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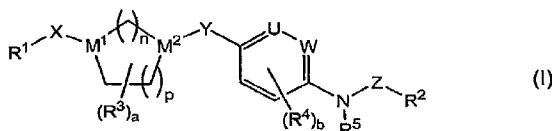
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(54) Title: SUBSTITUTED ANILINE DERIVATIVES USEFUL AS HISTAMINE H<sub>3</sub> ANTAGONISTS

(57) Abstract: Disclosed are compounds of the formula Chemical formula (I) or a pharmaceutically acceptable salt thereof, wherein M<sup>1</sup> is N; X is a bond, optionally substituted alkylene, alkenylene, -O-, -CH<sub>2</sub>N(R<sup>12</sup>)-, -N(R<sup>12</sup>)CH<sub>2</sub>-, -N(R<sup>12</sup>)-, -NHC(O)-, -OCH<sub>2</sub>-, -CH<sub>2</sub>O-, or -S(O)<sub>0-2</sub>-; and Y is -(CH<sub>2</sub>)<sub>1-2</sub>-, -C(=O)-, -C(=NOR<sup>13</sup>)- or -SO<sub>0-2</sub>-; or M<sup>1</sup> is N; M<sup>2</sup> is N or CH; X is a bond, alkylene, alkenylene, -C(O)-, -NHC(O)-, -OC(O)- or -S(O)<sub>1-2</sub>-; Y is -(CH<sub>2</sub>)<sub>1-2</sub>-, -C(=O)- or -SO<sub>0-2</sub>-; and when M<sup>2</sup> is CH, Y is also Y is -O- or -C(=NOR<sup>13</sup>)-; Z is a bond or optionally substituted alkylene or alkenylene; U and W are CH, or one is CH and one is N; R<sup>1</sup> is optionally substituted alkyl, cycloalkyl, aryl, arylalkyl, heteroaryl, heterocycloalkyl; R<sup>2</sup> is optionally substituted alkyl, alkenyl, aryl, arylalkyl, heteroaryl, heteroarylalkyl, cycloalkyl or heterocycloalkyl; and the remaining variables are as defined in the specification; and compositions and methods of treating obesity, metabolic syndrome and a cognition deficit disorder, alone or in combination with other agents.



In the periphery, H<sub>3</sub> receptor sites are found on sympathetic nerves, where they modulate sympathetic neurotransmission and attenuate a variety of end organ responses under control of the sympathetic nervous system. Specifically, H<sub>3</sub> receptor activation by histamine attenuates norepinephrine outflow to resistance and capacitance vessels, causing vasodilation. In addition, in rodents, peripheral H<sub>3</sub> receptors are expressed in brown adipose tissue, suggesting that they may be involved in thermogenesis regulation.

H<sub>3</sub> receptors are also present in the CNS. H<sub>3</sub> receptor expression is observed in cerebral cortex, hippocampal formation, hypothalamus and other parts of the human and animal brain. H<sub>3</sub> receptors are expressed on histaminergic neurons and, as heteroreceptors, on neurons involved in other neurotransmitter systems, where H<sub>3</sub> receptor activation results in presynaptic inhibition of neurotransmitter release. In the particular case of histaminergic neurons, H<sub>3</sub> receptors have been implicated in the regulation of histamine hypothalamic tone, which in turn has been associated with the modulation of sleeping, feeding and cognitive processes in the human brain (see, for example, Leurs et al., *Nature Reviews, Drug Discovery*, 4, (2005), 107).

It is also known and has been described in the literature that histamine is involved in regulation of cognitive and memory processes in the human brain (see, for example, *Life Sciences*, 72, (2002), 409-414). Consequently, indirect modulation of histaminergic brain function through the central H<sub>3</sub> receptors may be a means to modulate these processes. Different classes of H<sub>3</sub> receptor ligands have been described and their use for neurological and psychiatric diseases has been suggested (see, e.g., US 20040224953, WO2004089373, WO2004101546). H<sub>3</sub> receptor antagonists may be useful in treating various neuropsychiatric conditions, where cognitive deficits are an integral part of the disease, specifically ADHD, schizophrenia and Alzheimer's disease (see, for example, Hancock, A.; Fox, G. in *Drug Therapy* (ed. Buccafusco, J.J.). (Birkhauser, Basel, 2003).

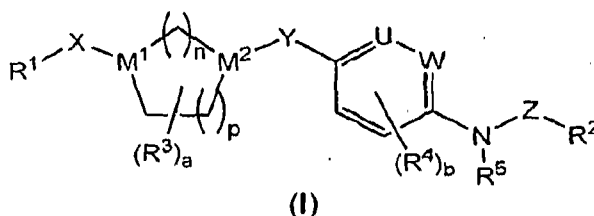
Imidazole H<sub>3</sub> receptor antagonists are well known in the art. More recently, non-imidazole H<sub>3</sub> receptor antagonists have been disclosed in US Patents 6,720,328 and 6,849,621, and in US Published Applications 2004/0097483, 2004/0048843 and 2004/0019099.

US 5,869,479 discloses compositions for the treatment of the symptoms of allergic rhinitis using a combination of at least one histamine H<sub>1</sub> receptor antagonist and at least one histamine H<sub>3</sub> receptor antagonist.

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### SUMMARY OF THE INVENTION

The present invention provides compounds of formula (I):



or a pharmaceutically acceptable salt thereof, wherein:

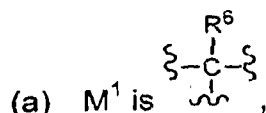
10

a is 0, 1 or 2;

b is 0, 1, 2, 3 or 4;

U and W are each CH, or one of U and W is CH and the other is N;

M<sup>1</sup>, M<sup>2</sup>, n, p, X and Y are as defined in (a), (b) or (c):



15

M<sup>2</sup> is N

n is 1 or 2; p is 0, 1 or 2;

X is a bond, alkylene, alkenylene, -C(O)-, -C(R<sup>8</sup>)(R<sup>9</sup>)-, -C(=N-OR<sup>10</sup>)-, -C(=N-OR<sup>10</sup>)-CH(R<sup>11</sup>)-, -CH(R<sup>11</sup>)-C(N-OR<sup>10</sup>)-, -O-, -CH<sub>2</sub>N(R<sup>12</sup>)-, -N(R<sup>12</sup>)CH<sub>2</sub>-, -N(R<sup>12</sup>)-, -NHC(O)-, -OCH<sub>2</sub>-, -CH<sub>2</sub>O-, -CH(OH)-, -S-, -S(O)- or -S(O)<sub>2</sub>-; and

20

Y is -CH<sub>2</sub>-, -(CH<sub>2</sub>)<sub>2</sub>-, -C(=O)-, -C(=NOR<sup>13</sup>)-, -S-, -S(O)- or -SO<sub>2</sub>-;

(b) M<sup>1</sup> is N

M<sup>2</sup> is N;

n is 2; p is 1 or 2;

X is a bond, alkylene, alkenylene, -C(O)-, -NHC(O)-, -OC(O)-, -S(O)- or -S(O)<sub>2</sub>-; and

25

Y is -CH<sub>2</sub>-, -(CH<sub>2</sub>)<sub>2</sub>-, -C(=O)-, -S-, -S(O)- or -SO<sub>2</sub>-;

(c) M<sup>1</sup> is N

M<sup>2</sup> is CH;

n is 1 or 2; p is 0, 1 or 2;

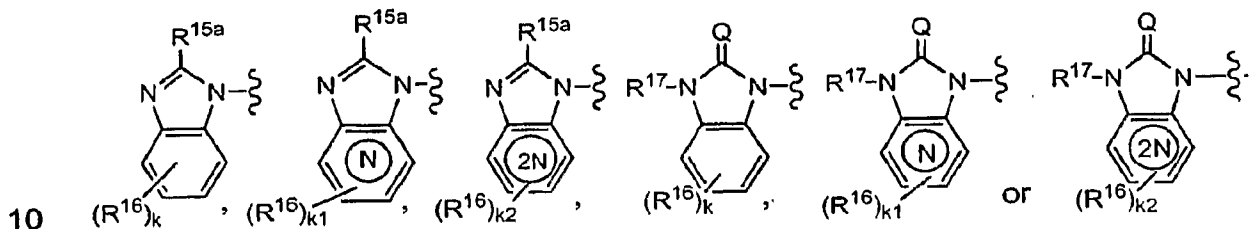
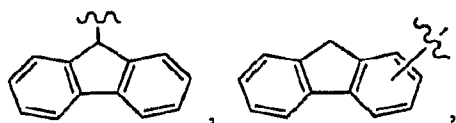
X is a bond, alkylene, alkenylene, -C(O)-, -NHC(O)-, -OC(O)-, -S(O)- or -S(O)<sub>2</sub>-; and

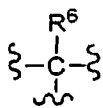
Y is -O-, -CH<sub>2</sub>-, -(CH<sub>2</sub>)<sub>2</sub>-, -C(=O)-, -C(=NOR<sup>13</sup>)-, -S-, -S(O)- or -SO<sub>2</sub>-;

Z is a bond, -CH(R<sup>14</sup>)-(R<sup>14a</sup>-(C<sub>1</sub>-C<sub>4</sub>)alkylene)- or -CH(R<sup>14</sup>)-CH(R<sup>14b</sup>)=CH(R<sup>14b</sup>)-

5 (R<sup>14a</sup>-(C<sub>1</sub>-C<sub>2</sub>)alkylene)-;

R<sup>1</sup> is R<sup>15</sup>-alkyl, R<sup>15</sup>-cycloalkyl, R<sup>15</sup>-aryl, R<sup>15</sup>-arylalkyl, R<sup>15</sup>-(6-membered heteroaryl), R<sup>15</sup>-(6-membered heteroaryl)alkyl, R<sup>15</sup>-(5-membered heteroaryl), R<sup>15</sup>-(5-membered heteroaryl)alkyl, R<sup>15</sup>-heterocycloalkyl, diphenylmethyl,



provided that when R<sup>1</sup> is attached to X by a nitrogen atom and M<sup>1</sup> is , X is a bond or alkylene; and provided that when R<sup>1</sup> is attached to X by a nitrogen atom and M<sup>1</sup> is N, X is -(CH<sub>2</sub>)<sub>2-6</sub>;

k is 0, 1, 2, 3 or 4;

15 k<sub>1</sub> is 0, 1, 2 or 3;

k<sub>2</sub> is 0, 1 or 2;

Q is O or S;

R<sup>2</sup> is R<sup>18</sup>-alkyl, R<sup>18</sup>-alkenyl, R<sup>18</sup>-aryl, R<sup>18</sup>-arylalkyl, R<sup>18</sup>-heteroaryl, R<sup>18</sup>-heteroarylalkyl, R<sup>18</sup>-cycloalkyl or R<sup>18</sup>-heterocycloalkyl;

20 each R<sup>3</sup> is independently selected from the group consisting of H, halo, alkyl, haloalkyl, -OH, alkoxy and -CN;

each R<sup>4</sup> is independently selected from the group consisting of H, alkyl, -OH, alkoxy, halo, -CF<sub>3</sub>, -OCF<sub>3</sub>, -NO<sub>2</sub>, -CO<sub>2</sub>R<sup>19</sup>, -N(R<sup>19</sup>)<sub>2</sub>, -CON(R<sup>19</sup>)<sub>2</sub>, -NHC(O)R<sup>19</sup>, -NHSO<sub>2</sub>R<sup>19</sup>, -SO<sub>2</sub>N(R<sup>19</sup>)<sub>2</sub> and -CN;

25 R<sup>5</sup> is H, alkyl, haloalkyl, R<sup>21</sup>-cycloalkyl, R<sup>21</sup>-aryl, R<sup>21</sup>-heteroaryl or -C(O)R<sup>20</sup>;

$R^6$  is H or alkyl; and when  $R^1$  is attached to X by a carbon atom and X is a bond or alkylene,  $R^6$  can also be  $R^{21}$ -cycloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -heteroaryl,  $-\text{NHC(O)}R^7$ ,  $-\text{CN}$ , hydroxyalkyl, alkoxyalkyl,  $-\text{C}(R^7)=\text{N}(\text{OR}^7)$ ,  $-\text{C(O)}R^7$  or  $-\text{N}(R^7)_2$ ;

$R^7$  is independently selected from the group consisting of H and alkyl;

5  $R^8$  and  $R^9$ , together with the carbon to which they are attached, form a 3- to 7-membered carbocyclic ring optionally substituted with 1 or 2 substituents independently selected from the group consisting of halo, alkyl and haloalkyl; or  $R^8$  and  $R^9$ , together with the carbon to which they are attached, form a 3- to 7-membered heterocyclic ring comprising 2 to 6 carbon atoms and 1 or 2 heteroatoms  
10 independently selected from the group consisting of O, S and N, provided that there is no  $-\text{O-O-}$ ,  $-\text{S-S-}$  or  $-\text{O-S-}$  bond, wherein said heterocyclic ring is optionally substituted with 1 or 2 substituents independently selected from the group consisting of halo, alkyl and haloalkyl; or  $R^8$  and  $R^9$  together are  $=\text{CH}_2$ ;

15  $R^{10}$  is H, alkyl, haloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -heteroaryl,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl or  $R^{21}$ -arylalkyl;

$R^{11}$  is H or alkyl;

$R^{12}$  is independently selected from the group consisting of H, alkyl,  $-\text{CH}_2\text{CF}_3$ ,  $R^{21}$ -aryl and  $R^{21}$ -heteroaryl;

$R^{13}$  is H, alkyl, haloalkyl,  $R^{21}$ -aryl or  $R^{21}$ -heteroaryl;

20  $R^{14}$  is H, alkyl or haloalkyl;

$R^{14a}$  is 1 to 3 substituents independently selected from the group consisting of H, halo,  $-\text{OH}$ , alkyl, haloalkyl,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -heteroaryl, alkoxy,  $-\text{OCF}_3$ ,  $-\text{OCHF}_2$ ,  $-\text{NO}_2$ ,  $-\text{CN}$  and  $-\text{N}(R^{11})_2$ ;

$R^{14b}$  is H, fluoro, alkyl or haloalkyl;

25  $R^{15}$  is 1, 2, 3 or 4 substituents independently selected from the group consisting of H, halo, alkyl, haloalkyl,  $-\text{OH}$ , alkoxy, alkylthio,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -arylalkyl,  $R^{21}$ -heteroaryl,  $R^{21}$ -heteroarylalkyl, aryloxy,  $-\text{OCF}_3$ ,  $-\text{OCHF}_2$ ,  $-\text{SCF}_3$ ,  $-\text{NO}_2$ ,  $-\text{CO}_2R^{12}$ ,  $-\text{C(O)}R^{20}$ ,  $-\text{N}(R^{12})_2$ ,  $-\text{CON}(R^{12})_2$ ,  $-\text{NHC(O)}R^{12}$ ,  $-\text{NH}\text{SO}_2R^{12}$ ,  $-\text{SO}_2\text{N}(R^{12})_2$  and  $-\text{CN}$ ; or two  $R^{15}$  substituents on adjacent ring carbon  
30 atoms together are  $-\text{O-CH}_2\text{-O-}$ ;

$R^{15a}$  is H, alkyl, haloalkyl, alkoxy, alkylthio,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -arylalkyl,  $R^{21}$ -heteroaryl,  $R^{21}$ -heteroarylalkyl,  $R^{21}$ -aryloxy,  $-\text{OCF}_3$ ,  $-\text{OCHF}_2$ ,  $-\text{N}(R^{12})_2$  or  $-\text{SCF}_3$ ;

R<sup>16</sup> is independently selected from the group consisting of alkyl, halogen, haloalkyl and alkenyl;

R<sup>17</sup> is H, alkyl, hydroxy(C<sub>2</sub>-C<sub>6</sub>)alkyl-, haloalkyl-, haloalkoxyalkyl-, alkoxyalkyl-, R<sup>21</sup>-aryl, R<sup>21</sup>-arylalkyl-, R<sup>21</sup>-heteroaryl, R<sup>21</sup>-heteroarylalkyl-, R<sup>21</sup>-cycloalkyl or R<sup>21</sup>-cycloalkylalkyl, or R<sup>21</sup>-heterocycloalkylalkyl;

R<sup>18</sup> is 1, 2 or 3 substituents independently selected from the group consisting of H, halo, alkyl, haloalkyl, -OH, alkoxy, R<sup>21</sup>-aryl, R<sup>21</sup>-aryloxy, -OCF<sub>3</sub>, -OCHF<sub>2</sub>, -NO<sub>2</sub>, -CO<sub>2</sub>R<sup>19</sup>, -N(R<sup>19</sup>)<sub>2</sub>, -CON(R<sup>19</sup>)<sub>2</sub>, -NHC(O)R<sup>19</sup>, -NHSO<sub>2</sub>R<sup>19</sup>, -SO<sub>2</sub>N(R<sup>19</sup>)<sub>2</sub> and -CN;

R<sup>19</sup> is independently selected from the group consisting of H, alkyl, haloalkyl, R<sup>21</sup>-aryl, R<sup>21</sup>-heteroaryl, R<sup>21</sup>-cycloalkyl and R<sup>21</sup>-heterocycloalkyl;

R<sup>20</sup> is alkyl, R<sup>21</sup>-aryl or R<sup>21</sup>-heteroaryl; and

R<sup>21</sup> is 1, 2 or 3 substituents independently selected from the group consisting of H, alkyl, halo, alkoxy, -CF<sub>3</sub>, -N(R<sup>11</sup>)<sub>2</sub> and -alkylene-N(R<sup>11</sup>)<sub>2</sub>.

This invention further provides methods for treating: allergy; an allergy-induced airway (e.g., upper airway) response, including but not limited to, pruritis, sneezing, rhinorrhea and mucosal inflammation (see, for example, McLeod, JPET, 305 (2003) 1037); congestion, such as nasal congestion; hypotension; a cardiovascular disease; a disease of the gastrointestinal tract; hyper- and hypo- motility and acidic secretion of the gastrointestinal tract, such as GERD; metabolic syndrome; obesity; an obesity-related disorder; a sleeping disorder such as hypersomnia, somnolence, insomnia or narcolepsy; hypo- and hyperactivity of the central nervous system, such as agitation and depression of the CNS; diabetes, including Type I and Type II diabetes mellitus; a CNS disorder, such as migraine, Parkinson's disease, amyotrophic lateral sclerosis (ALS), or a cognition deficit disorder (e.g., attention deficit hyperactivity disorder (ADHD), Alzheimer's Disease (AD) or schizophrenia); (each of the above described diseases/disorders being a "Condition") comprising administering to a patient in need of such treatment an effective amount of at least one compound of formula (I).

The invention also provides pharmaceutical compositions comprising an effective amount of at least one compound of formula (I) and a pharmaceutically acceptable carrier. In one aspect, the compositions further comprise one or more additional agents useful for treating obesity, diabetes, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder. In one aspect, the compositions

further comprise one or more H<sub>1</sub> receptor antagonists. The compositions are useful for treating a Condition.

The invention further provides methods for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder comprising administering  
5 to a patient in need of such treatment an effective amount of a combination of at least one compound of formula (I) and at least one other compound useful for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder.

The invention also provides methods for treating obesity or an obesity-related  
10 disorder in a patient, comprising administering to the patient an effective amount of at least one compound of formula (I) and an anti-diabetic agent.

The present invention also provides methods for treating allergy, an allergy-induced airway response or congestion comprising administering to a patient in need of such treatment an effective amount of at least one compound of claim 1 and an  
15 effective amount of an H<sub>1</sub> receptor antagonist.

The present invention further provides methods for treating diabetes in a patient, comprising administering to the patient an effective amount of at least one compound of claim 1.

The invention also provides kits comprising a single package which contains: (i)  
20 a container containing a pharmaceutical composition comprising an effective amount of a compound of formula (I), and (ii) another container containing a pharmaceutical composition comprising an H<sub>1</sub> receptor antagonist. Also provided are kits comprising a single package which contains: (i) a container containing a pharmaceutical  
25 composition comprising an effective amount of a compound of formula (I), and (ii) another container containing a pharmaceutical composition comprising an effective amount of a separate compound useful for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder.

### **DETAILED DESCRIPTION OF THE INVENTION**

30 The present invention provides compounds of formula (I), pharmaceutical compositions comprising at least one compound of formula (I), and methods of using at least one compound of formula (I) to treat or prevent a Condition.

### Definitions and Abbreviations

As used herein, the following terms have the following meanings, unless indicated otherwise:

5 A "patient" is a human or non-human mammal. In one embodiment, a patient is a human. In another embodiment, a patient is a non-human mammal, including, but not limited to, a monkey, dog, baboon, rhesus, mouse, rat, horse, cat or rabbit. In another embodiment, a patient is a companion animal, including but not limited to a dog, cat, rabbit, horse or ferret. In one embodiment, a patient is a dog. In another embodiment, a patient is a cat.

10 "Alkyl" (including, for example, the alkyl portions of arylalkyl and alkoxy) refers to straight and branched carbon chains and contains from one to six carbon atoms.

"Alkylene" refers to a divalent straight or branched alkyl chain, e.g., methylene (-CH<sub>2</sub>-) or propylene (-CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>-).

15 "Haloalkyl" or "haloalkoxy" refer to alkyl or alkoxy chains as defined above wherein one or more hydrogen atoms are replaced by halogen atoms, e.g., -CF<sub>3</sub>, CF<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>-, CF<sub>3</sub>CF<sub>2</sub>- or CF<sub>3</sub>O-.

20 "Aryl" (including the aryl portion of arylalkyl) refers a carbocyclic group containing from 6 to 15 carbon atoms and having at least one aromatic ring (e.g., aryl is a phenyl or naphthyl ring), with all available substitutable carbon atoms of the carbocyclic group being intended as possible points of attachment.

"Arylalkyl" refers to an aryl group, as defined above, bound to an alkyl group, as defined above, wherein said alkyl group is the point of attachment.

25 "Cycloalkyl" refers to a non-aromatic mono- or multicyclic ring system comprising about 3 to about 10 carbon atoms, preferably about 5 to about 10 carbon atoms. Preferred cycloalkyl rings contain about 3 to about 7 ring atoms. Non-limiting examples of suitable monocyclic cycloalkyls include cyclopropyl, cyclopentyl, cyclohexyl, cycloheptyl and the like. Non-limiting examples of suitable multicyclic cycloalkyls include 1-decalinyl, norbornyl, adamantyl and the like.

"Halogen" or "halo" refers to -F, -Cl, -Br, or -I.

30 "Heteroaryl" refers to cyclic groups, having 1 to 4 heteroatoms selected from O, S or N, said heteroatom interrupting a carbocyclic ring structure and having a sufficient number of delocalized pi electrons to provide aromatic character, with the aromatic heterocyclic groups preferably containing from 2 to 14 carbon atoms. The

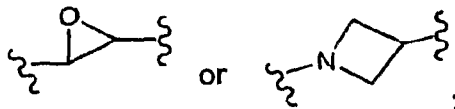
rings do not contain adjacent oxygen and/or sulfur atoms. Examples include but are not limited to 5-membered rings such as isothiazolyl, isoxazolyl, oxazolyl, furazanyl, triazolyl, tetrazolyl, thiazolyl, thienyl, furanyl (furyl), pyrrolyl and pyrazolyl, and 6-membered rings such as pyranyl, pyrimidinyl, pyrazinyl, pyridazinyl, pyridyl (e.g., 2-, 3-, or 4-pyridyl), pyridyl N-oxide (e.g., 2-, 3-, or 4-pyridyl N-oxide) and triazinyl, and bicyclic groups such as pteridinyl, indolyl (benzopyrrolyl), pyridopyrazinyl, isoquinolinyl, quinolinyl, naphthyridinyl. All available substitutable carbon and nitrogen atoms can be substituted as defined.

"Heterocycloalkyl" refers to a saturated carbocyclic ring containing from 3 to 15 carbon atoms, preferably from 4 to 6 carbon atoms, which carbocyclic ring is interrupted by 1 to 3 hetero atoms selected from -O-, -S-, -SO-, -SO<sub>2</sub> or -NR<sup>40</sup>- wherein R<sup>40</sup> represents H, C<sub>1</sub> to C<sub>6</sub> alkyl, arylalkyl, -C(O)R<sup>30</sup>, -C(O)OR<sup>30</sup>, or -C(O)N(R<sup>30</sup>)<sub>2</sub> (wherein each R<sup>30</sup> is independently selected from the group consisting of H, alkyl, phenyl and benzyl). The rings do not contain adjacent oxygen and/or sulfur atoms. Examples include but are not limited to 2- or 3-tetrahydrofuranyl, 2- or 3-tetrahydrothienyl, 2-, 3- or 4-piperidinyl, 2- or 3-pyrrolidinyl, 2- or 3-piperizinyl, 2- or 4-dioxanyl, 1,3-dioxolanyl, 1,3,5-trithianyl, pentamethylene sulfide, perhydroisoquinolinyl, decahydroquinolinyl, trimethylene oxide, azetidyl, 1-azacycloheptanyl, 1,3-dithianyl, 1,3,5-trioxanyl, morpholinyl, thiomorpholinyl, 1,4-thioxanyl, and 1,3,5-hexahydrotriazinyl, thiazolidinyl, tetrahydropyranyl.

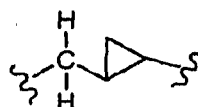
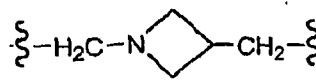
"Cycloalkylene" refers to a divalent cycloalkyl ring, e.g.



"Heterocycloalkylene" refers to a divalent heterocycloalkyl ring, e.g.

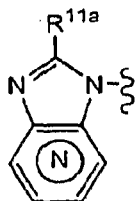


therefore, when R<sup>8</sup>-alkylene is said to be interrupted by cycloalkylene or

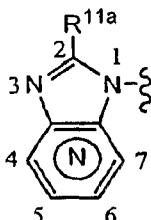
heterocycloalkylene, groups such as  or  are contemplated.

(N) , for example in the structure

10



represents a nitrogen atom that is located at one of the 4 non-fused positions of the ring, *i.e.*, positions 4, 5, 6 or 7 indicated below:



- 5 Similarly,  $\textcircled{2N}$  means that two nitrogens are located at any two of the 4 non-fused positions of the ring, *e.g.*, the 4 and 6 positions, the 4 and 7 positions, or the 5 and 6 positions.

Also, as used herein, "upper airway" usually means the upper respiratory system, *i.e.*, the nose, throat, and associated structures.

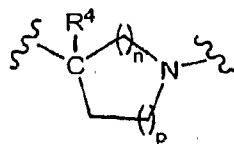
- 10 "Effective amount" or "therapeutically effective amount" is meant to describe an amount of compound or a composition of the present invention effective in inhibiting the above-noted diseases and thus producing the desired therapeutic, ameliorative, inhibitory or preventative effect.

- 15 A line drawn into a ring means that the indicated bond may be attached to any of the substitutable ring carbon atoms.

- The term "substituted" means that one or more hydrogens on the designated atom is replaced with a selection from the indicated group, provided that the designated atom's normal valency under the existing circumstances is not exceeded, and that the substitution results in a stable compound. Combinations of substituents and/or variables are permissible only if such combinations result in stable compounds. The term "stable compound" or "stable structure" is meant to describe a compound that is sufficiently robust to survive isolation to a useful degree of purity from a reaction mixture, and formulation into an efficacious therapeutic agent.

- 25 When M is CH and an  $R^4$  substituent is present on the ring (*i.e.*, b is 1, 2 or 3), the  $R^4$  substituent can replace the H on said carbon, *e.g.*, the ring can be:

11



The term "optionally substituted" means optional substitution with the specified groups, radicals or moieties.

The term "purified", "in purified form" or "in isolated and purified form" for a  
5 compound refers to the physical state of said compound after being isolated from a synthetic process or natural source or combination thereof. Thus, the term "purified", "in purified form" or "in isolated and purified form" for a compound refers to the physical state of said compound after being obtained from a purification process or processes described herein or well known to the skilled artisan, in sufficient purity to  
10 be characterizable by standard analytical techniques described herein or well known to the skilled artisan.

It should also be noted that any carbon as well as heteroatom with unsatisfied valences in the text, schemes, examples and Tables herein is assumed to have the sufficient number of hydrogen atom(s) to satisfy the valences.

15 When a functional group in a compound is termed "protected", this means that the group is in modified form to preclude undesired side reactions at the protected site when the compound is subjected to a reaction. Suitable protecting groups will be recognized by those with ordinary skill in the art as well as by reference to standard textbooks such as, for example, T. W. Greene *et al*, *Protective Groups in organic*  
20 *Synthesis* (1991), Wiley, New York.

When any variable (e.g., aryl, heterocycle, R<sup>2</sup>, etc.) occurs more than one time in any constituent or in formula (I), its definition on each occurrence is independent of its definition at every other occurrence.

As used herein, the term "composition" is intended to encompass a product  
25 comprising the specified ingredients in the specified amounts, as well as any product which results, directly or indirectly, from combination of the specified ingredients in the specified amounts.

Prodrugs and solvates of the compounds of the invention are also contemplated herein. A discussion of prodrugs is provided in T. Higuchi and V. Stella,  
30 *Pro-drugs as Novel Delivery Systems* (1987) 14 of the A.C.S. Symposium Series, and in *Bioreversible Carriers in Drug Design*, (1987) Edward B. Roche, ed., American

Pharmaceutical Association and Pergamon Press. The term "prodrug" means a compound (e.g, a drug precursor) that is transformed *in vivo* to yield a compound of formula (I) or a pharmaceutically acceptable salt, hydrate or solvate of the compound. The transformation may occur by various mechanisms (e.g., by metabolic or chemical processes), such as, for example, through hydrolysis in blood. A discussion of the use of prodrugs is provided by T. Higuchi and W. Stella, "Pro-drugs as Novel Delivery Systems," Vol. 14 of the A.C.S. Symposium Series, and in *Bioreversible Carriers in Drug Design*, ed. Edward B. Roche, American Pharmaceutical Association and Pergamon Press, 1987.

For example, if a compound of formula (I) or a pharmaceutically acceptable salt, hydrate or solvate of the compound contains a carboxylic acid functional group, a prodrug can comprise an ester formed by the replacement of the hydrogen atom of the acid group with a group such as, for example, (C<sub>1</sub>-C<sub>8</sub>)alkyl, (C<sub>2</sub>-C<sub>12</sub>)alkanoyloxymethyl, 1-(alkanoyloxy)ethyl having from 4 to 9 carbon atoms, 1-methyl-1-(alkanoyloxy)-ethyl having from 5 to 10 carbon atoms, alkoxycarbonyloxymethyl having from 3 to 6 carbon atoms, 1-(alkoxycarbonyloxy)ethyl having from 4 to 7 carbon atoms, 1-methyl-1-(alkoxycarbonyloxy)ethyl having from 5 to 8 carbon atoms, N-(alkoxycarbonyl)aminomethyl having from 3 to 9 carbon atoms, 1-(N-(alkoxycarbonyl)amino)ethyl having from 4 to 10 carbon atoms, 3-phthalidyl, 4-crotonolactonyl, gamma-butyrolacton-4-yl, di-N,N-(C<sub>1</sub>-C<sub>2</sub>)alkylamino(C<sub>2</sub>-C<sub>3</sub>)alkyl (such as β-dimethylaminoethyl), carbamoyl-(C<sub>1</sub>-C<sub>2</sub>)alkyl, N,N-di (C<sub>1</sub>-C<sub>2</sub>)alkylcarbamoyl-(C<sub>1</sub>-C<sub>2</sub>)alkyl and piperidino-, pyrrolidino- or morpholino(C<sub>2</sub>-C<sub>3</sub>)alkyl, and the like.

Similarly, if a compound of formula (I) contains an alcohol functional group, a prodrug can be formed by the replacement of the hydrogen atom of the alcohol group with a group such as, for example, (C<sub>1</sub>-C<sub>6</sub>)alkanoyloxymethyl, 1-((C<sub>1</sub>-C<sub>6</sub>)alkanoyloxy)-ethyl, 1-methyl-1-((C<sub>1</sub>-C<sub>6</sub>)alkanoyloxy)ethyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxycarbonyloxymethyl, N-(C<sub>1</sub>-C<sub>6</sub>)alkoxycarbonylaminomethyl, succinoyl, (C<sub>1</sub>-C<sub>6</sub>)alkanoyl, α-amino(C<sub>1</sub>-C<sub>4</sub>)alkanyl, arylacyl and α-aminoacyl, or α-aminoacyl-α-aminoacyl, where each α-aminoacyl group is independently selected from the naturally occurring L-amino acids, P(O)(OH)<sub>2</sub>, -P(O)(O(C<sub>1</sub>-C<sub>6</sub>)alkyl)<sub>2</sub> or glycosyl (the radical resulting from the removal of a hydroxyl group of the hemiacetal form of a carbohydrate), and the like.

If a compound of formula (I) incorporates an amine functional group, a prodrug can be formed by the replacement of a hydrogen atom in the amine group with a

group such as, for example, R<sup>n</sup>-carbonyl, R<sup>n</sup>O-carbonyl, NR<sup>n</sup>R<sup>m</sup>-carbonyl where R<sup>n</sup> and R<sup>m</sup> are each independently (C<sub>1</sub>-C<sub>10</sub>)alkyl, (C<sub>3</sub>-C<sub>7</sub>) cycloalkyl, benzyl, or R<sup>n</sup>-carbonyl is a natural α-aminoacyl or natural α-aminoacyl, —C(OH)C(O)OY<sup>1</sup> wherein Y<sup>1</sup> is H, (C<sub>1</sub>-C<sub>6</sub>)alkyl or benzyl, —C(OY<sup>2</sup>)Y<sup>3</sup> wherein Y<sup>2</sup> is (C<sub>1</sub>-C<sub>4</sub>) alkyl and Y<sup>3</sup> is (C<sub>1</sub>-C<sub>6</sub>)alkyl, carboxy (C<sub>1</sub>-C<sub>6</sub>)alkyl, amino(C<sub>1</sub>-C<sub>4</sub>)alkyl or mono-N— or di-N,N-(C<sub>1</sub>-C<sub>6</sub>)alkylaminoalkyl, —C(Y<sup>4</sup>)Y<sup>5</sup> wherein Y<sup>4</sup> is H or methyl and Y<sup>5</sup> is mono-N— or di-N,N-(C<sub>1</sub>-C<sub>6</sub>)alkylamino morpholino, piperidin-1-yl or pyrrolidin-1-yl, and the like.

“Solvate” means a physical association of a compound of this invention with one or more solvent molecules. This physical association involves varying degrees of ionic and covalent bonding, including hydrogen bonding. In certain instances the solvate will be capable of isolation, for example when one or more solvent molecules are incorporated in the crystal lattice of the crystalline solid. “Solvate” encompasses both solution-phase and isolatable solvates. Non-limiting examples of suitable solvates include ethanlates, methanlates, and the like. “Hydrate” is a solvate wherein the solvent molecule is water.

The compounds of formula (I) can form salts which are also within the scope of this invention. Reference to a compound of formula (I) herein is understood to include reference to salts thereof, unless otherwise indicated. The term “salt(s)”, as employed herein, denotes acidic salts formed with inorganic and/or organic acids, as well as basic salts formed with inorganic and/or organic bases. In addition, when a compound of formula (I) contains both a basic moiety, such as, but not limited to a pyridine or imidazole, and an acidic moiety, such as, but not limited to a carboxylic acid, zwitterions (“inner salts”) may be formed and are included within the term “salt(s)” as used herein. Pharmaceutically acceptable (*i.e.*, non-toxic, physiologically acceptable) salts are preferred, although other salts are also useful. Salts of the compounds of the formula (I) may be formed, for example, by reacting a compound of formula (I) with an amount of acid or base, such as an equivalent amount, in a medium such as one in which the salt precipitates or in an aqueous medium followed by lyophilization.

Exemplary acid addition salts include acetates, ascorbates, benzoates, benzenesulfonates, bisulfates, borates, butyrates, citrates, camphorates, camphorsulfonates, fumarates, hydrochlorides, hydrobromides, hydroiodides, lactates, maleates, methanesulfonates, naphthalenesulfonates, nitrates, oxalates,

phosphates, propionates, salicylates, succinates, sulfates, tartarates, thiocyanates, toluenesulfonates (also known as tosylates,) and the like. Additionally, acids which are generally considered suitable for the formation of pharmaceutically useful salts from basic pharmaceutical compounds are discussed, for example, by P. Stahl *et al*,  
5 Camille G. (eds.) *Handbook of Pharmaceutical Salts. Properties, Selection and Use*. (2002) Zurich: Wiley-VCH; S. Berge *et al*, *Journal of Pharmaceutical Sciences* (1977) 66(1) 1-19; P. Gould, *International J. of Pharmaceutics* (1986) 33 201-217; Anderson *et al*, *The Practice of Medicinal Chemistry* (1996), Academic Press, New York; and in *The Orange Book* (Food & Drug Administration, Washington, D.C. on their website).

10 These disclosures are incorporated herein by reference thereto.

Exemplary basic salts include ammonium salts, alkali metal salts such as sodium, lithium, and potassium salts, alkaline earth metal salts such as calcium and magnesium salts, salts with organic bases (for example, organic amines) such as dicyclohexylamines, t-butyl amines, and salts with amino acids such as arginine,  
15 lysine and the like. Basic nitrogen-containing groups may be quarternized with agents such as lower alkyl halides (*e.g.*, methyl, ethyl, and butyl chlorides, bromides and iodides), dialkyl sulfates (*e.g.*, dimethyl, diethyl, and dibutyl sulfates), long chain halides (*e.g.*, decyl, lauryl, and stearyl chlorides, bromides and iodides), aralkyl halides (*e.g.*, benzyl and phenethyl bromides), and others.

20 All such acid salts and base salts are intended to be pharmaceutically acceptable salts within the scope of the invention and all acid and base salts are considered equivalent to the free forms of the corresponding compounds for purposes of the invention.

Pharmaceutically acceptable esters of the present compounds include the  
25 following groups: (1) carboxylic acid esters obtained by esterification of the hydroxy groups, in which the non-carbonyl moiety of the carboxylic acid portion of the ester grouping is selected from straight or branched chain alkyl (for example, acetyl, n-propyl, t-butyl, or n-butyl), alkoxyalkyl (for example, methoxymethyl), aralkyl (for example, benzyl), aryloxyalkyl (for example, phenoxymethyl), aryl (for example,  
30 phenyl optionally substituted with, for example, halogen, C<sub>1-4</sub>alkyl, or C<sub>1-4</sub>alkoxy or amino); (2) sulfonate esters, such as alkyl- or aralkylsulfonyl (for example, methanesulfonyl); (3) amino acid esters (for example, L-valyl or L-isoleucyl); (4) phosphonate esters and (5) mono-, di- or triphosphate esters. The phosphate esters

may be further esterified by, for example, a C<sub>1-20</sub> alcohol or reactive derivative thereof, or by a 2,3-di (C<sub>6-24</sub>)acyl glycerol.

One or more compounds of the invention may also exist as, or optionally converted to, a solvate. Preparation of solvates is generally known. Thus, for  
5 example, M. Caira *et al*, *J. Pharmaceutical Sci.*, 93(3), 601-611 (2004) describe the preparation of the solvates of the antifungal fluconazole in ethyl acetate as well as from water. Similar preparations of solvates, hemisolvate, hydrates and the like are described by E. C. van Tonder *et al*, *AAPS PharmSciTech.*, 5(1), article 12 (2004);  
10 and A. L. Bingham *et al*, *Chem. Commun.*, 603-604 (2001). A typical, non-limiting, process involves dissolving the inventive compound in desired amounts of the desired solvent (organic or water or mixtures thereof) at a higher than ambient temperature, and cooling the solution at a rate sufficient to form crystals which are then isolated by standard methods. Analytical techniques such as, for example I. R. spectroscopy, show the presence of the solvent (or water) in the crystals as a solvate (or hydrate).

15 Compounds of formula (I), and salts, solvates, esters and prodrugs thereof, may exist in their tautomeric form (for example, as an amide or imino ether). All such tautomeric forms are contemplated herein as part of the present invention.

All stereoisomers (for example, geometric isomers, optical isomers and the like) of the present compounds (including those of the salts, solvates, esters and  
20 prodrugs of the compounds as well as the salts, solvates and esters of the prodrugs), such as those which may exist due to asymmetric carbons on various substituents, including enantiomeric forms (which may exist even in the absence of asymmetric carbons), rotameric forms, atropisomers, and diastereomeric forms, are contemplated within the scope of this invention, as are positional isomers (such as, for example, 4-  
25 pyridyl and 3-pyridyl). Individual stereoisomers of the compounds of the invention may, for example, be substantially free of other isomers, or may be admixed, for example, as racemates or with all other, or other selected, stereoisomers. The chiral centers of the present invention can have the S or R configuration as defined by the *IUPAC 1974 Recommendations*. The use of the terms "salt", "solvate", "ester",  
30 "prodrug" and the like, is intended to equally apply to the salt, solvate, ester and prodrug of enantiomers, stereoisomers, rotamers, tautomers, positional isomers, racemates or prodrugs of the inventive compounds.

Polymorphic forms of the compounds of formula (I), and of the salts, solvates, esters and prodrugs of the compounds of formula (I), are intended to be included in the present invention.

The phrase "at least one compound of formula (I)" means that one to three  
5 different compounds of formula (I) may be used in a pharmaceutical composition or method of treatment. In one embodiment one compound of formula (I) is used. Similarly, "at least one H<sub>1</sub> receptor antagonist" or "at least one other compound (or agent) for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder" means that one to three different H<sub>1</sub> antagonists or other  
10 compounds may be used in a pharmaceutical composition or method of treatment. In one embodiment, one H<sub>1</sub> antagonist or one other compound for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder is used in the combinations.

The term "obesity" as used herein, refers to a patient being overweight and  
15 having a body mass index (BMI) of 25 or greater. In one embodiment, an obese patient has a BMI of 25 or greater. In another embodiment, an obese patient has a BMI from 25 to 30. In another embodiment, an obese patient has a BMI greater than 30. In still another embodiment, an obese patient has a BMI greater than 40.

The term "obesity-related disorder" as used herein refers to any disorder which  
20 results from a patient having a BMI of 25 or greater. Non-limiting examples of an obesity-related disorder include edema, shortness of breath, sleep apnea, skin disorders and high blood pressure.

The term "metabolic syndrome" refers to a combination of risk factors for  
25 cardiovascular disease (CVD) identified in the National Cholesterol Education Program's Adult Treatment Panel III report. See for example the discussion by Grundy et al in *Circulation*, 109 (2004), 433-438. The components of metabolic syndrome are: 1) abdominal obesity; 2) atherogenic dyslipidemia; 3) raised blood pressure; 4) insulin resistance; 5) proinflammatory state; and 6) prothrombotic state.

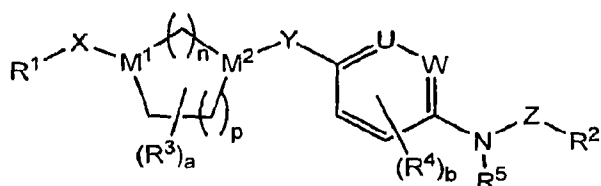
Unless otherwise stated, the following abbreviations have the stated meanings:  
30 Me=methyl; Et=ethyl; Bn=benzyl; Bu=butyl; Pr=propyl; Ph=phenyl; t-BOC=tert-butoxycarbonyl; Ac=acetyl; BINAP=2,2'-bis(diphenylphosphino)-1,1'-binaphthyl; DCE=1,2-dichloroethane; DCM= dichloro-methane; DEAD= diethyl azodicarboxylate; DIPEA= *N,N*-diisopropylethylamine (Hunig's base); DMF=dimethylformamide; EDC=

1-(3-dimethylaminopropyl)-3-ethylcarbodiimide; HOBT= 1-hydroxybenzotriazole;  
 NaBH(Oac)<sub>3</sub>= sodium triacetoxyboro-hydride; PyBOP=benzotriazol-1-yloxytri-  
 pyrrolidinophosphonium hexafluorophosphate; RT=room temperature;  
 TFA=trifluoroacetic acid; THF=tetrahydrofuran; TEMPO=2,2,6,6-tetramethyl-1-  
 5 piperidinyloxy, free radical; TLC=thin layer chromatography; MS=Mass Spectrometry;  
 nM= nanomolar; Ki= Dissociation Constant for substrate/receptor complex.

### The Compounds of Formula (I)

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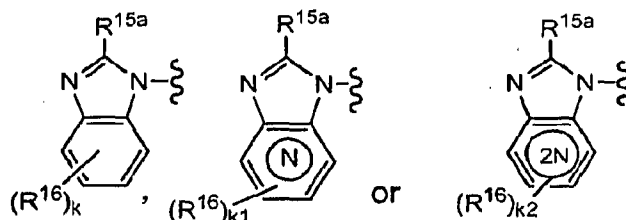
The invention provides compounds having the formula:



15

and pharmaceutically acceptable salts thereof, wherein R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup>, R<sup>4</sup>, R<sup>5</sup>, M<sup>1</sup>, M<sup>2</sup>, U,  
 V, W, X, Y, Z, a, b, n and p are defined above for the compounds of formula (I).

In one embodiment, R<sup>1</sup> is R<sup>15</sup>-aryl, R<sup>15</sup>-(6-membered heteroaryl),



20 In another embodiment, R<sup>1</sup> is R<sup>15</sup>-phenyl and R<sup>15</sup> is 1 to 4 substituents  
 independently selected from the group consisting of H, halo, alkyl, haloalkyl or -CN.

In still another embodiment, R<sup>15</sup> is one or two substituents independently  
 selected from H and halo.

In yet another embodiment, R<sup>15</sup> is one substituent selected from the group  
 consisting of -CF<sub>3</sub>, -CHF<sub>2</sub> and -CN.

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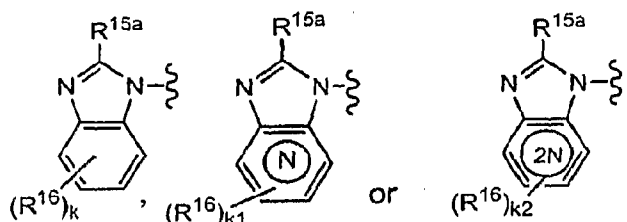
In one embodiment, R<sup>1</sup> is R<sup>15</sup>-pyridyl. In another embodiment, the 6-  
 membered heteroaryl is 2-pyridyl.

In one embodiment, R<sup>15</sup> is 1-3 substituents independently selected from the group consisting of H, halo, alkyl, haloalkyl and -CN.

In another embodiment, R<sup>15</sup> is one or two substituents independently selected from the group consisting of H and halo.

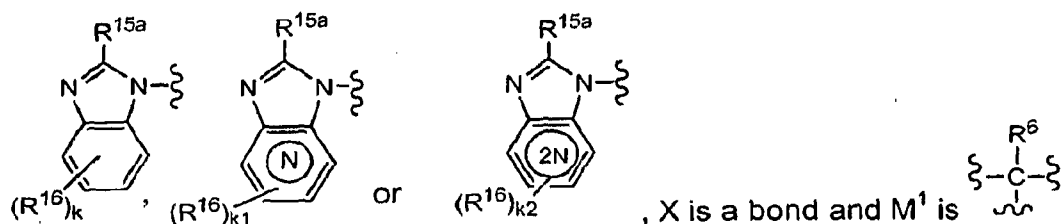
5 In a further embodiment, R<sup>15</sup> is one substituent selected from the group consisting of -CF<sub>3</sub>, -CHF<sub>2</sub> and -CN.

In one embodiment, R<sup>1</sup> is

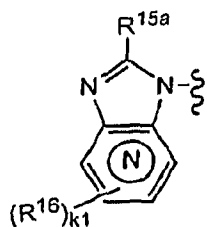


10 wherein R<sup>15a</sup> is C<sub>1</sub>-C<sub>3</sub> alkyl, halo(C<sub>1</sub>-C<sub>3</sub>)alkyl; C<sub>1</sub>-C<sub>3</sub> alkoxy, C<sub>1</sub>-C<sub>3</sub> alkylthio; R<sup>21</sup>-phenyl or R<sup>21</sup>-pyridyl; R<sup>21</sup> is 1-3 substituents independently selected from the group consisting of H, halo, alkyl, haloalkyl, -OCF<sub>3</sub>, -CHF<sub>2</sub> or -CN; R<sup>16</sup> is as defined above; and k, k<sub>1</sub> and k<sub>2</sub> are each independently 0, 1 or 2.

In another embodiment, R<sup>1</sup> is

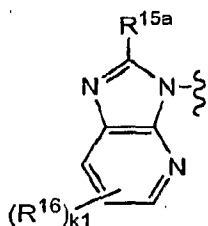


15 In still another embodiment, R<sup>1</sup> is



wherein R<sup>15a</sup> is (C<sub>1</sub>-C<sub>3</sub>)alkyl, C<sub>1</sub>-C<sub>3</sub> alkoxy, C<sub>1</sub>-C<sub>3</sub> alkylthio, R<sup>21</sup>-phenyl or R<sup>21</sup>-pyridyl; R<sup>21</sup> is 1 or 2 substituents independently selected from the group consisting of H, halo, alkyl and haloalkyl; R<sup>16</sup> is as defined above; and k<sub>1</sub> is 0 or 1.

20 In another embodiment R<sup>1</sup> is



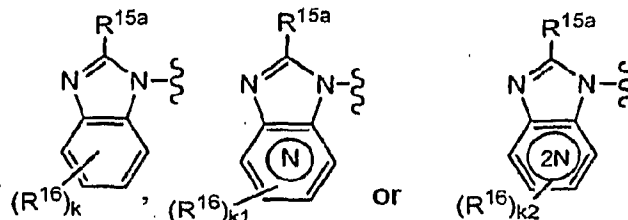
wherein  $R^{15a}$  is  $-C_2F_5$ ,  $-CF_3$ ,  $C_2H_5-O-$ ,  $CH_3-O-$ ,  $C_2H_5-S-$ ,  $CH_3-S-$ ,  $R^{21}$ -phenyl or  $R^{21}$ -pyridyl;  $R^{21}$  is 1 or 2 substituents independently selected from the group consisting of H, F, Cl,  $-CH_3$ , and  $-CF_3$ ;  $k_1$  is 0 or 1; and  $R^{16}$  is F, Cl or  $-CF_3$ .

- 5 In one embodiment, n is 1.
- In another embodiment, p is 1.
- In one embodiment, a and b are each independently 0 or 1.
- In another embodiment, a and b are each 0.
- In still another embodiment, both U and W are CH.

- 10 In one embodiment,  $M^1$  is  $\begin{matrix} R^6 \\ | \\ \xi-C-\xi \\ | \\ \sim \end{matrix}$ , wherein  $R^6$  is H,  $-NHC(O)R^7$  or  $-N(R^7)_2$ ; and  $R^7$  is alkyl.

- In another embodiment,  $M^1$  is  $\begin{matrix} R^6 \\ | \\ \xi-C-\xi \\ | \\ \sim \end{matrix}$ , wherein  $R^6$  is H.
- In one embodiment,  $M^2$  is preferably N.
- In another embodiment,  $R^5$  is H or alkyl.

- 15 X is preferably a single bond,  $-NHC(O)-$  or  $-C(N-OR^{10})-$ , wherein  $R^{10}$  is H or alkyl; more preferably, X is a single bond.
- Y is preferably  $-O-$  or  $-C(=O)-$ , more preferably  $-C(=O)-$ .
- Preferred compounds are those wherein  $M^1$ ,  $M^2$ , n, p, X and Y are as defined in (a) or (b), with (a) being more preferred for compounds wherein  $R^1$  is



- 20 and (b) being preferred for compounds wherein  $R^1$  is  $R^{15}$ -aryl or  $R^{15}$ -(6-membered heteroaryl).

In a further embodiment, Z is a bond.

In one embodiment, R<sup>3</sup> and R<sup>4</sup> are each independently H, alkyl, fluoro or –OH.

In another embodiment, R<sup>2</sup> is R<sup>18</sup>-heteroaryl or R<sup>18</sup>-heterocycloalkyl.

5 In still another embodiment, R<sup>2</sup> is a 5 or 6 membered R<sup>18</sup>-heteroaryl or a 4, 5 or 6-membered R<sup>18</sup>-heterocycloalkyl.

In yet another embodiment, R<sup>2</sup> is R<sup>18</sup>-pyridyl, R<sup>18</sup>-pyrimidyl, R<sup>18</sup>-pyradazinyl, R<sup>18</sup>-tetrahydropyranyl, R<sup>18</sup>-azetidiny, R<sup>18</sup>-oxazolyl and R<sup>18</sup>-thiazolyl.

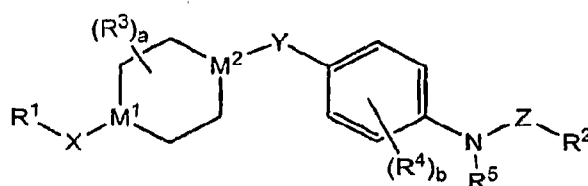
10 In a further embodiment, R<sup>2</sup> is R<sup>18</sup>-pyridyl, R<sup>18</sup>-pyrimidyl, R<sup>18</sup>-pyradazinyl, R<sup>18</sup>-oxazolyl or R<sup>18</sup>-thiazolyl, and R<sup>18</sup> is 1 or 2 substituents independently selected from the group consisting of H, -CH<sub>3</sub>, -NH<sub>2</sub> and -NHCH<sub>3</sub>.

In one embodiment, R<sup>2</sup> is R<sup>18</sup>-tetrahydropyranyl or R<sup>18</sup>-azetidiny, and R<sup>18</sup> is 1 or 2 substituents independently selected from the group consisting of H and -CH<sub>3</sub>.

15 In another embodiment, R<sup>2</sup> is 2-amino pyridyl, 2-amino oxazolyl, 2-amino thiazolyl, 1-methyl-azetidiny and tetrahydropyranyl.

In another embodiment, R<sup>2</sup> is 2-amino pyridyl.

In one embodiment, the compounds of formula (I) have the formula (IA):



20

(IA)

and pharmaceutically acceptable salts thereof,

wherein

M<sup>1</sup> is CR<sup>6</sup> or N;

25

M<sup>2</sup> is CH or N;

X is a bond, alkylene, -C(O)-, -C(=N-O-R<sup>a</sup>)-, -N(R<sup>12</sup>)-, -CH<sub>2</sub>N(R<sup>12</sup>)-, -C(=CH<sub>2</sub>)-, -NHC(O)-, -SO<sub>2</sub>-, such that when M<sup>1</sup> is N, X is not -N(R<sup>12</sup>)- or -CH<sub>2</sub>N(R<sup>12</sup>)-;

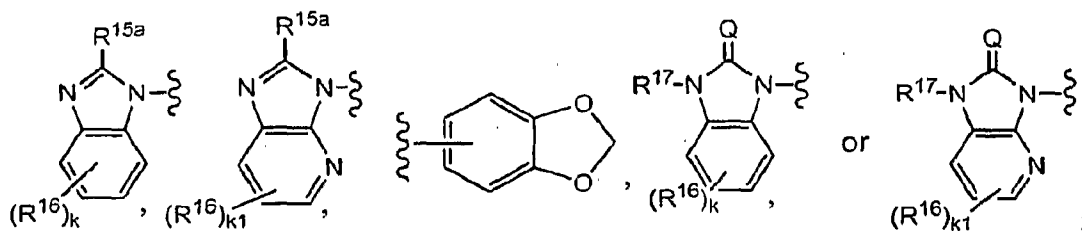
Y is -C(O)- when M<sup>2</sup> is N, and Y is -C(O) or O when M<sup>2</sup> is CH;

Z is a bond;

30

R<sup>1</sup> is R<sup>15</sup>-arylalkyl, R<sup>15</sup>-aryl, R<sup>15</sup>-cycloalkyl, R<sup>15</sup>-heteroaryl, R<sup>15</sup>-heterocycloalkyl, fluorenyl,

21



$R^2$  is  $R^{18}$ -arylalkyl,  $R^{18}$ -alkyl,  $R^{18}$ -aryl,  $R^{18}$ -heteroaryl, or  $R^{18}$ -heterocycloalkyl;  
 each  $R^3$  is independently selected from the group consisting of H, halo, alkyl,

5 haloalkyl, -OH, alkoxy and -CN;

each  $R^4$  is independently selected from the group consisting of H, alkyl, -OH, alkoxy, halo, -CF<sub>3</sub>, -OCF<sub>3</sub>, -NO<sub>2</sub> and -CN;

$R^5$  is H, alkyl or -C(O)alkyl;

$R^6$  is -H, -NH<sub>2</sub>, -NH-alkyl, -CN, -hydroxy-substituted alkyl, -NHC(O)-alkyl, or -

10 C(alkyl)(=N-O-R<sup>a</sup>);

$R^{12}$  is -H or alkyl;

$R^{15}$  is -H, -CN, -O-phenyl, -OH, alkoxy, halo, alkyl, -benzyl, -NH<sub>2</sub>, -NO<sub>2</sub>, -CF<sub>3</sub>, -OCF<sub>3</sub>, -S-alkyl, phenyl, -C(O)O-alkyl, -C(O)alkyl, or -S-CF<sub>3</sub>;

$R^{15a}$  is -H, or -heteroaryl (2-benzofuranyl, 2-quinolinyl, pyridyl);

15  $R^{16}$  is -CF<sub>3</sub>, or halo;

$R^{17}$  is -H, alkoxy, or  $R^{21}$ -heterocycloalkylalkyl (-CH<sub>2</sub>CH<sub>2</sub>-(N-morpholinyl));

$R^{18}$  is -H, halo, -NO<sub>2</sub>, or -NH<sub>2</sub>;

$R^{21}$  is -H, halo or alkyl;

Q is O or S;

20  $R^a$  is -H, alkyl, or -CH<sub>2</sub>CF<sub>3</sub>;

a is 0 or 1;

b is 0 or 1;

k is 0, 1 or 2; and

k1 is 0, 1 or 2.

25

In one embodiment, a is 0.

In another embodiment, a is 1.

In one embodiment, b is 0.

In another embodiment, b is 1.

In one embodiment, k is 0.

In another embodiment, k is 1.

In one embodiment, k1 is 0.

In another embodiment, k1 is 1.

5 In one embodiment, Q is O.

In one embodiment, R<sup>1</sup> is R<sup>15</sup>-arylalkyl.

In another embodiment, R<sup>1</sup> is R<sup>15</sup>-aryl.

In another embodiment, R<sup>1</sup> is R<sup>15</sup>-cycloalkyl.

In still another embodiment, R<sup>1</sup> is R<sup>15</sup>-heteroaryl.

10 In another embodiment, R<sup>1</sup> is R<sup>15</sup>-heterocycloalkyl.

In yet another embodiment, R<sup>1</sup> is fluorenyl.

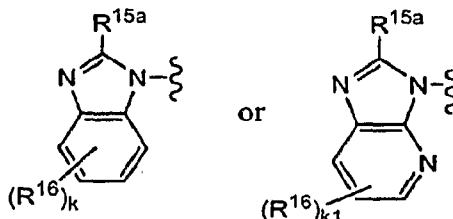
In one embodiment, R<sup>1</sup> is R<sup>15</sup>-phenyl or R<sup>15</sup>-naphthyl.

In another embodiment, R<sup>1</sup> is R<sup>15</sup>-cyclohexyl or R<sup>15</sup>-cyclopropyl.

15 In another embodiment, R<sup>1</sup> is R<sup>15</sup>-isoxazolyl, R<sup>15</sup>-pyridyl, R<sup>15</sup>-pyrimidinyl or R<sup>15</sup>-pyridazinyl.

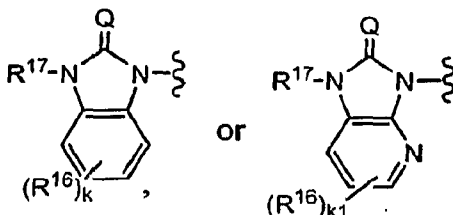
In still another embodiment, R<sup>1</sup> is R<sup>15</sup>-piperazinyl, R<sup>15</sup>-piperidinyl or R<sup>15</sup>-morpholinyl.

In yet another embodiment, R<sup>1</sup> is:



20 wherein R<sup>15a</sup> is benzofuranyl, quinolinyl or pyridyl, and R<sup>16</sup>, k and k1 are as defined above for the compounds of formula (IA).

In one embodiment, R<sup>1</sup> is:



25 wherein R<sup>17</sup> is -H, alkoxy, or -CH<sub>2</sub>CH<sub>2</sub>-(N-morpholinyl), and R<sup>16</sup>, k and k1 are as defined above for the compounds of formula (IA).

In one embodiment, R<sup>2</sup> is R<sup>18</sup>-arylalkyl.

- In another embodiment,  $R^2$  is  $R^{18}$ -benzyl.
- In another embodiment,  $R^2$  is  $R^{18}$ -alkyl.
- In still another embodiment,  $R^2$  is  $R^{18}$ -aryl.
- In another embodiment,  $R^2$  is  $R^{18}$ -phenyl.
- 5 In yet another embodiment,  $R^2$  is  $R^{18}$ -heteroaryl.
- In one embodiment,  $R^2$  is pyridyl.
- In another embodiment,  $R^2$  is  $-NH_2$ -substituted pyridyl.
- In another embodiment,  $R^2$  is 2-amino-pyridin-4-yl
- In yet another embodiment,  $R^2$  is pyrimidinyl.
- 10 In still another embodiment,  $R^2$  is  $R^{18}$ -heterocycloalkyl.
- In another embodiment,  $R^2$  is tetrahydropyranyl.
- In one embodiment,  $R^{15a}$  is benzofuranyl, quinolinyl or pyridyl.
- In one embodiment,  $M^1$  is N.
- In another embodiment,  $M^1$  is  $CR^6$ .
- 15 In another embodiment,  $M^1$  is CH.
- In one embodiment,  $M^2$  is N.
- In another embodiment,  $M^2$  is CH.
- In one embodiment, X is a bond.
- In another embodiment, X is alkylene.
- 20 In another embodiment, X is  $-CH_2-$ .
- In still another embodiment, X is  $-CH_2CH_2-$ .
- In another embodiment, X is  $-C(O)-$ .
- In yet another embodiment, X is  $-C(=N-O-R^a)-$ .
- In one embodiment, X is  $-C(=N-O-CH_3)-$ .
- 25 In another embodiment, X is  $-C(=N-OH)-$ .
- In still another embodiment, X is  $-N(R^{12})-$ .
- In yet another embodiment, X is NH.
- In a further embodiment, X is  $-CH_2N(R^{12})-$ .
- In another embodiment, X is  $-CH_2N(CH_3)-$ .
- 30 In one embodiment, X is  $-C(=CH_2)-$ .
- In another embodiment, X is  $-NHC(O)-$ .
- In another embodiment, X is  $-SO_2-$ .
- In one embodiment, Y is  $-C(O)-$  and  $M^2$  is N.

In another embodiment, Y is -C(O)- and M<sup>2</sup> is CH.

In another embodiment, Y is -O- and M<sup>2</sup> is CH.

In one embodiment, M<sup>2</sup> is N, Y is -C(O)-.

In another embodiment, M<sup>1</sup> is N, M<sup>2</sup> is N, Y is -C(O)-.

5 In another embodiment, M<sup>1</sup> is CH, M<sup>2</sup> is N, Y is -C(O)-.

In still another embodiment, a is 0, b is 1, and R<sup>4</sup> is alkoxy or alkyl.

In yet another embodiment, M<sup>2</sup> is CH, Y is -C(O)-.

In a further embodiment, M<sup>2</sup> is CH, Y is -O-.

In another embodiment, M<sup>1</sup> is N, M<sup>2</sup> is CH, Y is -C(O)-.

10 In another embodiment, M<sup>1</sup> is N, M<sup>2</sup> is CH, Y is -O-.

In one embodiment, M<sup>1</sup> and M<sup>2</sup> are each N, X is -NHC(O)-, Y is -C(O)-, R<sup>1</sup> is phenyl, R<sup>2</sup> is 4-pyridyl and R<sup>5</sup> is methyl.

In another embodiment, M<sup>1</sup> and M<sup>2</sup> are each N, X is -NHC(O)-, Y is -C(O)-, R<sup>1</sup> is phenyl, R<sup>2</sup> is 4-pyridyl and R<sup>5</sup> is H.

15 In one embodiment, M<sup>1</sup> is CH, M<sup>2</sup> is N, X is a bond, Y is -C(O)-, R<sup>1</sup> is phenyl, R<sup>2</sup> is 4-pyridyl and R<sup>5</sup> is methyl.

In another embodiment, M<sup>1</sup> is CH, M<sup>2</sup> is N, X is a bond, Y is -C(O)-, R<sup>1</sup> is phenyl, R<sup>2</sup> is 4-pyridyl and R<sup>5</sup> is H.

20 In another embodiment, M<sup>1</sup> is CH, M<sup>2</sup> is N, X is a bond, Y is -C(O)-, R<sup>1</sup> is phenyl, R<sup>2</sup> is 2-amino-pyridin-4-yl and R<sup>5</sup> is H.

In yet another embodiment, M<sup>1</sup> is CH, M<sup>2</sup> is N, X is -C(=NOCH<sub>3</sub>), Y is -C(O)-, R<sup>1</sup> is phenyl, R<sup>2</sup> is 2-amino-pyridin-4-yl and R<sup>5</sup> is H.

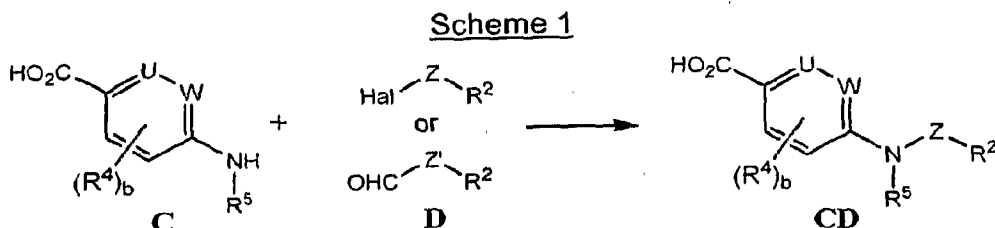
25 Illustrative examples of the compounds of formula (I) include, but are not limited to, Compounds 1A-160A as set forth below in the Examples section.

#### **Methods for Making the Compounds of Formula (I)**

30 The compounds of this invention can be prepared via procedures known to those skilled in the art. Compounds described in this invention are typically prepared by preassembling the right portion of the molecule (CD fragment) and then building onto it the left portion of the molecule in a one-step (AB + CD) or two-step (B + CD, followed by A + BCD) approach (see Schemes 2-4, below).

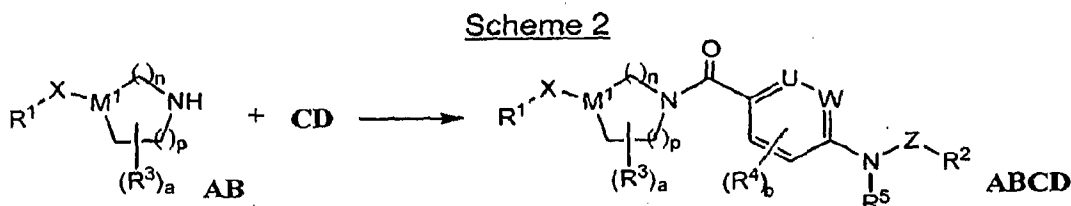
The CD portion of the molecule is typically assembled as shown in Scheme 1:

25

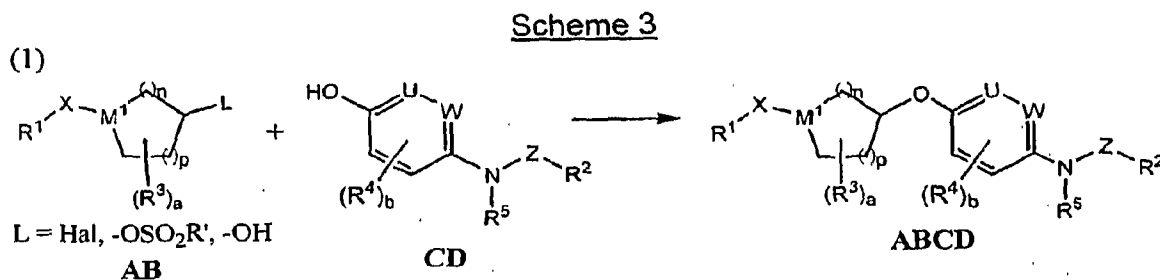


A typical reaction involves thermal reaction of the appropriately functionalized aniline C with halogen-substituted reagent D wherein R<sup>2</sup> is heteroaryl (Z is a single bond); the procedure is applicable to reaction of an aniline C with halogen-substituted aryl, cycloalkyl and heterocycloalkyl versions of fragment D. In cases, where linker Z is a C<sub>1</sub>-C<sub>6</sub> alkyl or alkenyl moiety (Z'), a reductive amination or a nucleophilic substitution process between the aniline C and an appropriate aldehyde or alkyl halide reagent D leads to CD.

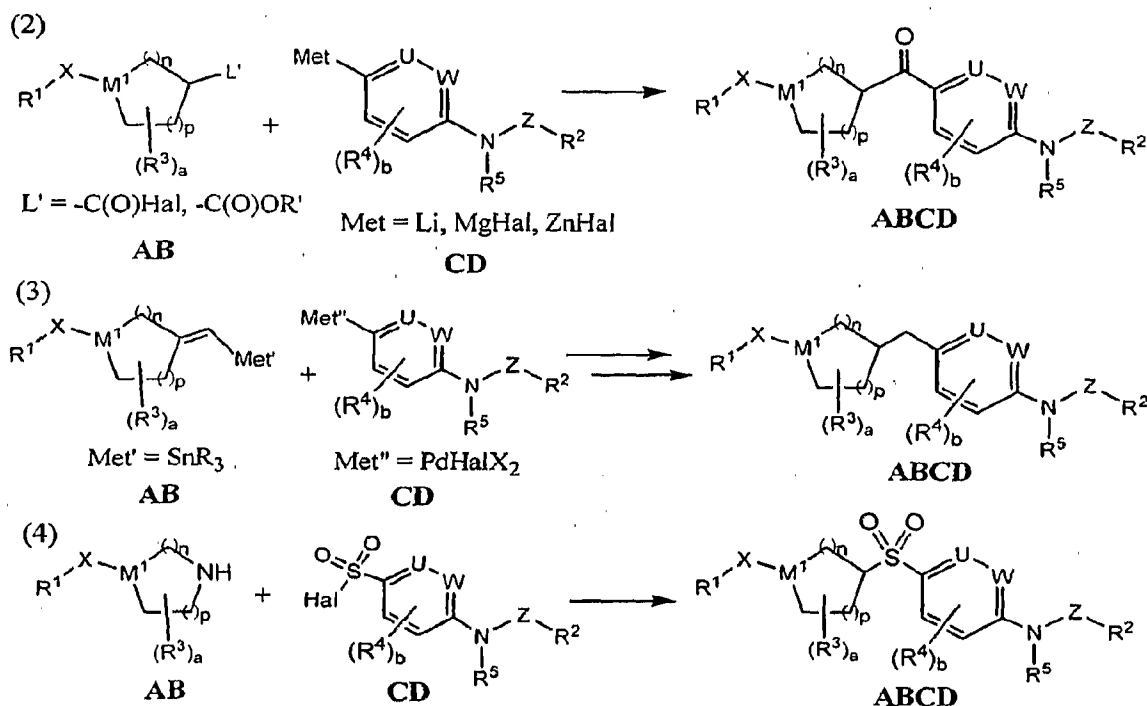
Where M<sup>2</sup> is nitrogen, construction of the link between the CD and the AB (or alternatively, B) fragments of the molecule is typically accomplished through amide coupling of the preinstalled carboxylic acid functionality of the C fragment and the corresponding secondary amine functionality of the B fragment. See Scheme 2:



Pre-installation of a different functional group on the fragment C in place of the carboxylic acid functionality, e.g. a hydroxyl, halogen or sulfonyl moiety, allows formation of different types of Y moieties as the B-C links, as shown in Scheme 3:



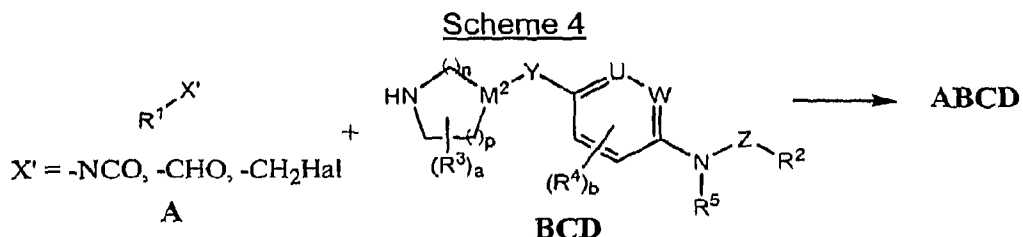
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- Suitable reactions for achieving B-C coupling include, but are not limited to, (1) a Mitsunobu reaction or nucleophilic substitution with a phenolate anion (i.e., Y is  $-O^-$ ,  $M^2=C$ ); (2) metal-halogen exchange, followed by the addition of the corresponding C-arylmatal (e.g., catalyzed by a transition metal catalyst) species to the appropriate B-fragment electrophile (Y =  $-C(O)-$ ,  $M^2=C$ ), optionally followed by the reduction of the ketone (Y =  $CH_2$ ,  $M^2=C$ ); (3) transition-metal catalyzed coupling of the C-arylhalide with an appropriate vinyl metal species, derived from B (Y =  $CH_2$ ,  $M^2=C$ ), followed by the reduction of the double bond; or (4) reaction of the B-ring secondary amine with a C-ring sulfonyl chloride (Y =  $SO_2$ ).

A variety of approaches to the construction of the corresponding AB fragments are known in the art. Synthetic approaches in most cases are dictated by the particular nature of the AB fragment. Some approaches to the AB fragments are illustrated by the specific examples below. In some instances, a stepwise approach to the construction of left side of the molecule (B + CD, followed by A + BCD) is more convenient. This approach is useful, if the A + BCD coupling process conditions are tolerated by the functionalities already present in the BCD fragment. A non-limiting example of this approach (when  $M^1$  is nitrogen) is shown in Scheme 4.

27



### Uses of the Compounds of Formula (I)

- 5           The compounds of formula (I) are useful for treating or preventing a Condition. Accordingly, the present invention provides methods for treating or preventing a Condition in a patient, comprising administering to the patient an effective amount of at least one compound of formula (I) or a pharmaceutically acceptable salt or solvate thereof.
- 10           In one embodiment, the compounds of formula (I) are useful for treating congestion, metabolic syndrome, obesity, an obesity-related disorder or a cognition deficit disorder.
- In another embodiment, the compounds of formula (I) are useful for treating obesity or an obesity-related disorder.
- 15           In another embodiment, the compounds of formula (I) are useful for treating diabetes. There are two major forms of diabetes: Type I diabetes (also referred to as insulin-dependent diabetes or NIDDM) and Type II diabetes (also referred to as noninsulin dependent diabetes or NIDDM). In one embodiment, the compounds of formula (I) are useful for treating Type I diabetes. In another embodiment, the
- 20           compounds of formula (I) are useful for treating Type II diabetes.

### Combination Therapy

- The present methods for treating or preventing a Condition can further comprise administering one or more additional therapeutic agents in addition to the at
- 25           least one compound of formula (I). Additional therapeutic agents useful in the present methods include, but are not limited to, H<sub>1</sub> receptor antagonists, weight-loss agents, HMG-CoA reductase inhibitors, sterol absorption inhibitors, anti-diabetic agents, any agent useful for treating obesity, an obesity-related disorder, any agent useful for treating metabolic syndrome, any agent useful for treating a cognition deficit disorder,
- 30           or any combination of two or more of these additional therapeutic agents.

In one embodiment, the compounds of formula (I) can be combined with an H<sub>1</sub> receptor antagonist (*i.e.*, the compounds of formula (I) can be combined with an H<sub>1</sub> receptor antagonist in a pharmaceutical composition, or the compounds of formula (I) can be administered with an H<sub>1</sub> receptor antagonist).

5 Numerous chemical substances are known to have histamine H<sub>1</sub> receptor antagonist activity and can therefore be used in the methods of this invention. Representative H<sub>1</sub> receptor antagonists include, without limitation: astemizole, azatadine, azelastine, acrivastine, brompheniramine, cetirizine, chlorpheniramine, clemastine, cyclizine, carebastine, cyproheptadine, carbinoxamine,  
10 descarboethoxyloratadine, diphenhydramine, doxylamine, dimethindene, ebastine, epinastine, efletirizine, fexofenadine, hydroxyzine, ketotifen, loratadine, levocabastine, meclizine, mizolastine, mequitazine, mianserin, noberastine, norastemizole, picumast, pyrilamine, promethazine, terfenadine, tripeleminamine, temelastine, trimeprazine and triprolidine. Other compounds can readily be evaluated to determine activity at H<sub>1</sub>  
15 receptors by known methods, including specific blockade of the contractile response to histamine of isolated guinea pig ileum. See for example, WO98/06394 published February 19, 1998.

Those skilled in the art will appreciate that the H<sub>1</sub> receptor antagonist is used at its known therapeutically effective dose, or the H<sub>1</sub> receptor antagonist is used at its  
20 normally prescribed dosage.

In one embodiment, said H<sub>1</sub> receptor antagonist is selected from: azatadine, brompheniramine, cetirizine, chlorpheniramine, carebastine, descarboethoxy-  
loratadine, diphenhydramine, ebastine, fexofenadine, loratadine, or norastemizole. More preferably, said H<sub>1</sub> antagonist is selected from loratadine,  
25 descarboethoxyloratadine, fexofenadine or cetirizine.

In one embodiment, in the above combinations of H<sub>3</sub> and H<sub>1</sub> antagonists, nasal congestion is treated.

Weight-loss agents include appetite suppressants, metabolic rate enhancers and nutrient absorption inhibitors. Appetite suppressant agents useful for treating  
30 obesity or metabolic syndrome include cannabinoid receptor 1 (CB<sub>1</sub>) antagonists or inverse agonists (*e.g.*, rimonabant); Neuropeptide Y (NPY1, NPY2, NPY4 and NPY5) antagonists; metabotropic glutamate subtype 5 receptor (mGluR5) antagonists (*e.g.*, 2-methyl-6-(phenylethynyl)-pyridine and 3[(2-methyl-1,4-thiazol-4-yl)ethynyl]pyridine);

melanin-concentrating hormone receptor (MCH1R and MCH2R) antagonists; melanocortin receptor agonists (e.g., Melanotan-II and Mc4r agonists); serotonin uptake inhibitors (e.g., dexfenfluramine and fluoxetine); serotonin (5HT) transport inhibitors (e.g., paroxetine, fluoxetine, fenfluramine, fluvoxamine, sertraline and imipramine); norepinephrine (NE) transporter inhibitors (e.g., desipramine, talsupram and nomifensine); ghrelin antagonists; leptin or derivatives thereof; opioid antagonists (e.g., nalmefene, 3-methoxynaltrexone, naloxone and naltrexone); orexin antagonists; bombesin receptor subtype 3 (BRS3) agonists; Cholecystokinin-A (CCK-A) agonists; ciliary neurotrophic factor (CNTF) or derivatives thereof (e.g., butabindide and axokine); monoamine reuptake inhibitors (e.g., sibutramine); glucagons-like peptide 1 (GLP-1) agonists; topiramate; and phytopharm compound 57. Metabolic rate enhancers include acetyl-CoA carboxylase-2 (ACC2) inhibitors; beta adrenergic receptor 3 ( $\beta$ 3) agonists; diacylglycerol acyltransferase inhibitors (DGAT1 and DGAT2); fatty acid synthase (FAS) inhibitors (e.g., Cerulenin); phosphodiesterase (PDE) inhibitors (e.g., theophylline, pentoxifylline, zaprinast, sildenafil, amrinone, milrinone, cilostamide, rolipram and cilomilast); thyroid hormone  $\beta$  agonists; uncoupling protein activators (UCP-1,2 or 3) (e.g., phytanic acid, 4-[(E)-2-(5,6,7,8-tetramethyl-2-naphthalenyl)-1-propenyl]benzoic acid and retinoic acid); acyl-estrogens (e.g., oleoyl-estrone); glucocorticoid antagonists; 11-beta hydroxyl steroid dehydrogenase type 1 ( $11\beta$  HSD-1) inhibitors; melanocortin-3 receptor (Mc3r) agonists; and stearoyl-CoA desaturase-1 (SCD-1) compounds. Nutrient absorption inhibitors include lipase inhibitors (e.g., orlistat, lipstatin, tetrahydrolipstatin, teasaponin and diethylumbelliferyl phosphate); fatty acid transporter inhibitors; dicarboxylate transporter inhibitors; glucose transporter inhibitors; and phosphate transporter inhibitors.

Specific compounds for use in the combination for treating obesity and metabolic syndrome include rimonabant, 2-methyl-6-(phenylethynyl)-pyridine, 3[(2-methyl-1,4-thiazol-4-yl)ethynyl]pyridine, Melanotan-II, dexfenfluramine, fluoxetine, paroxetine, fenfluramine, fluvoxamine, sertraline, imipramine, desipramine, talsupram, nomifensine, leptin, nalmefene, 3-methoxynaltrexone, naloxone, naltrexone, butabindide, axokine, sibutramine, topiramate, phytopharm compound 57, Cerulenin, theophylline, pentoxifylline, zaprinast, sildenafil, amrinone, milrinone, cilostamide, rolipram, cilomilast, phytanic acid, 4-[(E)-2-(5,6,7,8-tetramethyl-2-naphthalenyl)-1-

propenyl]benzoic acid, retinoic acid, oleoyl-estrone, orlistat, lipstatin, tetrahydrolipstatin, teasaponin and diethylumbelliferyl phosphate.

Preferred compounds for use in the combination for treating obesity and metabolic syndrome include rimonabant, dexfenfluramine, fenfluramine, phentermine, 5 leptin, nalmefene, axokine, sibutramine, topiramate, phytopharm compound 57, oleoyl-estrone and orlistat.

Also preferred are combinations of at least one compound of formula (I) and one or more HMG-CoA reductase inhibitors and/or one or more substituted azetidinone or substituted  $\beta$ -lactam sterol absorption inhibitors for treating metabolic 10 syndrome or obesity.

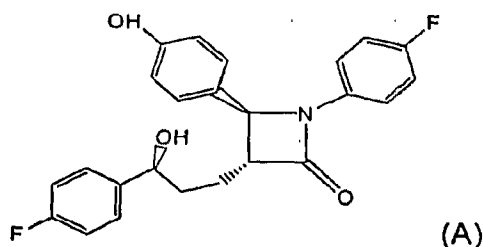
Typical HMG-CoA reductase inhibitors include statins such as lovastatin, simvastatin, pravastatin, atorvastatin, fluvastatin, resuvastatin, cerivastatin, rivastatin and pitavastatin. In one embodiment, the HMG-CoA reductase inhibitor is simvastatin.

As used herein, "sterol absorption inhibitor" means a compound capable of 15 inhibiting the absorption of one or more sterols, including but not limited to cholesterol, phytosterols (such as sitosterol, campesterol, stigmasterol and avenosterol),  $5\alpha$ -stanols (such as cholestanol,  $5\alpha$ -campestanol,  $5\alpha$ -sitostanol), and/or mixtures thereof, when administered in a therapeutically effective (sterol and/or  $5\alpha$ - 20 stanol absorption inhibiting) amount to a mammal or human.

Non-limiting examples of suitable substituted azetidinones and methods of making the same include those disclosed in U.S. Patents Nos. RE 37,721, 5,306,817, 5,561,227, 5,618,707, 5,624,920, 5,631,365, 5,656,624, 5,627,176, 5,633,246, 5,661,145, 5,688,785, 5,688,787, 5,688,990, 5,698,548, 5,728,827, 5,739,321, 25 5,744,467, 5,756,470, 5,767,115, 5,846,966, 5,856,473, 5,886,171, 5,919,672, 6,093,812, 6,096,883, 6,133,001, 6,207,822, 6,627,757, 6,632,933, U.S. Patent Publication Nos. 2003/0105028, 2004/0180860, 2004/0180861, and 2004/0198700, N-sulfonyl-2-azetidinones such as are disclosed in U.S. Patent No. 4,983,597, ethyl 4-(2-oxoazetidin-4-yl)phenoxy-alkanoates such as are disclosed in Ram et al., Indian J. 30 Chem. Sect. B. 29B, 12 (1990), p. 1134-7, and diphenyl azetidinones and derivatives disclosed in U.S. Patent Publication Nos. 2002/0039774, 2002/0128252, 2002/0128253 and 2002/0137689, and PCT Published Application Nos. WO 2002/066464, WO 04/000805, WO 04/005247, WO 04/000804, WO 04/000803, WO

04/014947, WO 04/087655, WO 05/009955, WO 05/023305, WO 05/021495, WO 05/021497, WO 05/044256, WO 05/042692, WO 05/033100, WO 05/030225, WO 05/047248, WO 05/046662, WO 05/061451, WO 05/061452, WO 05/062824, WO 05/02897, WO 05/000353, each of which is incorporated by reference herein.

5 An example of a suitable substituted azetidinone compound is represented by Formula (A) (ezetimibe) below:



or pharmaceutically acceptable salts or solvates of the compound of Formula (A). The compound of Formula (A) can be in anhydrous or hydrated form. A product containing ezetimibe compound is commercially available as ZETIA® ezetimibe formulation from MSP Pharmaceuticals.

Typical compounds for use in combination with an H<sub>3</sub> antagonist of this invention for the treatment of a cognition deficit disorder are atomoxetine and dexmethylphenidate for the treatment of ADHD, olanzapine, risperidone or aripiprazole for treatment of schizophrenia, and donepezil, heptylphysostigmine, tacrine, rivastigmine or galantamine for the treatment of Alzheimer's Disease.

In one embodiment, the compounds of formula (I) can be co-administered with an anti-diabetic agent for treating diabetes.

Examples of anti-diabetic agents useful in the present methods for treating diabetes include sulfonylureas, insulin sensitizers (such as PPAR agonists, DPPIV inhibitors, PTP-1B inhibitors and glucokinase activators),  $\alpha$ -glucosidase inhibitors, insulin secretagogues, hepatic glucose output lowering compounds, anti-obesity agents, antihypertensive agents, meglitinides, insulin and insulin-containing compositions.

In one embodiment, the anti-diabetic agent is an insulin sensitizer or a sulfonylurea.

Non-limiting examples of sulfonylureas include glipizide, tolbutamide, glyburide, glimepiride, chlorpropamide, acetohexamide, gliamilide, gliclazide, glibenclamide and tolazamide. Insulin sensitizers include PPAR- $\gamma$  agonists described in detail above,

preferably troglitazone, rosiglitazone, pioglitazone and englitazone; biguanidines such as metformin and phenformin; DPPIV inhibitors such as sitagliptin, saxagliptin, denagliptin and vildagliptin; PTP-1B inhibitors; and glucokinase activators.  $\alpha$ -Glucosidase inhibitors that can be useful in treating type II diabetes include miglitol, acarbose, and voglibose. Hepatic glucose output lowering drugs include Glucophage and Glucophage XR. Insulin secretagogues include sulfonylurea and non-sulfonylurea drugs such as GLP-1, exendin, GIP, secretin, glipizide, chlorpropamide, nateglinide, meglitinide, glibenclamide, repaglinide and glimepiride. Insulin includes all formulations of insulin, including long acting and short acting forms of insulin.

10 Non-limiting examples of anti-obesity agents useful in the present methods for treating diabetes include CB1 antagonists or inverse agonists such as rimonabant, neuropeptide Y antagonists, MCR4 agonists, MCH receptor antagonists, histamine H3 receptor antagonists or inverse agonists, leptin, appetite suppressants such as sibutramine, and lipase inhibitors such as xenical.

15 Non-limiting examples of antihypertensive agents useful in the present methods for treating diabetes include  $\beta$ -blockers and calcium channel blockers (for example diltiazem, verapamil, nifedipine, amlodipine, and mybefradil), ACE inhibitors (for example captopril, lisinopril, enalapril, spirapril, ceranopril, zefenopril, fosinopril, cilazopril, and quinapril), AT-1 receptor antagonists (for example losartan, irbesartan, and valsartan), renin inhibitors and endothelin receptor antagonists (for example sitaxsentan).

20 Non-limiting examples of meglitinides useful in the present methods for treating diabetes include repaglinide and nateglinide.

25 Non-limiting examples of insulin sensitizers include biguanides, such as metformin and thiazolidinediones.

In one embodiment, the insulin sensitizer is a thiazolidinedione.

30 Non-limiting examples of antidiabetic agents that slow or block the breakdown of starches and certain sugars and are suitable for use in the compositions and methods of the present invention include alpha-glucosidase inhibitors and certain peptides for increasing insulin production. Alpha-glucosidase inhibitors help the body to lower blood sugar by delaying the digestion of ingested carbohydrates, thereby resulting in a smaller rise in blood glucose concentration following meals. Non-limiting examples of suitable alpha-glucosidase inhibitors include acarbose; miglitol;

camiglibose; certain polyamines as disclosed in WO 01/47528 (incorporated herein by reference); voglibose. Non-limiting examples of suitable peptides for increasing insulin production including amlintide (CAS Reg. No. 122384-88-7 from Amylin; pramlintide, exendin, certain compounds having Glucagon-like peptide-1 (GLP-1) agonistic activity as disclosed in WO 00/07617 (incorporated herein by reference).

Non-limiting examples of orally administrable insulin and insulin containing compositions include AL-401 from AutoImmune, and the compositions disclosed in U.S. Patent Nos. 4,579,730; 4,849,405; 4,963,526; 5,642,868; 5,763,396; 5,824,638; 5,843,866; 6,153,632; 6,191,105; and International Publication No. WO 85/05029, each of which is incorporated herein by reference.

In one embodiment, the compounds of formula (I) can be co-administered with an anti-diabetic agent for treating obesity or an obesity-related disorder.

Anti-diabetic agents useful in the present methods for treating obesity or an obesity-related disorder include, but are not limited to the anti-diabetic agents listed above herein.

In the combination therapies of the present invention, the at least one compound of formula (I) and the one or more additional therapeutic agents can be administered simultaneously (at the same time, in a single dosage form or in separate dosage forms) or sequentially (first one and then another, etc... over a period of time) in any order.

### **Pharmaceutical Compositions and Administration**

For preparing pharmaceutical compositions from the compounds described by this invention, inert, pharmaceutically acceptable carriers can be either solid or liquid. Solid form preparations include powders, tablets, dispersible granules, capsules, cachets and suppositories. The powders and tablets may be comprised of from about 5 to about 95 percent active ingredient. Suitable solid carriers are known in the art, e.g. magnesium carbonate, magnesium stearate, talc, sugar or lactose. Tablets, powders, cachets and capsules can be used as solid dosage forms suitable for oral administration. Examples of pharmaceutically acceptable carriers and methods of manufacture for various compositions may be found in A. Gennaro (ed.), *The Science and Practice of Pharmacy*, 20<sup>th</sup> Edition, (2000), Lippincott Williams & Wilkins, Baltimore, MD.

Liquid form preparations include solutions, suspensions and emulsions. As an example may be mentioned water or water-propylene glycol solutions for parenteral injection or addition of sweeteners and opacifiers for oral solutions, suspensions and emulsions. Liquid form preparations may also include solutions for intranasal  
5 administration.

Aerosol preparations suitable for inhalation may include solutions and solids in powder form, which may be in combination with a pharmaceutically acceptable carrier, such as an inert compressed gas, e.g. nitrogen.

Also included are solid form preparations which are intended to be converted,  
10 shortly before use, to liquid form preparations for either oral or parenteral administration. Such liquid forms include solutions, suspensions and emulsions.

The compounds of the invention may also be deliverable transdermally. The transdermal compositions can take the form of creams, lotions, aerosols and/or emulsions and can be included in a transdermal patch of the matrix or reservoir type  
15 as are conventional in the art for this purpose.

In one embodiment, the compound of formula (I) is administered orally.

In one embodiment, the pharmaceutical preparation is in a unit dosage form. In such form, the preparation is subdivided into suitably sized unit doses containing appropriate quantities of the active component, e.g., an effective amount to achieve  
20 the desired purpose.

The quantity of active compound in a unit dose of preparation may be varied or adjusted from about 1 mg to about 150 mg, preferably from about 1 mg to about 75 mg, more preferably from about 1 mg to about 50 mg, according to the particular application.

25 The actual dosage employed may be varied depending upon the requirements of the patient and the severity of the condition being treated. Determination of the proper dosage regimen for a particular situation is within the skill of the art. For convenience, the total daily dosage may be divided and administered in portions during the day as required.

30 The amount and frequency of administration of the compounds of the invention and/or the pharmaceutically acceptable salts thereof will be regulated according to the judgment of the attending clinician considering such factors as age, condition and size of the patient as well as severity of the symptoms being treated. A typical

recommended daily dosage regimen for oral administration can range from about 1 mg/day to about 300 mg/day, preferably 1 mg/day to 75 mg/day, in two to four divided doses.

When the invention comprises a combination of H<sub>3</sub> antagonist and H<sub>1</sub> antagonist compounds, the two active components may be co-administered simultaneously or sequentially, or a single pharmaceutical composition comprising a H<sub>3</sub> antagonist and an H<sub>1</sub> antagonist in a pharmaceutically acceptable carrier can be administered. The components of the combination can be administered individually or together in any conventional dosage form such as capsule, tablet, powder, cachet, suspension, solution, suppository, nasal spray, etc. The dosage of the H<sub>1</sub> antagonist can be determined from published material, and may range from about 1 to about 1000 mg per dose. When used in combination, the dosage levels of the individual components are preferably lower than the recommended individual dosages because of the advantageous effect of the combination.

When separate H<sub>3</sub> and H<sub>1</sub> antagonist pharmaceutical compositions are to be administered, they can be provided in a kit comprising in a single package, one container comprising an H<sub>3</sub> antagonist in a pharmaceutically acceptable carrier, and a separate container comprising an H<sub>1</sub> antagonist in a pharmaceutically acceptable carrier, with the H<sub>3</sub> and H<sub>1</sub> antagonists being present in amounts such that the combination is therapeutically effective. A kit is advantageous for administering a combination when, for example, the components must be administered at different time intervals or when they are in different dosage forms.

Similarly, when the invention comprises a combination of H<sub>3</sub> antagonist and another compound for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder, the two active components may be co-administered simultaneously or sequentially, or a single pharmaceutical composition comprising a H<sub>3</sub> antagonist and another compound in a pharmaceutically acceptable carrier can be administered. The components of the combination can be administered individually or together in any conventional dosage form such as capsule, tablet, powder, cachet, suspension, solution, suppository, nasal spray, etc. The dosage of the other compound for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder can be determined from published material, and may range from about 1 to about 1000 mg per dose.

### Kits

When separate pharmaceutical compositions comprising an H<sub>3</sub> antagonist and another compound for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder are to be administered, they can be provided in a kit comprising in a single package, one container comprising an H<sub>3</sub> antagonist in a pharmaceutically acceptable carrier, and a separate container comprising a compound for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder in a pharmaceutically acceptable carrier, with the H<sub>3</sub> antagonists and other compounds being present in amounts such that the combination is therapeutically effective. A kit is advantageous for administering a combination when, for example, the components must be administered at different time intervals or when they are in different dosage forms.

Compounds of formula (I) can be prepared by the general methods outlined above. Specifically exemplified compounds were prepared as described in the examples below, from starting materials known in the art or prepared as described below. These examples are being provided to further illustrate the present invention. They are for illustrative purposes only; the scope of the invention is not to be considered limited in any way thereby.

20

### EXAMPLES

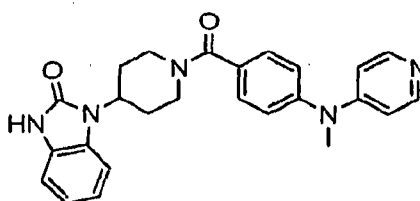
#### **General Methods**

The starting materials and reagents used in preparing compounds described are either available from commercial suppliers such as Aldrich Chemical Co. (Wisconsin, USA) and Acros Organics Co. (New Jersey, USA) or were prepared using methods well-known to those skilled in the art of organic synthesis. All commercially purchased solvents and reagents were used as received. LCMS analysis was performed using an Applied Biosystems API-100 mass spectrometer equipped with a Shimadzu SCL-10A LC column: Altech platinum C18, 3  $\mu$ m, 33 mm X 7 mm ID; gradient flow: 0 minutes, 10% CH<sub>3</sub>CN; 5 minutes, 95% CH<sub>3</sub>CN; 7 minutes, 95% CH<sub>3</sub>CN; 7.5 minutes, 10% CH<sub>3</sub>CN; 9 minutes, stop. Flash column chromatography was performed using Selecto Scientific flash silica gel, 32–63 mesh. Analytical and preparative TLC was performed using Analtech Silica gel GF plates. Chiral HPLC

was performed using a Varian PrepStar system equipped with a Chiralpak OD column (Chiral Technologies).

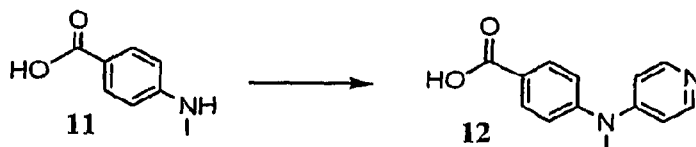
### Example 1

#### Preparation of Compound 1A



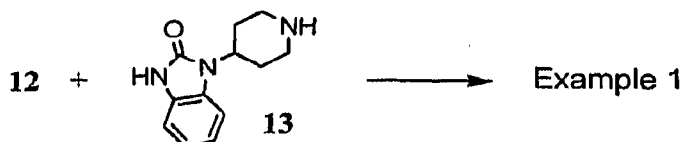
1A

#### Step 1:



A mixture of amino acid **11** (1.0 g; 6.62 mmol) and 4-bromopyridine hydrochloride (1.54 g; 7.94 mmol) was heated until melted, and then the temperature was maintained for 1 h. The mixture was cooled to produce crude **12** as a brown solid, which was used directly without purification.

#### Step 2:

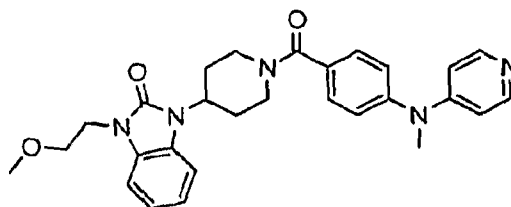


A mixture of crude **12** from Step 1, benzimidazolone **13** (1.43 g; 6.60 mmol), HOBT (1.34 g; 9.92 mmol) and EDC (1.90 g; 9.90 mmol) was stirred in DMF (20 ml) at room temperature overnight. DMF was removed under vacuum and the residue was partitioned between aqueous  $\text{NaHCO}_3$  and  $\text{CH}_2\text{Cl}_2$ . The organic phase was separated, washed with brine, dried ( $\text{Na}_2\text{SO}_4$ ) and concentrated. The residue was flash chromatographed (5% 2.3M  $\text{NH}_3$  in  $\text{MeOH} / \text{CH}_2\text{Cl}_2$ ) to produce 0.11 g of title compound as a white solid.  $\text{MH}^+$  428

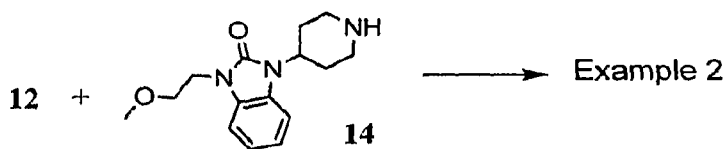
### Example 2

38

## Preparation of Compound 2A



2A



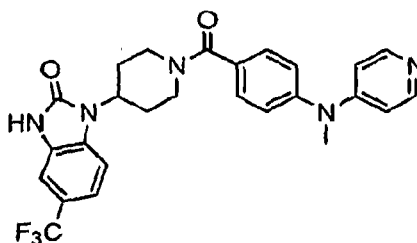
Compound 14 was prepared as described in US 2004/0048843.

A mixture of crude 12 from Example 1, Step 1, amine 14 (1.82 g; 6.6 mmol), HATU (3.0 g; 7.89 mmol) and Et<sub>3</sub>N (1.0 ml) in DMF (20 ml) was stirred at room temperature overnight. DMF was removed under vacuum, the residue was dissolved in MeOH and treated with diethylaminomethyl-polystyrene resin until basic. The mixture was filtered and concentrated. The residue was flash chromatographed (5% MeOH/CH<sub>2</sub>Cl<sub>2</sub> with 1% NH<sub>4</sub>OH) to provide 1.61 g of the title compound as a white solid. MH<sup>+</sup> 486

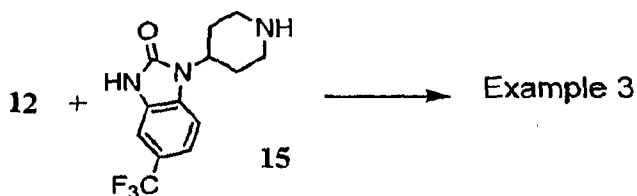
10

Example 3

## Preparation of Compound 3A



3A

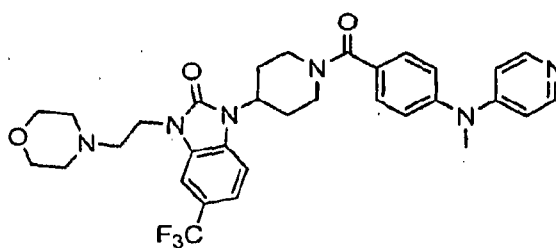


Compound 15 was prepared as described in US 2004/0048843.

Compounds **12** and **15** were converted into the title compound using the procedure described in Example 1, Step 2.  $MH^+$  496

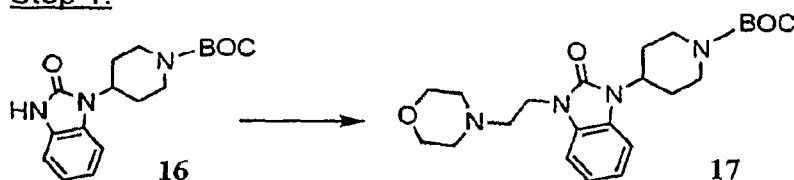
#### Example 4

#### Preparation of Compound **4A**



**4A**

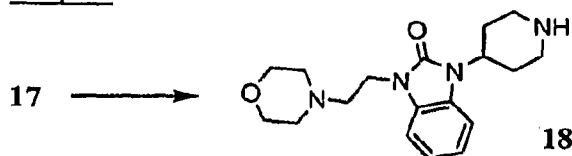
#### Step 1:



Compound **16** was prepared as described in US 2004/0048843.

A mixture of benzimidazolone **16** (5.74 g; 18.1 mmol), N-(2-chloroethyl-morpholine) hydrochloride (5.07 g; 27.3 mmol), NaOH (2.53 g; 63.3 mmol),  $K_2CO_3$  (5.01 g; 36.3 mmol) and tetrabutylammonium hydrosulfate (1.24 g; 3.65 mmol) in toluene (100 ml) was refluxed overnight. The reaction mixture was allowed to cool and was filtered. The filtrate was concentrated and the residue was flash chromatographed (2% MeOH/ $CH_2Cl_2$ ) to produce 5.71 g of compound **17** as a white foam.

#### Step 2:



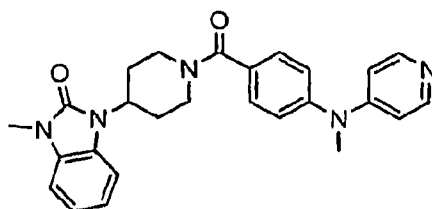
To a solution of compound **17** (7.81 g; 18.2 mmol) in  $CH_2Cl_2$  (50 ml) was added 4.0 M HCl solution in MeOH (28 ml, 109.9 mmol). The reaction mixture was stirred overnight and concentrated to produce 7.92 g of **18** as a hydrochloride salt.

Compound **18** was converted into the title compound using the procedure of Example 2.  $MH^+$  541

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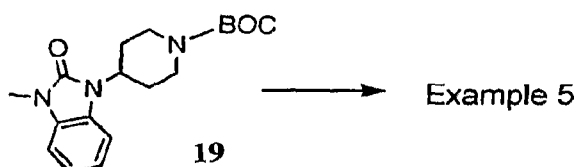
Example 5

Preparation of Compound 5A



5A

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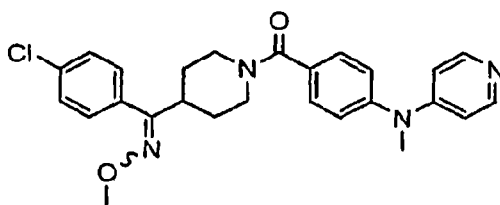


Compound **19** was prepared from compound **16** using the procedure described in US 2004/0048843.

Compound **19** was converted into the title compound using the procedure of Example 1, Step 2.  $MH^+$  442

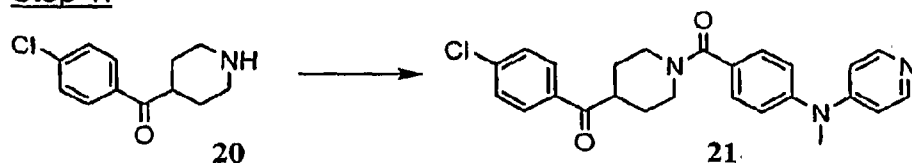
Example 6

Preparation of Compound 6A



6A

15

Step 1:

Compound **20** was converted into **21** using the procedure from Example 2.

Step 2:

To a solution of ketone **21** (160 mg; 0.37 mmol) in pyridine (20 ml) was added methoxylamine hydrochloride (62 mg; 0.74 mmol). The mixture was stirred overnight at 60°C, cooled and concentrated under vacuum. The residue was partitioned

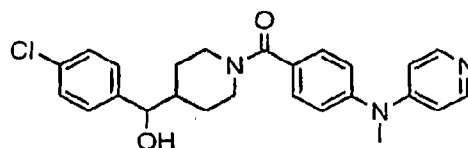


42

extraction. The organic phase was concentrated to produce the title compound. MH<sup>+</sup> 428471

Example 9

## Preparation of Compound 9A

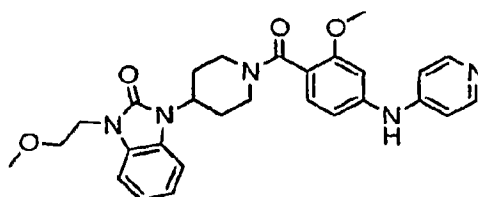


9A

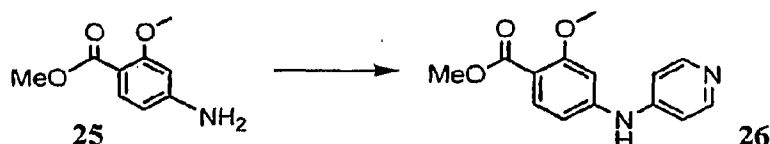
The title compound was prepared in quantitative yield by the NaBH<sub>4</sub> reduction in MeOH of the compound 21. MH<sup>+</sup> 436

Example 10

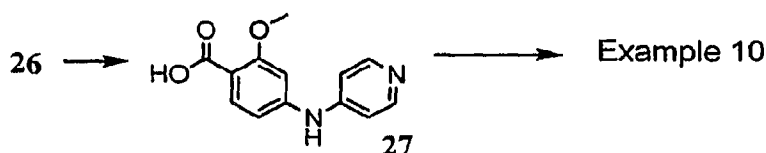
## Preparation of Compound 10A



10A

15 Step 1:

A mixture of aniline 25 (1.0 g; 5.5 mmol) and 4-bromopyridine hydrochloride (0.82 g; 4.2 mmol) in AcOH was stirred at reflux overnight. The mixture was concentrated under vacuum, and the residue was flash chromatographed (1% of 2.3M NH<sub>3</sub> in MeOH/CH<sub>2</sub>Cl<sub>2</sub>) to produce 0.052 g of compound 26.

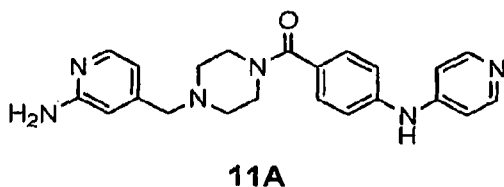
Step 2

Acid 27 was prepared from ester 26 through LiOH hydrolysis in acetone.

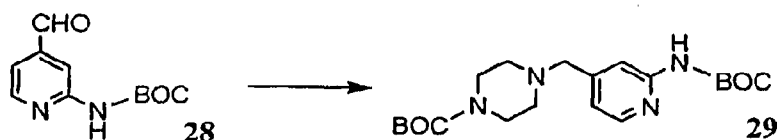
Acid **27** was converted into the title compound using the procedure of Example 1, Step 2. MH<sup>+</sup> 502

### Example 11

#### Preparation of Compound 11A

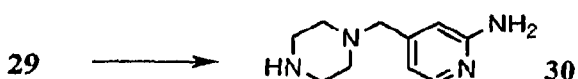


#### Step 1:



A mixture of aldehyde **28** (5.33 g; 24.1 mmol) (prepared as described in US 6,720,328), N-BOC-piperazine (4.49 g; 24.1 mmol) and NaBH(OAc)<sub>3</sub> (10.2 g; 48.1 mmol) in DCE (100 ml) was stirred overnight at room temperature. The mixture was subjected to basic aqueous work-up (NaOH) – CH<sub>2</sub>Cl<sub>2</sub> extraction. The organic phase was concentrated to provide **29**.

#### Step 2:



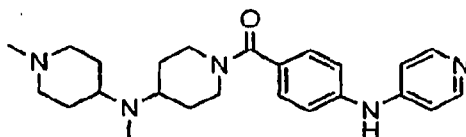
Crude **29** from step 1 was dissolved in 3M HCl in MeOH (200 ml) and the mixture was stirred at 60°C for 4 h. The mixture was concentrated under vacuum, the residue was redissolved in MeOH, basified with NaOH, filtered through solid Na<sub>2</sub>SO<sub>4</sub>, and the filtrate was concentrated to provide 4.3 g of diamine **30** as a free base.

#### Step 3:

Compound **30** was converted into the title compound using the procedure of Example 1, Step 2. MH<sup>+</sup> 389

### Example 12

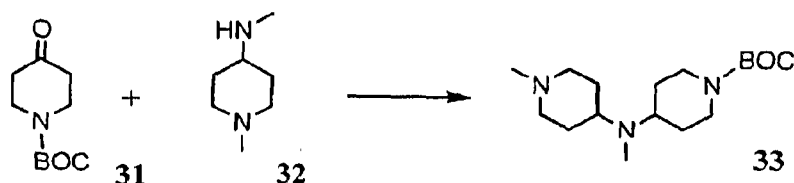
#### Preparation of Compound 12A



44

12A

Step 1:



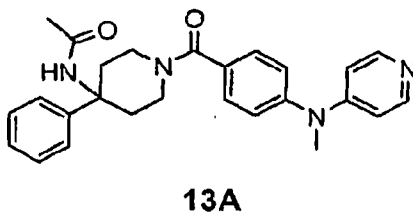
5 Compound 33 was prepared using the procedure of Example 11, Step 1.

Step 2:

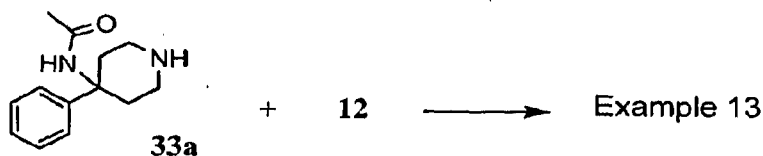
Compound 33 was converted into the title compound using the procedures of Example 4, Step 2, followed by Example 1, Step 2. MH<sup>+</sup> 408

Example 13

Preparation of Compound 13A



13A

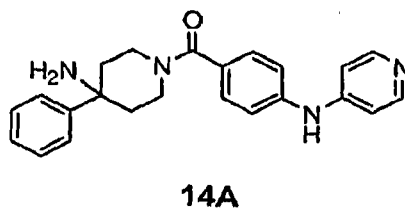


15 Compound 33a was prepared as described in *Bioorganic & Medicinal Chemistry Letters* 1993, 3, 925.

Compound 33a was converted into the title compound as described in Example 1, Step 2. MH<sup>+</sup> 429

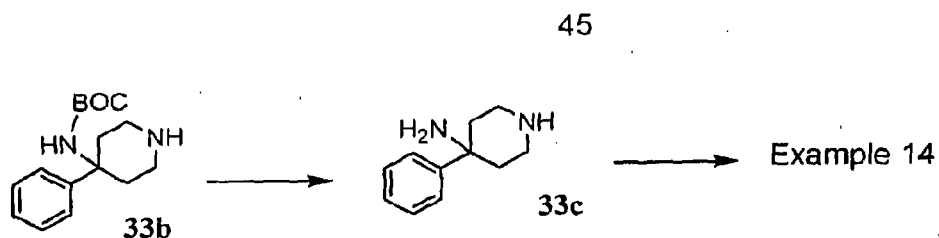
Example 14

Preparation of Compound 14A



14A

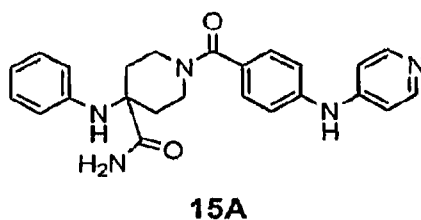
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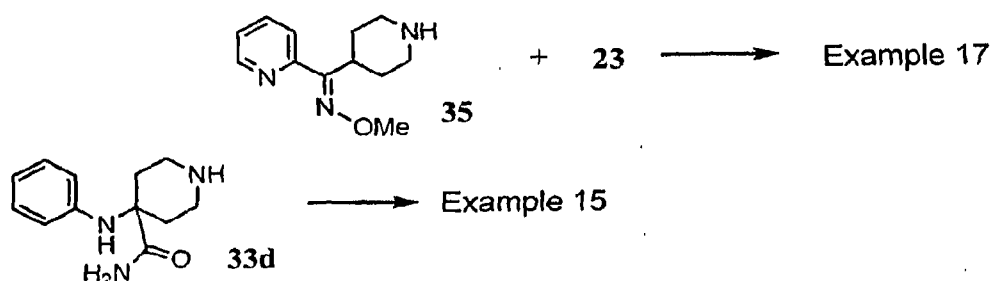
The preparation of compound **33b** is described in US 6716846. Compound **33c** was obtained from **33b** by using the procedure of Example 4, Step 2. Compound **33c** was converted into the title compound through reaction with acid **23** in a procedure identical to Example 1, Step 2.  $MH^+$  373

#### Example 15

#### Preparation of Compound 15A



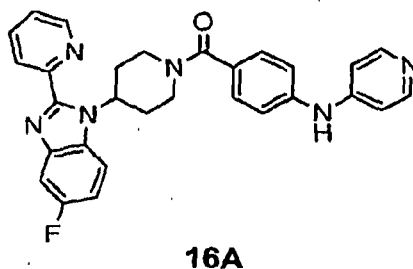
10



Compound **33d** (purchased from Sigma-Aldrich rare chemical library) was converted into the title compound through reaction with acid **23** in a procedure identical to Example 1, Step 2.  $MH^+$  416

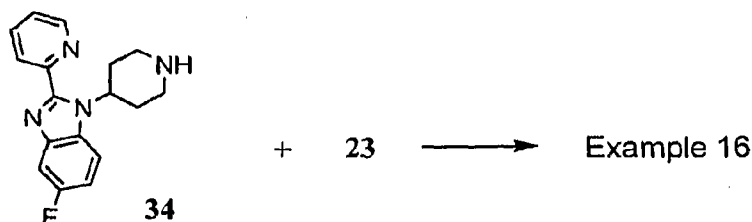
#### Example 16

#### Preparation of Compound 16A



20

46



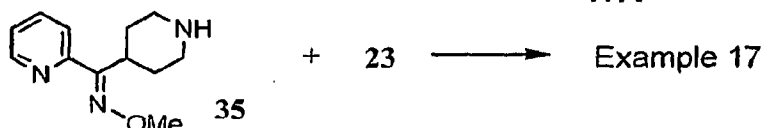
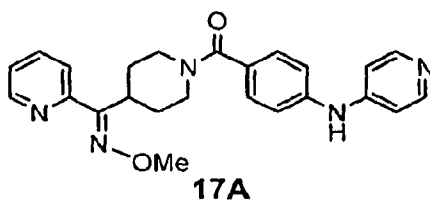
Compound 34 was prepared as described in US 2004/0097483.

Compound 34 was reacted with compound 23 using the procedure of Example 1, Step 2, to obtain the title compound.  $MH^+$  493

5

#### Example 17

#### Preparation of Compound 17A



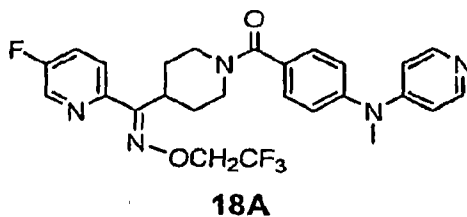
10

Compound 35 was prepared as described in US 6,720,328.

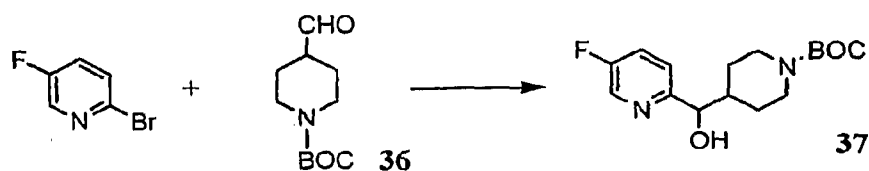
Compound 35 was reacted with compound 23 using the procedure of Example 1, Step 2, to obtain the title compound.  $MH^+$  416.

#### Example 18

#### Preparation of Compound 18A

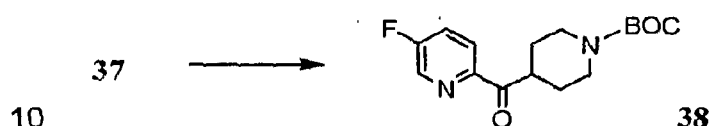


#### Step 1:

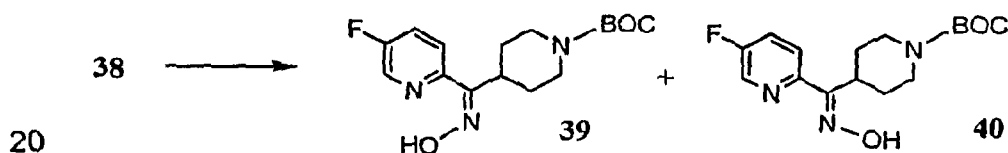


47

A solution of 2-bromo-5-fluoropyridine (2.0 g, 11.4 mmol) in toluene (20 ml) was added slowly to a solution of n-BuLi (5.0 ml, 12.5 mmol) in toluene (80 ml), cooled to  $-78\text{ }^{\circ}\text{C}$  and the mixture was stirred at  $-78\text{ }^{\circ}\text{C}$  for 30 min. Then, a solution of aldehyde **36** (3.64 g, 17.0 mmol) in toluene (20 ml) was added and the reaction mixture was stirred at  $-78\text{ }^{\circ}\text{C}$  for 2 h. It was quenched with AcOH at  $-78\text{ }^{\circ}\text{C}$  and diluted with water. The product was extracted with  $\text{CH}_2\text{Cl}_2$  and the organic layer was dried over  $\text{Na}_2\text{SO}_4$ . Purification by flash chromatography (0–1% 2N  $\text{NH}_3$  in  $\text{MeOH}/\text{CH}_2\text{Cl}_2$ ) provided 3.50 g (99%) of alcohol **37** as a yellowish oil.

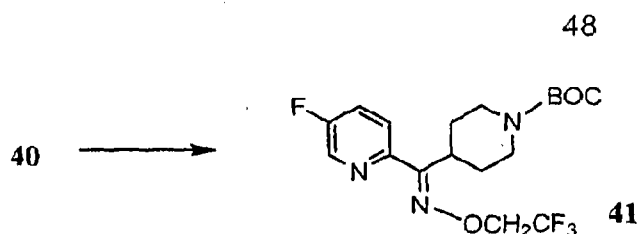
Step 2:

To a solution of alcohol **37** (9.0 g, 29.0 mmol) in  $\text{CH}_2\text{Cl}_2$  (200 ml) was added saturated aqueous solution of  $\text{NaHCO}_3$  (3.0 g, 35.6 mmol) and  $\text{NaBr}$  (0.15 g, 1.49 mmol). The mixture was cooled to  $0\text{ }^{\circ}\text{C}$  and TEMPO (0.05 g, 0.32 mmol) was added, followed by 0.7 M (85 ml, 59.5 mmol) commercial bleach ( $\text{NaOCl}$ ) in portions over 15 min. The reaction mixture was stirred at  $0\text{ }^{\circ}\text{C}$  for 30 min and then quenched with saturated aqueous  $\text{Na}_2\text{S}_2\text{O}_3$  solution. The product was extracted with  $\text{CH}_2\text{Cl}_2$  and the organic layer was dried over  $\text{Na}_2\text{SO}_4$ . Purification by flash chromatography ( $\text{CH}_2\text{Cl}_2$ ) provided 6.31 g of **38** as a yellowish oil.

Step 3:

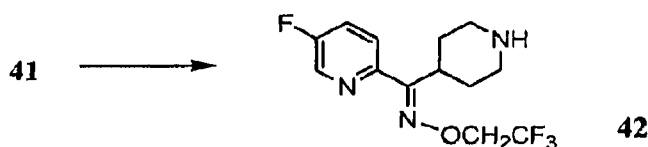
To the solution of ketone **38** (1.00 g; 3.24 mmol) in pyridine (6 ml) was added hydroxylamine hydrochloride (540 mg; 7.77 mmol). The mixture was heated at  $80\text{ }^{\circ}\text{C}$  overnight, cooled and concentrated under vacuum. The residue was flash chromatographed (1% 2.3M  $\text{NH}_3$  in  $\text{MeOH}/\text{CH}_2\text{Cl}_2$ ) to produce 385 mg of Z-oxime **39** and 553 mg of E-oxime **40**.

Step 4:



To a solution of oxime **40** (553 mg; 1.71 mmol) in a mixture of THF (16 ml) and DMF (30 ml) cooled to 0°C was added KHMDS (1.02 g; 5.13 mmol) in portions. The reaction mixture was allowed to warm up and was stirred for 10 min at room temperature, after which 2,2,2-trifluoroethyl trifluoromethanesulfonate (1.19 g; 5.13 mmol) was added. The reaction mixture was stirred for 1 h. Water was added and the product was extracted with CH<sub>2</sub>Cl<sub>2</sub>. The organic phase was concentrated and the residue was flash chromatographed (2-4% EtOAc/CH<sub>2</sub>Cl<sub>2</sub>) to produce 438 mg of **41** as a yellow oil.

10 Step 5:



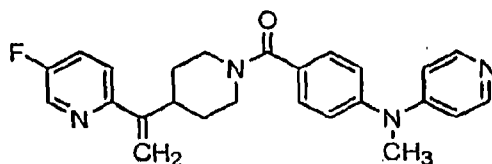
Compound **41** (438 mg; 1.08 mmol) was stirred in 20% TFA/CH<sub>2</sub>Cl<sub>2</sub> for 5 h at room temperature. The mixture was concentrated under vacuum and the residue was partitioned between aqueous NaHCO<sub>3</sub> and CH<sub>2</sub>Cl<sub>2</sub>. The organic phase was separated and concentrated to produce 322 mg of free amine **42** as a yellow oil.

15 Step 6:

Compound **42** was reacted with compound **12** using the procedure of Example 1, Step 2, to obtain the title compound. MH<sup>+</sup> 516.

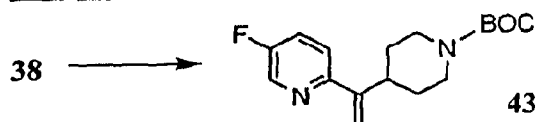
Example 19

Preparation of Compound **19A**



20 **19A**

49

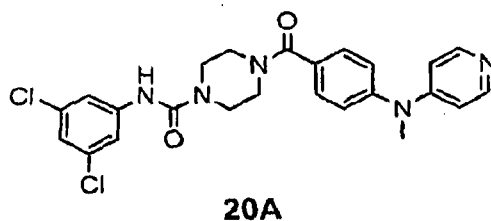
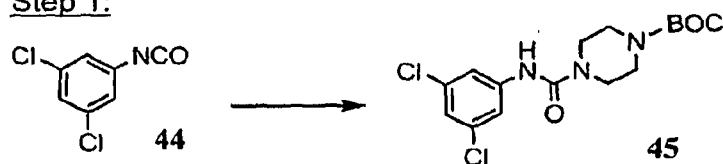
Step 1:

To a suspension of methyltriphenylphosphonium bromide (6.08 g, 17.0 mmol) in THF (60 ml), cooled to  $-78\text{ }^{\circ}\text{C}$ , was added n-BuLi (6.48 ml of 2.5M solution in  
 5 hexanes; 16.2 mmol); the mixture was stirred at  $-78\text{ }^{\circ}\text{C}$  for 30 min and then at  $0\text{ }^{\circ}\text{C}$  for 45 min. It was cooled back to  $-78\text{ }^{\circ}\text{C}$  and a solution of ketone **38** (2.50 g, 8.1 mmol) in THF (20 ml) was added. The reaction mixture was stirred at  $-78\text{ }^{\circ}\text{C}$  for 30 min and warmed up to room temperature. It was quenched with water, and the product was extracted with  $\text{CH}_2\text{Cl}_2$ . The organic layer was dried over  $\text{Na}_2\text{SO}_4$  and  
 10 purified by flash chromatography (1:9:10 EtOAc/hexanes/ $\text{CH}_2\text{Cl}_2$ ) to provide 1.45 g of **43** as a yellow oil.

Step 2:

Compound **43** was converted into the title compound using procedures of  
 Example 18, Step 5, followed by Example 1, Step 2.  $\text{MH}^+$  417

15

Example 20Preparation of Compound **20A**20 Step 1:

A solution of isocyanate **44** (5.60g, 29.8 mmol), N-BOC-piperazine (5.60 g, 30.1 mmol) and  $\text{Et}_3\text{N}$  (4.2 ml, 30.1 mmol) in  $\text{CH}_2\text{Cl}_2$  (200 ml) was stirred at room temperature for 1 h before treatment with 1N aqueous NaOH. The organic layer was  
 25 washed with brine and dried over anhydrous  $\text{MgSO}_4$ . The drying agent was filtered

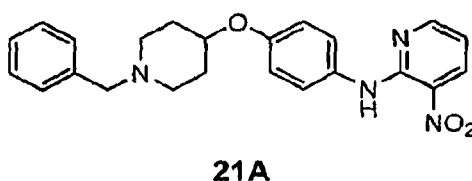
and the filtrate was stripped of solvent under vacuum to obtain 11.0 g of compound **45**, which was used directly without purification.

Step 2:

Compound **45** was converted into the title compound using procedures of Example 18, Step 5, followed by Example 1. Step 2. MH<sup>+</sup> 484

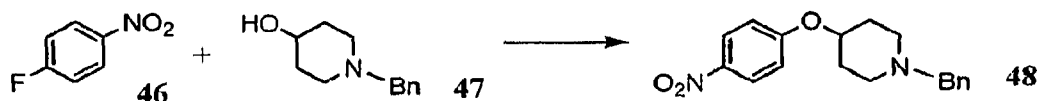
Example 21

Preparation of Compound **21A**



10

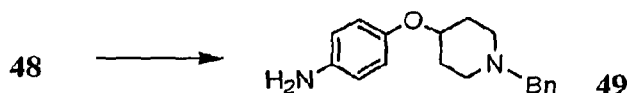
Step 1:



To a stirred suspension of compound **47** (20.1 g, 0.100 mol) in *tert*-butanol (120 ml) was added, portionwise, potassium *tert*-butoxide (9.5 g, 0.084 mol). The mixture was heated under reflux for 30 min, yielding a homogeneous solution which was cooled to 35 °C, and to which was added compound **46** (12.7 g, 0.09 mol) in a single portion. An exothermic reaction raised the internal temperature to 68 °C. When the exotherm had subsided, the mixture was heated to reflux for 30 min. Solvent was removed under vacuum, and the residue was treated with ice water, which resulted in formation of an insoluble fraction. Crude product **48** was isolated by filtration of the insoluble solid. Crude **48** (21g, 0.0672 mol) was treated with a mixture of 2N HCl and EtOAc, and the resultant mixture was stirred at room temperature for 10 min. The insoluble material was filtered and washed thoroughly with water and EtOAc to obtain 18.1 g of the hydrochloride salt of compound **48**, mp 287-289 °C. The HCl salt was stirred in a mixture of 1N NaOH (150 ml) and CH<sub>2</sub>Cl<sub>2</sub> (250 ml) until all solids dissolved. The organic phase was separated, washed with water and dried (anhydrous MgSO<sub>4</sub>). The drying agent was filtered, and the filtrate was stripped of solvent under vacuum to obtain 15.7 g of the free base form of compound **48** as a beige solid.

30 Step 2:

51



A solution of 9.0 g (28.8 mmol) of compound **48** in warm DMF (40 ml) was diluted with EtOH (120 ml). The solution was cooled to room temperature, and to it was added half a teaspoon of Raney nickel paste (50% water). The resultant mixture was hydrogenated at 35 psi until hydrogen uptake leveled off. The spent catalyst was filtered through a pad of celite, and the filtrate was concentrated under vacuum. The residue was partitioned between water and Et<sub>2</sub>O-EtOAc (1:1). The organic extract was washed with water, dried over anhydrous MgSO<sub>4</sub> and filtered. The filtrate was concentrated under vacuum to obtain 7.8 g of compound **49** as syrup, which was sufficiently pure for use in next step.

### Step 3:

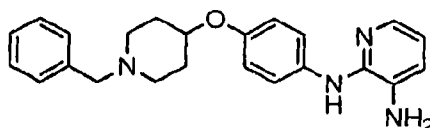
A stirred mixture of compound **49** (3.5 g, 12.4 mmol), anhydrous K<sub>2</sub>CO<sub>3</sub> (1.87 g, 13.5 mmol) and 2-chloro-3-nitropyridine (1.97 g, 12.4 mmol) in anhydrous toluene (50 ml) was heated under reflux for 18 h. TLC revealed a mixture of starting material and product. Therefore, additional quantities of 2-chloro-3-nitropyridine (0.5 g) and anhydrous K<sub>2</sub>CO<sub>3</sub> (0.5 g) were introduced, and heating under reflux was continued for another 18 h. After cooling to room temperature, the mixture was treated with ice-water and extracted with toluene. Combined toluene extracts were washed successively with 0.5N aqueous NaOH and water and were then treated with 0.5N HCl (200 ml). The red precipitate which formed was filtered to obtain 3.3 g of the crude HCl salt of the title compound. The acidic aqueous phase was separated, washed with EtOAc and basified with 10% aqueous NaOH. The resultant red precipitate was filtered and washed with water to provide 1.3 g of the free base form of the title compound. A mixture of HCl salt (3.2 g) and free base (1.3 g) was partitioned between 0.5N NaOH and CH<sub>2</sub>Cl<sub>2</sub>. The organic phase was washed with water and dried (anhydrous MgSO<sub>4</sub>). The drying agent was filtered, and the filtrate was concentrated under vacuum to obtain 4.5 g of the free base form of the title compound. MH<sup>+</sup> 405

### Example 22

#### Preparation of Compound **22A**

30

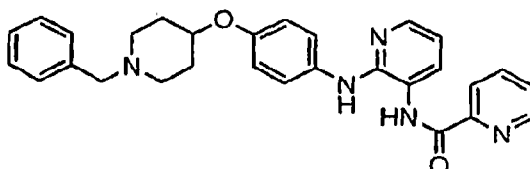
52

**22A**

A solution of 2.2 g (5.5 mmol) of Example 21 in warm DMF (30 ml) was diluted  
5 with EtOH (60 ml). The solution was cooled to room temperature, and to it was  
added half a teaspoon of Raney nickel paste (50% water). The resultant mixture was  
hydrogenated at 44 psi until hydrogen uptake leveled off. The spent catalyst was  
filtered through a pad of celite, and the filtrate was concentrated under vacuum. The  
residual oil was partitioned between water and EtOAc. The organic extract was  
10 washed with water, dried over anhydrous  $MgSO_4$  and filtered. The filtrate was  
concentrated under vacuum to produce a solid that was triturated with hexane.  
Filtration yielded 1.58 g of title compound.  $MH^+$  375

Example 23

## Preparation of Compound 23A

**23A**

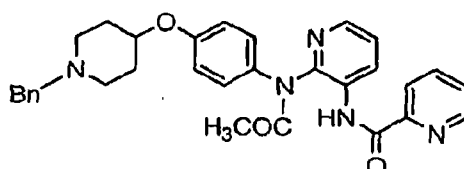
To a stirred, ice-cooled solution of Example 22 (0.73 g, 1.95 mmol) and  $Et_3N$   
(2.0 ml) in dry  $CH_2Cl_2$  (30 ml) was added picolinoyl chloride hydrochloride (0.38 g,  
2.15 mmol) in a few portions. Stirring at  $\sim 5^\circ C$  was maintained for 5 min, then  
20 continued at room temperature for 18 h. The reaction mixture was treated with ice  
water and the organic phase was separated and washed with water, dried over  
anhydrous  $MgSO_4$ , filtered and concentrated to a viscous residue, which contained  
significant unchanged starting material according to TLC. Therefore, this residue  
(0.85 g) was dissolved in dry  $CH_2Cl_2$  (30 ml), and to this solution were added  
25 picolinoyl chloride hydrochloride (0.38 g, 2.15 mmol) and  $Et_3N$  (1 ml). The reaction  
solution was stirred at room temperature for 18 h. The reaction mixture was treated  
with water, and the organic phase was separated and washed with water, dried over  
anhydrous  $MgSO_4$ , filtered and concentrated to a viscous residue, which was purified

53

by flash column chromatography on silica gel, eluting with CH<sub>2</sub>Cl<sub>2</sub>-MeOH (95:5) to obtain the title compound as a glass (810 mg). MH<sup>+</sup> 480

#### Example 24

##### Preparation of Compound 24A



5

**24A**

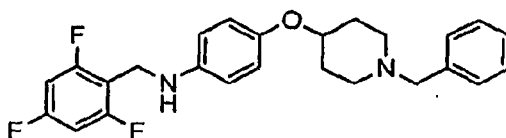
A solution of Example 23 (260 mg, 0.54 mmol) in glacial AcOH (10 ml) was heated under reflux for 18 h, then was concentrated under vacuum to a viscous residue, which was partitioned between water and Et<sub>2</sub>O-EtOAc (3:1). The aqueous phase was made basic with dilute aqueous NH<sub>4</sub>OH and was extracted with EtOAc. Combined organic extracts were washed with water, dried (anhydrous MgSO<sub>4</sub>) and filtered. The filtrate was concentrated *in vacuo* to obtain a viscous residue which was purified by flash column chromatography on silica gel, eluting with EtOAc-MeOH (95:5) to obtain the free base form of title compound as a glass (0.091g).

To a solution of free base (91 mg, 0.174 mmol) in EtOAc was added a solution of maleic acid (20 mg; 0.172 mmol) in EtOAc. The resultant mixture was concentrated *in vacuo* to a small volume, diluted with Et<sub>2</sub>O and allowed to stand at room temperature. Filtration of the resultant precipitate yielded 70 mg of the maleic acid salt of title compound as a beige solid. MH<sup>+</sup> 522

20

#### Example 25

##### Preparation of Compound 25A

**25A**

To a stirred solution of compound 49 (0.720g, 2.55 mmol) and 2,4,6-trifluorobenzaldehyde (0.407 g, 2.55 mmol) in anhydrous CH<sub>2</sub>Cl<sub>2</sub> (15 ml) was added portionwise NaBH(OAc)<sub>3</sub> (1.62 g, 7.7 mmol). The reaction mixture was stirred at room temperature for 18 h and was then treated with water. The organic phase was

25

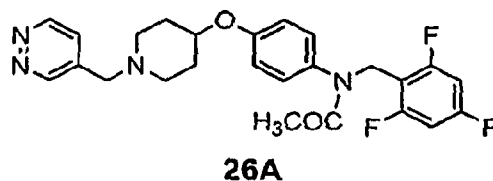
separated and concentrated under vacuum to a viscous residue, which was partitioned between Et<sub>2</sub>O and 1N aqueous NaOH. The organic extracts were washed with brine, dried (anhydrous MgSO<sub>4</sub>) and filtered. The filtrate was concentrated *in vacuo* to obtain a viscous residue which was flash chromatographed on silica gel.

5 Elution with CH<sub>2</sub>Cl<sub>2</sub>:EtOAc (1:1) yielded 0.72 g of the free base form of the title compound as a syrup.

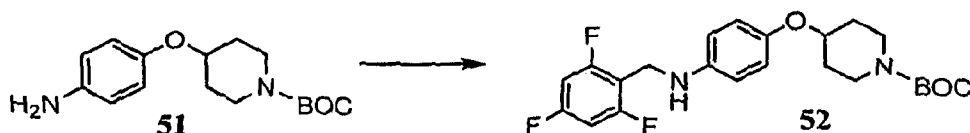
To a solution of free base (630 mg, 1.48 mmol) in EtOAc was added a solution of maleic acid (172 mg; 1.48 mmol) in EtOAc. As the resultant mixture was cooled in an ice-water bath, a precipitate began to form. Filtration yielded 786 mg of the maleic acid salt of title compound as a white crystalline solid. MH<sup>+</sup> 427

#### Example 26

#### Preparation of Compound 26A

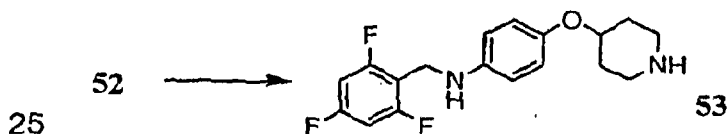


#### 15 Step 1:



To a stirred solution of compound 51 (4.65g, 15.9 mmol) and 2,4,6-trifluorobenzaldehyde (2.55 g, 15.9 mmol) in anhydrous CH<sub>2</sub>Cl<sub>2</sub> (70 ml) was added portionwise over 2 min NaBH(Oac)<sub>3</sub> (10 g, 48 mmol). The reaction mixture was stirred at room temperature for 18 h and was then treated with water. The organic phase was separated and concentrated under vacuum to a syrup, which was flash chromatographed on silica gel. Elution with CH<sub>2</sub>Cl<sub>2</sub>:MeOH (99:1) yielded 5.55 g of compound 52 as a syrup.

#### Step 2:



To a stirred solution of compound 52 (5.5 g, 12.6 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (6 ml) was added dropwise TFA (10 ml). The resultant solution was stirred at room temperature

for 48 h. The reaction mixture was concentrated under vacuum. The viscous residue was partitioned between aqueous NaOH and CH<sub>2</sub>Cl<sub>2</sub>. Combined extracts were washed with brine and dried over anhydrous MgSO<sub>4</sub>. The drying agent was filtered, and the filtrate was stripped of solvent under vacuum. The solid residue was

5 triturated with hexanes to obtain 3.7 g of compound **53** as a solid.

Step 3:

To a stirred solution of compound **53** (0.200 g, 0.596 mmol) and pyridazine-4-carbaldehyde (see US 6,720,328) (0.074 g; 0.68 mmol) in anhydrous CH<sub>2</sub>Cl<sub>2</sub> (50 ml) was added NaBH(OAc)<sub>3</sub> (0.433 g, 2.0 mmol). The reaction mixture was stirred at

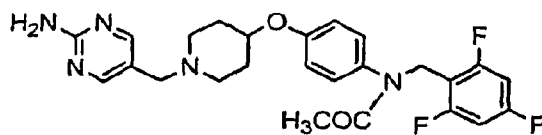
10 room temperature for 18 h and was then concentrated *in vacuo*. The viscous residue was partitioned between water and EtOAc. The organic extract was washed with water, dried (anhydrous MgSO<sub>4</sub>) and filtered. The filtrate was concentrated *in vacuo* to obtain the free base form of the title compound as a syrup which exhibited a single spot on TLC.

15 A portion (150 mg, 0.318 mmol) of free base was dissolved in EtOAc and the resultant solution mixed with a solution of maleic acid (40 mg; 0.345 mmol). Upon standing at room temperature, a precipitate began to form. The mixture was then cooled in an ice-water bath and filtered to obtain 59 mg of the maleic acid salt of title compound.

20 MH<sup>+</sup> 471

Example 27

Preparation of Compound **27A**



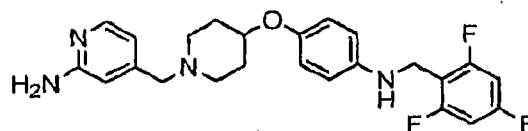
**27A**

25 The title compound was prepared using the procedure described in Example 26, except that in the last step, 2-aminopyrimidine-5-carbaldehyde (see US 6,720,328) was used in place of pyridazine-4-carbaldehyde. MH<sup>+</sup> 486

Example 28

56

## Preparation of Compound 28A

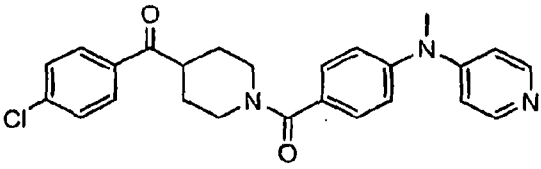
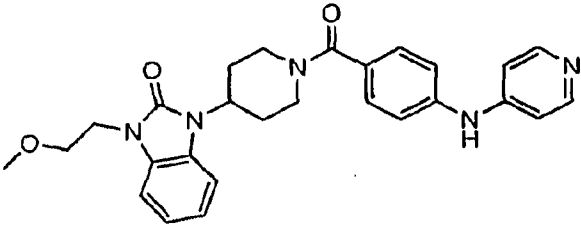
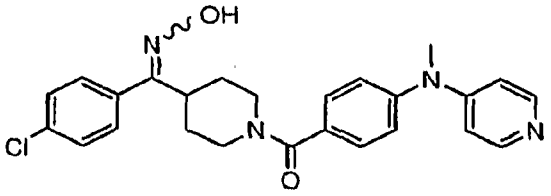
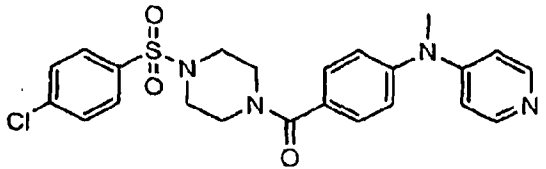
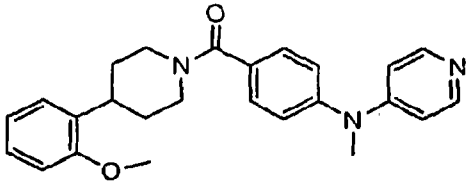
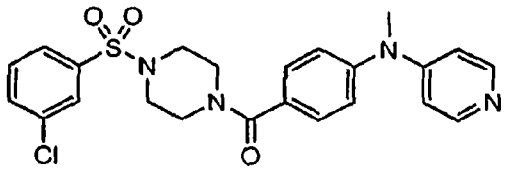
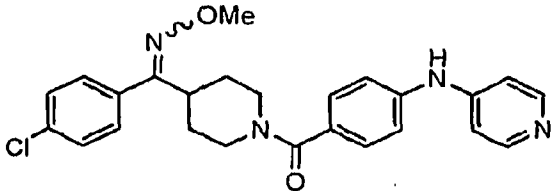


28A

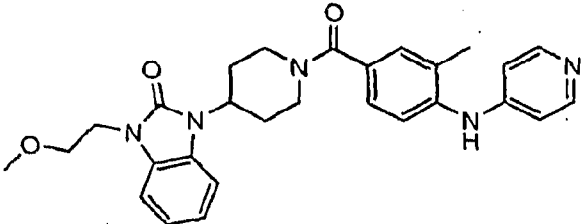
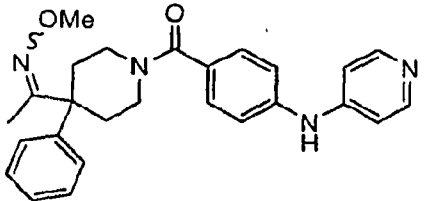
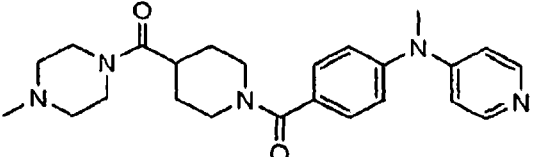
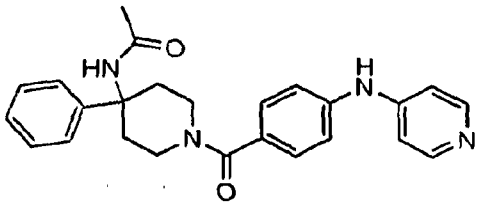
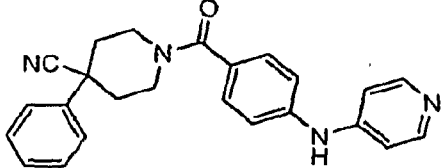
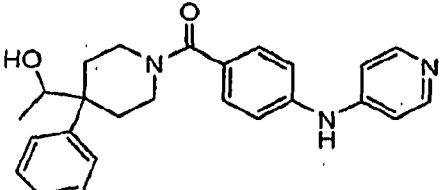
To a stirred solution of compound 53 (200 mg, 0.596 mmol) and N-BOC-2-aminopyridine-4-carbaldehyde (see US 6,720,328) (152 mg, 0.68 mmol) in anhydrous CH<sub>2</sub>Cl<sub>2</sub> (50 ml) was added NaBH(Oac)<sub>3</sub> (433 mg, 2.0 mmol). The reaction mixture was stirred at room temperature for 48 h and was then treated with water. The organic phase was separated and concentrated to a solid residue, which was dissolved in EtOAc-Et<sub>2</sub>O (1:1) and extracted with 2% aqueous maleic acid solution. Combined aqueous extracts were basified to pH 8 with 1N aqueous NaOH and extracted with EtOAc. The organic extracts were washed with brine, dried (anhydrous MgSO<sub>4</sub>) and filtered. The filtrate was concentrated *in vacuo* to obtain a glass which was flash chromatographed on silica gel. Elution with CH<sub>2</sub>Cl<sub>2</sub>-7N methanolic ammonia (98:2) yielded 0.18 g of the title compound as a solid. MH<sup>+</sup> 443

Using the procedures, described above, compounds 29A-60A were prepared:

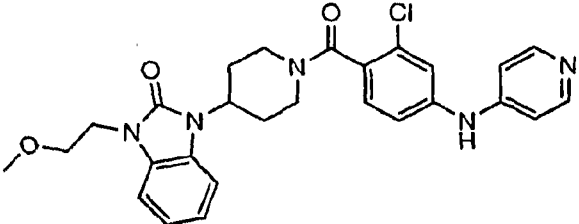
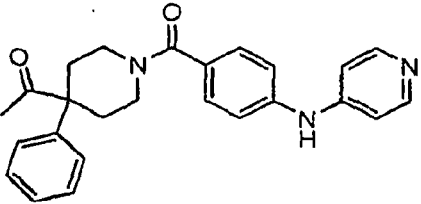
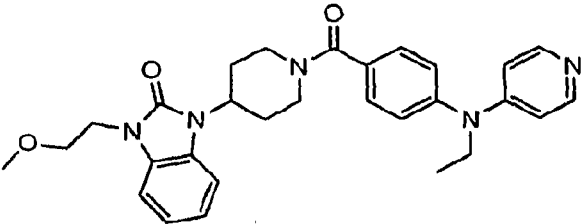
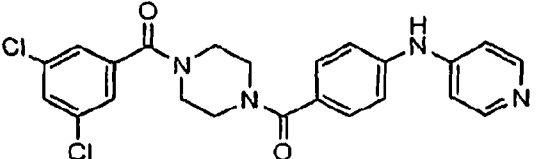
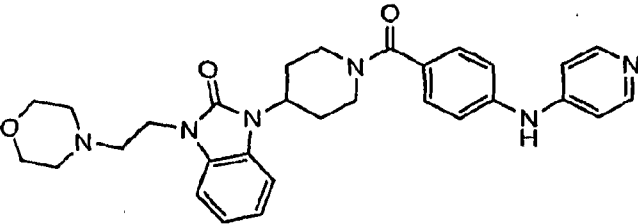
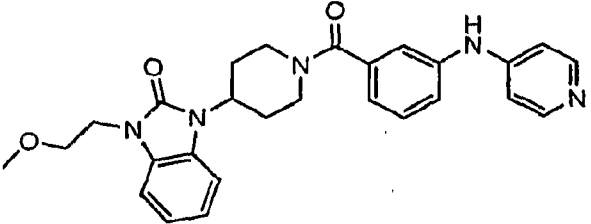
Compound	Structure	MS (M+H)
29A		389
30A		465
31A		407

<p>32A</p>		<p>434</p>
<p>33A</p>		<p>472</p>
<p>34A</p>		<p>449</p>
<p>35A</p>		<p>471</p>
<p>36A</p>		<p>402</p>
<p>37A</p>		<p>471</p>
<p>38A</p>		<p>449</p>

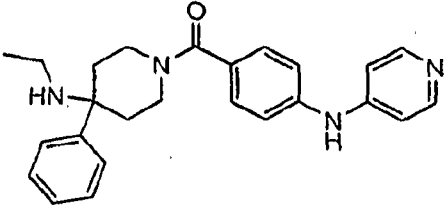
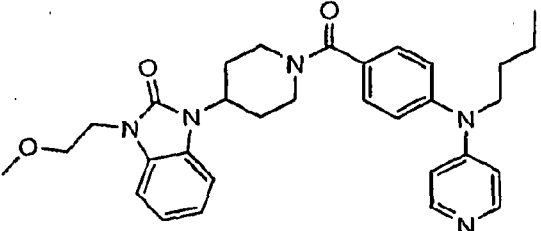
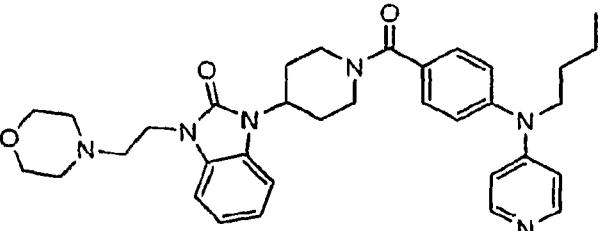
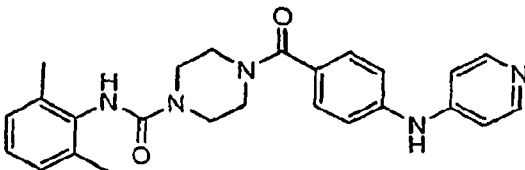
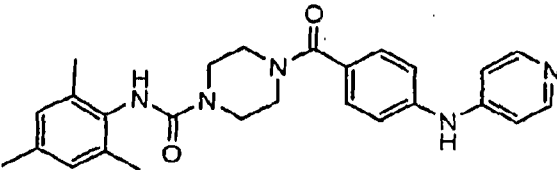
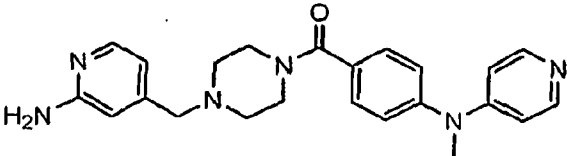
58

39A		486
40A		429
41A		422
42A		415
43A		383
44A		402

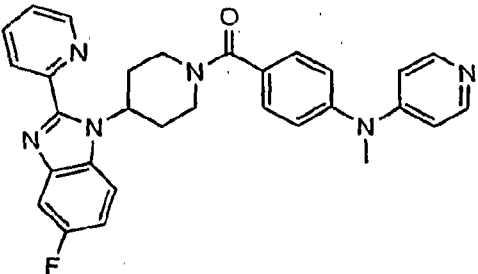
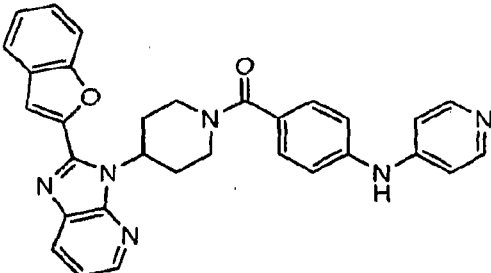
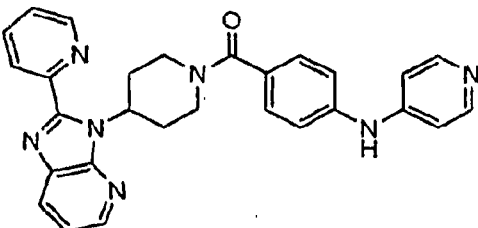
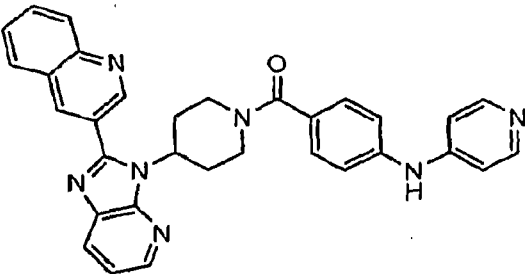
59

45A		506
46A		400
47A		500
48A		455
49A		527
50A		472

60

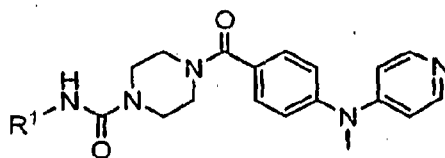
51A		401
52A		528
53A		583
54A		430
55A		444
56A		403

61

57A		507
58A		515
59A		476
60A		526

Example 29

## Preparation of Compound 61A-158A



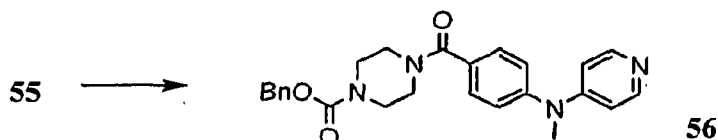
5 General Procedure:

62

Step 1:

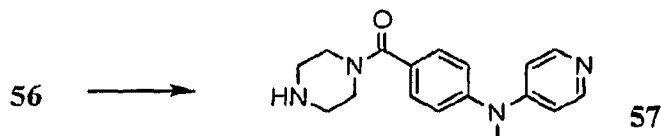
To a MeOH solution (20 ml) of ester **54** (1.6 g, 6.512 mmol) at 25°C was added a 1M aqueous LiOH solution (7.16 mmol, 1.1 equiv). After stirring at 25°C for 1 day, additional 1M aqueous LiOH solution (7.16 mmol, 1.1 equiv) was added and let stir overnight. The solvent was then removed *in vacuo* and the resultant solid dried under vacuum for 2 days.

The resultant solid was then suspended in CH<sub>2</sub>Cl<sub>2</sub> (70 ml) and oxalyl chloride (25.05 mmol, 4 equiv) was added at 25°C under N<sub>2</sub>. After stirring overnight, additional oxalyl chloride (25.05 mmol, 4 equiv) was added and let stir for several days. DMF was added (1 drop) and the mixture was stirred at 25°C for 2 days, then the solvent was removed *in vacuo*. Additional CH<sub>2</sub>Cl<sub>2</sub> (50ml) was added and the solvent was removed *in vacuo*. This was repeated two additional times to obtain **55**.

Step 2:

To a CH<sub>2</sub>Cl<sub>2</sub> solution (50ml) of **55** (6.512 mmol) was added Et<sub>3</sub>N (1.8 ml, 2 equiv) then CBZ-piperazine (7.16 mmol, 1.1 equiv) at 25°C under N<sub>2</sub>. The solution was stirred at 25°C for 4 days, then 1N aqueous NaOH was added (50 ml), the products extracted with CH<sub>2</sub>Cl<sub>2</sub>, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and dried *in vacuo*. The products were then purified by FLC (CH<sub>2</sub>Cl<sub>2</sub>-MeOH-NH<sub>4</sub>OH 97:3:0.5 to 92:8:0.5) to provide **56** contaminated with CBZ-piperazine. CBZ-piperazine was removed from **56** by dissolving the mixture in CH<sub>2</sub>Cl<sub>2</sub> (100 ml) and then adding PS-Isocyanate resin (1.2 g). The mixture was stirred at 25°C for 1 h then an additional 1.5 g of PS-Isocyanate resin added. After an additional 3 h, the products were filtered from the resin, washing with CH<sub>2</sub>Cl<sub>2</sub>, and the solvent was removed *in vacuo* to give **56** (1.51g, 54% yield) as a yellow-white foam.

63

Step 3:

H<sub>2</sub> was bubbled into a MeOH suspension of 10% Pd on carbon (120.3 mg), **56** (1.19 g, 2.77 mmol) and conc. HCl (1.2 ml, 5 equiv) for 20 min at 25°C, then the mixture was stirred for 4 h under an H<sub>2</sub> atmosphere. After N<sub>2</sub> was bubbled through the solution for 20 min, the mixture was filtered through a Celite pad, eluting with MeOH, and the solvent was removed *in vacuo*. The products were partitioned between CH<sub>2</sub>Cl<sub>2</sub> and 1N NaOH, the layers separated, and the aqueous layer back-extracted with CH<sub>2</sub>Cl<sub>2</sub> (3x). The CH<sub>2</sub>Cl<sub>2</sub> layers were then combined, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and dried *in vacuo*. The products were then purified by FLC (CH<sub>2</sub>Cl<sub>2</sub>-MeOH-NH<sub>4</sub>OH 94:6:0.5 to 92:8:0.5) to provide **57** (834 mg, 100% yield).

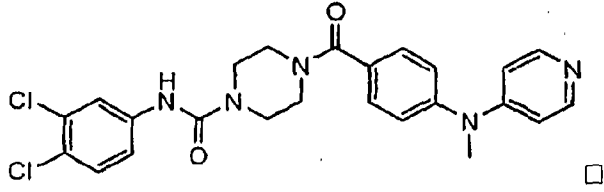
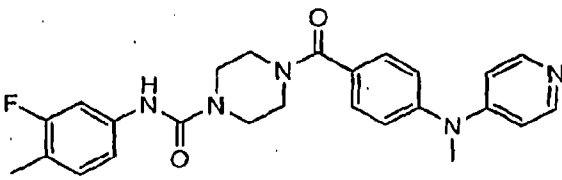
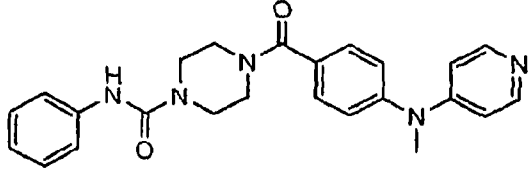
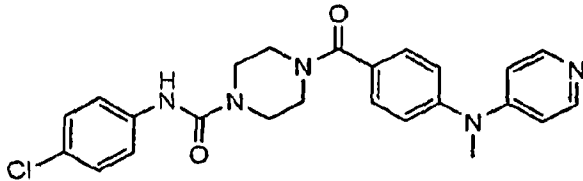
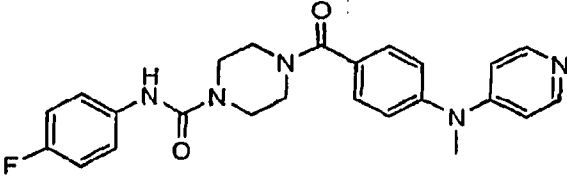
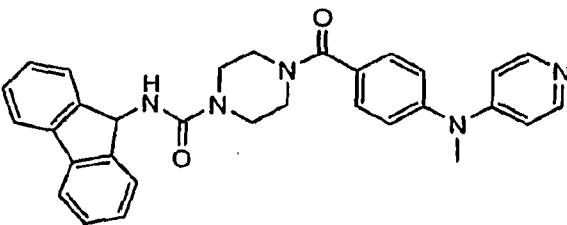
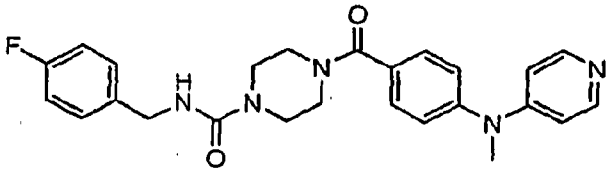
Step 4:

A stock solution of **57** (1 ml, 0.0268 mmol) in CH<sub>2</sub>Cl<sub>2</sub> was added to 104-fritted tubes in Bohdan Miniblocks. To each tube was added 1M stock solutions of the individual isocyanates (R<sup>1</sup>NCO) in toluene (0.05 mmol, 2 equiv). The Miniblocks were sealed and shaken at 25°C for 4h. To each tube was added an additional 2 equiv. of the individual isocyanate and the Miniblocks were sealed and shaken at 25°C for 4h. A DCE solution of acetic anhydride (0.54 mmol, 20 equiv) was added to each tube and the blocks were shaken at 25°C for 16h. Amberlyst-15 resin (~0.10g) was added to each tube and the Miniblocks were shaken at 25°C for 2h. The tubes were drained and the resin was washed three times each with CH<sub>2</sub>Cl<sub>2</sub>, then MeOH, shaking for 5 min each time, to remove unreacted reagents. Ammonia in MeOH (2N, 2 ml) was then added to each tube and the Miniblocks were shaken at 25°C for 20 min. The MeOH filtrates were collected and the resin was again shaken with ammonia in MeOH (2N, 2 ml) at 25°C for 20 min. The combined filtrates from each tube were then evaporated to dryness on a SpeedVac concentrator overnight. The resulting samples were evaluated by LCMS and were at least 70% pure.

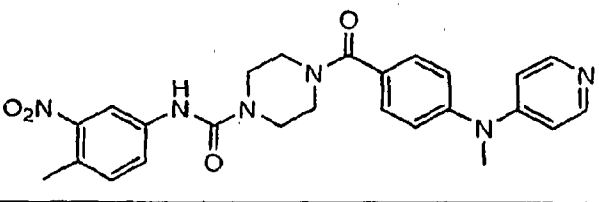
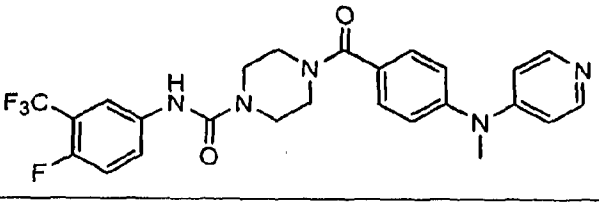
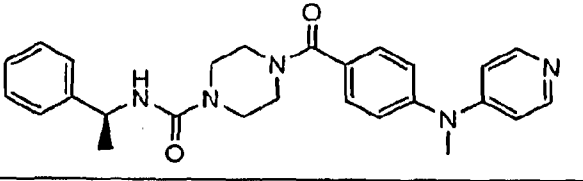
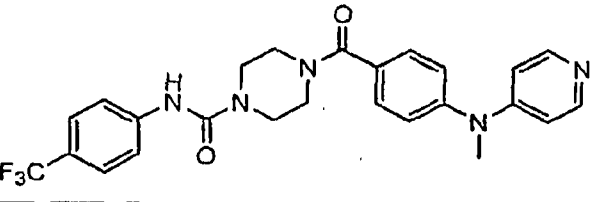
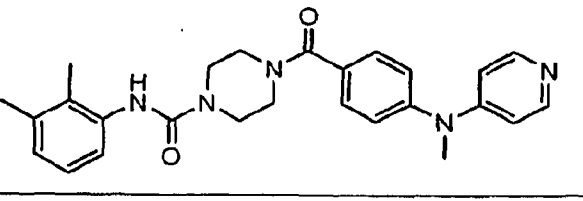
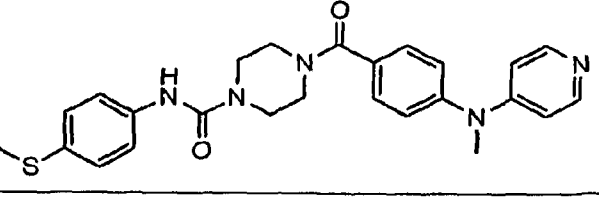
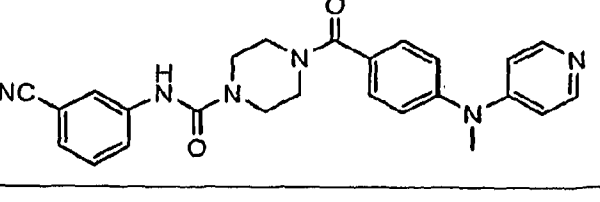
Using the procedure described above, compounds **61A-158A** were prepared:

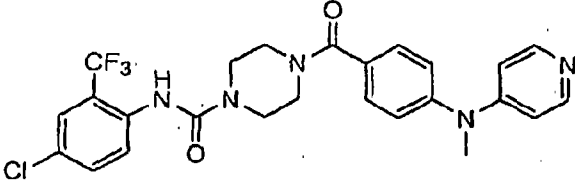
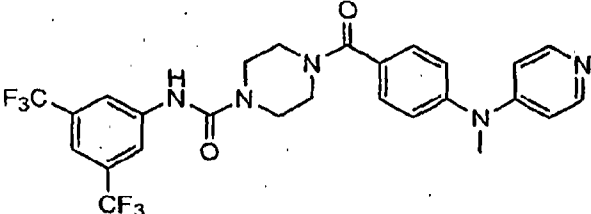
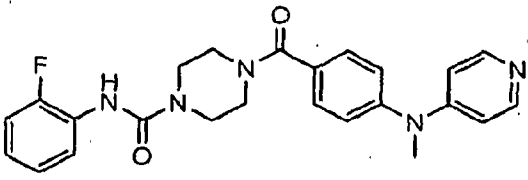
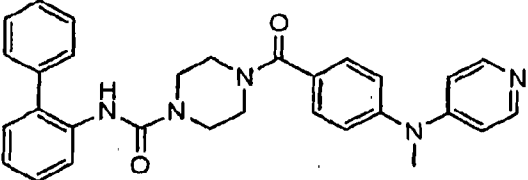
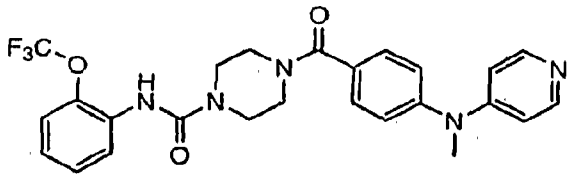
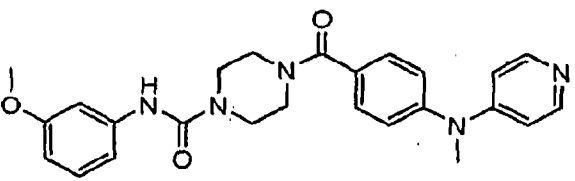
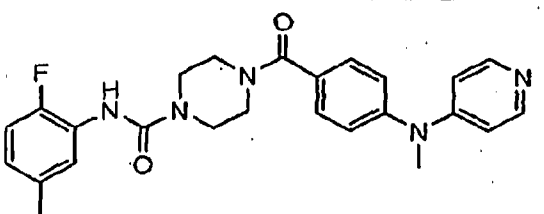
Compound	Structure	MS (M+H)
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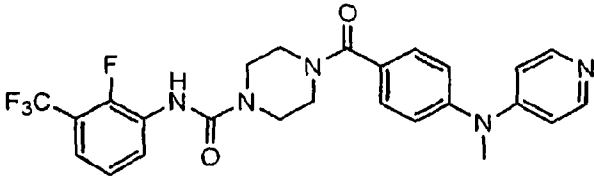
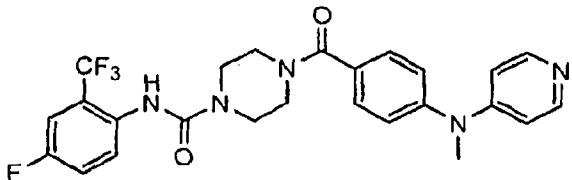
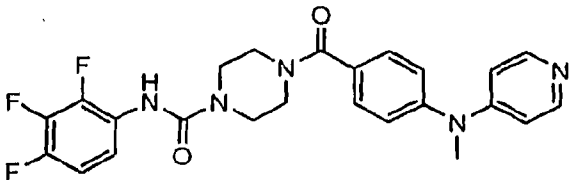
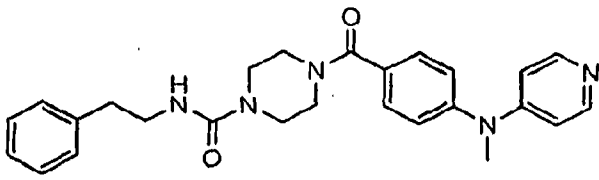
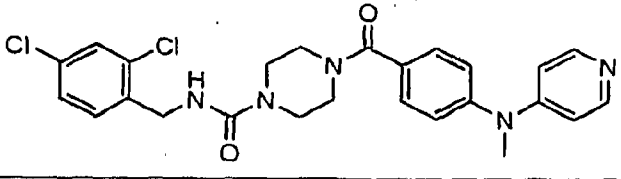
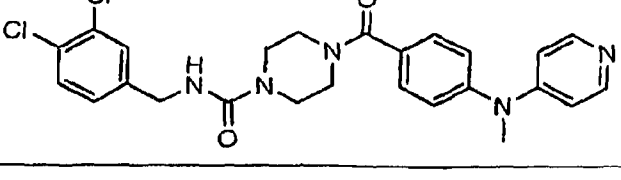
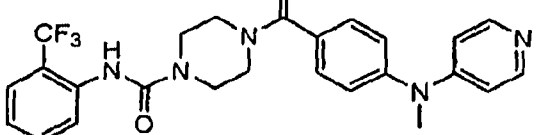
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<p>61A</p>		<p>484</p>
<p>62A</p>		<p>448</p>
<p>63A</p>		<p>416</p>
<p>64A</p>		<p>450</p>
<p>65A</p>		<p>434</p>
<p>66A</p>		<p>504</p>
<p>67A</p>		<p>448</p>

65

68A		475
69A		502
70A		444
71A		484
72A		444
73A		462
74A		441

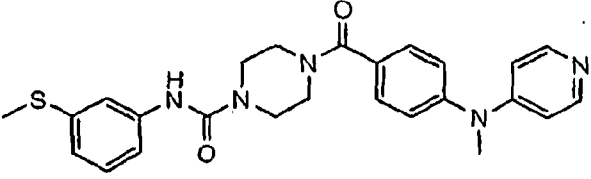
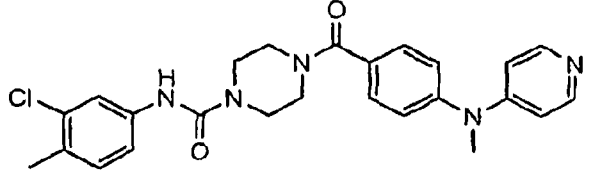
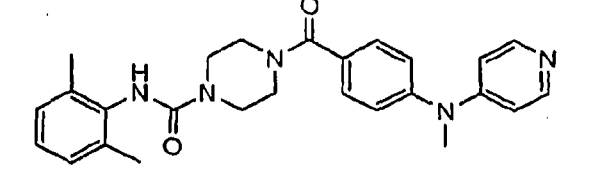
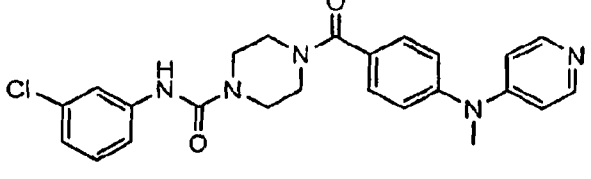
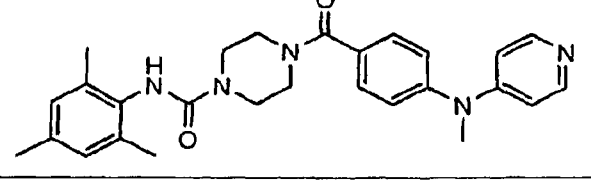
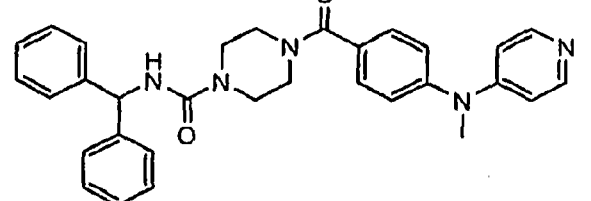
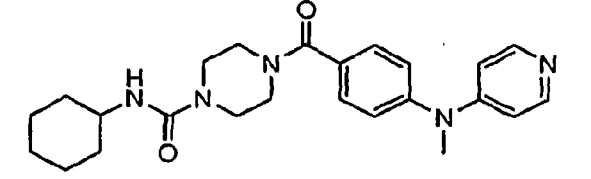
<p>75A</p>		<p>518</p>
<p>76A</p>		<p>552</p>
<p>77A</p>		<p>434</p>
<p>78A</p>		<p>492</p>
<p>79A</p>		<p>500</p>
<p>80A</p>		<p>446</p>
<p>81A</p>		<p>448</p>

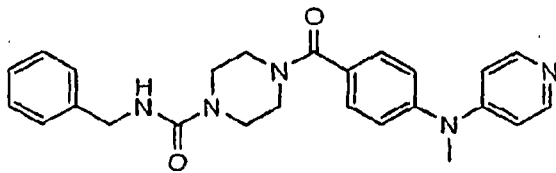
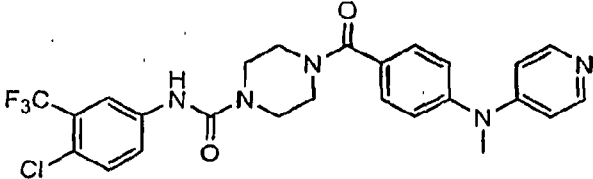
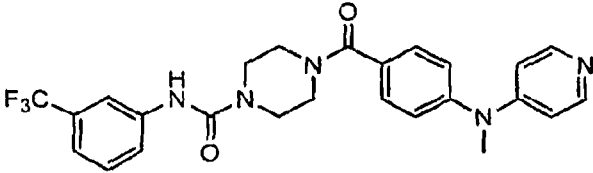
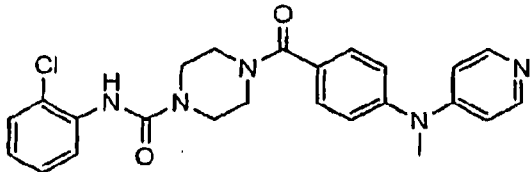
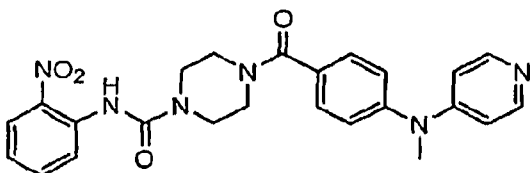
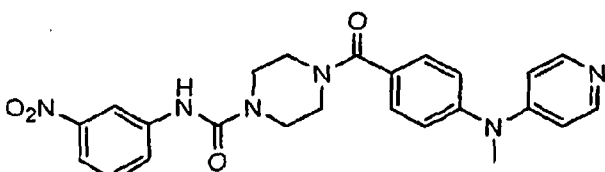
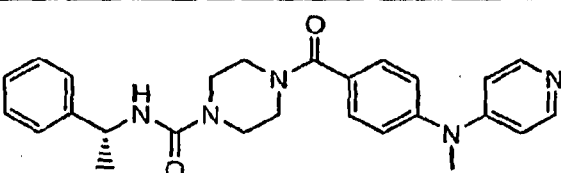
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<p>86A</p>		<p>498</p>
<p>87A</p>		<p>498</p>
<p>88A</p>		<p>484</p>

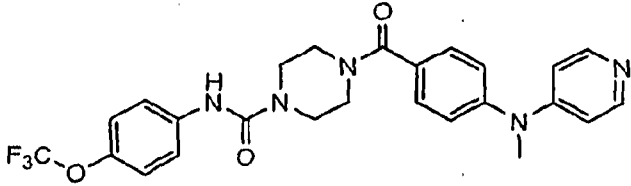
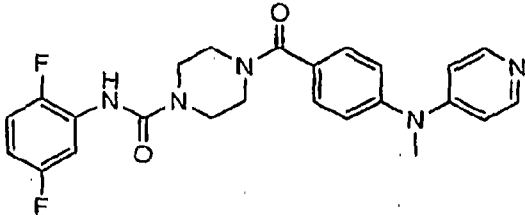
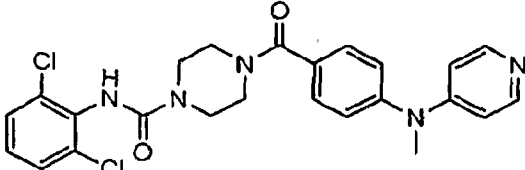
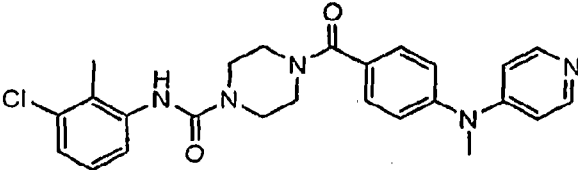
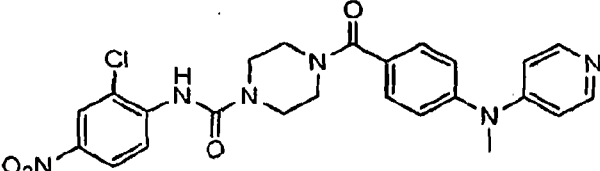
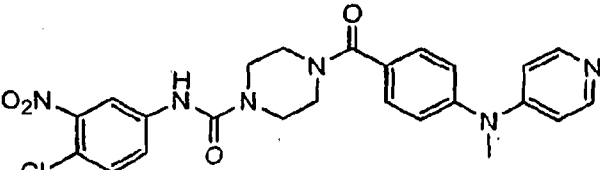
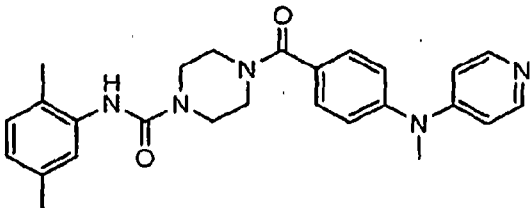
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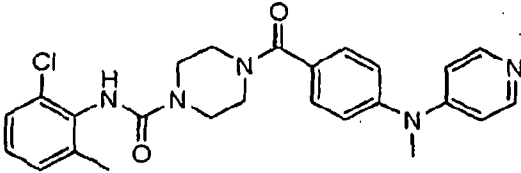
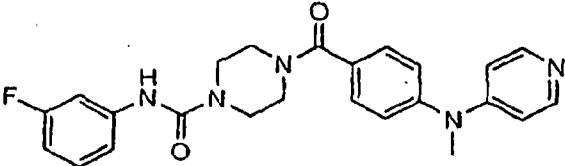
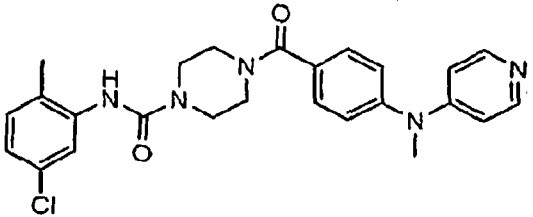
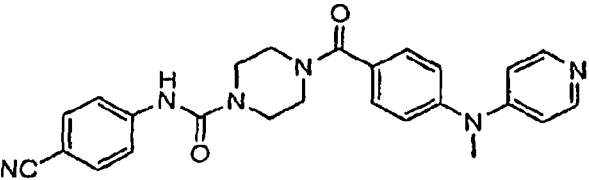
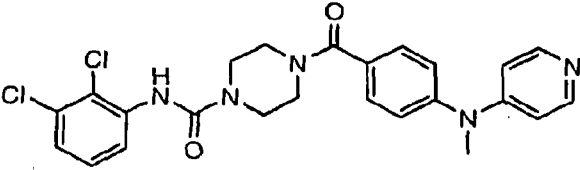
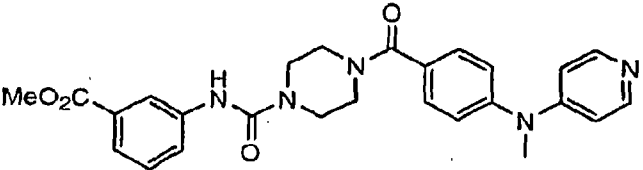
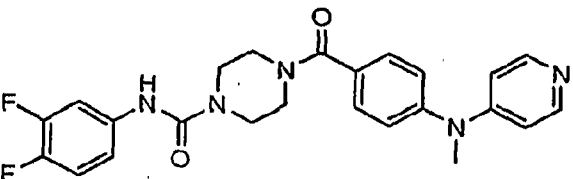
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90A	 <chem>CC(=O)c1ccc(NC(=O)N2CCN(CC2)C(=O)c3ccc(NC4=CC=CN=C4)cc3)cc1</chem>	458
91A	 <chem>CS(=O)(F)(F)F)c1ccc(NC(=O)N2CCN(CC2)C(=O)c3ccc(NC4=CC=CN=C4)cc3)cc1</chem>	516
92A	 <chem>Clc1c(Cl)cc(NC(=O)N2CCN(CC2)C(=O)c3ccc(NC4=CC=CN=C4)cc3)cc1Cl</chem>	518
93A	 <chem>Clc1cc(NC(=O)N2CCN(CC2)C(=O)c3ccc(NC4=CC=CN=C4)cc3)cc(Cl)c1</chem>	484
94A	 <chem>Clc1c(Cl)cc(NC(=O)N2CCN(CC2)C(=O)c3ccc(NC4=CC=CN=C4)cc3)cc1Cl</chem>	518
95A	 <chem>O=[N+]([O-])c1cc(NC(=O)N2CCN(CC2)C(=O)c3ccc(NC4=CC=CN=C4)cc3)cc(Cl)c1</chem>	495

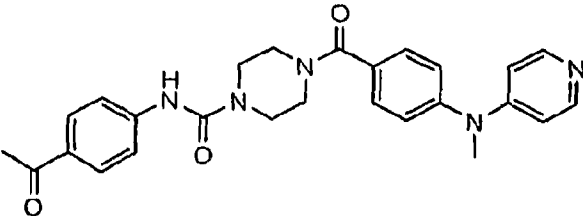
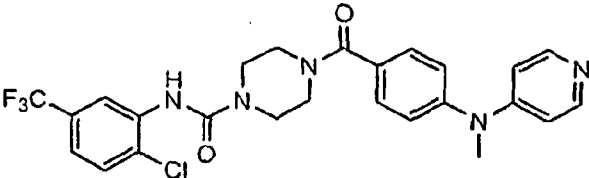
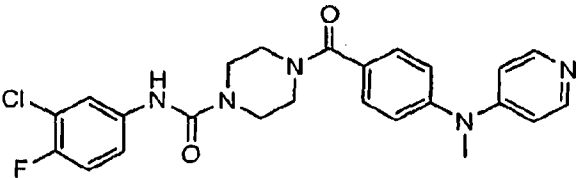
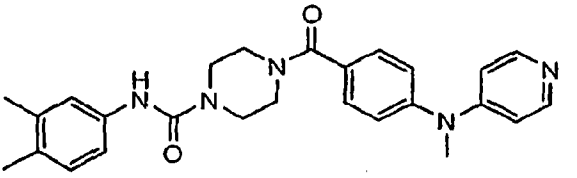
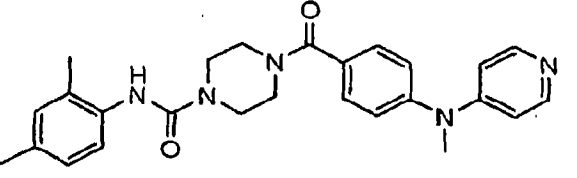
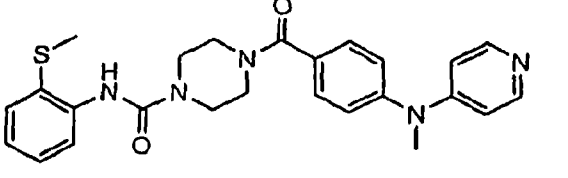
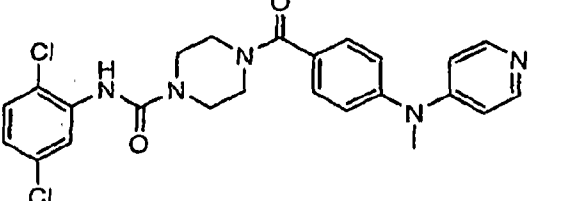
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96A		462
97A		464
98A		444
99A		450
100A		458
101A		506
102A		422

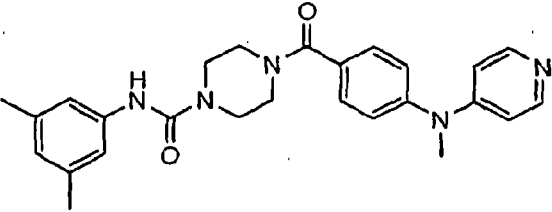
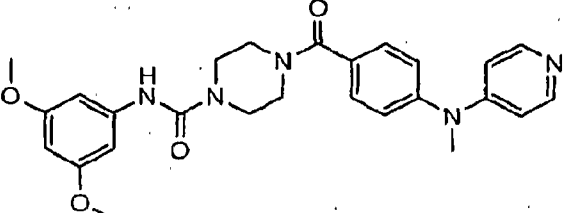
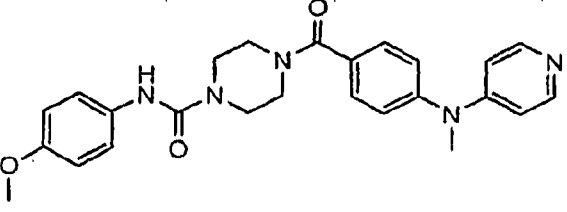
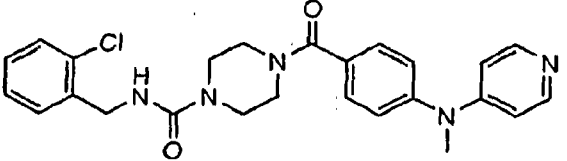
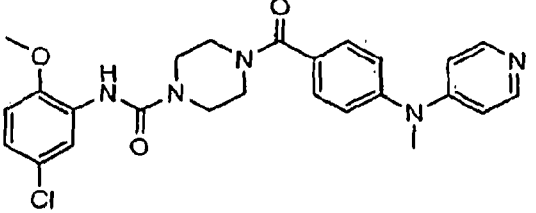
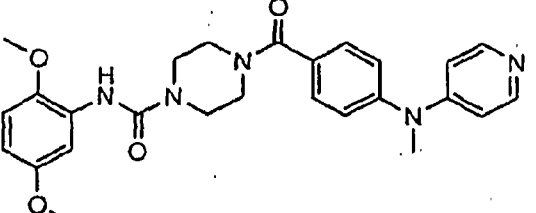
103A		430
104A		518
105A		484
106A		450
107A		461
108A		461
109A		444

<p>110A</p>		<p>500</p>
<p>111A</p>		<p>452</p>
<p>112A</p>		<p>484</p>
<p>113A</p>		<p>464</p>
<p>114A</p>		<p>495</p>
<p>115A</p>		<p>495</p>
<p>116A</p>		<p>444</p>

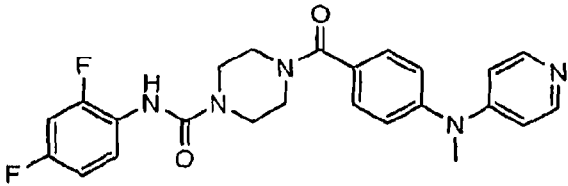
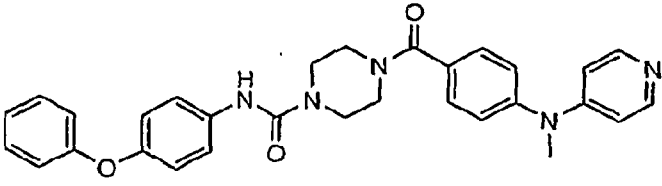
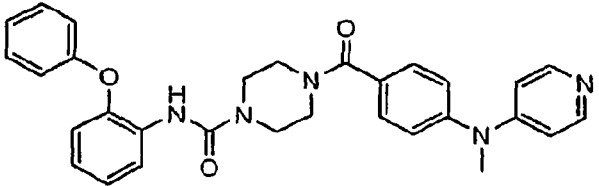
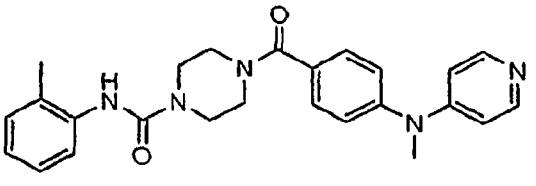
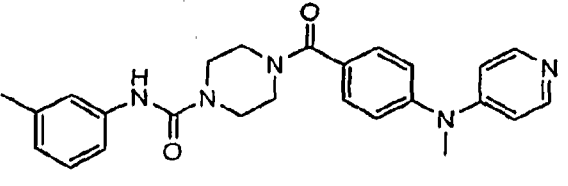
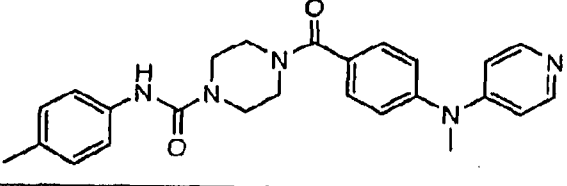
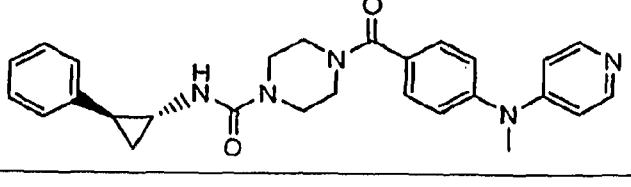
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119A		464
120A		441
121A		484
122A		474
123A		452

<p>124A</p>		<p>458</p>
<p>125A</p>		<p>518</p>
<p>126A</p>		<p>468</p>
<p>127A</p>		<p>444</p>
<p>128A</p>		<p>444</p>
<p>129A</p>		<p>462</p>
<p>130A</p>		<p>484</p>

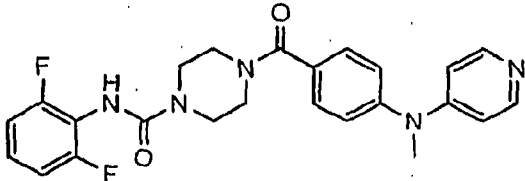
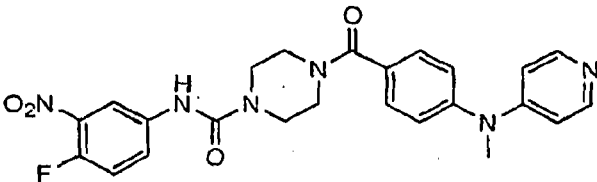
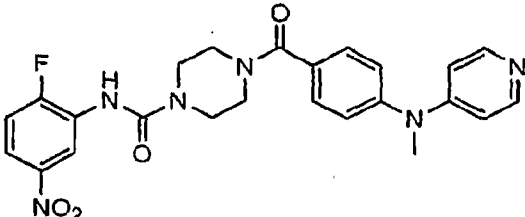
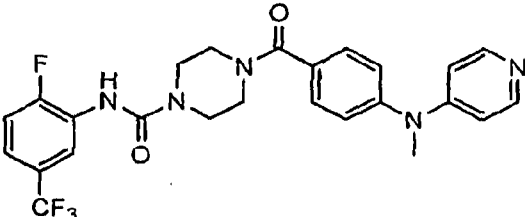
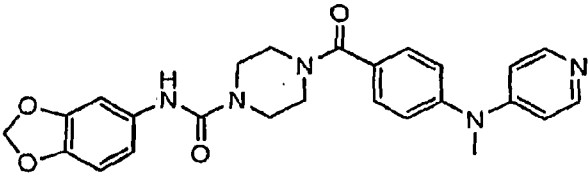
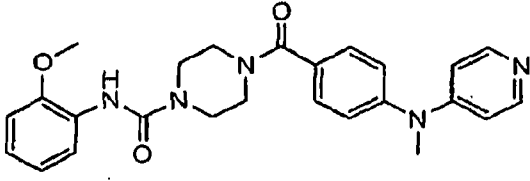
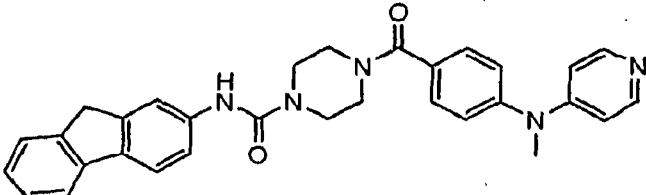
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131A		444
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133A		446
134A		464
135A		480
136A		476

75

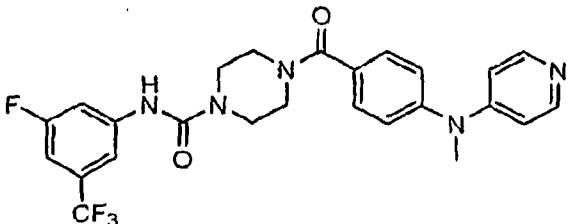
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139A		508
140A		430
141A		430
142A		430
143A		456

76

144A		452
145A		479
146A		479
147A		502
148A		460
149A		446
150A		504

151A		476
152A		458
153A		466
154A		516
155A		494
156A		492
157A		435

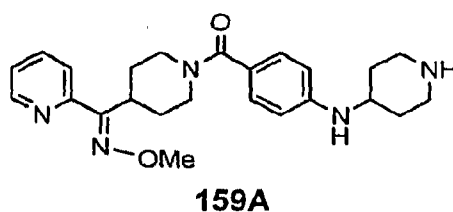
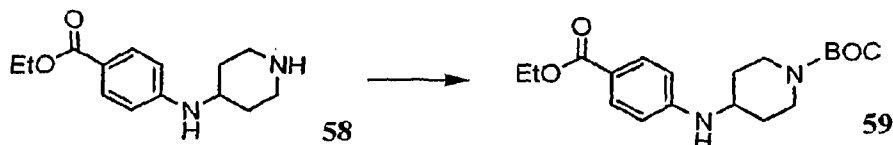
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158A		502
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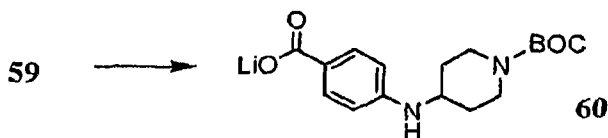
Example 30

## Preparation of Compound 159A

5

Step 1:

Di-*tert*-butyl dicarbonate (2.40 g, 11.0 mmol) was added to a stirred solution of **58** (2.09 g, 8.42 mmol) in *tert*-butanol (80 ml) at room temperature. The resulting mixture was heated at 60 °C for 16 h, then cooled to room temperature and the solvent was removed under vacuum. The residue was purified by column chromatography (EtOAc:Hexanes 1:5) to give **59** (2.899 g, 99%) as a white foam.

Step 2:

15

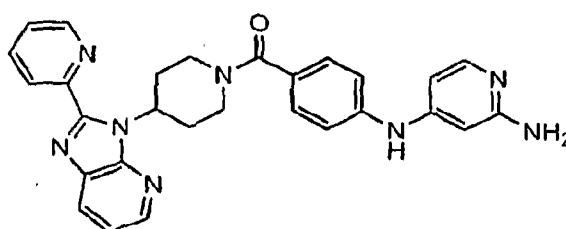
1N LiOH (5.44 ml, 5.44 mmol, 1.30 eq) was added to a stirred solution of **59** (1.58 g, 4.54 mmol) in MeOH (20 ml) at room temperature. The resulting mixture was stirred at 60 °C for 2.5 h, then the solvent was removed under vacuo and the resulting lithium carboxylate was dried under high vacuum for 24 h to give **60** (1.675 g, 100%) as a white solid which contained LiOH (0.3 eq) and was used without further purification.

20

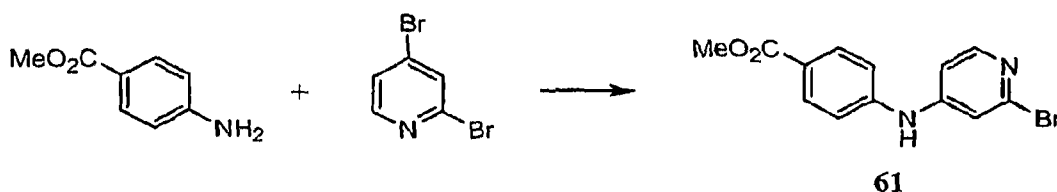
Step 3:

Compound **60** was converted into the title compound using the procedure of Example 1, Step 2, followed by the procedure of Example 4, Step 2. MH<sup>+</sup> 495

5

Example 131Preparation of Compound **160A****160A**

10

Step 1**61**

15

To a stirred solution of 2,4-dibromopyridinium hydrochloride (535 mg, 1.96 mmol) in 2,2,2-trifluoroethanol (5 mL) in a sealed tube, was added 4-aminobenzoic acid methyl ester (296 mg, 1.96 mmol, 1.0 eq). The resulting reaction was heated to 110 °C and allowed to stir at this temperature for 15 h. The reaction mixture was then cooled to room temperature, concentrated *in vacuo* and the resulting

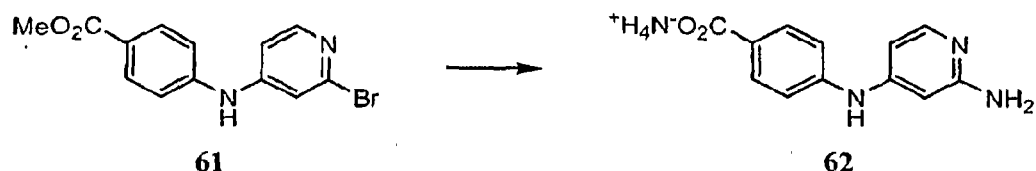
20

residue was diluted with 10% aqueous NH<sub>3</sub> (150 mL) and DCM (150 mL) and the mixture was transferred to a separatory funnel. The aqueous layer was extracted with DCM (150 mL) and the combined organic phases were dried over MgSO<sub>4</sub> and concentrated *in vacuo* to provide a white solid residue which was purified using

25

column chromatography (AcOEt:Hexane 0% to 50%) to provide compound **61** (308 mg, 51%) as a white solid. Note: The 2-isomer (72 mg, 12%) was also obtained as a less polar compound.

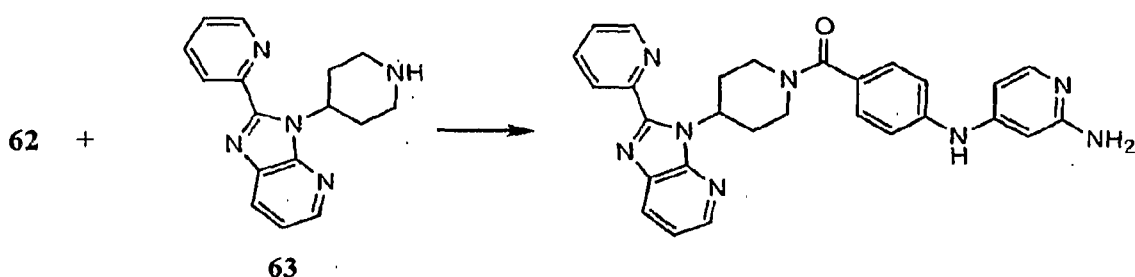
80

Step 2

5

A bomb was charged with a solution of compound **61** (2.2 g, 7.16 mmol) in aqueous concentrated ammonia (75 mL) and the resulting mixture was heated to 210 °C and allowed to stir at this temperature for 20 h. The system was cooled to room temperature and the reaction mixture was concentrated *in vacuo* to provide the title compound (2.3 g) *in vacuo* as a white solid which was used in the next step without further purification.

10

Step 3

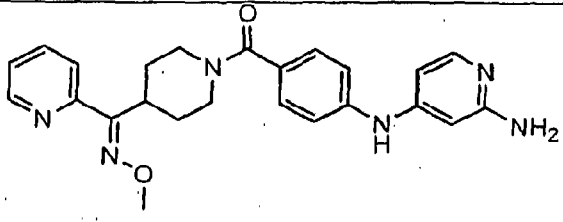
15

Compound **63** (prepared as describe in U.S. Patent Publication No. 2004/0097483) was reacted with compound **62** using the method set forth in Example 1, step 2 to obtain the title compound.  $MH^+$  491

20

Using procedures described above the following compounds were prepared:

Example #	Structure	(M+H) <sup>+</sup>

Example #	Structure	(M+H) <sup>+</sup>
161A		431

### Example 32

#### H<sub>3</sub>-Receptor Binding Assay

5 The source of the H<sub>3</sub> receptors in this experiment was guinea pig brain.

Alternatively, the source of H<sub>3</sub> receptors was recombinant human receptor, expressed in HEK-293 (human embryonic kidney) cells.

The animals weighed 400-600 g. The brain tissue was homogenized with a solution of 50 mM Tris, pH 7.5. The final concentration of tissue in the  
 10 homogenization buffer was 10% w/v. The homogenates were centrifuged at 1,000 x g for 10 min. in order to remove clumps of tissue and debris. The resulting supernatants were then centrifuged at 50,000 x g for 20 min. in order to sediment the membranes, which were next washed three times in homogenization buffer (50,000 x g for 20 min. each). The membranes were frozen and stored at -70°C until needed.

15 All compounds to be tested were dissolved in DMSO and then diluted into the binding buffer (50 mM Tris, pH 7.5) such that the final concentration was 2 µg/ml with 0.1% DMSO. Membranes were then added (400 µg of protein, 5 µg in the case of recombinant human receptor) to the reaction tubes. The reaction was started by the  
 20 addition of 3 nM [<sup>3</sup>H]R-α-methyl histamine (8.8 Ci/mmol) or 3 nM [<sup>3</sup>H]N<sup>α</sup>-methyl histamine (80 Ci/mmol) and continued under incubation at 30°C for 30 min. Bound ligand was separated from unbound ligand by filtration, and the amount of radioactive ligand bound to the membranes was quantitated by liquid scintillation spectrometry. All incubations were performed in duplicate and the standard error was always less than 10%. Compounds that inhibited more than 70% of the specific binding of  
 25 radioactive ligand to the receptor were serially diluted to determine a K<sub>i</sub> (nM).

Compounds of formula (I) have a K<sub>i</sub> within the range of about 3 to about 600 nM at the recombinant human H<sub>3</sub> receptor and from about 2 nM to about 2000

nM at the guinea pig brain receptor. The compound of Example 59 has a  $K_i$  of 3 nM the recombinant human receptor assay, and the compound of Example 54 has a  $K_i$  of 2 nM in the guinea pig receptor assay.

5

### Example 33

#### Effects of the Compounds of the Invention on Diet-Induced Obesity in Mice

Lean mice (male, approx. 5 weeks of age, purchased from The Jackson Laboratory, Bar Harbor, ME) were maintained in individual cages at 22 °C on a 12:12 hr light/dark cycle. The "treated" mice (N=12) were administered a Thiazole Derivative (10 mg/kg) by gavage once daily for four consecutive days. Control mice (N=12) were administered vehicle only, once daily for four days. Both control and treated mice were fed a high-fat diet from days 0 to 4 and body weight and food intake were monitored daily. The percent inhibition for weight gain and food intake was calculated by comparing the increase in weight gain and food intake in the treated mice to the increase in weight gain and food intake in the control mice.

Table 1 shows the effects of illustrative compounds of the invention on diet-induced obesity in mice. Compound numbers correspond to the compound numbering set forth in the specification.

20

**Table 1**

<b>Compound No.</b>	<b>Weight Gain Inhibition (%)</b>	<b>Food intake Inhibition (%)</b>
<b>57A</b>	17.0	2.5
<b>59A</b>	21.0	1.1
<b>160A</b>	33.0	18.3

25

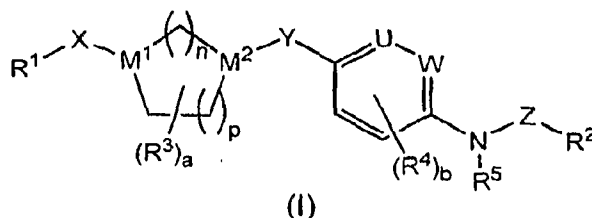
The present invention is not to be limited in scope by the specific embodiments disclosed in the examples which are intended as illustrations of a few aspects of the invention and any embodiments that are functionally equivalent are within the scope

of this invention. Indeed, various modifications of the invention in addition to those shown and described herein will become apparent to those skilled in the relevant art and are intended to fall within the scope of the appended claims.

A number of references have been cited, the entire disclosures of which have  
5 been incorporated herein in their entirety.

WHAT IS CLAIMED:

1. A compound represented by the structural formula



5

or a pharmaceutically acceptable salt thereof, wherein:

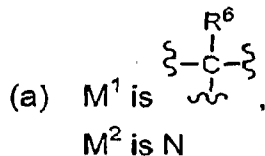
a is 0, 1 or 2;

b is 0, 1, 2, 3 or 4;

10

U and W are each CH, or one of U and W is CH and the other is N;

$M^1$ ,  $M^2$ , n, p, X and Y are as defined in (a), (b) or (c):



n is 1 or 2; p is 0, 1 or 2;

15

X is a bond, alkylene, alkenylene,  $-C(O)-$ ,  $-C(R^8)(R^9)-$ ,  $-C(=N-OR^{10})-$ ,  $-C(=N-OR^{10})-CH(R^{11})-$ ,  $-CH(R^{11})-C(N-OR^{10})-$ ,  $-O-$ ,  $-CH_2N(R^{12})-$ ,  $-N(R^{12})CH_2-$ ,  $-N(R^{12})-$ ,  $-NHC(O)-$ ,  $-OCH_2-$ ,  $-CH_2O-$ ,  $-CH(OH)-$ ,  $-S-$ ,  $-S(O)-$  or  $-S(O)_2-$ ; and  
 Y is  $-CH_2-$ ,  $-(CH_2)_2-$ ,  $-C(=O)-$ ,  $-C(=NOR^{13})-$ ,  $-S-$ ,  $-S(O)-$  or  $-SO_2-$ ;

(b)  $M^1$  is N

20

$M^2$  is N;

n is 2; p is 1 or 2;

X is a bond, alkylene, alkenylene,  $-C(O)-$ ,  $-NHC(O)-$ ,  $-OC(O)-$ ,  $-S(O)-$  or  $-S(O)_2-$ ; and

Y is  $-CH_2-$ ,  $-(CH_2)_2-$ ,  $-C(=O)-$ ,  $-S-$ ,  $-S(O)-$  or  $-SO_2-$ ;

25

(c)  $M^1$  is N

$M^2$  is CH;

n is 1 or 2; p is 0, 1 or 2;

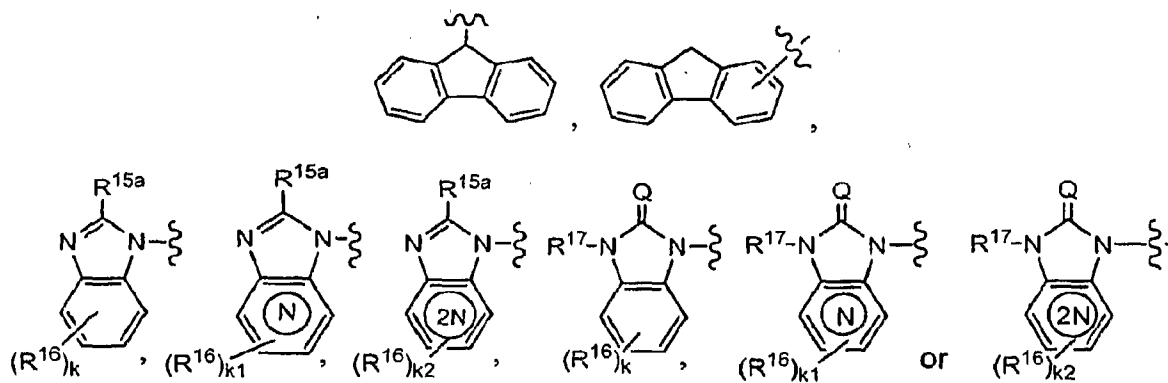
X is a bond, alkylene, alkenylene,  $-C(O)-$ ,  $-NHC(O)-$ ,  $-OC(O)-$ ,  $-S(O)-$  or  $-S(O)_2-$ ; and

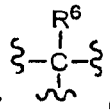
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Y is  $-O-$ ,  $-CH_2-$ ,  $-(CH_2)_2-$ ,  $-C(=O)-$ ,  $-C(=NOR^{13})-$ ,  $-S-$ ,  $-S(O)-$  or  $-SO_2-$ ;

Z is a bond,  $-\text{CH}(\text{R}^{14})-(\text{R}^{14a}\text{-}(\text{C}_1\text{-C}_4)\text{alkylene})-$  or  $-\text{CH}(\text{R}^{14})-\text{CH}(\text{R}^{14b})=\text{CH}(\text{R}^{14b})-$   
 $(\text{R}^{14a}\text{-}(\text{C}_1\text{-C}_2)\text{alkylene})-$ ;

R<sup>1</sup> is R<sup>15</sup>-alkyl, R<sup>15</sup>-cycloalkyl, R<sup>15</sup>-aryl, R<sup>15</sup>-arylalkyl, R<sup>15</sup>-(6-membered  
 heteroaryl), R<sup>15</sup>-(6-membered heteroaryl)alkyl, R<sup>15</sup>-(5-membered heteroaryl), R<sup>15</sup>-(5-  
 5 membered heteroaryl)alkyl, R<sup>15</sup>-heterocycloalkyl, diphenylmethyl,



provided that when R<sup>1</sup> is attached to X by a nitrogen atom and M<sup>1</sup> is , X is a  
 bond or alkylene; and provided that when R<sup>1</sup> is attached to X by a nitrogen atom and  
 10 M<sup>1</sup> is N, X is  $-(\text{CH}_2)_{2-6}$ ;

k is 0, 1, 2, 3 or 4;

k1 is 0, 1, 2 or 3;

k2 is 0, 1 or 2;

Q is O or S;

15 R<sup>2</sup> is R<sup>18</sup>-alkyl, R<sup>18</sup>-alkenyl, R<sup>18</sup>-aryl, R<sup>18</sup>-arylalkyl, R<sup>18</sup>-heteroaryl, R<sup>18</sup>-  
 heteroarylalkyl, R<sup>18</sup>-cycloalkyl or R<sup>18</sup>-heterocycloalkyl;

each R<sup>3</sup> is independently selected from the group consisting of H, halo, alkyl,  
 haloalkyl, -OH, alkoxy and -CN;

20 each R<sup>4</sup> is independently selected from the group consisting of H, alkyl, -OH,  
 alkoxy, halo, -CF<sub>3</sub>, -OCF<sub>3</sub>, -NO<sub>2</sub>, -CO<sub>2</sub>R<sup>19</sup>, -N(R<sup>19</sup>)<sub>2</sub>, -CON(R<sup>19</sup>)<sub>2</sub>, -NHC(O)R<sup>19</sup>, -  
 NHSO<sub>2</sub>R<sup>19</sup>, -SO<sub>2</sub>N(R<sup>19</sup>)<sub>2</sub> and -CN;

R<sup>5</sup> is H, alkyl, haloalkyl, R<sup>21</sup>-cycloalkyl, R<sup>21</sup>-aryl, R<sup>21</sup>-heteroaryl or -C(O)R<sup>20</sup>;

R<sup>6</sup> is H or alkyl; and when R<sup>1</sup> is attached to X by a carbon atom and X is a  
 bond or alkylene, R<sup>6</sup> can also be R<sup>21</sup>-cycloalkyl, R<sup>21</sup>-aryl, R<sup>21</sup>-heteroaryl, -NHC(O)R<sup>7</sup>, -  
 25 CN, hydroxyalkyl, alkoxyalkyl, -C(R<sup>7</sup>)=N(OR<sup>7</sup>), -C(O)R<sup>7</sup> or -N(R<sup>7</sup>)<sub>2</sub>;

R<sup>7</sup> is independently selected from the group consisting of H and alkyl;

$R^8$  and  $R^9$ , together with the carbon to which they are attached, form a 3- to 7-membered carbocyclic ring optionally substituted with 1 or 2 substituents independently selected from the group consisting of halo, alkyl and haloalkyl; or  $R^8$  and  $R^9$ , together with the carbon to which they are attached, form a 3- to 7-membered heterocyclic ring comprising 2 to 6 carbon atoms and 1 or 2 heteroatoms independently selected from the group consisting of O, S and N, provided that there is no -O-O-, -S-S- or -O-S- bond, wherein said heterocyclic ring is optionally substituted with 1 or 2 substituents independently selected from the group consisting of halo, alkyl and haloalkyl; or  $R^8$  and  $R^9$  together are =CH<sub>2</sub>;

10  $R^{10}$  is H, alkyl, haloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -heteroaryl,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl or  $R^{21}$ -arylalkyl;

$R^{11}$  is H or alkyl;

$R^{12}$  is independently selected from the group consisting of H, alkyl, -CH<sub>2</sub>CF<sub>3</sub>,  $R^{21}$ -aryl and  $R^{21}$ -heteroaryl;

15  $R^{13}$  is H, alkyl, haloalkyl,  $R^{21}$ -aryl or  $R^{21}$ -heteroaryl;

$R^{14}$  is H, alkyl or haloalkyl;

$R^{14a}$  is 1 to 3 substituents independently selected from the group consisting of H, halo, -OH, alkyl, haloalkyl,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -heteroaryl, alkoxy, -OCF<sub>3</sub>, -OCHF<sub>2</sub>, -NO<sub>2</sub>, -CN and -N( $R^{11}$ )<sub>2</sub>;

20  $R^{14b}$  is H, fluoro, alkyl or haloalkyl;

$R^{15}$  is 1, 2, 3 or 4 substituents independently selected from the group consisting of H, halo, alkyl, haloalkyl, -OH, alkoxy, alkylthio,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -arylalkyl,  $R^{21}$ -heteroaryl,  $R^{21}$ -heteroarylalkyl, aryloxy, -OCF<sub>3</sub>, -OCHF<sub>2</sub>, -SCF<sub>3</sub>, -NO<sub>2</sub>, -CO<sub>2</sub>R<sup>12</sup>, -C(O)R<sup>20</sup>, -N( $R^{12}$ )<sub>2</sub>, -CON( $R^{12}$ )<sub>2</sub>, -NHC(O)R<sup>12</sup>, -NHSO<sub>2</sub>R<sup>12</sup>, -SO<sub>2</sub>N( $R^{12}$ )<sub>2</sub> and -CN; or two  $R^{15}$  substituents on adjacent ring carbon atoms together are -O-CH<sub>2</sub>-O-;

$R^{15a}$  is H, alkyl, haloalkyl, alkoxy, alkylthio,  $R^{21}$ -cycloalkyl,  $R^{21}$ -heterocycloalkyl,  $R^{21}$ -aryl,  $R^{21}$ -arylalkyl,  $R^{21}$ -heteroaryl,  $R^{21}$ -heteroarylalkyl,  $R^{21}$ -aryloxy, -OCF<sub>3</sub>, -OCHF<sub>2</sub>, -N( $R^{12}$ )<sub>2</sub> or -SCF<sub>3</sub>;

30  $R^{16}$  is independently selected from the group consisting of alkyl, halogen, haloalkyl and alkenyl;

R<sup>17</sup> is H, alkyl, hydroxy(C<sub>2</sub>-C<sub>6</sub>)alkyl-, haloalkyl-, haloalkoxyalkyl-, alkoxyalkyl-, R<sup>21</sup>-aryl, R<sup>21</sup>-arylalkyl-, R<sup>21</sup>-heteroaryl, R<sup>21</sup>-heteroarylalkyl-, R<sup>21</sup>-cycloalkyl or R<sup>21</sup>-cycloalkylalkyl, or R<sup>21</sup>-heterocycloalkylalkyl;

5 R<sup>18</sup> is 1, 2 or 3 substituents independently selected from the group consisting of H, halo, alkyl, haloalkyl, -OH, alkoxy, R<sup>21</sup>-aryl, R<sup>21</sup>-aryloxy, -OCF<sub>3</sub>, -OCHF<sub>2</sub>, -NO<sub>2</sub>, -CO<sub>2</sub>R<sup>19</sup>, -N(R<sup>19</sup>)<sub>2</sub>, -CON(R<sup>19</sup>)<sub>2</sub>, -NHC(O)R<sup>19</sup>, -NHSO<sub>2</sub>R<sup>19</sup>, -SO<sub>2</sub>N(R<sup>19</sup>)<sub>2</sub> and -CN;

R<sup>19</sup> is independently selected from the group consisting of H, alkyl, haloalkyl, R<sup>21</sup>-aryl, R<sup>21</sup>-heteroaryl, R<sup>21</sup>-cycloalkyl and R<sup>21</sup>-heterocycloalkyl;

R<sup>20</sup> is alkyl, R<sup>21</sup>-aryl or R<sup>21</sup>-heteroaryl; and

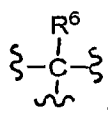
10 R<sup>21</sup> is 1, 2 or 3 substituents independently selected from the group consisting of H, alkyl, halo, alkoxy, -CF<sub>3</sub>, -N(R<sup>11</sup>)<sub>2</sub> and -alkylene-N(R<sup>11</sup>)<sub>2</sub>.

2. The compound of claim 1, wherein both U and W are CH.

15 3. The compound of claim 1, wherein X is a single bond, -NHC(O)- or -C(=N-OR<sup>10</sup>)- and wherein R<sup>10</sup> is H or alkyl.

4. The compound of claim 1, wherein Y is -O- or -C(=O)-.

20 5. The compound of claim 1, wherein Z is a bond.

6. The compound of claim 1, wherein M<sup>1</sup> is , wherein R<sup>6</sup> is H, -NHC(O)R<sup>7</sup> or -N(R<sup>7</sup>)<sub>2</sub> and R<sup>7</sup> is alkyl.

25 7. The compound of claim 1, wherein n is 2, p is 1, a and b are each 0, X is a single bond, Y is -C(O)-, and Z is a bond.

8. The compound of claim 1, wherein R<sup>2</sup> is a 5- or 6-membered R<sup>18</sup>-heteroaryl or a 4, 5 or 6-membered R<sup>18</sup>-heterocycloalkyl.

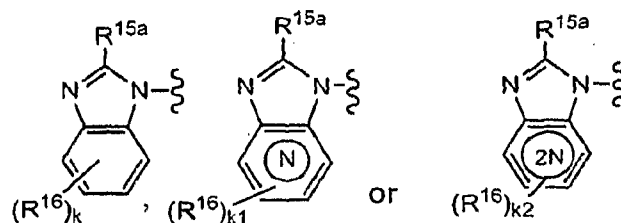
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9. A compound of claim 8 wherein R<sup>2</sup> is selected from the group consisting of R<sup>18</sup>-pyridyl, R<sup>18</sup>-pyrimidyl, R<sup>18</sup>-pyradaziny, R<sup>18</sup>-tetrahydropyranyl, R<sup>18</sup>-azetidiny, R<sup>18</sup>-

oxazolyl and R<sup>18</sup>-thiazolyl, wherein R<sup>18</sup> is 1 or 2 substituents independently selected from the group consisting of H, -CH<sub>3</sub>, -NH<sub>2</sub> and -NHCH<sub>3</sub>.

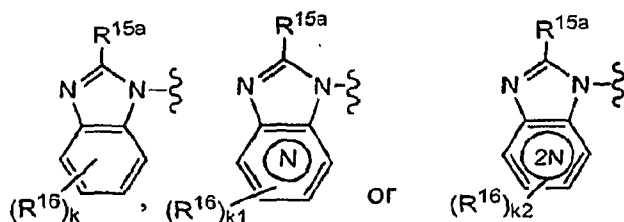
10. A compound of claim 9 wherein R<sup>2</sup> is 2-amino pyridyl, 2-amino oxazolyl, 2-amino thiazolyl, 1-methyl-azetidiny or tetrahydropyranyl.

11. The compound of claim 1, wherein R<sup>1</sup> is R<sup>15</sup>-aryl, R<sup>15</sup>-(6-membered heteroaryl),



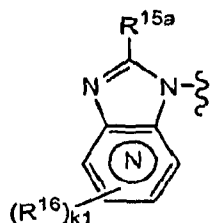
10 12. A compound of claim 11 wherein R<sup>1</sup> is R<sup>15</sup>-phenyl or R<sup>15</sup>-pyridyl, and R<sup>15</sup> is 1 to 4 substituents independently selected from the group consisting of H, halo, alkyl, haloalkyl and -CN.

13. The compound of claim 1, wherein R<sup>1</sup> is



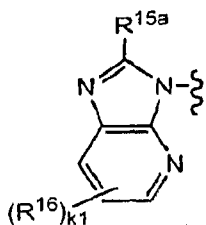
15 wherein R<sup>15a</sup> is C<sub>1</sub>-C<sub>3</sub> alkyl, halo(C<sub>1</sub>-C<sub>3</sub>)alkyl, C<sub>1</sub>-C<sub>3</sub> alkoxy, C<sub>1</sub>-C<sub>3</sub> alkylthio, R<sup>21</sup>-phenyl or R<sup>21</sup>-pyridyl; R<sup>21</sup> is 1-3 substituents independently selected from H, halo, alkyl, haloalkyl, -OCF<sub>3</sub>, and k, k<sub>1</sub> and k<sub>2</sub> are each independently 0, 1 or 2.

20 14. A compound of claim 13 wherein R<sup>1</sup> is



wherein  $R^{15a}$  is  $(C_1-C_3)$ alkyl,  $C_1-C_3$  alkoxy,  $C_1-C_3$  alkylthio,  $R^{21}$ -phenyl or  $R^{21}$ -pyridyl;  $R^{21}$  is 1 or 2 substituents independently selected from H, halo, alkyl and haloalkyl; and  $k_1$  is 0 or 1.

- 5 15. A compound of claim 14 wherein  $R^1$  is

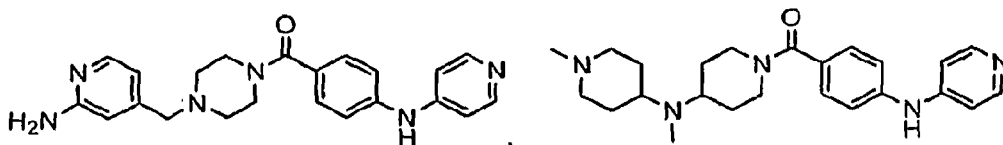


wherein  $R^{15a}$  is  $-C_2F_5$ ,  $-CF_3$ ,  $C_2H_5-O-$ ,  $CH_3-O-$ ,  $C_2H_5-S-$ ,  $CH_3-S-$ ,  $R^{21}$ -phenyl or  $R^{21}$ -pyridyl;  $R^{21}$  is 1 or 2 substituents independently selected from H, F, Cl,  $-CH_3$ , and  $-CF_3$ ; and  $k_1$  is 0 or 1 and  $R^{16}$ , when present, is F, Cl or  $-CF_3$ .

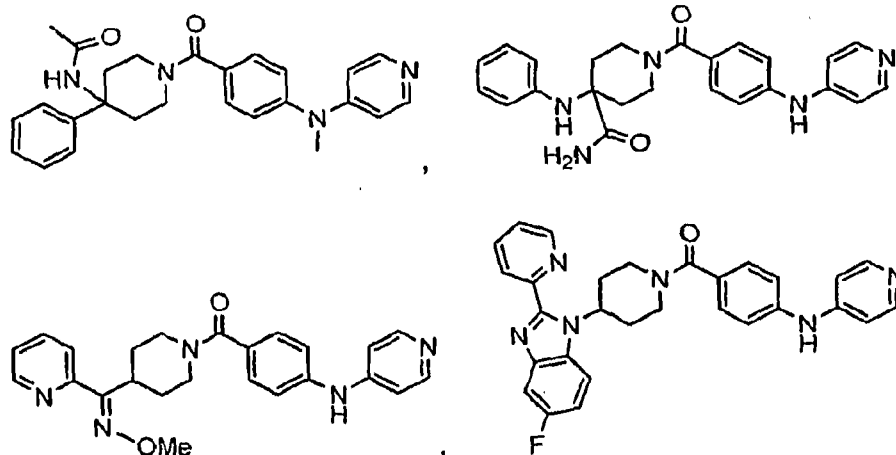
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16. The compound of claim 3, wherein X is  $-C(=N-OCH_3)-$ .

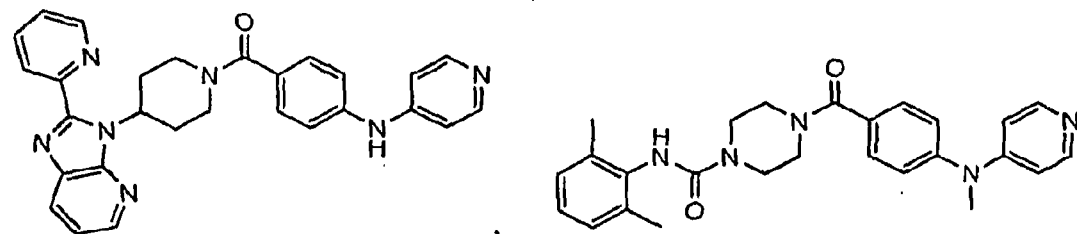
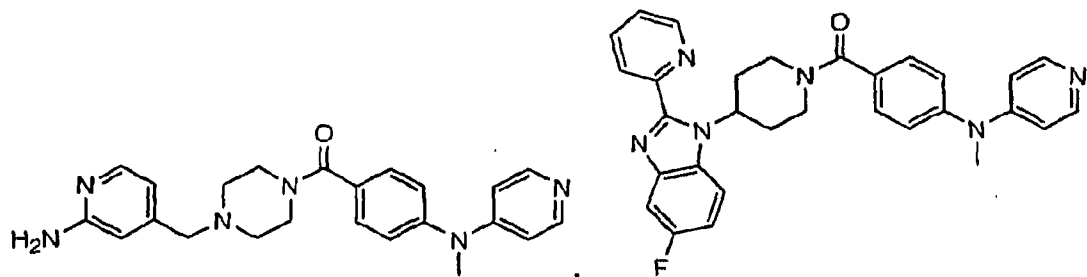
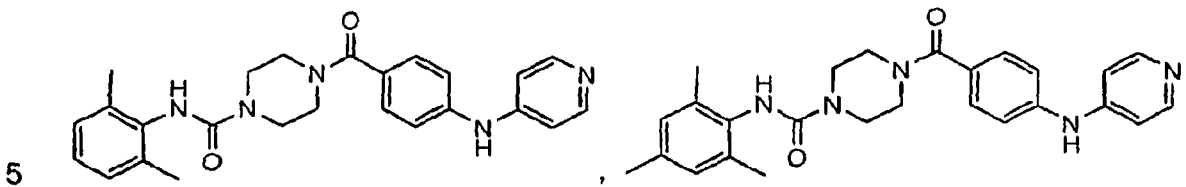
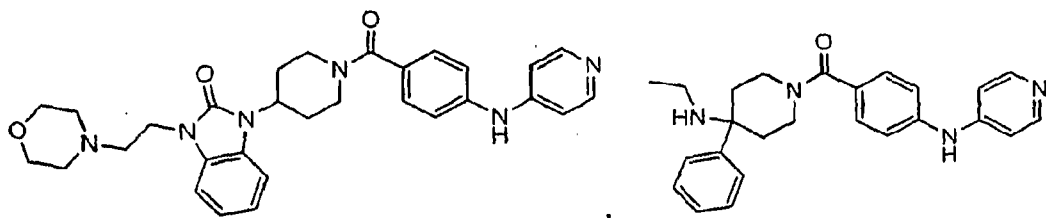
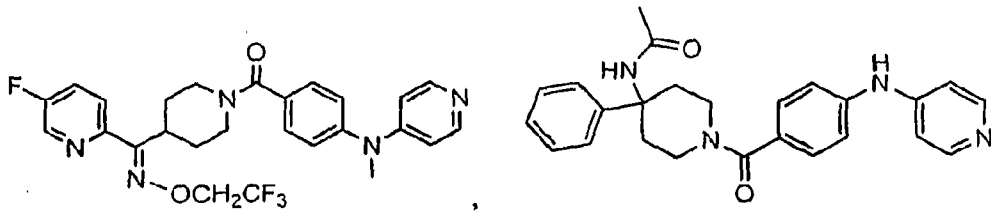
17. A compound having the structure:



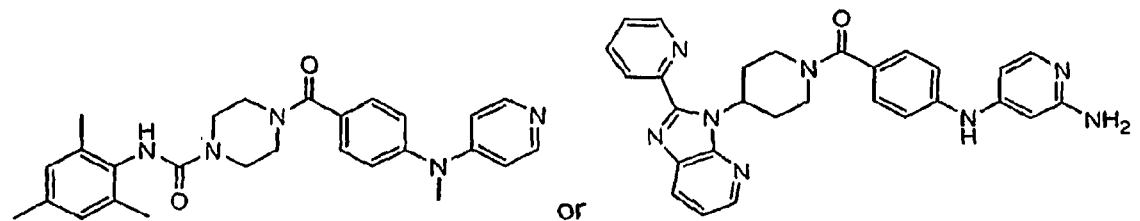
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or a pharmaceutically acceptable salt thereof.

18. A pharmaceutical composition comprising an effective amount of at least one compound of claim 1 and a pharmaceutically acceptable carrier.

5

19. The composition of claim 18 further comprising an effective amount of at least one H<sub>1</sub> receptor antagonist.

20. The composition of claim 18 further comprising an effective amount of at least one other compound useful for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder.

10

21. The composition of claim 20 wherein the at least one other compound useful for treating obesity, an obesity-related disorder or metabolic syndrome is selected from the group consisting of appetite suppressants, anti-diabetic agents, metabolic rate enhancers, nutrient absorption inhibitors, HMG-CoA reductase inhibitors, substituted azetidiones and substituted  $\beta$ -lactam sterol absorption inhibitors, and the other compound useful for treating a cognition deficit disorder is selected from the group consisting of atomoxetine, dexmethylphenidate, olanzapine, risperidone, aripiprazole, donepezil, heptylphysostigmine, tacrine, rivastigmine and galantamine.

15

20

22. The composition of claim 21, wherein the at least one other compound is an appetite suppressant.

25

23. The composition of claim 20, wherein the at least one other compound useful for treating obesity, an obesity-related disorder or metabolic syndrome is rimonabant.

24. The composition of claim 18, wherein the at least one compound of claim 1 is a compound of claim 17.

30

25. The composition of claim 22, further comprising at least one HMG-CoA reductase inhibitor.

26. The composition of claim 25, wherein the at least one HMG-CoA reductase inhibitor is selected from the group consisting of lovastatin, simvastatin, pravastatin, atorvastatin, fluvastatin, resuvastatin, cerivastatin, rivastatin and pitavastatin.
- 5 27. The composition of claim 26, wherein the at least one HMG-CoA reductase inhibitor comprises simvastatin.
28. A method for treating allergy, an allergy-induced airway response, congestion, hypotension, a cardiovascular disease, a disease of the gastrointestinal tract,  
10 hypermotility of the gastrointestinal tract, hypomotility of the gastrointestinal tract, acidic secretion of the gastrointestinal tract, metabolic syndrome, obesity, an obesity-related disorder, a sleeping disorder, hypo or hyperactivity of the central nervous system, a cognition deficit disorder, or migraine in a patient, the method comprising administering to the patient an effective amount of at least one compound of claim 1.  
15
29. The method of claim 28 wherein the treating is for an allergy-induced airway response, nasal congestion, metabolic syndrome, obesity, an obesity-related disorder or a cognition deficit disorder.
- 20 30. A method for treating allergy, an allergy-induced airway response or congestion in a patient, comprising administering to the patient an effective amount of at least one compound of claim 1 and an effective amount of an H<sub>1</sub> receptor antagonist.
- 25 31. A method for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder in a patient, comprising administering to the patient an effective amount of at least one compound of claim 1 and an effective amount of at least one other compound useful for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder.
- 30 32. The method of claim 31, wherein the at least one compound useful for treating obesity, an obesity-related disorder or metabolic syndrome is selected from the group consisting of appetite suppressants, metabolic rate enhancers and nutrient absorption inhibitors.

33. The method of claim 32, wherein the appetite suppressants are selected from the group consisting of cannabinoid receptor 1 antagonists or inverse agonists, Neuropeptide Y antagonists, metabotropic glutamate subtype 5 receptor antagonists, melanin-concentrating hormone receptor antagonists, melanocortin receptor agonists, serotonin uptake inhibitors, serotonin transporter inhibitors, norepinephrine transporter inhibitors, ghrelin antagonists, leptin or derivatives thereof, opioid antagonists, orexin antagonists, bombesin receptor subtype 3 agonists, Cholecystikinin-A agonists, ciliary neurotrophic factor or derivatives thereof, monoamine reuptake inhibitors, glucagons-like peptide 1 agonists, topiramate, and phytopharm compound 57; the Metabolic rate enhancers are selected from the group consisting of acetyl-CoA carboxylase-2 inhibitors, beta adrenergic receptor 3 agonists, diacylglycerol acyltransferase inhibitors, fatty acid synthase inhibitors, phosphodiesterase inhibitors, thyroid hormone  $\beta$  agonists; uncoupling protein activators, acyl-estrogens; glucocorticoid antagonists; 11-beta hydroxyl steroid dehydrogenase type 1 inhibitors, melanocortin-3 receptor agonists and stearyl-CoA desaturase-1 compounds; and the nutrient absorption inhibitors are selected from the group consisting of lipase inhibitors, fatty acid transporter inhibitors, dicarboxylate transporter inhibitors, glucose transporter inhibitors and phosphate transporter inhibitors.

20

34. The method of claim 31, wherein the compound useful for treating obesity or metabolic syndrome is selected from the group consisting of rimonabant, 2-methyl-6-(phenylethynyl)-pyridine, 3[(2-methyl-1,4-thiazol-4-yl)ethynyl]pyridine, Melanotan-II, Mc4r agonists, dexfenfluramine, fluoxetine, paroxetine, fenfluramine, fluvoxamine, sertaline, imipramine, desipramine, talsupram, nomifensine, leptin or derivatives thereof; nalmefene, 3-methoxy-naltrexone, naloxone, nalterxone, butabindide, axokine, sibutramine, topiramate, phytopharm compound 57, Cerulenin, theophylline, pentoxifylline, zaprinast, sildenafil, amrinone, milrinone, cilostamide, rolipram, cilomilast, phytanic acid, 4-[(E)-2-(5,6,7,8-tetramethyl-2-naphthalenyl)-1-propenyl]benzoic acid, retinoic acid, oleoyl-estrone, orlistat, lipstatin, tetrahydrolipstatin, teasaponin and diethylumbelliferyl phosphate.

30

35. The method of claim 34, wherein the compound useful for treating obesity or metabolic syndrome is rimonabant.

36. The method of claim 31, wherein the compound useful for treating a cognition deficit disorder is selected from the group consisting of atomoxetine,  
5 dexmethylphenidate, olanzapine, risperidone, aripiprazole, donepezil, heptylphysostigmine, tacrine, rivastigmine and galantamine.

37. The method of claim 31, further comprising administering an effective amount  
10 of at least one additional compound selected from: an HMG-CoA reductase inhibitor, a substituted azetidinone or a substituted  $\beta$ -lactam sterol absorption inhibitor.

38. The method of claim 37, wherein the at least one additional compounds being administered comprise an HMG-CoA reductase inhibitor.  
15

39. The method of claim 38, wherein the at least one HMG-CoA reductase inhibitors are selected from the group consisting of lovastatin, simvastatin, pravastatin, atorvastatin, fluvastatin, resuvastatin, cerivastatin, rivastatin and pitavastatin.  
20

40. The method of claim 39, wherein the at least one HMG-CoA reductase inhibitors comprise simvastatin.

41. The composition of claim 18 further comprising an effective amount of at least  
25 one anti-diabetic agent.

42. The composition of claim 41 wherein the at least one antidiabetic agent is selected from: a sulfonylurea, an insulin sensitizer, an  $\alpha$ -glucosidase inhibitor, an insulin secretagogue, an anti-obesity agent, a meglitinide, insulin or an insulin-containing composition.  
30

43. A method for treating diabetes in a patient, comprising administering to the patient an effective amount of at least one compound of claim 1.

44. The method of claim 43, further comprising administering to the patient an effective amount of at least one anti-diabetic agent.

5 45. The method of claim 44, wherein the at least one antidiabetic agent is selected from: a sulfonylurea, an insulin sensitizer, an  $\alpha$ -glucosidase inhibitor, an insulin secretagogue, an anti-obesity agent, a meglitinide, insulin or an insulin-containing composition.

10 46. The method of claim 45, wherein the at least one anti-diabetic agent comprises an insulin sensitizer or a sulfonylurea.

47. The method of claim 46, wherein the insulin sensitizer is a PPAR activator.

15 48. The method of claim 47, wherein the PPAR activator is a thiazolidinedione.

49. A method for treating obesity or metabolic syndrome in a patient, comprising administering to the patient an effective amount of at least one compound of claim 1 and an effective amount of at least one anti-diabetic agent.

20 50. The method of claim 49, wherein the at least one antidiabetic agent is selected from: a sulfonylurea, an insulin sensitizer, an  $\alpha$ -glucosidase inhibitor, an insulin secretagogue, an anti-obesity agent, a meglitinide, insulin or an insulin-containing composition.

25 51. The method of claim 50, wherein the at least one anti-diabetic agent comprises an insulin sensitizer or a sulfonylurea.

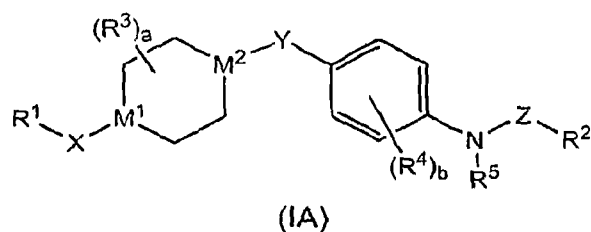
52. The method of claim 51, wherein the insulin sensitizer is a PPAR activator.

30 53. The method of claim 52, wherein the PPAR activator is a thiazolidinedione.

54. The method of claim 43, wherein the diabetes is type I diabetes.

55. The method of claim 43, wherein the diabetes is type II diabetes.
56. The method of claim 31, wherein the treating is for obesity.
- 5  
57. The method of claim 28, wherein the at least one compound administered is a compound of claim 17.
58. The method of claim 30, wherein the at least one compound administered is a  
10 compound of claim 17.
59. The method of claim 31, wherein the at least one compound administered is a compound of claim 17.
- 15 60. The method of claim 43, wherein the at least one compound administered is a compound of claim 17.
61. The method of claim 49, wherein the at least one compound administered is a  
20 compound of claim 17.
62. A pharmaceutical composition comprising an effective amount of at least one compound of claim 17 and a pharmaceutically acceptable carrier.
63. The composition of claim 62 further comprising an effective amount of at least  
25 one H<sub>1</sub> receptor antagonist.
64. The composition of claim 62 further comprising an effective amount of at least one other compound useful for treating obesity, an obesity-related disorder, metabolic syndrome or a cognition deficit disorder.
- 30

65. A compound having the formula:



5 or a pharmaceutically acceptable salt or solvate thereof, wherein

$M^1$  is  $CR^6$  or N;

$M^2$  is CH or N;

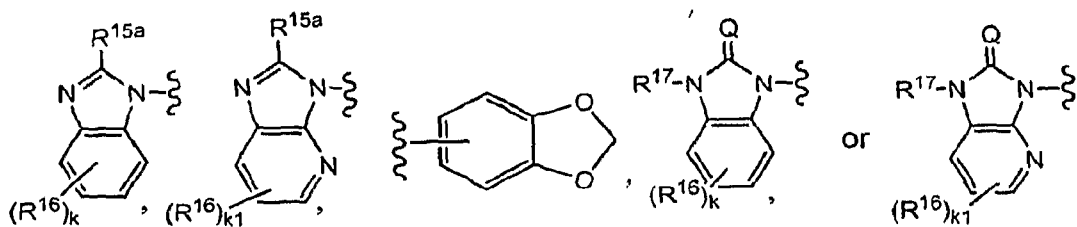
10 X is a bond, alkylene,  $-C(O)-$ ,  $-C(=N-O-R^a)-$ ,  $-N(R^{12})-$ ,  $-CH_2N(R^{12})-$ ,  $-C(=CH_2)-$ ,  $-NHC(O)-$ ,  $-SO_2-$ , such that when  $M^1$  is N, X is not  $-N(R^{12})-$  or  $-CH_2N(R^{12})-$ ;

Y is  $-C(O)-$  when  $M^2$  is N, and Y is  $-C(O)-$  or O when  $M^2$  is CH;

Z is a bond;

$R^1$  is  $R^{15}$ -arylalkyl,  $R^{15}$ -aryl,  $R^{15}$ -cycloalkyl,  $R^{15}$ -heteroaryl,  $R^{15}$ -heterocycloalkyl,

15 fluorenyl,



$R^2$  is  $R^{18}$ -arylalkyl,  $R^{18}$ -alkyl,  $R^{18}$ -aryl,  $R^{18}$ -heteroaryl, or  $R^{18}$ -heterocycloalkyl;

each  $R^3$  is independently selected from the group consisting of H, halo, alkyl,

20 haloalkyl,  $-OH$ , alkoxy and  $-CN$ ;

each  $R^4$  is independently selected from the group consisting of H, alkyl,  $-OH$ , alkoxy, halo,  $-CF_3$ ,  $-OCF_3$ ,  $-NO_2$  and  $-CN$ ;

$R^5$  is H, alkyl or  $-C(O)$ alkyl;

$R^6$  is  $-H$ ,  $-NH_2$ ,  $-NH$ -alkyl,  $-CN$ ,  $-hydroxy$ -substituted alkyl,  $-NHC(O)$ -alkyl, or -

25  $C(alkyl)(=N-O-R^a)$ ;

$R^{12}$  is  $-H$  or alkyl;

$R^{15}$  is -H, -CN, -O-phenyl, -OH, alkoxy, halo, alkyl, -benzyl, -NH<sub>2</sub>, -NO<sub>2</sub>, -CF<sub>3</sub>, -OCF<sub>3</sub>, -S-alkyl, phenyl, -C(O)O-alkyl, -C(O)alkyl, or -S-CF<sub>3</sub>;

$R^{15a}$  is -H, or -heteroaryl (2-benzofuranyl, 2-quinolinyl, pyridyl);

$R^{16}$  is -CF<sub>3</sub>, or halo;

5  $R^{17}$  is -H, alkoxy, or  $R^{21}$ -heterocycloalkylalkyl (-CH<sub>2</sub>CH<sub>2</sub>-(N-morpholinyl));

$R^{18}$  is -H, halo, -NO<sub>2</sub>, or -NH<sub>2</sub>;

$R^{21}$  is -H, halo or alkyl;

Q is O or S;

$R^a$  is -H, alkyl, or -CH<sub>2</sub>CF<sub>3</sub>;

10 a is 0 or 1;

b is 0 or 1;

k is 0, 1 or 2; and

k1 is 0, 1 or 2.