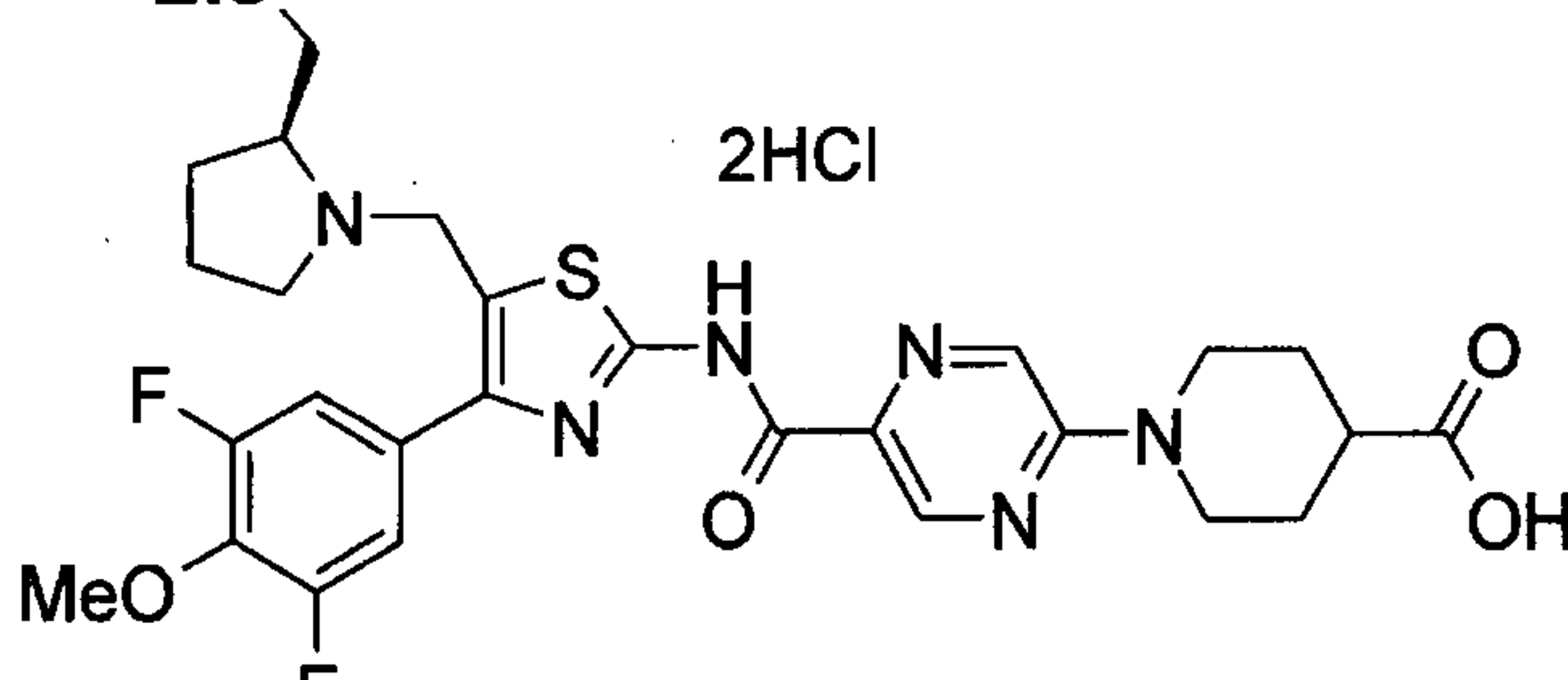
[0213]

[Table 52]

Ex	Str
71	
72	
73	
74	

[0214]

[Table 53]

Ex	Str
75	 Chemical structure of compound 75: A thiazine ring system with a carboxylic acid group, a piperidine ring, and a thiazine ring. The thiazine ring is substituted with a 4-(2,4-difluorophenoxy)phenyl group and a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group.
76	 Chemical structure of compound 76: A thiazine ring system with a carboxylic acid group, a piperidine ring, and a thiazine ring. The thiazine ring is substituted with a 4-(2,4-difluorophenoxy)phenyl group and a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group.
77	 Chemical structure of compound 77: A thiazine ring system with a carboxylic acid group, a piperidine ring, and a thiazine ring. The thiazine ring is substituted with a 4-(2,4-difluorophenoxy)phenyl group and a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group.
78	 Chemical structure of compound 78: A thiazine ring system with a carboxylic acid group, a piperidine ring, and a thiazine ring. The thiazine ring is substituted with a 4-(2,4-difluorophenoxy)phenyl group and a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group.
79	 Chemical structure of compound 79: A thiazine ring system with a carboxylic acid group, a piperidine ring, and a thiazine ring. The thiazine ring is substituted with a 4-(2,4-difluorophenoxy)phenyl group and a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group. The thiazine ring is also substituted with a 4-(2,4-difluorophenoxy)phenyl group.

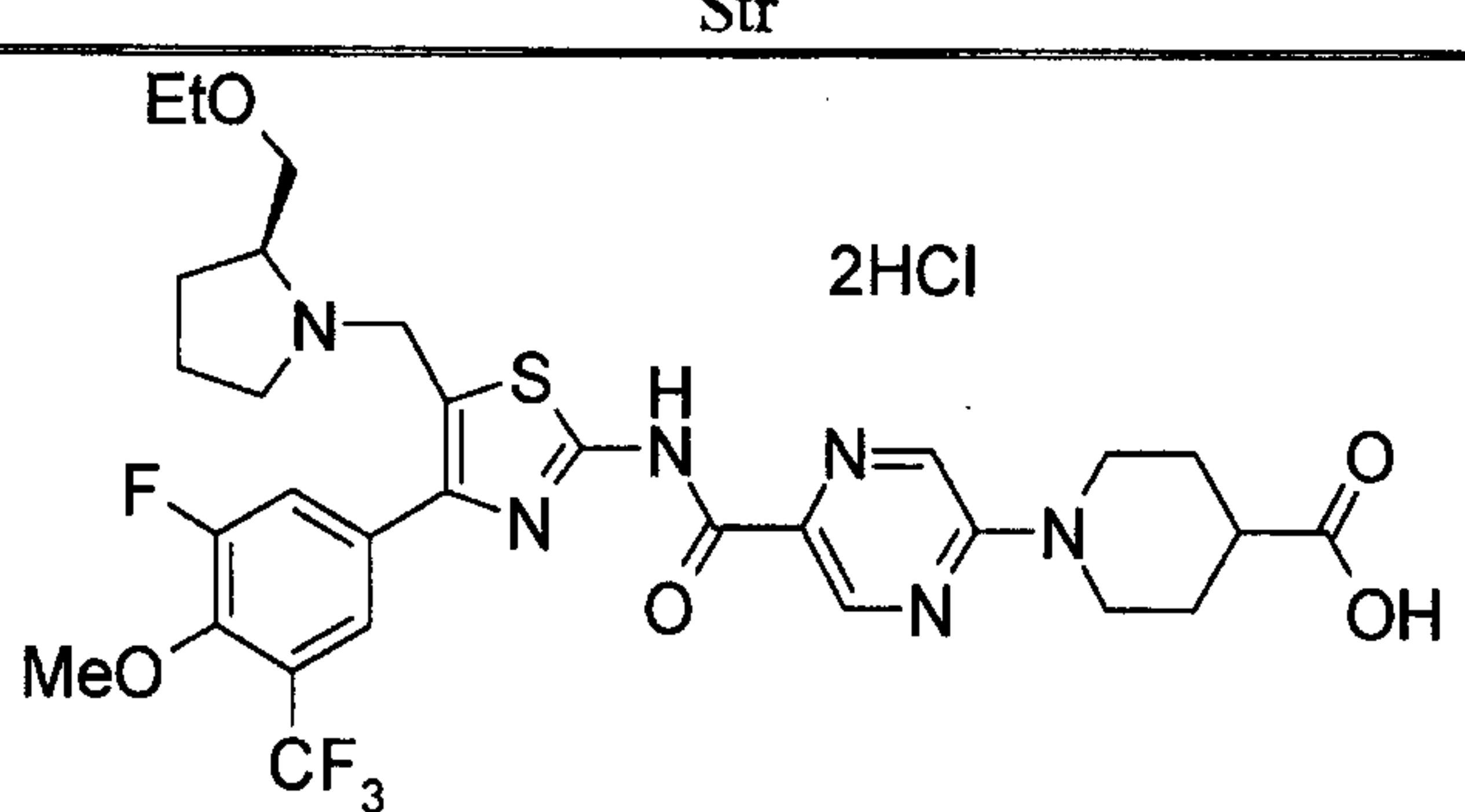
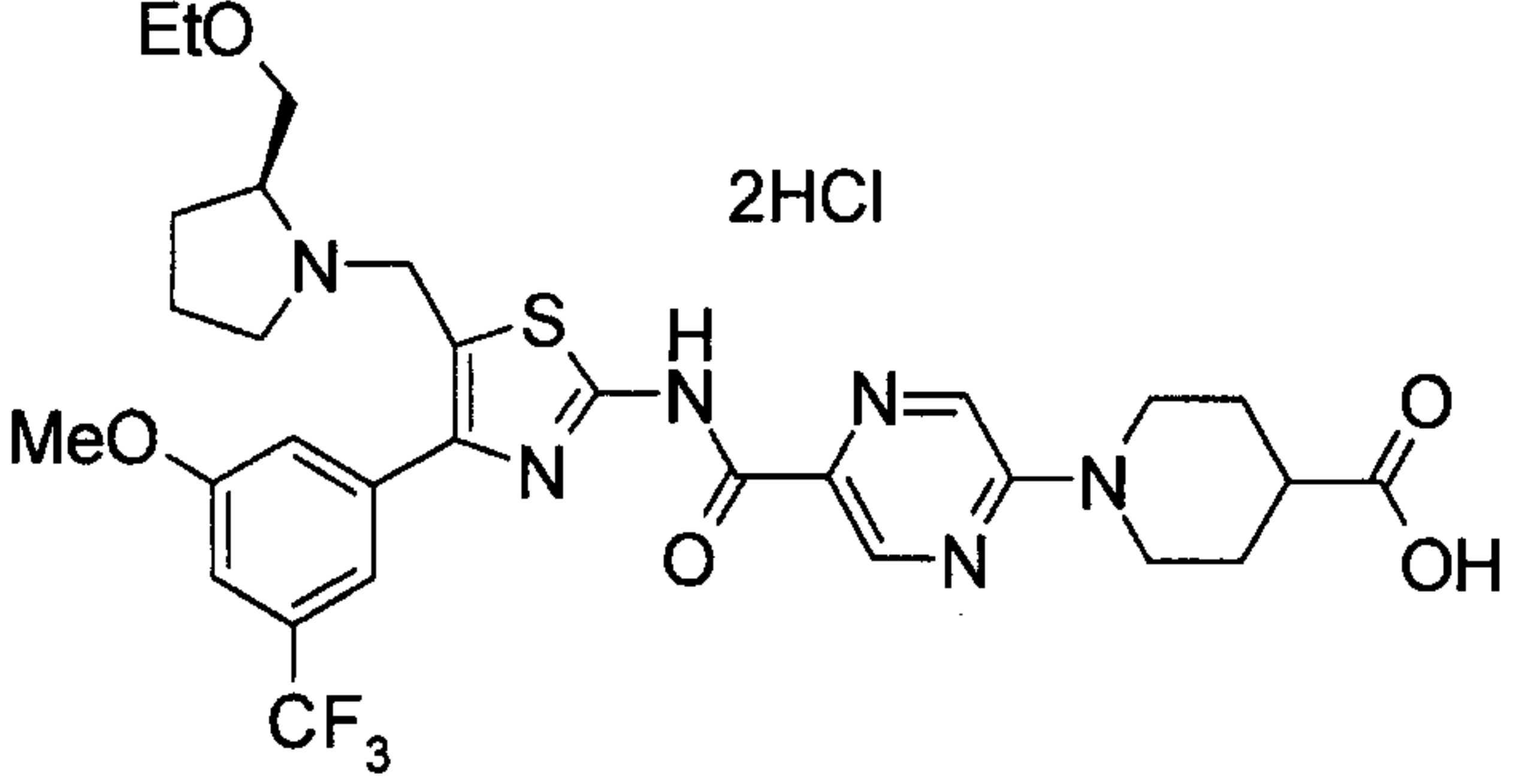
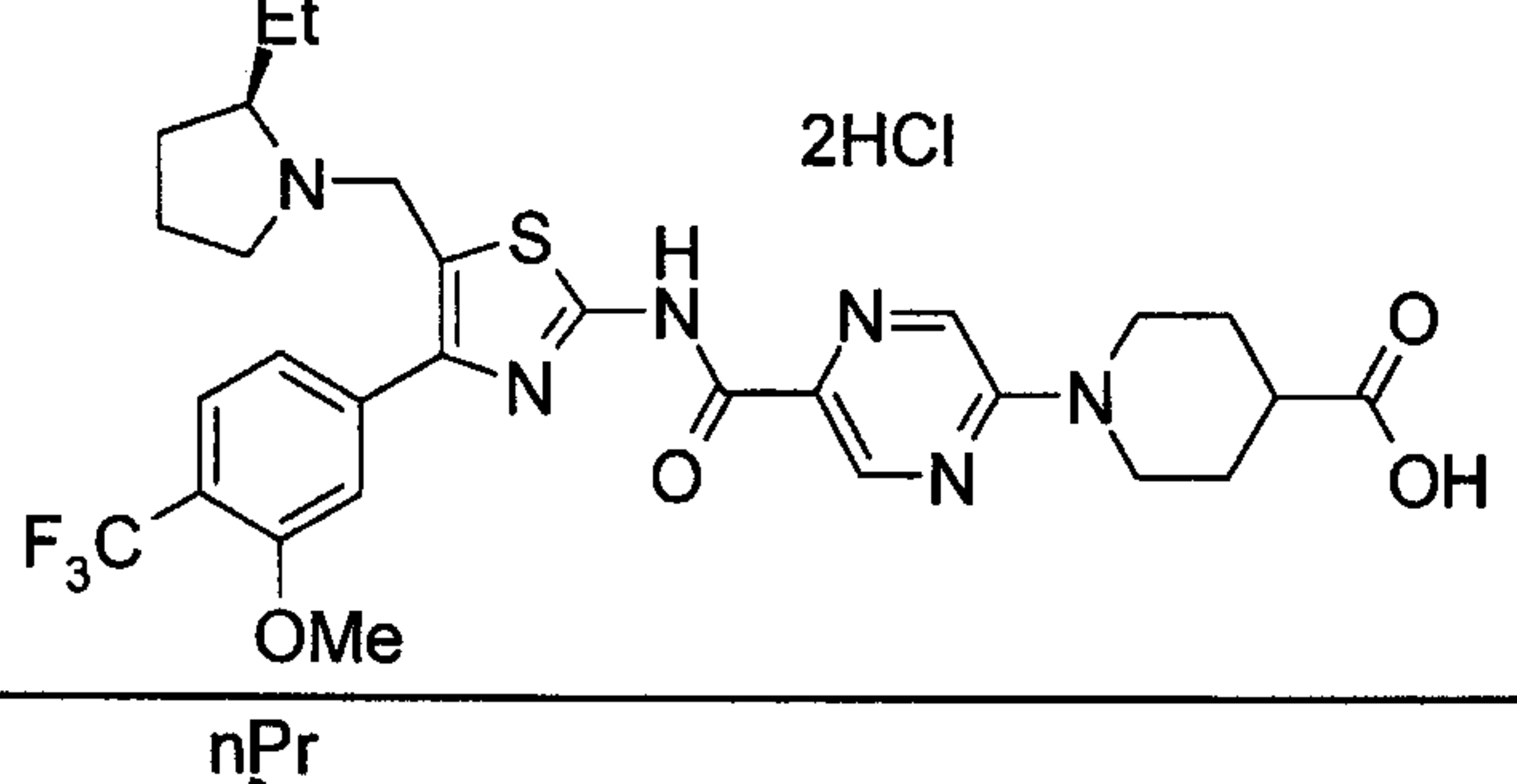
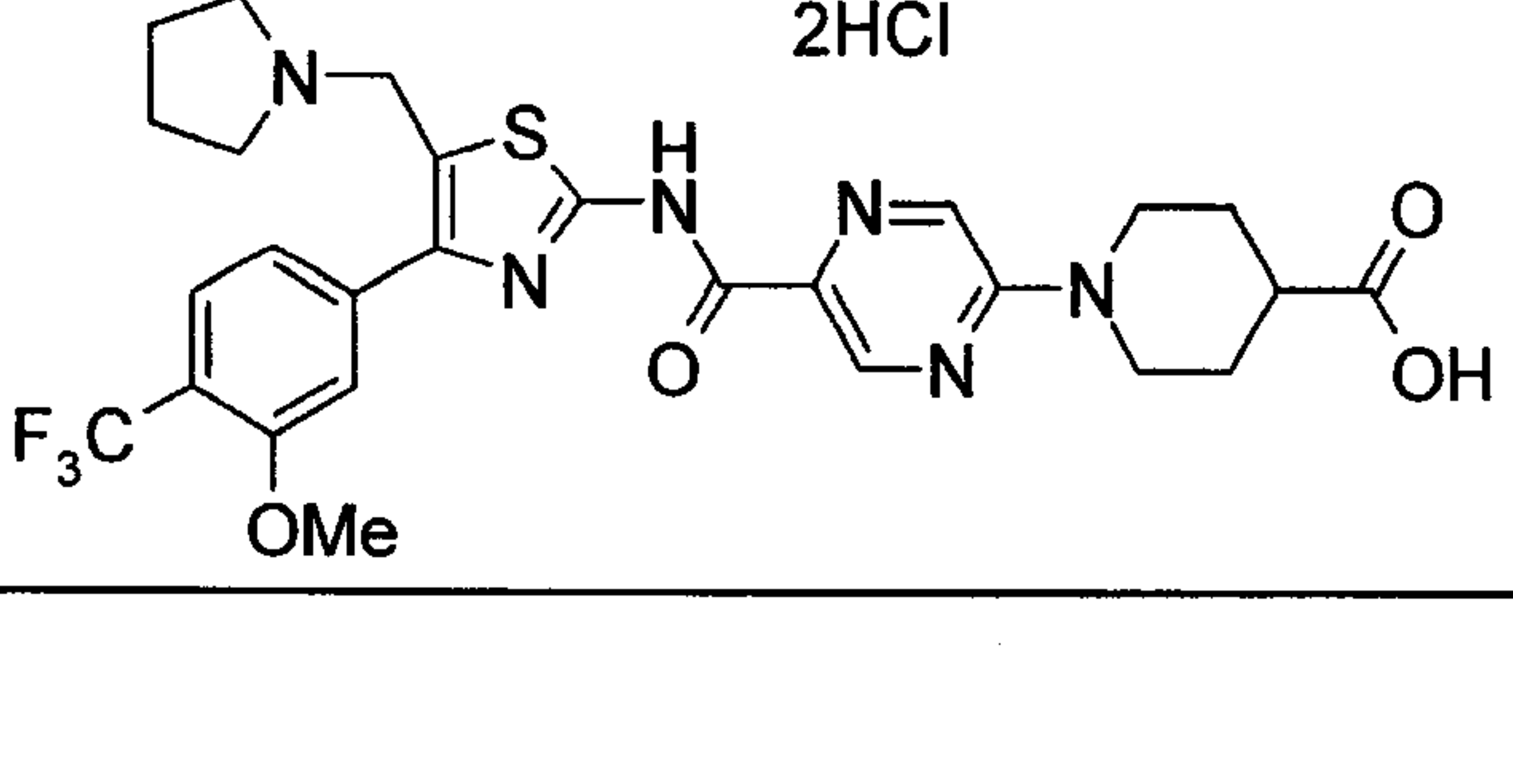
[0215]

[Table 54]

Ex	Str
80	
81	
82	
83	

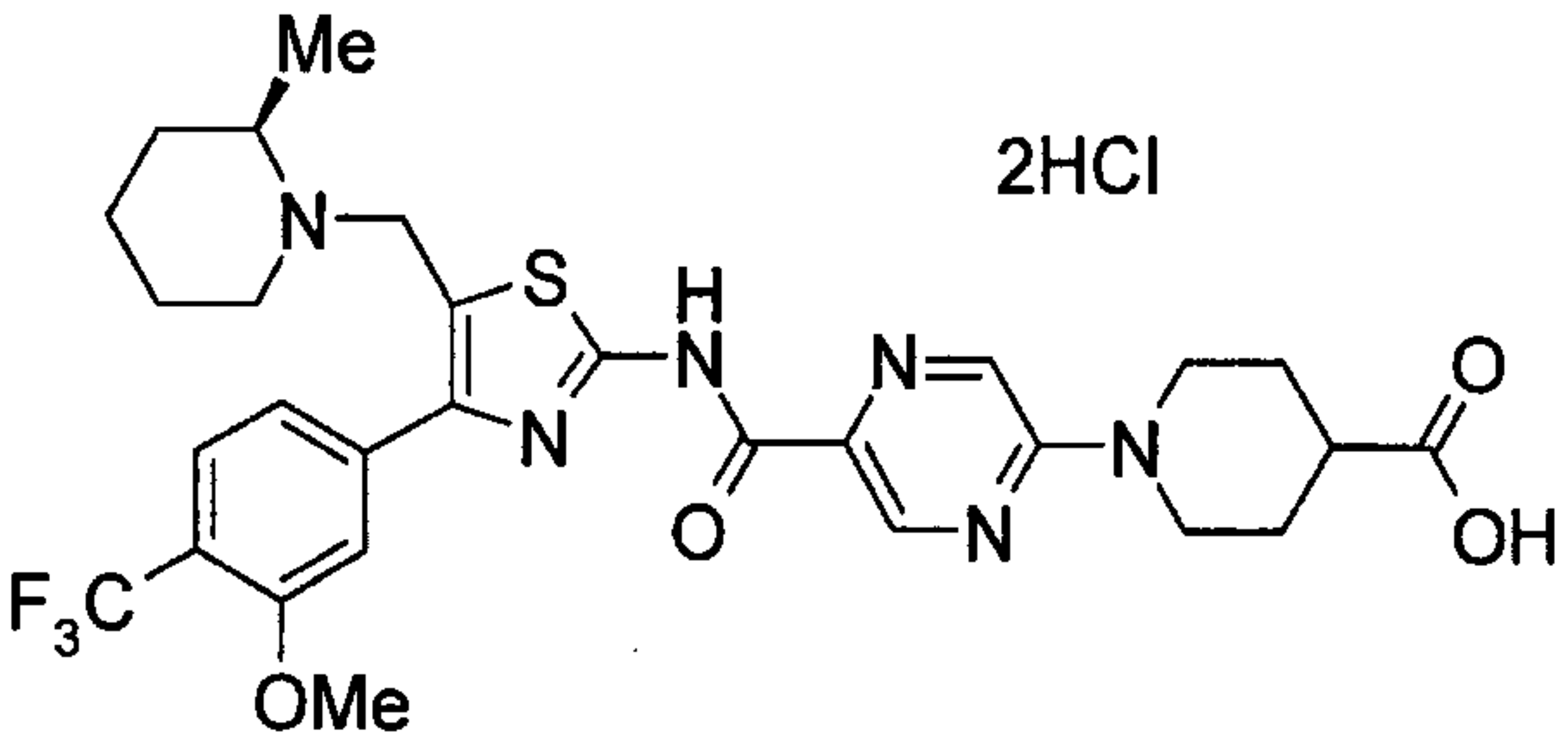
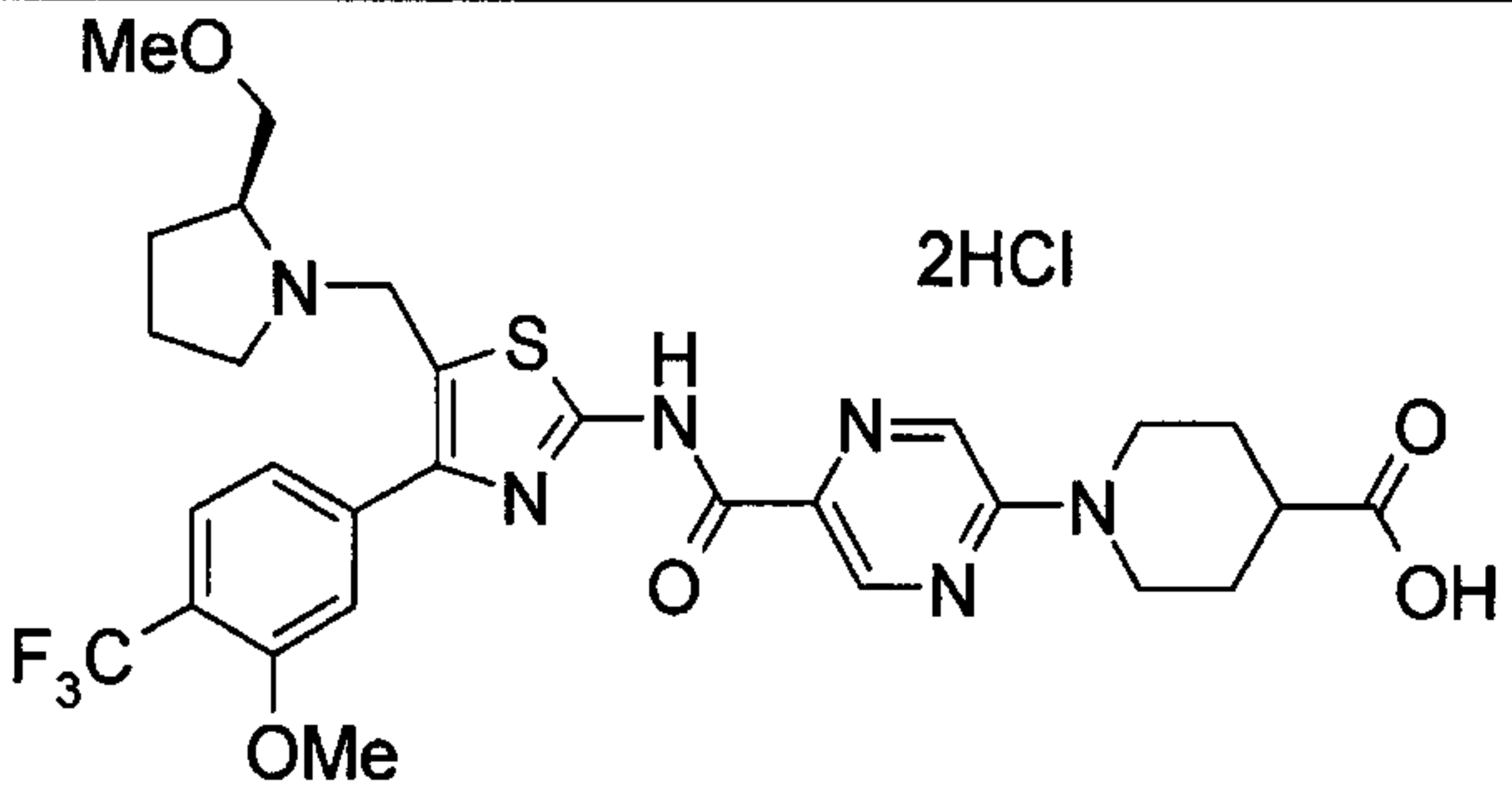
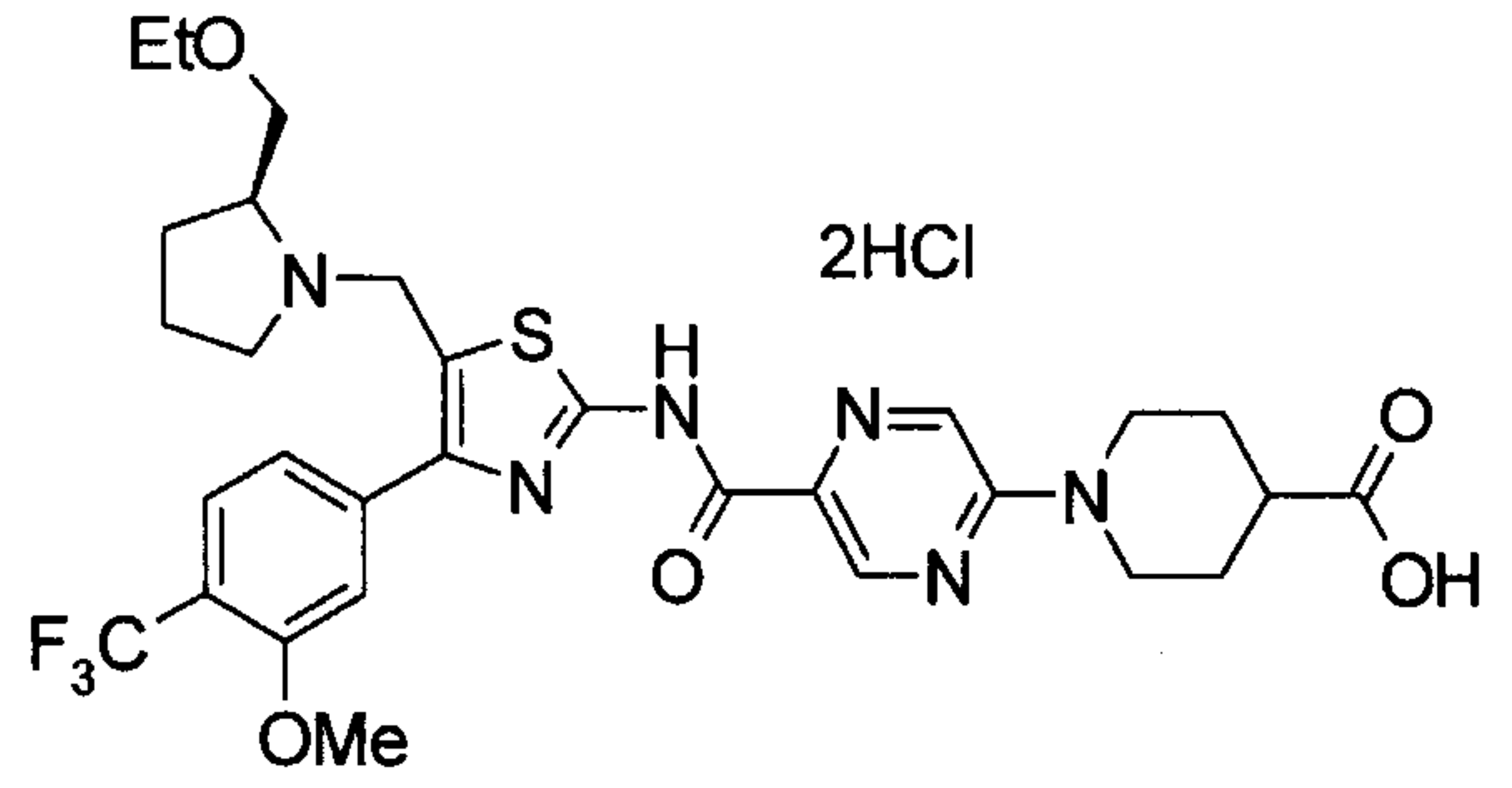
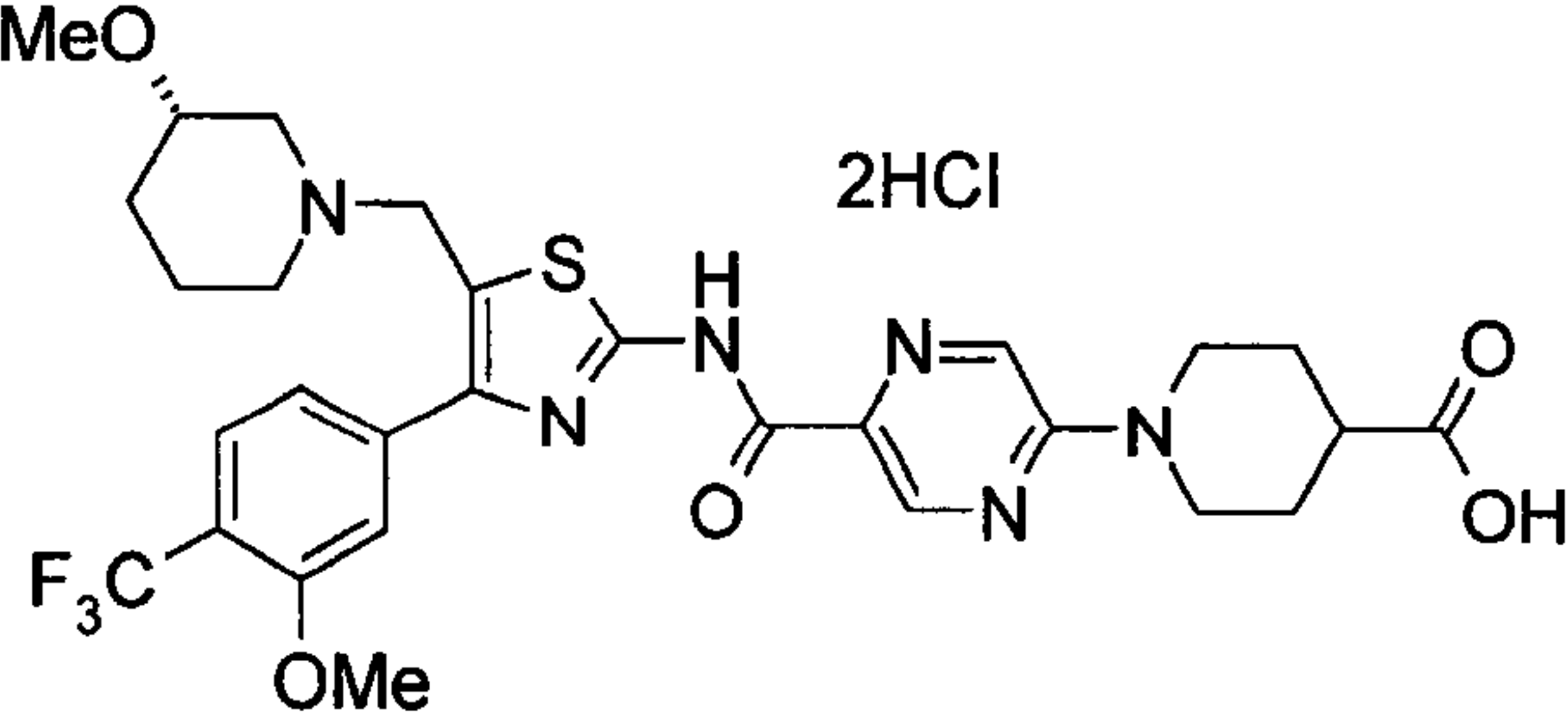
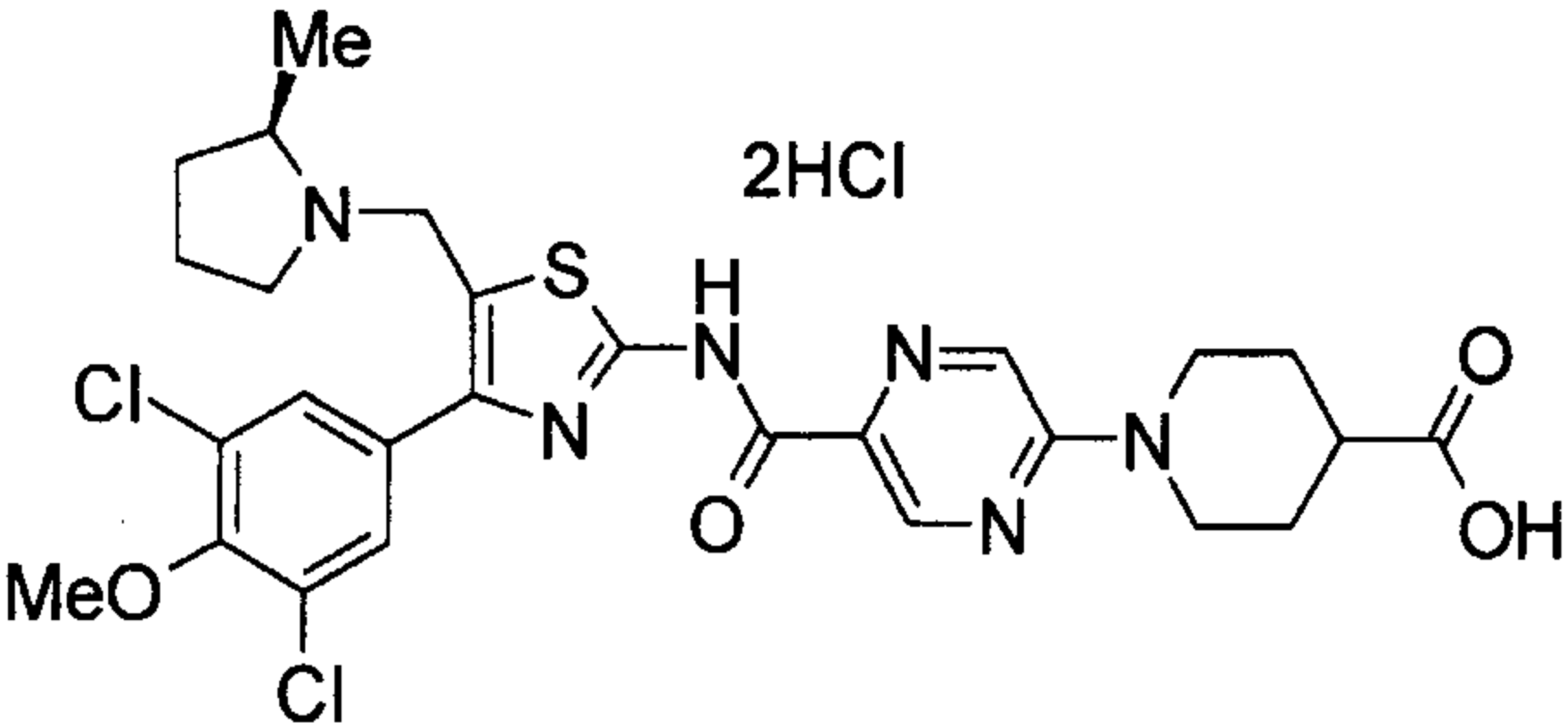
[0216]

[Table 55]

Ex	Str
84	
85	
86	
87	

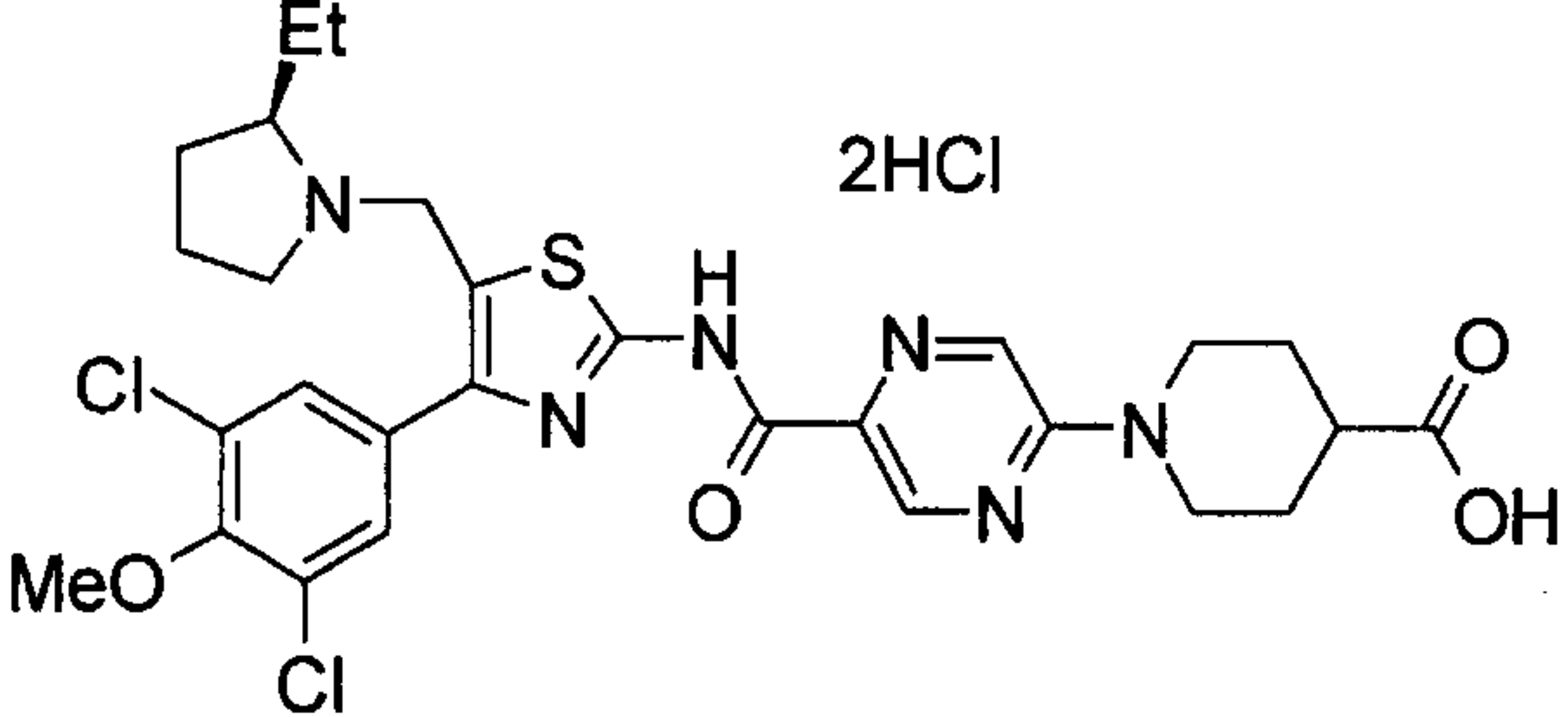
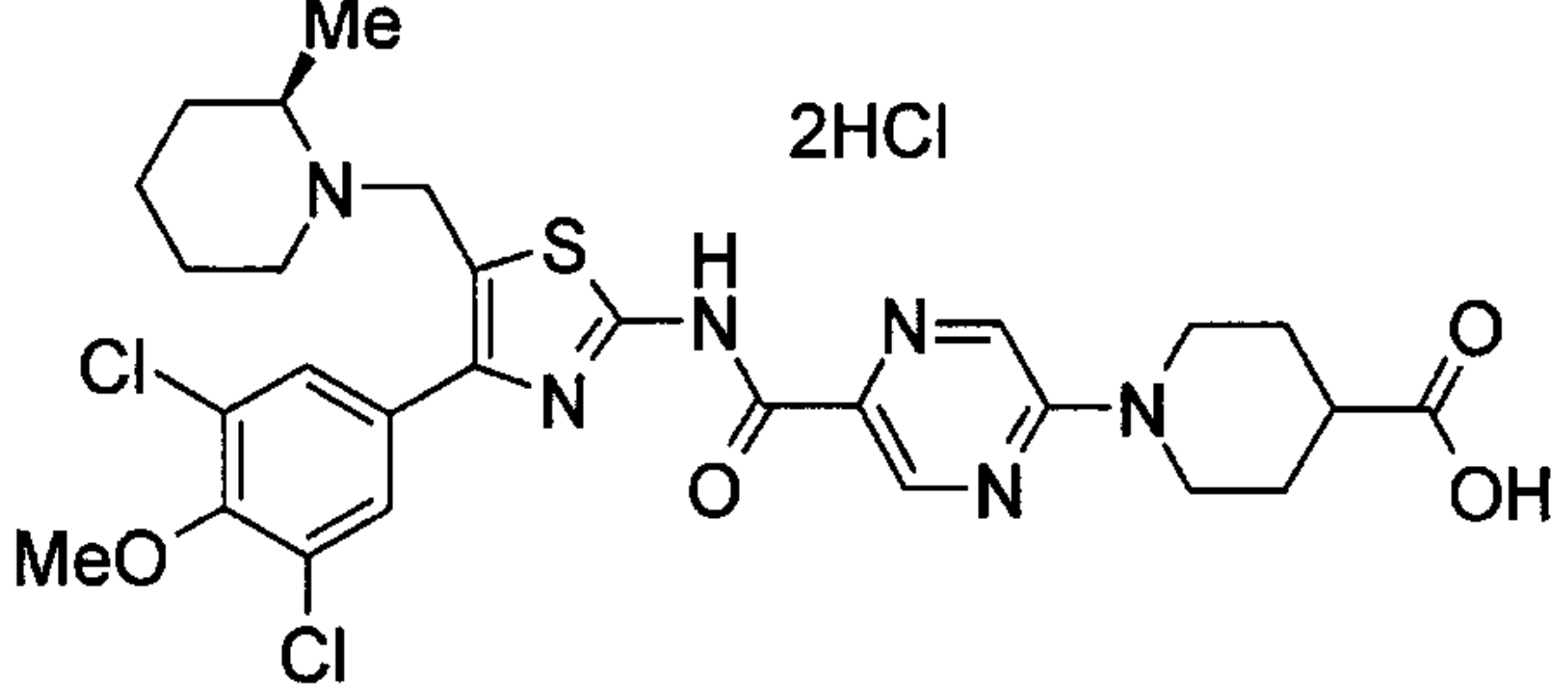
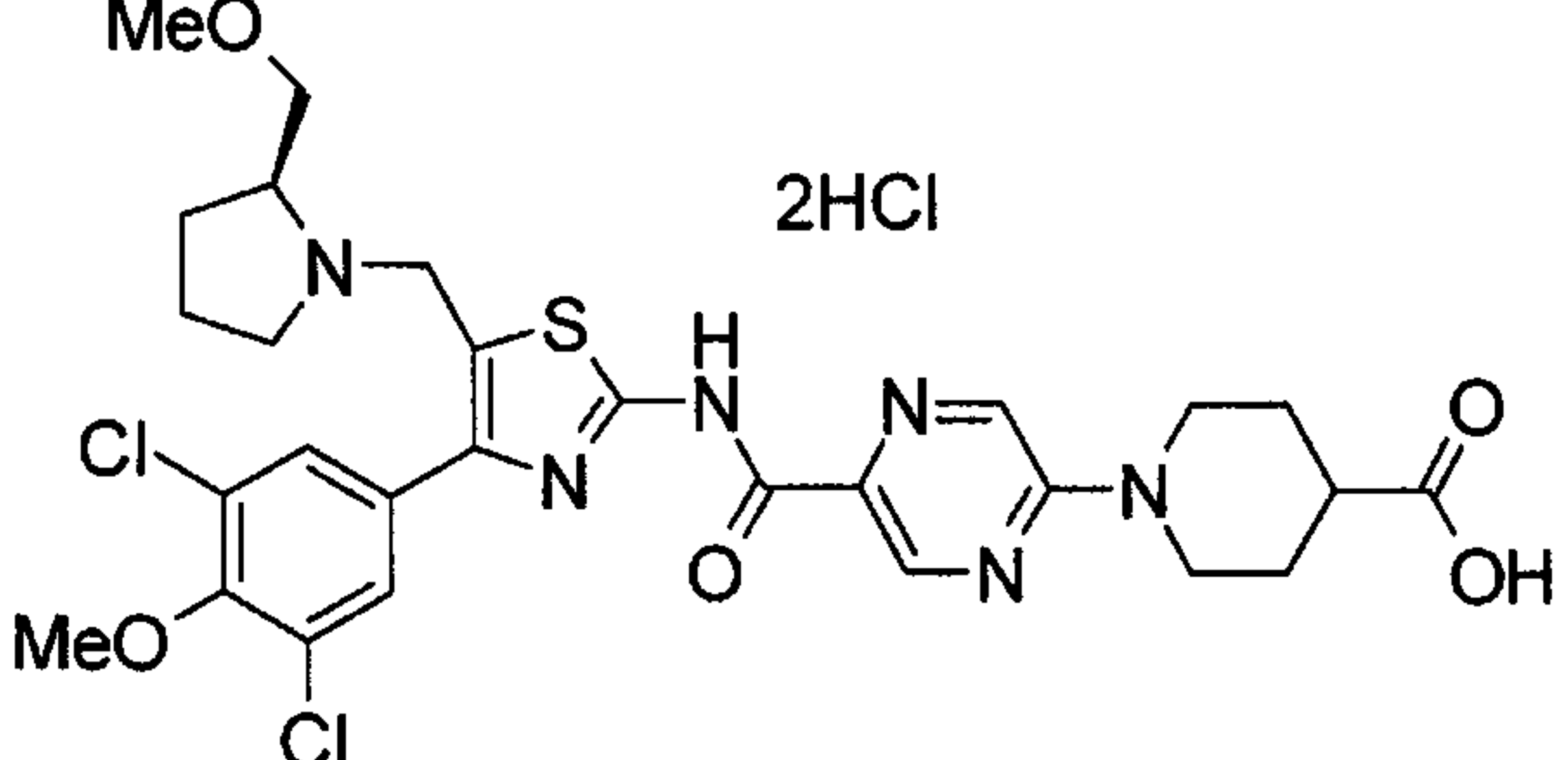
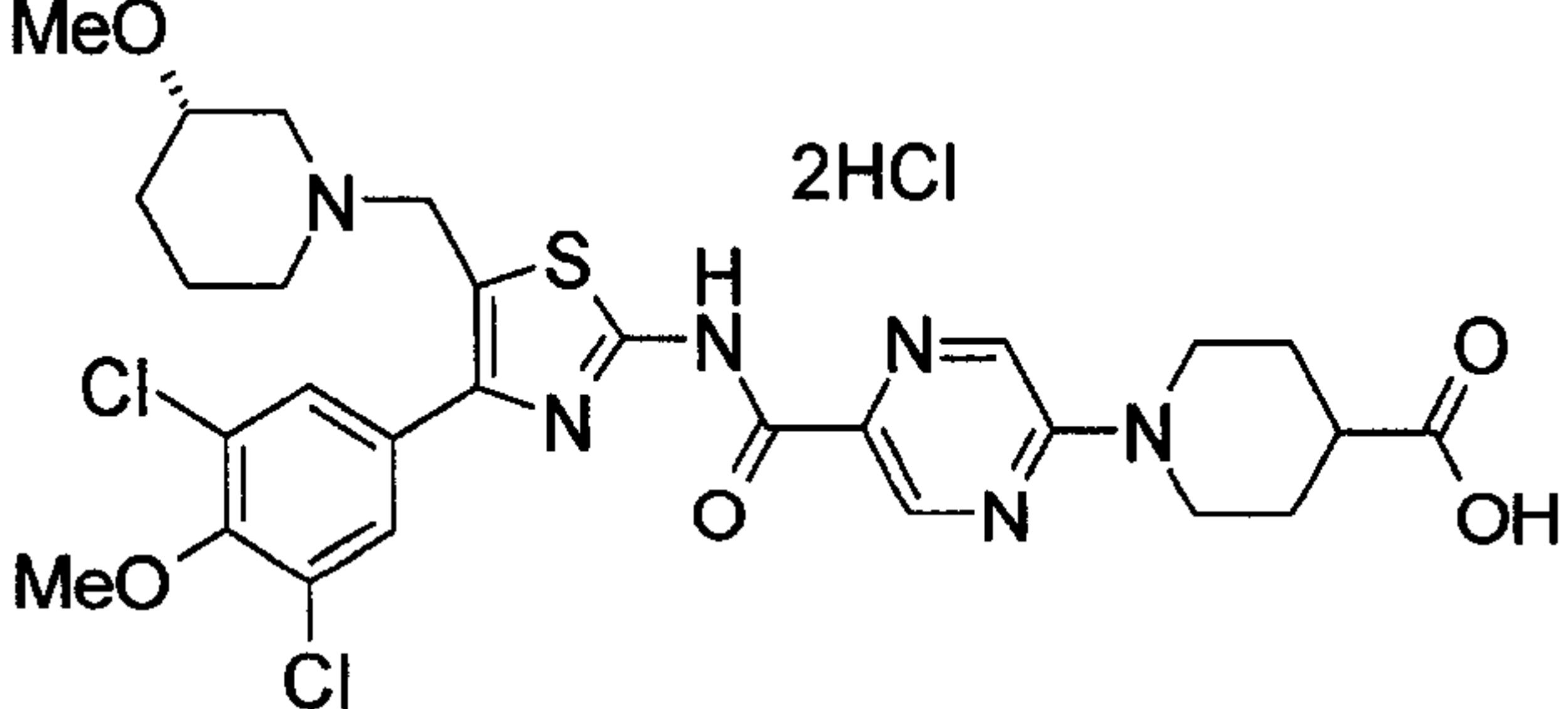
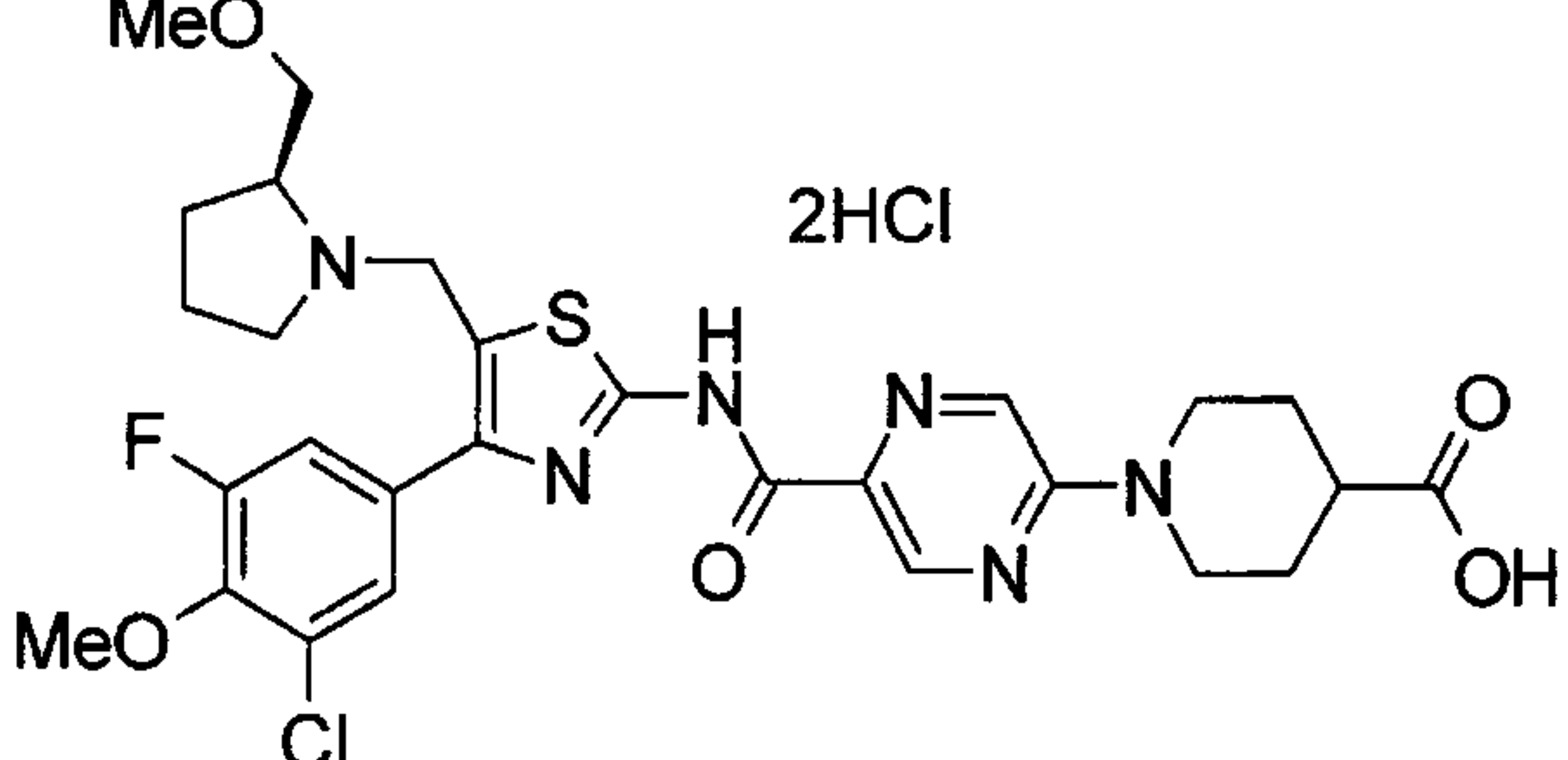
[0217]

[Table 56]

Ex	Str
88	
89	
90	
91	
92	

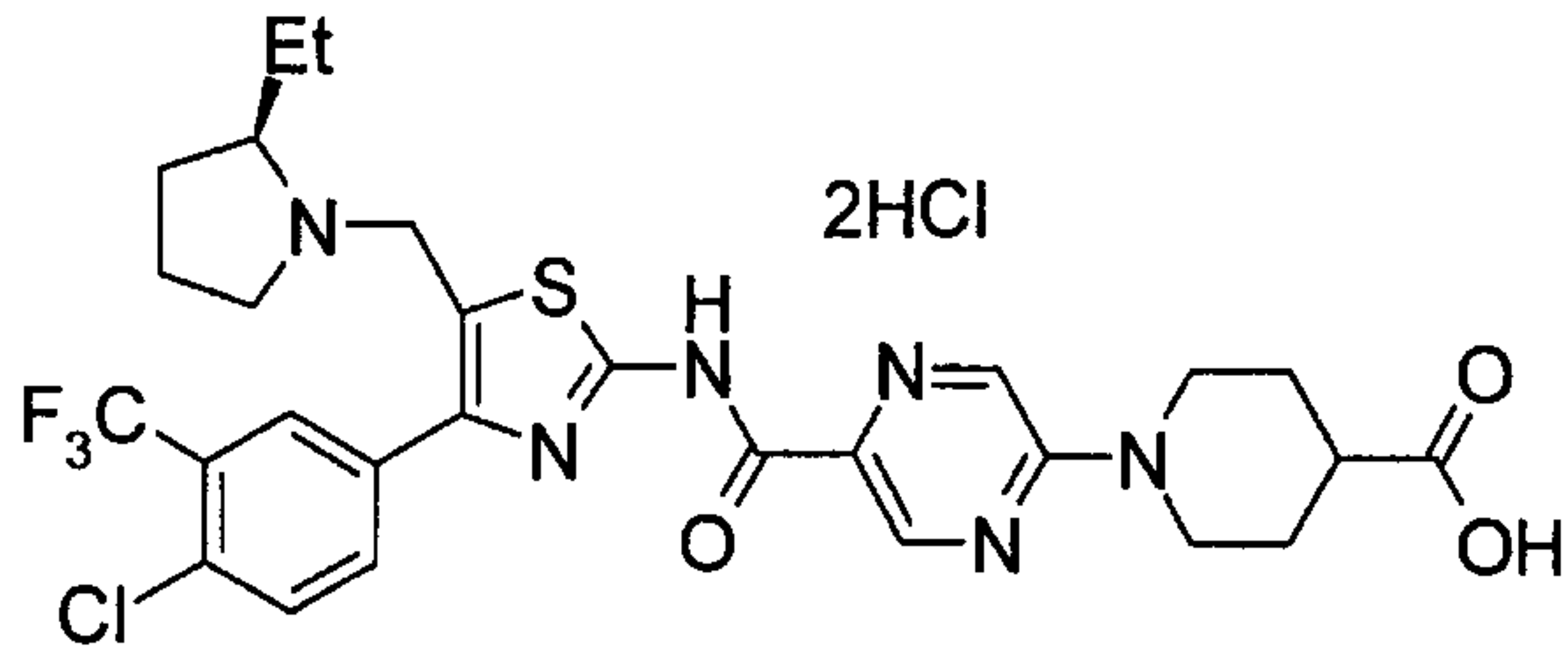
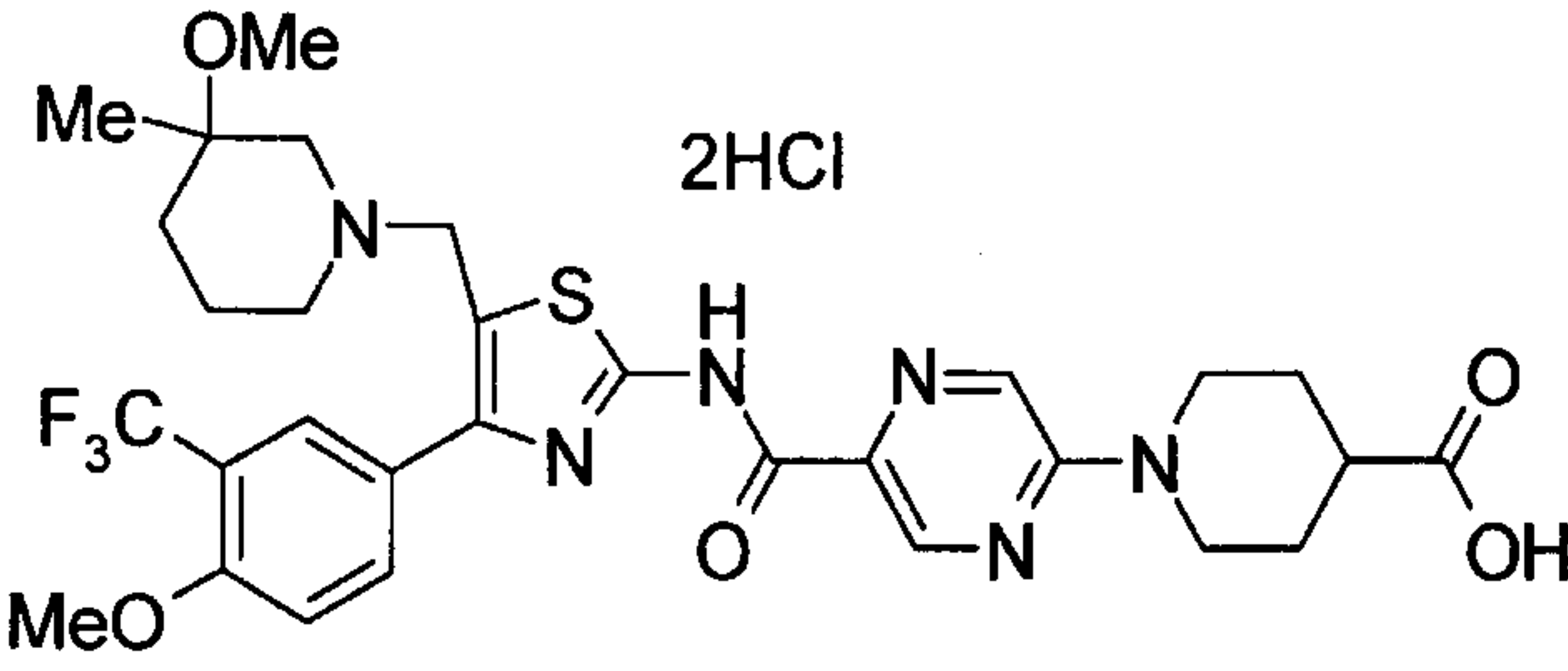
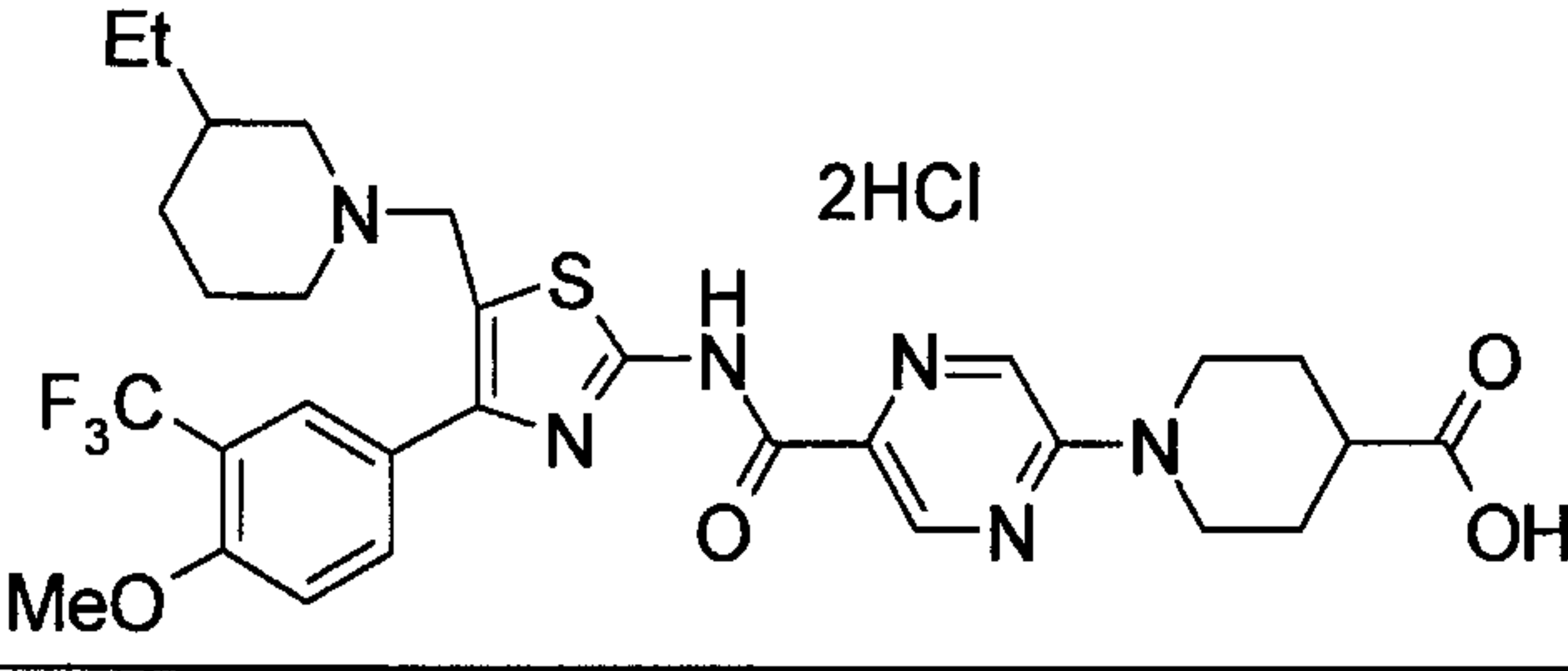
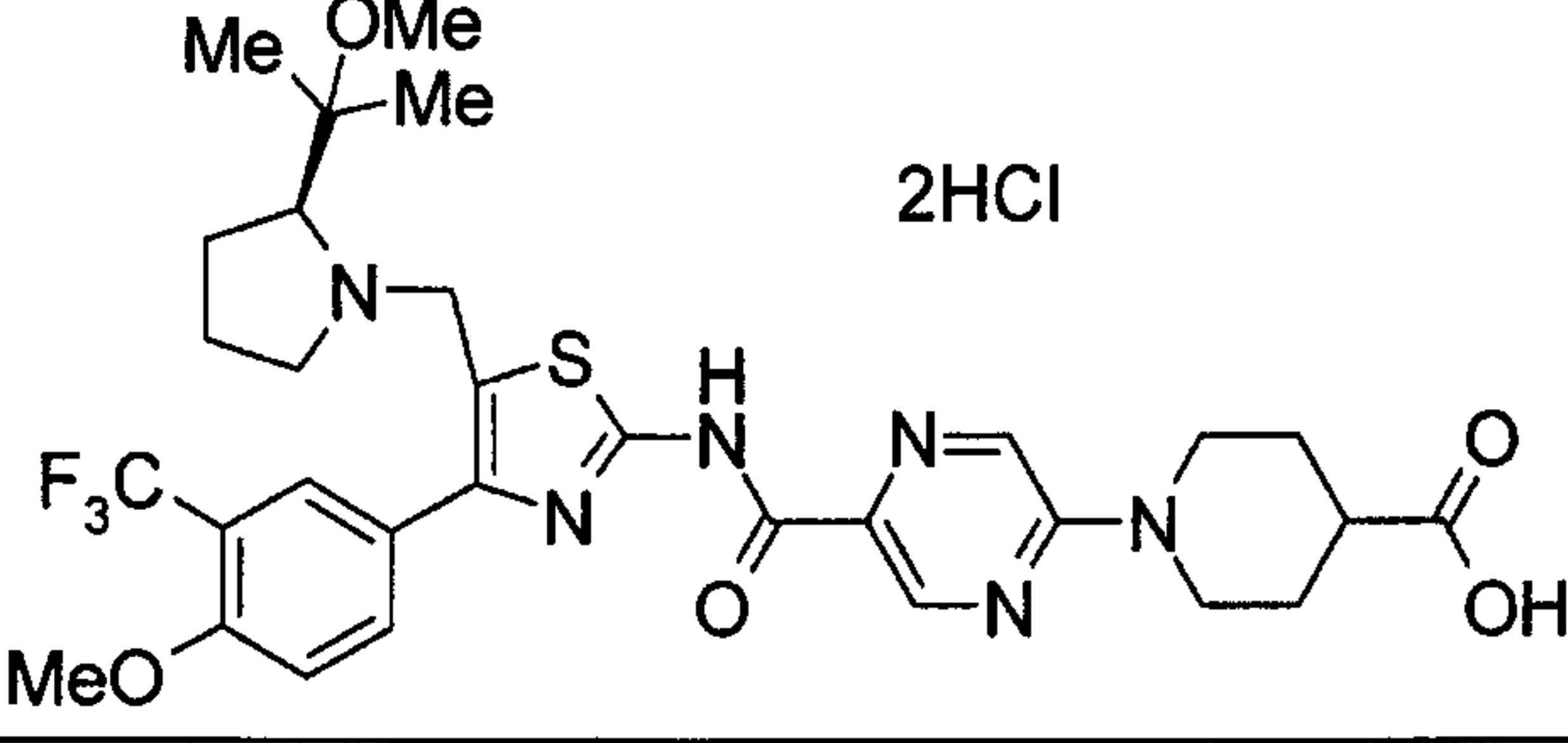
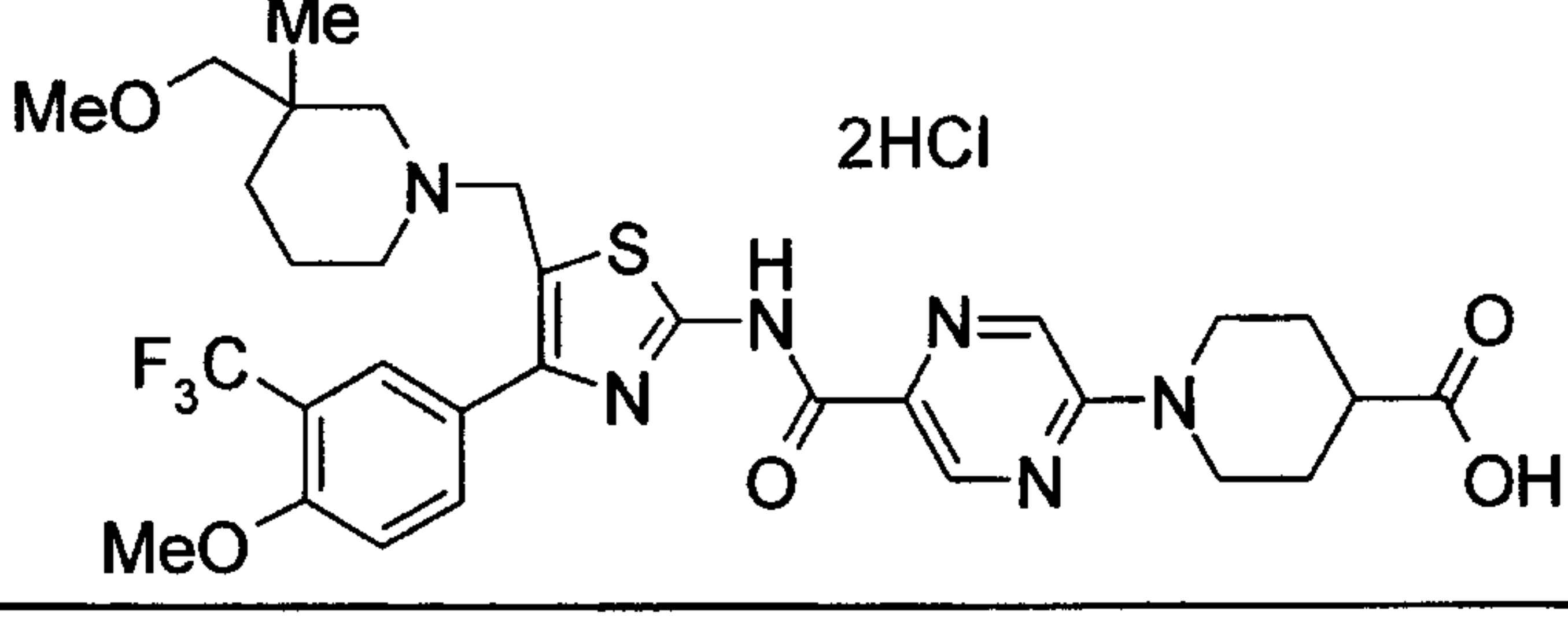
[0218]

[Table 57]

Ex	Str
93	
94	
95	
96	
97	

[0219]

[Table 58]

Ex	Str
98	
99	
100	
101	
102	

[0220]

[Table 59]

Ex	Str
103	
104	
105	
106	
107	

[0221]

[Table 60]

Ex	Str
108	
109	
110	
111	
112	

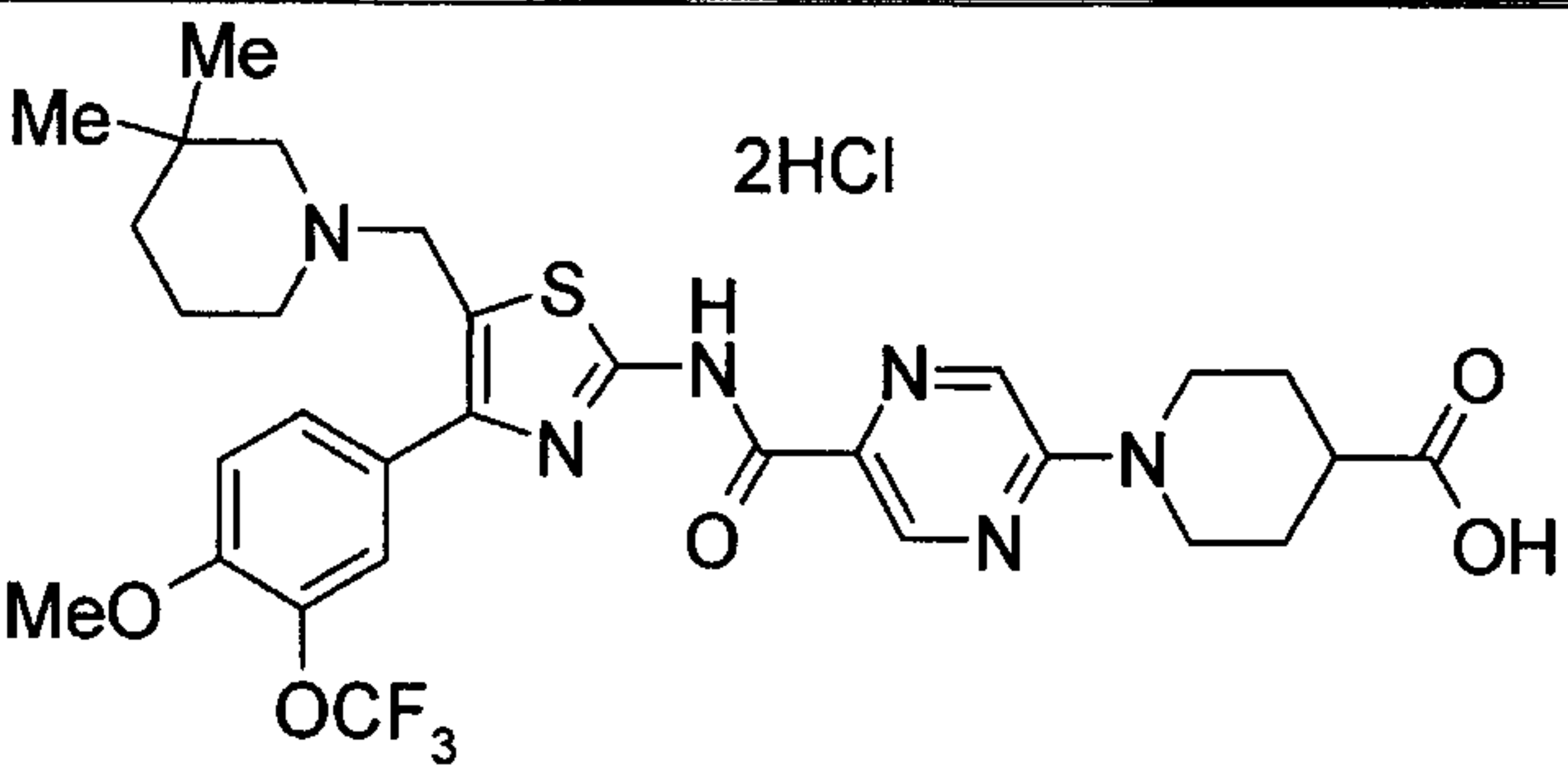
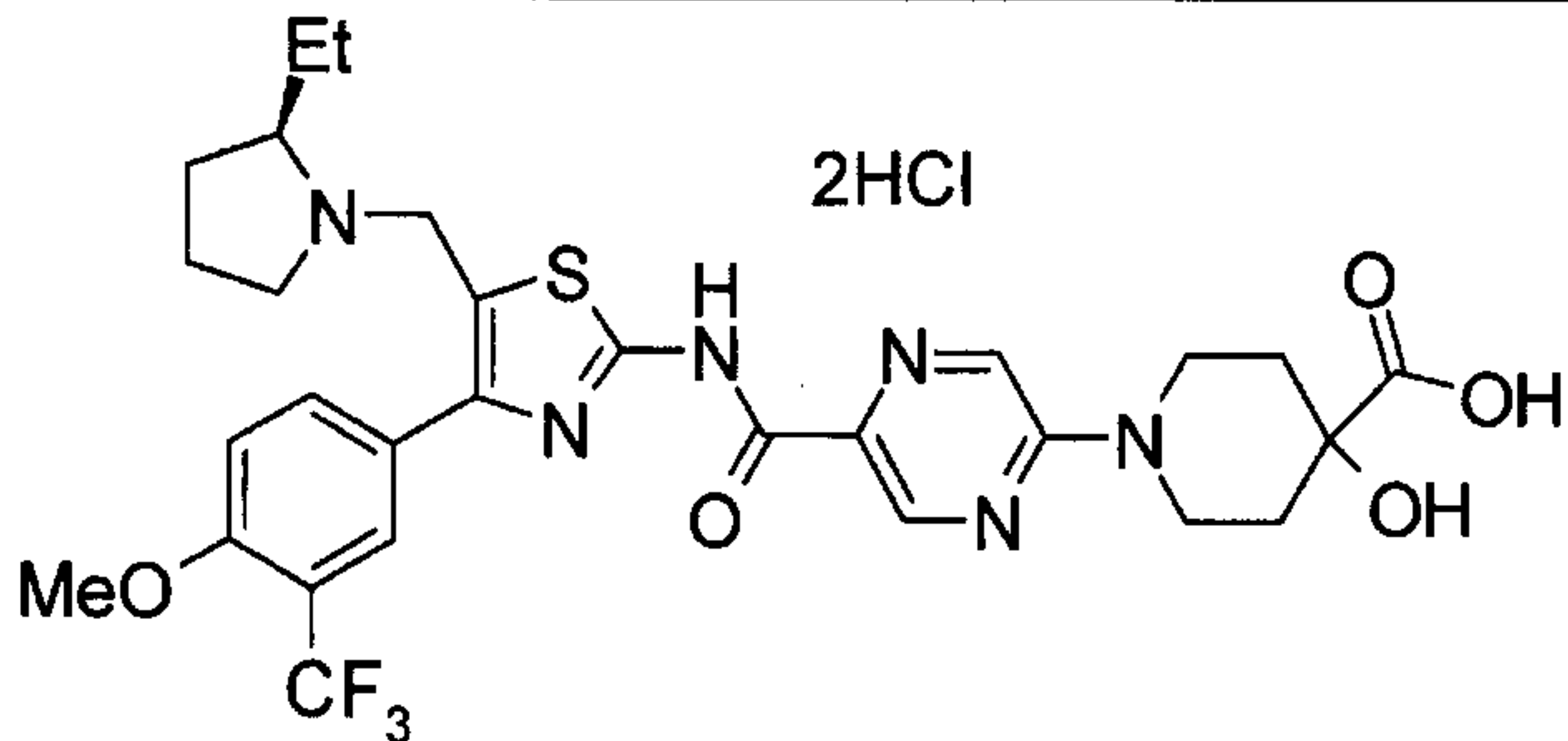
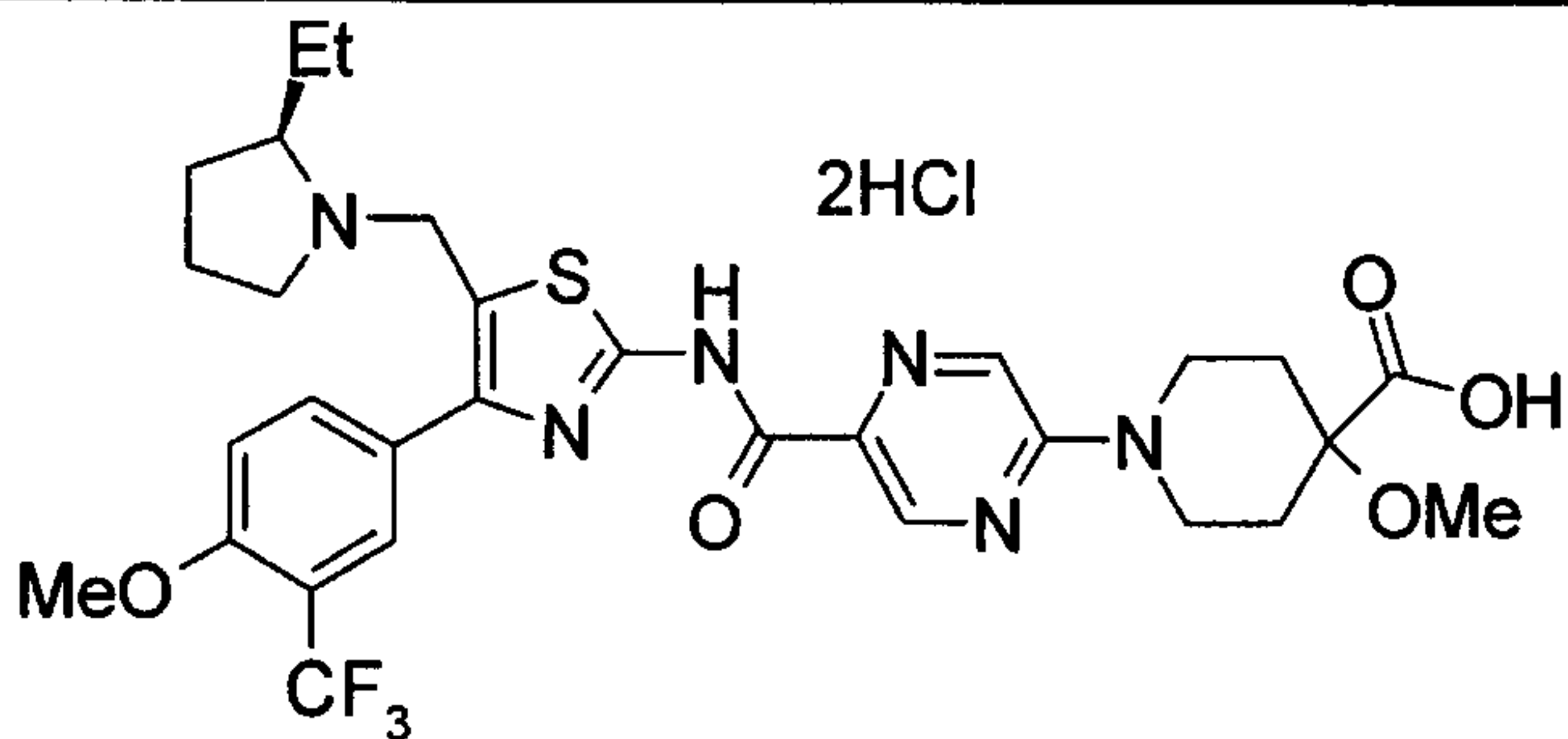
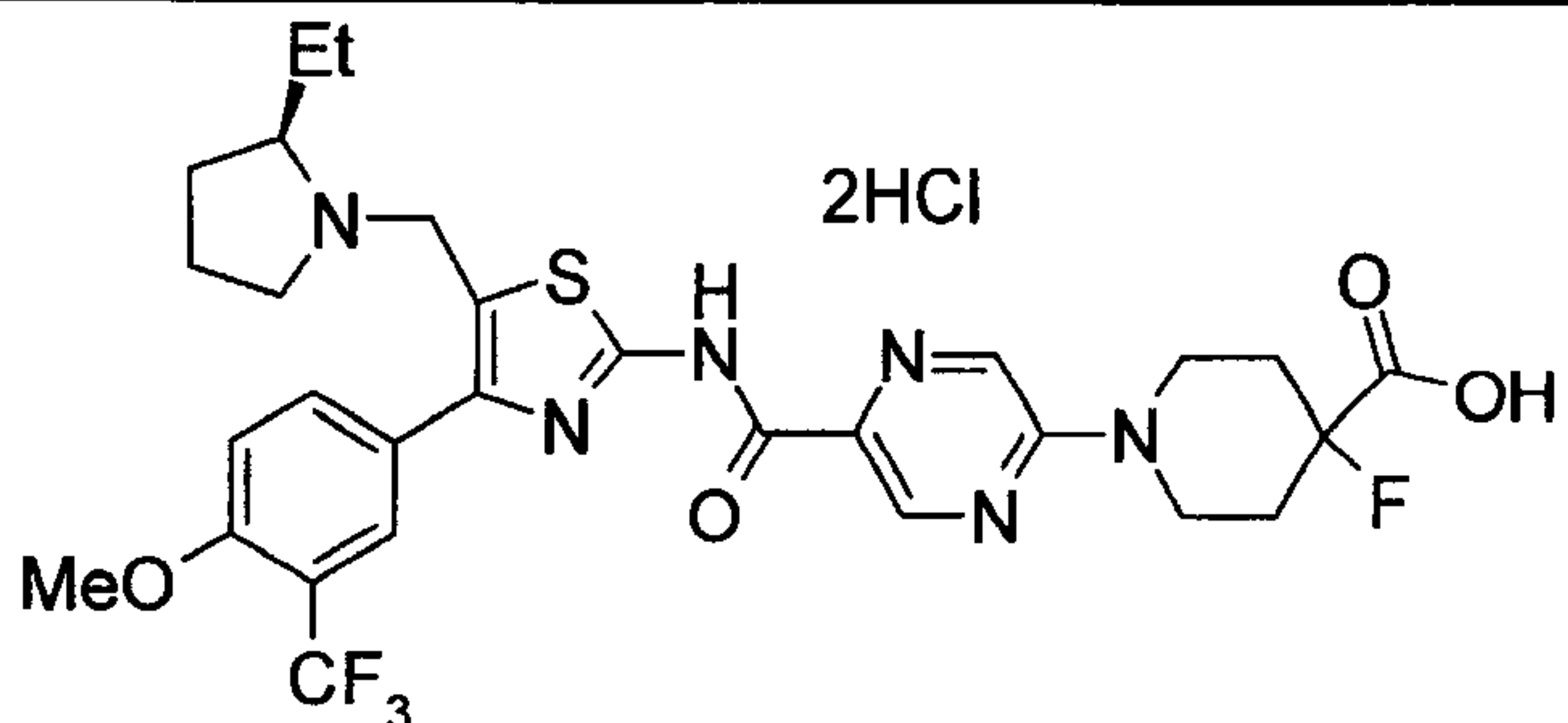
[0223]

[Table 62]

Ex	Str
117	<chem>COCCN(C)Cc1c(C2=CC(=CC=C2C(F)=CC(F)(F)F)S1=NC(=N1)NC(=O)C3=CN=C(N4CCN(C4)C(=O)O)C=N3)nc2ccccc2</chem>
118	<chem>COc1cc(C(F)(F)F)ccc1-c1ccc(C(F)(F)F)cc1S1=NC(=N1)NC(=O)C2=CN=C(N3CCN(C3)C(=O)O)C=N2</chem>
119	<chem>CC[C@H](C)N(C)Cc1c(C2=CC(=CC=C2C(OC(F)(F)F)=CC(OC)=C2)S1=NC(=N1)NC(=O)C3=CN=C(N4CCN(C4)C(=O)O)C=N3)nc2ccccc2</chem>
120	<chem>CC[C@H](C)N(C)Cc1c(C2=CC(=CC=C2C(OC(F)(F)F)=CC(OC)=C2)S1=NC(=N1)NC(=O)C3=CN=C(N4CCN(C4)C(=O)O)C=N3)nc2ccccc2</chem>
121	<chem>CC[C@H](C)N(C)Cc1c(C2=CC(=CC=C2C(OC(F)(F)F)=CC(OC)=C2)S1=NC(=N1)NC(=O)C3=CN=C(N4CCN(C4)C(=O)O)C=N3)nc2ccccc2</chem>

[0224]

[Table 63]

Ex	Str
122	
123	
124	
125	

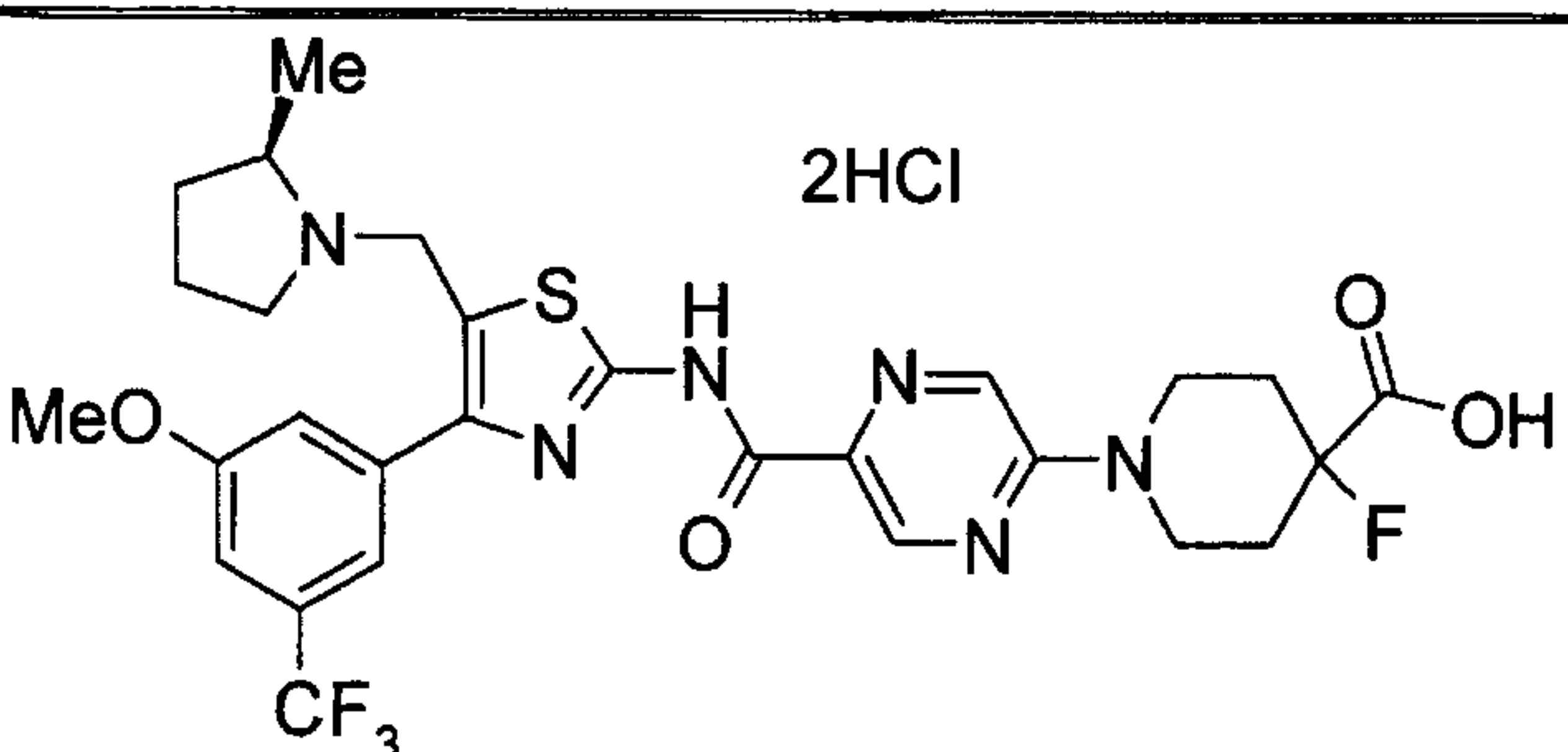
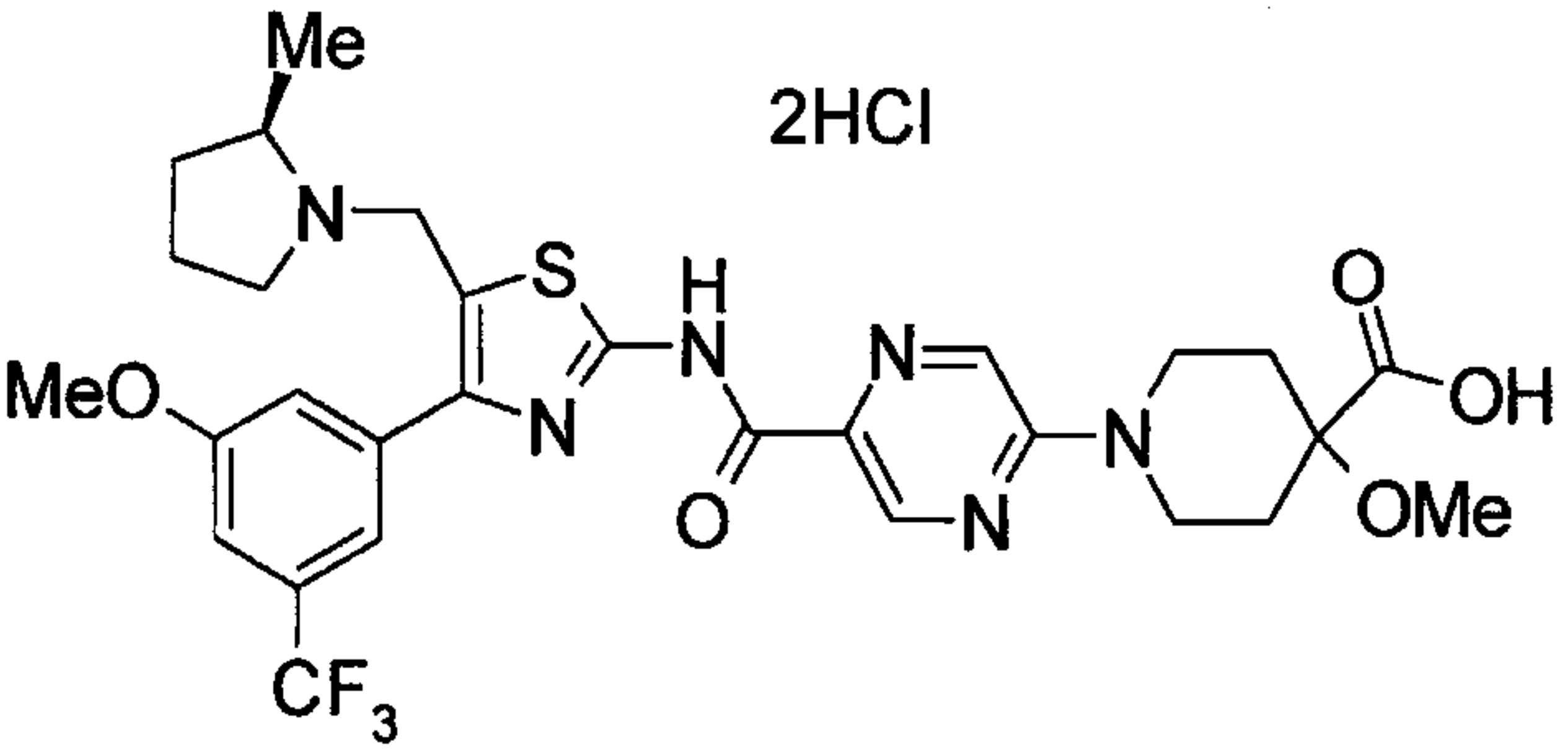
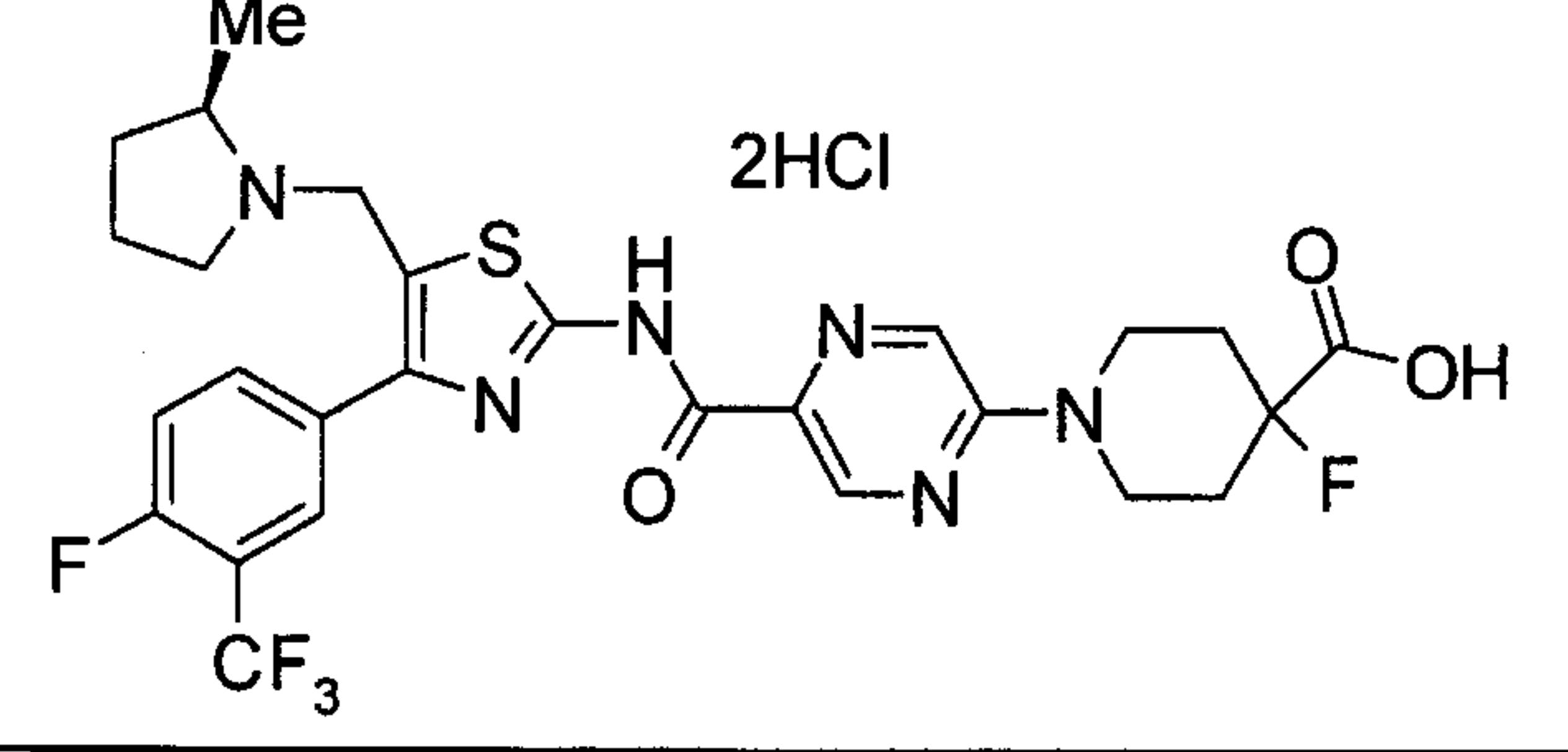
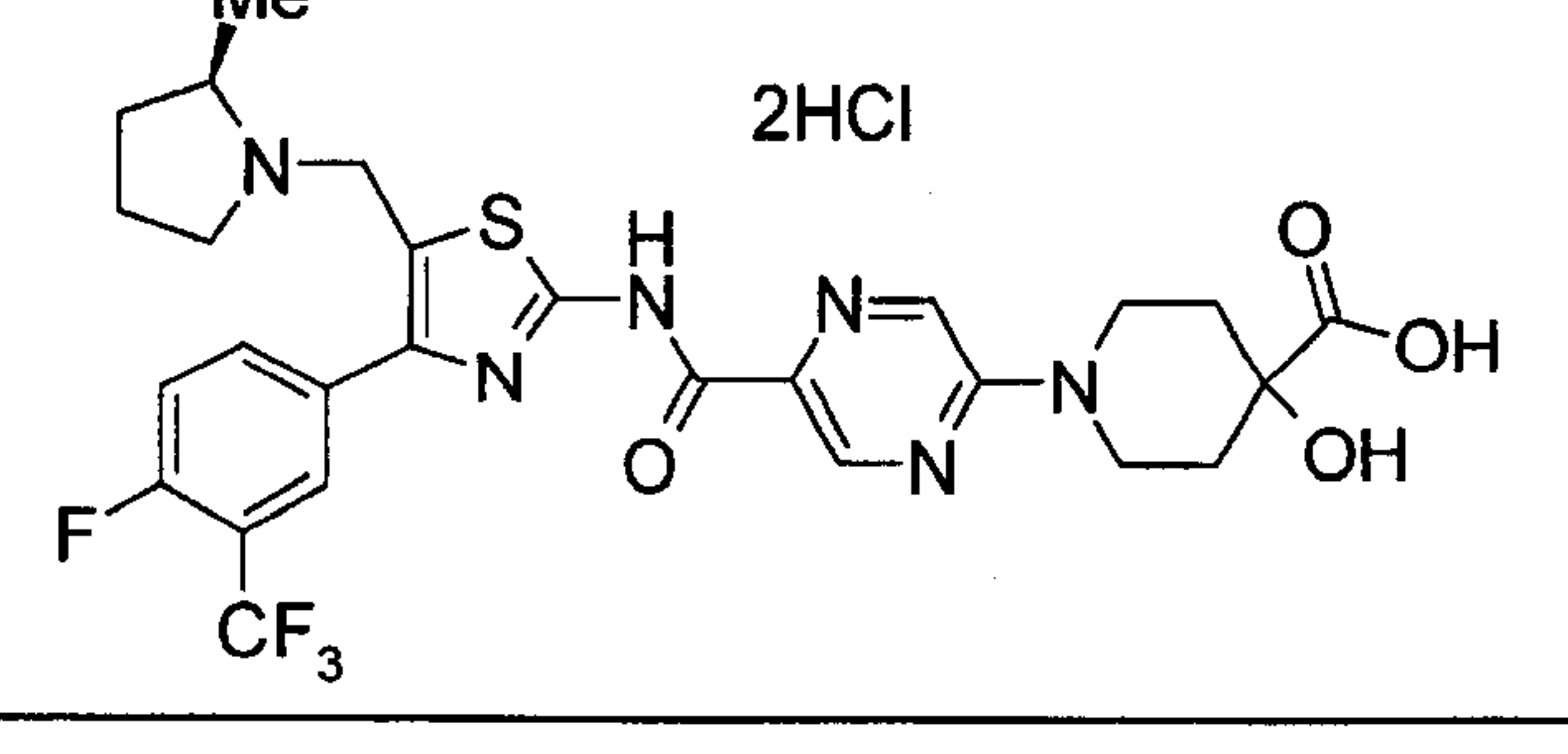
[0225]

[Table 64]

Ex	Str
126	<chem>CN1CCCC1Cc2nc(NC(=O)c3ncnc(N1CCCC1C(=O)O)c3)c(Cc4ccc(OC(F)(F)F)cc4)c5ccc(OC(F)(F)F)cc5</chem>
127	<chem>CN1CCCC1Cc2nc(NC(=O)c3ncnc(N1CCCC1C(=O)OC)c3)c(Cc4ccc(OC(F)(F)F)cc4)c5ccc(OC(F)(F)F)cc5</chem>
128	<chem>CN1CCCC1Cc2nc(NC(=O)c3ncnc(N1CCCC1C(=O)O)c3)c(Cc4ccc(F)cc4)c5ccc(C(F)(F)F)cc5</chem>
129	<chem>CN1CCCC1Cc2nc(NC(=O)c3ncnc(N1CCCC1C(=O)O)c3)c(Cc4ccc(Cl)cc4)c5ccc(C(F)(F)F)cc5</chem>
130	<chem>CN1CCCC1Cc2nc(NC(=O)c3ncnc(N1CCCC1C(=O)O)c3)c(Cc4ccc(OC)c4)c5ccc(C(F)(F)F)cc5</chem>

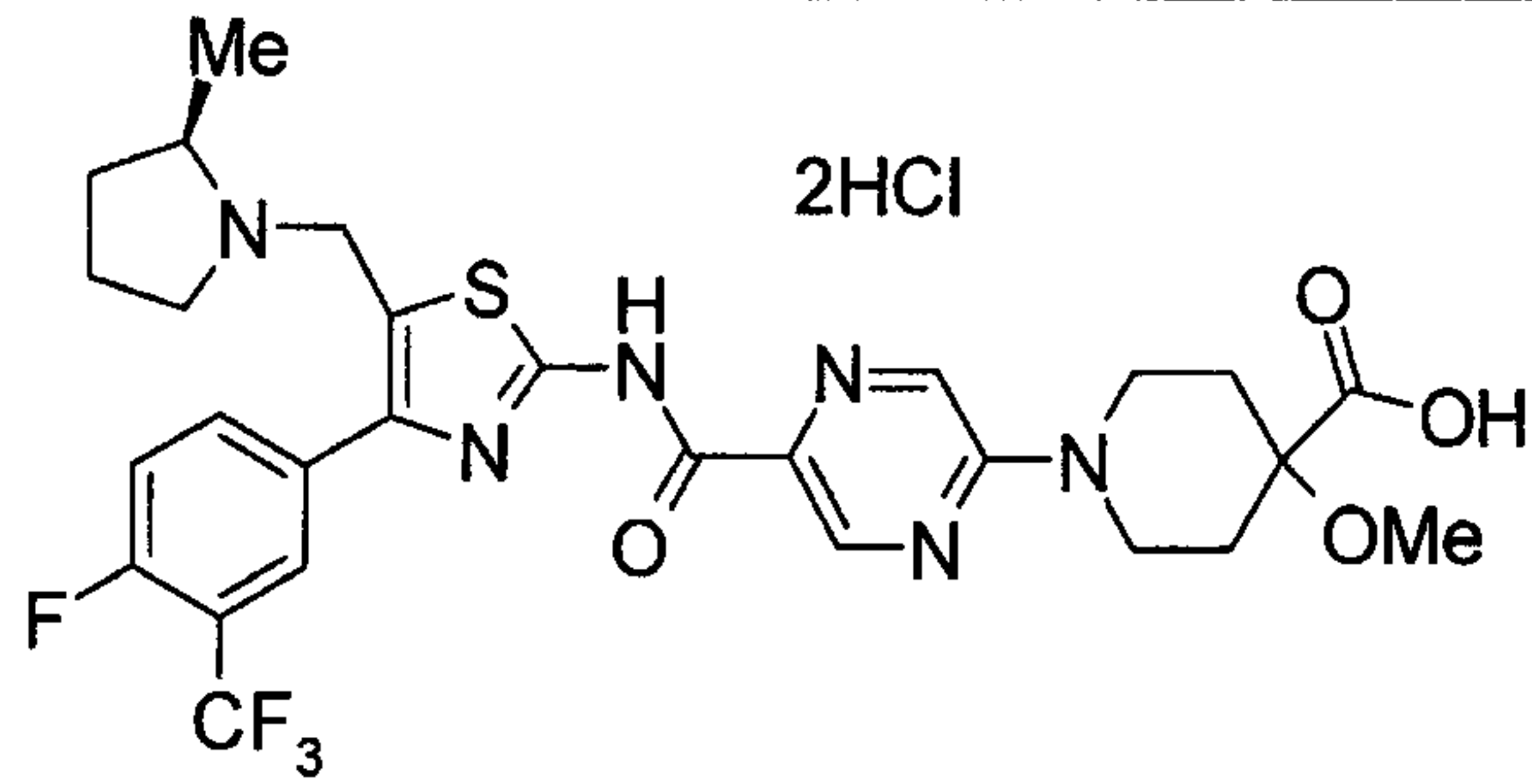
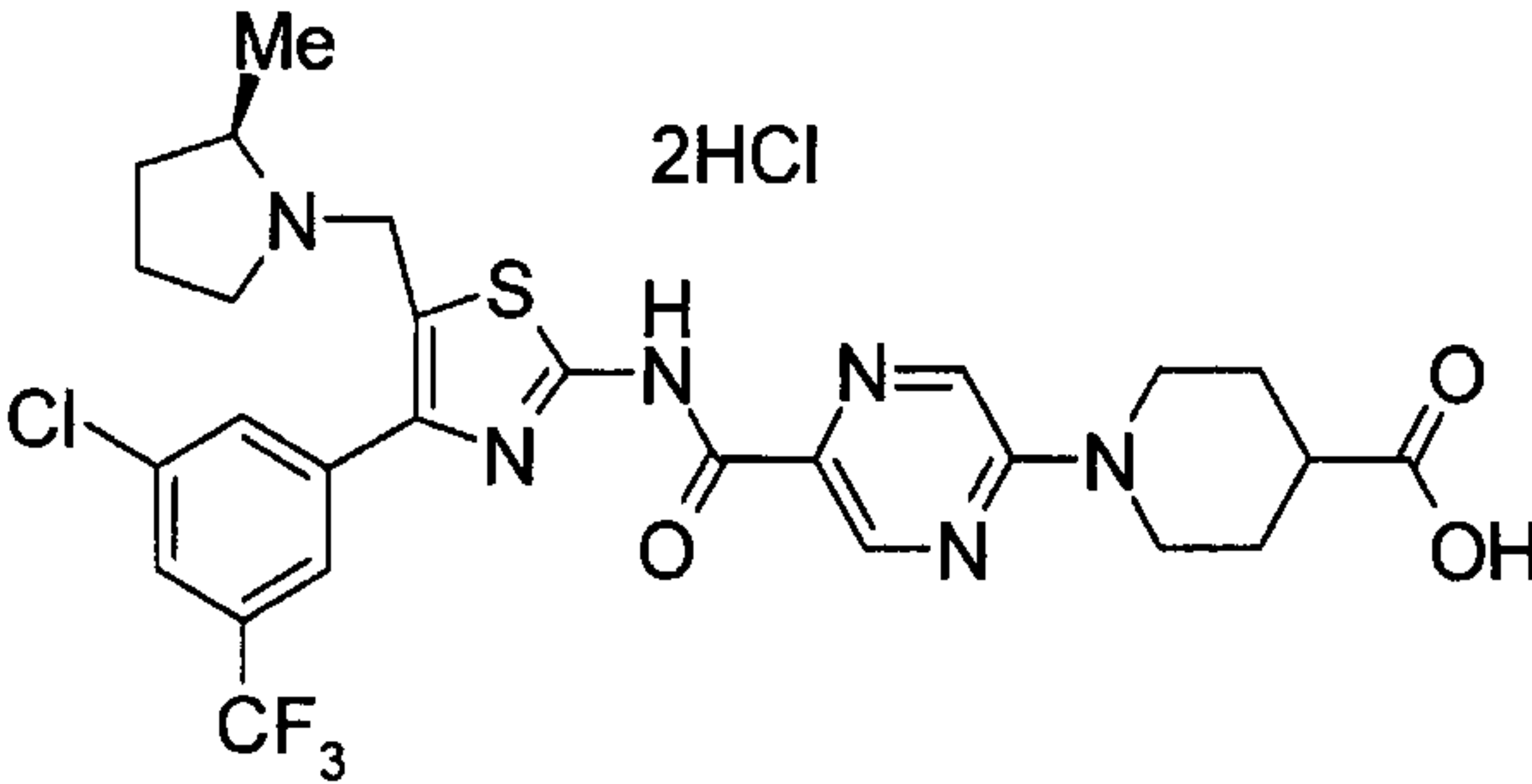
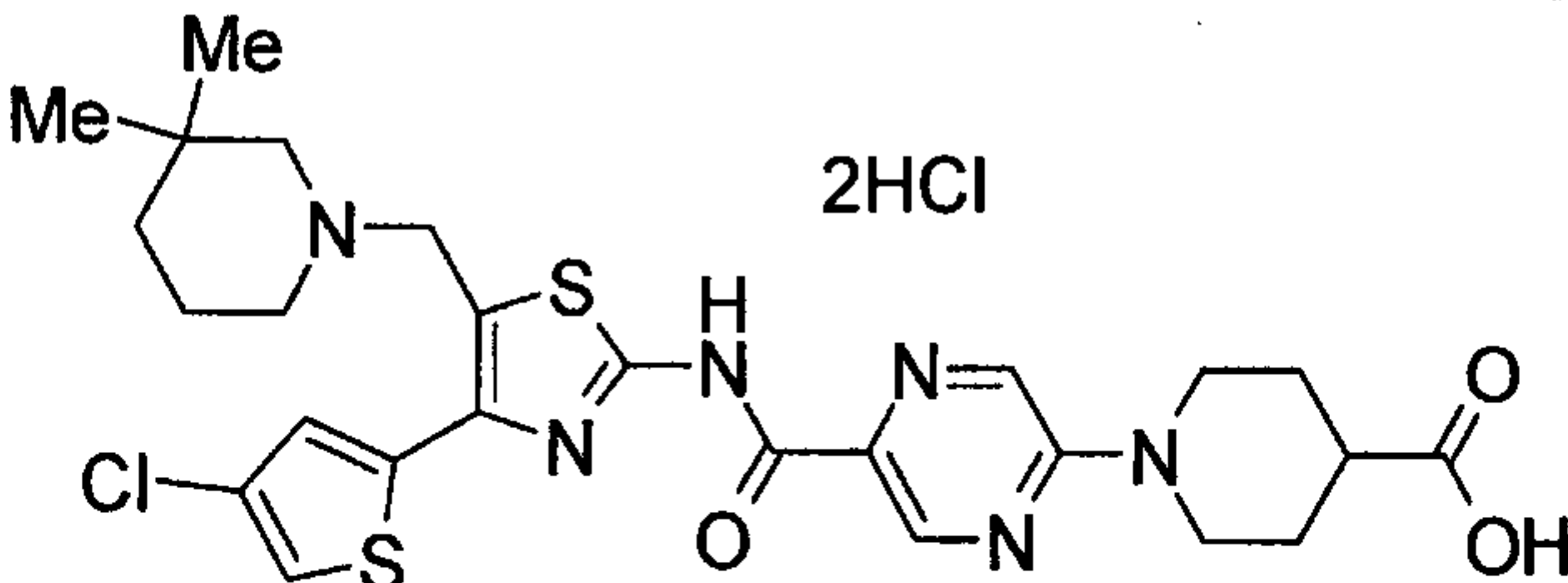
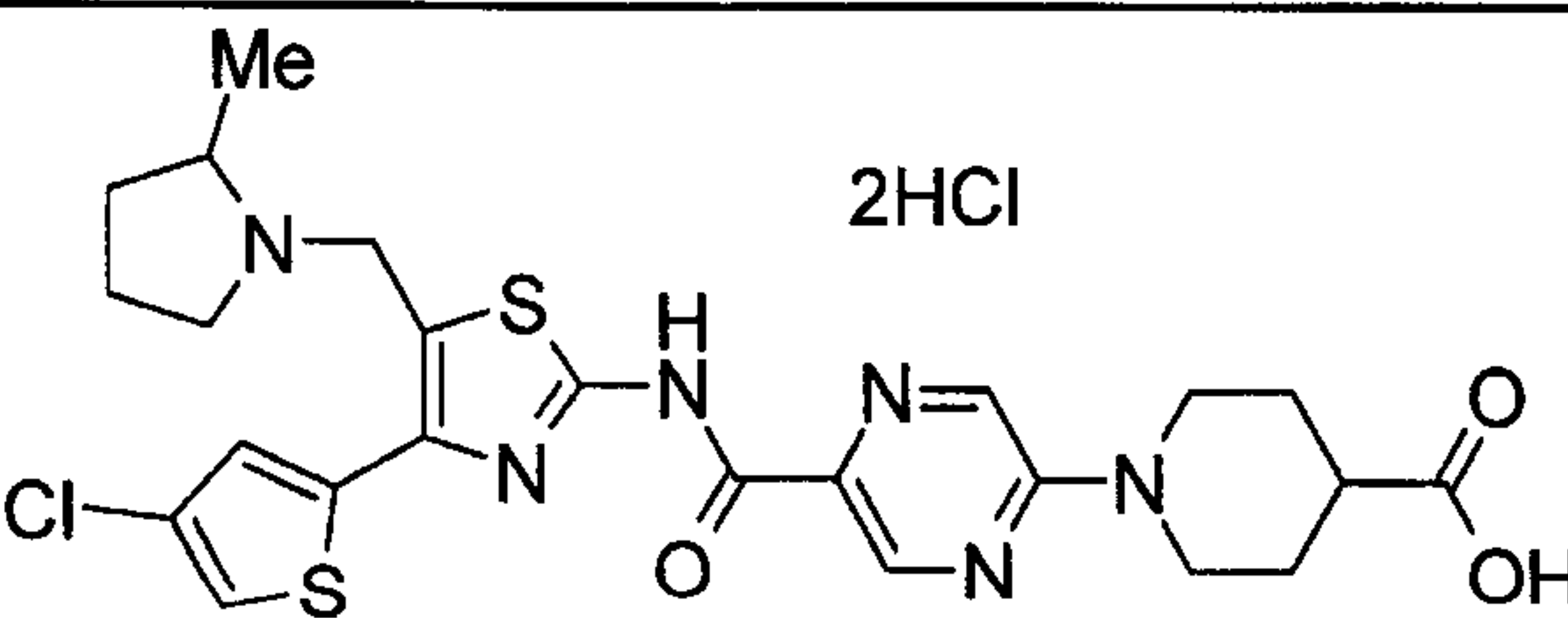
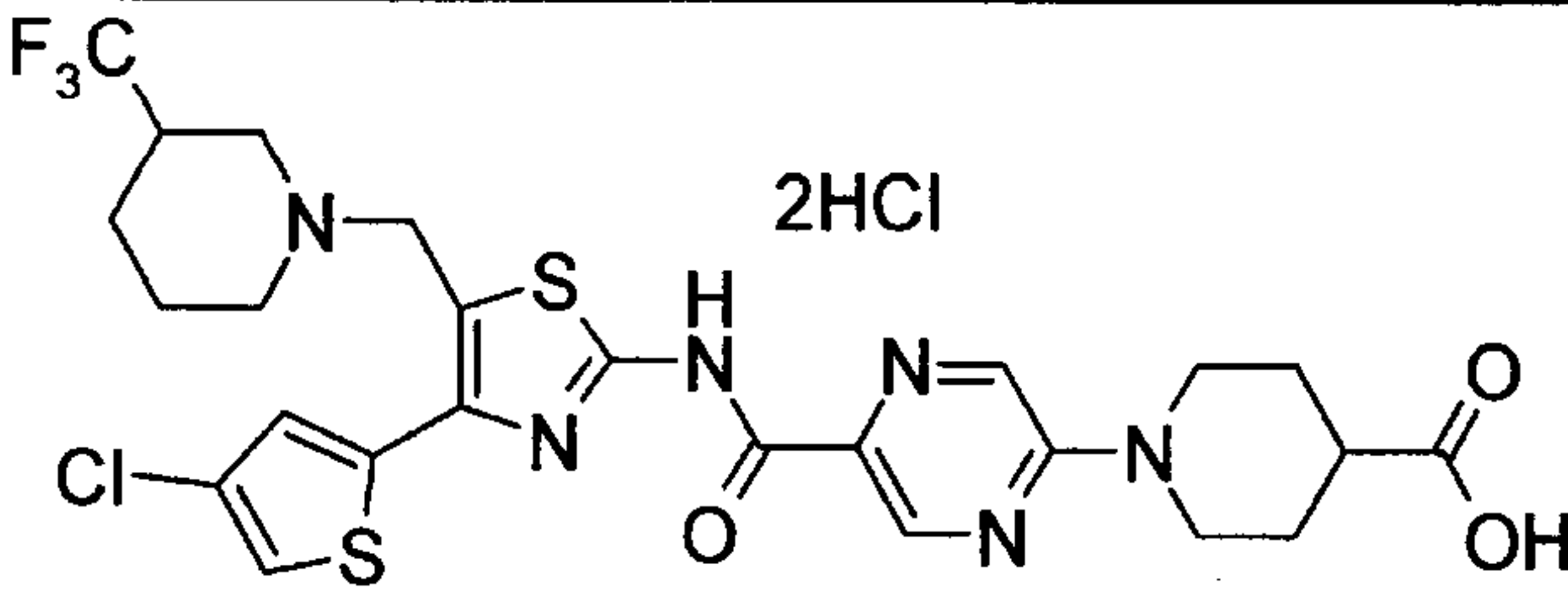
[0226]

[Table 65]

Ex	Str
131	
132	
133	
134	

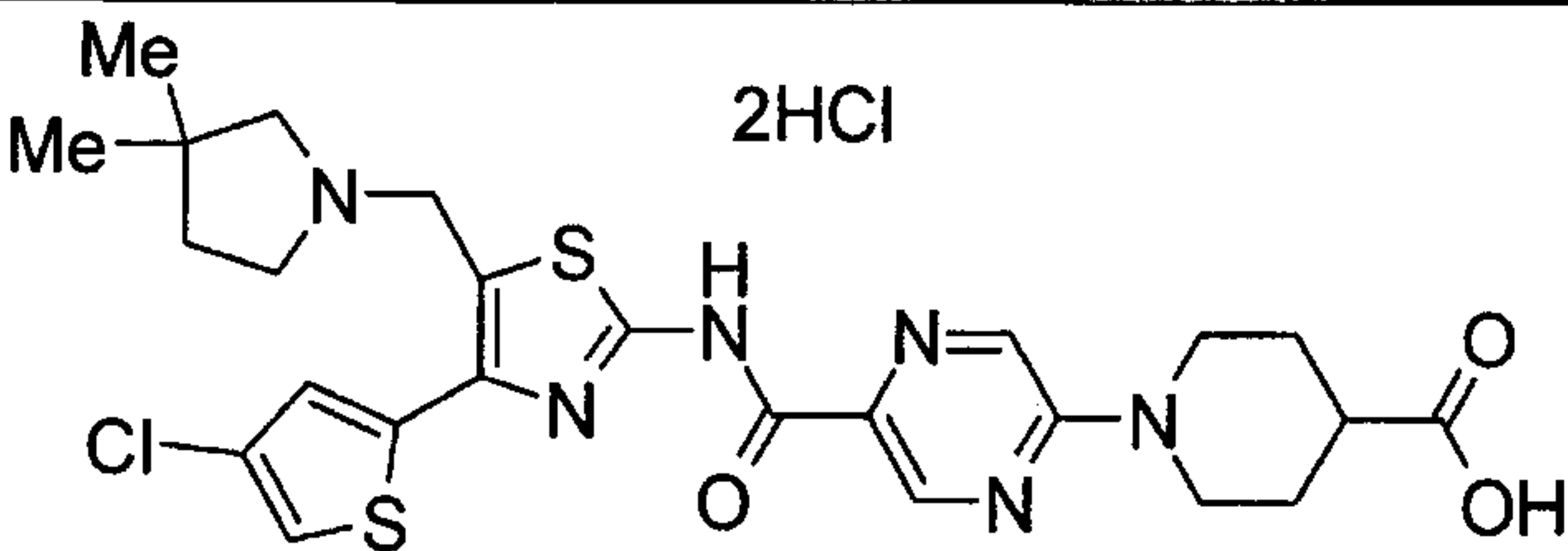
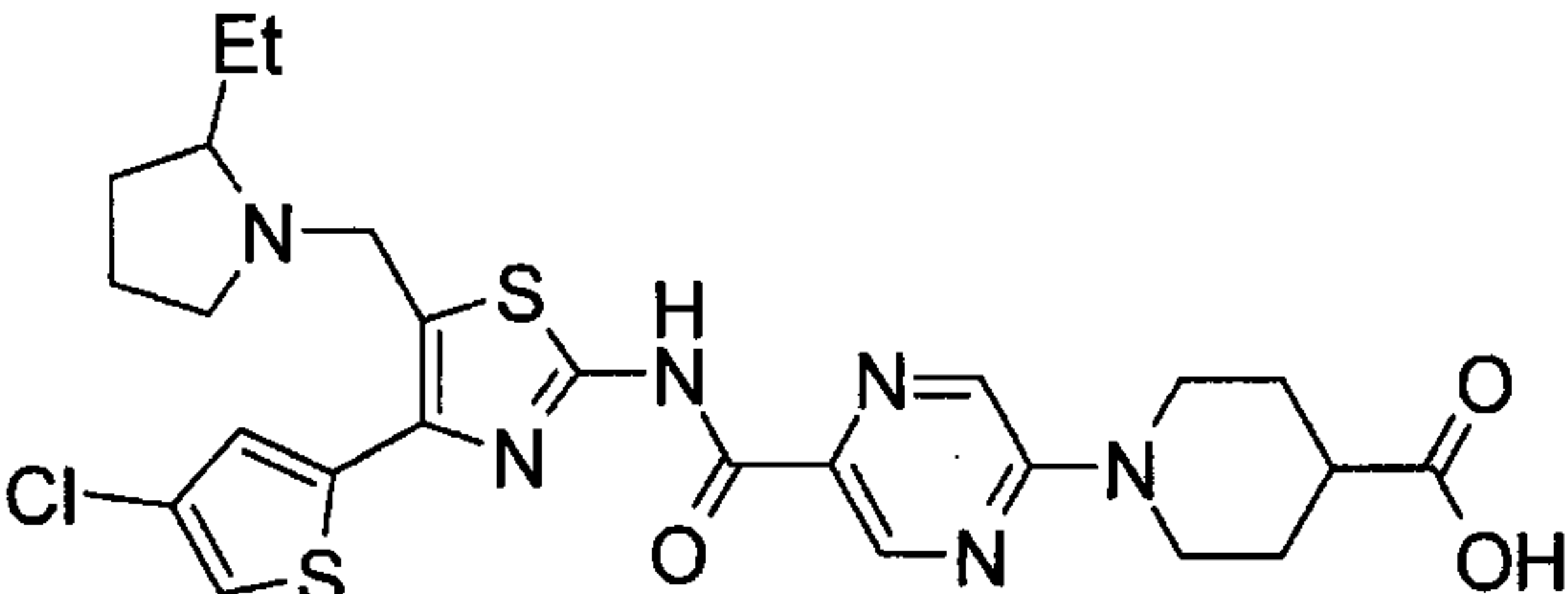
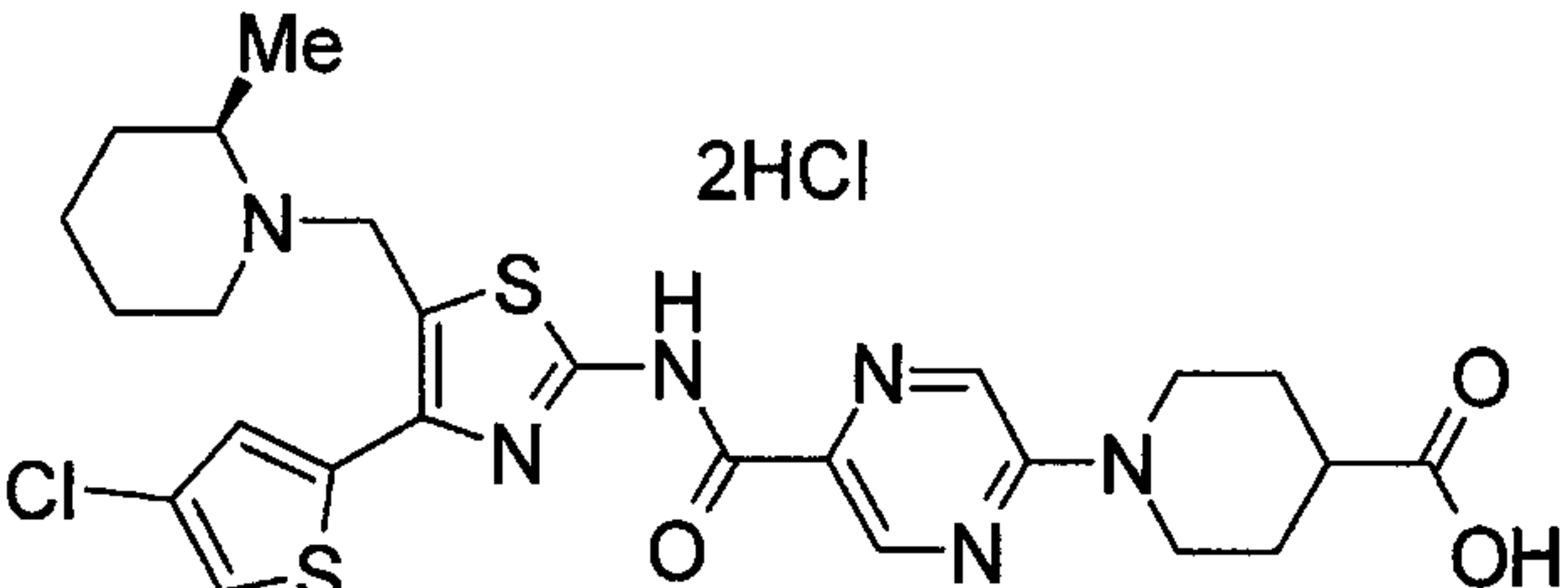
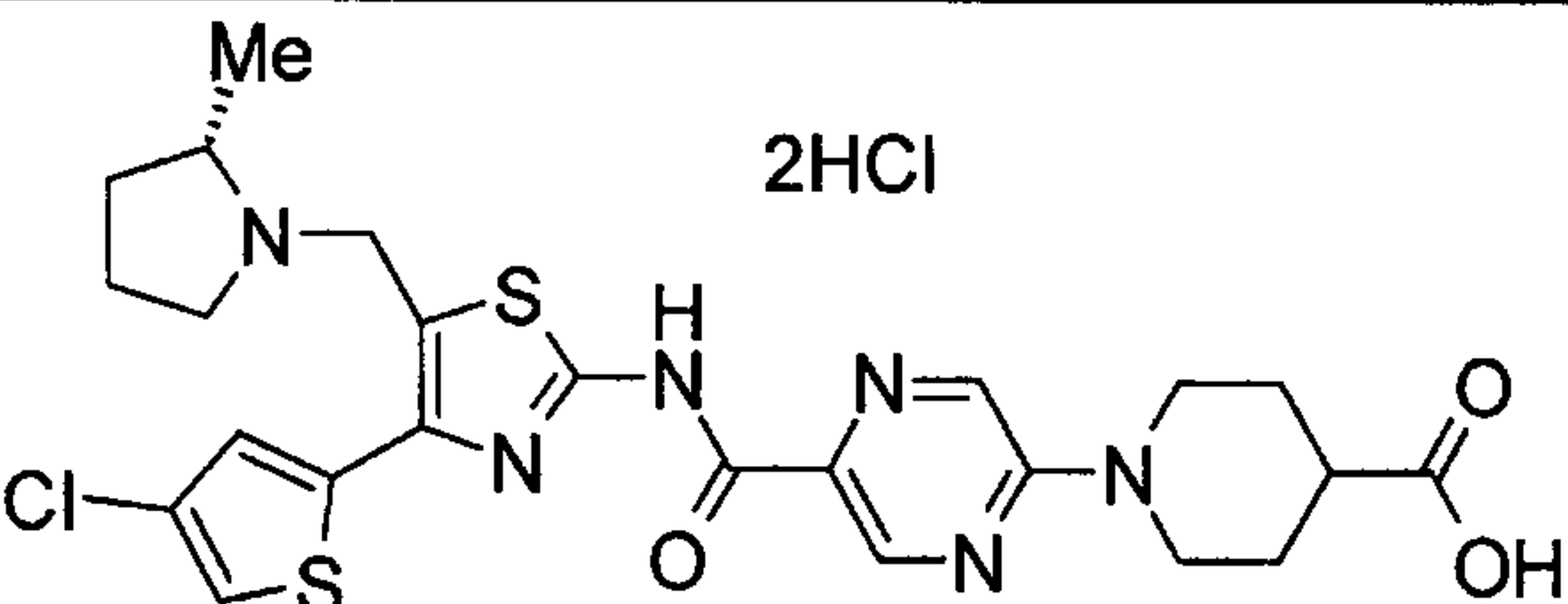
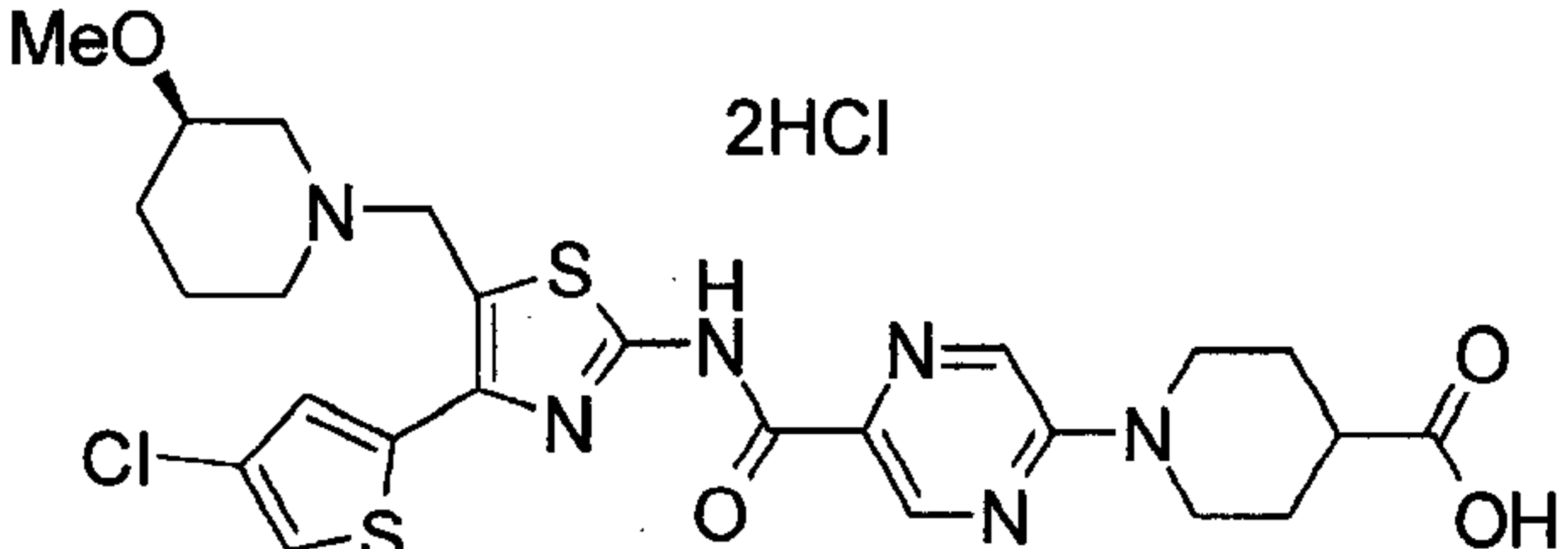
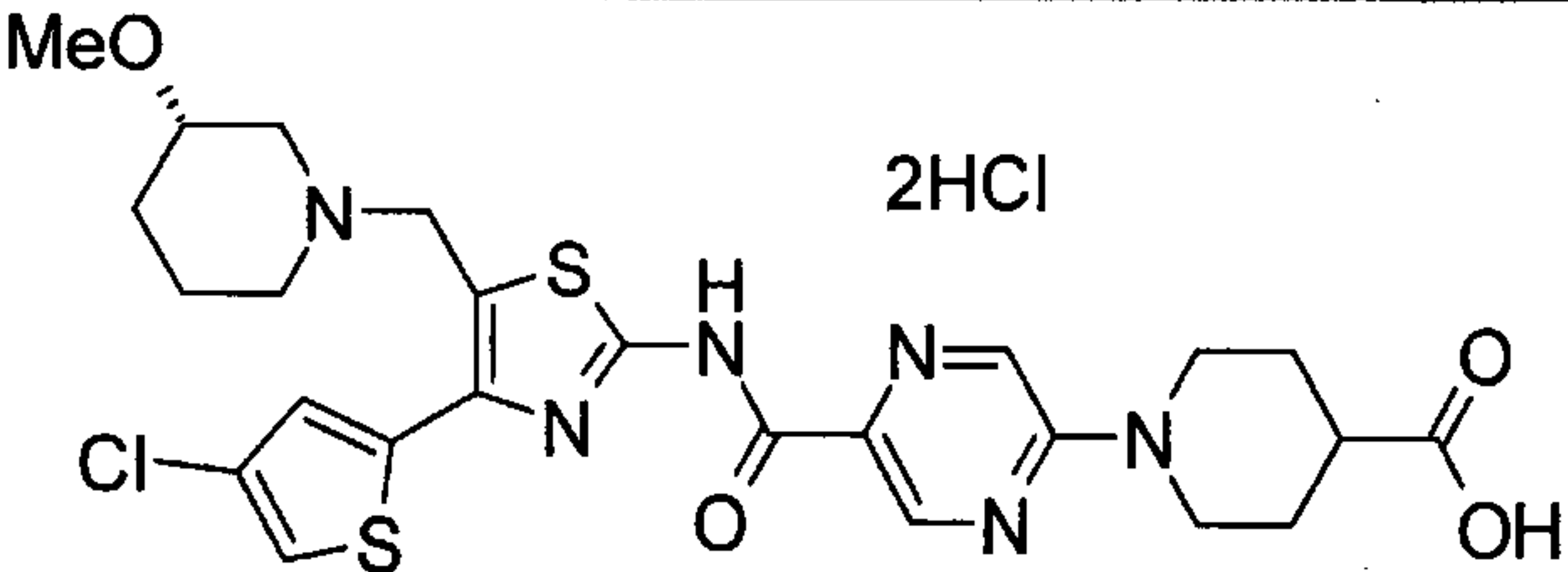
[0227]

[Table 66]

Ex	Str
135	
136	
137	
138	
139	

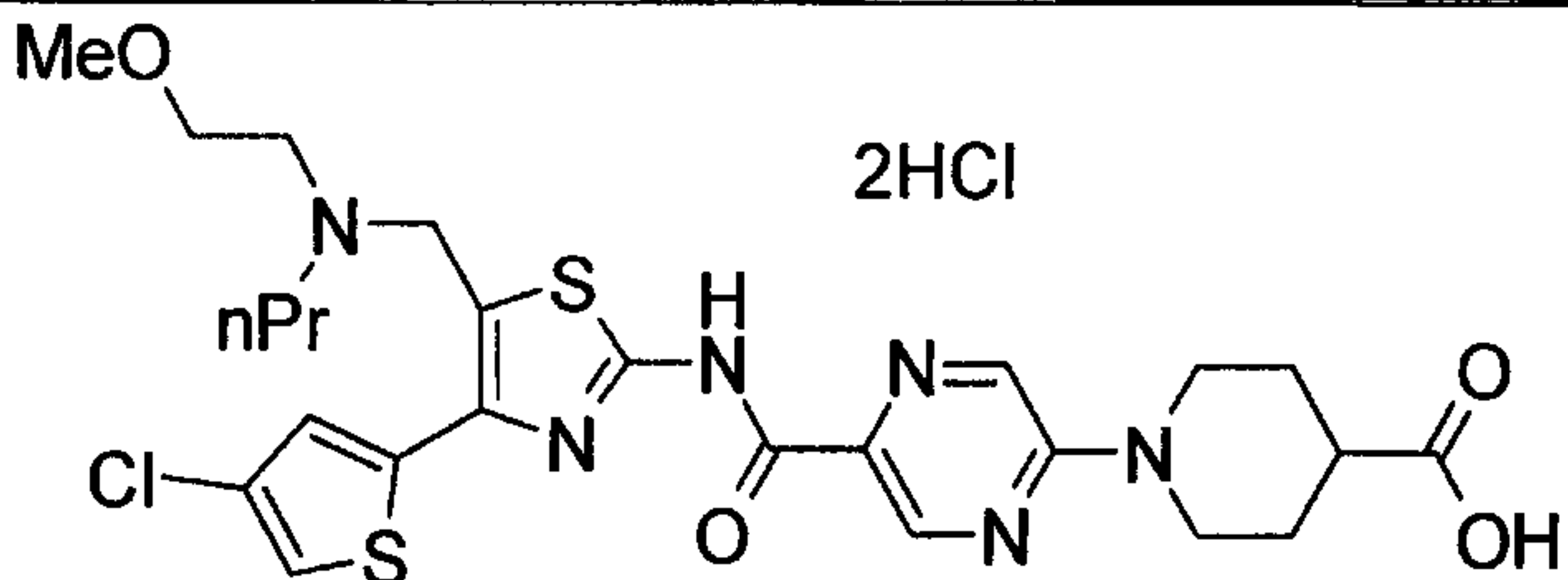
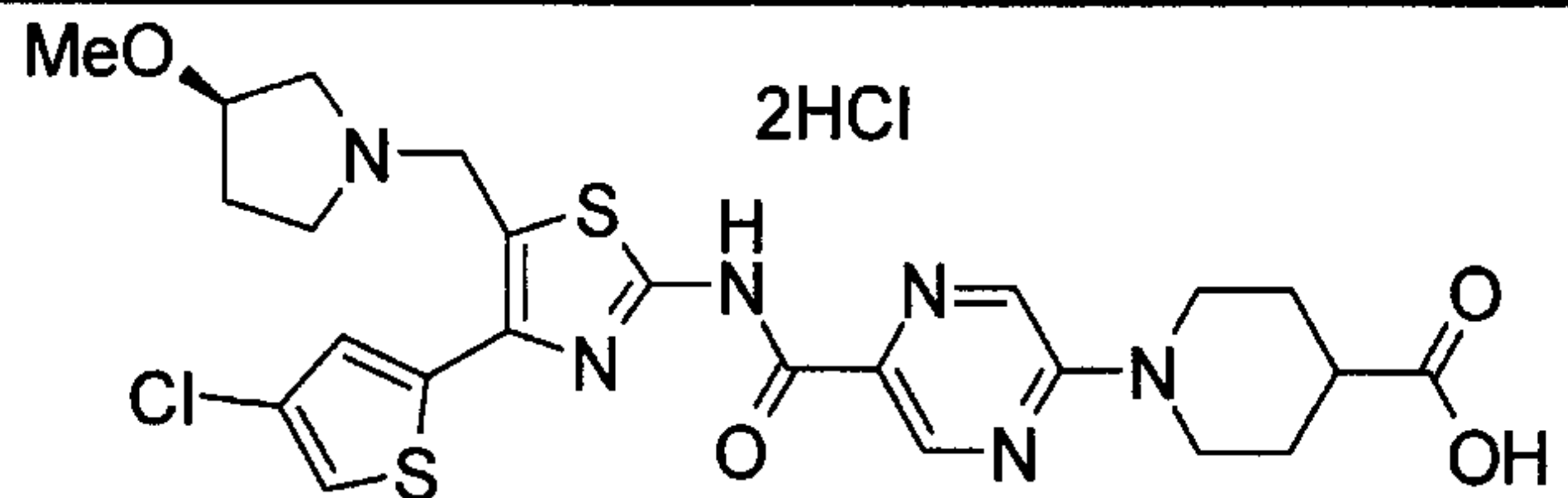
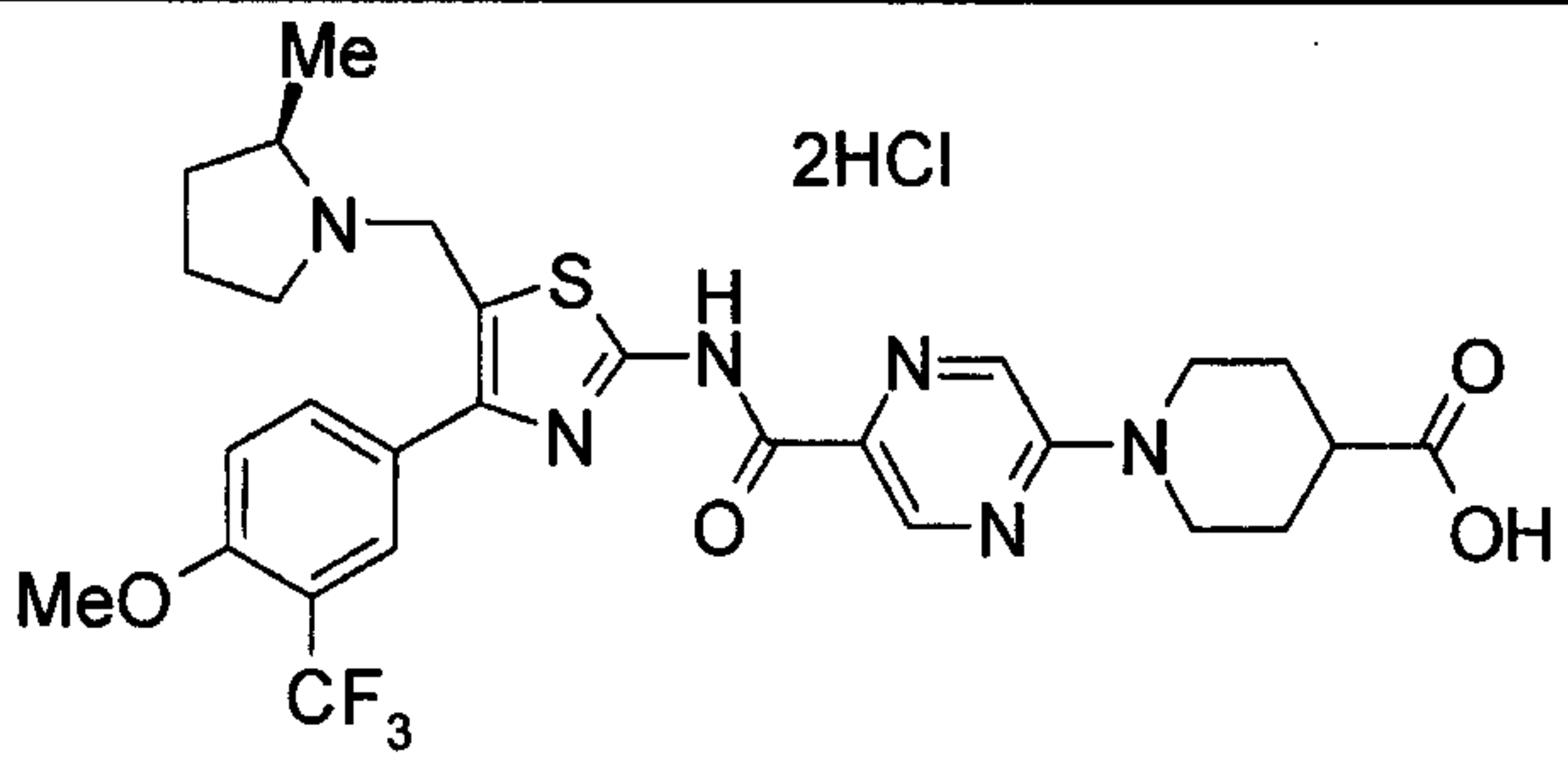
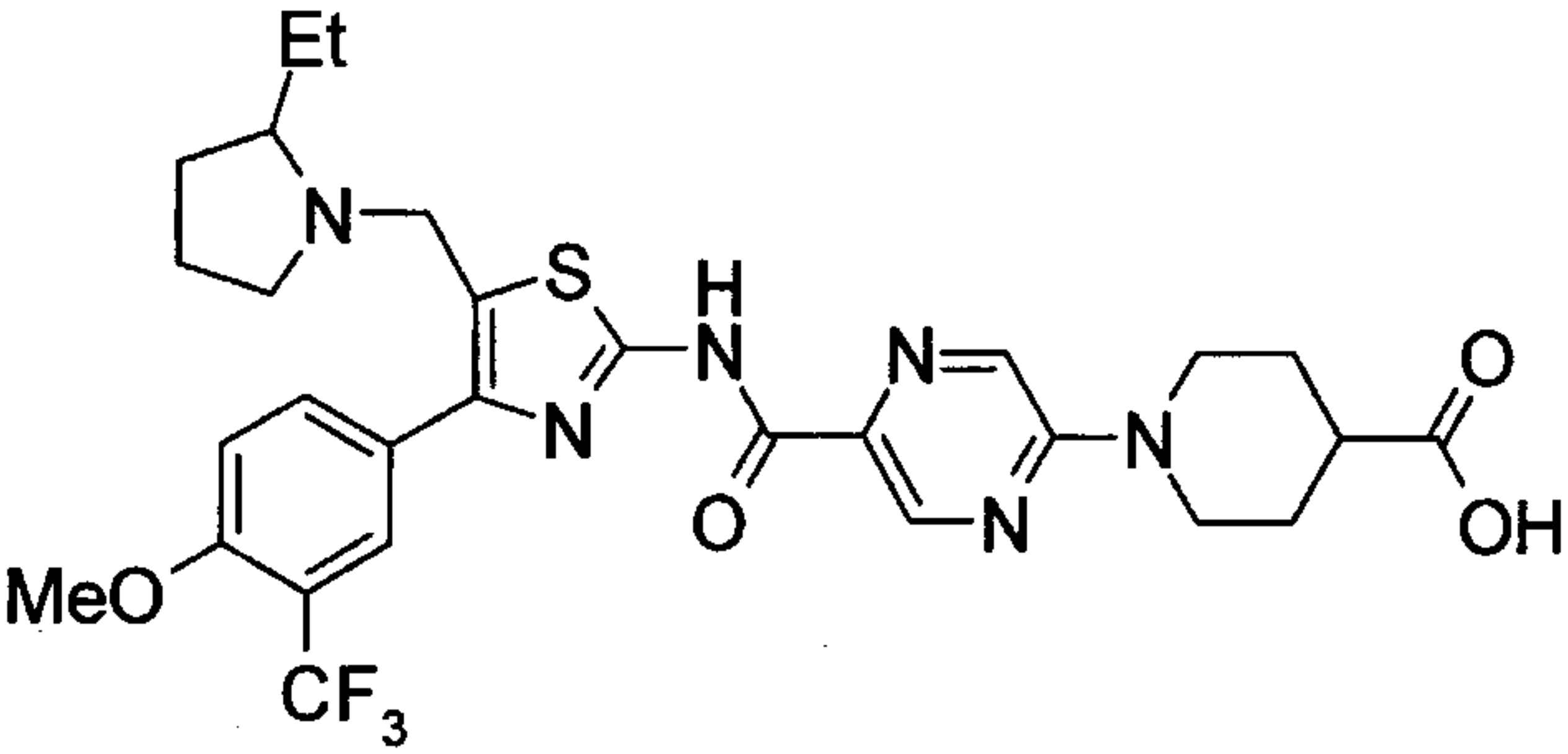
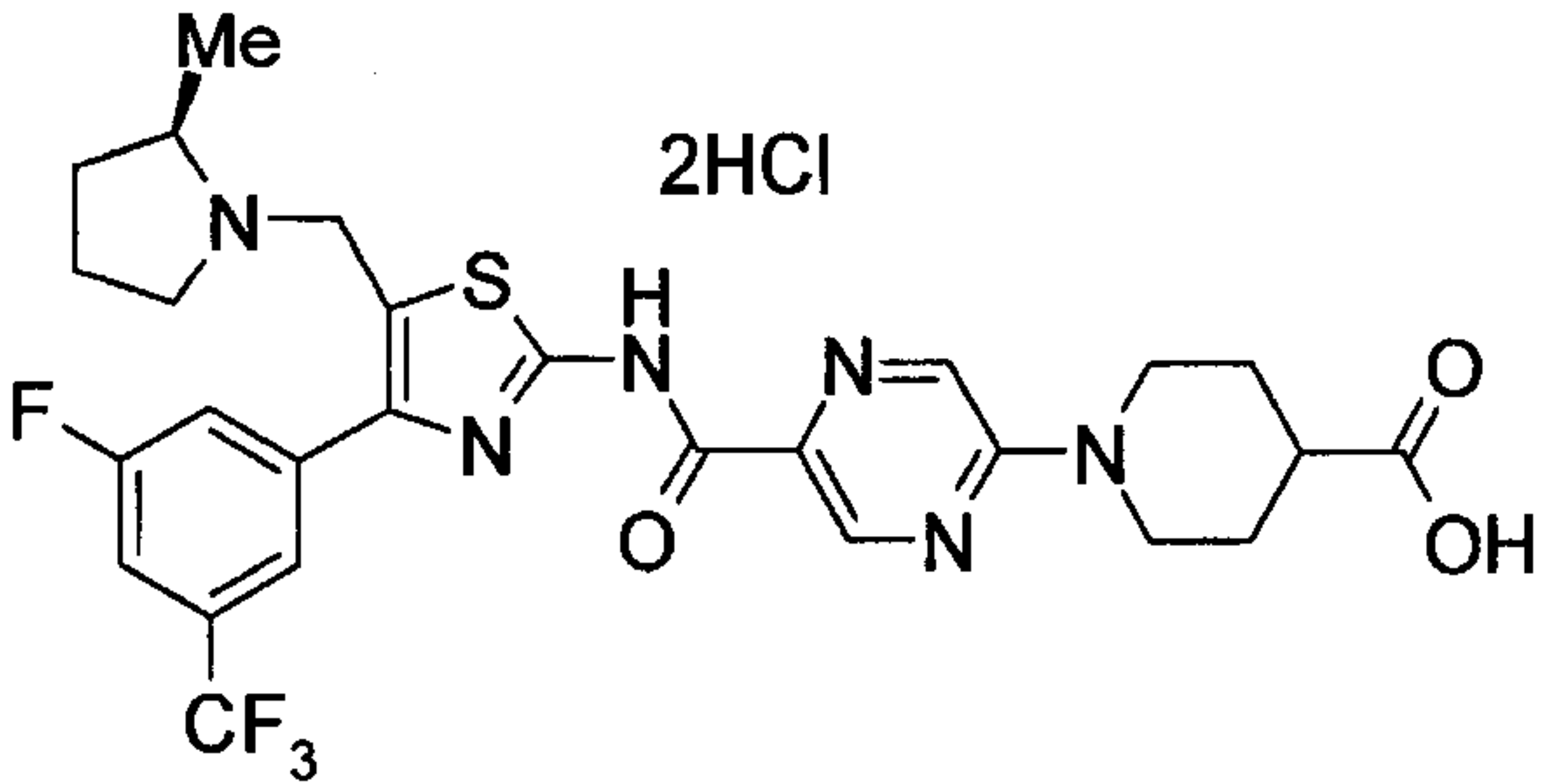
[0228]

[Table 67]

Ex	Str
140	 2HCl
141	
142	 2HCl
143	 2HCl
144	 2HCl
145	 2HCl

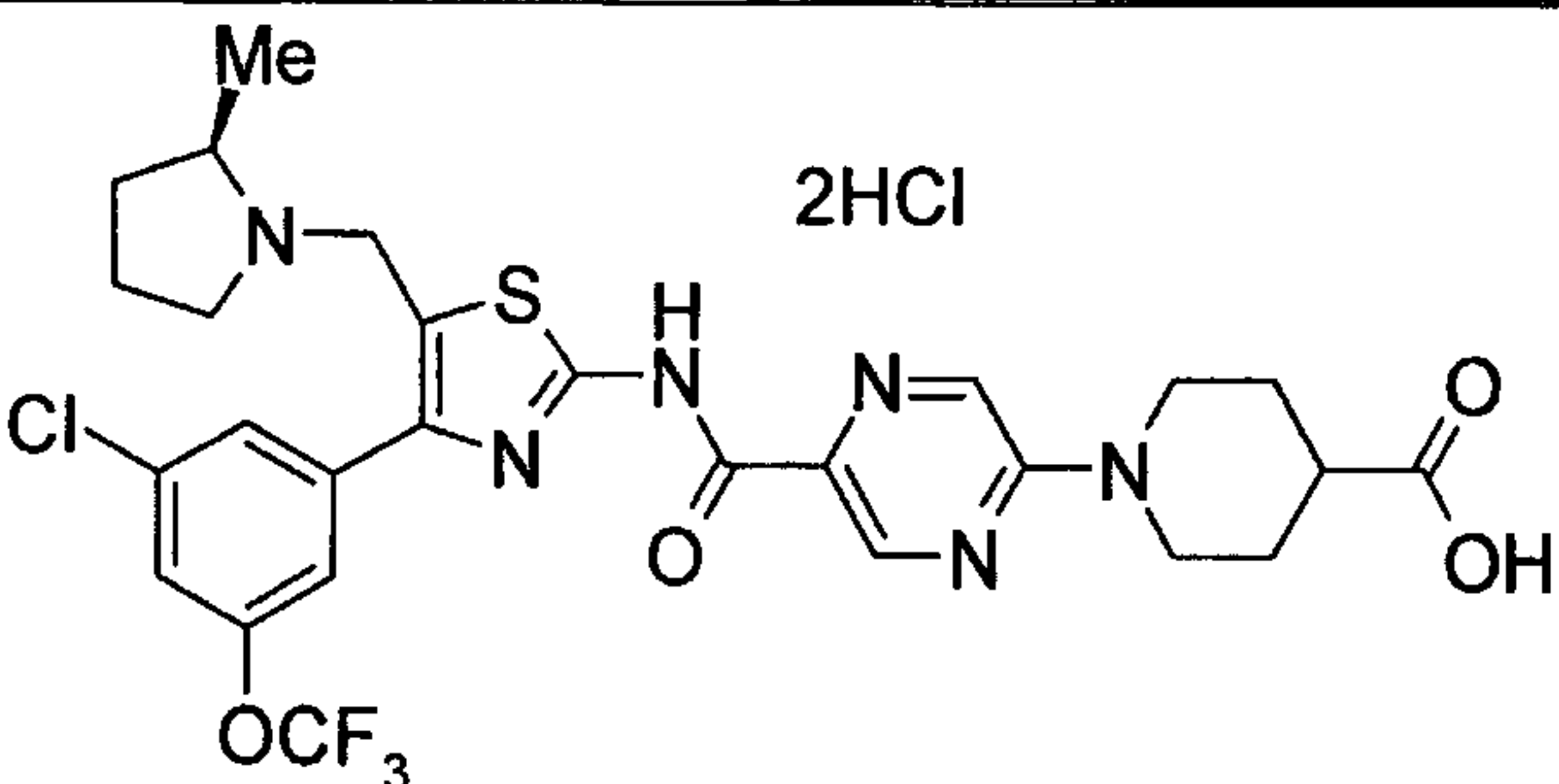
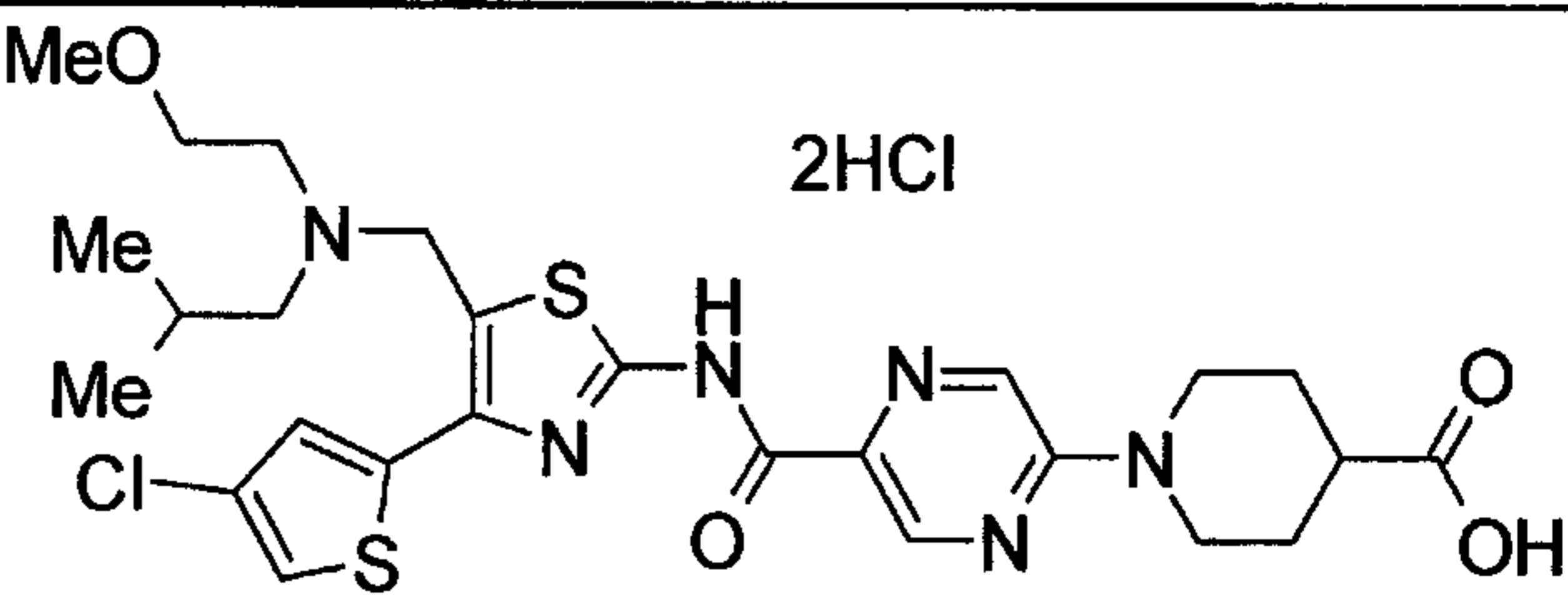
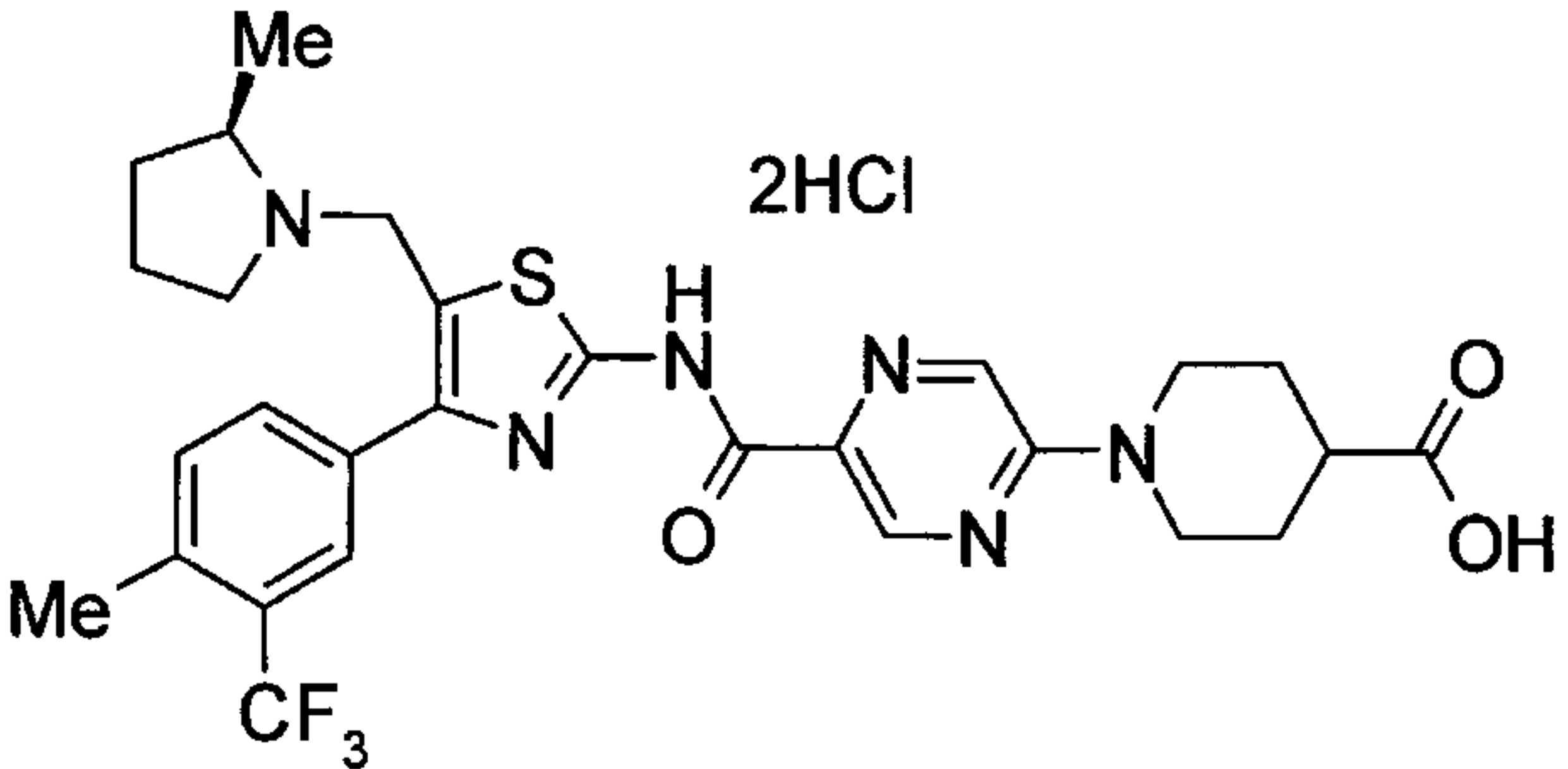
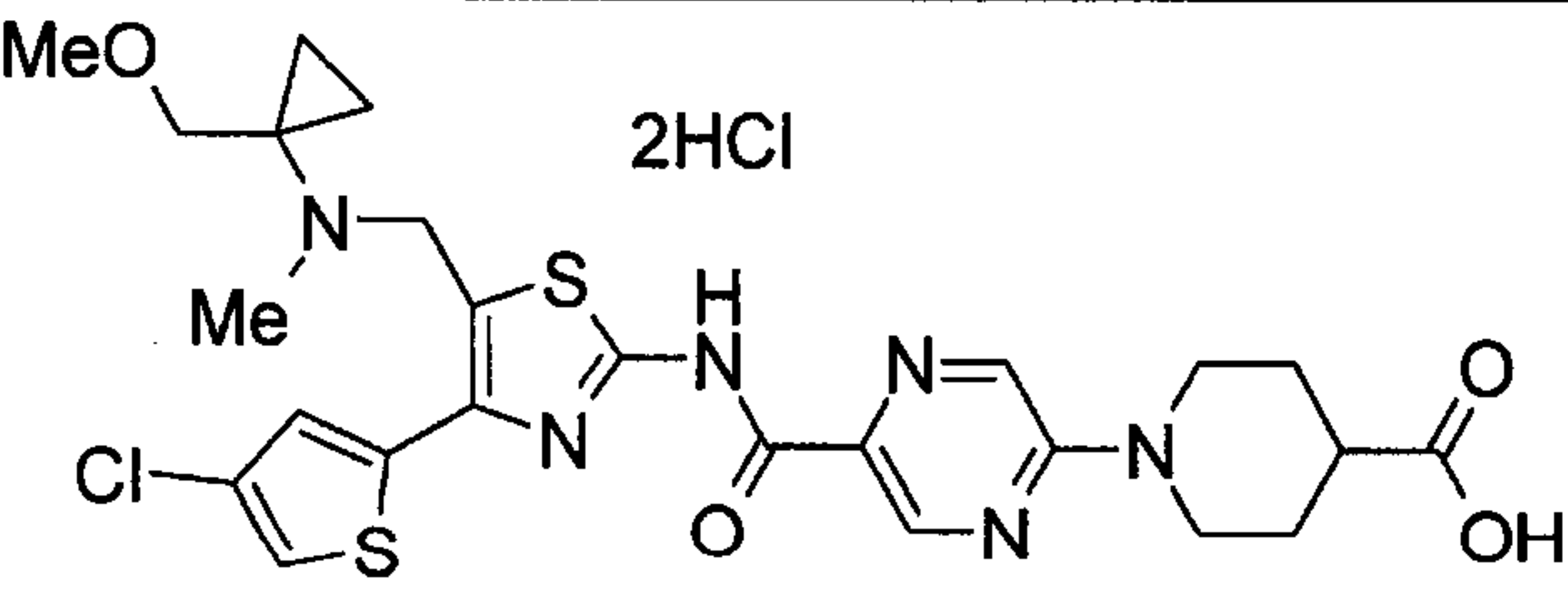
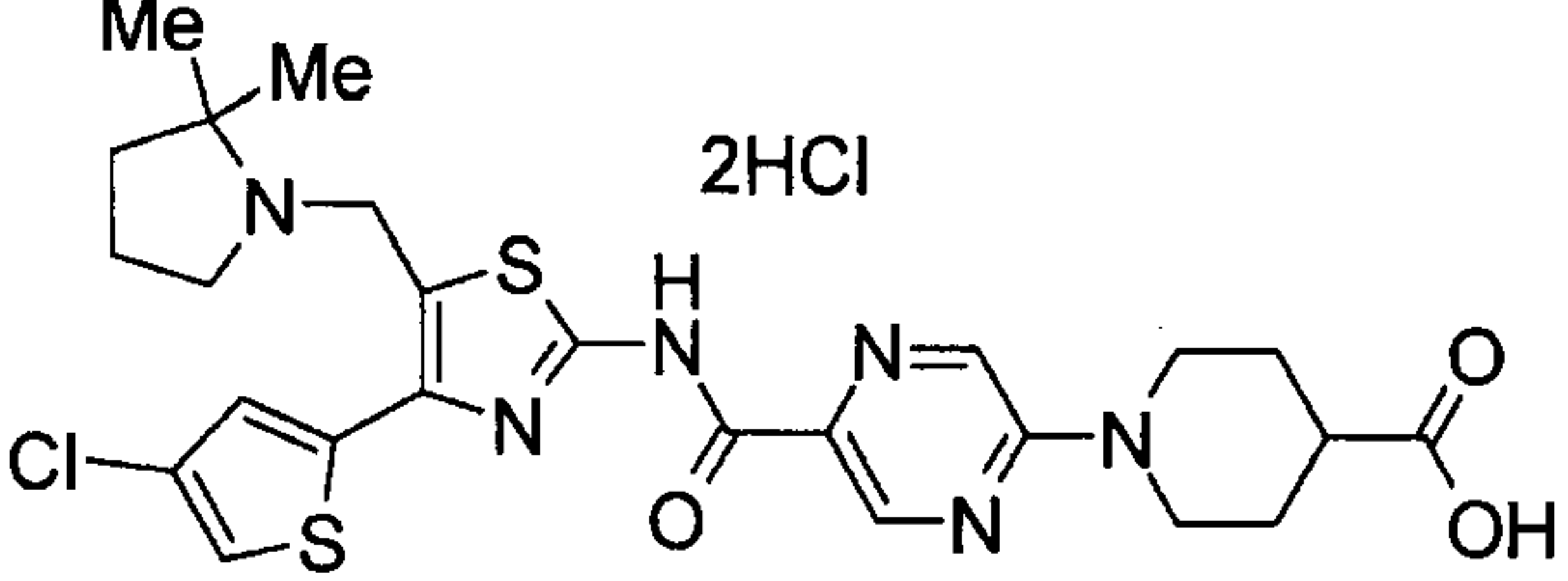
[0229]

[Table 68]

Ex	Str
146	
147	
148	
149	
150	

[0230]

[Table 69]

Ex	Str
151	
152	
153	
154	
155	

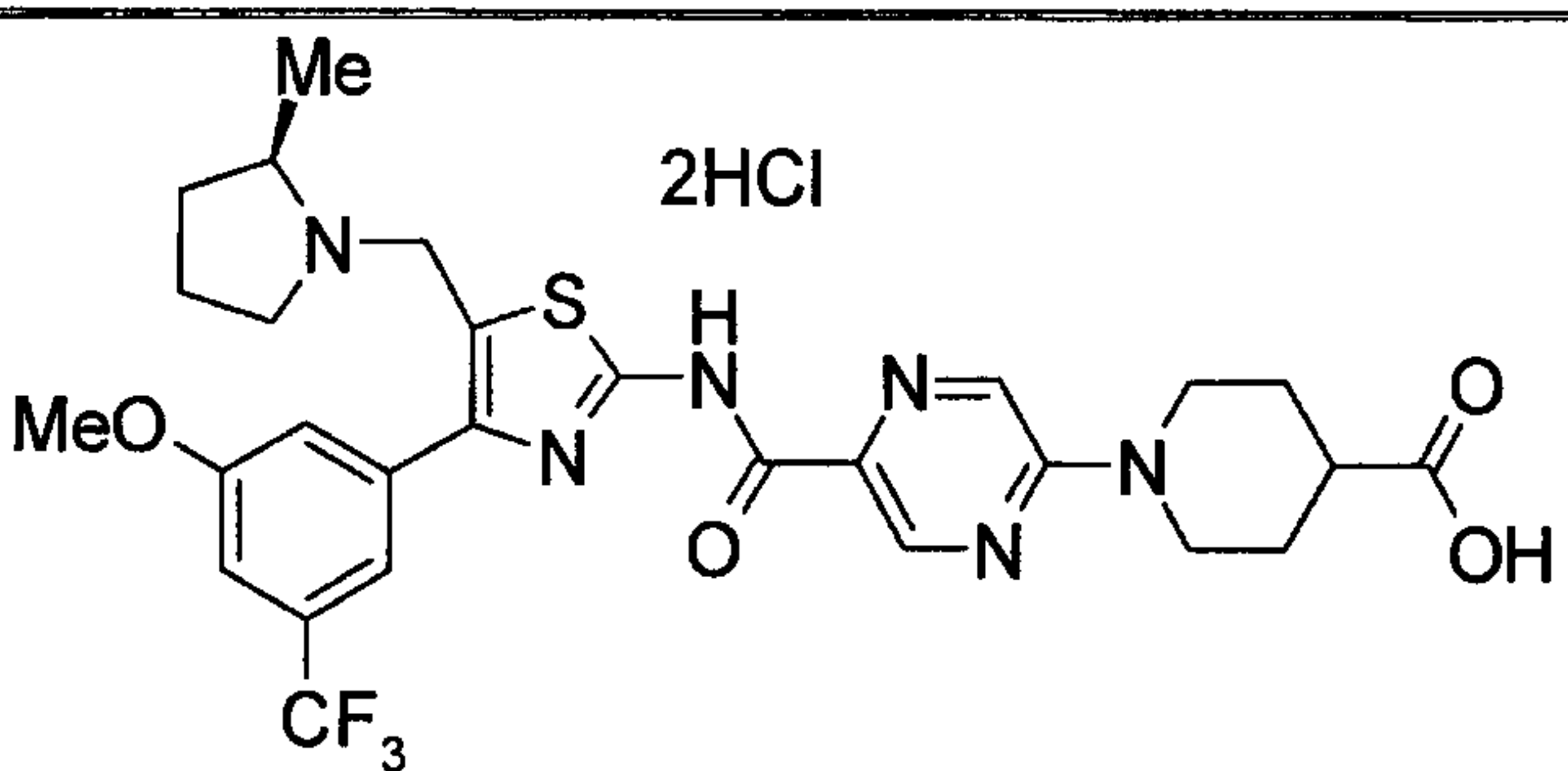
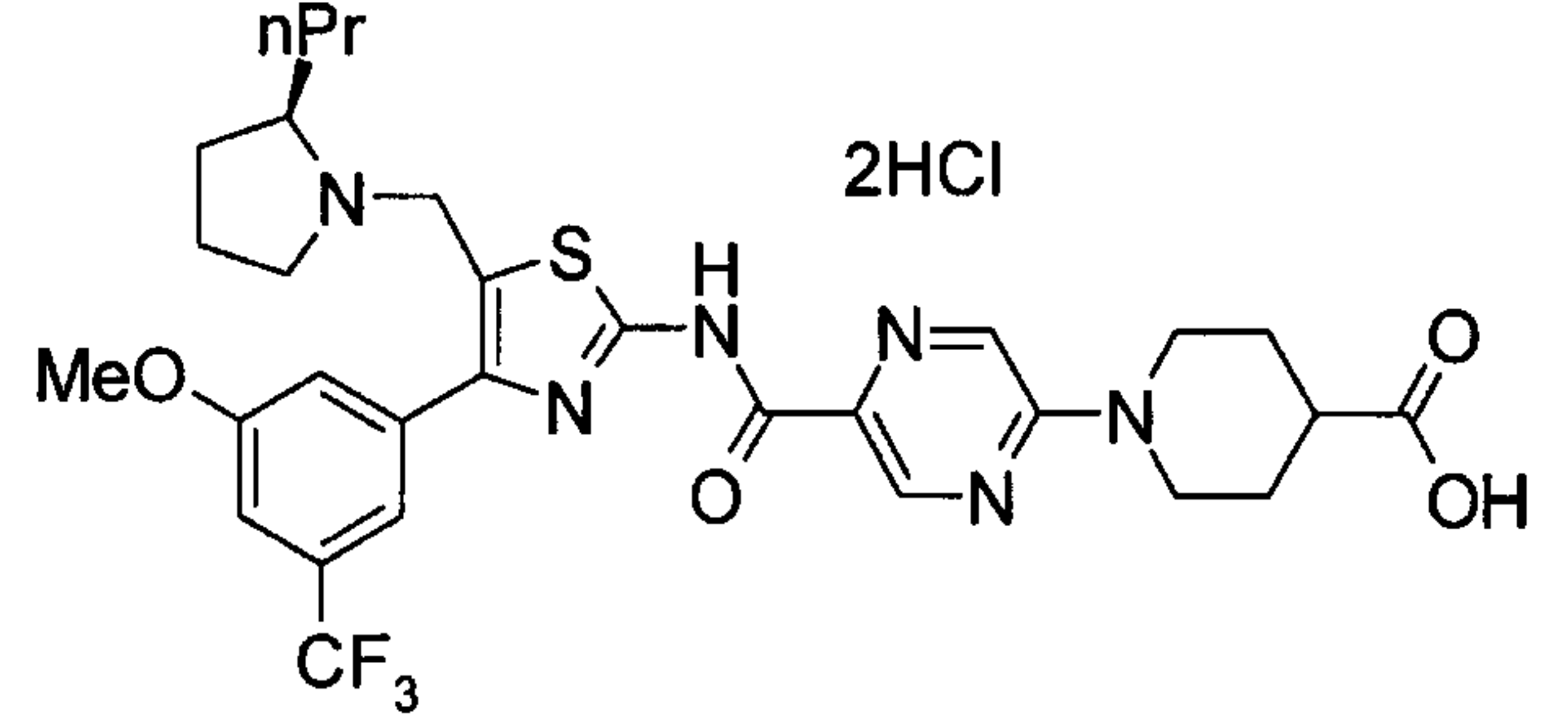
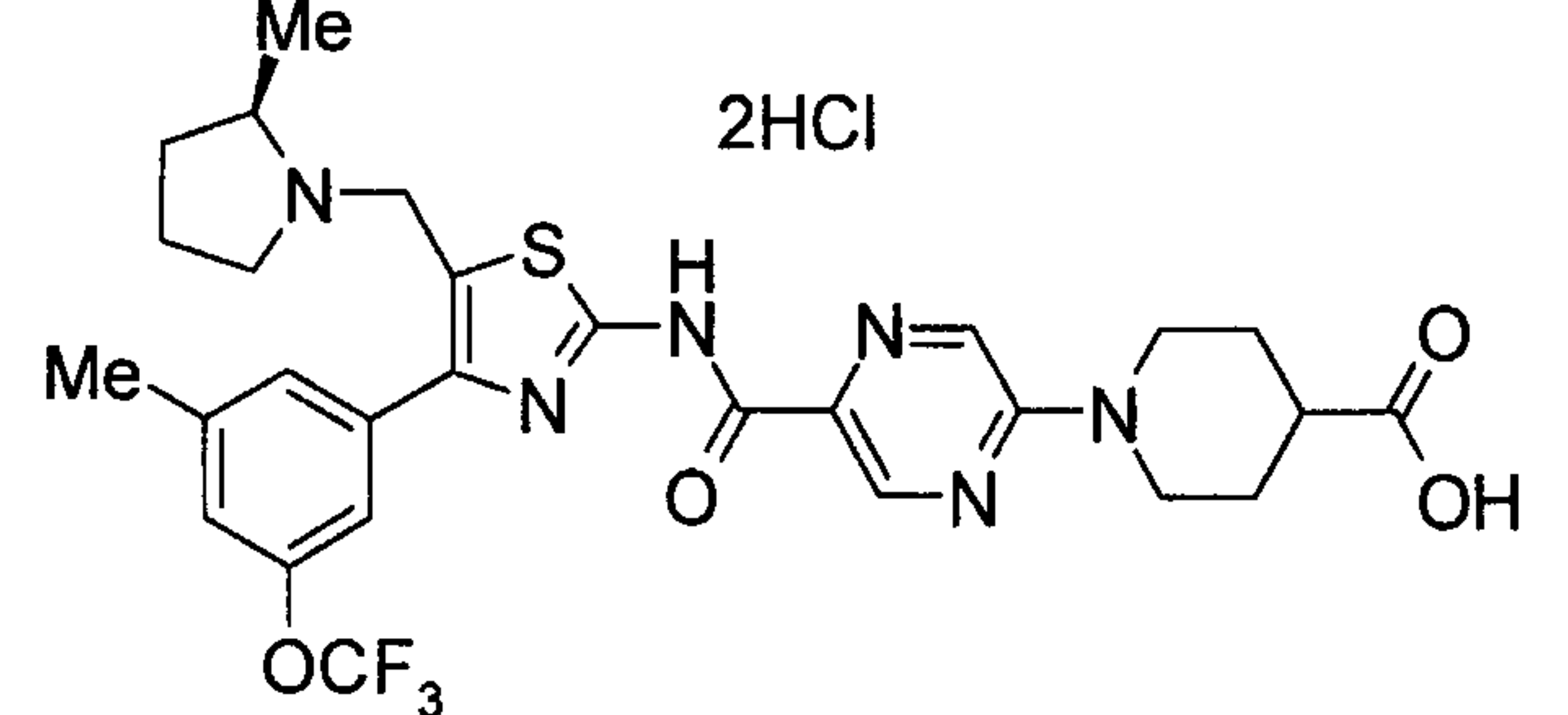
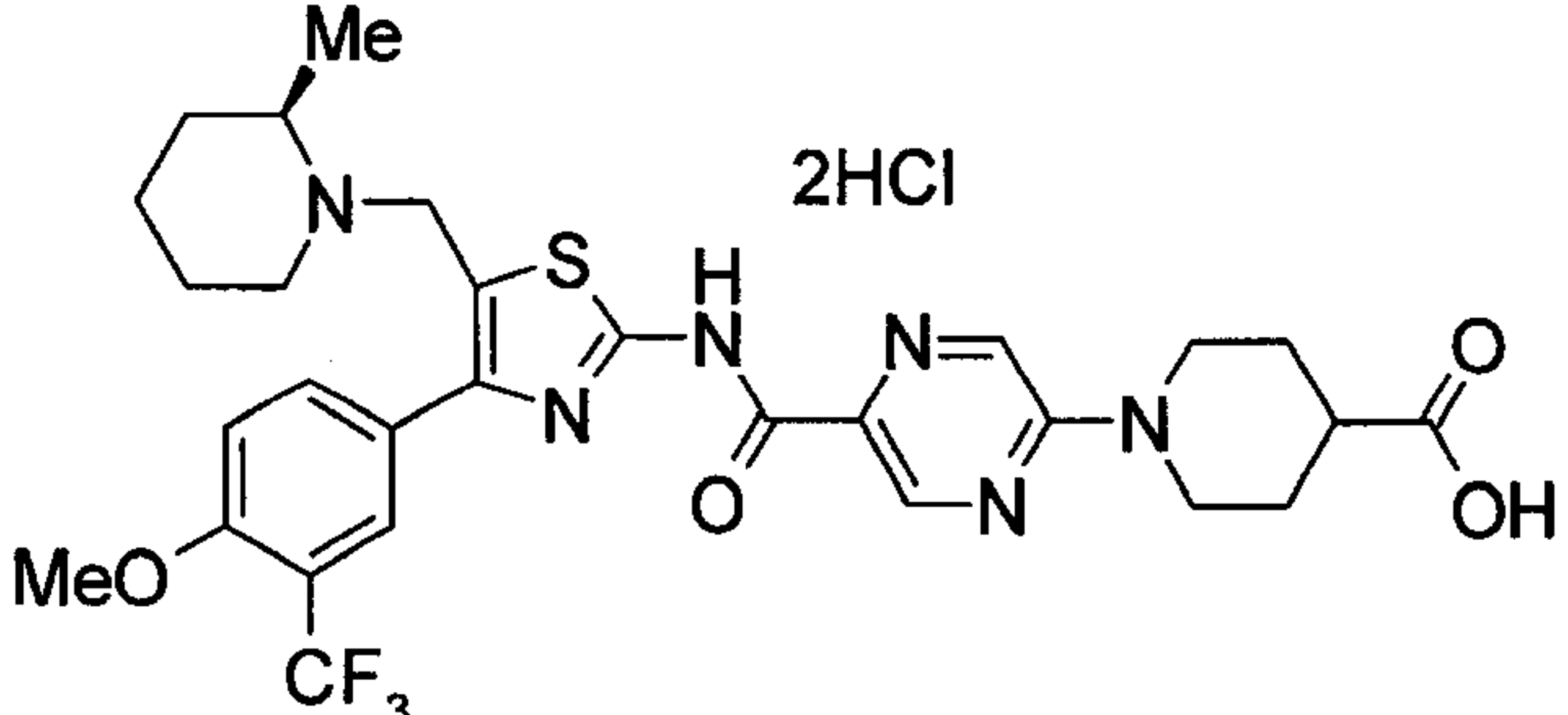
[0231]

[Table 70]

Ex	Str
156	
157	
158	
159	

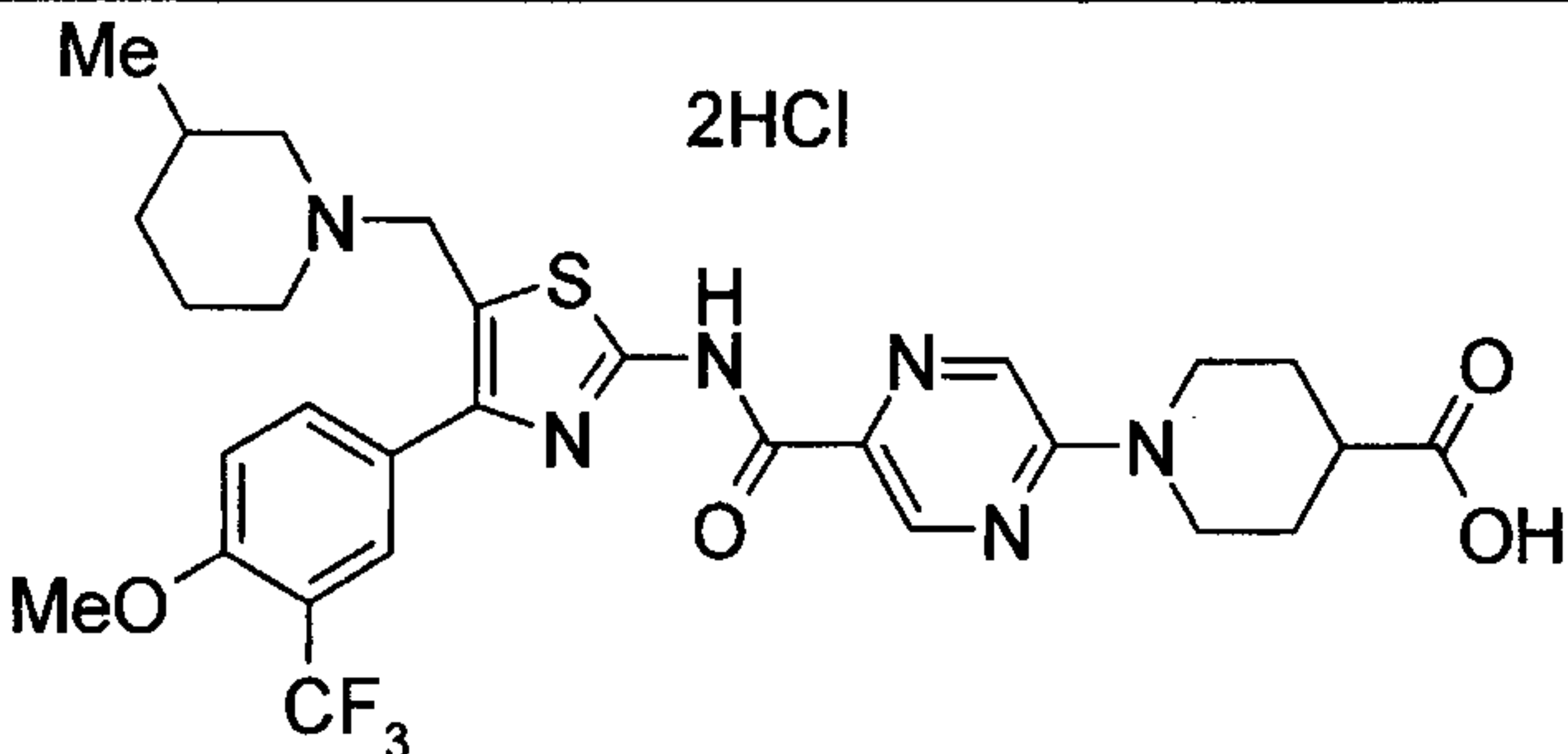
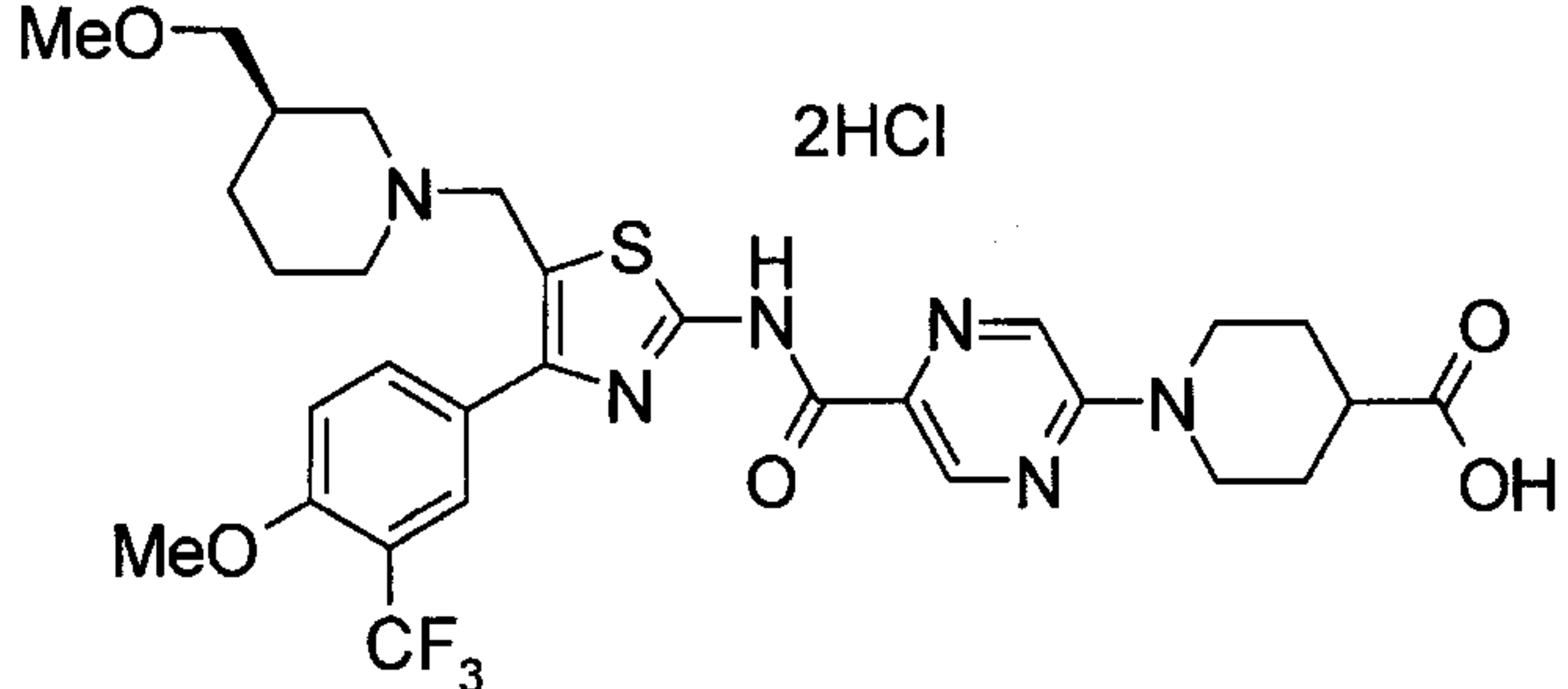
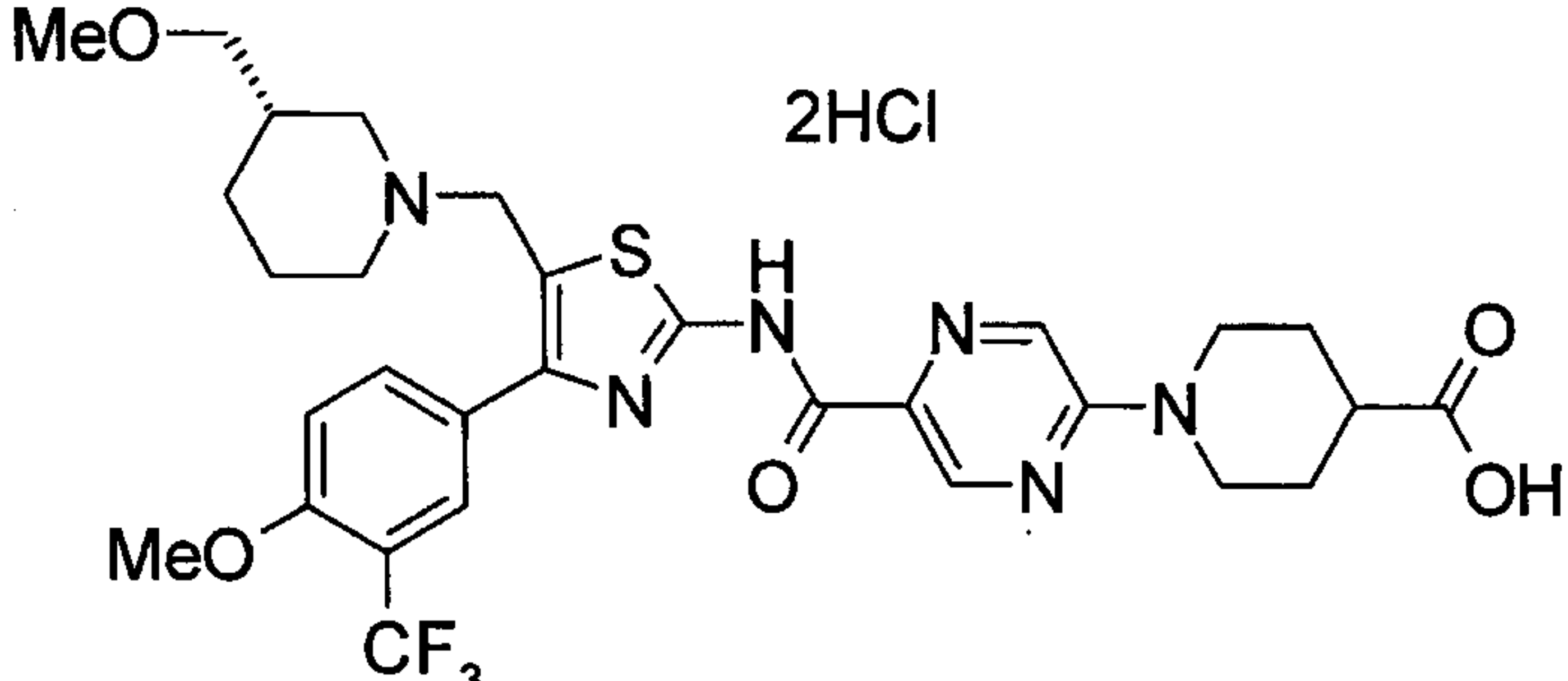
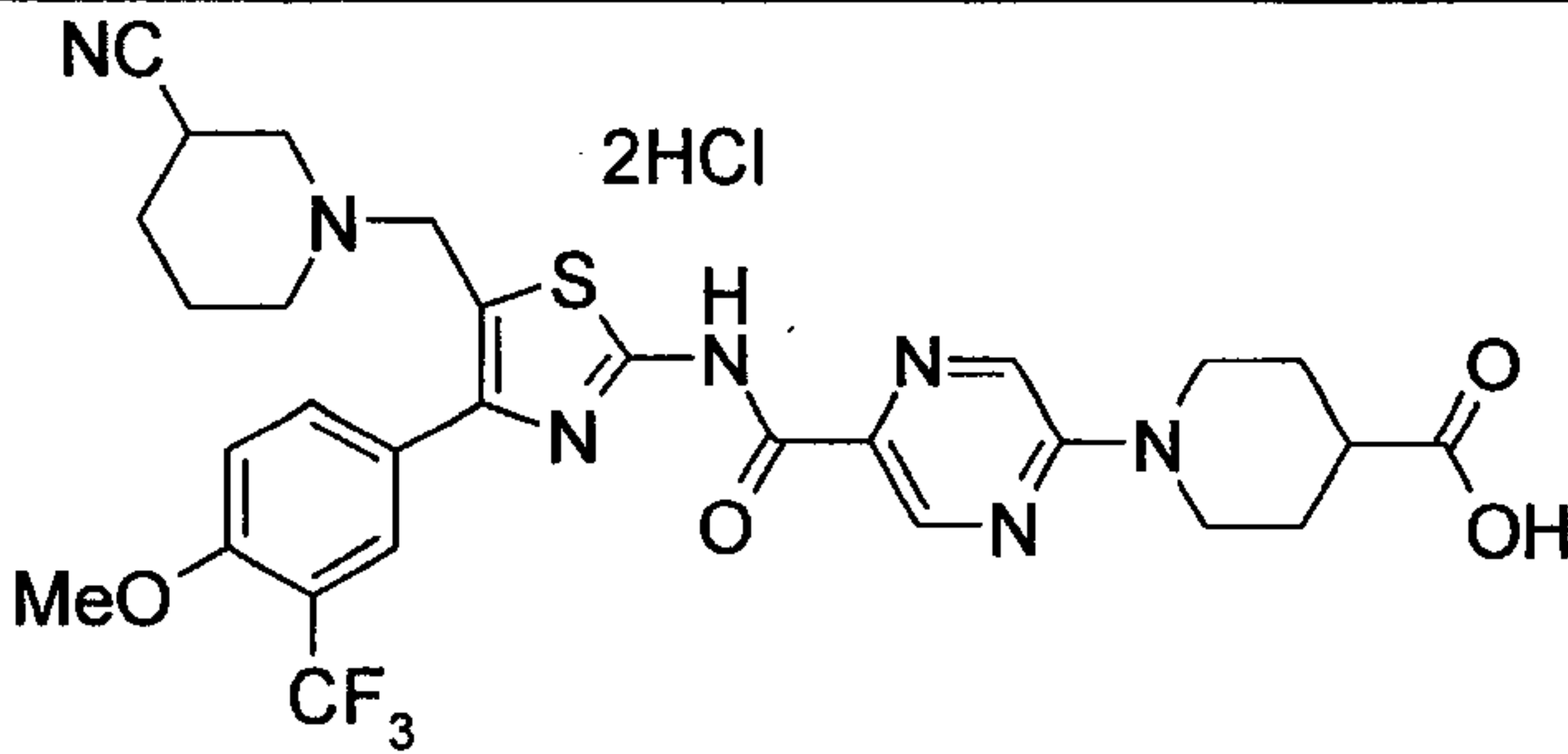
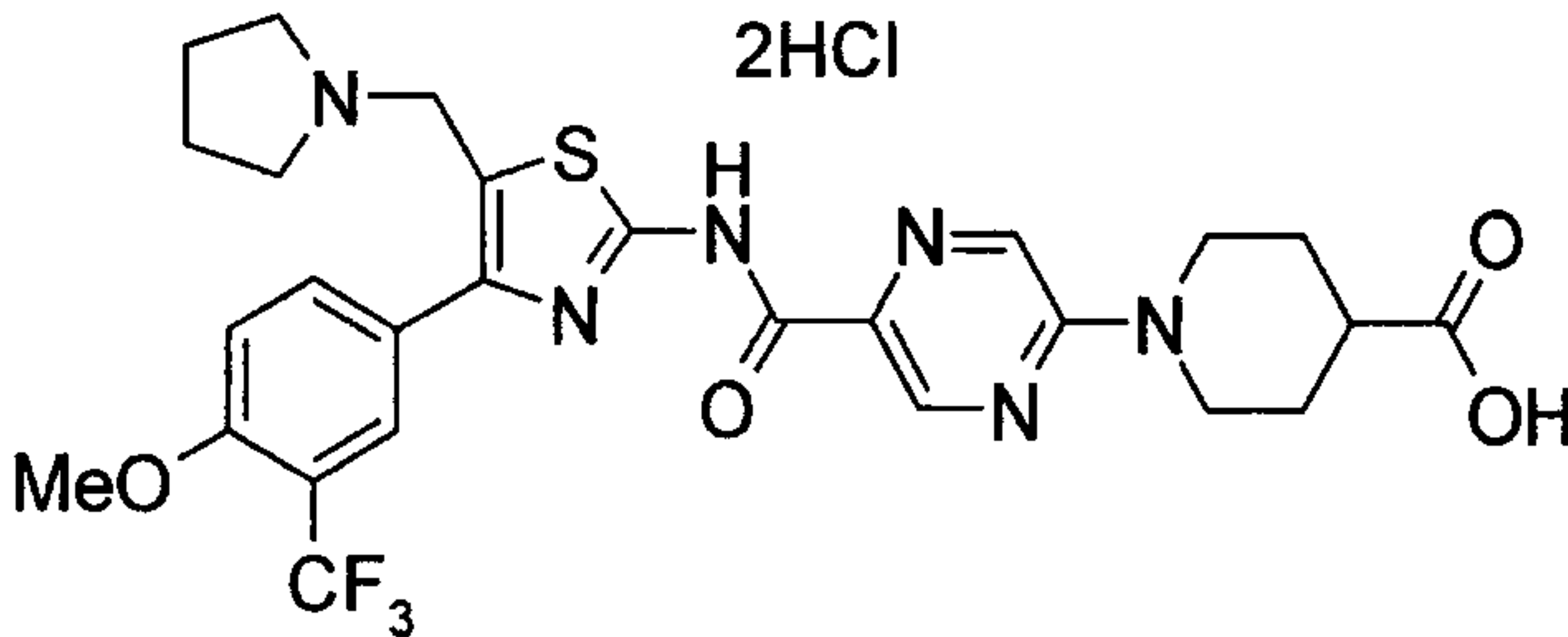
[0232]

[Table 71]

Ex	Str
160	
161	
162	
163	

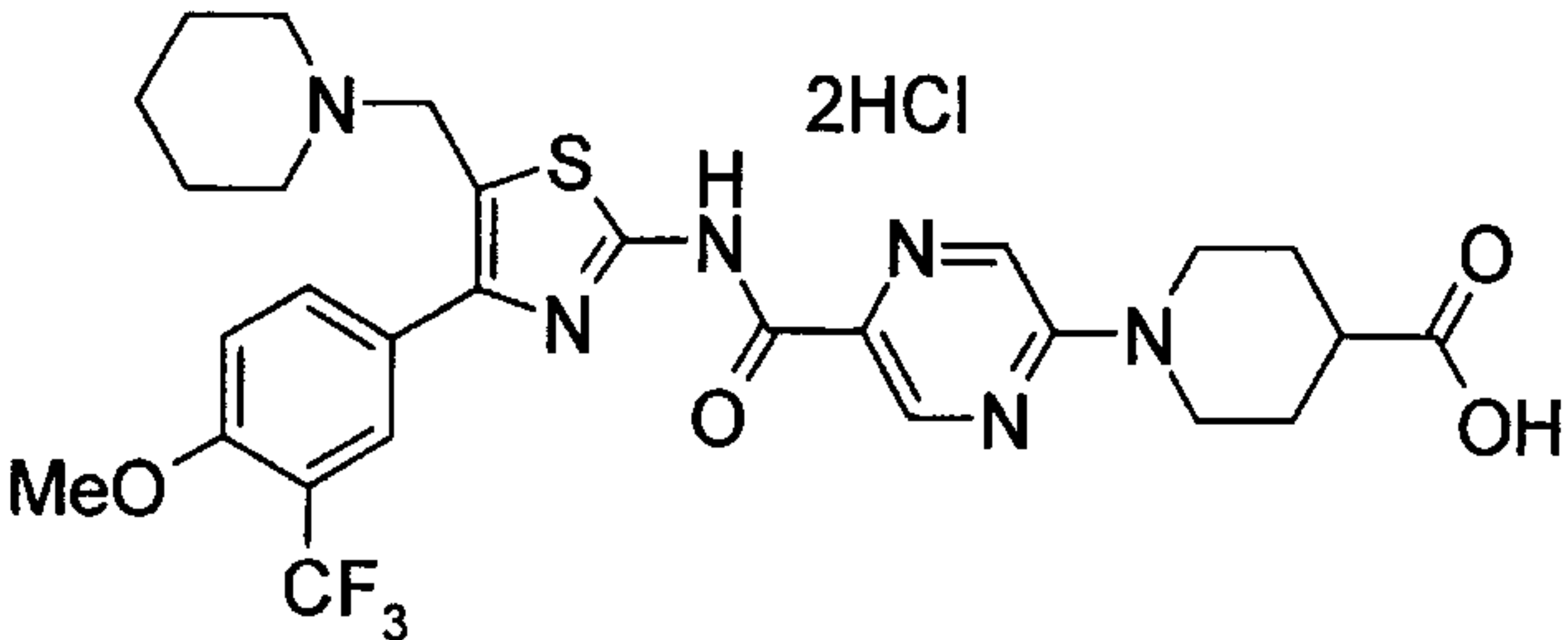
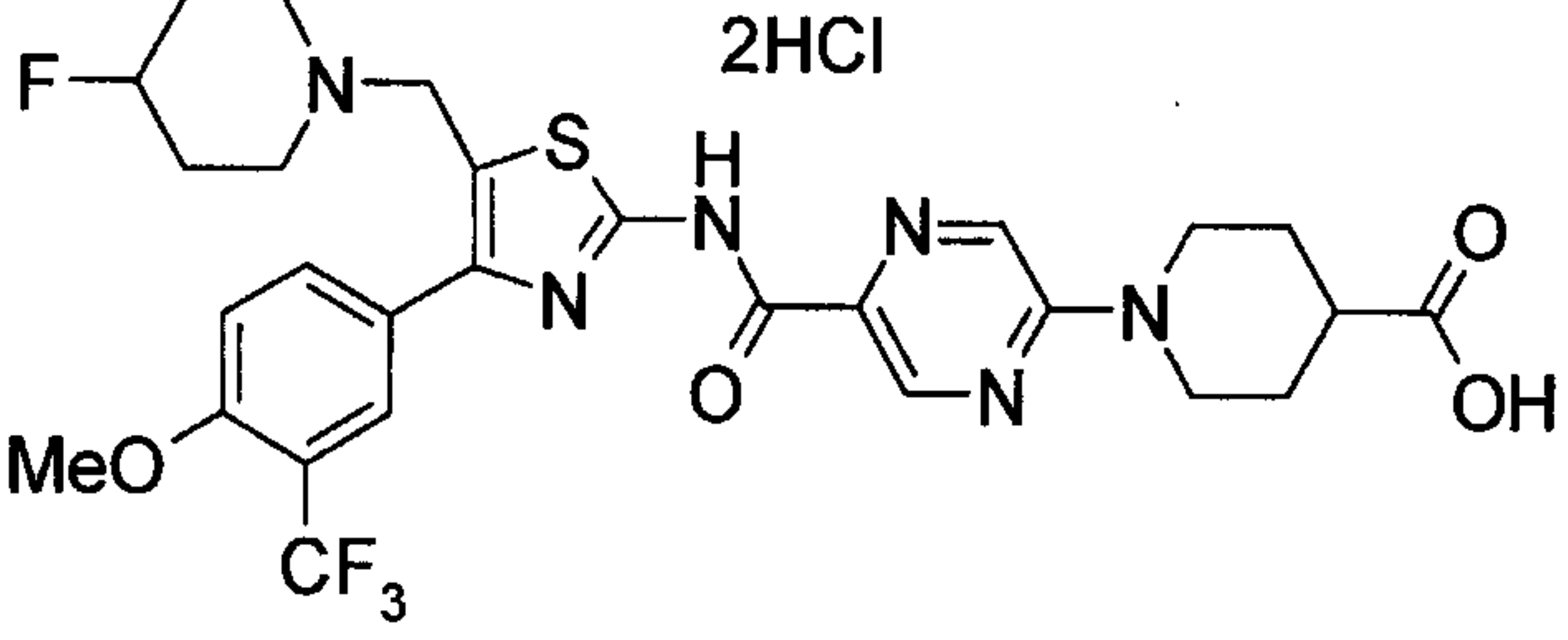
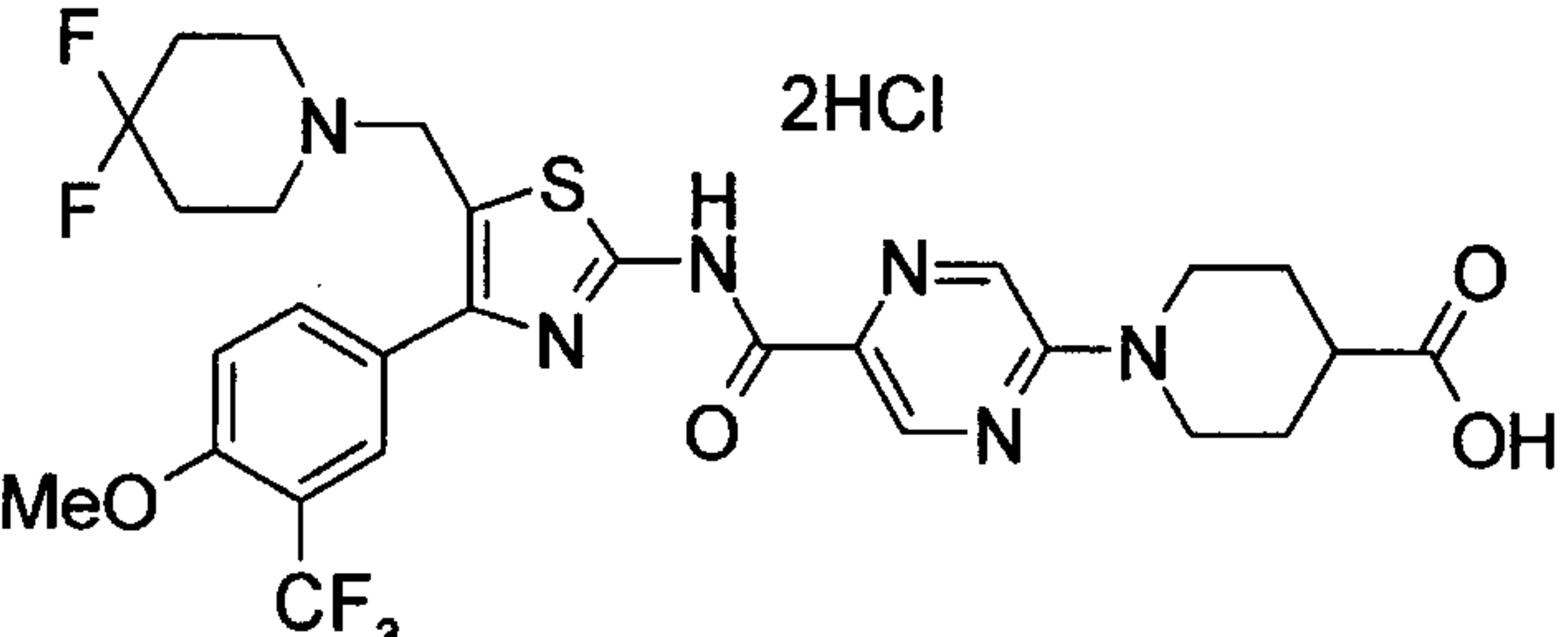
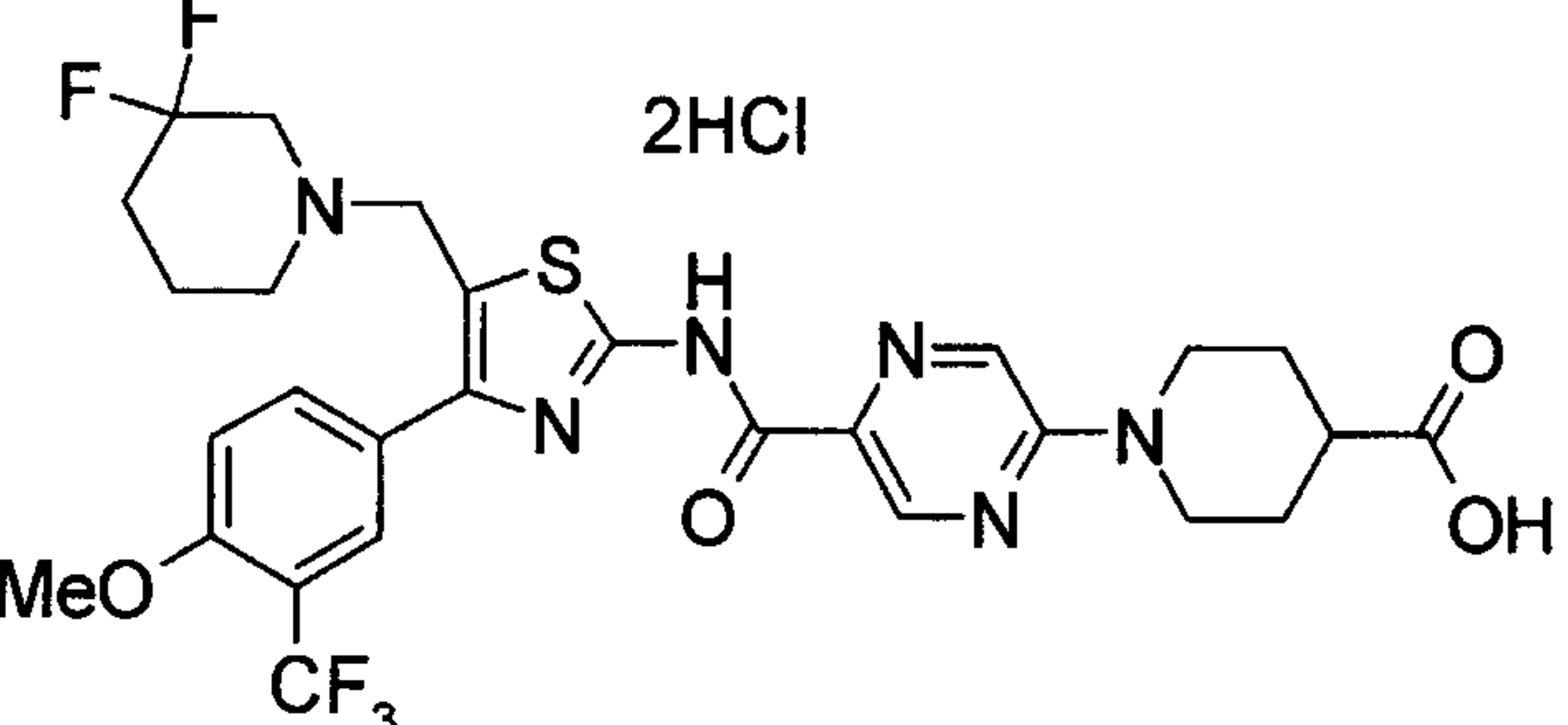
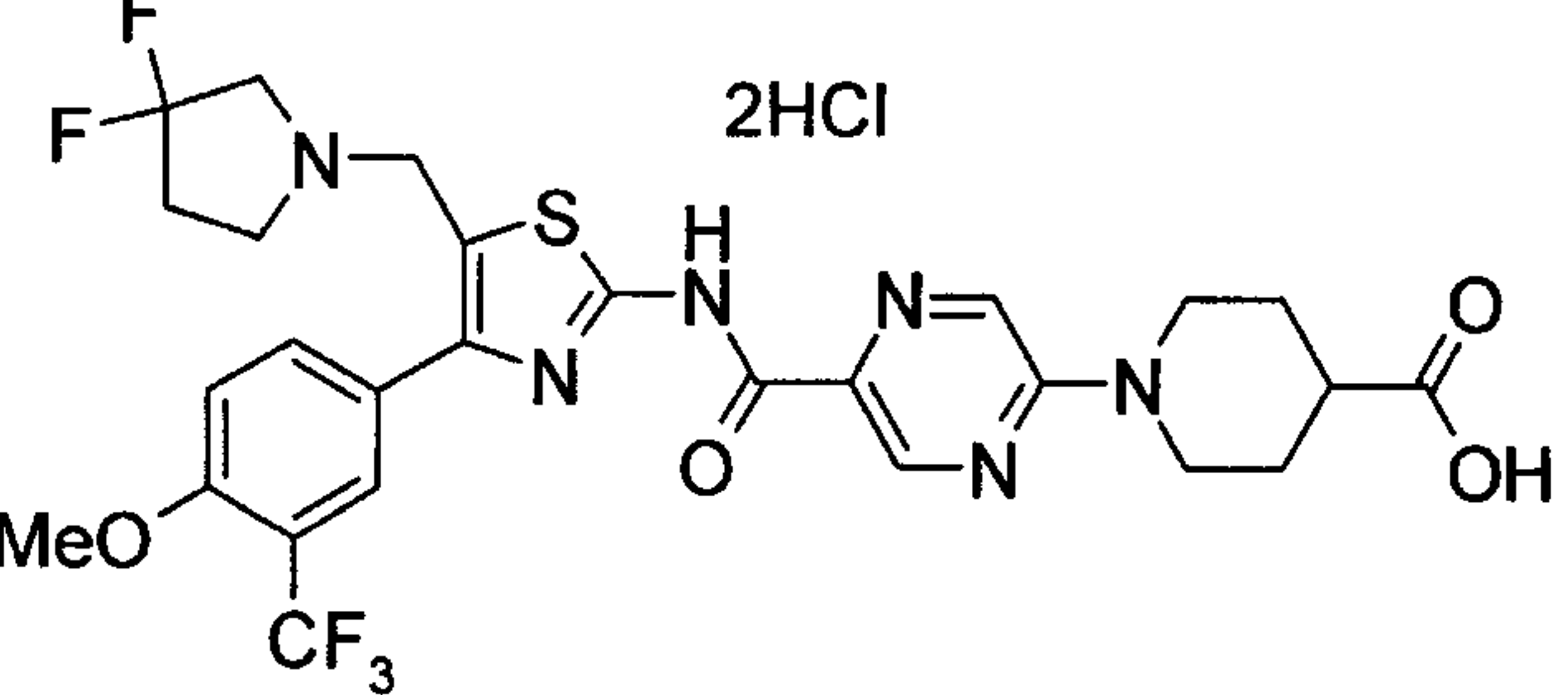
[0233]

[Table 72]

Ex	Str
164	
165	
166	
167	
168	

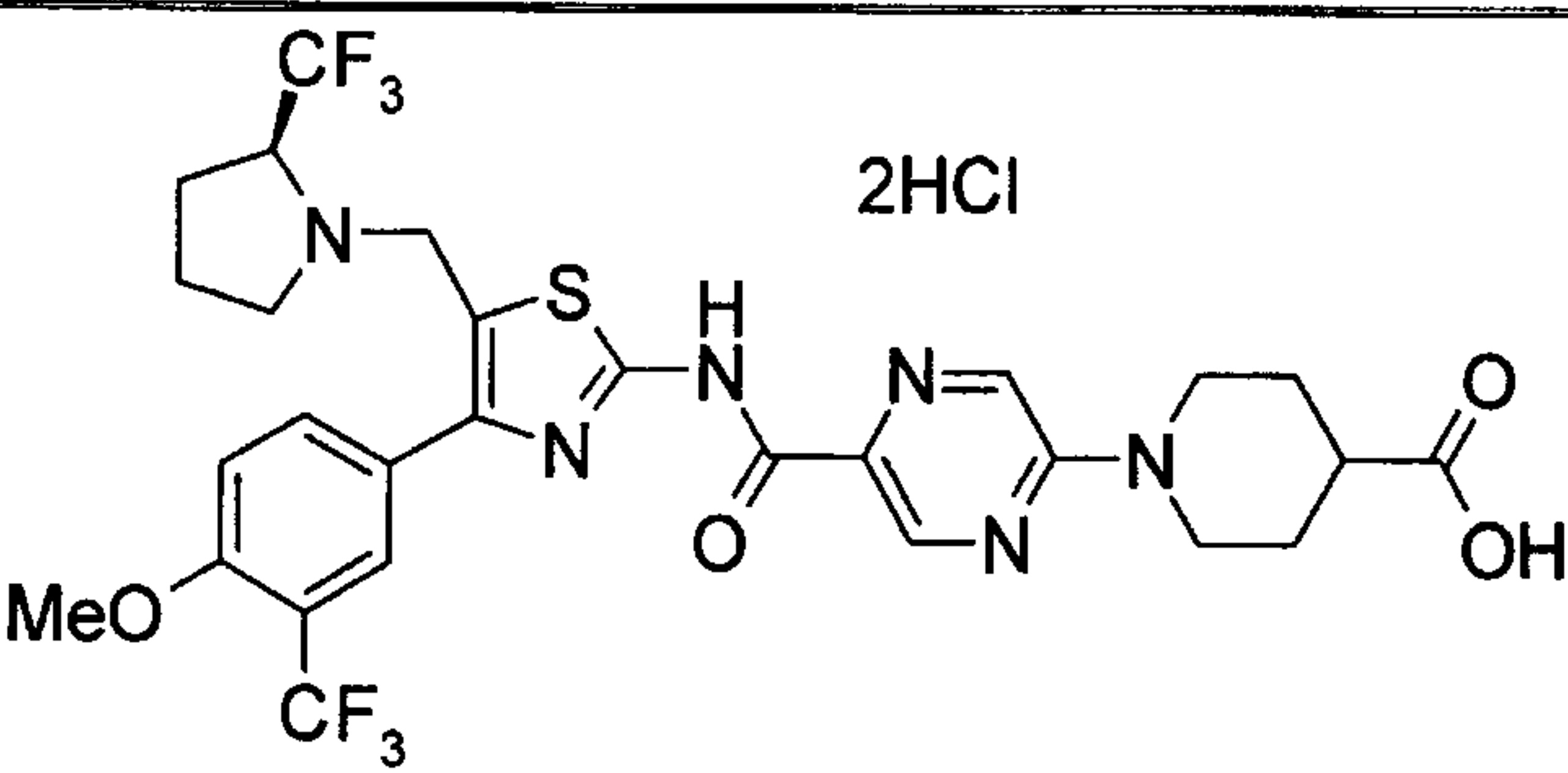
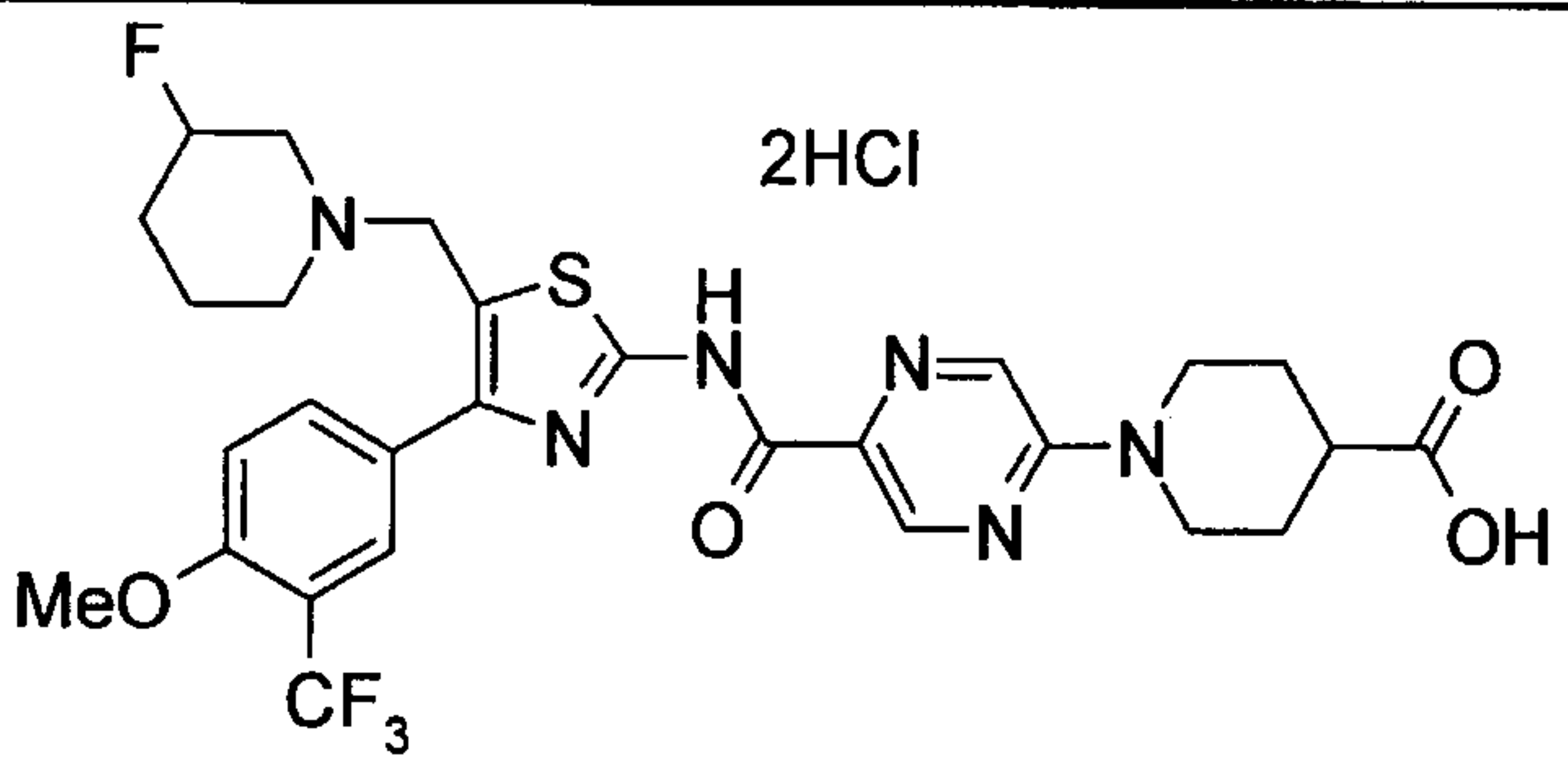
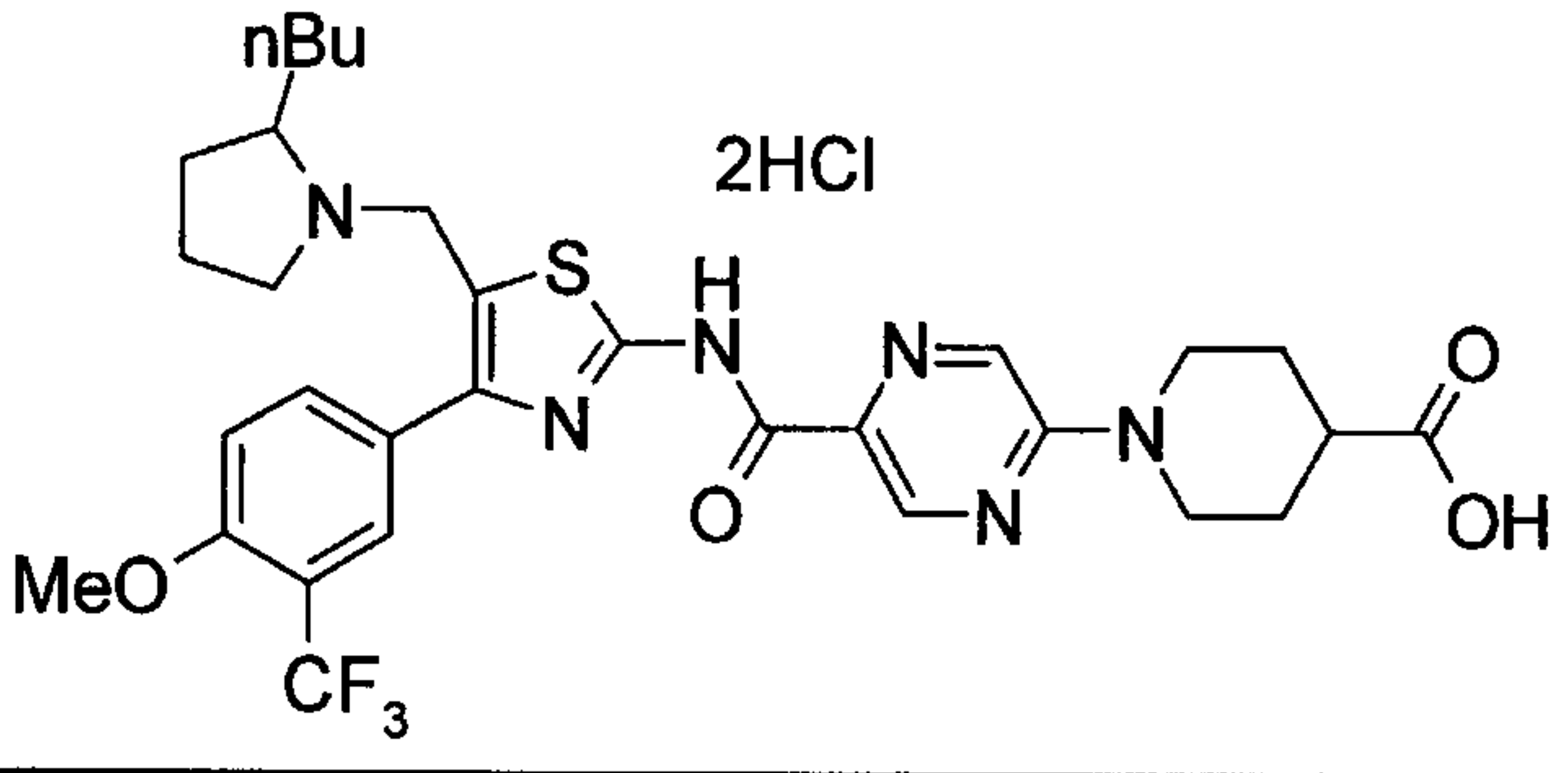
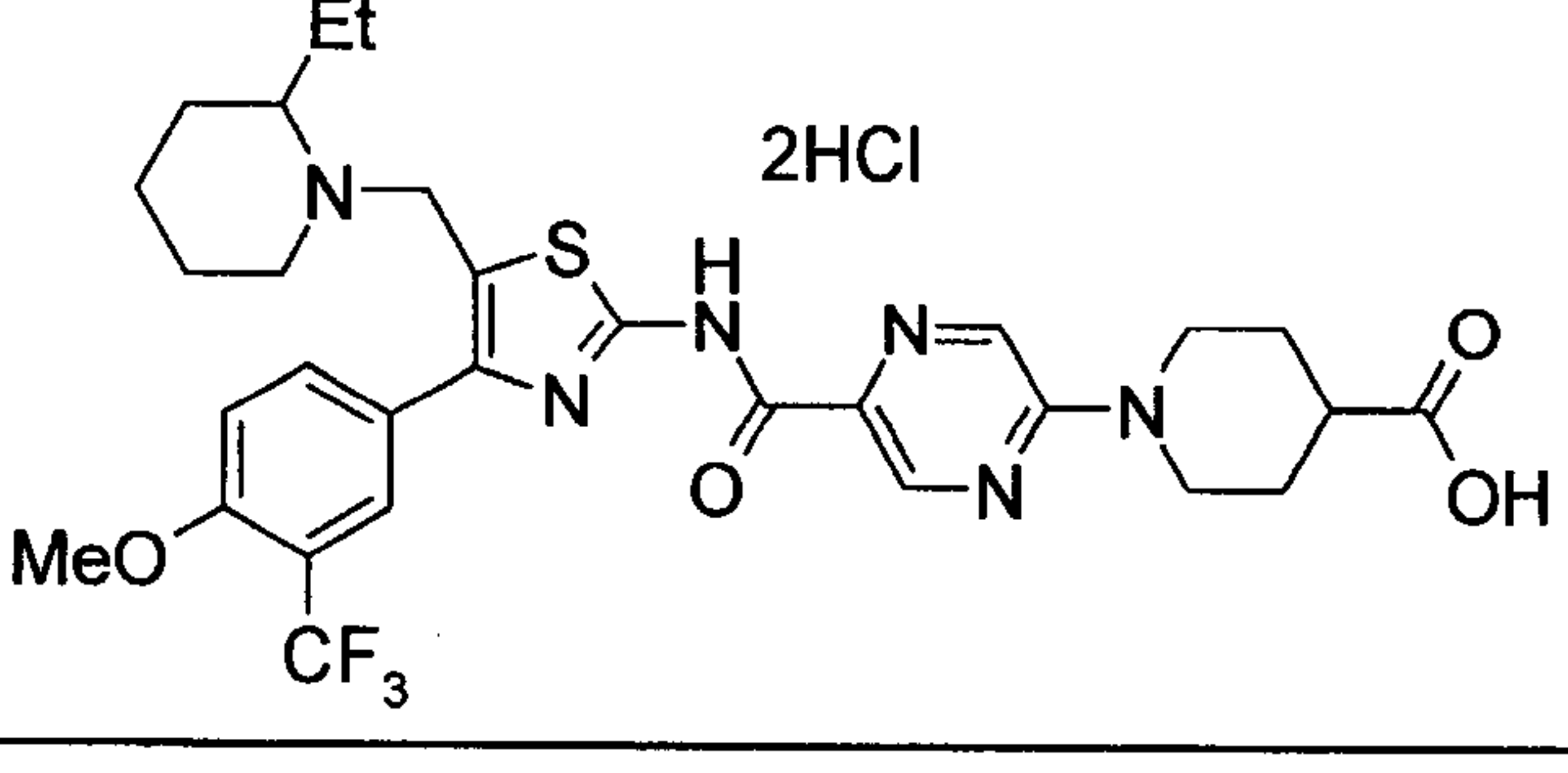
[0234]

[Table 73]

Ex	Str
169	
170	
171	
172	
173	

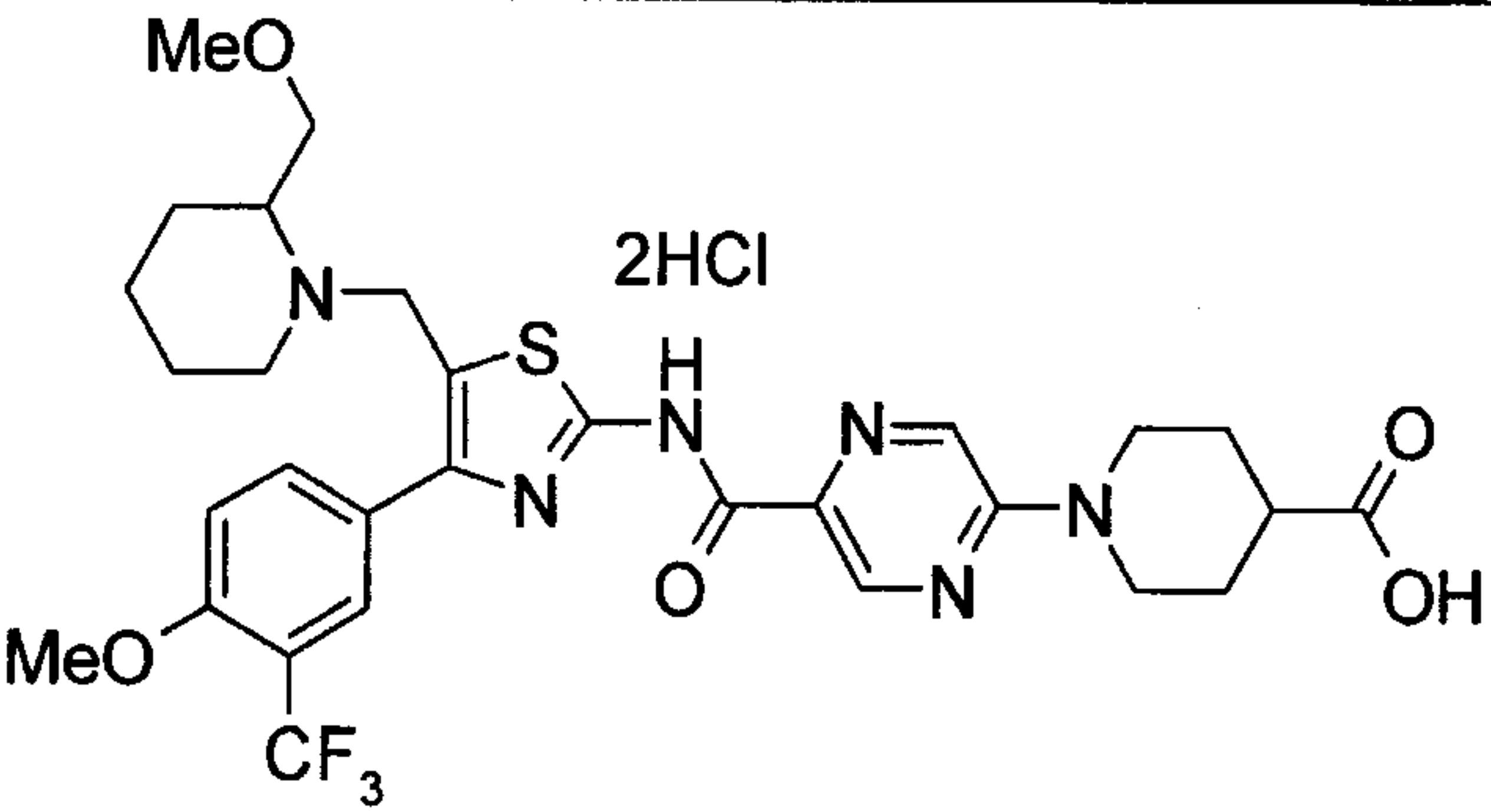
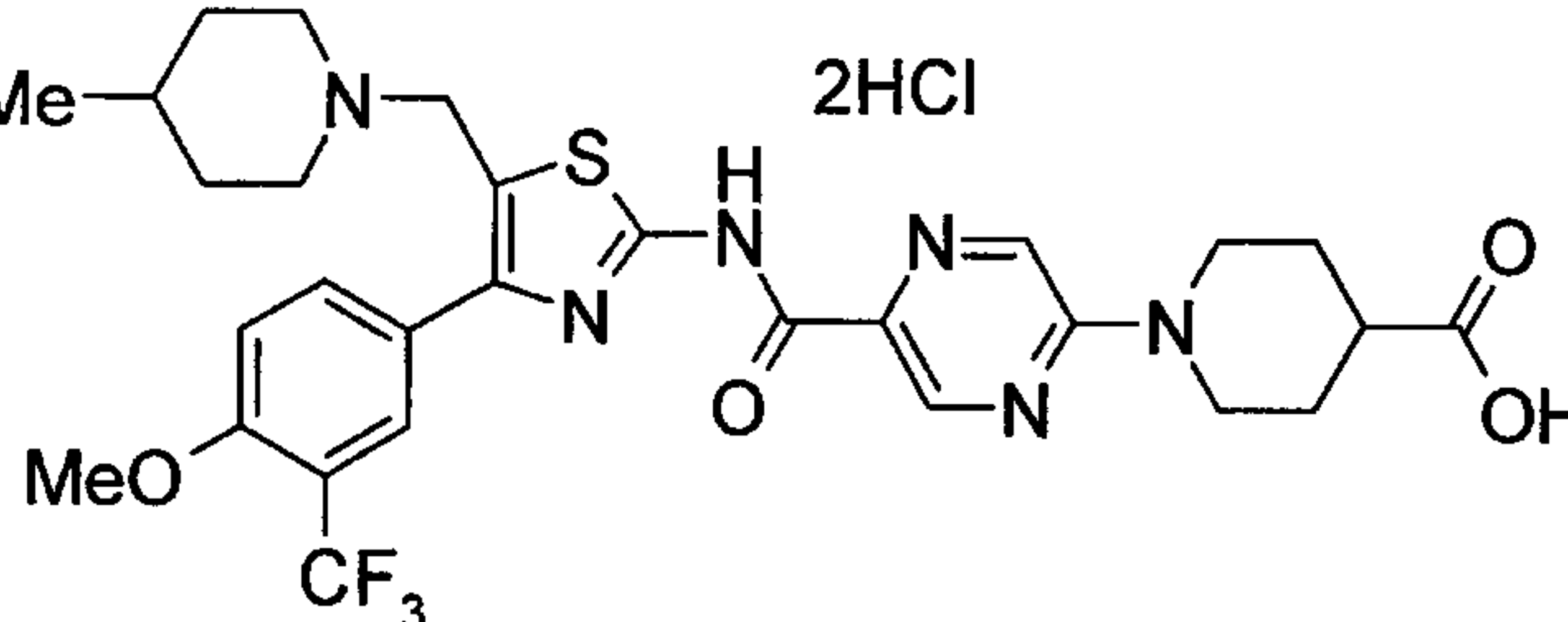
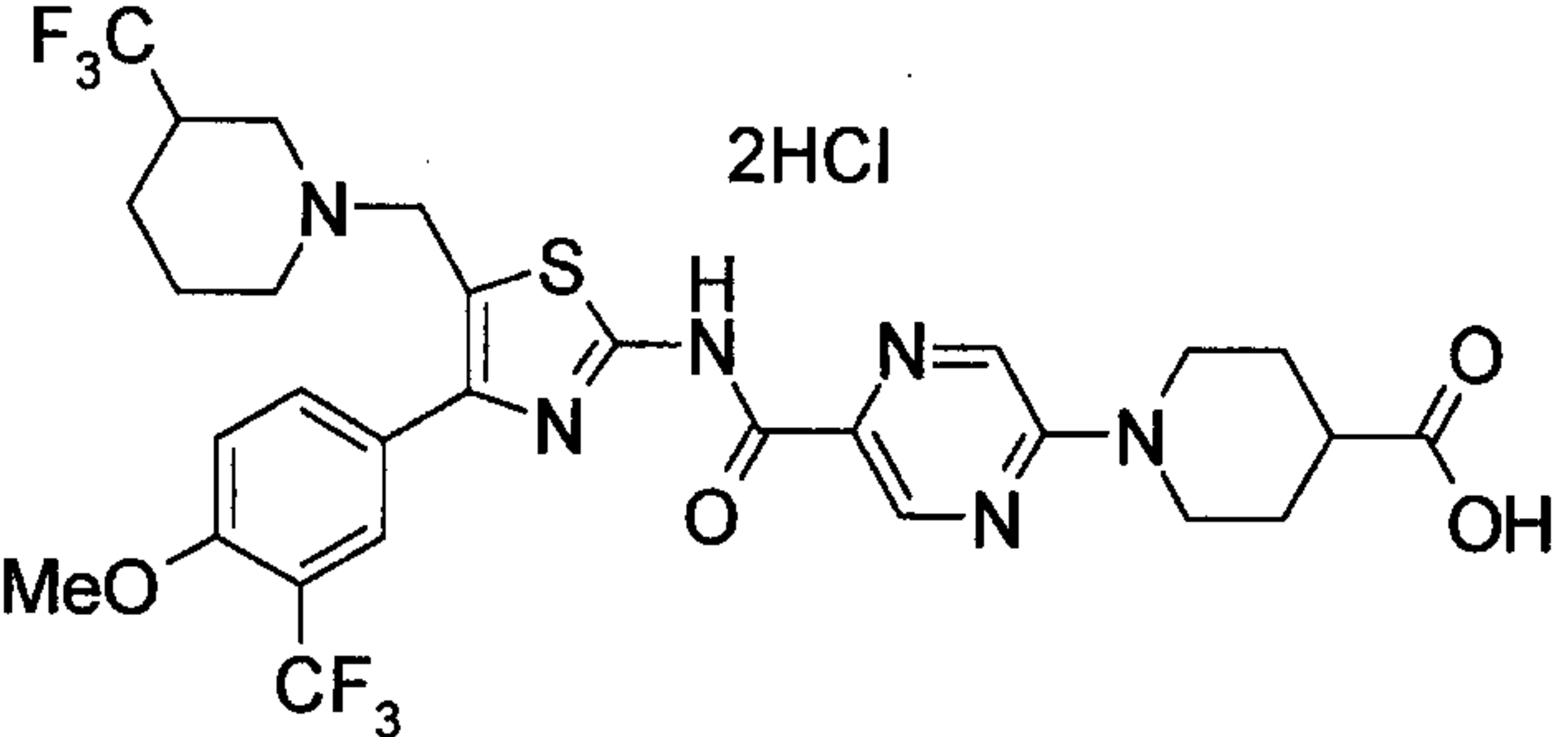
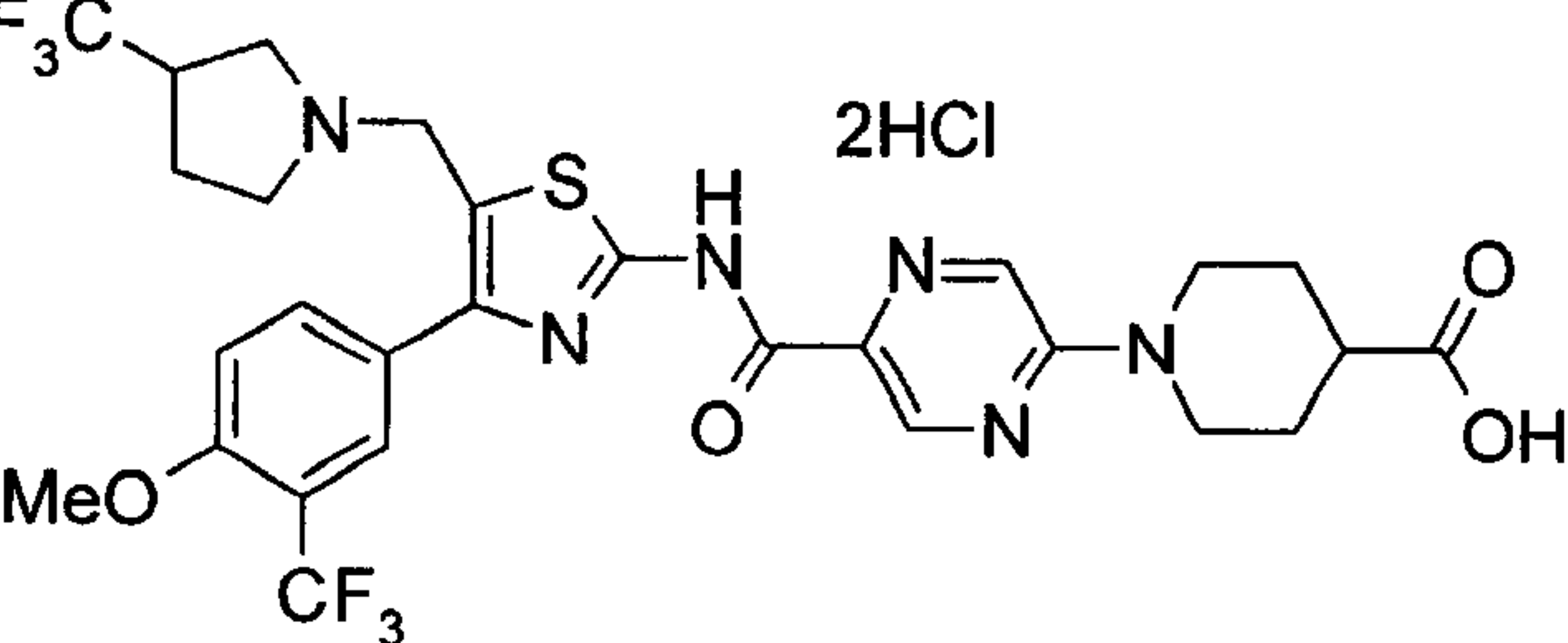
[0236]

[Table 75]

Ex	Str
179	
180	
181	
182	

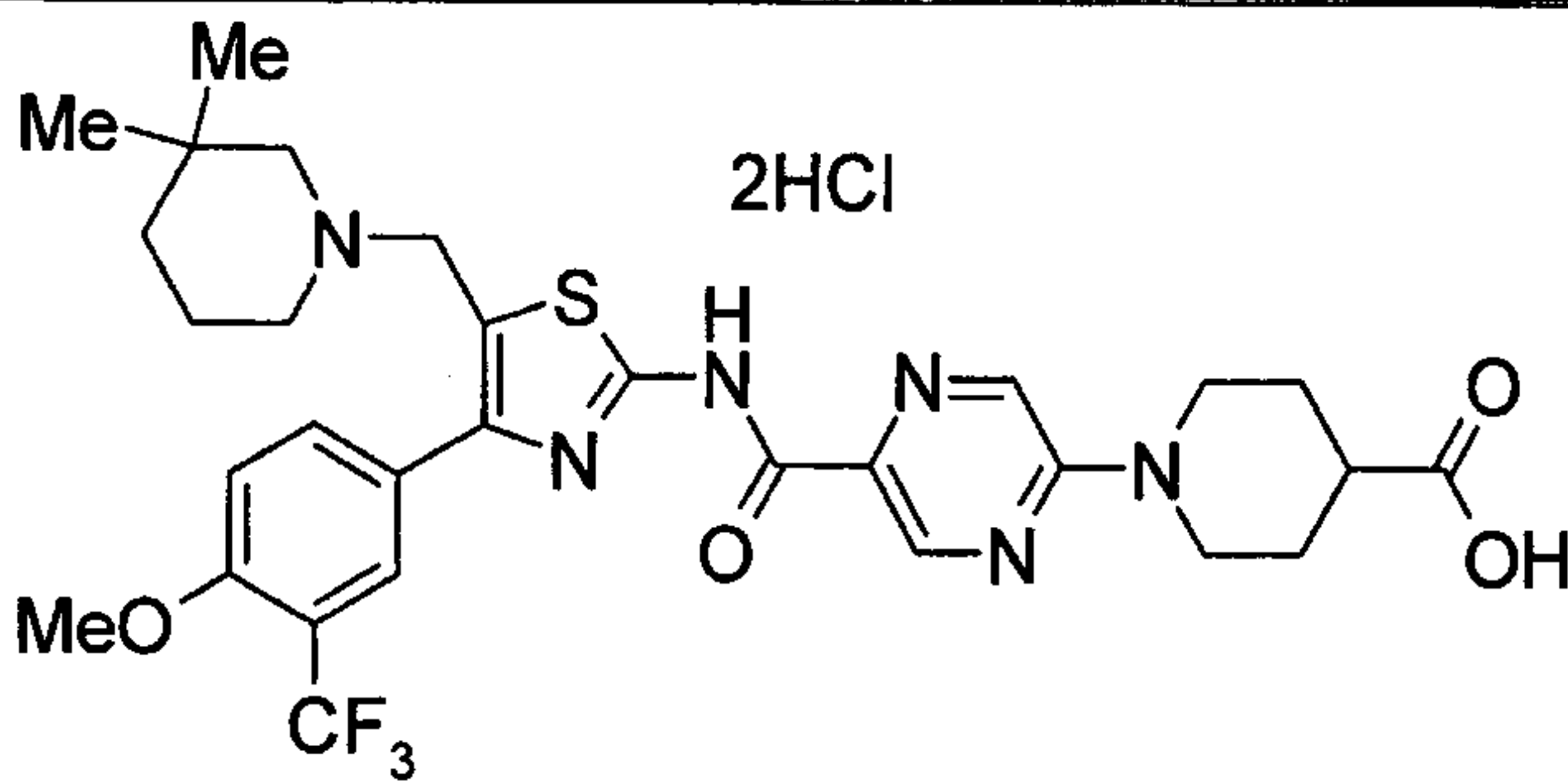
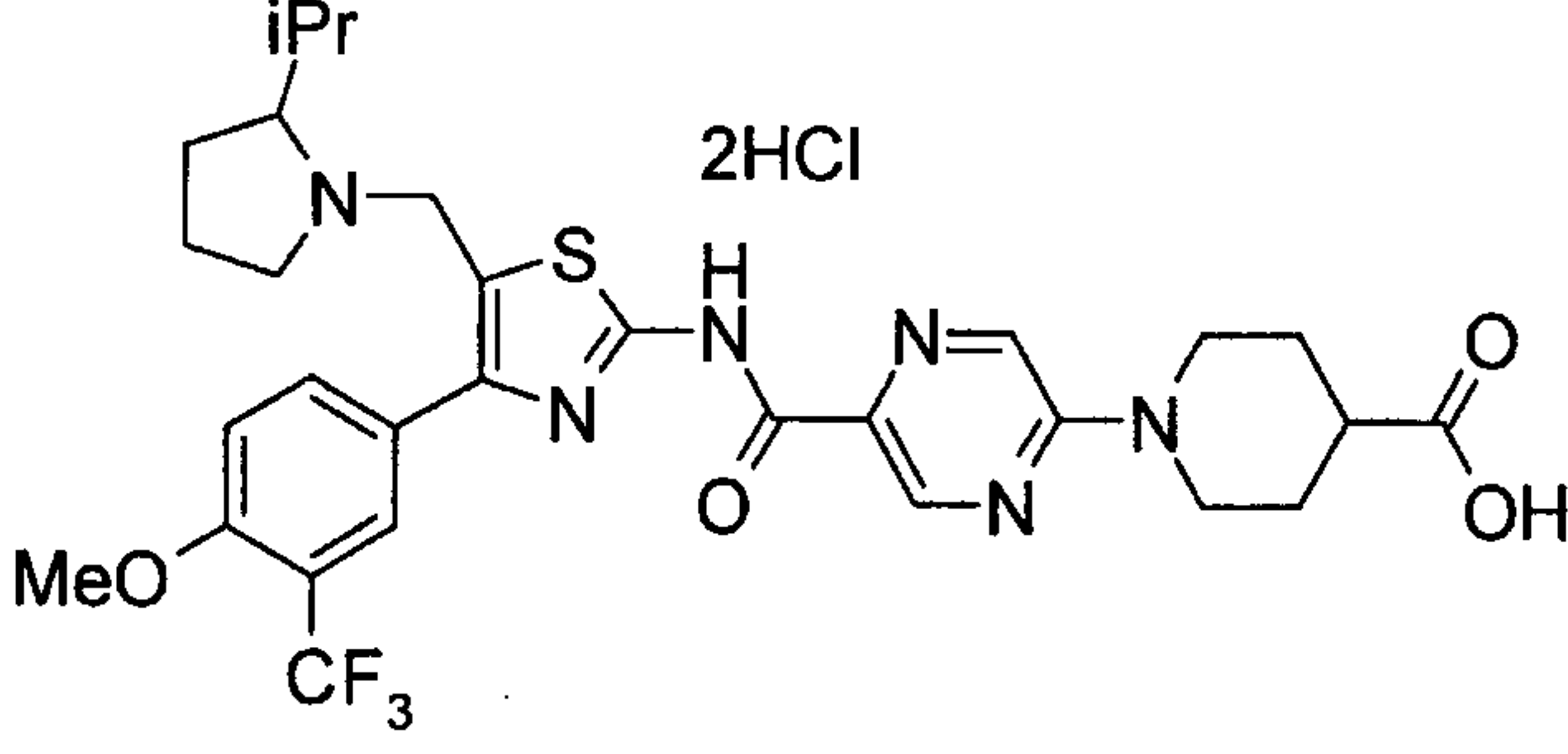
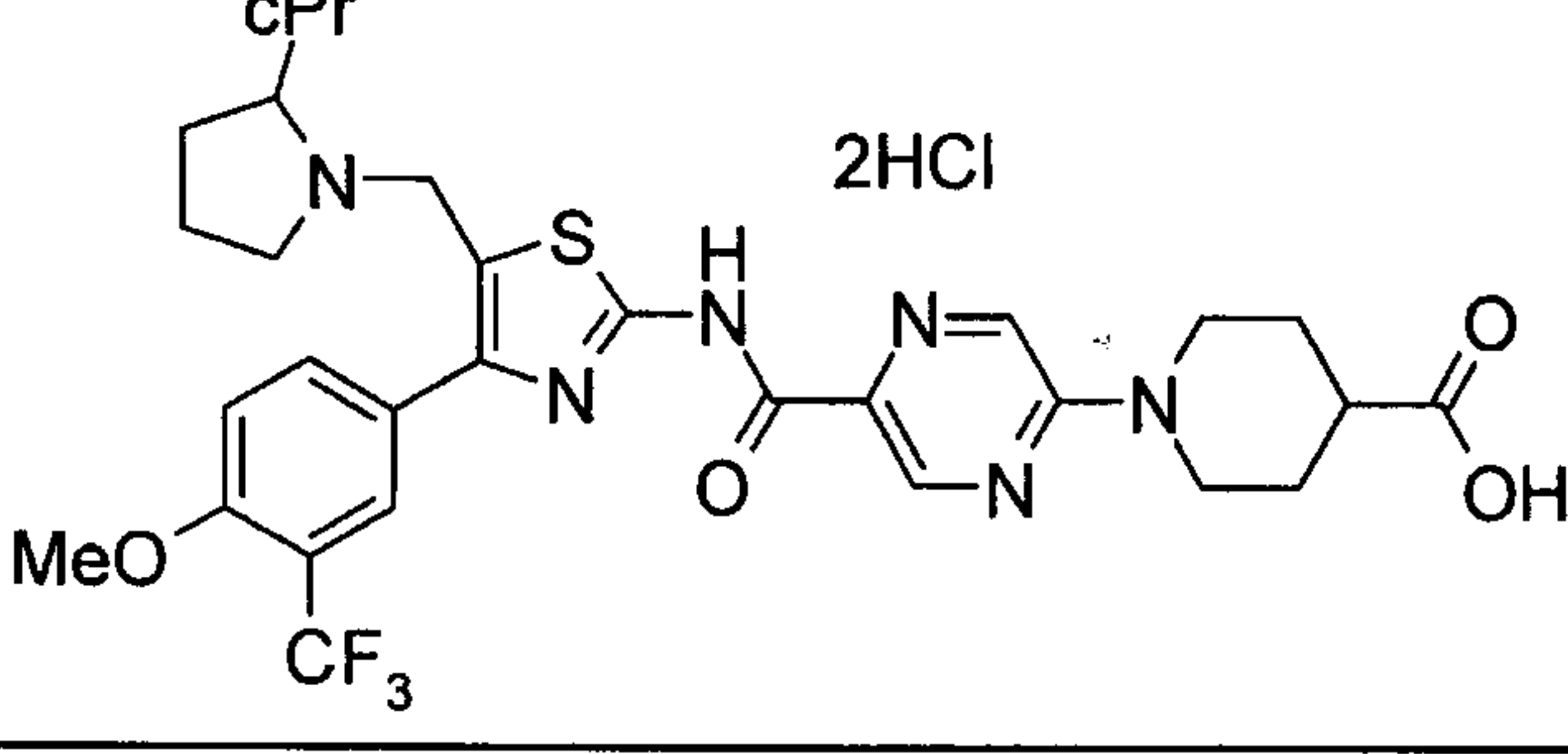
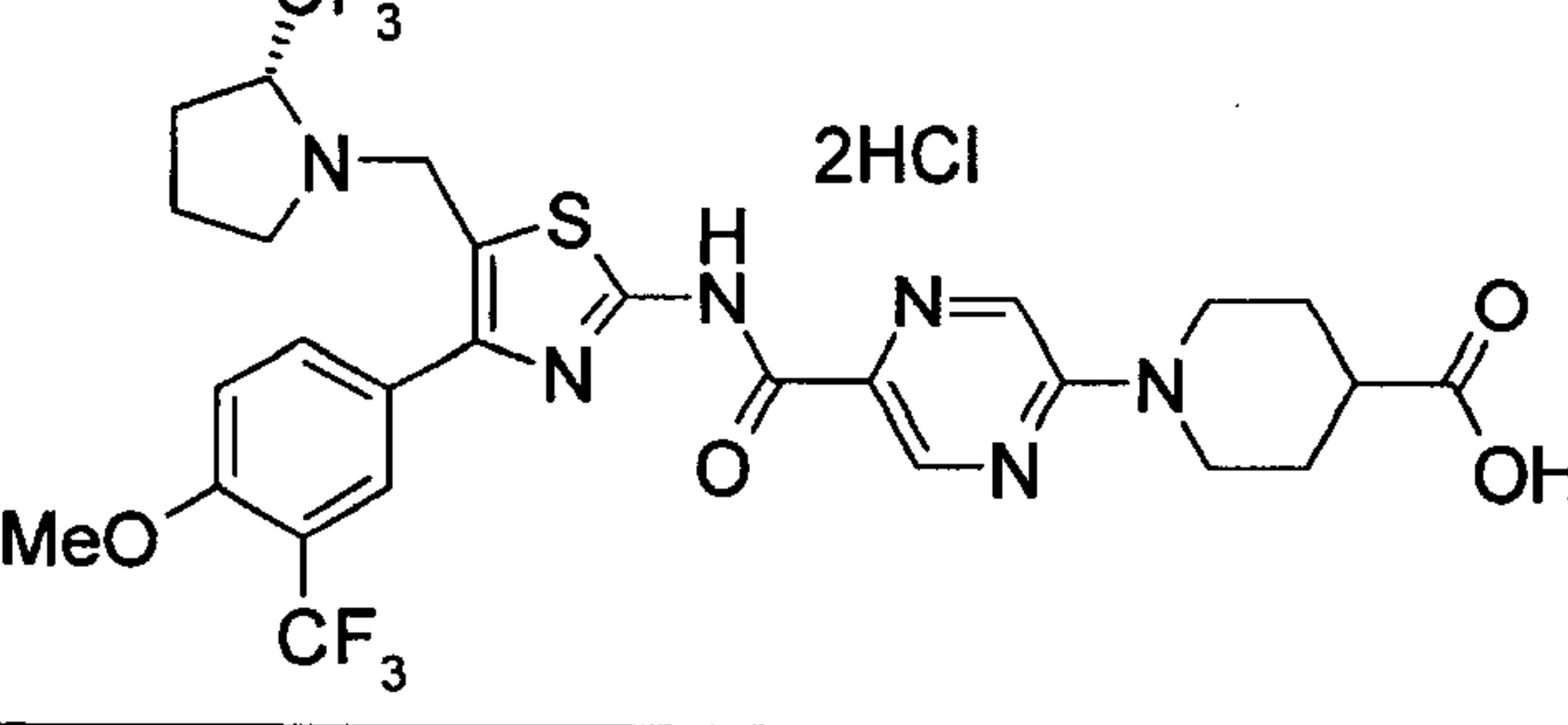
[0237]

[Table 76]

Ex	Str
183	
184	
185	
186	

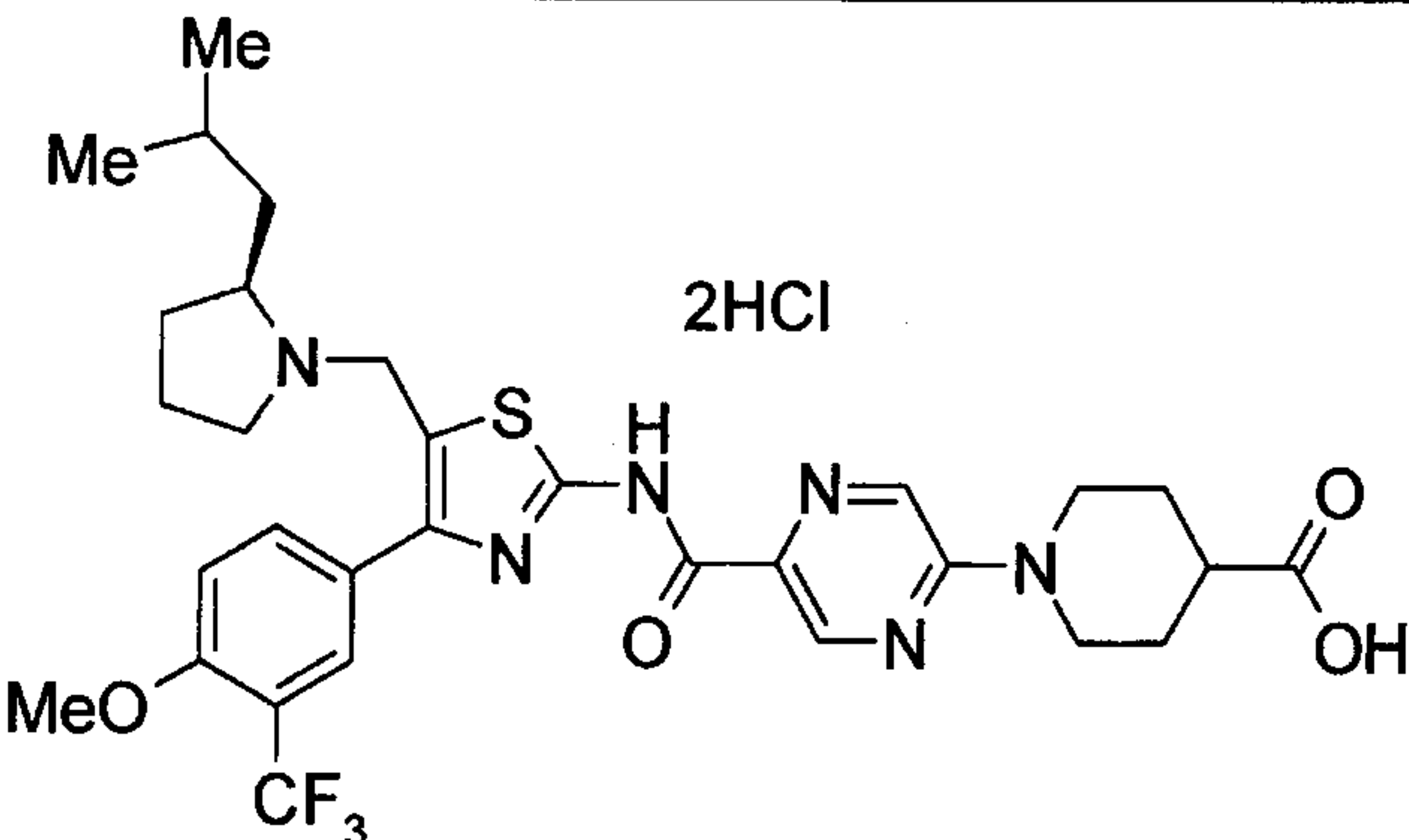
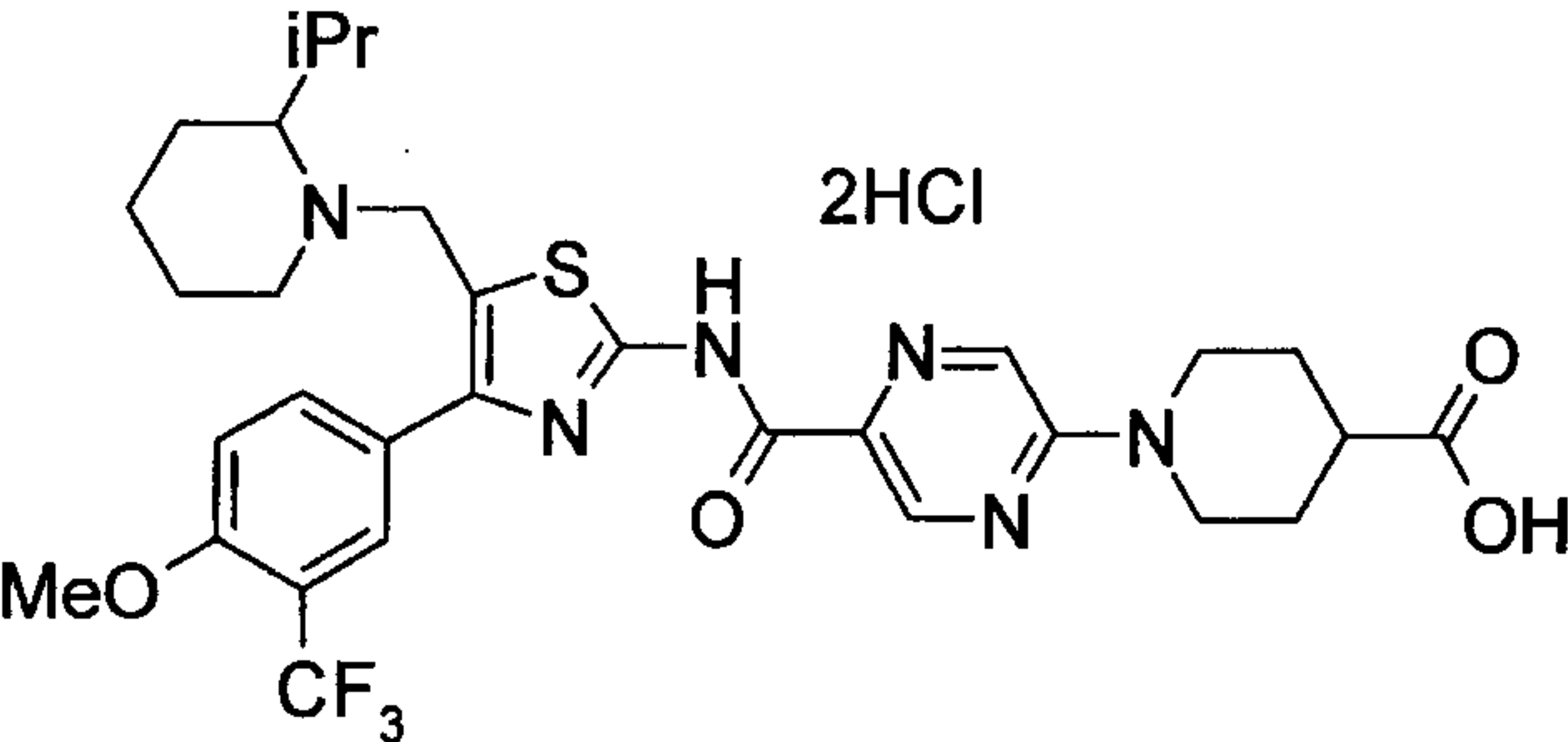
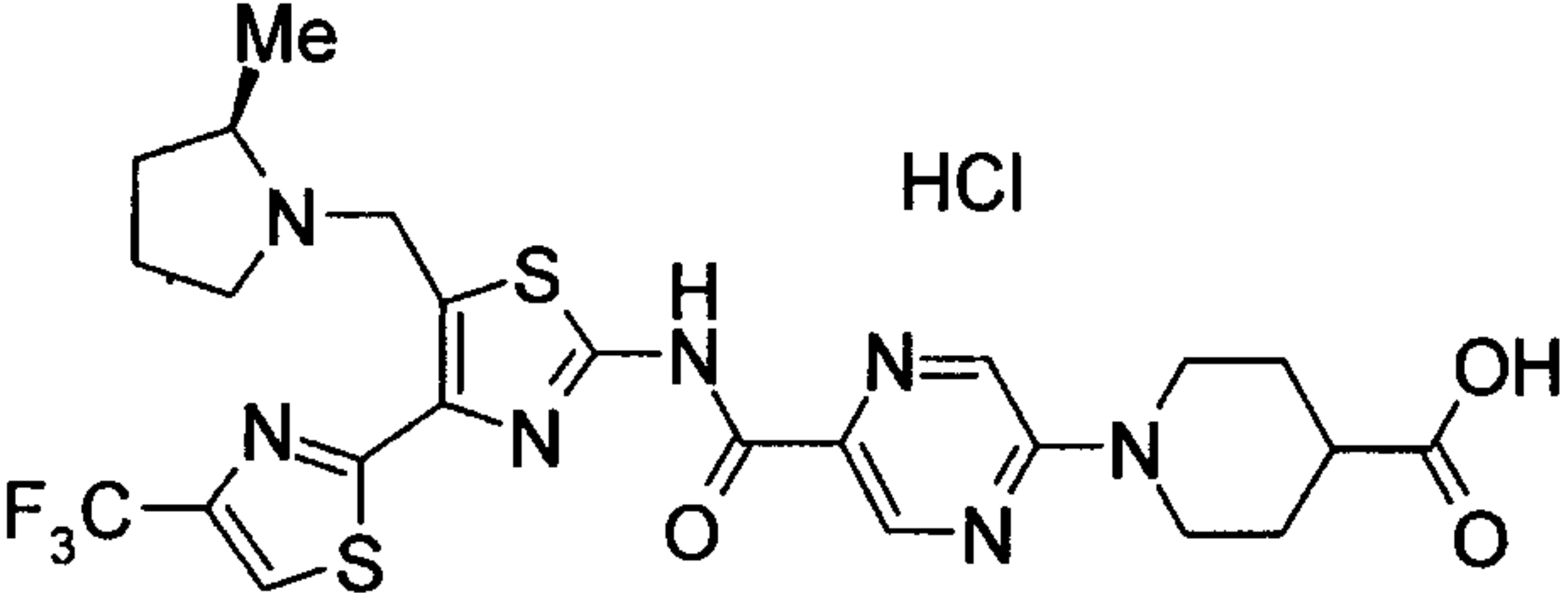
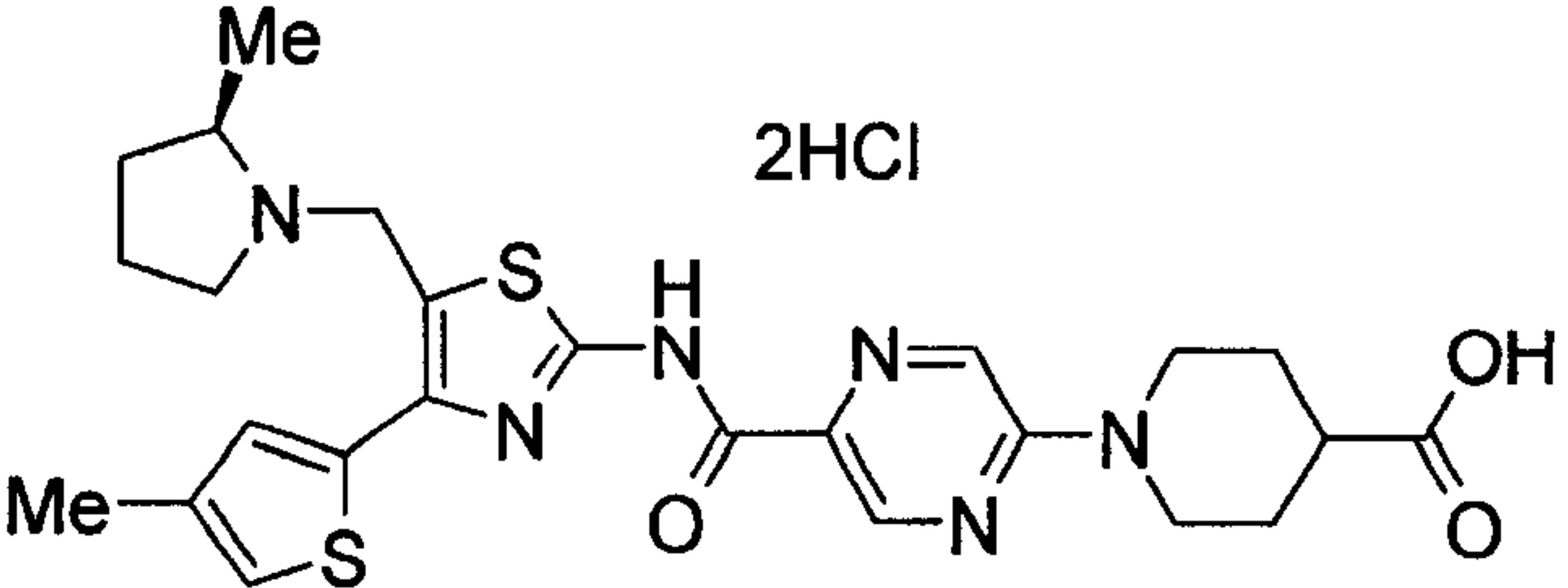
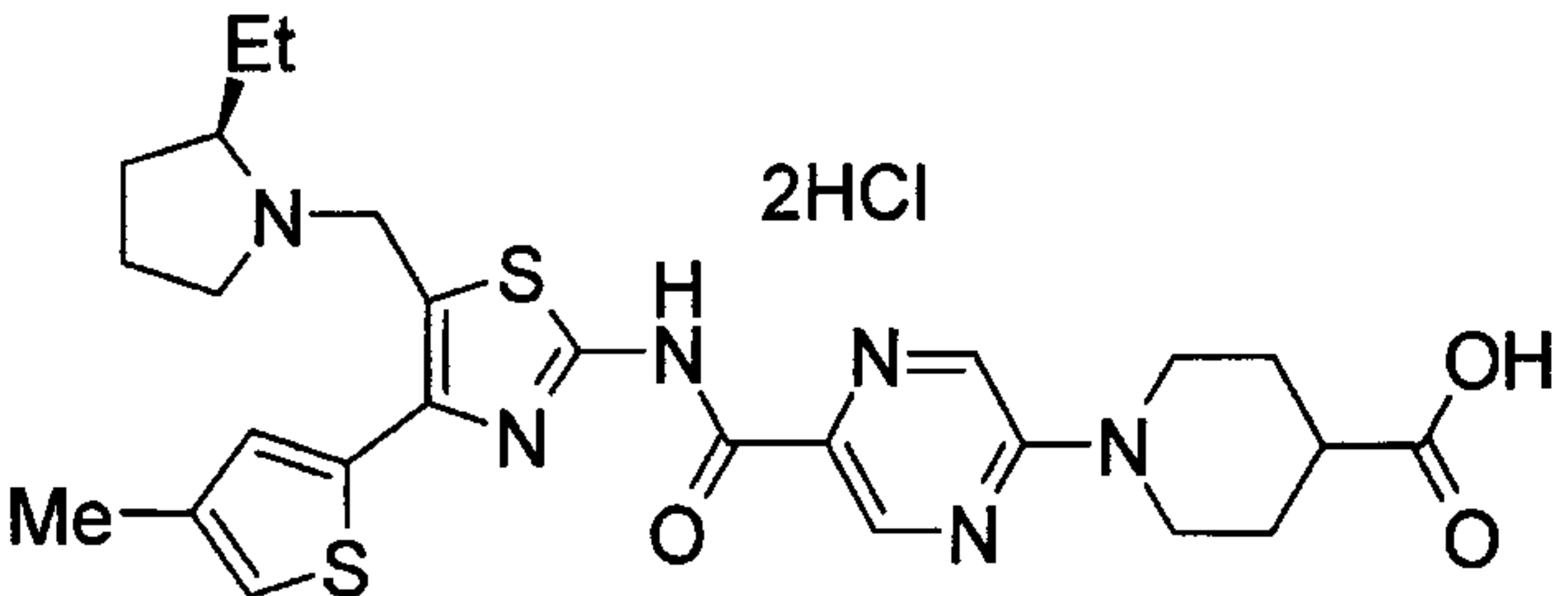
[0238]

[Table 77]

Ex	Str
187	
188	
189	
190	

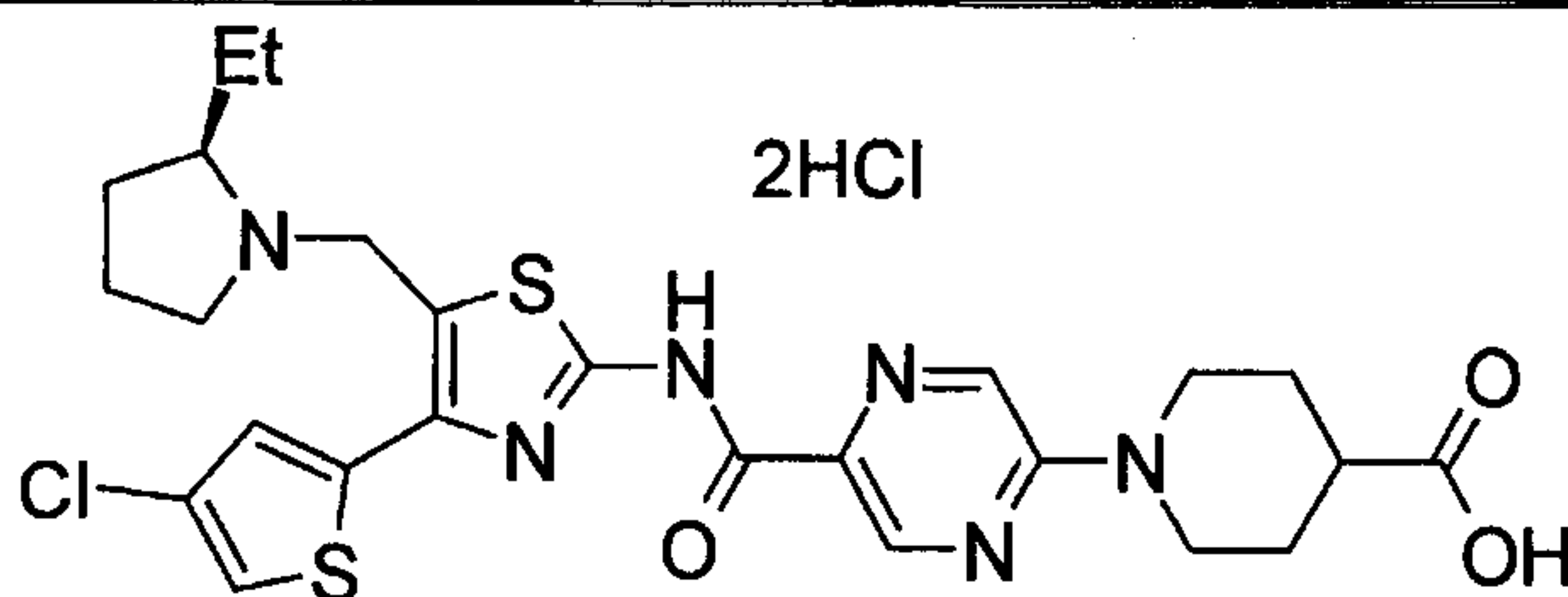
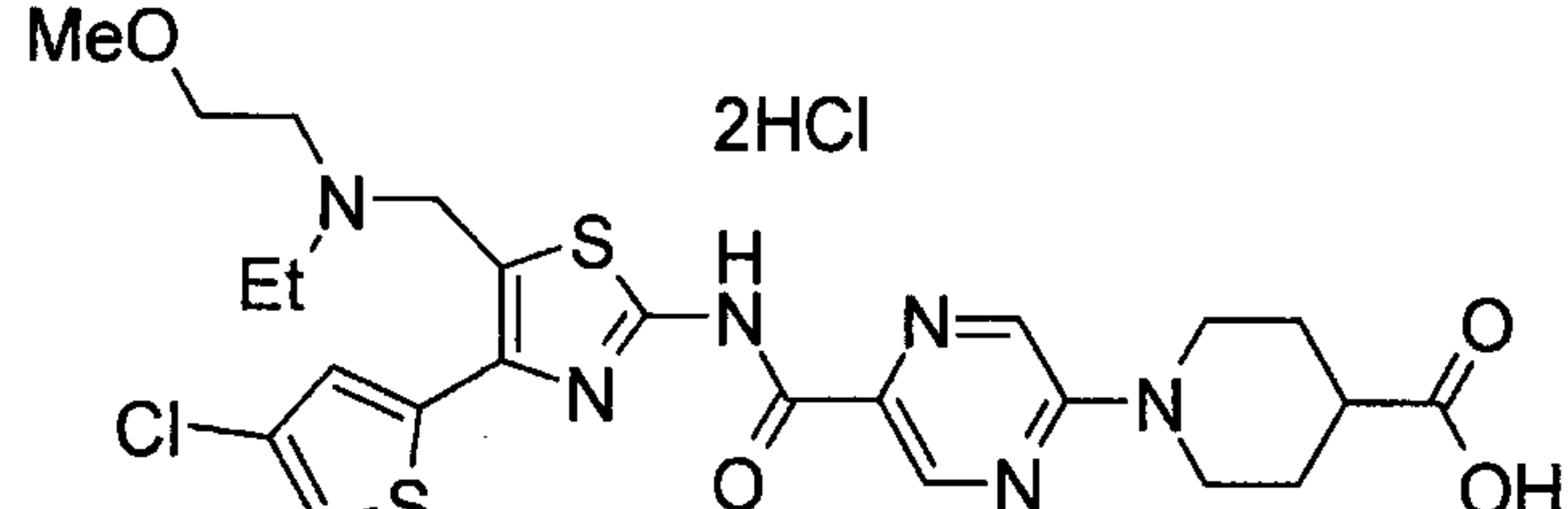
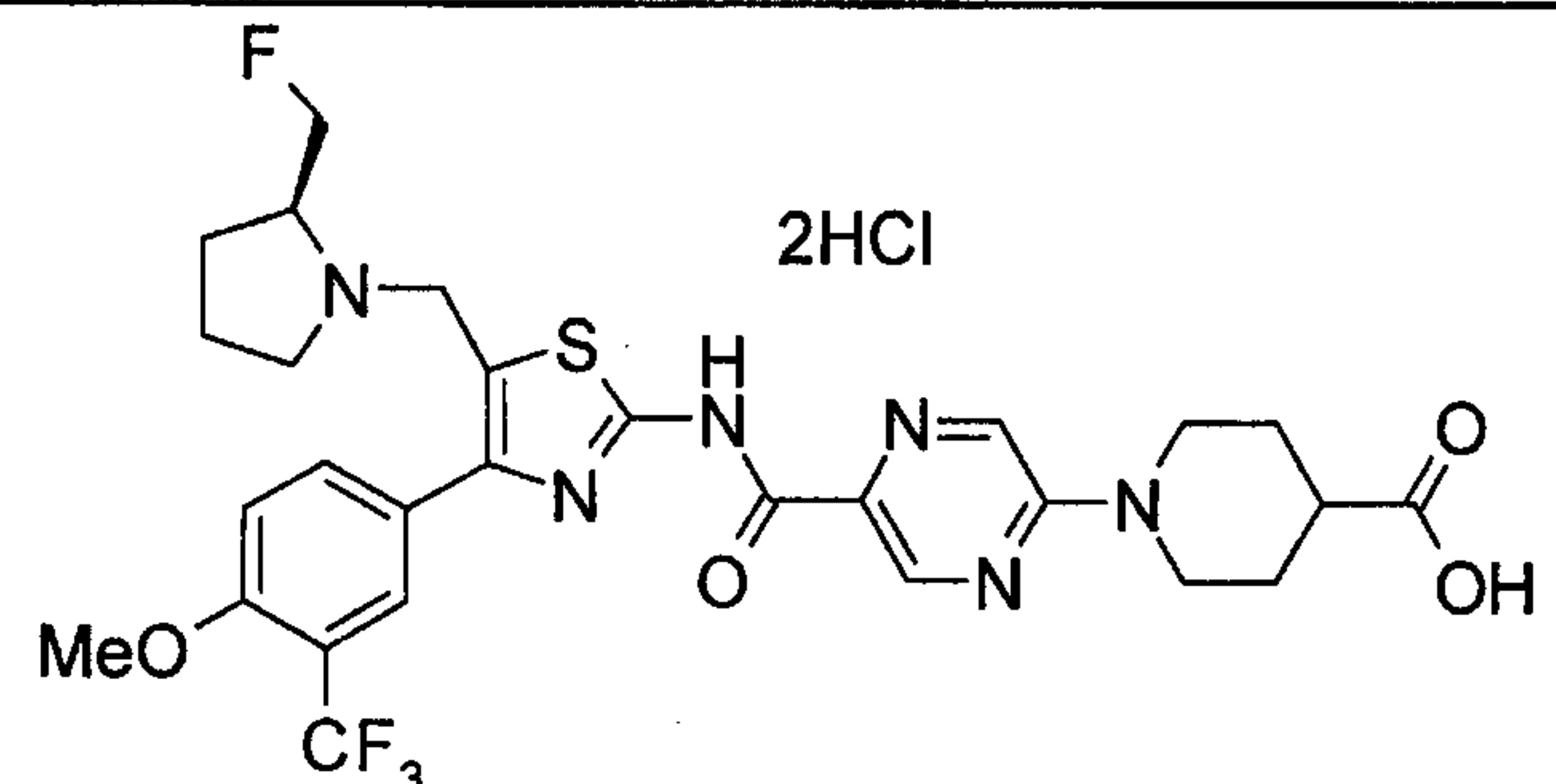
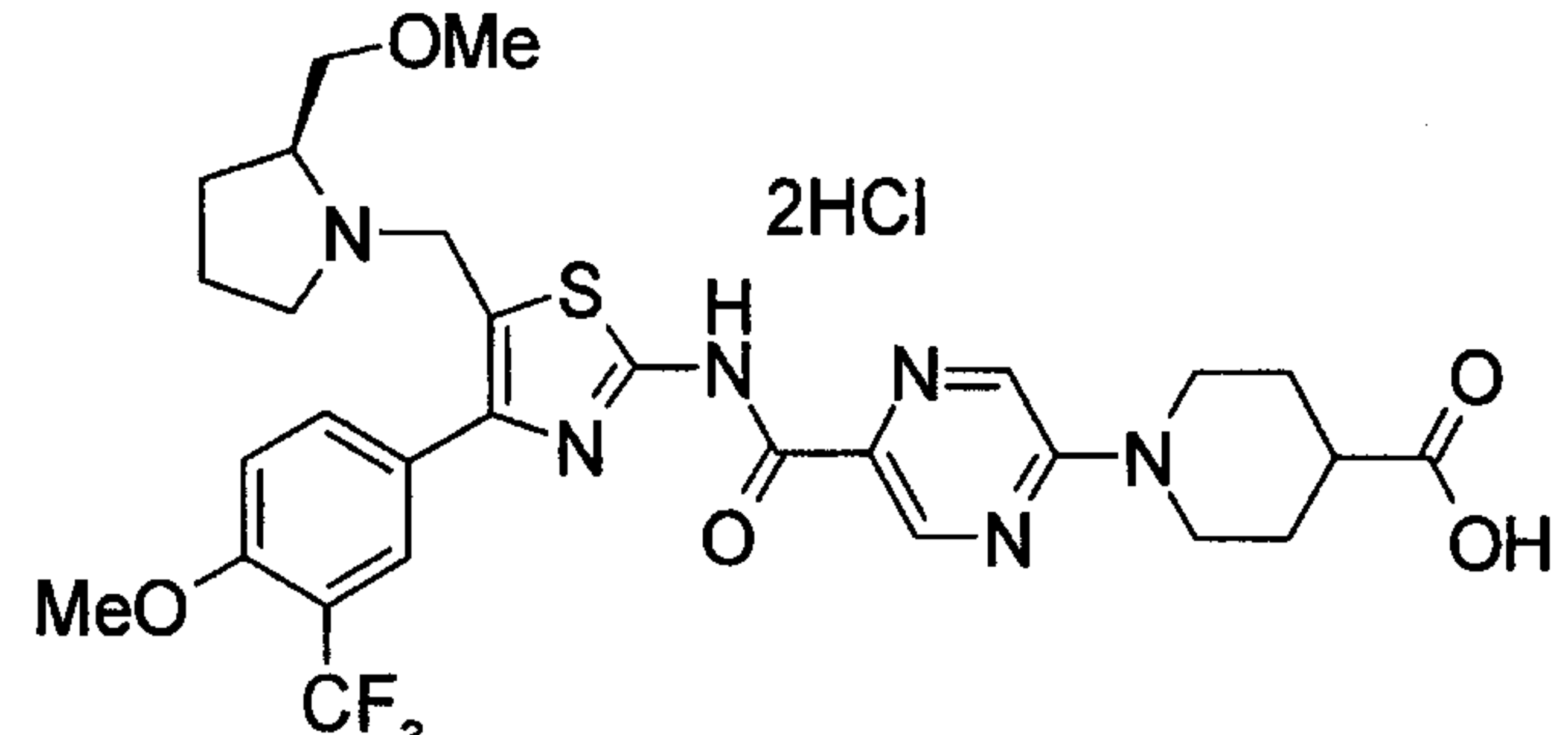
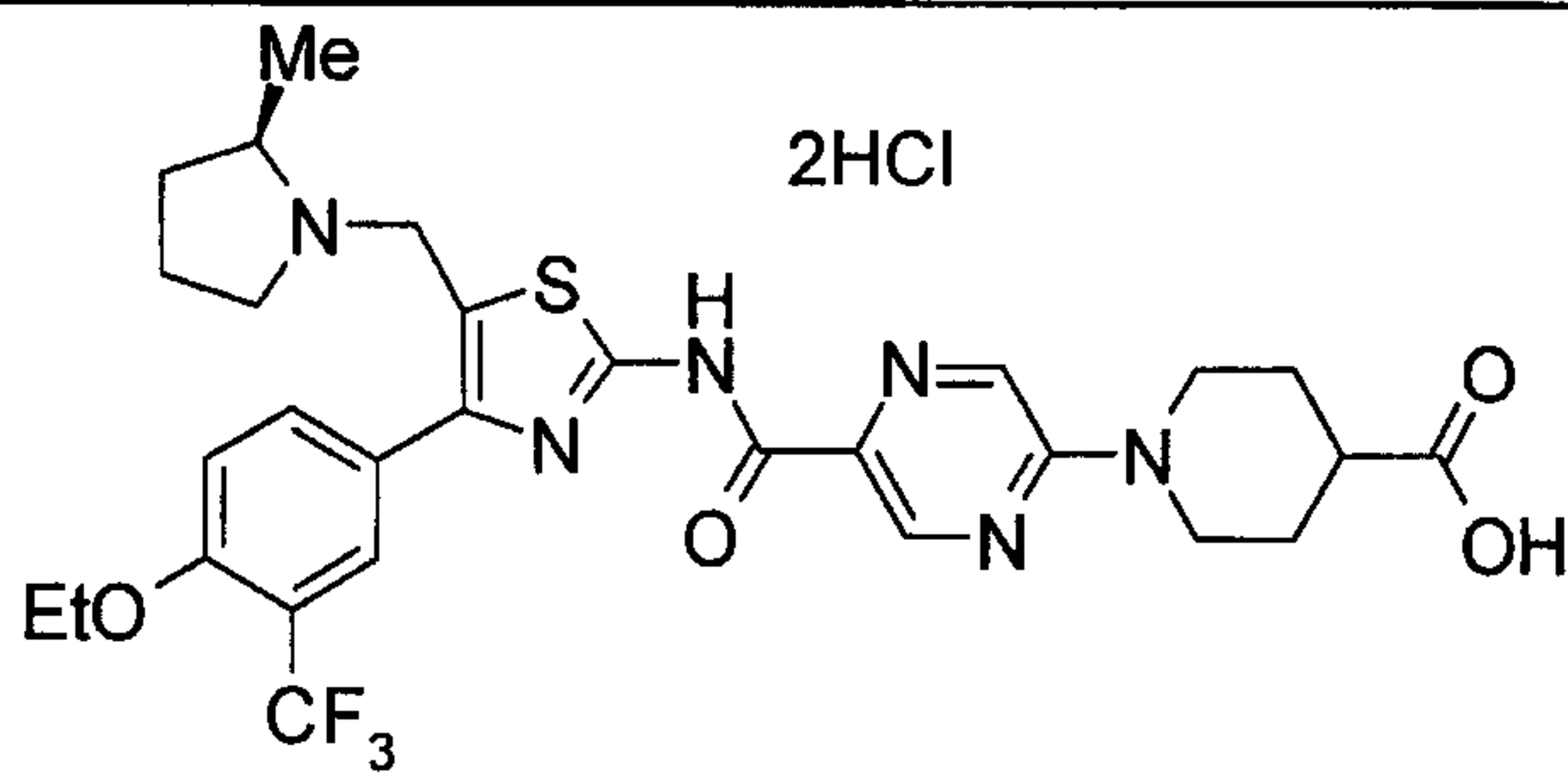
[0239]

[Table 78]

Ex	Str
191	
192	
193	
194	
195	

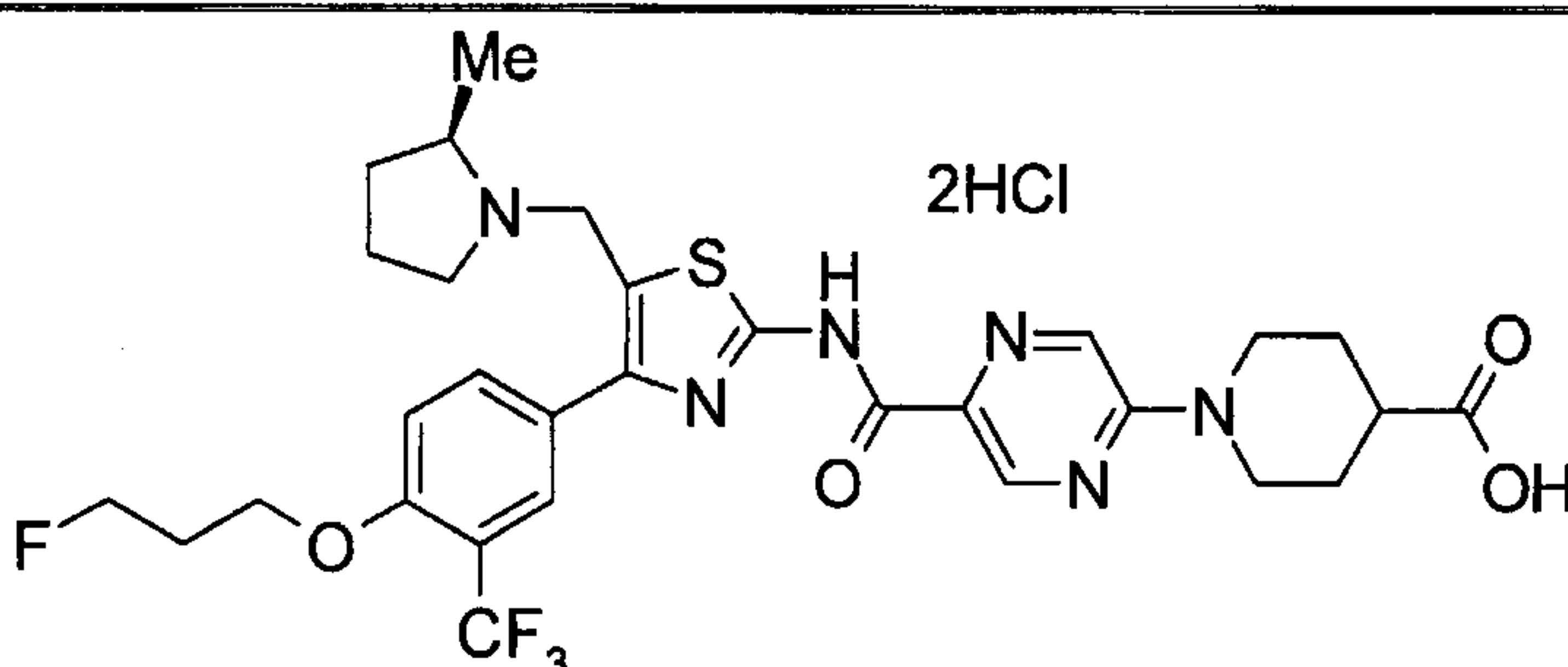
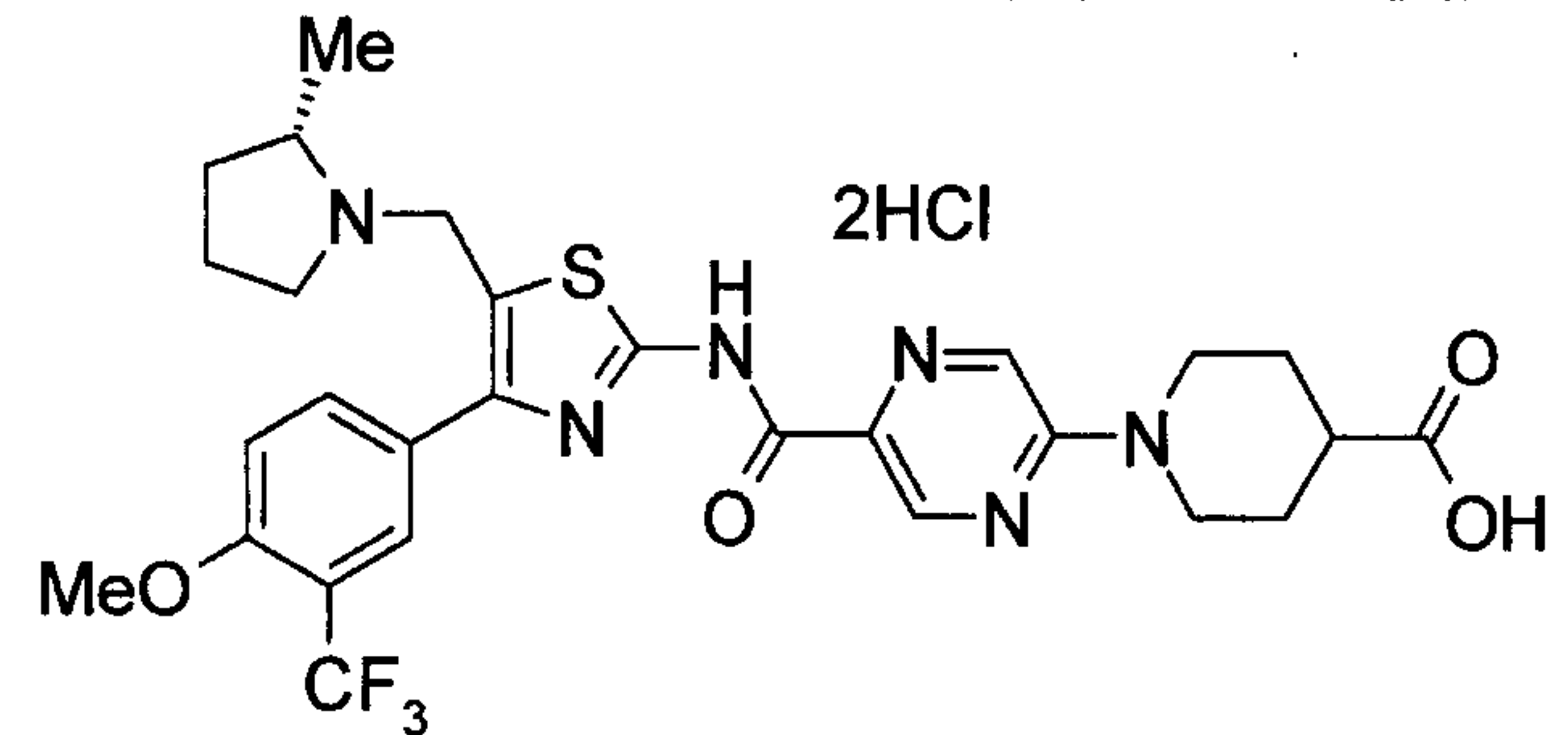
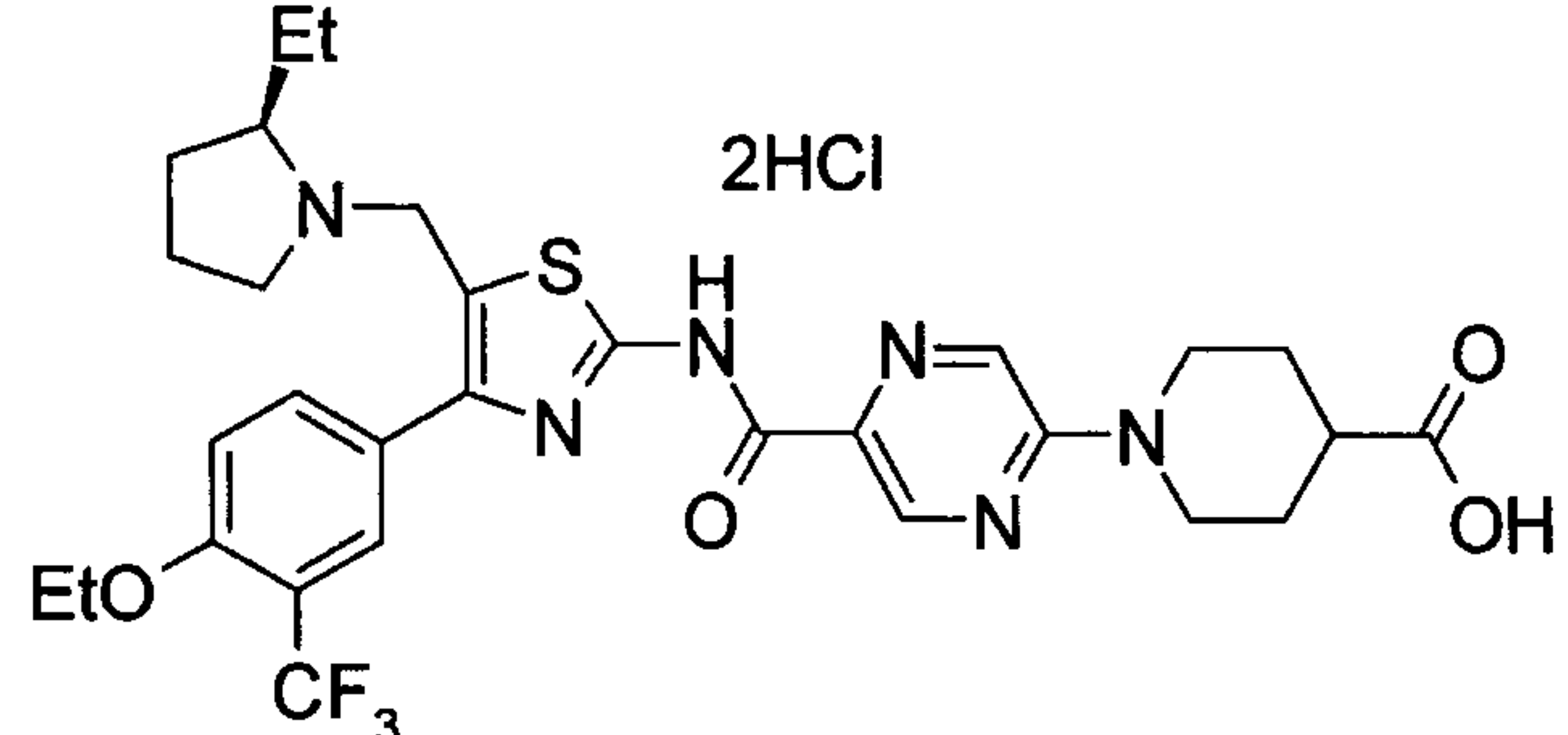
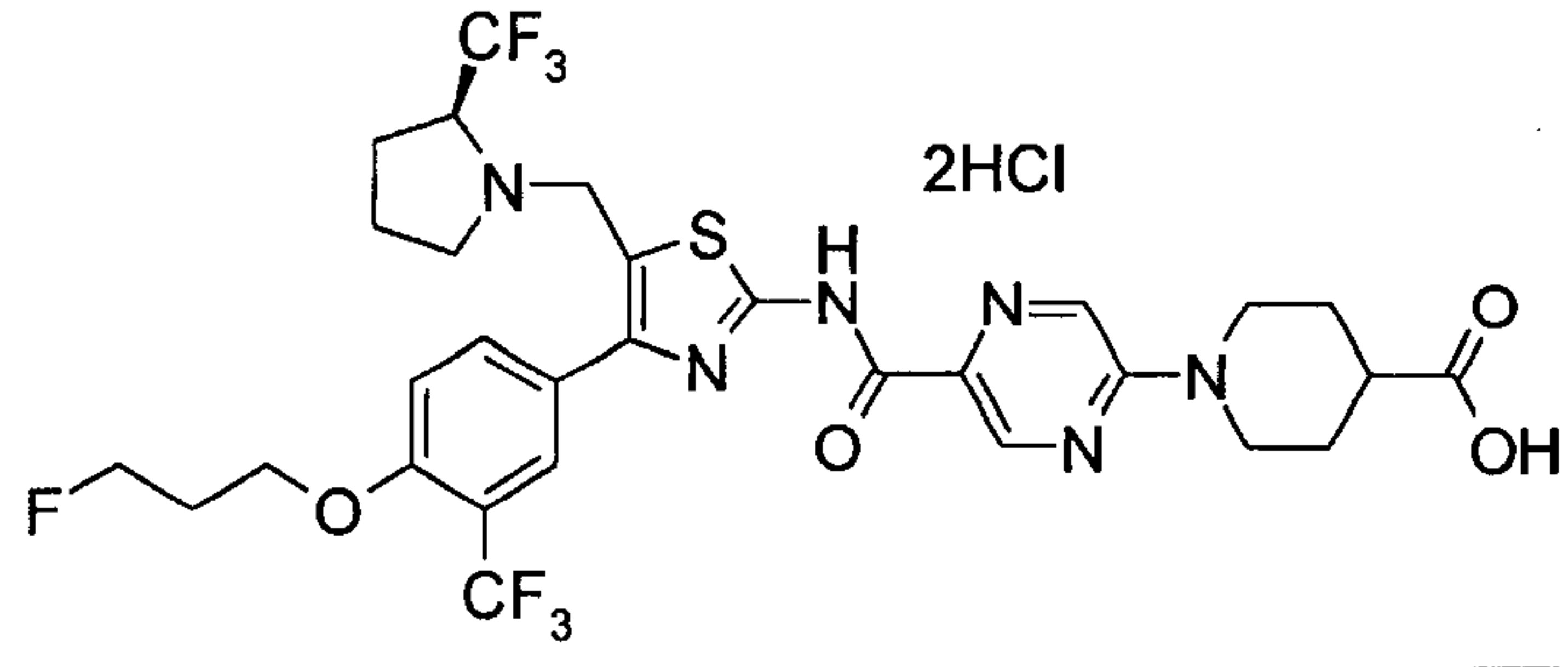
[0240]

[Table 79]

Ex	Str
196	
197	
198	
199	
200	

[0241]

[Table 80]

Ex	Str
201	
202	
203	
204	

[0243]

[Table 82]

Ex	Syn	DATA
1	1	ESI+: 647
2	2	ESI+: 619 NMR-DMSO-d ₆ : 1.06-1.35 (3H, m), 1.49-2.00 (10H, m), 2.58-2.72 (2H, m), 3.09-3.29 (4H, m), 3.89-3.93 (3H, m), 4.35-4.49 (3H, m), 4.64-5.21 (3H, m), 7.34-7.36 (1H, m), 7.47-7.59 (2H, m), 8.40 (1H, d, J = 1.1 Hz), 8.78 (1H, d, J = 1.2 Hz), 10.33-10.51 (1H, m), 12.11-12.19 (1H, m)
3	3	ESI+: 623 NMR-DMSO-d ₆ : 1.34 (3H, d, J = 6.4 Hz), 1.58-1.71 (1H, m), 1.83-1.95 (2H, m), 1.97-2.22 (5H, m), 2.44 (3H, s), 3.05-3.18 (1H, m), 3.31-3.45 (3H, m), 3.46-3.56 (1H, m), 3.80-4.30 (2H, m), 4.44-4.54 (3H, m), 4.72-4.80 (1H, m), 7.31 (1H, s), 7.48 (1H, s), 7.61 (1H, s), 8.47 (1H, d, J = 1.3 Hz), 8.80 (1H, d, J = 1.3 Hz), 10.56 (1H, brs), 12.17 (1H, s)
4	4	ESI+: 547 , 549 NMR-DMSO-d ₆ : 1.47 (3H, d, J = 6.4 Hz), 1.53-1.77 (3H, m), 1.89-2.06 (4H, m), 2.15-2.26 (1H, m), 2.60-2.70 (1H, m), 3.12-3.29 (3H, m), 3.43-3.60 (2H, m), 4.40-4.48 (2H, m), 4.59-4.67 (1H, m), 4.83-4.90 (1H, m), 7.68-7.74 (2H, m), 8.40 (1H, d, J = 1.0 Hz), 8.76 (1H, d, J = 1.1 Hz), 9.45-10.37 (2H, br), 11.22 (1H, brs), 12.09 (1H, s)
5	5	ESI+: 547
6	6	ESI+: 651
7	7	ESI+: 647
8	8	ESI+: 619 NMR-DMSO-d ₆ : 0.87 (3H, t, J = 7.4 Hz), 1.25-1.36 (1H, m), 1.39-1.48 (1H, m), 1.53-1.72 (5H, m), 1.86-1.99 (3H, m), 2.14 (1H, q, J = 8.6 Hz), 2.32-2.41 (1H, m), 2.59-2.68 (1H, m), 2.98-3.04 (1H, m), 3.17-3.26 (2H, m), 3.49 (1H, d, J = 14.3 Hz), 3.94 (3H, s), 4.17 (1H, d, J = 14.4 Hz), 4.38-4.45 (2H, m), 7.34 (1H, d, J = 8.8 Hz), 7.98 (1H, dd, J = 2.1, 8.7 Hz), 8.03 (1H, d, J = 2.1 Hz), 8.38 (1H, d, J = 1.3 Hz), 8.74 (1H, d, J = 1.3 Hz), 11.54 (1H, s), 12.32 (1H, brs) m.p.:194°C
9	1	ESI+:641 , 643

[0244]

[Table 83]

Ex	Syn	DATA
10	1	ESI+:609 , 611
11	1	ESI+:618 NMR-DMSO-d6: 1.35 (3H, d, J = 6.4 Hz), 1.51-1.70 (3H, m), 1.84-2.02 (5H, m), 2.12-2.22 (1H, m), 2.58-2.68 (1H, m), 2.76 (6H, s), 3.09-3.29 (3H, m), 3.37-3.58 (2H, m), 3.92-4.90 (6H, m), 7.54 (1H, d, J = 9.0 Hz), 7.92-7.98 (2H, m), 8.40 (1H, s), 8.77 (1H, d, J = 1.0 Hz), 10.54 (1H, brs), 12.11 (1H, s)
12	1	ESI+:593
13	1	ESI+:605
14	1	ESI+:653
15	1	ESI+:649
16	4	APCI/ESI+: 679
17	1	ESI+: 647
18	1	ESI+: 647
19	1	ESI+: 661
20	1	ESI+: 661
21	1	ESI+: 677
22	1	ESI+: 691
23	1	ESI+: 691
24	1	ESI+: 677
25	1	ESI+: 647
26	1	ESI+: 661
27	1	ESI+: 661
28	1	ESI+: 563

[0245]

[Table 84]

Ex	Syn	DATA
29	1	ESI+: 577
30	1	ESI+: 619
31	2	ESI-: 591
32	2	ESI-: 605
33	2	ESI-: 637
34	2	ESI-: 623
35	2	ESI-: 619
36	2	ESI-: 581
37	2	ESI-: 547
38	6	ESI+: 689 NMR-DMSO-d6: 0.77-0.87 (6H, m), 1.51-1.64 (2H, m), 1.76-2.00 (3H, m), 2.57-2.91 (3H, m), 3.11-3.33 (7H, m), 3.56-3.68 (2H, m), 3.96-4.49 (4H, m), 4.63-4.72 (2H, m), 8.23-8.28 (1H, m), 8.34-8.38 (2H, m), 8.39-8.41 (1H, m), 8.77-8.80 (1H, m), 9.90 (1H, brs), 12.26 (1H, s)
39	6	ESI+: 637
40	2	ESI+: 639
41	2	ESI+: 653
42	2	ESI+: 671
43	2	ESI+: 657
44	2	ESI+: 609
45	2	ESI+: 659
46	2	ESI+: 633
47	2	ESI+: 651

[0246]

[Table 85]

Ex	Syn	DATA
48	2	ESI+: 659
49	2	ESI+: 651
50	2	ESI+: 633
51	2	ESI+: 625
52	2	ESI+: 585
53	2	ESI+: 619
54	2	ESI+: 619
55	2	ESI+: 585
56	2	ESI+: 599
57	2	APCI/ESI+: 603
58	2	APCI/ESI+: 603
59	2	APCI/ESI+: 617
60	2	APCI/ESI+: 643
61	2	ESI+: 621
62	2	ESI+: 635
63	2	ESI+: 635
64	2	ESI+: 649
65	2	ESI+: 649
66	2	ESI+: 635
67	2	ESI+: 579
68	2	ESI+: 579

[0247]

[Table 86]

Ex	Syn	DATA
69	2	ESI+: 633 , 635 NMR-DMSO-d6: 1.05 (3H, t, J = 7.0 Hz), 1.51-1.71 (3H, m), 1.79-2.02 (4H, m), 2.07-2.18 (1H, m), 2.59-2.69 (1H, m), 3.12-3.28 (3H, m), 3.42-3.81 (8H, m), 3.95-3.98 (3H, m), 4.38-4.47 (2H, m), 4.56-4.64 (1H, m), 4.88-4.95 (1H, m), 7.66-7.71 (2H, m), 8.40 (1H, d, J = 1.2 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.45 (1H, brs), 12.10 (1H, s)
70	2	ESI+: 649
71	2	ESI+: 665
72	2	ESI+: 649
73	2	ESI+: 617
74	2	ESI+: 655
75	2	ESI+: 669
76	2	ESI+: 655
77	2	ESI+: 587
78	2	ESI+: 601
79	2	ESI+: 617
80	2	ESI+: 623
81	2	ESI+: 637
82	2	ESI+: 651
83	2	ESI+: 637
84	2	ESI+: 667 NMR-DMSO-d6: 1.03 (3H, t, J = 7.0 Hz), 1.52-1.70 (3H, m), 1.80-2.00 (4H, m), 2.07-2.18 (1H, m), 2.60-2.68 (1H, m), 3.14-3.27 (3H, m), 3.39-3.56 (3H, m), 3.59-4.00 (5H, m), 4.02-4.04 (3H, m), 4.39-4.47 (2H, m), 4.57-4.65 (1H, m), 4.89-4.96 (1H, m), 7.78-7.80 (1H, m), 8.07 (1H, dd, J = 12.5, 1.9 Hz), 8.40 (1H, d, J = 1.2 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.44 (1H, brs), 12.15 (1H, s)

[0248]

[Table 87]

Ex	Syn	DATA
85	2	ESI+: 649
86	2	ESI+: 619
87	2	ESI+: 633
88	2	ESI+: 619
89	2	ESI+: 635
90	2	ESI+: 649
91	2	ESI+: 635
92	2	ESI+: 605 , 607 NMR-DMSO-d6: 1.41 (3H, d, J = 6.4 Hz), 1.52-1.71 (3H, m), 1.86-2.01 (4H, m), 2.14-2.25 (1H, m), 2.59-2.68 (1H, m), 3.08-3.29 (3H, m), 3.39-3.87 (4H, m), 3.90 (3H, s), 4.38-4.51 (3H, m), 4.75-4.82 (1H, m), 7.82-7.85 (2H, m), 8.40 (1H, d, J = 1.2 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.41 (1H, brs), 12.11 (1H, s)
93	2	ESI+: 619
94	2	ESI+: 619
95	2	ESI+: 635
96	2	ESI+: 635
97	2	ESI+: 619
98	2	ESI+: 623 , 625
99	2	ESI+: 649
100	2	ESI+: 633
101	2	ESI+: 663
102	2	ESI+: 663
103	103	ESI+: 649

[0249]

[Table 88]

Ex	Syn	DATA
104	2	ESI+: 589 , 591 NMR-DMSO-d6: 0.86 (3H, t, J = 7.4 Hz), 1.46-1.74 (4H, m), 1.74-2.01 (4H, m), 2.06-2.24 (1H, m), 2.57-2.70 (1H, m), 3.00-3.30 (4H, m), 3.40-3.60 (1H, m), 4.20-5.50 (7H, m), 7.74 (1H, t, J = 1.9 Hz), 7.76-7.80 (2H, d, J = 1.9 Hz), 8.37-8.43 (1H, m), 8.75-8.79 (1H, m), 10.40-10.70 (1H, m), 12.15 (1H, s)
105	2	ESI+: 674 NMR-DMSO-d6: 0.76 (3H, t, J = 7.4 Hz), 1.48-1.76 (5H, m), 1.80-2.02 (4H, m), 2.06-2.22 (1H, m), 2.56-2.72 (1H, m), 2.83-3.00 (4H, m), 3.08-3.30 (4H, m), 3.45-3.60 (1H, m), 3.66-3.80 (4H, m), 4.00-5.40 (6H, m), 7.67 (1H, d, J = 8.0 Hz), 7.93-8.05 (2H, m), 8.40 (1H, d, J = 1.2 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.39-10.64 (1H, m), 12.14 (1H, s)
106	2	ESI+: 658
107	107	ESI+: 688 NMR-DMSO-d6: 0.88 (3H, t, J = 7.0 Hz), 1.15-1.49 (4H, m), 1.49-1.71 (5H, m), 1.76-1.98 (3H, m), 2.08-2.27 (2H, m), 2.31-2.44 (1H, m), 2.83-2.96 (4H, m), 2.96-3.05 (1H, m), 3.10-3.60 (4H, m), 3.66-3.80 (4H, m), 4.15 (1H, d, J = 14.2 Hz), 4.20-4.32 (2H, m), 7.59 (1H, d, J = 8.4 Hz), 8.02 (1H, dd, J = 1.7, 8.4 Hz), 8.12 (1H, d, J = 1.9 Hz), 8.29 (1H, s), 8.76 (1H, d, J = 1.0 Hz)
108	107	ESI+: 674 NMR-DMSO-d6: 1.09 (3H, d, J = 6.2 Hz), 1.21-1.71 (9H, m), 1.77-1.90 (2H, m), 2.00-2.13 (1H, m), 2.13-2.24 (1H, m), 2.38-2.49 (1H, m), 2.72-2.84 (1H, m), 2.85-2.97 (4H, m), 3.10-3.66 (3H, m), 3.66-3.82 (4H, m), 4.08 (1H, d, J = 14.3 Hz), 4.17-4.33 (2H, m), 7.60 (1H, d, J = 8.5 Hz), 7.95-8.07 (1H, m), 8.15-8.25 (1H, m), 8.29 (1H, s), 8.76 (1H, d, J = 1.0 Hz)
109	107	ESI+: 660 NMR-DMSO-d6: 1.13 (3H, d, J = 6.0 Hz), 1.30-1.46 (1H, m), 1.48-1.74 (4H, m), 1.77-2.02 (3H, m), 2.10-2.31 (2H, m), 2.41-2.50 (1H, m), 2.84-2.97 (4H, m), 2.97-3.06 (1H, m), 3.10-3.93 (8H, m), 4.16 (1H, d, J = 14.2 Hz), 4.20-4.38 (2H, m), 7.61 (1H, d, J = 8.5 Hz), 8.04 (1H, dd, J = 1.8, 8.4 Hz), 8.15 (1H, d, J = 1.9 Hz), 8.29-8.34 (1H, m), 8.74 (1H, d, J = 1.2 Hz)

[0250]

[Table 89]

Ex	Syn	DATA
110	107	ESI+: 689 NMR-DMSO-d6: 0.90 (6H, s), 1.15-1.30 (2H, m), 1.47-1.65 (4H, m), 1.75-1.90 (2H, m), 1.96-2.31 (4H, m), 2.31-2.49 (1H, m), 3.00-3.70 (7H, m), 3.75-3.88 (3H, m), 3.97 (1H, dd, J = 4.6, 10.3 Hz), 4.17-4.35 (2H, m), 5.22-5.30 (1H, m), 7.32 (1H, d, J = 8.8 Hz), 7.96-8.02 (1H, m), 8.11-8.18 (1H, m), 8.31 (1H, s), 8.76 (1H, d, J = 1.1 Hz)
111	107	ESI+: 675 NMR-DMSO-d6: 0.86 (3H, t, J = 7.4 Hz), 1.19-1.75 (7H, m), 1.76-2.08 (4H, m), 2.08-2.42 (4H, m), 2.90-3.72 (5H, m), 3.75-3.90 (3H, m), 3.97 (1H, dd, J = 4.6, 10.3 Hz), 4.13 (1H, d, J = 14.2 Hz), 4.20-4.35 (2H, m), 5.22-5.30 (1H, m), 7.31 (1H, d, J = 8.8 Hz), 7.98 (1H, dd, J = 1.9, 8.7 Hz), 8.06 (1H, d, J = 2.0 Hz), 8.30 (1H, s), 8.75 (1H, d, J = 1.1 Hz)
112	107	ESI+: 689 NMR-DMSO-d6: 0.90 (6H, s), 1.15-1.30 (2H, m), 1.47-1.65 (4H, m), 1.75-1.90 (2H, m), 1.96-2.31 (4H, m), 2.31-2.49 (1H, m), 3.00-3.70 (7H, m), 3.75-3.88 (3H, m), 3.97 (1H, dd, J = 4.6, 10.3 Hz), 4.17-4.35 (2H, m), 5.22-5.30 (1H, m), 7.32 (1H, d, J = 8.9 Hz), 7.96-8.02 (1H, m), 8.11-8.18 (1H, m), 8.31 (1H, s), 8.76 (1H, d, J = 1.1 Hz)
113	107	ESI+: 675 NMR-DMSO-d6: 0.86 (3H, t, J = 7.4 Hz), 1.19-1.75 (7H, m), 1.76-2.08 (4H, m), 2.08-2.42 (4H, m), 2.90-3.72 (5H, m), 3.75-3.90 (3H, m), 3.97 (1H, dd, J = 4.6, 10.3 Hz), 4.13 (1H, d, J = 14.3 Hz), 4.20-4.35 (2H, m), 5.22-5.30 (1H, m), 7.31 (1H, d, J = 8.8 Hz), 7.98 (1H, dd, J = 1.9, 8.7 Hz), 8.06 (1H, d, J = 1.9 Hz), 8.30 (1H, s), 8.75 (1H, d, J = 0.9 Hz)
114	2	ESI+: 639 NMR-DMSO-d6: 0.76-0.92 (6H, m), 1.51-1.64 (2H, m), 1.77-1.88 (1H, m), 1.91-2.00 (2H, m), 2.59-2.92 (3H, m), 3.17-3.33 (7H, m), 3.53-3.93 (4H, m), 4.38-4.49 (2H, m), 4.70 (2H, brs), 7.80-7.91 (3H, m), 8.40 (1H, d, J = 1.1 Hz), 8.78 (1H, d, J = 1.1 Hz), 9.65 (1H, brs), 12.20 (1H, s)
115	2	ESI+: 607 NMR-DMSO-d6: 0.82 (3H, t, J = 7.3 Hz), 1.51-2.01 (9H, m), 2.10-2.21 (1H, m), 2.59-2.68 (1H, m), 3.09-3.28 (4H, m), 3.47-3.59 (1H, m), 3.86-4.65 (5H, m), 4.72-4.85 (1H, m), 7.81 (1H, d, J = 8.5 Hz), 7.93-8.00 (2H, m), 8.40 (1H, s), 8.78 (1H, s), 10.80 (1H, brs), 12.18 (1H, s)
116	2	ESI+: 621 NMR-DMSO-d6: 0.83 (3H, t, J = 7.2 Hz), 1.03-1.35 (2H, m), 1.49-1.72 (5H, m), 1.82-2.00 (4H, m), 2.08-2.21 (1H, m), 2.59-2.69 (1H, m), 3.12-3.30 (4H, m), 3.49-3.58 (1H, m), 4.00-4.89 (6H, m), 7.82 (1H, d, J = 8.4 Hz), 7.93-7.99 (2H, m), 8.40 (1H, s), 8.78 (1H, s), 10.82 (1H, brs), 12.18 (1H, s)

[0251]

[Table 90]

Ex	Syn	DATA
117	2	ESI+: 625 NMR-DMSO-d6: 0.74 (3H, t, J = 7.2 Hz), 1.46-1.66 (4H, m), 1.89-2.01 (2H, m), 2.59-2.69 (1H, m), 2.85-2.96 (2H, m), 3.16-3.29 (7H, m), 3.60-3.69 (2H, m), 4.37-5.26 (6H, m), 7.78-7.95 (3H, m), 8.40 (1H, s), 8.78 (1H, s), 10.71 (1H, brs), 12.17 (1H, s)
118	2	ESI+: 613 NMR-DMSO-d6: 1.51-1.65 (2H, m), 1.89-2.01 (2H, m), 2.59-2.69 (1H, m), 3.16-3.28 (2H, m), 3.60-3.73 (1H, m), 3.97 (3H, s), 4.18-4.29 (1H, m), 4.38-4.69 (6H, m), 5.20-7.00 (2H, br), 7.35-7.41 (1H, m), 7.86-8.01 (2H, m), 8.39 (1H, s), 8.75-8.79 (1H, m), 9.80-10.60 (1H, br), 11.98 (1H, s)
119	2	ESI+: 635
120	2	ESI+: 635
121	2	ESI+: 621
122	2	ESI+: 649
123	3	ESI+: 635
124	3	ESI+: 649
125	3	ESI+: 637 NMR-DMSO-d6: 0.81 (3H, t, J = 7.3 Hz), 1.52-1.66 (2H, m), 1.69-1.80 (1H, m), 1.82-1.93 (2H, m), 1.98-2.23 (5H, m), 3.08-3.25 (2H, m), 3.30-3.41 (2H, m), 3.45-3.80 (3H, m), 3.97 (3H, s), 4.43-4.57 (3H, m), 4.70-4.80 (1H, m), 7.40 (1H, d, J = 8.7 Hz), 7.92 (1H, d, J = 2.0 Hz), 7.98 (1H, dd, J = 8.6, 2.1 Hz), 8.47 (1H, d, J = 1.2 Hz), 8.80 (1H, d, J = 1.2 Hz), 10.42 (1H, brs), 12.17 (1H, s)
126	3	ESI+: 621
127	3	ESI+: 635
128	3	ESI+: 611 NMR-DMSO-d6: 1.37 (3H, d, J = 6.4 Hz), 1.60-1.72 (1H, m), 1.86-1.95 (2H, m), 1.98-2.22 (5H, m), 3.09-3.20 (1H, m), 3.30-3.58 (4H, m), 3.82-4.36 (2H, m), 4.43-4.55 (3H, m), 4.75-4.83 (1H, m), 7.78-7.84 (1H, m), 7.92-7.99 (2H, m), 8.47 (1H, d, J = 1.2 Hz), 8.81 (1H, d, J = 1.3 Hz), 10.75 (1H, brs), 12.25 (1H, s)

[0252]

[Table 91]

Ex	Syn	DATA
129	3	ESI+: 563 , 565 NMR-DMSO-d6: 1.43 (3H, d, J = 6.4 Hz), 1.59-1.77 (3H, m), 1.83-2.03 (4H, m), 2.17-2.28 (1H, m), 3.12-3.64 (8H, m), 4.27-4.37 (2H, m), 4.59-4.70 (1H, m), 4.90-4.99 (1H, m), 7.65 (1H, d, J = 1.4 Hz), 7.74 (1H, d, J = 1.4 Hz), 8.42 (1H, d, J = 1.2 Hz), 8.77 (1H, d, J = 1.3 Hz), 10.23 (1H, brs), 12.14 (1H, s)
130	3	ESI+: 621
131	3	ESI+: 623
132	3	ESI+: 635
133	3	ESI+: 611 NMR-DMSO-d6: 1.34 (3H, d, J = 6.4 Hz), 1.58-1.69 (1H, m), 1.84-1.95 (2H, m), 1.98-2.22 (5H, m), 3.06-3.18 (1H, m), 3.30-3.80 (6H, m), 4.42-4.53 (3H, m), 4.73-4.80 (1H, m), 7.64-7.73 (1H, m), 8.06-8.13 (2H, m), 8.47 (1H, d, J = 1.2 Hz), 8.81 (1H, d, J = 1.2 Hz), 10.46 (1H, brs), 12.22 (1H, s)
134	3	ESI+: 609
135	3	ESI+: 623
136	3	ESI+: 609 , 611
137	4	ESI+: 575
138	4	ESI+: 547
139	4	ESI+: 615
140	4	ESI+: 561
141	141	ESI+: 561 , 563 NMR-DMSO-d6: 0.89 (3H, t, J = 7.3 Hz), 1.28-1.78 (7H, m), 1.87-2.00 (3H, m), 2.17-2.27 (1H, m), 2.56-2.69 (1H, m), 3.00-3.09 (1H, m), 3.15-3.36 (2H, m), 3.64 (1H, d, J = 15.1 Hz), 4.19 (1H, d, J = 15.1 Hz), 4.38-4.46 (2H, m), 7.40-7.43 (1H, m), 7.56-7.59 (1H, m), 8.38 (1H, d, J = 1.2 Hz), 8.74 (1H, d, J = 1.2 Hz), 11.55 (1H, s), 12.31 (1H, brs)
142	4	ESI+: 561 , 563 NMR-DMSO-d6: 1.22-2.00 (12H, m), 2.59-2.69 (1H, m), 2.76-2.88 (1H, m), 3.10-3.71 (7H, m), 4.38-4.48 (2H, m), 4.52-4.67 (1H, m), 4.90-5.00 (1H, m), 7.64-7.76 (2H, m), 8.40 (1H, d, J = 1.1 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.08-10.26 (1H, m), 12.12-12.17 (1H, m)

[0253]

[Table 92]

Ex	Syn	DATA
143	4	ESI+: 547
144	4	ESI+: 577
145	4	ESI+: 577
146	4	ESI+: 579 , 581 NMR-DMSO-d6: 0.84 (3H, t, J = 7.2 Hz), 1.52-1.74 (4H, m), 1.90-2.00 (2H, m), 2.59-2.69 (1H, m), 3.00-3.10 (2H, m), 3.17-3.27 (2H, m), 3.28-3.40 (4H, m), 3.70-3.75 (2H, m), 4.37-5.11 (7H, m), 7.64 (1H, d, J = 1.4 Hz), 7.75 (1H, d, J = 1.4 Hz), 8.40 (1H, d, J = 1.2 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.53 (1H, brs), 12.14 (1H, s)
147	4	ESI+: 563
148	4	ESI+: 605
149	141	ESI+: 619
150	4	ESI+: 593 NMR-DMSO-d6: 1.36 (3H, d, J = 6.4 Hz), 1.51-1.70 (3H, m), 1.85-2.00 (4H, m), 2.12-2.23 (1H, m), 2.59-2.68 (1H, m), 3.08-3.27 (3H, m), 3.38-3.80 (4H, m), 4.38-4.54 (3H, m), 4.77-4.85 (1H, m), 7.79-7.85 (1H, m), 7.91-7.97 (2H, m), 8.40 (1H, d, J = 1.3 Hz), 8.78 (1H, d, J = 1.3 Hz), 10.51 (1H, brs), 12.20 (1H, s)
151	4	ESI+: 625
152	4	ESI+: 593 , 595 NMR-DMSO-d6: 0.82-1.00 (6H, m), 1.51-1.65 (2H, m), 1.89-2.06 (3H, m), 2.59-2.69 (1H, m), 2.79-3.11 (2H, m), 3.16-3.44 (7H, m), 3.56-4.08 (4H, m), 4.38-4.48 (2H, m), 4.73-4.89 (2H, m), 7.57-7.81 (2H, m), 8.38-8.42 (1H, m), 8.74-8.79 (1H, m), 9.84 (1H, brs), 12.15 (1H, s)
153	4	ESI+: 589
154	4	ESI+: 577
155	4	ESI+: 561
156	4	ESI+: 619 NMR-DMSO-d6: 0.80 (3H, t, J = 7.3 Hz), 1.45-2.01 (9H, m), 2.04-2.20 (1H, m), 2.56-2.70 (1H, m), 3.05-3.28 (4H, m), 3.44-3.56 (1H, m), 3.97 (3H, s), 4.07-4.77 (6H, m), 7.40 (1H, d, J = 8.8 Hz), 7.93 (1H, d, J = 2.0 Hz), 7.99 (1H, dd, J = 8.7, 2.0 Hz), 8.40 (1H, d, J = 1.2 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.62 (1H, brs), 12.10 (1H, s)

[0254]

[Table 93]

Ex	Syn	DATA
157	4	ESI+: 603
158	4	ESI+: 633 NMR-DMSO-d6: 0.81 (3H, t, J = 7.2 Hz), 0.97-1.11 (1H, m), 1.19-1.32 (1H, m), 1.50-1.66 (5H, m), 1.82-2.00 (4H, m), 2.06-2.20 (1H, m), 2.58-2.69 (1H, m), 3.08-3.28 (4H, m), 3.46-3.57 (1H, m), 3.97 (3H, s), 4.03-4.86 (6H, m), 7.40 (1H, d, J = 8.7 Hz), 7.93 (1H, d, J = 2.0 Hz), 7.98 (1H, dd, J = 8.6, 2.0 Hz), 8.40 (1H, d, J = 1.1 Hz), 8.77 (1H, d, J = 1.2 Hz), 10.55 (1H, brs), 12.11 (1H, s)
159	4	ESI+: 637
160	4	ESI+: 605
161	4	ESI+: 633
162	4	ESI+: 605
163	4	ESI+: 619
164	4	ESI+: 619
165	4	ESI+: 649
166	4	ESI+: 649
167	4	ESI+: 630
168	4	ESI+: 591
169	4	ESI+: 605
170	4	ESI+: 623
171	4	ESI+: 641
172	4	ESI+: 641
173	4	ESI+: 627
174	4	ESI+: 609

[0255]

[Table 94]

Ex	Syn	DATA
175	4	ESI+: 609
176	4	ESI+: 605
177	4	ESI+: 605
178	4	ESI+: 635
179	4	ESI+: 659 NMR-DMSO-d6: 1.51-1.65 (2H, m), 1.67-2.16 (7H, m), 2.39-2.48 (1H, m), 2.58-2.69 (1H, m), 3.00-3.08 (1H, m), 3.16-3.27 (2H, m), 3.51-3.66 (1H, m), 3.95 (3H, s), 3.98-4.05 (1H, m), 4.29 (1H, d, J = 14.6 Hz), 4.38-4.46 (2H, m), 4.80-6.12 (2H, m), 7.33 (1H, d, J = 8.5 Hz), 7.90-7.97 (2H, m), 8.39 (1H, d, J = 1.2 Hz), 8.75 (1H, d, J = 1.2 Hz), 11.63 (1H, brs)
180	4	ESI+: 623
181	4	ESI+: 647
182	4	ESI+: 633
183	4	ESI+: 649
184	4	ESI+: 619
185	4	ESI+: 673
186	4	ESI+: 659
187	4	ESI+: 633
188	4	ESI+: 633 NMR-DMSO-d6: 0.79 (3H, d, J = 6.7 Hz), 0.86 (3H, d, J = 6.7 Hz), 1.51-2.00 (9H, m), 2.59-2.70 (1H, m), 3.12-3.28 (4H, m), 3.31-3.86 (3H, m), 3.97 (3H, s), 4.38-4.47 (2H, m), 4.52-4.62 (1H, m), 4.68-4.77 (1H, m), 7.39 (1H, d, J = 8.7 Hz), 7.90 (1H, d, J = 2.0 Hz), 7.95 (1H, dd, J = 8.7, 2.0 Hz), 8.40 (1H, d, J = 1.1 Hz), 8.78(1H, d, J = 1.2 Hz), 9.80 (1H, brs), 12.12 (1H, s)
189	4	ESI+: 631
190	4	ESI+: 659

[0256]

[Table 95]

Ex	Syn	DATA
191	4	ESI+: 647
192	4	ESI+: 647
193	4	ESI+: 582
194	4	ESI+: 527
195	4	ESI+: 541
196	4	ESI-: 559 NMR-DMSO-d6: 0.89 (3H, t, J = 7.4 Hz), 1.50-2.27 (10H, m), 2.60-2.69 (1H, m), 3.12-4.00 (7H, m), 4.39-4.48 (2H, m), 4.66-4.75 (1H, m), 4.92-5.00 (1H, m), 7.66 (1H, d, J = 1.4 Hz), 7.74 (1H, d, J = 1.4 Hz), 8.40 (1H, d, J = 1.1 Hz), 8.77 (1H, d, J = 1.1 Hz), 10.10 (1H, brs), 12.15 (1H, s)
197	4	ESI-: 563 NMR-DMSO-d6: 1.24 (3H, t, J = 7.2 Hz), 1.51-1.65 (2H, m), 1.89-2.01 (2H, m), 2.59-2.68 (1H, m), 3.15-3.43 (9H, m), 3.66-4.14 (4H, m), 4.37-4.48 (2H, m), 4.70-4.84 (2H, m), 7.63 (1H, d, J = 1.2 Hz), 7.74 (1H, d, J = 1.3 Hz), 8.39-8.41 (1H, m), 8.77 (1H, d, J = 1.1 Hz), 10.28 (1H, brs), 12.14 (1H, s)
198	4	ESI+: 623 NMR-DMSO-d6: 1.51-2.00 (8H, m), 2.58-2.69 (1H, m), 2.92-3.53 (5H, m), 3.82-4.35 (5H, m), 4.39-3.69 (4H, m), 4.94-5.12 (2H, m), 7.39 (1H, d, J = 8.7 Hz), 7.84-7.96 (2H, m), 8.38-8.41 (1H, m), 8.77 (1H, d, J = 1.2 Hz), 10.14 (1H, brs), 12.09 (1H, brs)
199	4	ESI+: 635 NMR-DMSO-d6: 1.52-1.69 (3H, m), 1.80-2.01 (4H, m), 2.06-2.16 (1H, m), 2.58-2.68 (1H, m), 3.16-3.28 (5H, m), 3.48-3.78 (4H, m), 3.94-4.01 (4H, m), 4.31-4.99 (6H, m), 7.39 (1H, d, J = 8.8 Hz), 7.92 (1H, d, J = 2.0 Hz), 8.03 (1H, dd, J = 8.6, 2.0 Hz), 8.39-8.40 (1H, m), 8.77 (1H, d, J = 1.2 Hz), 10.62 (1H, brs), 12.09 (1H, s)
200	4	ESI+: 619 NMR-DMSO-d6: 1.34 (3H, d, J = 6.4 Hz), 1.38 (3H, t, J = 6.9 Hz), 1.51-1.67 (3H, m), 1.84-1.99 (4H, m), 2.11-2.22 (1H, m), 2.59-2.68 (1H, m), 3.07-3.28 (3H, m), 3.38-3.55 (2H, m), 3.80-4.55 (7H, m), 4.71-4.80 (1H, m), 7.38 (1H, d, J = 8.7 Hz), 7.79-7.97 (2H, m), 8.38-8.42 (1H, m), 8.77 (1H, d, J = 1.1 Hz), 10.33 (1H, brs), 12.09 (1H, s)

[0257]

[Table 96]

Ex	Syn	DATA
201	4	ESI+: 651 NMR-DMSO-d6: 1.35 (3H, d, J = 6.5 Hz), 1.53-1.68 (3H, m), 1.86-1.99 (5H, m), 2.10-2.23 (3H, m), 2.60-2.67 (1H, m), 3.07-3.25 (3H, m), 3.38-3.55 (2H, m), 4.29 (2H, t, J = 6.0 Hz), 4.37-5.01 (7H, m), 7.42 (1H, d, J = 8.6 Hz), 7.92-8.00 (2H, m), 8.40 (1H, d, J = 1.0 Hz), 8.77 (1H, d, J = 1.0 Hz), 10.52 (1H, brs), 12.10 (1H, brs)
202	4	ESI+: 605 NMR-DMSO-d6: 1.34 (3H, d, J = 6.5 Hz), 1.51-1.68 (3H, m), 1.83-1.99 (4H, m), 2.12-2.22 (1H, m), 2.59-2.68 (1H, m), 3.07-3.27 (3H, m), 3.37-3.56 (2H, m), 3.62-3.92 (2H, m), 3.97 (3H, s), 4.38-4.52 (3H, m), 4.72-4.79 (1H, m), 7.40 (1H, d, J = 8.8 Hz), 7.92 (1H, d, J = 2.0 Hz), 7.95-7.99 (1H, m), 8.37-8.42 (1H, m), 8.77 (1H, d, J = 1.2 Hz), 10.25 (1H, brs), 12.10 (1H, s)
203	4	ESI+: 633 NMR-DMSO-d6: 0.80 (3H, t, J = 7.5 Hz), 1.38 (3H, t, J = 7.0 Hz), 1.48-1.66 (4H, m), 1.68-1.80 (1H, m), 1.83-1.99 (4H, m), 2.09-2.20 (1H, m), 2.58-2.69 (1H, m), 3.08-3.28 (4H, m), 3.44-3.56 (1H, m), 3.67-4.23 (2H, m), 4.25 (2H, q, J = 7.0 Hz), 4.37-4.80 (4H, m), 7.38 (1H, d, J = 8.7 Hz), 7.88-7.98 (2H, m), 8.37-8.43 (1H, m), 8.77 (1H, d, J = 1.1 Hz), 10.37 (1H, brs), 12.10 (1H, s)
204	4	ESI+: 705 NMR-DMSO-d6: 1.49-2.22 (10H, m), 2.38-3.65 (7H, m), 3.98-4.06 (1H, m), 4.23-4.32 (2H, m), 4.37-4.47 (2H, m), 4.54-4.72 (2H, m), 4.93-6.00 (2H, br), 7.35 (1H, d, J = 8.6 Hz), 7.91 (1H, d, J = 8.8 Hz), 7.95 (1H, s), 8.39 (1H, s), 8.75 (1H, s), 9.99-11.00 (1H, m), 11.62 (1H, s)
205	4	ESI+: 649 NMR-DMSO-d6: 1.34 (3H, d, J = 6.4 Hz), 1.51-1.67 (3H, m), 1.84-2.00 (4H, m), 2.10-2.22 (1H, m), 2.59-2.69 (1H, m), 3.06-3.27 (3H, m), 3.34 (3H, s), 3.38-3.55 (2H, m), 3.61-3.90 (4H, m), 4.29-4.35 (2H, m), 4.38-4.52 (3H, m), 4.71-4.79 (1H, m), 7.41 (1H, d, J = 8.8 Hz), 7.90-7.98 (2H, m), 8.38-8.42 (1H, m), 8.77 (1H, d, J = 1.2 Hz), 10.33 (1H, brs), 12.10 (1H, s)
206	8	ESI+: 547, 549 NMR-DMSO-d6: 1.16 (3H, d, J = 6.0 Hz), 1.34-1.44 (1H, m), 1.52-1.72 (4H, m), 1.90-2.01 (3H, m), 2.17-2.25 (1H, m), 2.54-2.68 (2H, m), 3.00-3.06 (1H, m), 3.17-3.26 (2H, m), 3.59 (1H, d, J = 14.9 Hz), 4.19 (1H, d, J = 14.9 Hz), 4.37-4.45 (2H, m), 7.45 (1H, d, J = 1.5 Hz), 7.58 (1H, d, J = 1.4 Hz), 8.38 (1H, d, J = 1.2 Hz), 8.74 (1H, d, J = 1.2 Hz), 11.57 (1H, brs), 12.20-12.45 (1H, br) m.p.: 201°C

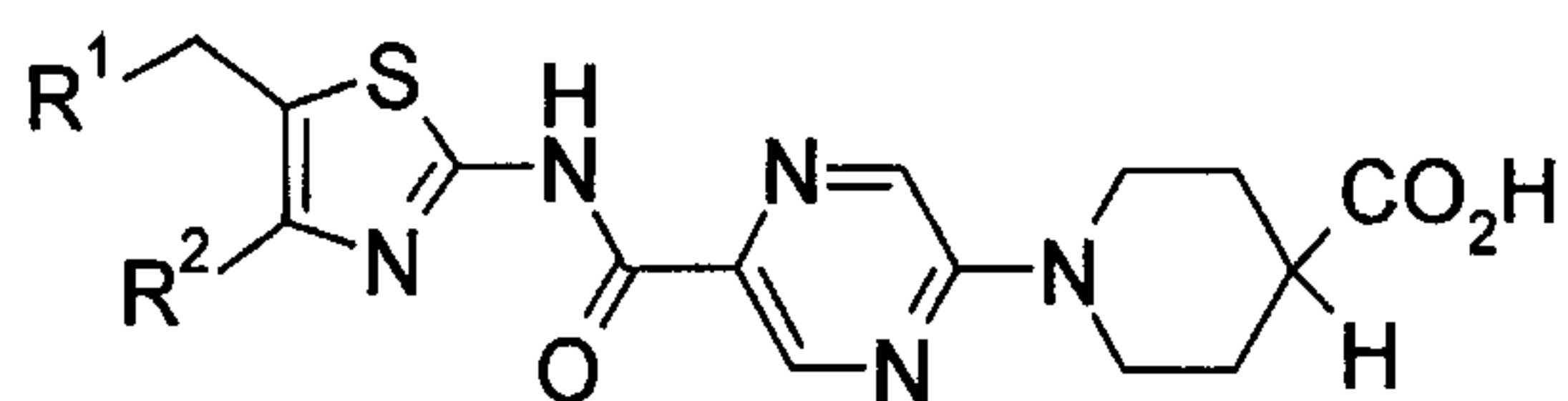
[0258]

[Table 97]

Ex	Syn	DATA
207	8	ESI+: 619 NMR-DMSO-d6: 1.09 (3H, d, J = 6.0 Hz), 1.25-1.67 (8H, m), 1.90-1.99 (2H, m), 2.07-2.14 (1H, m), 2.33-2.68 (2H, m), 2.73-2.79 (1H, m), 3.17-3.40 (2H, m), 3.49 (1H, d, J = 14.4 Hz), 3.90 (3H, s), 4.14 (1H, d, J = 14.5 Hz), 4.38-4.46 (2H, m), 7.23 (1H, s), 7.60 (1H, s), 7.78 (1H, s), 8.39 (1H, s), 8.75 (1H, s), 11.58 (1H, s), 12.22-12.45 (1H, br) m.p.:136°C

[0259]

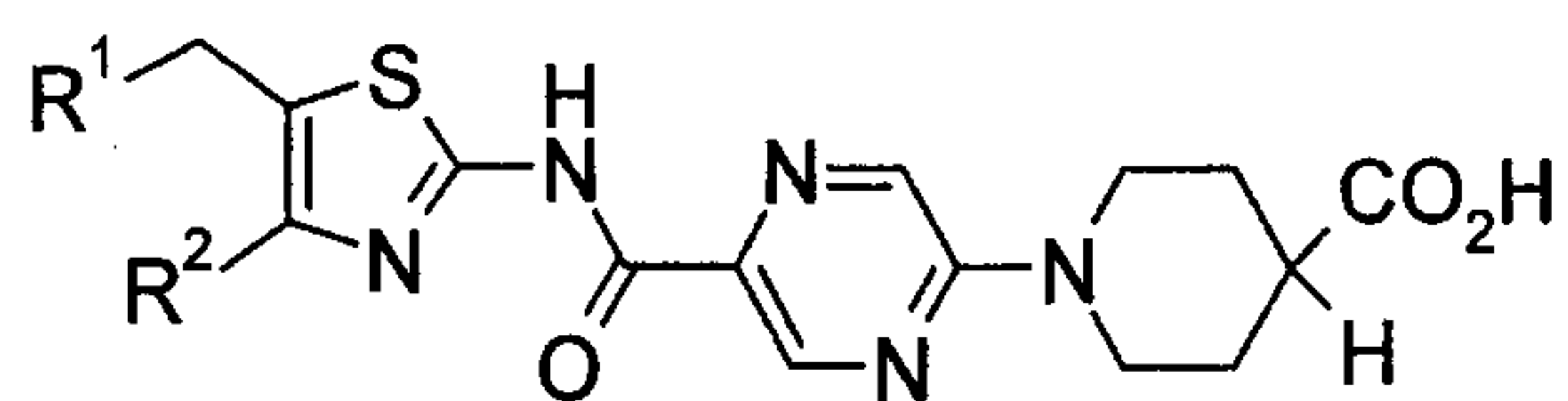
[Table 98]



No.	R1	R2	No.	R1	R2
A1			A8		
A2			A9		
A3			A10		
A4			A11		
A5			A12		
A6			A13		
A7			A14		

[0260]

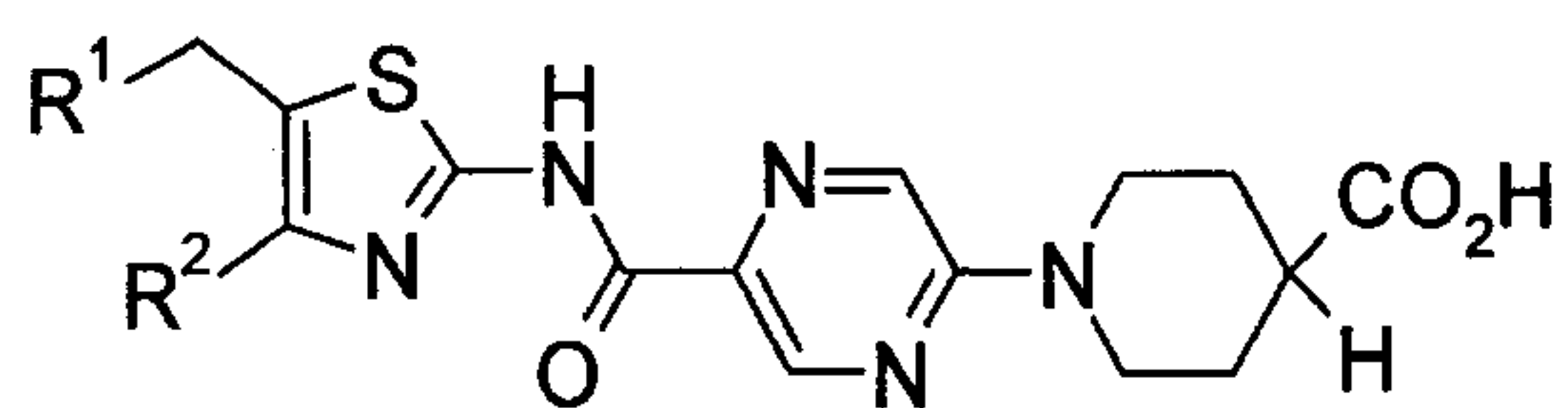
[Table 99]



No.	R1	R2	No.	R1	R2
A15			A23		
A16			A24		
A17			A25		
A18			A26		
A19			A27		
A20			A28		
A21			A29		
A22			A30		

[0261]

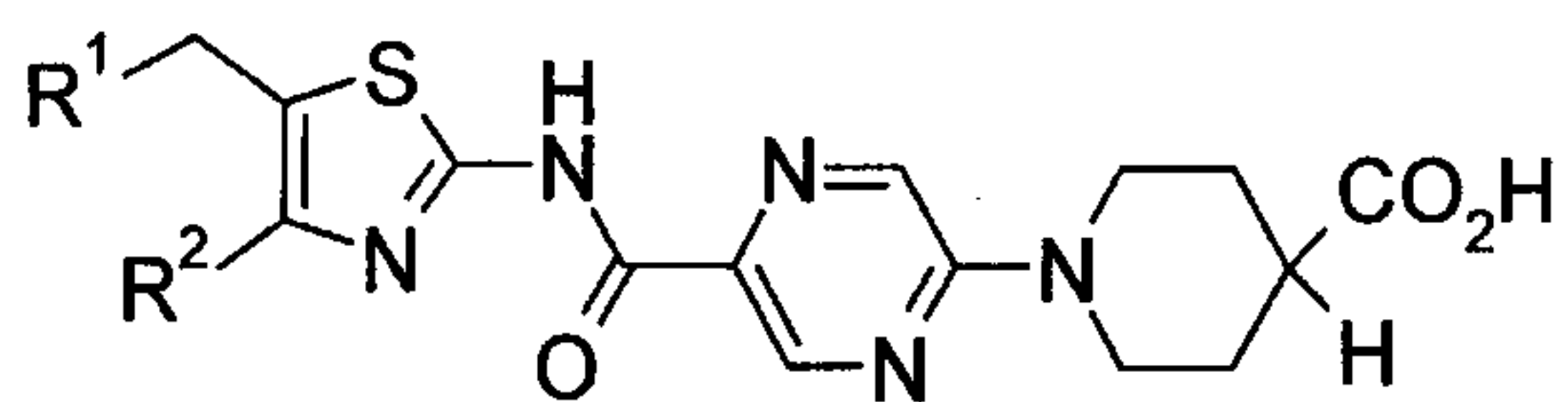
[Table 100]



No.	R1	R2	No.	R1	R2
B1			B8		
B2			B9		
B3			B10		
B4			B11		
B5			B12		
B6			B13		
B7			B14		

[0262]

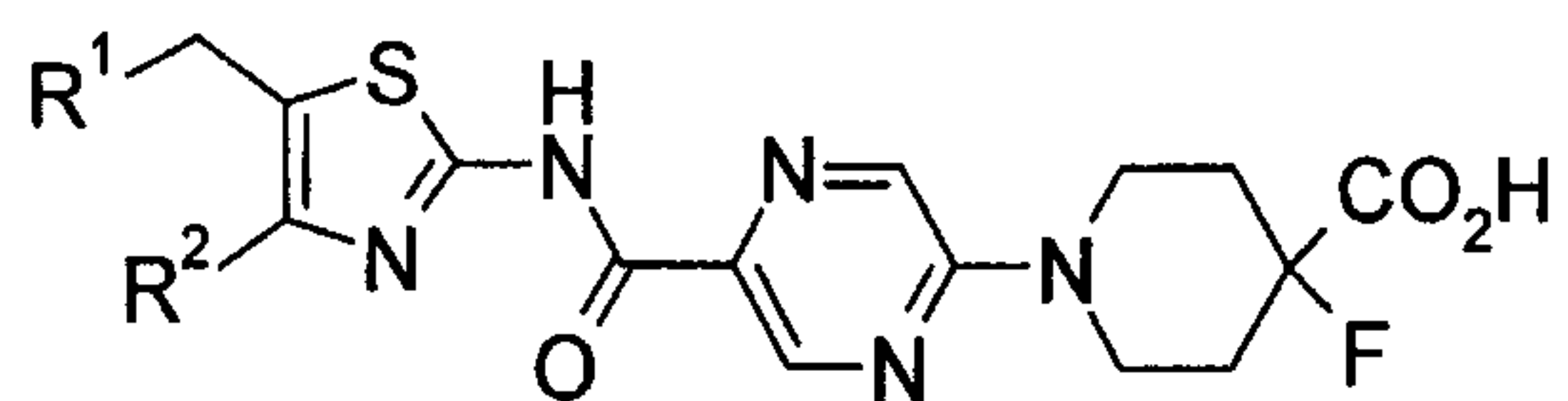
[Table 101]



No.	R1	R2	No.	R1	R2
B15			B23		
B16			B24		
B17			B25		
B18			B26		
B19			B27		
B20			B28		
B21			B29		
B22			B30		

[0263]

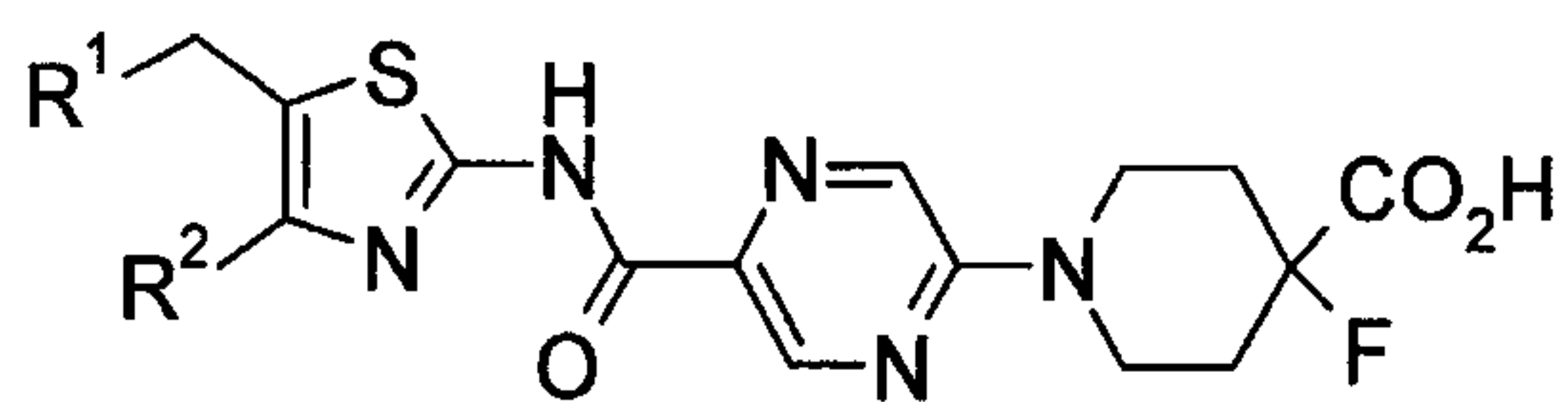
[Table 102]



No.	R1	R2	No.	R1	R2
C1			C8		
C2			C9		
C3			C10		
C4			C11		
C5			C12		
C6			C13		
C7			C14		

[0264]

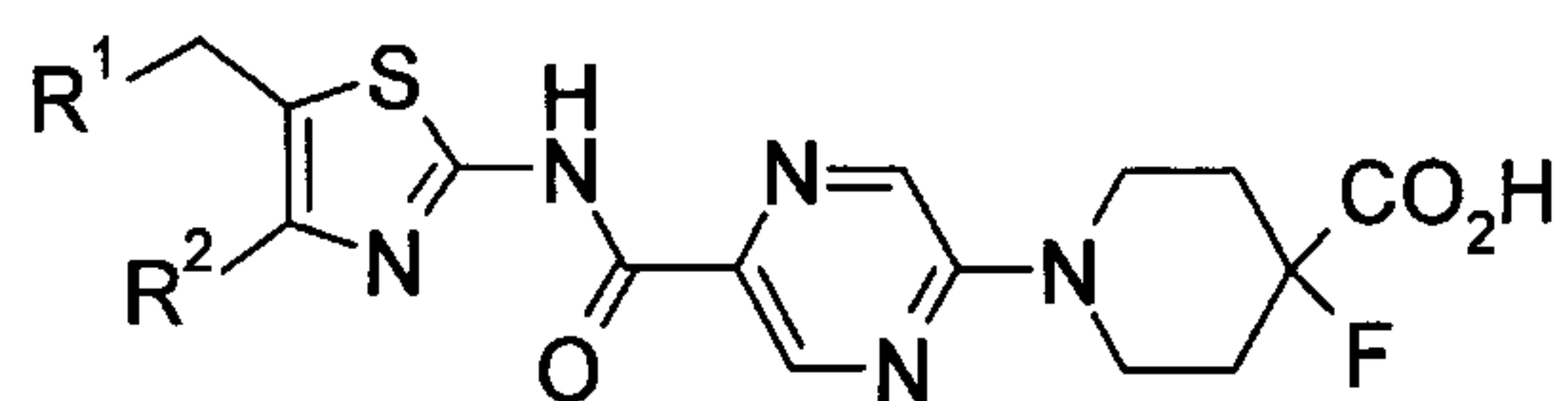
[Table 103]



No.	R1	R2	No.	R1	R2
C15			C23		
C16			C24		
C17			C25		
C18			C26		
C19			C27		
C20			C28		
C21			C29		
C22			C30		

[0265]

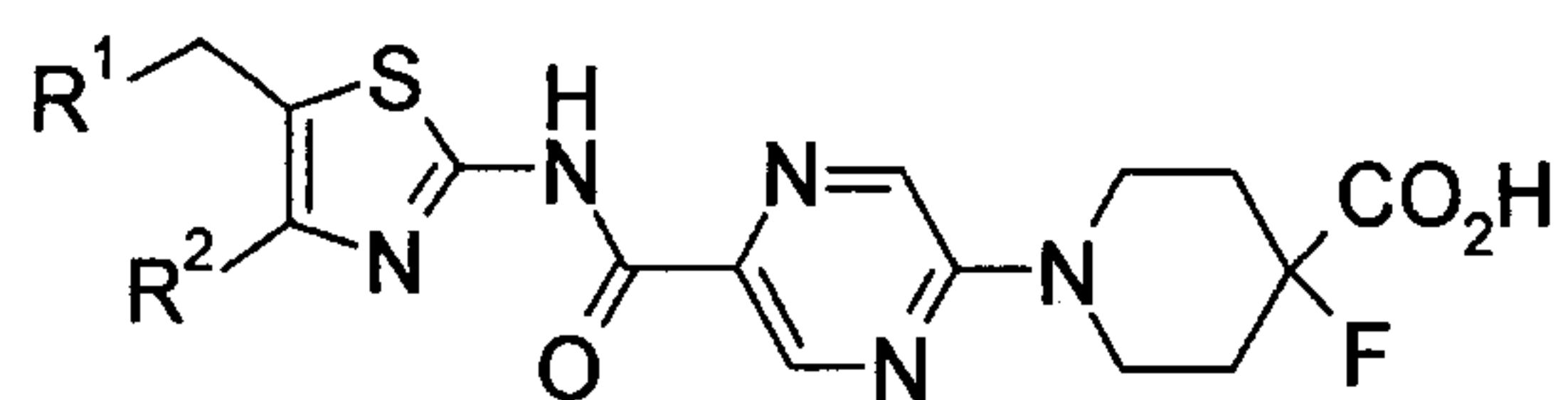
[Table 104]



No.	R1	R2	No.	R1	R2
D1			D8		
D2			D9		
D3			D10		
D4			D11		
D5			D12		
D6			D13		
D7			D14		

[0266]

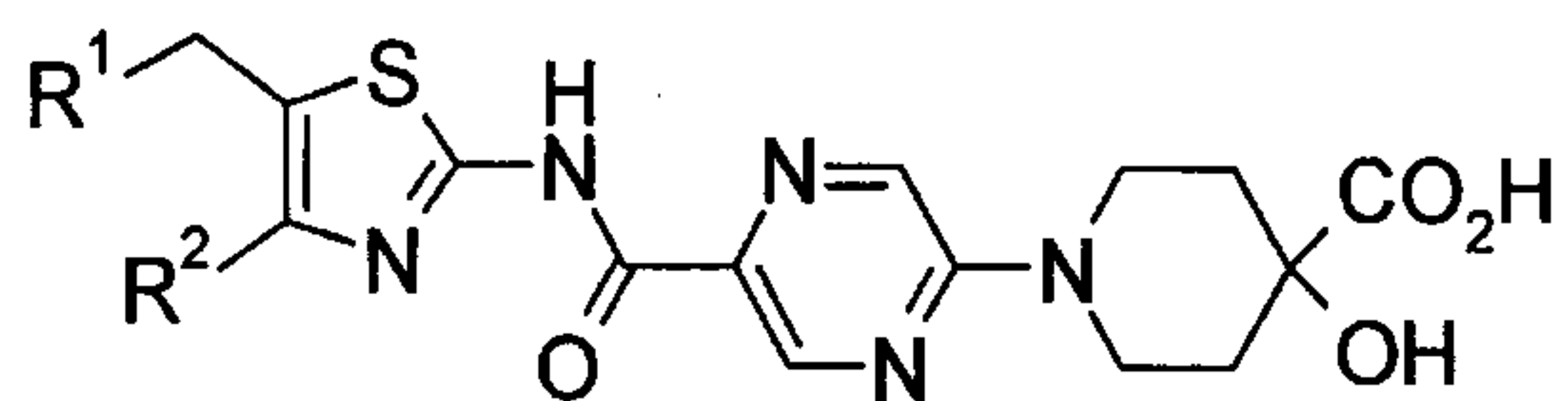
[Table 105]



No.	R1	R2	No.	R1	R2
D15			D23		
D16			D24		
D17			D25		
D18			D26		
D19			D27		
D20			D28		
D21			D29		
D22			D30		

[0267]

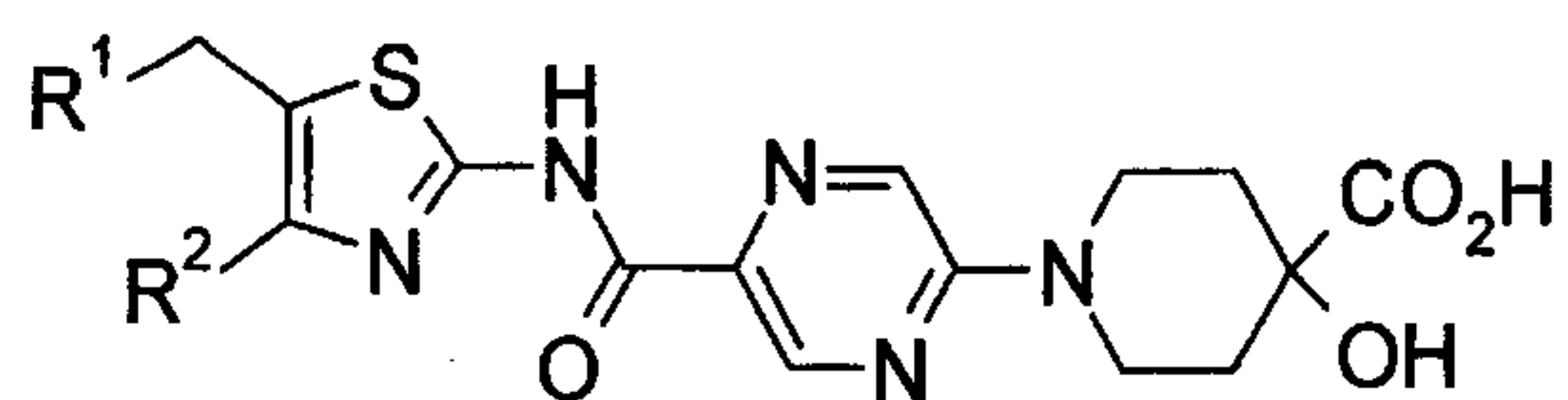
[Table 106]



No.	R1	R2	No.	R1	R2
F1			F8		
F2			F9		
F3			F10		
F4			F11		
F5			F12		
F6			F13		
F7			F14		

[0268]

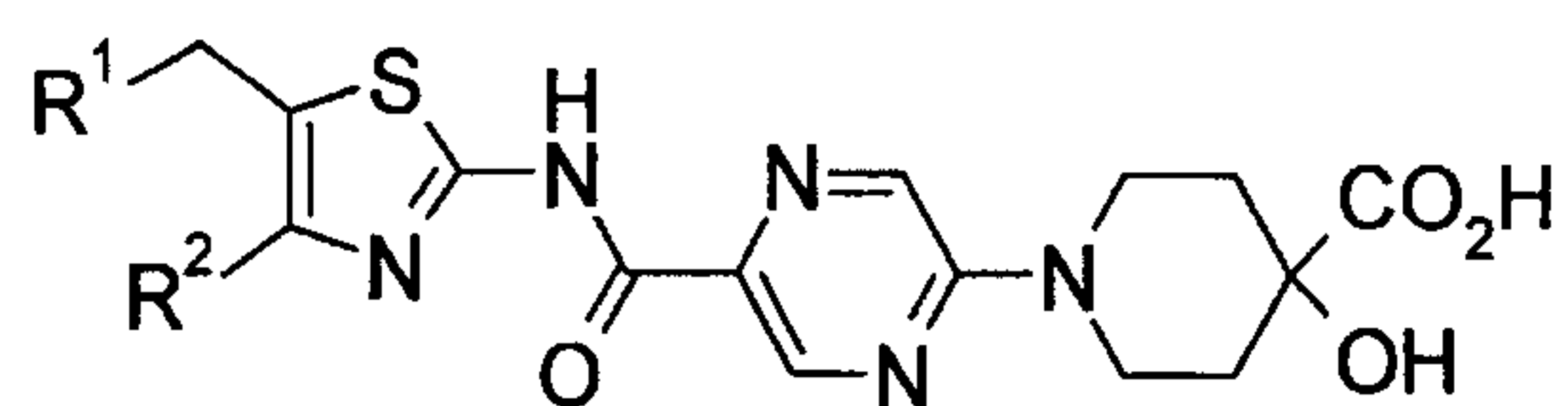
[Table 107]



No.	R1	R2	No.	R1	R2
F15			F23		
F16			F24		
F17			F25		
F18			F26		
F19			F27		
F20			F28		
F21			F29		
F22			F30		

[0269]

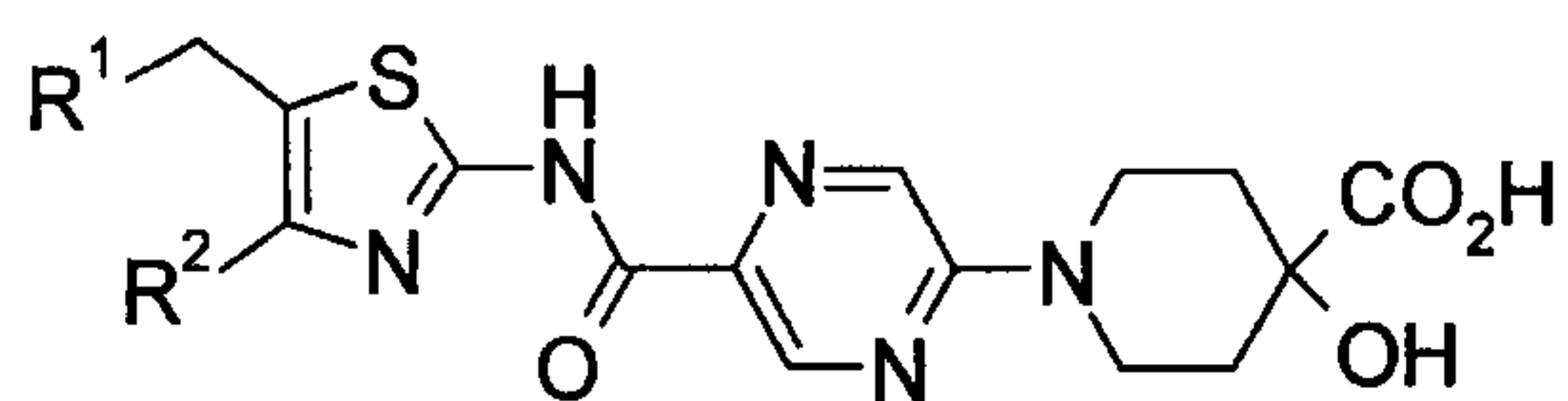
[Table 108]



No.	R1	R2	No.	R1	R2
H1			H8		
H2			H9		
H3			H10		
H4			H11		
H5			H12		
H6			H13		
H7			H14		

[0270]

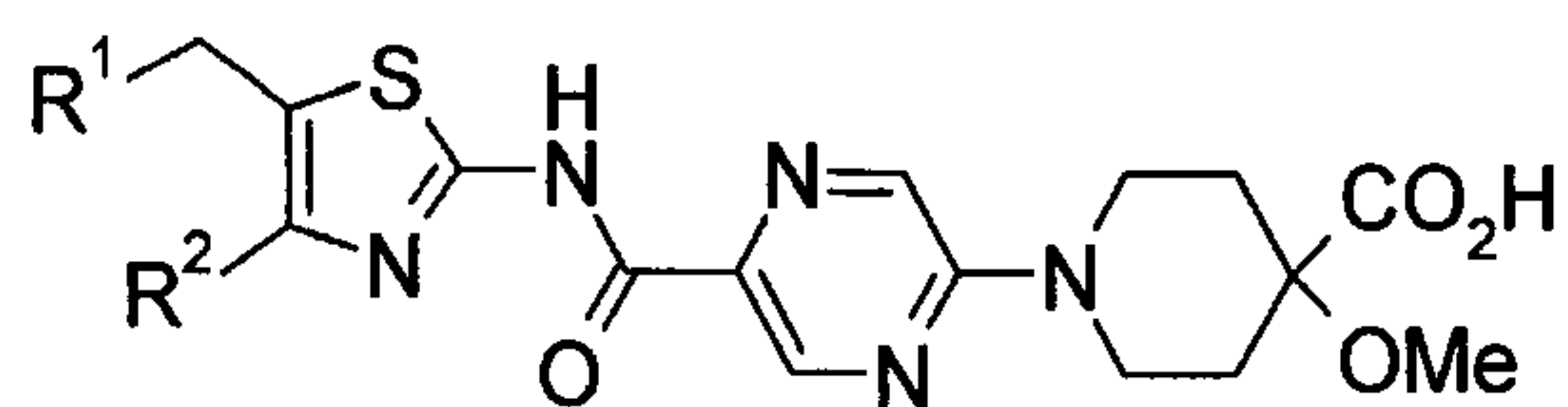
[Table 109]



No.	R1	R2	No.	R1	R2
H15			H23		
H16			H24		
H17			H25		
H18			H26		
H19			H27		
H20			H28		
H21			H29		
H22			H30		

[0271]

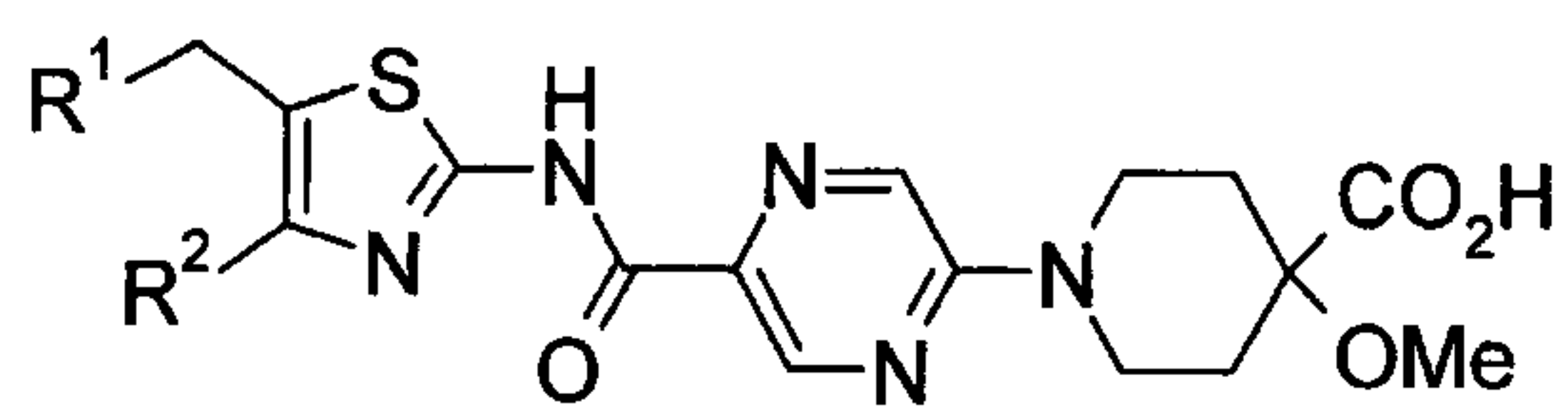
[Table 110]



No.	R1	R2	No.	R1	R2
I1			I8		
I2			I9		
I3			I10		
I4			I11		
I5			I12		
I6			I13		
I7			I14		

[0272]

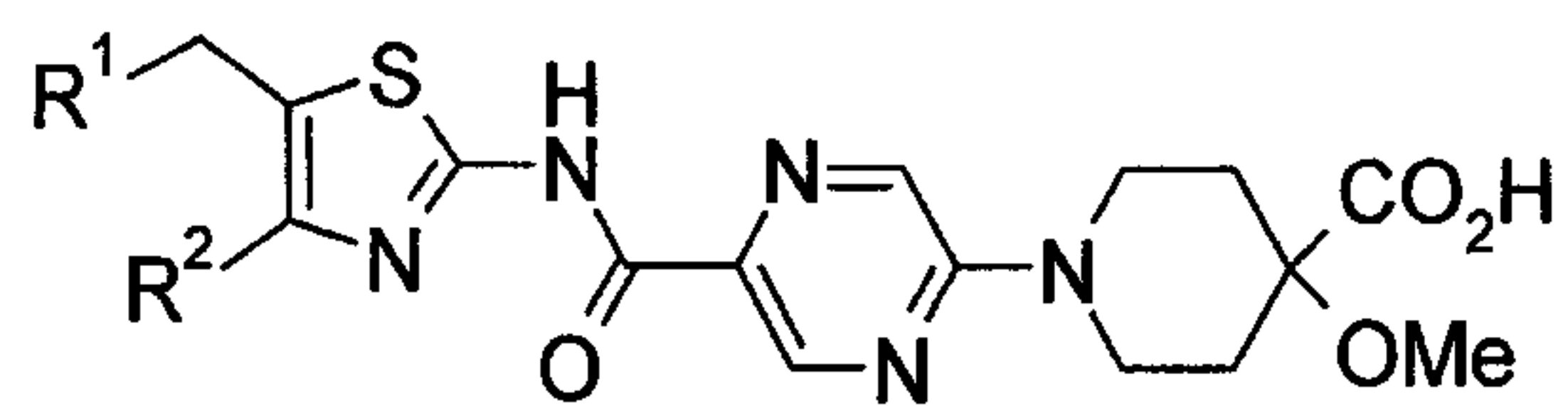
[Table 111]



No.	R1	R2	No.	R1	R2
I15			I23		
I16			I24		
I17			I25		
I18			I26		
I19			I27		
I20			I28		
I21			I29		
I22			I30		

[0273]

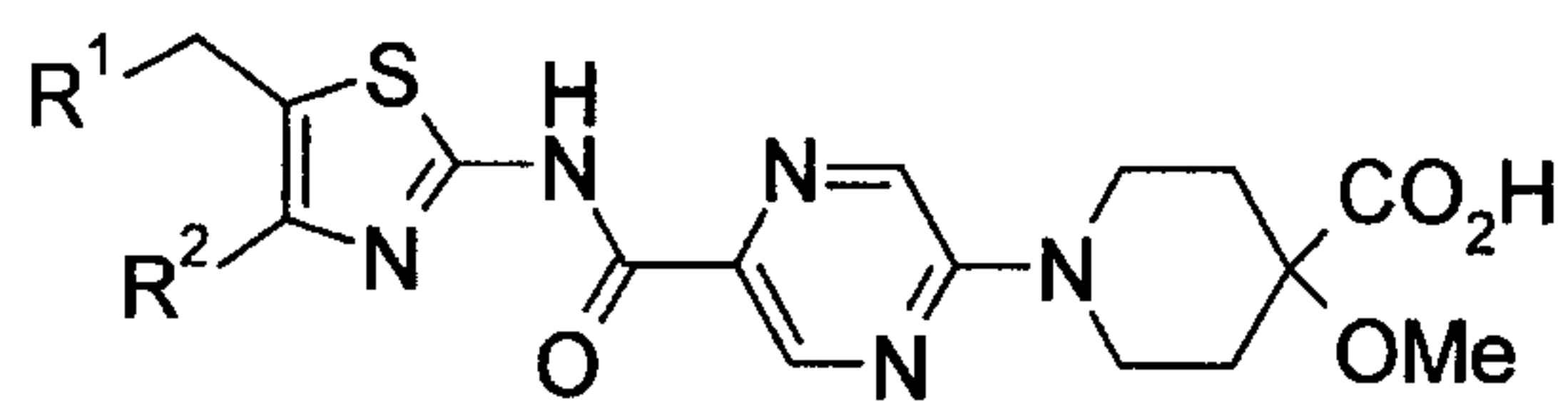
[Table 112]



No.	R1	R2	No.	R1	R2
J1			J8		
J2			J9		
J3			J10		
J4			J11		
J5			J12		
J6			J13		
J7			J14		

[0274]

[Table 113]



No.	R1	R2	No.	R1	R2
J15			J23		
J16			J24		
J17			J25		
J18			J26		
J19			J27		
J20			J28		
J21			J29		
J22			J30		

Industrial Applicability**[0275]**

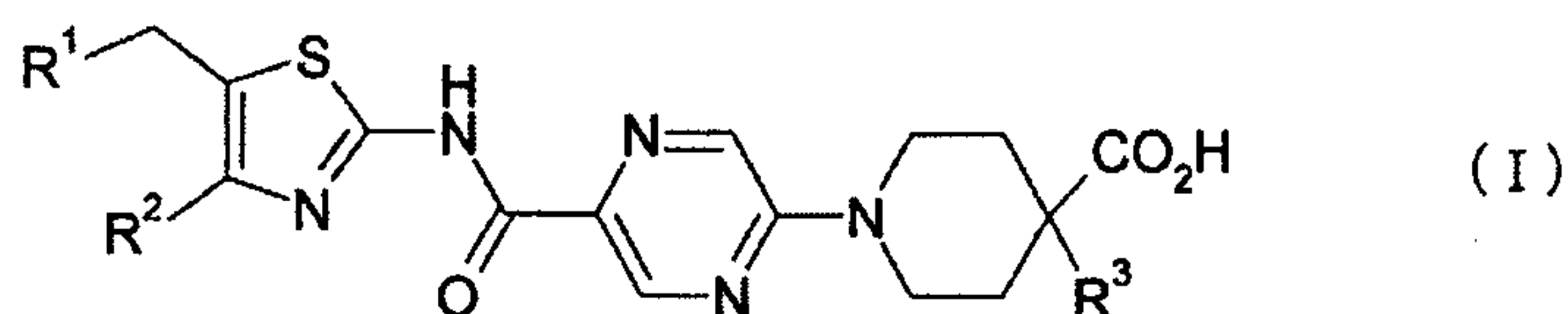
The compound of the formula (I) or a salt thereof can be used as an agent for preventing and/or treating bladder or urinary tract diseases, related to bladder contraction
5 by a muscarinic M₃ receptor, as a muscarinic M₃ receptor positive allosteric modulator.

Claims

[Claim 1] A compound of the formula (I) or a salt thereof:

[Chem. 9]

5



wherein

R¹ is -N(-R¹¹)(-R¹²), or cyclic amino which may be substituted;

R¹¹ is C₁₋₆ alkyl;

10 R¹² is C₁₋₆ alkyl which may be substituted, or C₃₋₈ cycloalkyl which may be substituted;

R² is aryl which may be substituted, a monocyclic aromatic hetero ring which may be substituted, or a bicyclic aromatic hetero ring which may be substituted; and

R³ is -H, -OH, -O-(C₁₋₆ alkyl), or halogen.

15

[Claim 2] The compound or a salt thereof according to claim 1, wherein R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl, piperidin-1-yl, azetidin-1-yl, and morpholin-4-yl, or -N(-R¹¹)(-R¹²), and the cyclic amino may be substituted with the same or different 1 to 3 substituent(s) selected from a Group G1,

20 in which the Group G1 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -OH, -O-(C₁₋₆ alkyl), and halogen; -O-(C₁₋₆ alkyl); C₃₋₈ cycloalkyl; halogen; and -CN;

R¹¹ is C₁₋₆ alkyl;

25 R¹² is C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl), or C₃₋₈ cycloalkyl which may be substituted with C₁₋₆ alkyl substituted with -O-(C₁₋₆ alkyl);

R² is phenyl which may be substituted with the same or different 1 to 5 substituent(s) selected from a Group G2, thienyl which may be substituted with the same or different 1 to 3 substituent(s) selected from a Group G3, thiazolyl which may be substituted with the same or different 1 to 2 substituent(s) selected from the Group G3, or 2,3-dihydrobenzofuranyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the Group G3,

30 in which the Group G2 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the group

35

consisting of halogen and -O-(C₁₋₆ alkyl)); an -O-saturated hetero ring, halogen; -N(C₁₋₆ alkyl)₂; -NH(C₁₋₆ alkyl); -NH₂; and cyclic amino, and

the Group G3 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s)); halogen; -N(C₁₋₆ alkyl)₂; -NH(C₁₋₆ alkyl); -NH₂; and cyclic amino; and

R³ is -H, -OH, methoxy, or fluoro.

[Claim 3] The compound or a salt thereof according to claim 2, wherein R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 5 substituent(s) selected from a group G21 and the thienyl may be substituted with the same or different 1 to 3 substituent(s) selected from a group G32,

in which the Group G21 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the group consisting of halogen and -O-(C₁₋₆ alkyl)); an -O-saturated hetero ring; halogen; -N(C₁₋₆ alkyl)₂; and cyclic amino; and

the Group G32 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); and halogen.

20

[Claim 4] The compound or a salt thereof according to claim 3, wherein R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, or -N(-R¹¹)(-R¹²), and the cyclic amino may be substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of -O-(C₁₋₆ alkyl) and halogen;

R¹² is C₁₋₆ alkyl which may be substituted with -O-(C₁₋₆ alkyl);

R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 5 substituent(s) selected from a Group G22 and the thienyl may be substituted with the same or different 1 to 3 halogen(s),

in which the group G22 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -O-(C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 substituent(s) selected from the group consisting of halogen and -O-(C₁₋₆ alkyl)); halogen; and -N(C₁₋₆ alkyl)₂; and

R³ is -H, -OH, or fluoro.

35

[Claim 5] The compound or a salt thereof according to claim 4, wherein R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the

cyclic amino is substituted with C₁₋₆ alkyl which may be substituted with the same or different 1 to 3 -O-(C₁₋₆ alkyl) group(s);

R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 3 substituent(s) selected from a Group G24 and the thienyl may be substituted with the same or different 1 to 3 halogen(s),

in which the Group G24 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); -O-(C₁₋₆ alkyl); and halogen; and R³ is -H.

[Claim 6] The compound or a salt thereof according to claim 5, wherein R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the cyclic amino is substituted with C₁₋₆ alkyl; and

R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 3 substituent(s) selected from a Group G25 and the thienyl may be substituted with the same or different 1 to 3 halogen(s),

in which the Group G25 is a group consisting of C₁₋₆ alkyl which may be substituted with the same or different 1 to 5 halogen(s); and -O-(C₁₋₆ alkyl).

[Claim 7] The compound or a salt thereof according to claim 6, wherein R¹ is cyclic amino selected from the group consisting of pyrrolidin-1-yl and piperidin-1-yl, and the cyclic amino is substituted with the same or different 1 to 3 substituent(s) selected from the group consisting of methyl and ethyl; and

R² is phenyl or thienyl, in which the phenyl may be substituted with the same or different 1 to 2 substituent(s) selected from the group consisting of trifluoromethyl and methoxy, and the thienyl may be substituted with one chloro.

[Claim 8] The compound or a salt thereof according to claim 7, wherein R² is phenyl which may be substituted with the same or different 1 to 2 substituent(s) selected from the group consisting of trifluoromethyl and methoxy.

[Claim 9] The compound or a salt thereof according to claim 7, wherein R² is thienyl which may be substituted with one chloro.

[Claim 10] The compound or a salt thereof according to claim 1, wherein the compound is a compound selected from the following group:

1-{5-[(4-[3-methoxy-5-(trifluoromethyl)phenyl]-5-[(2R)-2-methylpiperidin-1-yl]methyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid,

1-(5-{[4-(4-chloro-2-thienyl)-5-{[(2R)-2-methylpyrrolidin-1-yl]methyl}-1,3-thiazol-2-yl]carbamoyl}pyrazin-2-yl)piperidine-4-carboxylic acid,

1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[3-fluoro-5-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid, and

1-{5-[(5-{[(2R)-2-ethylpyrrolidin-1-yl]methyl}-4-[4-methoxy-3-(trifluoromethyl)phenyl]-1,3-thiazol-2-yl)carbamoyl]pyrazin-2-yl}piperidine-4-carboxylic acid.

10 [Claim 11] A pharmaceutical composition comprising the compound or a salt thereof according to claim 1, and a pharmaceutically acceptable excipient.

[Claim 12] The pharmaceutical composition according to claim 11, for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor.

[Claim 13] The pharmaceutical composition according to claim 11, for preventing or treating voiding dysfunctions or storage dysfunctions in underactive bladder, hypotonic bladder, acontractile bladder, detrusor underactivity, or neurogenic bladder.

20 [Claim 14] Use of the compound or a salt thereof according to claim 1, for the manufacture of a pharmaceutical composition for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor.

25 [Claim 15] Use of the compound or a salt thereof according to claim 1, for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor.

30 [Claim 16] The compound or a salt thereof according to claim 1, for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor.

35 [Claim 17] A method for preventing or treating bladder or urinary tract diseases, related to bladder contraction by a muscarinic M₃ receptor, comprising administering to a subject an effective amount of the compound or a salt thereof according to claim 1.

Fig. 1

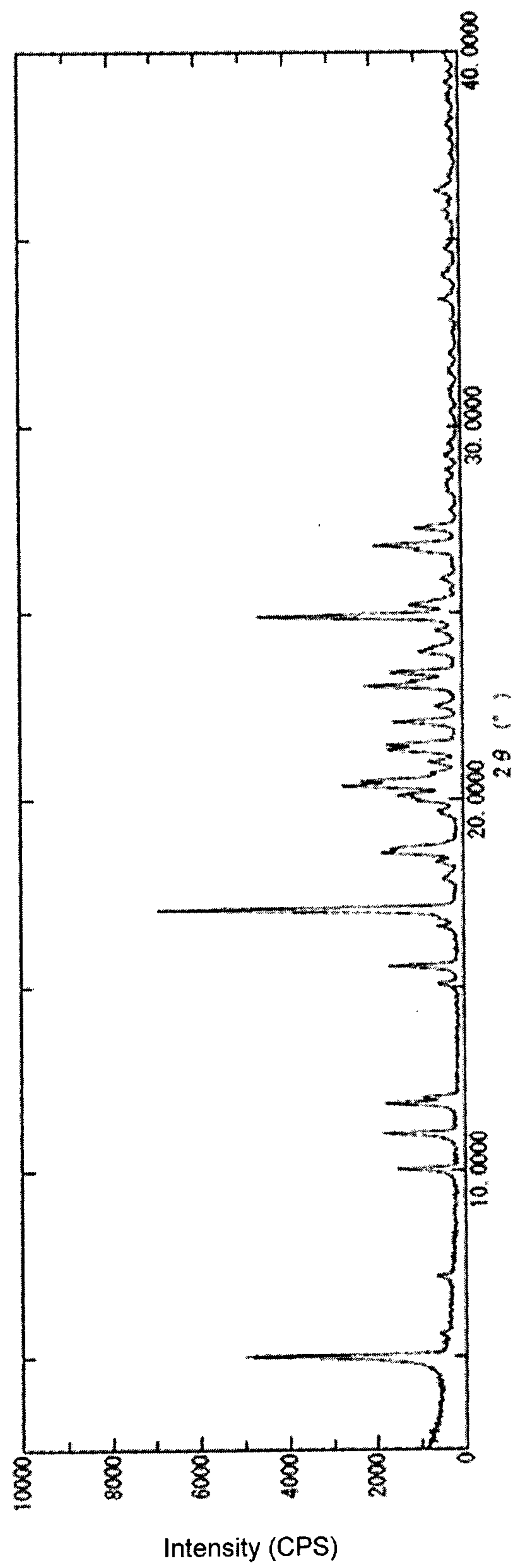


Fig. 2

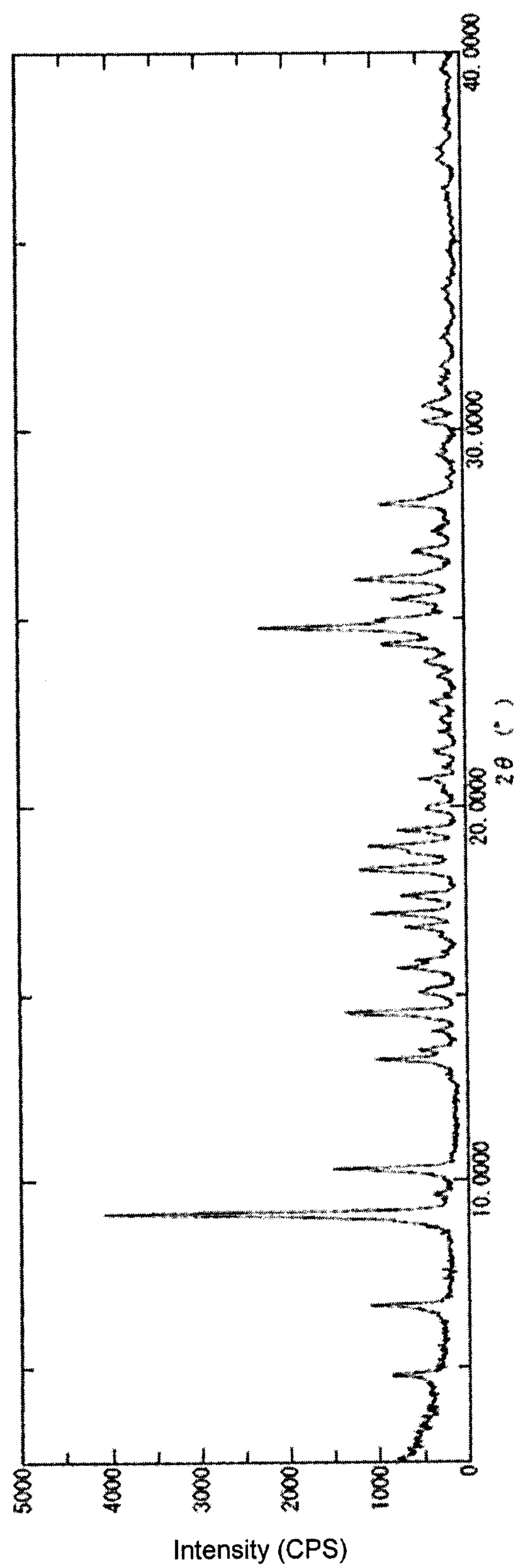


Fig. 3

