TITLE OF THE INVENTION

ISONICOTINAMIDE OREXIN RECEPTOR ANTAGONISTS

BACKGROUND OF THE INVENTION

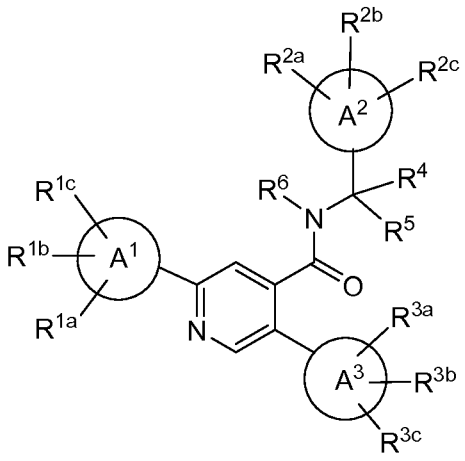
The orexins (hypocretins) comprise two neuropeptides produced in the hypothalamus: the orexin A (OX-A) (a 33 amino acid peptide) and the orexin B (OX-B) (a 28 amino acid peptide) (Sakurai T. et al., Cell, 1998, 92, 573-585). Orexins are found to stimulate food consumption in rats suggesting a physiological role for these peptides as mediators in the central feedback mechanism that regulates feeding behaviour (Sakurai T. et al., Cell, 1998, 92, 573-585). Orexins regulate states of sleep and wakefulness opening potentially novel therapeutic approaches for narcoleptic or insomniac patients (Chemelli R.M. et al., Cell, 1999, 98, 437-451). Orexins have also been indicated as playing a role in arousal, reward, learning and memory (Harris, et al., Trends Neurosci., 2006, 29 (10), 571-577). Two orexin receptors have been cloned and characterized in mammals. They belong to the super family of G-protein coupled receptors (Sakurai T. et al., Cell, 1998, 92, 573-585): the orexin-1 receptor (OX or OX1R) is selective for OX-A and the orexin-2 receptor (OX2 or OX2R) is capable to bind OX-A as well as OX-B. The physiological actions in which orexins are presumed to participate are thought to be expressed via one or both of OX 1 receptor and OX 2 receptor as the two subtypes of orexin receptors.

SUMMARY OF THE INVENTION

The present invention is directed to isonicotinamide compounds which are antagonists of orexin receptors, and which are useful in the treatment or prevention of neurological and psychiatric disorders and diseases in which orexin receptors are involved. The invention is also directed to pharmaceutical compositions comprising these compounds and the use of these compounds and compositions in the prevention or treatment of such diseases in which orexin receptors are involved.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to compounds of the formula I:



I

wherein:

A^1 is selected from the group consisting of phenyl, naphthyl and heteroaryl;

A^2 is selected from the group consisting of phenyl, naphthyl and heteroaryl;

A^3 is selected from the group consisting of phenyl, naphthyl, C_{3-6}cycloalkyl, $-NR^{10}R^{11}$ and heterocycle;

R^{1a}, R^{1b} and R^{1c} may be absent if the valency of A^1 does not permit such substitution and are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) $-(C=O)_m-O_n-C_{1-6}$alkyl, where m is independently 0 or 1, n is independently 0 or 1 (wherein if m is 0 or n is 0, a bond is present) and where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(5) $-(C=O)_m-O_n-C_{3-6}$cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(6) $-(C=O)_m-C_{2-4}$alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(7) $-(C=O)_m-C_{2-4}$alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(8) -$(C=O)_m$-O_n-phenyl or -$(C=O)_m$-O_n-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(9) -$(C=O)_m$-O_n-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{13},

(10) -$(C=O)_m$-$NR^{10}R^{11}$, wherein R^{10} and R^{11} are independently selected from the group consisting of:

(a) hydrogen,

(b) C_{1-6}alkyl, which is unsubstituted or substituted with R^{13},

(c) C_{3-6}alkenyl, which is unsubstituted or substituted with R^{13},

(d) C_{3-6}alkynyl, which is unsubstituted or substituted with R^{13},

(e) C_{3-6}cycloalkyl which is unsubstituted or substituted with R^{13},

(f) phenyl, which is unsubstituted or substituted with R^{13}, and

(g) heterocycle, which is unsubstituted or substituted with R^{13},

(11) -$S(O)_2$-$NR^{10}R^{11}$,

(12) -$S(O)_q$-R^{12}, where q is 0, 1 or 2 and where R^{12} is selected from the definitions of R^{10} and R^{11},

(13) -CO_2H,

(14) -CN, and

(15) -NO_2;

R^{2a}, R^{2b} and R^{2c} may be absent if the valency of A^2 does not permit such substitution and are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) -$(C=O)_m$-O_n-C_{1-6}alkyl, where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(5) -$(C=O)_m$-O_n-C_{3-6}cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(6) -$(C=O)_m$-C_{2-4}alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(7) -$(C=O)_m$-C_{2-4}alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(8) -$(C=O)_m$-O_n-phenyl or -$(C=O)_m$-O_n-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(9) -$(C=O)_m$-O_n-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{13},
(10) -$(C=O)_m$-$NR^{10}R^{11}$,
(11) -$S(O)_2$-$NR^{10}R^{11}$,
(12) -$S(O)_q$-R^{12},
(13) -CO_2H,
(14) -CN, and
(15) -NO_2;

R^{3a}, R^{3b} and R^{3c} may be absent if the valency of A^3 does not permit such substitution and are independently selected from the group consisting of:
(1) hydrogen,
(2) halogen,
(3) hydroxyl,
(4) -$(C=O)_m$-O_n-C_{1-6}alkyl, where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(5) -$(C=O)_m$-O_n-C_{3-6}cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(6) -$(C=O)_m$-C_{2-4}alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(7) -$(C=O)_m$-C_{2-4}alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(8) -$(C=O)_m$-O_n-phenyl or -$(C=O)_m$-O_n-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(9) -$(C=O)_m$-O_n-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{13},
(10) -$(C=O)_m$-$NR^{10}R^{11}$,
(11) -$S(O)_2$-$NR^{10}R^{11}$,
(12) -$S(O)_q$-R^{12},
(13) -CO_2H,
(14) -CN, and
(15) -NO_2;

R^4 and R^5 are independently selected from hydrogen and C_{1-6}alkyl, which is unsubstituted or substituted with one or more substituents selected from R^{13}, or R^4 and R^5 may be joined

together to form a C_{3-6}cycloalkyl with the carbon atom to which they are attached, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13};

R^6 is hydrogen, C_{1-6}alkyl or C_{3-6}cycloalkyl, which is unsubstituted or substituted with one or more substituents selected from R^{13};

R^{13} is selected from the group consisting of:

(1) halogen,
(2) hydroxyl,
(3) $-(C=O)_m-O_n-C_{1-6}$alkyl, where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(4) $-O_n-(C_{1-3})$perfluoroalkyl,
(5) $-(C=O)_m-O_n-C_{3-6}$cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(6) $-(C=O)_m-C_{2-4}$alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(7) $-(C=O)_m-C_{2-4}$alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(8) $-(C=O)_m-O_n$-phenyl or $-(C=O)_m-O_n$-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(9) $-(C=O)_m-O_n$-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{14},
(10) $-(C=O)_m-NR^{10}R^{11}$,
(11) $-S(O)_2-NR^{10}R^{11}$,
(12) $-S(O)_q-R^{12}$,
(13) $-CO_2H$,
(14) -CN, and
(15) $-NO_2$;

R^{14} is selected from the group consisting of:

(1) hydroxyl,
(2) halogen,
(3) C_{1-6}alkyl,
(4) $-C_{3-6}$cycloalkyl,
(5) $-O-C_{1-6}$alkyl,

(6) -O(C=O)-C_{1-6}alkyl,

(7) -NH-C_{1-6}alkyl,

(8) phenyl,

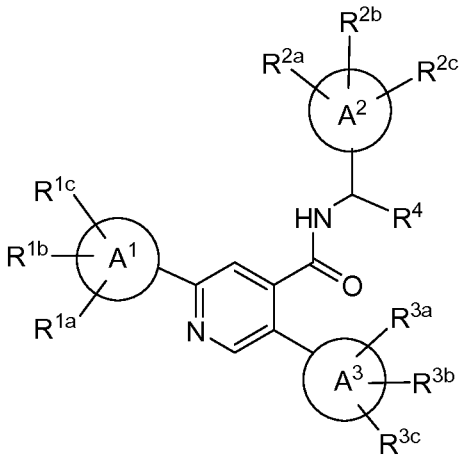
(9) heterocycle,

(10) -CO_2H, and

(11) -CN;

or a pharmaceutically acceptable salt thereof.

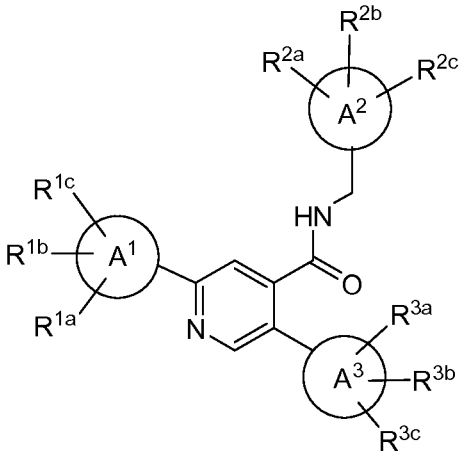
An embodiment of the present invention includes compounds of the formula Ia:



Ia

wherein A^1, A^2, A^3, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b}, R^{3c} and R^4 are defined herein; or a pharmaceutically acceptable salt thereof.

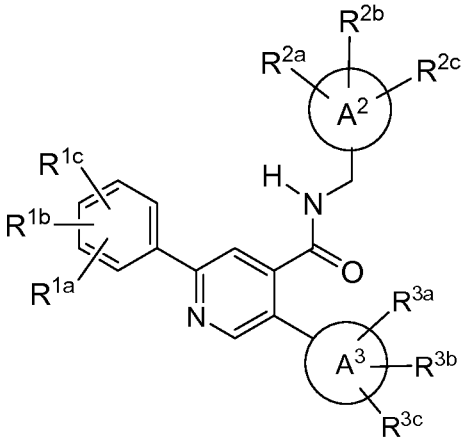
An embodiment of the present invention includes compounds of the formula Ib:



Ib

wherein A^1, A^2, A^3, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

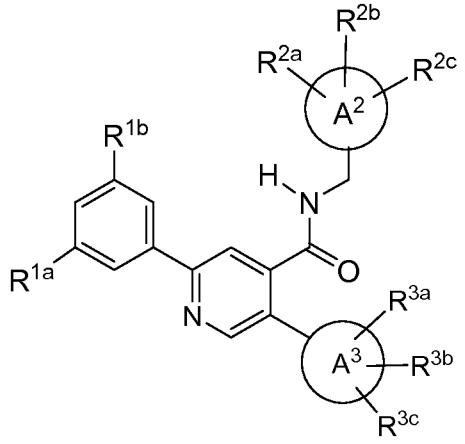
An embodiment of the present invention includes compounds of the formula Ic:



Ic

wherein A^2, A^3, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

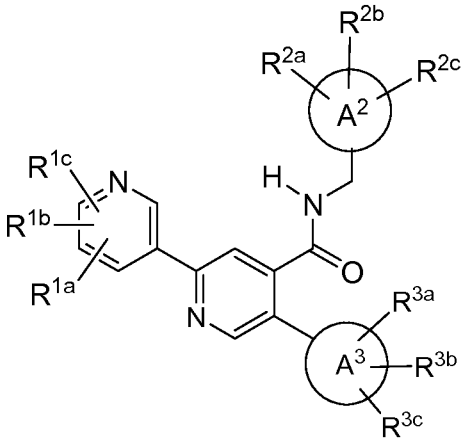
An embodiment of the present invention includes compounds of the formula Ic':



Ic'

wherein A^2, A^3, R^{1a}, R^{1b}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

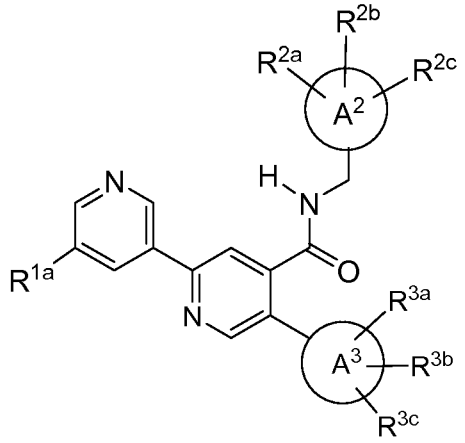
An embodiment of the present invention includes compounds of the formula Id:



Id

wherein A^2, A^3, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

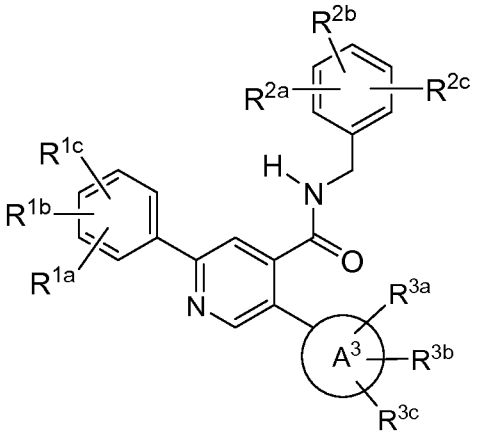
An embodiment of the present invention includes compounds of the formula Id':



Id'

wherein A^2, A^3, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

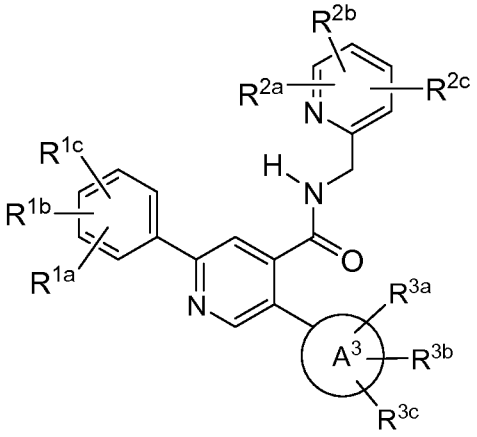
An embodiment of the present invention includes compounds of the formula Ie:



Ie

wherein A^3, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

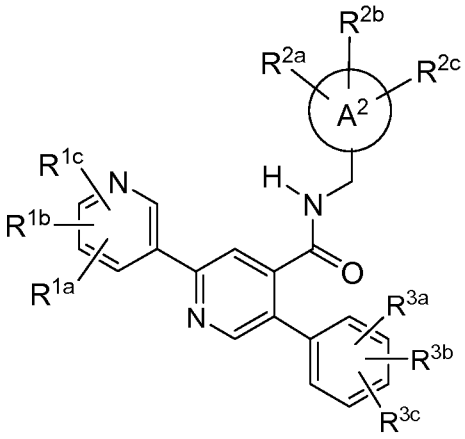
An embodiment of the present invention includes compounds of the formula If:



If

wherein A^3, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

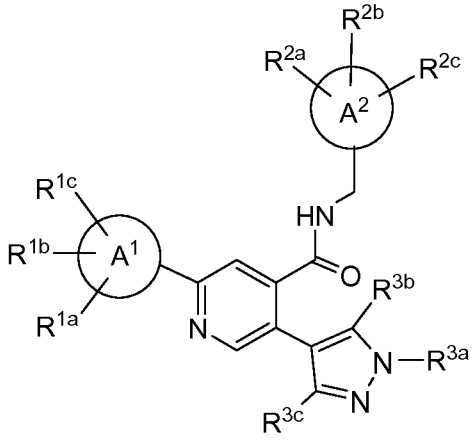
An embodiment of the present invention includes compounds of the formula Ig:



Ig

wherein A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

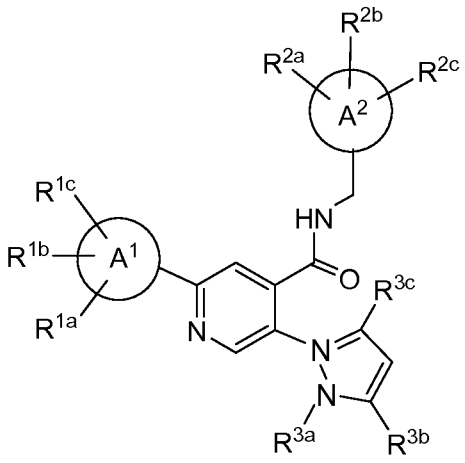
An embodiment of the present invention includes compounds of the formula Ih:



Ih

wherein A^1, A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

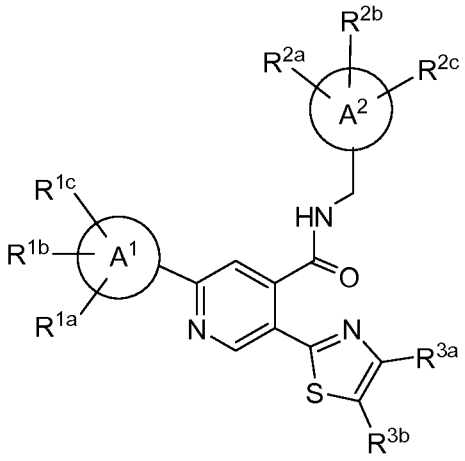
An embodiment of the present invention includes compounds of the formula Ii:



Ii

wherein A^1, A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a}, R^{3b} and R^{3c} are defined herein; or a pharmaceutically acceptable salt thereof.

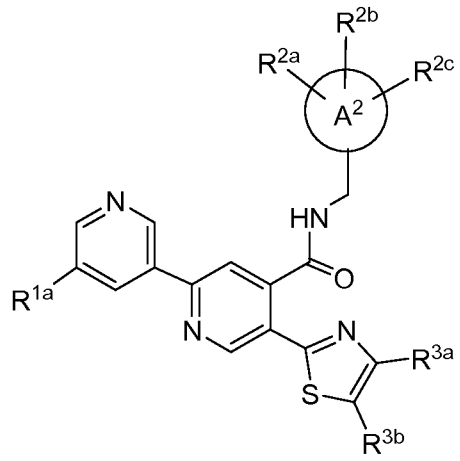
An embodiment of the present invention includes compounds of the formula Ij:



Ij

wherein A^1, A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a} and R^{3b} are defined herein; or a pharmaceutically acceptable salt thereof.

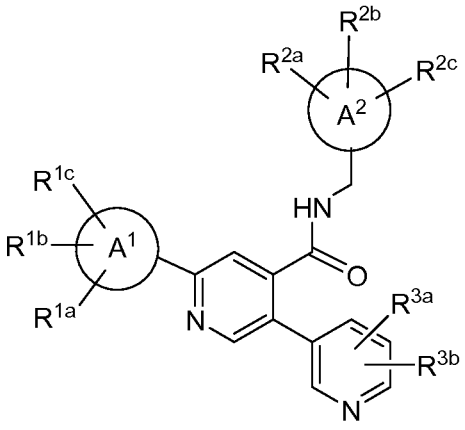
An embodiment of the present invention includes compounds of the formula Ij':



Ij'

wherein A^2, R^{1a}, R^{2a}, R^{2b}, R^{2c}, R^{3a} and R^{3b} are defined herein; or a pharmaceutically acceptable salt thereof.

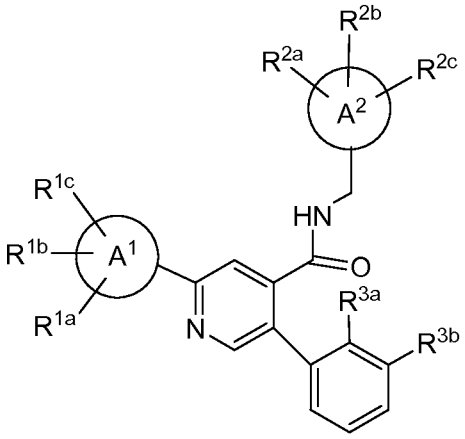
An embodiment of the present invention includes compounds of the formula Ik:



Ik

wherein A^1, A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a} and R^{3b} are defined herein; or a pharmaceutically acceptable salt thereof.

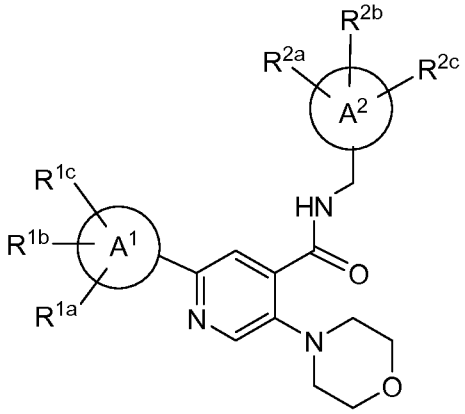
An embodiment of the present invention includes compounds of the formula Il:



Il

wherein A^1, A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b}, R^{2c}, R^{3a} and R^{3b} are defined herein; or a pharmaceutically acceptable salt thereof.

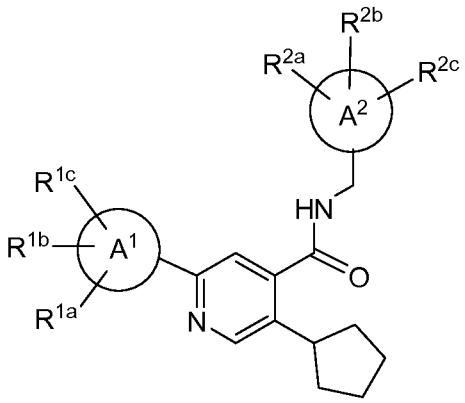
An embodiment of the present invention includes compounds of the formula Im:



Im

wherein A^1, A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b} and R^{2c} are defined herein; or a pharmaceutically acceptable salt thereof.

An embodiment of the present invention includes compounds of the formula In:



In

wherein A^1, A^2, R^{1a}, R^{1b}, R^{1c}, R^{2a}, R^{2b} and R^{2c} are defined herein; or a pharmaceutically acceptable salt thereof.

An embodiment of the present invention includes compounds wherein A^1 is phenyl. An embodiment of the present invention includes compounds wherein A^1 is naphthyl. An embodiment of the present invention includes compounds wherein A^1 is heteroaryl. An embodiment of the present invention includes compounds wherein A^1 is pyridyl.

An embodiment of the present invention includes compounds wherein A^2 is phenyl or pyridyl. An embodiment of the present invention includes compounds wherein A^2 is phenyl. An embodiment of the present invention includes compounds wherein A^2 is naphthyl. An embodiment of the present invention includes compounds wherein A^2 is heteroaryl. An embodiment of the present invention includes compounds wherein A^2 is quinoxalinyl. An embodiment of the present invention includes compounds wherein A^2 is pyridyl. An embodiment of the present invention includes compounds wherein A^2 is pyrazinly. An embodiment of the present invention includes compounds wherein A^2 is quinolinyl. An embodiment of the present invention includes compounds wherein A^2 is indolyl. An embodiment of the present invention includes compounds wherein A^2 is dihydroindolyl. An embodiment of the present invention includes compounds wherein A^2 is benzimidazolyl.

An embodiment of the present invention includes compounds wherein A^3 is pyrazolyl. An embodiment of the present invention includes compounds wherein A^3 is pyrazolyl which is substituted with methyl. An embodiment of the present invention includes compounds wherein A^3 is pyridyl. An embodiment of the present invention includes compounds wherein A^3 is pyridyl, which is substituted with at least one substituent other than hydrogen. An embodiment of the present invention includes compounds wherein A^3 is pyridyl, which is substituted with fluroro or chloro. An embodiment of the present invention includes compounds wherein A^3 is 2-pyridyl or 4-pyridyl. An embodiment of the present invention

includes compounds wherein A^3 is other than unsubstituted 3-pyridyl. An embodiment of the present invention includes compounds wherein A^3 is thiazolyl. An embodiment of the present invention includes compounds wherein A^3 is 5-thiazolyl. An embodiment of the present invention includes compounds wherein A^3 is thiazolyl, which is substituted with C_{1-6}alkyl. An embodiment of the present invention includes compounds wherein A^3 is phenyl. An embodiment of the present invention includes compounds wherein A^3 is phenyl, which is substituted with at least one substituent other than hydrogen. An embodiment of the present invention includes compounds wherein A^3 is phenyl, which is substituted with hydroxyl, methylaminocarbonyl or dimethylaminomethyl. An embodiment of the present invention includes compounds wherein A^3 is cyclopentyl. An embodiment of the present invention includes compounds wherein A^3 is morpholinyl. An embodiment of the present invention includes compounds wherein A^3 is pyrrolidinyl. An embodiment of the present invention includes compounds wherein A^3 is azetidinyl.

An embodiment of the present invention includes compounds wherein R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:

(1) hydrogen,
(2) halogen,
(3) hydroxyl,
(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl, phenyl or napthyl,
(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl,
(6) heteroaryl, wherein heteroaryl is selected from pyrrolyl, imidazolyl, indolyl, pyridyl, and pyrimidinyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,
(7) phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,
(8) -O-phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2, and
(9) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2.

An embodiment of the present invention includes compounds wherein R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:

(1) hydrogen,
(2) halogen,

(3) hydroxyl,
(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl or napthyl, and
(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl.

An embodiment of the present invention includes compounds wherein R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:
(1) hydrogen,
(2) halogen, and
(3) C_{1-6}alkyl.

An embodiment of the present invention includes compounds wherein R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:
(1) hydrogen,
(2) chloro,
(3) fluroro, and
(4) methyl.

An embodiment of the present invention includes compounds wherein A^1 is phenyl and R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:
(1) hydrogen,
(2) chloro,
(3) fluroro, and
(4) methyl.

An embodiment of the present invention includes compounds wherein R^{2a}, R^{2b} and R^{2c} are independently selected from the group consisting of:
(1) hydrogen,
(2) halogen,
(3) hydroxyl,
(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl or napthyl,
(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl,
(6) heteroaryl, wherein heteroaryl is selected from pyrrolyl, imidazolyl, indolyl, pyridyl, and pyrimidinyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,
(7) phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,

(8) -O-phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2, and

(9) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2.

An embodiment of the present invention includes compounds wherein R^{2a}, R^{2b} and R^{2c} are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl,

(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl, and

(6) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen.

An embodiment of the present invention includes compounds wherein R^{2a}, R^{2b} and R^{2c} are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) C_{1-6}alkyl, which is unsubstituted or substituted with halogen,

(4) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, and

(5) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen.

An embodiment of the present invention includes compounds wherein R^{2a}, R^{2b} and R^{2c} are independently selected from the group consisting of:

(1) hydrogen,

(2) chloro,

(3) fluoro,

(4) bromo,

(5) methoxy,

(6) t-butoxy,

(7) difluoromethyl, and

(8) trifluoromethyl,

(9) -N(CH_3).

An embodiment of the present invention includes compounds wherein A^2 is phenyl and R^{2a}, R^{2b} and R^{2c} are independently selected from the group consisting of:

(1) hydrogen,
(2) chloro,
(3) fluoro,
(4) bromo,
(5) methoxy,
(6) t-butoxy,
(7) difluoromethyl, and
(8) trifluoromethyl,
(9) -N(CH_3).

An embodiment of the present invention includes compounds wherein R^{3a}, R^{3b} and R^{3c} are independently selected from the group consisting of:

(1) hydrogen,
(2) halogen,
(3) hydroxyl,
(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl, phenyl or napthyl,
(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl,
(6) heteroaryl, wherein heteroaryl is selected from pyrrolyl, imidazolyl, indolyl, pyridyl, and pyrimidinyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,
(7) phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,
(8) -O-phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2, and
(9) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2.

An embodiment of the present invention includes compounds wherein R^{3a}, R^{3b} and R^{3c} are independently selected from the group consisting of:

(1) hydrogen,
(2) halogen,
(3) hydroxyl,
(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl or napthyl, and
(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl.

An embodiment of the present invention includes compounds wherein R^{3a}, R^{3b} and R^{3c} are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen, and

(3) C_{1-6}alkyl.

An embodiment of the present invention includes compounds wherein R^{3a}, R^{3b} and R^{3c} are independently selected from the group consisting of:

(1) hydrogen,

(2) chloro,

(3) fluroro, and

(4) methyl.

An embodiment of the present invention includes compounds wherein A^3 is pyridyl and wherein R^{3a} is halogen, R^{3b} is hydrogen and R^{3c} is hydrogen. An embodiment of the present invention includes compounds wherein A^3 is pyridyl and wherein R^{3a} is chloro or fluoro, R^{3b} is hydrogen and R^{3c} is hydrogen.

An embodiment of the present invention includes compounds wherein A^3 is pyrazolyl and wherein R^{3a} is C_{1-6}alkyl, R^{3b} is hydrogen and R^{3c} is hydrogen. An embodiment of the present invention includes compounds wherein A^3 is pyrazolyl and wherein R^{3a} is methyl, R^{3b} is hydrogen and R^{3c} is hydrogen.

An embodiment of the present invention includes compounds wherein R^4 is hydrogen or C_{1-6}alkyl. An embodiment of the present invention includes compounds wherein R^4 is hydrogen or methyl. An embodiment of the present invention includes compounds wherein R^4 is hydrogen. An embodiment of the present invention includes compounds wherein R^5 is hydrogen or C_{1-6}alkyl. An embodiment of the present invention includes compounds wherein R^5 is hydrogen or methyl. An embodiment of the present invention includes compounds wherein R^5 is hydrogen.

An embodiment of the present invention includes compounds wherein R^6 is hydrogen, C_{1-6}alkyl or C_{3-6}cycloalkyl. An embodiment of the present invention includes compounds wherein R^6 is C_{1-6}alkyl. An embodiment of the present invention includes compounds wherein R^6 is C_{3-6}cycloalkyl. An embodiment of the present invention includes compounds wherein R^6 is hydrogen, methyl or ethyl. An embodiment of the present invention includes compounds wherein R^6 is hydrogen.

Specific embodiments of the present invention include a compound which is selected from the group consisting of the subject compounds of the Examples herein or a pharmaceutically acceptable salt thereof.

The compounds of the present invention may contain one or more asymmetric centers and can thus occur as racemates and racemic mixtures, single enantiomers, diastereomeric mixtures and individual diastereomers. Additional asymmetric centers may be present depending upon the nature of the various substituents on the molecule. Each such asymmetric center will independently produce two optical isomers and it is intended that all of the possible optical isomers and diastereomers in mixtures and as pure or partially purified compounds are included within the ambit of this invention. The present invention is meant to comprehend all such isomeric forms of these compounds. Formula I shows the structure of the class of compounds without specific stereochemistry.

The independent syntheses of these diastereomers or their chromatographic separations may be achieved as known in the art by appropriate modification of the methodology disclosed herein. Their absolute stereochemistry may be determined by the x-ray crystallography of crystalline products or crystalline intermediates which are derivatized, if necessary, with a reagent containing an asymmetric center of known absolute configuration. If desired, racemic mixtures of the compounds may be separated so that the individual enantiomers are isolated. The separation can be carried out by methods well known in the art, such as the coupling of a racemic mixture of compounds to an enantiomerically pure compound to form a diastereomeric mixture, followed by separation of the individual diastereomers by standard methods, such as fractional crystallization or chromatography. The coupling reaction is often the formation of salts using an enantiomerically pure acid or base. The diasteromeric derivatives may then be converted to the pure enantiomers by cleavage of the added chiral residue. The racemic mixture of the compounds can also be separated directly by chromatographic methods utilizing chiral stationary phases, which methods are well known in the art. Alternatively, any enantiomer of a compound may be obtained by stereoselective synthesis using optically pure starting materials or reagents of known configuration by methods well known in the art.

As appreciated by those of skill in the art, halogen or halo as used herein are intended to include fluoro, chloro, bromo and iodo. Similarly, C_{1-6}, as in C_{1-6}alkyl is defined to identify the group as having 1, 2, 3, 4, 5 or 6 carbons in a linear or branched arrangement, such that C_{1-8}alkyl specifically includes methyl, ethyl, n-propyl, iso-propyl, n-butyl, iso-butyl, tert-butyl, pentyl, and hexyl. A group which is designated as being independently substituted with substituents may be independently substituted with multiple numbers of such substituents. The term "heterocycle" as used herein includes both unsaturated and saturated heterocyclic moieties, wherein the unsaturated heterocyclic moieties (i.e. "heteroaryl") include benzoimidazolyl, benzimidazolonyl, benzofuranyl, benzofurazanyl, benzopyrazolyl, benzothiazolyl, benzotriazolyl, benzothiophenyl, benzoxazepin, benzoxazolyl, carbazolyl, carbolinyl, cinnolinyl, furanyl, imidazolyl, indolinyl, indolyl, dihydroindolyl, indolazinyl,

indazolyl, isobenzofuranyl, isoindolyl, isoquinolyl, isothiazolyl, isoxazolyl, naphthpyridinyl, oxadiazolyl, oxazolyl, oxazoline, isoxazoline, oxetanyl, pyrazinyl, pyrazolyl, pyridazinyl, pyridopyridinyl, pyridazinyl, pyridyl, pyrimidyl, pyrrolyl, quinazolinyl, quinolyl, quinoxalinyl, tetrahydroquinoxalinyl, tetrazolyl, tetrazolopyridyl, thiadiazolyl, thiazolyl, thienyl, triazolyl, and N-oxides thereof, and wherein the saturated heterocyclic moieties include azetidinyl, 1,4-dioxanyl, hexahydroazepinyl, piperazinyl, piperidinyl, pyridin-2-onyl, pyrrolidinyl, morpholinyl, tetrahydrofuranyl, thiomorpholinyl, and tetrahydrothienyl, and N-oxides thereof.

The term "pharmaceutically acceptable salts" refers to salts prepared from pharmaceutically acceptable non-toxic bases or acids including inorganic or organic bases and inorganic or organic acids. Salts derived from inorganic bases include aluminum, ammonium, calcium, copper, ferric, ferrous, lithium, magnesium, manganic salts, manganous, potassium, sodium, zinc, and the like. Particular embodiments include the ammonium, calcium, magnesium, potassium, and sodium salts. Salts in the solid form may exist in more than one crystal structure, and may also be in the form of hydrates. Salts derived from pharmaceutically acceptable organic non-toxic bases include salts of primary, secondary, and tertiary amines, substituted amines including naturally occurring substituted amines, cyclic amines, and basic ion exchange resins, such as arginine, betaine, caffeine, choline, N,N'-dibenzylethylene-diamine, diethylamine, 2-diethylaminoethanol, 2-dimethylaminoethanol, ethanolamine, ethylenediamine, N-ethyl-morpholine, N-ethylpiperidine, glucamine, glucosamine, histidine, hydrabamine, isopropylamine, lysine, methylglucamine, morpholine, piperazine, piperidine, polyamine resins, procaine, purines, theobromine, triethylamine, trimethylamine, tripropylamine, tromethamine, and the like.

When the compound of the present invention is basic, salts may be prepared from pharmaceutically acceptable non-toxic acids, including inorganic and organic acids. Such acids include acetic, benzenesulfonic, benzoic, camphorsulfonic, citric, ethanesulfonic, fumaric, gluconic, glutamic, hydrobromic, hydrochloric, isethionic, lactic, maleic, malic, mandelic, methanesulfonic, mucic, nitric, pamoic, pantothenic, phosphoric, succinic, sulfuric, tartaric, p-toluenesulfonic acid, and the like. Particular embodiments include the citric, hydrobromic, hydrochloric, maleic, phosphoric, sulfuric, fumaric, and tartaric acids. It will be understood that, as used herein, references to the compounds of Formula I are meant to also include the pharmaceutically acceptable salts.

Exemplifying the invention is the use of the compounds disclosed in the Examples and herein. Specific compounds within the present invention include a compound which selected from the group consisting of the compounds disclosed in the following Examples and pharmaceutically acceptable salts thereof and individual enantiomers or diastereomers thereof.

The subject compounds are useful in a method of antagonizing orexin receptor activity in a patient such as a mammal in need of such inhibition comprising the administration of an effective amount of the compound. The present invention is directed to the use of the compounds disclosed herein as antagonists of orexin receptor activity. In addition to primates, especially humans, a variety of other mammals can be treated according to the method of the present invention. The present invention is directed to a compound of the present invention or a pharmaceutically acceptable salt thereof for use in medicine. The present invention is further directed to a use of a compound of the present invention or a pharmaceutically acceptable salt thereof for the manufacture of a medicament for antagonizing orexin receptor activity or treating the disorders and diseases noted herein in humans and animals.

The subject treated in the present methods is generally a mammal, such as a human being, male or female. The term "therapeutically effective amount" means the amount of the subject compound that will elicit the biological or medical response of a tissue, system, animal or human that is being sought by the researcher, veterinarian, medical doctor or other clinician. It is recognized that one skilled in the art may affect the neurological and psychiatric disorders by treating a patient presently afflicted with the disorders or by prophylactically treating a patient afflicted with the disorders with an effective amount of the compound of the present invention. As used herein, the terms "treatment" and "treating" refer to all processes wherein there may be a slowing, interrupting, arresting, controlling, or stopping of the progression of the neurological and psychiatric disorders described herein, but does not necessarily indicate a total elimination of all disorder symptoms, as well as the prophylactic therapy of the mentioned conditions, particularly in a patient who is predisposed to such disease or disorder. The terms "administration of" and or "administering a" compound should be understood to mean providing a compound of the invention or a prodrug of a compound of the invention to the individual in need thereof.

The term "composition" as used herein is intended to encompass a product 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. Such term in relation to pharmaceutical composition, is intended to encompass a product comprising the active ingredient(s), and the inert ingredient(s) that make up the carrier, as well as any product which results, directly or indirectly, from combination, complexation or aggregation of any two or more of the ingredients, or from dissociation of one or more of the ingredients, or from other types of reactions or interactions of one or more of the ingredients. Accordingly, the pharmaceutical compositions of the present invention encompass any composition made by admixing a compound of the present invention and a pharmaceutically acceptable carrier. By "pharmaceutically acceptable" it is meant the carrier, diluent or excipient

must be compatible with the other ingredients of the formulation and not deleterious to the recipient thereof.

The utility of the compounds in accordance with the present invention as orexin receptor OX1R and/or OX2R antagonists may be readily determined without undue experimentation by methodology well known in the art, including the "FLIPR Ca^{2+} Flux Assay" (Okumura et al., Biochem. Biophys. Res. Comm. 280:976-981, 2001). In a typical experiment the OX1 and OX2 receptor antagonistic activity of the compounds of the present invention was determined in accordance with the following experimental method. For intracellular calcium measurements, Chinese hamster ovary (CHO) cells expressing the rat orexin-1 receptor or the human orexin-2 receptor, are grown in Iscove's modified DMEM containing 2 mM L-glutamine, 0.5 g/ml G418, 1% hypoxanthine-thymidine supplement, 100 U/ml penicillin, 100 ug/ml streptomycin and 10 % heat-inactivated fetal calf serum (FCS). The cells are seeded at 20,000 cells / well into Becton-Dickinson black 384-well clear bottom sterile plates coated with poly-D-lysine. All reagents were from GIBCO-Invitrogen Corp. The seeded plates are incubated overnight at 37°C and 5% CO2. Ala-6,12 human orexin-A as the agonist is prepared as a 1 mM stock solution in 1% bovine serum albumin (BSA) and diluted in assay buffer (HBSS containing 20 mM HEPES, 0.1% BSA and 2.5mM probenecid, pH7.4) for use in the assay at a final concentration of 70pM. Test compounds are prepared as 10 mM stock solution in DMSO, then diluted in 384-well plates, first in DMSO, then assay buffer. On the day of the assay, cells are washed 3 times with 100 ul assay buffer and then incubated for 60 min (37° C, 5% CO2) in 60 ul assay buffer containing 1 uM Fluo-4AM ester, 0.02 % pluronic acid, and 1 % BSA. The dye loading solution is then aspirated and cells are washed 3 times with 100 ul assay buffer. 30 ul of that same buffer is left in each well. Within the Fluorescent Imaging Plate Reader (FLIPR, Molecular Devices), test compounds are added to the plate in a volume of 25 ul, incubated for 5 min and finally 25 ul of agonist is added. Fluorescence is measured for each well at 1 second intervals for 5 minutes and the height of each fluorescence peak is compared to the height of the fluorescence peak induced by 70 pM Ala-6,12 orexin-A with buffer in place of antagonist. For each antagonist, IC50 value (the concentration of compound needed to inhibit 50 % of the agonist response) is determined. Alternatively, compound potency can be assessed by a radioligand binding assay (described in Bergman et. al. Bioorg. Med. Chem. Lett. 2008, 18, 1425 - 1430) in which the inhibition constant (K_i) is determined in membranes prepared from CHO cells expressing either the OX1 or OX2 receptor. The intrinsic orexin receptor antagonist activity of a compound which may be used in the present invention may be determined by these assays.

In particular, the compounds of the following examples had activity in antagonizing the rat orexin-1 receptor and/or the human orexin-2 receptor in the aforementioned

assays, generally with an IC_{50} of less than about 50 μM. Many of compounds within the present invention had activity in antagonizing the rat orexin-1 receptor and/or the human orexin-2 receptor in the aforementioned assays with an IC_{50} of less than about 100 nM. Compounds of the present invention also have activity in the radioligand binding assay, generally with a Ki < 100 nM against the orexin-1 and/or the orexin-2 receptor. Additional data is provided in the following Examples. Such a result is indicative of the intrinsic activity of the compounds in use as antagonists of orexin-1 receptor and/or the orexin-2 receptor. In general, one of ordinary skill in the art would appreciate that a substance is considered to effectively antagonize the orexin receptor if it has an IC_{50} of less than about 50 μM, preferably less than about 100 nM. The present invention also includes compounds within the generic scope of the invention which possess activity as agonists of the orexin-1 receptor and/or the orexin-2 receptor. With respect to other pyridyl compounds, the present compounds exhibit unexpected properties, such as with respect to increased oral bioavailability, metabolic stability, decreased inhibition of metabolic enzymes (such as decreased cytochrome P450 3A4 (CYP3A4) inhibition), decreased inhibition of transporters (such as decreased p-glycoprotein/PGP inhibition) and/or selectivity with respect to other receptors, including the human orexin-2 receptor.

The orexin receptors have been implicated in a wide range of biological functions. This has suggested a potential role for these receptors in a variety of disease processes in humans or other species. The compounds of the present invention have utility in treating, preventing, ameliorating, controlling or reducing the risk of a variety of neurological and psychiatric disorders associated with orexin receptors, including one or more of the following conditions or diseases: sleep disorders, sleep disturbances, including enhancing sleep quality, improving sleep quality, increasing sleep efficiency, augmenting sleep maintenance; increasing the value which is calculated from the time that a subject sleeps divided by the time that a subject is attempting to sleep; improving sleep initiation; decreasing sleep latency or onset (the time it takes to fall asleep); decreasing difficulties in falling asleep; increasing sleep continuity; decreasing the number of awakenings during sleep; decreasing intermittent wakings during sleep; decreasing nocturnal arousals; decreasing the time spent awake following the initial onset of sleep; increasing the total amount of sleep; reducing the fragmentation of sleep; altering the timing, frequency or duration of REM sleep bouts; altering the timing, frequency or duration of slow wave (i.e. stages 3 or 4) sleep bouts; increasing the amount and percentage of stage 2 sleep; promoting slow wave sleep; enhancing EEG-delta activity during sleep; decreasing nocturnal arousals, especially early morning awakenings; increasing daytime alertness; reducing daytime drowsiness; treating or reducing excessive daytime sleepiness; increasing satisfaction with the intensity of sleep; increasing sleep maintenance; idiopathic

insomnia; sleep problems; insomnia, hypersomnia, idiopathic hypersomnia, repeatability hypersomnia, intrinsic hypersomnia, narcolepsy, interrupted sleep, sleep apnea, wakefulness, nocturnal myoclonus, REM sleep interruptions, jet-lag, shift workers' sleep disturbances, dyssomnias, night terror, insomnias associated with depression, emotional/mood disorders, Alzheimer's disease or cognitive impairment, as well as sleep walking and enuresis, and sleep disorders which accompany aging; Alzheimer's sundowning; conditions associated with circadian rhythmicity as well as mental and physical disorders associated with travel across time zones and with rotating shift-work schedules, conditions due to drugs which cause reductions in REM sleep as a side effect; fibromyalgia; syndromes which are manifested by non-restorative sleep and muscle pain or sleep apnea which is associated with respiratory disturbances during sleep; conditions which result from a diminished quality of sleep; increasing learning; augmenting memory; increasing retention of memory; eating disorders associated with excessive food intake and complications associated therewith, compulsive eating disorders, obesity (due to any cause, whether genetic or environmental), obesity-related disorders, overeating, anorexia, bulimia, cachexia, dysregulated appetite control, hypertension, diabetes, elevated plasma insulin concentrations and insulin resistance, dyslipidemias, hyperlipidemia, endometrial, breast, prostate and colon cancer, osteoarthritis, obstructive sleep apnea, cholelithiasis, gallstones, heart disease, lung disease, abnormal heart rhythms and arrythmias, myocardial infarction, congestive heart failure, coronary heart disease, acute and congestive heart failure; hypotension; hypertension; urinary retention; osteoporosis; angina pectoris; myocardinal infarction; ischemic or haemorrhagic stroke; subarachnoid haemorrhage; ulcers; allergies; benign prostatic hypertrophy; chronic renal failure; renal disease; impaired glucose tolerance; sudden death, polycystic ovary disease, craniopharyngioma, the Prader-Willi Syndrome, Frohlich's syndrome, GH-deficient subjects, normal variant short stature, Turner's syndrome, and other pathological conditions showing reduced metabolic activity or a decrease in resting energy expenditure as a percentage of total fat-free mass, e.g, children with acute lymphoblastic leukemia, metabolic syndrome, also known as syndrome X, insulin resistance syndrome, reproductive hormone abnormalities, sexual and reproductive dysfunction, such as impaired fertility, infertility, hypogonadism in males and hirsutism in females, fetal defects associated with maternal obesity, gastrointestinal motility disorders, intestinal motility dyskinesias, obesity-related gastro-esophageal reflux, hypothalmic diseases, hypophysis diseases, respiratory disorders, such as obesity-hypoventilation syndrome (Pickwickian syndrome), breathlessness, cardiovascular disorders, inflammation, such as systemic inflammation of the vasculature, arteriosclerosis, hypercholesterolemia, hyperuricaemia, lower back pain, gallbladder disease, gout, kidney cancer, increased anesthetic risk, reducing the risk of secondary outcomes of obesity, such as reducing the risk of left ventricular hypertrophy; diseases or disorders where abnormal

oscillatory activity occurs in the brain, including depression, migraine, neuropathic pain, Parkinson's disease, psychosis and schizophrenia, as well as diseases or disorders where there is abnormal coupling of activity, particularly through the thalamus; enhancing cognitive function, including cognitive dysfunctions that comprise deficits in all types of attention, learning and memory functions occuring transiently or chronically in the normal, healthy, young, adult or aging population, and also occurring transiently or chronically in psychiatric, neurologic, cardiovascular and immune disorders; enhancing memory; increasing memory retention; increasing immune response; increasing immune function; hot flashes; night sweats; extending life span; schizophrenia; muscle-related disorders that are controlled by the excitation/relaxation rhythms imposed by the neural system such as cardiac rhythm and other disorders of the cardiovascular system; conditions related to proliferation of cells such as vasodilation or vasorestriction and blood pressure; cancer; cardiac arrhythmia; hypertension; congestive heart failure; conditions of the genital/urinary system; disorders of sexual function and fertility; sexual dysfunction; psychosexual dysfunction; sex disorder; adequacy of renal function; responsivity to anesthetics; mood disorders, such as depression or more particularly depressive disorders, for example, single episodic or recurrent major depressive disorders and dysthymic disorders, or bipolar disorders, for example, bipolar I disorder, bipolar II disorder and cyclothymic disorder, mood disorders due to a general medical condition, and substance-induced mood disorders; affective neurosis; depressive neurosis; anxiety neurosis; anxiety disorders including acute stress disorder, agoraphobia, generalized anxiety disorder, obsessive-compulsive disorder, panic attack, panic disorder, post-traumatic stress disorder, separation anxiety disorder, social phobia, specific phobia, substance-induced anxiety disorder and anxiety due to a general medical condition; acute neurological and psychiatric disorders such as cerebral deficits subsequent to cardiac bypass surgery and grafting, stroke, ischemic stroke, cerebral ischemia, spinal cord trauma, head trauma, perinatal hypoxia, cardiac arrest, hypoglycemic neuronal damage; Huntington's Chorea; Huntington's disease and Tourette syndrome; Cushing's syndrome/disease; basophile adenoma; prolactinoma; hyperprolactinemia; hypophysis tumour/adenoma; hypothalamic diseases; inflammatory bowel disease; gastric diskinesia; gastric ulcers; Froehlich's syndrome; adrenohypophysis disease; hypophysis disease; adrenohypophysis hypofunction; adrenohypophysis hyperfunction; hypothalamic hypogonadism; Kallman's syndrome (anosmia, hyposmia); functional or psychogenic amenorrhea; hypopituitarism; hypothalamic hypothyroidism; hypothalamic- adrenal dysfunction; idiopathic hyperprolactinemia; hypothalamic disorders of growth hormone deficiency; idiopathic growth deficiency; dwarfism; gigantism; acromegaly; amyotrophic lateral sclerosis; multiple sclerosis; ocular damage; retinopathy; cognitive disorders; idiopathic and drug-induced Parkinson's disease; muscular spasms and disorders associated with muscular spasticity including tremors, epilepsy,

convulsions, seizure disorders, absence seisures, complex partial and generalized seizures; Lennox-Gastaut syndrome; cognitive disorders including dementia (associated with Alzheimer's disease, ischemia, trauma, vascular problems or stroke, HIV disease, Parkinson's disease, Huntington's disease, Pick's disease, Creutzfeldt-Jacob disease, perinatal hypoxia, other general medical conditions or substance abuse); delirium, amnestic disorders or age related cognitive decline; schizophrenia or psychosis including schizophrenia (paranoid, disorganized, catatonic or undifferentiated), schizophreniform disorder, schizoaffective disorder, delusional disorder, brief psychotic disorder, shared psychotic disorder, psychotic disorder due to a general medical condition and substance-induced psychotic disorder; dissociateive disorders including multiple personality syndromes and psychogenic amnesias; substance-related disorders, substance use, substance abuse, substance seeking, substance reinstatement, all types of psychological and physical addictions and addictive behaviors, reward-related behaviors (including substance-induced delirium, persisting dementia, persisting amnestic disorder, psychotic disorder or anxiety disorder; tolerance, addictive feeding, addictive feeding behaviors, binge/purge feeding behaviors, dependence, withdrawal or relapse from substances including alcohol, amphetamines, cannabis, cocaine, hallucinogens, inhalants, morphine, nicotine, opioids, phencyclidine, sedatives, hypnotics or anxiolytics); appetite, taste, eating or drinking disorders; movement disorders, including akinesias and akinetic-rigid syndromes (including Parkinson's disease, drug-induced parkinsonism, postencephalitic parkinsonism, progressive supranuclear palsy, multiple system atrophy, corticobasal degeneration, parkinsonism-ALS dementia complex and basal ganglia calcification), chronic fatigue syndrome, fatigue, including Parkinson's fatigue, multiple sclerosis fatigue, fatigue caused by a sleep disorder or a circadian rhythm disorder, medication-induced parkinsonism (such as neuroleptic-induced parkinsonism, neuroleptic malignant syndrome, neuroleptic-induced acute dystonia, neuroleptic-induced acute akathisia, neuroleptic-induced tardive dyskinesia and medication-induced postural tremor), Gilles de la Tourette's syndrome, epilepsy, and dyskinesias [including tremor (such as rest tremor, essential tremor, postural tremor and intention tremor), chorea (such as Sydenham's chorea, Huntington's disease, benign hereditary chorea, neuroacanthocytosis, symptomatic chorea, drug-induced chorea and hemiballism), myoclonus (including generalised myoclonus and focal myoclonus), tics (including simple tics, complex tics and symptomatic tics), restless leg syndrome and dystonia (including generalised dystonia such as iodiopathic dystonia, drug-induced dystonia, symptomatic dystonia and paroxymal dystonia, and focal dystonia such as blepharospasm, oromandibular dystonia, spasmodic dysphonia, spasmodic torticollis, axial dystonia, dystonic writer's cramp and hemiplegic dystonia); neurodegenerative disorders including nosological entities such as disinhibition-dementia-parkinsonism-amyotrophy complex; pallido-ponto-nigral degeneration; epilepsy; seizure disorders; attention deficit/hyperactivity disorder (ADHD);

conduct disorder; migraine (including migraine headache); headache; hyperalgesia; pain; enhanced or exaggerated sensitivity to pain such as hyperalgesia, causalgia, and allodynia; acute pain; burn pain; atypical facial pain; neuropathic pain; back pain; complex regional pain syndrome I and II; arthritic pain; sports injury pain; pain related to infection e.g. HIV, post-chemotherapy pain; post-stroke pain; post-operative pain; neuralgia; emesis, nausea, vomiting; gastric dyskinesia; gastric ulcers; Kallman's syndrome (anosmia); asthma; cancer; conditions associated with visceral pain such as irritable bowel syndrome, and angina; eating disorders; urinary incontinence; substance tolerance, substance withdrawal (including, substances such as opiates, nicotine, tobacco products, alcohol, benzodiazepines, cocaine, sedatives, hypnotics, etc.); psychosis; schizophrenia; anxiety (including generalized anxiety disorder, panic disorder, and obsessive compulsive disorder); mood disorders (including depression, mania, bipolar disorders); trigeminal neuralgia; hearing loss; tinnitus; neuronal damage including ocular damage; retinopathy; macular degeneration of the eye; emesis; brain edema; pain, including acute and chronic pain states, severe pain, intractable pain, inflammatory pain, neuropathic pain, post-traumatic pain, bone and joint pain (osteoarthritis), repetitive motion pain, dental pain, cancer pain, myofascial pain (muscular injury, fibromyalgia), perioperative pain (general surgery, gynecological), chronic pain, neuropathic pain, post-traumatic pain, trigeminal neuralgia, migraine and migraine headache and other diseases related to general orexin system dysfunction.

Thus, in specific embodiments the present invention provides methods for: enhancing the quality of sleep; augmenting sleep maintenance; increasing REM sleep; increasing stage 2 sleep; decreasing fragmentation of sleep patterns; treating insomnia and all types of sleep disorders; treating or controlling sleep disturbances associated with diseases such as neurological disorders including neuropathic pain and restless leg syndrome; treating or controlling addiction disorders; treating or controlling psychoactive substance use and abuse; enhancing cognition; increasing memory retention; treating or controlling obesity; treating or controlling diabetes and appetite, taste, eating, or drinking disorders; treating or controlling hypothalamic diseases; treating or controlling depression; treating, controlling, ameliorating or reducing the risk of epilepsy, including absence epilepsy; treating or controlling pain, including neuropathic pain; treating or controlling Parkinson's disease; treating or controlling psychosis; treating or controlling dysthymic, mood, psychotic and anxiety disorders; treating or controlling depression, including major depression and major dperession disorder; treating or controlling bipolar disorder; or treating, controlling, ameliorating or reducing the risk of schizophrenia, in a mammalian patient in need thereof which comprises administering to the patient a therapeutically effective amount of a compound of the present invention.

The subject compounds are further useful in a method for the prevention, treatment, control, amelioration, or reduction of risk of the diseases, disorders and conditions noted herein. The dosage of active ingredient in the compositions of this invention may be varied, however, it is necessary that the amount of the active ingredient be such that a suitable dosage form is obtained. The active ingredient may be administered to patients (animals and human) in need of such treatment in dosages that will provide optimal pharmaceutical efficacy. The selected dosage depends upon the desired therapeutic effect, on the route of administration, and on the duration of the treatment. The dose will vary from patient to patient depending upon the nature and severity of disease, the patient's weight, special diets then being followed by a patient, concurrent medication, and other factors which those skilled in the art will recognize. Generally, dosage levels of between 0.0001 to 10 mg/kg. of body weight daily are administered to the patient, e.g., humans and elderly humans, to obtain effective antagonism of orexin receptors. The dosage range will generally be about 0.5 mg to 1.0 g. per patient per day which may be administered in single or multiple doses. In one embodiment, the dosage range will be about 0.5 mg to 500 mg per patient per day; in another embodiment about 0.5 mg to 200 mg per patient per day; and in yet another embodiment about 5 mg to 50 mg per patient per day. Pharmaceutical compositions of the present invention may be provided in a solid dosage formulation such as comprising about 0.5 mg to 500 mg active ingredient, or comprising about 1 mg to 250 mg active ingredient. The pharmaceutical composition may be provided in a solid dosage formulation comprising about 1 mg, 5 mg, 10 mg, 25 mg, 30 mg, 50 mg, 80 mg, 100 mg, 200 mg or 250 mg active ingredient. For oral administration, the compositions may be provided in the form of tablets containing 1.0 to 1000 milligrams of the active ingredient, such as 1, 5, 10, 15, 20, 25, 50, 75, 100, 150, 200, 250, 300, 400, 500, 600, 750, 800, 900, and 1000 milligrams of the active ingredient for the symptomatic adjustment of the dosage to the patient to be treated. The compounds may be administered on a regimen of 1 to 4 times per day, such as once or twice per day. The compounds may be administered before bedtime. For example, the compounds may be administered about 1Hour prior to bedtime, about 30 minutes prior to bedtime or immediately before bedtime.

The compounds of the present invention may be used in combination with one or more other drugs in the treatment, prevention, control, amelioration, or reduction of risk of diseases or conditions for which compounds of the present invention or the other drugs may have utility, where the combination of the drugs together are safer or more effective than either drug alone. Such other drug(s) may be administered, by a route and in an amount commonly used therefor, contemporaneously or sequentially with a compound of the present invention. When a compound of the present invention is used contemporaneously with one or more other drugs, a pharmaceutical composition in unit dosage form containing such other drugs and the compound

of the present invention is contemplated. However, the combination therapy may also includes therapies in which the compound of the present invention and one or more other drugs are administered on different overlapping schedules. It is also contemplated that when used in combination with one or more other active ingredients, the compounds of the present invention and the other active ingredients may be used in lower doses than when each is used singly. Accordingly, the pharmaceutical compositions of the present invention include those that contain one or more other active ingredients, in addition to a compound of the present invention. The above combinations include combinations of a compound of the present invention not only with one other active compound, but also with two or more other active compounds.

Likewise, compounds of the present invention may be used in combination with other drugs that are used in the prevention, treatment, control, amelioration, or reduction of risk of the diseases or conditions for which compounds of the present invention are useful. Such other drugs may be administered, by a route and in an amount commonly used therefor, contemporaneously or sequentially with a compound of the present invention. When a compound of the present invention is used contemporaneously with one or more other drugs, a pharmaceutical composition containing such other drugs in addition to the compound of the present invention is contemplated. Accordingly, the pharmaceutical compositions of the present invention include those that also contain one or more other active ingredients, in addition to a compound of the present invention.

The weight ratio of the compound of the compound of the present invention to the second active ingredient may be varied and will depend upon the effective dose of each ingredient. Generally, an effective dose of each will be used. Thus, for example, when a compound of the present invention is combined with another agent, the weight ratio of the compound of the present invention to the other agent will generally range from about 1000:1 to about 1:1000, such as about 200:1 to about 1:200. Combinations of a compound of the present invention and other active ingredients will generally also be within the aforementioned range, but in each case, an effective dose of each active ingredient should be used. In such combinations the compound of the present invention and other active agents may be administered separately or in conjunction. In addition, the administration of one element may be prior to, concurrent to, or subsequent to the administration of other agent(s).

The compounds of the present invention may be administered in conbination with other compounds which are known in the art to be useful for enhancing sleep quality and preventing and treating sleep disorders and sleep disturbances, including e.g., sedatives, hypnotics, anxiolytics, antipsychotics, antianxiety agents, antihistamines, benzodiazepines, barbiturates, cyclopyrrolones, GABA agonists, 5HT-2 antagonists including 5HT-2A antagonists and 5HT-2A/2C antagonists, histamine antagonists including histamine H3 antagonists,

histamine H3 inverse agonists, imidazopyridines, minor tranquilizers, melatonin agonists and antagonists, melatonergic agents, other orexin antagonists, orexin agonists, prokineticin agonists and antagonists, pyrazolopyrimidines, T-type calcium channel antagonists, triazolopyridines, and the like, such as: adinazolam, allobarbital, alonimid, alprazolam, amitriptyline, amobarbital, amoxapine, armodafinil, APD-125, bentazepam, benzoctamine, brotizolam, bupropion, busprione, butabarbital, butalbital, capromorelin, capuride, carbocloral, chloral betaine, chloral hydrate, chlordiazepoxide, clomipramine, clonazepam, cloperidone, clorazepate, clorethate, clozapine, conazepam, cyprazepam, desipramine, dexclamol, diazepam, dichloralphenazone, divalproex, diphenhydramine, doxepin, EMD-281014, eplivanserin, estazolam, eszopiclone, ethchlorynol, etomidate, fenobam, flunitrazepam, flurazepam, fluvoxamine, fluoxetine, fosazepam, gaboxadol, glutethimide, halazepam, hydroxyzine, ibutamoren, imipramine, indiplon, lithium, lorazepam, lormetazepam, LY-156735, maprotiline, MDL-100907, mecloqualone, melatonin, mephobarbital, meprobamate, methaqualone, methyprylon, midaflur, midazolam, modafinil, nefazodone, NGD-2-73, nisobamate, nitrazepam, nortriptyline, ornortriptyline, oxazepam, paraldehyde, paroxetine, pentobarbital, perlapine, perphenazine, phenelzine, phenobarbital, prazepam, promethazine, propofol, protriptyline, quazepam, ramelteon, reclazepam, roletamide, secobarbital, sertraline, suproclone, TAK-375, temazepam, thioridazine, tiagabine, tracazolate, tranylcypromaine, trazodone, triazolam, trepipam, tricetamide, triclofos, trifluoperazine, trimetozine, trimipramine, uldazepam, venlafaxine, zaleplon, zolazepam, zopiclone, zolpidem, and salts thereof, and combinations thereof, and the like, or the compound of the present invention may be administered in conjunction with the use of physical methods such as with light therapy or electrical stimulation.

In another embodiment, the subject compound may be employed in combination with other compounds which are known in the art, either administered separately or in the same pharmaceutical compositions, include, but are not limited to: insulin sensitizers including (i) PPARγ antagonists such as glitazones (e.g. ciglitazone; darglitazone; englitazone; isaglitazone (MCC-555); pioglitazone; rosiglitazone; troglitazone; tularik; BRL49653; CLX-0921; 5-BTZD), GW-0207, LG-100641, and LY-300512, and the like); (iii) biguanides such as metformin and phenformin; (b) insulin or insulin mimetics, such as biota, LP-100, novarapid, insulin detemir, insulin lispro, insulin glargine, insulin zinc suspension (lente and ultralente); Lys-Pro insulin, GLP-1 (73-7) (insulintropin); and GLP-1 (7-36)-NH_2); (c) sulfonylureas, such as acetohexamide; chlorpropamide; diabinese; glibenclamide; glipizide; glyburide; glimepiride; gliclazide; glipentide; gliquidone; glisolamide; tolazamide; and tolbutamide; (d) α-glucosidase inhibitors, such as acarbose, adiposine; camiglibose; emiglitate; miglitol; voglibose; pradimicin-Q; salbostatin; CKD-711; MDL-25,637; MDL-73,945; and MOR 14, and the like; (e) cholesterol lowering agents such as (i) HMG-CoA reductase inhibitors (atorvastatin, itavastatin, fluvastatin,

lovastatin, pravastatin, rivastatin, rosuvastatin, simvastatin, and other statins), (ii) bile acid absorbers/sequestrants, such as cholestyramine, colestipol, dialkylaminoalkyl derivatives of a cross-linked dextran; Colestid®; LoCholest®, and the like, (ii) nicotinyl alcohol, nicotinic acid or a salt thereof, (iii) proliferator-activater receptor α agonists such as fenofibric acid derivatives (gemfibrozil, clofibrate, fenofibrate and benzafibrate), (iv) inhibitors of cholesterol absorption such as stanol esters, beta-sitosterol, sterol glycosides such as tiqueside; and azetidinones such as ezetimibe, and the like, and (acyl CoA:cholesterol acyltransferase (ACAT)) inhibitors such as avasimibe, and melinamide, (v) anti-oxidants, such as probucol, (vi) vitamin E, and (vii) thyromimetics; (f) PPARα agonists such as beclofibrate, benzafibrate, ciprofibrate, clofibrate, etofibrate, fenofibrate, and gemfibrozil; and other fibric acid derivatives, such as Atromid®, Lopid® and Tricor®, and the like, and PPARα agonists as described in WO 97/36579; (g) PPARδ agonists, such as those disclosed in WO97/28149; (h) PPAR α/δ agonists, such as muraglitazar, and the compounds disclosed in US 6,414,002; (i) anti-obesity agents, such as (1) growth hormone secretagogues, growth hormone secretagogue receptor agonists/antagonists, such as NN703, hexarelin, MK-0677, SM-130686, CP-424,391, L-692,429, and L-163,255, and such as those disclosed in U.S. Patent Nos. 5,536,716, and 6,358,951, U.S. Patent Application Nos. 2002/049196 and 2002/022637, and PCT Application Nos. WO 01/56592 and WO 02/32888; (2) protein tyrosine phosphatase-1B (PTP-1B) inhibitors; (3) cannabinoid receptor ligands, such as cannabinoid CB_1 receptor antagonists or inverse agonists, such as rimonabant, taranabant, AMT-251, and SR-14778 and SR 141716A (Sanofi Synthelabo), SLV-319 (Solvay), BAY 65-2520 (Bayer) and those disclosed in U.S. Patent Nos. 5,532,237, 4,973,587, 5,013,837, 5,081,122, 5,112,820, 5,292,736, 5,624,941, 6,028,084, PCT Application Nos. WO 96/33159, WO 98/33765, WO98/43636, WO98/43635, WO 01/09120, WO98/31227, WO98/41519, WO98/37061, WO00/10967, WO00/10968, WO97/29079, WO99/02499, WO 01/58869, WO 01/64632, WO 01/64633, WO 01/64634, W002/076949, WO 03/007887, WO 04/048317, and WO 05/000809; (4) anti-obesity serotonergic agents, such as fenfluramine, dexfenfluramine, phentermine, and sibutramine; (5) β3-adrenoreceptor agonists, such as AD9677/TAK677 (Dainippon/Takeda), CL-316,243, SB 418790, BRL-37344, L-796568, BMS-196085, BRL-35135A, CGP12177A, BTA-243, Trecadrine, Zeneca D7114, SR 59119A; (6) pancreatic lipase inhibitors, such as orlistat (Xenical®), Triton WR1339, RHC80267, lipstatin, tetrahydrolipstatin, teasaponin, diethylumbelliferyl phosphate, and those disclosed in PCT Application No. WO 01/77094; (7) neuropeptide Y1 antagonists, such as BIBP3226, J-115814, BIBO 3304, LY-357897, CP-671906, GI-264879A, and those disclosed in U.S. Patent No. 6,001,836, and PCT Patent Publication Nos. WO 96/14307, WO 01/23387, WO 99/51600, WO 01/85690, WO 01/85098, WO 01/85173, and WO 01/89528; (8) neuropeptide Y5 antagonists, such as GW-569180A, GW-594884A, GW-587081X, GW-548118X, FR226928, FR 240662, FR252384,

1229U91, GI-264879A, CGP71683A, LY-377897, PD-160170, SR-120562A, SR-120819A and JCF-104, and those disclosed in U.S. Patent Nos. 6,057,335; 6,043,246; 6,140,354; 6,166,038; 6,180,653; 6,191,160; 6,313,298; 6,335,345; 6,337,332; 6,326,375; 6,329,395; 6,340,683; 6,388,077; 6,462,053; 6,649,624; and 6,723,847, European Patent Nos. EP-01010691, and EP-01044970; and PCT International Patent Publication Nos. WO 97/19682, WO 97/20820, WO 97/20821, WO 97/20822, WO 97/20823, WO 98/24768; WO 98/25907; WO 98/25908; WO 98/27063, WO 98/47505; WO 98/40356; WO 99/15516; WO 99/27965; WO 00/64880, WO 00/68197, WO 00/69849, WO 01/09120, WO 01/14376; WO 01/85714, WO 01/85730, WO 01/07409, WO 01/02379, WO 01/02379, WO 01/23388, WO 01/23389, WO 01/44201, WO 01/62737, WO 01/62738, WO 01/09120, WO 02/22592, WO 0248152, and WO 02/49648; WO 02/094825; WO 03/014083; WO 03/10191; WO 03/092889; WO 04/002986; and WO 04/031175; (9) melanin-concentrating hormone (MCH) receptor antagonists, such as those disclosed in WO 01/21577 and WO 01/21169; (10) melanin-concentrating hormone 1 receptor (MCH1R) antagonists, such as T-226296 (Takeda), and those disclosed in PCT Patent Application Nos. WO 01/82925, WO 01/87834, WO 02/051809, WO 02/06245, WO 02/076929, WO 02/076947, WO 02/04433, WO 02/51809, WO 02/083134, WO 02/094799, WO 03/004027; (11) melanin-concentrating hormone 2 receptor (MCH2R) agonist/antagonists; (12) orexin receptor antagonists, such as SB-334867-A, and those disclosed in patent publications herein; (13) serotonin reuptake inhibitors such as fluoxetine, paroxetine, and sertraline; (14) melanocortin agonists, such as Melanotan II; (15) Mc4r (melanocortin 4 receptor) agonists, such as CHIR86036 (Chiron), ME-10142, and ME-10145 (Melacure), CHIR86036 (Chiron); PT-141, and PT-14 (Palatin); (16) 5HT-2 agonists; (17) 5HT2C (serotonin receptor 2C) agonists, such as BVT933, DPCA37215, WAY161503, R-1065, and those disclosed in U.S. Patent No. 3,914,250, and PCT Application Nos. WO 02/36596, WO 02/48124, WO 02/10169, WO 01/66548, WO 02/44152, WO 02/51844, WO 02/40456, and WO 02/40457; (18) galanin antagonists; (19) CCK agonists; (20) CCK-A (cholecystokinin-A) agonists, such as AR-R 15849, GI 181771, JMV-180, A-71378, A-71623 and SR14613, and those discribed in U.S. Patent No. 5,739,106; (21) GLP-1 agonists; (22) corticotropin-releasing hormone agonists; (23) histamine receptor-3 (H3) modulators; (24) histamine receptor-3 (H3) antagonists/inverse agonists, such as hioperamide, 3-(1H-imidazol-4-yl)propyl N-(4-pentenyl)carbamate, clobenpropit, iodophenpropit, imoproxifan, GT2394 (Gliatech), and O-[3-(1H-imidazol-4-yl)propanol]-carbamates; (25) β-hydroxy steroid dehydrogenase-1 inhibitors (β-HSD-1); (26) PDE (phosphodiesterase) inhibitors, such as theophylline, pentoxifylline, zaprinast, sildenafil, amrinone, milrinone, cilostamide, rolipram, and cilomilast; (27) phosphodiesterase-3B (PDE3B) inhibitors; (28) NE (norepinephrine) transport inhibitors, such as GW 320659, despiramine, talsupram, and nomifensine; (29) ghrelin receptor antagonists, such as those disclosed in PCT Application Nos. WO 01/87335, and WO

02/08250; (30) leptin, including recombinant human leptin (PEG-OB, Hoffman La Roche) and recombinant methionyl human leptin (Amgen); (31) leptin derivatives; (32) BRS3 (bombesin receptor subtype 3) agonists such as [D-Phe6,beta-Ala11,Phe13,Nle14]Bn(6-14) and [D-Phe6,Phe13]Bn(6-13)propylamide, and those compounds disclosed in Pept. Sci. 2002 Aug; 8(8): 461-75); (33) CNTF (Ciliary neurotrophic factors), such as GI-181771 (Glaxo-SmithKline), SR146131 (Sanofi Synthelabo), butabindide, PD170,292, and PD 149164 (Pfizer); (34) CNTF derivatives, such as axokine (Regeneron); (35) monoamine reuptake inhibitors, such as sibutramine; (36) UCP-1 (uncoupling protein-1), 2, or 3 activators, such as phytanic acid, 4-[(E)-2-(5,6,7,8-tetrahydro-5,5,8,8-tetramethyl-2-napthalenyl)-1-propenyl]benzoic acid (TTNPB), retinoic acid; (37) thyroid hormone β agonists, such as KB-2611 (KaroBioBMS); (38) FAS (fatty acid synthase) inhibitors, such as Cerulenin and C75; (39) DGAT1 (diacylglycerol acyltransferase 1) inhibitors; (40) DGAT2 (diacylglycerol acyltransferase 2) inhibitors; (41) ACC2 (acetyl-CoA carboxylase-2) inhibitors; (42) glucocorticoid antagonists; (43) acyl-estrogens, such as oleoyl-estrone, disclosed in del Mar-Grasa, M. et al., Obesity Research, 9:202-9 (2001); (44) dipeptidyl peptidase IV (DP-IV) inhibitors, such as isoleucine thiazolidide, valine pyrrolidide, NVP-DPP728, LAF237, P93/01, TSL 225, TMC-2A/2B/2C, FE 999011, P9310/K364, VIP 0177, SDZ 274-444, sitagliptin; and the compounds disclosed in US 6,699,871, WO 03/004498; WO 03/004496; EP 1 258 476; WO 02/083128; WO 02/062764; WO 03/000250; WO 03/002530; WO 03/002531; WO 03/002553; WO 03/002593; WO 03/000180; and WO 03/000181; (46) dicarboxylate transporter inhibitors; (47) glucose transporter inhibitors; (48) phosphate transporter inhibitors; (49) Metformin (Glucophage®); (50) Topiramate (Topimax®); (50) peptide YY, PYY 3-36, peptide YY analogs, derivatives, and fragments such as BIM-43073D, BIM-43004C (Olitvak, D.A. et al., Dig. Dis. Sci. 44(3):643-48 (1999)); (51) Neuropeptide Y2 (NPY2) receptor agonists such NPY3-36, N acetyl [Leu(28,31)] NPY 24-36, TASP-V, and cyclo-(28/32)-Ac-[Lys28-Glu32]-(25-36)-pNPY; (52) Neuropeptide Y4 (NPY4) agonists such as pancreatic peptide (PP), and other Y4 agonists such as 1229U91; (54) cyclooxygenase-2 inhibitors such as etoricoxib, celecoxib, valdecoxib, parecoxib, lumiracoxib, BMS347070, tiracoxib or JTE522, ABT963, CS502 and GW406381; (55) Neuropeptide Y1 (NPY1) antagonists such as BIBP3226, J-115814, BIBO 3304, LY-357897, CP-671906, GI-264879A; (56) Opioid antagonists such as nalmefene (Revex ®), 3-methoxynaltrexone, naloxone, naltrexone; (57) 11β HSD-1 (11-beta hydroxy steroid dehydrogenase type 1) inhibitors such as BVT 3498, BVT 2733, and those disclosed in WO 01/90091, WO 01/90090, WO 01/90092, US 6,730,690 and US 2004-0133011; (58) aminorex; (59) amphechloral; (60) amphetamine; (61) benzphetamine; (62) chlorphentermine; (63) clobenzorex; (64) cloforex; (65) clominorex; (66) clortermine; (67) cyclexedrine; (68) dextroamphetamine; (69) diphemethoxidine, (70) N-ethylamphetamine; (71) fenbutrazate; (72) fenisorex; (73)

fenproporex; (74) fludorex; (75) fluminorex; (76) furfurylmethylamphetamine; (77) levamfetamine; (78) levophacetoperane; (79) mefenorex; (80) metamfepramone; (81) methamphetamine; (82) norpseudoephedrine; (83) pentorex; (84) phendimetrazine; (85) phenmetrazine; (86) picilorex; (87) phytopharm 57; and (88) zonisamide., (89) neuromedin U and analogs or derivatives thereof, (90) oxyntomodulin and analogs or derivatives thereof, and (91) Neurokinin-1 receptor antagonists (NK-1 antagonists) such as the compounds disclosed in: U.S. Patent Nos. 5,162,339, 5,232,929, 5,242,930, 5,373,003, 5,387,595, 5,459,270, 5,494,926, 5,496,833, and 5,637,699.

In another embodiment, the subject compound may be employed in combination with an anti-depressant or anti-anxiety agent, including norepinephrine reuptake inhibitors (including tertiary amine tricyclics and secondary amine tricyclics), selective serotonin reuptake inhibitors (SSRIs), monoamine oxidase inhibitors (MAOIs), reversible inhibitors of monoamine oxidase (RIMAs), serotonin and noradrenaline reuptake inhibitors (SNRIs), corticotropin releasing factor (CRF) antagonists, α-adrenoreceptor antagonists, neurokinin-1 receptor antagonists, atypical anti-depressants, benzodiazepines, 5-HT_{1A} agonists or antagonists, especially 5-HT_{1A} partial agonists, and corticotropin releasing factor (CRF) antagonists. Specific agents include: amitriptyline, clomipramine, doxepin, imipramine and trimipramine; amoxapine, desipramine, maprotiline, nortriptyline and protriptyline; citalopram, duloxetine, fluoxetine, fluvoxamine, paroxetine and sertraline; isocarboxazid, phenelzine, tranylcypromine and selegiline; moclobemide: venlafaxine; aprepitant; bupropion, lithium, nefazodone, trazodone and viloxazine; alprazolam, chlordiazepoxide, clonazepam, chlorazepate, diazepam, halazepam, lorazepam, oxazepam and prazepam; buspirone, flesinoxan, gepirone and ipsapirone, and pharmaceutically acceptable salts thereof.

In another embodiment, the subject compound may be employed in combination with anti-Alzheimer's agents; beta-secretase inhibitors; gamma-secretase inhibitors; growth hormone secretagogues; recombinant growth hormone; HMG-CoA reductase inhibitors; NSAID's including ibuprofen; vitamin E; anti-amyloid antibodies; CB-1 receptor antagonists or CB-1 receptor inverse agonists; antibiotics such as doxycycline and rifampin; N-methyl-D-aspartate (NMDA) receptor antagonists, such as memantine; cholinesterase inhibitors such as galantamine, rivastigmine, donepezil, and tacrine; growth hormone secretagogues such as ibutamoren, ibutamoren mesylate, and capromorelin; histamine H_3 antagonists; AMPA agonists; PDE IV inhibitors; $GABA_A$ inverse agonists; or neuronal nicotinic agonists.

In another embodiment, the subject compound may be employed in combination with sedatives, hypnotics, anxiolytics, antipsychotics, antianxiety agents, cyclopyrrolones, imidazopyridines, pyrazolopyrimidines, minor tranquilizers, melatonin agonists and antagonists, melatonergic agents, benzodiazepines, barbiturates, 5HT-2 antagonists, and the like, such as:

adinazolam, allobarbital, alonimid, alprazolam, amitriptyline, amobarbital, amoxapine, bentazepam, benzoctamine, brotizolam, bupropion, busprione, butabarbital, butalbital, capuride, carbocloral, chloral betaine, chloral hydrate, chlordiazepoxide, clomipramine, clonazepam, cloperidone, clorazepate, clorethate, clozapine, cyprazepam, desipramine, dexclamol, diazepam, dichloralphenazone, divalproex, diphenhydramine, doxepin, estazolam, ethchlorvynol, etomidate, fenobam, flunitrazepam, flurazepam, fluvoxamine, fluoxetine, fosazepam, glutethimide, halazepam, hydroxyzine, imipramine, lithium, lorazepam, lormetazepam, maprotiline, mecloqualone, melatonin, mephobarbital, meprobamate, methaqualone, midaflur, midazolam, nefazodone, nisobamate, nitrazepam, nortriptyline, oxazepam, paraldehyde, paroxetine, pentobarbital, perlapine, perphenazine, phenelzine, phenobarbital, prazepam, promethazine, propofol, protriptyline, quazepam, reclazepam, roletamide, secobarbital, sertraline, suproclone, temazepam, thioridazine, tracazolate, tranylcypromaine, trazodone, triazolam, trepipam, tricetamide, triclofos, trifluoperazine, trimetozine, trimipramine, uldazepam, venlafaxine, zaleplon, zolazepam, zolpidem, and salts thereof, and combinations thereof, and the like, or the subject compound may be administered in conjunction with the use of physical methods such as with light therapy or electrical stimulation.

In another embodiment, the subject compound may be employed in combination with levodopa (with or without a selective extracerebral decarboxylase inhibitor such as carbidopa or benserazide), anticholinergics such as biperiden (optionally as its hydrochloride or lactate salt) and trihexyphenidyl (benzhexol) hydrochloride, COMT inhibitors such as entacapone, MOA-B inhibitors, antioxidants, A2a adenosine receptor antagonists, cholinergic agonists, NMDA receptor antagonists, serotonin receptor antagonists and dopamine receptor agonists such as alentemol, bromocriptine, fenoldopam, lisuride, naxagolide, pergolide and pramipexole.

In another embodiment, the subject compound may be employed in combination with acetophenazine, alentemol, benzhexol, bromocriptine, biperiden, chlorpromazine, chlorprothixene, clozapine, diazepam, fenoldopam, fluphenazine, haloperidol, levodopa, levodopa with benserazide, levodopa with carbidopa, lisuride, loxapine, mesoridazine, molindolone, naxagolide, olanzapine, pergolide, perphenazine, pimozide, pramipexole, risperidone, sulpiride, tetrabenazine, trihexyphenidyl, thioridazine, thiothixene or trifluoperazine.

In another embodiment, the subject compound may be employed in combination with a compound from the phenothiazine, thioxanthene, heterocyclic dibenzazepine, butyrophenone, diphenylbutylpiperidine and indolone classes of neuroleptic agent. Suitable examples of phenothiazines include chlorpromazine, mesoridazine, thioridazine, acetophenazine, fluphenazine, perphenazine and trifluoperazine. Suitable examples of thioxanthenes include

chlorprothixene and thiothixene. An example of a dibenzazepine is clozapine. An example of a butyrophenone is haloperidol. An example of a diphenylbutylpiperidine is pimozide. An example of an indolone is molindolone. Other neuroleptic agents include loxapine, sulpiride and risperidone.

In another embodiment, the subject compound may be employed in combination with a nicotine agonist or a nicotine receptor partial agonist such as varenicline, opioid antagonists (e.g., naltrexone (including naltrexone depot), antabuse, and nalmefene), dopaminergic agents (e.g., apomorphine), ADD/ADHD agents (e.g., methylphenidate hydrochloride (e.g., Ritalin® and Concerta®), atomoxetine (e.g., Strattera®), a monoamine oxidase inhibitor (MAOI), amphetamines (e.g., Adderall®)) and anti-obesity agents, such as apo-B/MTP inhibitors, 11Beta-hydroxy steroid dehydrogenase-1 (11Beta-HSD type 1) inhibitors, peptide YY3-36 or analogs thereof, MCR-4 agonists, CCK-A agonists, monoamine reuptake inhibitors, sympathomimetic agents, β3 adrenergic receptor agonists, dopamine receptor agonists, melanocyte-stimulating hormone receptor analogs, 5-HT2c receptor agonists, melanin concentrating hormone receptor antagonists, leptin, leptin analogs, leptin receptor agonists, galanin receptor antagonists, lipase inhibitors, bombesin receptor agonists, neuropeptide-Y receptor antagonists (e.g., NPY Y5 receptor antagonists), thyromimetic agents, dehydroepiandrosterone or analogs thereof, glucocorticoid receptor antagonists, other orexin receptor antagonists, glucagon-like peptide-1 receptor agonists, ciliary neurotrophic factors, human agouti-related protein antagonists, ghrelin receptor antagonists, histamine 3 receptor antagonists or inverse agonists, and neuromedin U receptor agonists, and pharmaceutically acceptble salts thereof.

In another embodiment, the subject compound may be employed in combination with an anoretic agent such as aminorex, amphechloral, amphetamine, benzphetamine, chlorphentermine, clobenzorex, cloforex, clominorex, clortermine, cyclexedrine, dexfenfluramine, dextroamphetamine, diethylpropion, diphemethoxidine, N-ethylamphetamine, fenbutrazate, fenfluramine, fenisorex, fenproporex, fludorex, fluminorex, furfurylmethylamphetamine, levamfetamine, levophacetoperane, mazindol, mefenorex, metamfepramone, methamphetamine, norpseudoephedrine, pentorex, phendimetrazine, phenmetrazine, phentermine, phenylpropanolamine, picilorex and sibutramine; selective serotonin reuptake inhibitor (SSRI); halogenated amphetamine derivatives, including chlorphentermine, cloforex, clortermine, dexfenfluramine, fenfluramine, picilorex and sibutramine; and pharmaceutically acceptble salts thereof.

In another embodiment, the subject compound may be employed in combination with an opiate agonist, a lipoxygenase inhibitor, such as an inhibitor of 5-lipoxygenase, a cyclooxygenase inhibitor, such as a cyclooxygenase-2 inhibitor, an interleukin inhibitor, such as

an interleukin-1 inhibitor, an NMDA antagonist, an inhibitor of nitric oxide or an inhibitor of the synthesis of nitric oxide, a non-steroidal antiinflammatory agent, or a cytokine-suppressing antiinflammatory agent, for example with a compound such as acetaminophen, asprin, codiene, fentanyl, ibuprofen, indomethacin, ketorolac, morphine, naproxen, phenacetin, piroxicam, a steroidal analgesic, sufentanyl, sunlindac, tenidap, and the like. Similarly, the subject compound may be administered with a pain reliever; a potentiator such as caffeine, an H2-antagonist, simethicone, aluminum or magnesium hydroxide; a decongestant such as phenylephrine, phenylpropanolamine, pseudophedrine, oxymetazoline, ephinephrine, naphazoline, xylometazoline, propylhexedrine, or levo-desoxy-ephedrine; an antiitussive such as codeine, hydrocodone, caramiphen, carbetapentane, or dextramethorphan; a diuretic; and a sedating or non-sedating antihistamine.

The compounds of the present invention may be administered by oral, parenteral (e.g., intramuscular, intraperitoneal, intravenous, ICV, intracisternal injection or infusion, subcutaneous injection, or implant), by inhalation spray, nasal, vaginal, rectal, sublingual, or topical routes of administration and may be formulated, alone or together, in suitable dosage unit formulations containing conventional non-toxic pharmaceutically acceptable carriers, adjuvants and vehicles appropriate for each route of administration. In addition to the treatment of warm-blooded animals such as mice, rats, horses, cattle, sheep, dogs, cats, monkeys, etc., the compounds of the invention are effective for use in humans.

The pharmaceutical compositions for the administration of the compounds of this invention may conveniently be presented in dosage unit form and may be prepared by any of the methods well known in the art of pharmacy. All methods include the step of bringing the active ingredient into association with the carrier which constitutes one or more accessory ingredients. In general, the pharmaceutical compositions are prepared by uniformly and intimately bringing the active ingredient into association with a liquid carrier or a finely divided solid carrier or both, and then, if necessary, shaping the product into the desired formulation. In the pharmaceutical composition the active object compound is included in an amount sufficient to produce the desired effect upon the process or condition of diseases. As used herein, the term "composition" is intended to encompass a product 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.

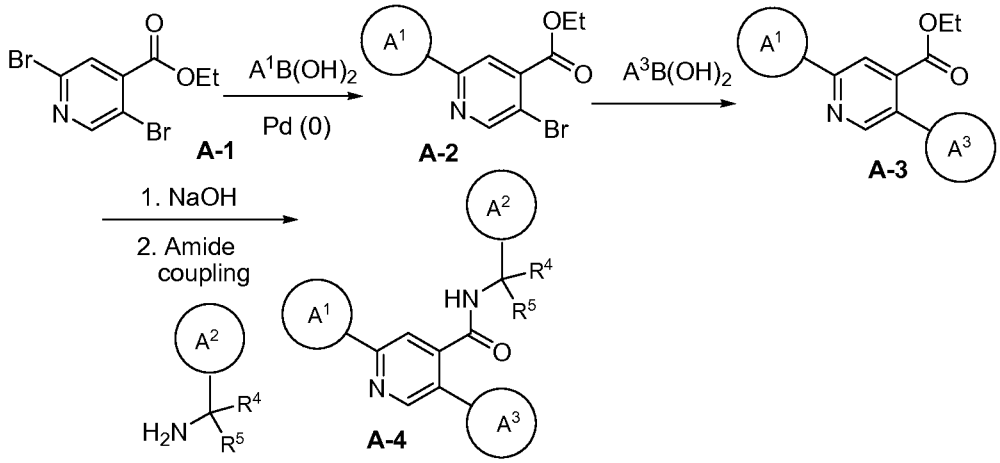
Pharmaceutical compositions intended for oral use may be prepared according to any method known to the art for the manufacture of pharmaceutical compositions and such compositions may contain one or more agents selected from the group consisting of sweetening agents, flavoring agents, coloring agents and preserving agents in order to provide pharmaceutically elegant and palatable preparations. Tablets contain the active ingredient in

admixture with non-toxic pharmaceutically acceptable excipients which are suitable for the manufacture of tablets. These excipients may be for example, inert diluents, such as calcium carbonate, sodium carbonate, lactose, calcium phosphate or sodium phosphate; granulating and disintegrating agents, for example, corn starch, or alginic acid; binding agents, for example starch, gelatin or acacia, and lubricating agents, for example magnesium stearate, stearic acid or talc. The tablets may be uncoated or they may be coated by known techniques to delay disintegration and absorption in the gastrointestinal tract and thereby provide a sustained action over a longer period. Compositions for oral use may also be presented as hard gelatin capsules wherein the active ingredient is mixed with an inert solid diluent, for example, calcium carbonate, calcium phosphate or kaolin, or as soft gelatin capsules wherein the active ingredient is mixed with water or an oil medium, for example peanut oil, liquid paraffin, or olive oil. Aqueous suspensions contain the active materials in admixture with excipients suitable for the manufacture of aqueous suspensions. Oily suspensions may be formulated by suspending the active ingredient in a suitable oil. Oil-in-water emulsions may also be employed. Dispersible powders and granules suitable for preparation of an aqueous suspension by the addition of water provide the active ingredient in admixture with a dispersing or wetting agent, suspending agent and one or more preservatives. Pharmaceutical compositions of the present compounds may be in the form of a sterile injectable aqueous or oleagenous suspension. The compounds of the present invention may also be administered in the form of suppositories for rectal administration. For topical use, creams, ointments, jellies, solutions or suspensions, etc., containing the compounds of the present invention may be employed. The compounds of the present invention may also be formulated for administered by inhalation. The compounds of the present invention may also be administered by a transdermal patch by methods known in the art.

Several methods for preparing the compounds of this invention are illustrated in the following Schemes and Examples. Starting materials are made according to procedures known in the art or as illustrated herein. The following abbreviations are used herein: Me: methyl; Et: ethyl; t-Bu: *tert*-butyl; Ar: aryl; Ph: phenyl; Bn: benzyl; Ac: acetyl; THF: tetrahydrofuran; DEAD: diethylazodicarboxylate; DIPEA: N,N-diisopropylethylamine; NMM: N-methylmorpholine; DMSO: dimethylsulfoxide; EDC: N-(3-Dimethylaminopropyl)-N'-ethylcarbodiimide; HOBT: hydroxybenzotriazole hydrate; Boc: tert-butyloxy carbonyl; Et_3N: triethylamine; DCM: dichloromethane; DCE: dichloroethane; BSA: bovine serum albumin; TFA: trifluoracetic acid; DMF: N,N-dimethylformamide; MTBE: methyl tert-butyl ether; $SOCl_2$: thionyl chloride; CDI: carbonyl diimidazole; PyClu: 1-(chloro-1-pyrrolidinylmethylene)-pyrrolidinium hexafluorophosphate; rt: room temperature; HPLC: high performance liquid chromatography. The compounds of the present invention can be prepared in a variety of fashions. In some cases the final product may be further modified, for example, by manipulation

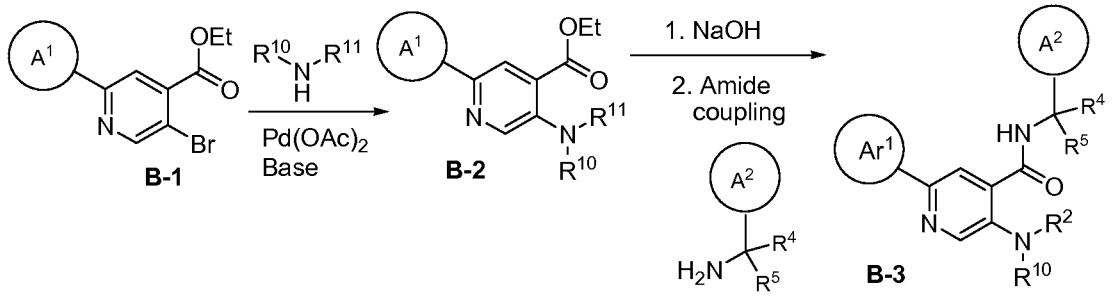
of substituents. These manipulations may include, but are not limited to, reduction, oxidation, alkylation, acylation, and hydrolysis reactions which are commonly known to those skilled in the art. In some cases the order of carrying out the foregoing reaction schemes may be varied to facilitate the reaction or to avoid unwanted reaction products. The following examples are provided so that the invention might be more fully understood. These examples are illustrative only and should not be construed as limiting the invention in any way.

REACTION SCHEME A



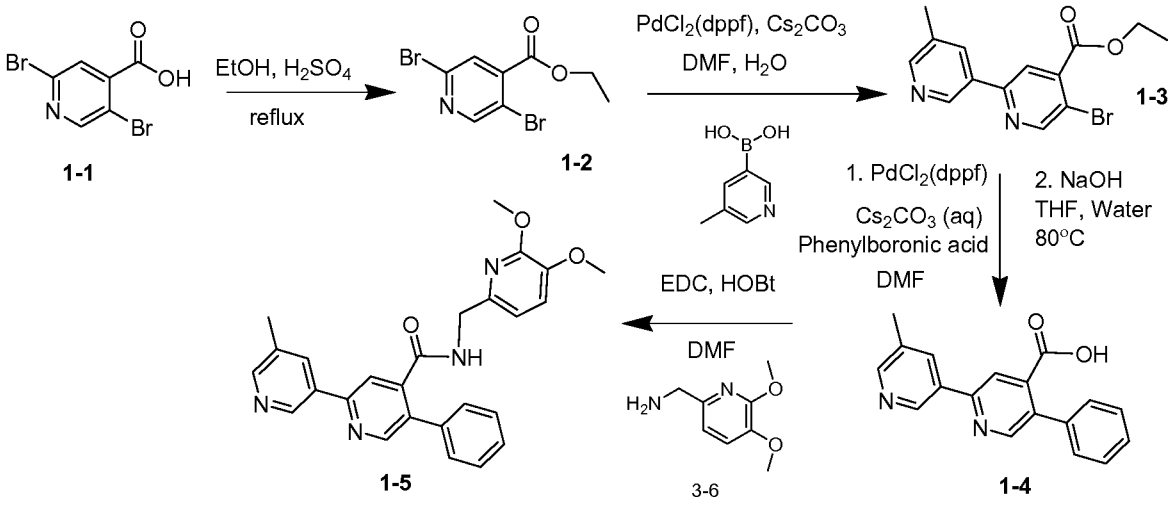
Ethyl 2,5-dibromoisonicotinate (A-1) can be selectively reacted at the 2-position under Suzuki reaction conditions to afford biaryl intermediate A-2. A second Suzuki reaction on A-2 can afford triaryl intermediates of type A-3. Triaryl esters of type A-3 can be saponified and then coupled to afford triarylisonicotinamides of type A-4.

REACTION SCHEME B



Biaryl isonicotinates of type B-1 can be reacted under Pd-catalyzed amination conditions to afford intermediates of type B-2. Compounds such as B-2 can be advanced to final compounds through saponification and amide coupling to afford B-3.

EXAMPLE 1



ethyl 2,5-dibromoisonicotinate (1-2)

A solution of 2,5-dibromoisonicotinic acid (1-1, 5 g, 17.80 mmol) and sulfuric acid (1.23 mL, 23.1 mmol)in ethanol (100 mL) was heated to reflux overnight. After reducing the volume of ethanol by rotary evaporation to approximately ¼ of it's original volume, the crude reaction mixture was partitioned between 2M sodium carbonate solution and EtOAc, separating layers and washing the organic layer with saturated sodium bicarbonate solution and brine. This solution was dried over anhydrous sodium sulfate, filtered and concentrated. The residue was purified by normal phase column chromatography (0 to 50% EtOAc in hexanes) to afford the product (1-2) as a dark oil. ESI+ MS $[M]^+$ $C_8H_7Br_2NO_2$ = 308.0.

ethyl 5-bromo-5'-methyl-2,3'-bipyridine-4-carboxylate (1-3)

To a solution ethyl 2,5-dibromoisonicotinate (1-2, 1.5 g, 4.86 mmol) in degassed dimethylformamide (24 mL) at 25°C was added (5-methylpyridin-3-yl)boronic acid (0.665 g, 4.86 mmol), $PdCl_2$dppf (0.355 g, 0.486 mmol), cesium carbonate (4.75 g, 14.6 mmol) and water (0.262 mL, 14.57 mmol). The reaction flask was purged with nitrogen, sealed and stirred at 50°C overnight. The crude reaction mixture was partitioned between water and EtOAc,

separating layers and washing the organic layer with saturated sodium bicarbonate solution and brine. The solvent was removed by rotary evaporation and the crude product was purified by normal phase column chromatography (0 to 50% EtOAc in hexanes) to afford the product (1-3) as a white solid. ESI+ MS $[M]^+$ $C_{14}H_{13}BrN_2O_2$ = 321.0.

5'-methyl-5-phenyl-2,3'-bipyridine-4-carboxylic acid dihydrochloride (1-4)

To a solution ethyl 5-bromo-5'-methyl-2,3'-bipyridine-4-carboxylate (1-3, 0.3 g, 0.934 mmol) in degassed dimethylformamide (4 mL) at 25°C was added phenylboronic acid (0.182 g, 1.5 mmol), $PdCl_2$dppf (0.068 g, 0.093 mmol) and 4M aqueous cesium carbonate (0.817 mL, 3.27 mmol). The reaction flask was purged with nitrogen, sealed and stirred for 2 hours at 65°C, then overnight at room temperature. An additional 30 minutes of heating at 90°C was required to drive the coupling to completion. After allowing the reaction to cool to room temperature, 1N LiOH (0.700 mL) and water (1 mL) were added and the reaction was heated to 70°C for 2 hours then stirred at room temperature overnight. The reaction mixture was concentrated to dryness by rotary evaporation. The crude product was taken up in DMF/DMSO/CH_3CN/water (5 mL;2:2:1:0.5), filtered and purified by reverse phase preparative chromatography (5-40% acetonitrile in water with 0.1% TFA buffer). The clean fractions were pooled and evaporated to give the TFA salt as a white solid. This material was taken up in a minimal amount of THF/acetonitrile and ethyl ether saturated with HCl was added, forming a white precipitate. The solvent was decanted away after centrifugation of the suspension. This was repeated 2 more times, once with HCl/ether and then with plain ethyl ether. After the final decant, the solids were dried under high vacuum to afford the title compound (1-4) as the Bis-HCl salt. ESI+ MS $[M+H]^+$ $C_{18}H_{14}N_2O_2 \cdot 2HCl$ = 291.1.

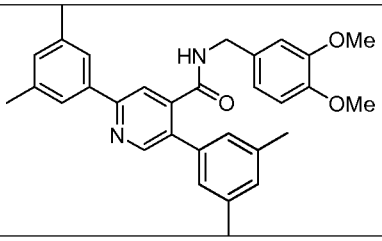
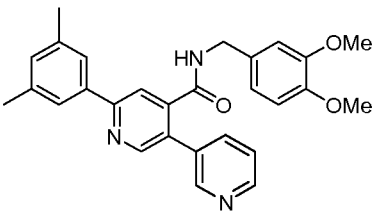
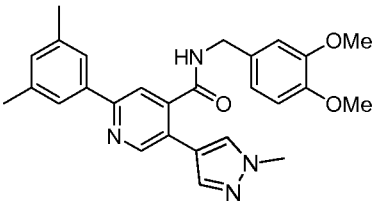
N-[(5,6-dimethoxypyridin-2-yl)methyl]-6-(2-fluorophenyl)-5'-methyl-3,3'-bipyridine-5-carboxamide (1-5)

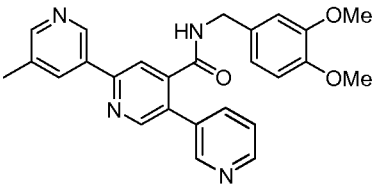
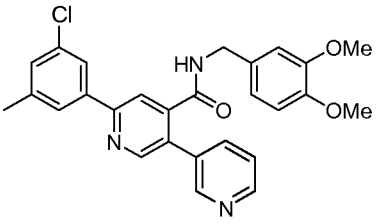
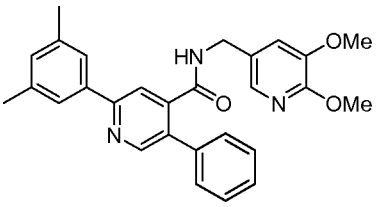
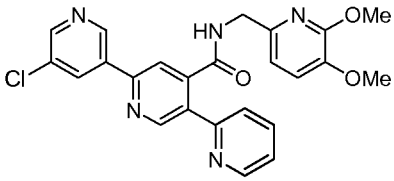
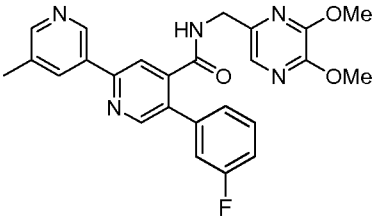
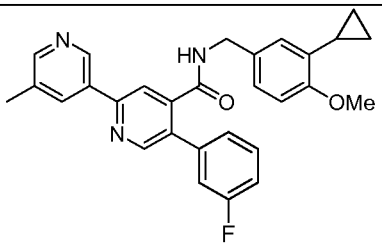
To a solution of 5'-methyl-5-phenyl-2,3'-bipyridine-4-carboxylic acid dihydrochloride (1-4, 0.056 g, 0.153 mmol) in dimethylformamide (13 mL) cooled to 0 °C, was added EDC (0.046 g, 0.24 mmol) and HOBt (0.039 g, 0.257 mmol) followed by 1-(5,6-dimethoxypyridin-2-yl)methanamine (3-6, 0.035g, 0.206 mmol) and N-methylmorpholine (0.113 mL, 1.028 mmol). The reaction was allowed to warm to room temperature and for 3 hours. The reaction mixture was diluted with DMSO (1 mL), filtered and purified via reverse phase chromatography

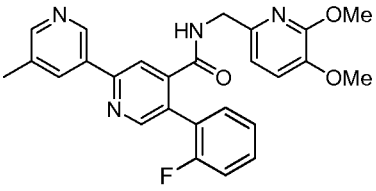
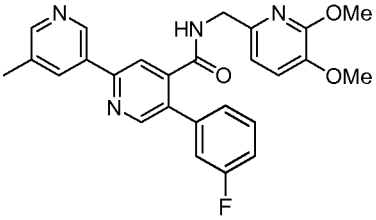
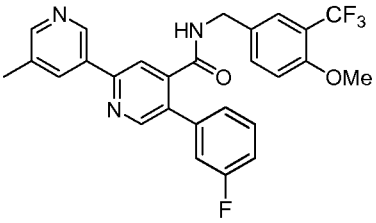
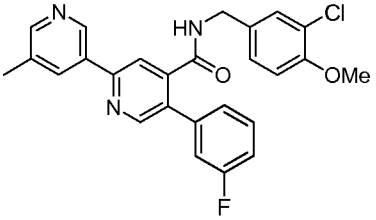
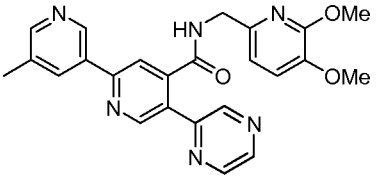
(5→65% acetonitrile in water with 0.1% TFA buffer). The clean fractions were pooled, partitioned between ethyl acetate and 2M sodium carbonate. The organic layer was washed with water and brine, dried over anhydrous sodium sulfate, filtered and concentrated to afford the title compound (1-5) as a white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.08 (s, 1H), 8.76 (s, 1H) 8.52 (s, 1H), 8.21 (s, 1H), 8.07 (s, 1H), 7.43 (m, 2H), 7.31 (t, J = 6.59 Hz, 2H), 6.95 (d, J=8.05 Hz, 1H), 6.66 (d, J=7.81 Hz, 1H), 6.46 (m, 1H), 4.39 (d, *J* = 5.37 Hz, 2H), 3.87 (s, 3H), 3.77(s, 3H), 2.44 (s, 3H). HRMS [M+H] $C_{26}H_{24}N_4O_3$ calc'd 441.1921, found 441.1925.

TABLE 1

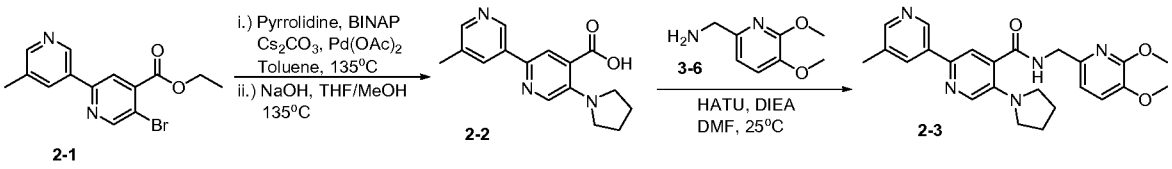
The following compounds were prepared using the methodology herein, but substituting the appropriately substituted reagent, as described in the Reaction Schemes and Examples. The requisite starting materials were commercially available, described in the literature or readily synthesized by one skilled in the art of organic synthesis without undue experimentation.

Cmp	Structure	Name	HRMS *m/z* (M+H)
1-6		*N*-(3,4-dimethoxybenzyl)-2,5-bis(3,5-dimethylphenyl) isonicotinamide	481.2483 found, 481.2486 required.
1-7		*N*-(3,4-dimethoxybenzyl)-6-(3,5-dimethylphenyl)-3,3'-bipyridine-4-carboxamide	454.2121 found, 454.2125 required.
1-8		*N*-(3,4-dimethoxybenzyl)-2-(3,5-dimethylphenyl)-5-(1-methyl-1*H*-pyrazol-4-yl)isonicotinamide	457.2246 found, 457.2234 required.

1-9		*N*-(3,4-dimethoxybenzyl)-5-methyl-3,2':5',3"-terpyridine-4'-carboxamide	441.1922 found, 441.1921 required.
1-10		6-(3-chloro-5-methylphenyl)-*N*-(3,4-dimethoxybenzyl)-3,3'-bipyridine-4-carboxamide	474.1575 found, 474.1579 required.
1-11		*N*-[(5,6-dimethoxypyridin-3-yl)methyl]-2-(3,5-dimethylphenyl)-5-phenylisonicotinamide	454.2121 found, 454.2125 required.
1-12		5"-chloro-*N*-[(5,6-dimethoxypyridin-2-yl)methyl]-2,3':6',3"-terpyridine-4'-carboxamide	462.1334 found, 462.1327 required.
1-13		*N*-[(5,6-dimethoxypyrazin-2-yl)methyl]-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide	460.1788 found, 460.1779 required.
1-14		*N*-(3-cyclopropyl-4-methoxybenzyl)-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide	468.2088 found, 468.2082 required.

1-15		*N*-[(5,6-dimethoxypyridin-2-yl)methyl]-5-(2-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide	459.1827 found, 459.1827 required.
1-16		*N*-[(5,6-dimethoxypyridin-2-yl)methyl]-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide	459.1831 found, 459.1827 required.
1-17		5-(3-fluorophenyl)-*N*-[4-methoxy-3-(trifluoromethyl)benzyl]-5'-methyl-2,3'-bipyridine-4-carboxamide	496.1650 found, 496.1643 required.
1-18		*N*-(3-chloro-4-methoxybenzyl)-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide	462.1385 found, 462.1379 required.
1-19		*N*-[(5,6-dimethoxypyridin-2-yl)methyl]-5'-methyl-5-pyrazin-2-yl-2,3'-bipyridine-4-carboxamide	443.1829 found, 443.1826 required.

EXAMPLE 2



5'-methyl-5-(1-pyrrolidinyl)-2,3'-bipyridine-4-carboxylic acid (2-2)

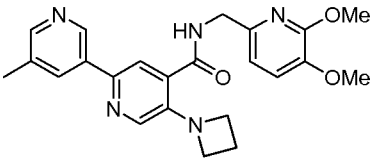
To a solution of ethyl 5-bromo-5'-methyl-2,3'-bipyridine-4-carboxylate (2-1, 0.050 g, 0.156 mmol) in toluene (0.31 mL) at 25°C was added pyrrolidine (0.026 mL, 0.311 mmol), BINAP (0.0096 g, 0.016 mmol) followed by $Pd(OAc)_2$ (0.0035 g, 0.016 mmol) and cesium carbonate (0.076 g, 0.234 mmol) and the system was heated in the microwave reactor at 135°C for 0.5h. The system was partitioned between saturated aqueous sodium bicarbonate and EtOAc, washed with brine and dried over magnesium sulfate. Filtration and concentration followed by purification via normal phase chromatography (0→100% EtOAc in Hx) afforded a pale yellow oil. To this pale yellow oil (0.026 g, 0.083 mmol) in 1:1 THF/MeOH (0.40 mL) at 25°C was added aqueous sodium hydroxide (0.0125 mL, 0.125 mmol, 10M) and the system was heated in the microwave reactor at 135°C for 10 minutes. The solvents were removed in vacuo to afford the title compound (2-2) as a grey solid. ESI+ MS $C_{16}H_{17}N_3O_2$: 284.2 found, 284.1 required.

N-[(5,6-dimethoxy-2-pyridinyl)methyl]-5'-methyl-5-(1-pyrrolidinyl)-2,3'-bipyridine-4-carboxamide (2-3)

To a solution of 5'-methyl-5-(1-pyrrolidinyl)-2,3'-bipyridine-4-carboxylic acid (2-2, 0.026 g, 0.085 mmol) and 1-(5,6-dimethoxy-2-pyridinyl)methanamine (3-6, 0.017 g, 0.102 mmol) in DMF (0.17 mL) was added HATU (0.032 g, 0.085 mmol) followed by DEA (0.074 mL, 0.426 mmol) and stirred at ambient temperature for 1h. The system was partitioned between saturated aqueous sodium bicarbonate and EtOAc, washed with brine and dried over magnesium sulfate. Filtration and concentration followed by purification via normal phase chromatography (0→10% MeOH in EtOAc) afforded the title compound (2-3) as a salmon powder. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.93 (s, 1H), 8.40 (m, 1H), 8.32 (s, 1H), 8.06 (m, 1H), 7.08 (s, 1H), 7.06 (d, 1H, *J*= 8.0Hz), 6.90 (d, 1H, *J*= 8.0Hz), 4.63 (d, 2H, *J*= 4.5Hz), 4.00 (s, 3H), 3.89 (s, 3H), 3.36 (m, 4H), 2.40 (s, 3H), 1.93 (m, 4H). HRMS [M+H] $C_{24}H_{27}N_5O_3$ calc'd 434.2187, found 434.2211.

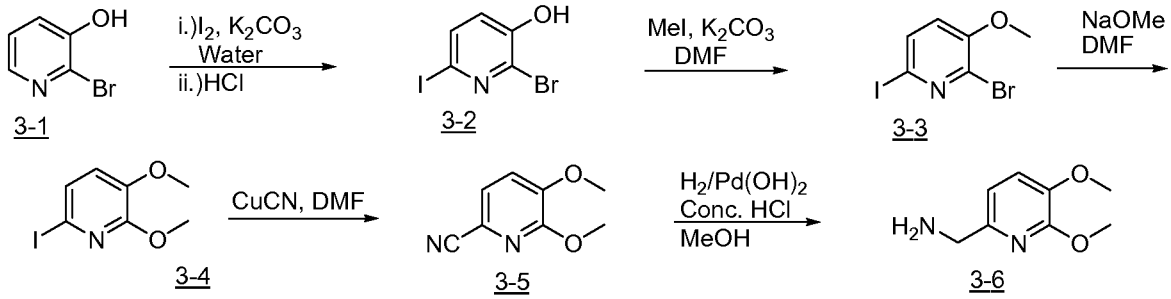
TABLE 2

The following compounds were prepared using the methodology herein, but substituting the appropriately substituted reagent, as described in the Reaction Schemes and Examples. The requisite starting materials were commercially available, described in the literature or readily synthesized by one skilled in the art of organic synthesis without undue experimentation.

Cmp	Structure	Name	HRMS *m/z* (M+H)
2-4		5-azetidin-1-yl-*N*-[(5,6-dimethoxypyridin-2-yl)methyl]-5'-methyl-2,3'-bipyridine-4-carboxamide	420.2031 found, 420.2030 required.

Most of the benzylamines employed as starting materials herein were commercially available. The following are examples of benzylamine syntheses where the benzylamine was not commercially available. These examples are illustrative only and should not be construed as limiting the invention in any way.

EXAMPLE 3



2-bromo-3-hydroxy-6-iodopyridine (3-2)

To a solution of 2-bromo-3-hydroxy pyridine (3-1, 28 g, 161 mmol) in water (360 mL) was added K_2CO_3 (44.5 g, 322 mmol) and I_2 (40.8 g, 161 mmol). The system was stirred for 1.5h at ambient temperature, cooled to 0°C and then treated with concentrated HCl until solids precipitated from solution (pH~ 6.0). The solids were isolated by filtration and dried to give the title compound (3-2) as a brown solid. ESI+ MS C_5H_3BrINO: 299.8 found, 299.9 required.

2-bromo-3-methoxy-6-iodopyridine (3-3)

To a solution of 2-bromo-3-hydroxy-6-iodopyridine (3-2, 40 g, 133 mmol) in DMF (80 ml) was added K_2CO_3 (16.77 g, 121 mmol) and Methyl Iodide (29.2 mL, 467 mmol). The system was stirred for 45 minutes at 100°C, cooled to room temperature and then treated

with water (650 mL) and stirred for 0.5h. The resulting solids that precipitated from solution were isolated by filtration and dried to give the title compound (3-3) as a pale brown solid. ESI+ MS C_6H_5BrINO: 313.8 found, 313.9 required.

2,3-dimethoxy-6-iodopyridine (3-4)

To a solution of 2-bromo-3-methoxy-6-iodopyridine (3-3, 34 g, 108 mmol) in DMF (65 mL) was added sodium methoxide in methanol(37 mL, 162 mmol, 4.37M) and heated to 100 °C. The mixture was stirred for 10 minutes and partitioned between saturated $NaHCO_3$ and DCM. The organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated. The crude material was purified by gradient elution on silica (0 to 20% EtOAc in hexanes) to afford the title compound (3-4) as a white powder. ESI+ MS $[M+H]^+$ $C_7H_8INO_2$: 265.8 found, 266.0 required.

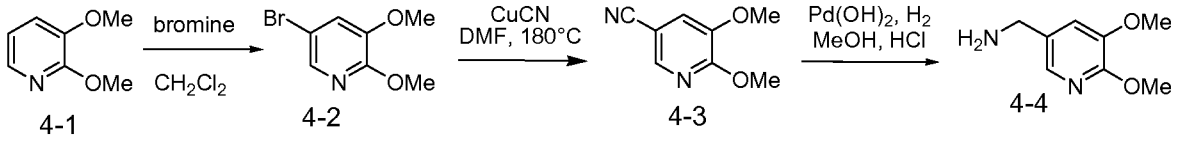
2,3-dimethoxy-6-cyanopyridine (3-5)

To a solution of 2,3-dimethoxy-6-iodopyridine (3-4, 24.0 g, 91 mmol) in DMF (181 mL) was added copper cyanide (9.73 g, 109 mmol) and heated to 150 °C for 20 minutes in a microwave reactor. The mixture was partitioned between saturated sodium carbonate and EtOAc three times. The organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated. The crude material was purified by gradient elution on silica gel (0 to 40% EtOAc in hexanes) to yield the desired product (3-5) as an off-white crystalline powder. ESI+ MS $[M+H]^+$ $C_8H_8N_2O_2$: 165.0 found, 165.1 required.

2,3-dimethoxy-6-aminomethylpyridine (3-6)

To a solution of 2,3-dimethoxy-6-cyanopyridine (3-5, 5.1g, 31.1 mmol) in MeOH (260 mL) was added Pearlman's Catalyst (2.18 g, 3.11 mmol, 20wt%) and concentrated HCl (20.0 mL, 249 mmol, 12M). The system was then stirred under an atmosphere of hydrogen via a balloon for 1.5h. The reaction contents were filtered through a pad of celite and methanol was removed in vacuo. The crude mixture was then basified using saturated Na_2CO_3 and then extracted using 4:1 Chloroform:Ethanol. The organic phase was washed with brine, dried over Na_2SO_4, filtered and purified by gradient elution on silica gel (0 to 12% MeOH(10% NH_4OH) in DCM) to yield the desired product (3-6) as a bone semi-solid. ESI+ MS $[M+H]^+$ $C_8H_{12}N_2O_2$: M-16 ($-NH_2$), 152.06 found, 168.2 required.

EXAMPLE 4



4-1 4-2 4-3 4-4

5-bromo-2,3-dimethoxypyridine (4-2)

To a solution of 2,3-dimthoxypyridine (4-1, 2.5 g, 18.0 mmol, 1.0 equiv) in dichloromethane:saturated $NaHCO_3$ (80 mL: 40 mL) at 0°C was added bromine (0.93 mL, 18.0 mmol, 1.0 equiv) and the reaction mixture was stirred for 2 h at 25°C. The reaction mixture was quenched with solid Na_2SO_3 (~10 g) and the aqueous phase was extracted with dichloromethane (3 x 100 mL). The organic phase was dried over magnesium sulfate and concentrated. The residue was purified via normal phase chromatography (0 to 20% EtOAc in hexanes, silica) to afford the desired product (4-2) as an oil after concentration. ESI+ MS $[M+H]^+$ $C_7H_8NO_2$ calc'd 218.0, found 218.0.

5,6-dimethoxynicotinonitrile (4-3)

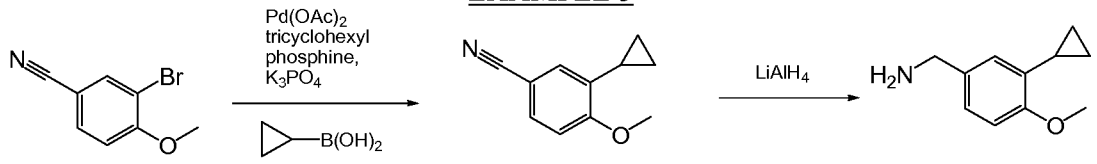
To a solution of 5-bromo-2,3-dimethoxypyridine (4-2, 0.300 g, 1.38 mmol, 1.0 equiv) in dimethylformamide (3.9 mL) was added copper (I) cyanide (0.15 gL, 1.65 mmol, 1.2 equiv) and the reaction mixture was heated for 40 minutes at 180C in a microwave reactor. The reaction mixture was cooled and partitioned between EtOAc (50 mL) and water (50 mL). The organic phase was washed with water (2 x 30 mL) and brine (1 x 30 mL), dried over magnesium sulfate and concentrated. The residue was purified via normal phase chromatography (0 to 40% EtOAc in hexanes, silica) to afford the desired product (4-3) as white solid after concentration. ESI+ MS $[M+H]^+$ $C_8H_8N_2O_2$ calc'd 165.1, found 165.1.

1-(5,6-dimethoxypyridin-3-yl)methanamine (4-4)

To a solution of 5,6-dimethoxynicotinonitrile (4-3, 0.600 g, 3.65 mmol, 1.0 equiv) in methanol (20 mL) under a nitrogen atmosphere was added Pearlman's catalyst (0.205 g, 0.292 mmol, 0.08 equiv, 20 weight percent) and concentrated HCl (2.44 mL), and the reaction was place under an atmosphere of hydrogen. After 2 h, the reaction was placed under an atmosphere of nitrogen and filtered through celite to remove the catalyst. The reaction mixture

was dissolved in EtOAc, dried over $MgSO_4$ and concentrated to an oily solid (4-4) of high purity. ESI+ MS $[M+H]^+$ $C_8H_{12}N_2O_2$ calc'd 169.1, found 169.1.

EXAMPLE 5



5-1 5-2 5-3

3-cyclopropyl-4-methoxybenzonitrile (5-2)

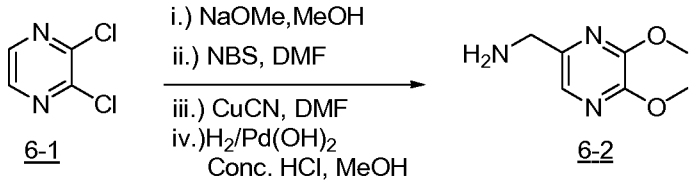
A mixture of 3-bromo-4-methoxybenzonitrile (5-1, 5.0g, 23.6 mmol, 1.0 eq), aqueous potassium phosphate tribasic (65.0 ml, 1.27 M, 3.5 eq), cyclopropylboronic acid (10.1 g, 118 mmol, 5.0 eq), $Pd(OAc)_2$ (0.539 g, 2.36 mmol, 0.1 eq) and tricyclohexylphosphine (0.661 g, 2.36 mmol, 0.1 eq) was stirred in degassed toluene (103 ml) and heated to 80°C for three hours. An additional amount of cyclopropylboronic acid (1.0g, 1.16 mmol, 0.5 eq) was added and the solution was further heated for 16 hours at 80°C to complete the reaction. The reaction mixture was cooled and partitioned between brine and EtOAc. The organic phase was dried over sodium sulfate, filtered and concentrated to give an orange oil. The oil was purified by normal phase column chromatography (0 to 10% EtOAc in hexanes) to afford the product (5-2) as a yellow oil. ^1H NMR ($CDCl_3$) δ 7.44 (dd, 1H, J=8.4, 2.0 Hz), 7.09 (d, 1H, J = 2.0 Hz), 6.86 (d, 1H, J = 8.4 Hz), 3.92 (s, 3H), 2.13 (m, 1H), 0.97 (m, 2H), 0.65 (m, 2H).

1-(3-cyclopropyl-4-methoxyphenyl)methanamine (5-3)

Lithium aluminum hydride in diethyl ether (17.3 ml, 1.0 M, 17.3 mmol, 3.0 eq) was carefully added over twenty minutes to a solution of 3-cyclopropyl-4-methoxybenzonitrile (15-2, 1.0g, 5.77 mmol, 1.0 eq) in tetrahydrofuran (28.9 ml) at 0°C under nitrogen atmosphere. The resulting dark orange mixture was allowed to stir at 0°C for 30 min, then carefully quenched in the following order: water (1.0ml), 15% NaOH aqueous (1.0 ml) and water (3.0 ml). The resulting emulsion was stirred at room temperature for 30 min. Several spatula amounts of magnesium sulfate was added to the mixture to remove any water. The entire mixture was filtered through a pad of sodium sulfate, washing with ethyl acetate. The collected filtrate was

concentrated to give the product (5-3) as a yellow oil. ESI+ MS $[M-16]^+$ $C_{11}H_{15}NO$: 161.1 found, 161.2 required.

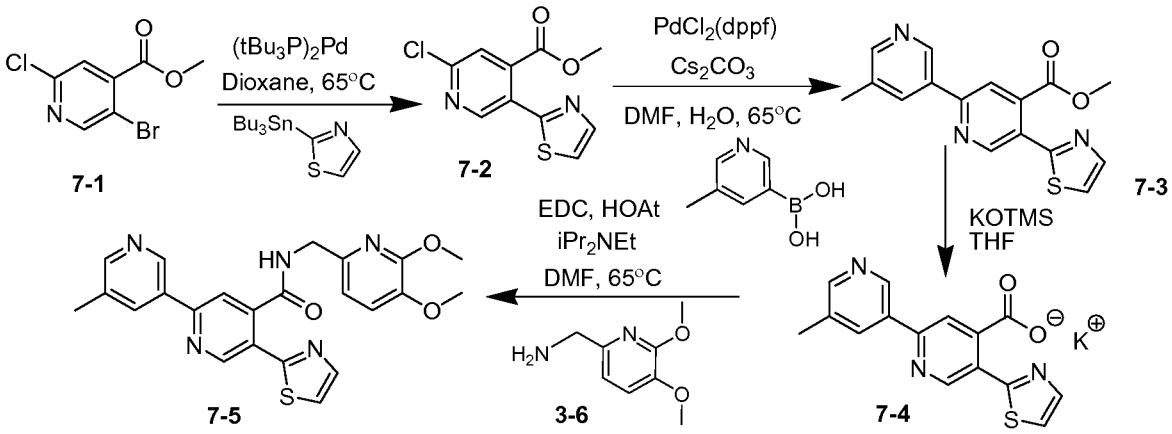
EXAMPLE 6



2,3-dimethoxy-5-aminomethylpyrazine (6-2)

To a solution of 2,3-dichloropyrazine (6-1, 3.5 g, 23.5 mmol) in MeOH (115 mL) was added NaOMe (15.0 mL, 70.5 mmol) and the system was stirred overnight. The reaction contents were then filtered through a fritted funnel of medium porosity, concentrated, and partitioned between EtOAc and water. The organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated to afford a clear oil. To this clear oil (2.5 g, 17.8 mmol) in DMF (17 ml) at 0°C was added NBS (3.5 g, 19.6 mmol) the system was stirred overnight. The system was quenched with Na_2SO_3 and then poured into ice water. The resulting solids that precipitated from solution were isolated by filtration and dried to afford a white solid. To this white solid (1 g, 4.5 mmol) in DMF (9 mL) was added copper cyanide (0.45 g, 5.0 mmol) and heated to 185 °C for 20 minutes in the microwave reactor. The mixture was cooled and partitioned between EtOAc and water. The organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated. The crude material was purified by gradient elution on silica (0 to 65% EtOAc in hexanes) to afford a white powder. To this white powder (0.740 g, 4.5 mmol) in MeOH (40 mL) was added Pearlman's Catalyst (0.315 g, 0.45 mmol) and concentrated HCl (3.0 mL, 36 mmol). The system was then stirred under an atmosphere of hydrogen via a balloon for 1.5h. The reaction contents were filtered through a pad of celite followed by removal of methanol in vacuo. The crude mixture was then dissolved in DCM, basified using saturated Na_2CO_3 and then extracted several times with DCM. The organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated to yield the desired product (6-2) as a bone solid. ESI+ MS $[M+H]^+$ $C_7H_{11}N_3O_2$: M-16 ($-NH_2$), 152.82 found, 169.2 required.

EXAMPLE 7



Methyl 2-chloro-5-(1,3-thiazol-2-yl)isonicotinate (7-2)

To a 100mL round bottom flask was added bis(tri-*tert*butylphosphine)palladium(0) (204 mg, 0.40 mmol, 0.1 equiv). The flask was then flushed with nitrogen and charged with 1,4-dioxane (20 mL), methyl 5-bromo-2-chloroisonicotinate (7-1, 1000 mg, 4.0 mmol, 1 equiv) and 2-(tributylstannyl)-1,3-thiazole (1.5 mL, 4.8 mmol, 1.2 equiv). The reaction mixture was heated for 3 hours at 65 °C, diluted with EtOAc (20 mL) and filtered through celite. The filtrate was concentrated and the residue purified by normal phase column chromatography (0-40% EtOAc in hexanes) to afford the title compound (7-2) as a yellow solid. ESI+ MS $[M+H]^+$ $C_{10}H_8ClN_2O_2S$ = 255.0

Methyl 5'-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxylate (7-3)

Methyl 2-chloro-5-(1,3-thiazol-2-yl)isonicotinate (7-2, 6.5 g, 26 mmol, 1 equiv), (5-methylpyridin-3-yl)boronic acid (3.8 g, 28 mmol, 1.1 equiv), cesium carbonate (29 g, 89 mmol, 3.5 equiv) and $PdCl_2(dppf)$-CH_2Cl_2 adduct (4.2 g 5.1 mmol, 0.2 equiv) were suspended in DMF (102 mL) and water (4.6 mL, 255 mmol, 10 equiv). The reaction mixture was heated for 45 minutes at 65 °C, diluted with EtOAc (200 mL) and filtered through celite. The organic layer was washed with water (2 x 200 mL), dried over $MgSO_4$ and concentrated. The residue was purified by normal phase column chromatography (40-80% EtOAc in hexanes) to afford the title compound (7-3) as a tan solid. ESI+ MS $[M+H]^+$ $C_{16}H_{14}N_3O_2S$ = 312.1

Potassium 5'-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxylate (7-4)

To a solution of methyl 5-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxylate (7-3, 890 mg, 2.9 mmol, 1 equiv) in tetrahydrofuran (14.3 mL) was added potassium trimethylsilanolate (640 mg, 5.0 mmol, 1.75 equiv). The reaction mixture was stirred at room temperature for 1 hour. Ethyl ether (15 mL) was added and the precipitate was filtered to afford the title compound (7-4) as a white solid. ESI+ MS $[M+H]^+$ $C_{15}H_{12}N_3O_2S$ = 298.1

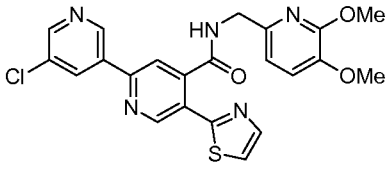
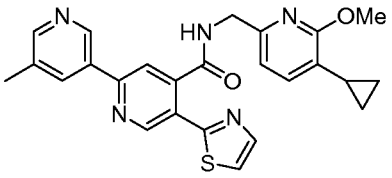
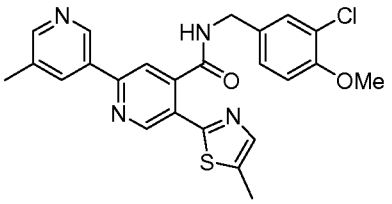
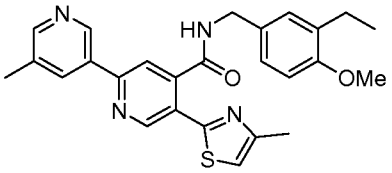
N-[(5,6-Dimethoxypyridin-2-yl)methyl]-5'-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide (7-5)

Potassium 5'-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxylate (7-4, 980 mg, 2.9 mmol, 1 equiv), 1-(5,6-dimethoxypyridin-2-yl)methanamine (3-6, 490 mg, 2.9 mmol, 1 equiv), EDC (670 mg, 3.5 mmol, 1.2 equiv), 1-hydroxy-7-azabenzotriazole (480 mg, 3.5 mmol, 1.2 equiv) and diisopropylethylamine (2.0 mL, 12 mmol, 4 equiv) were suspended in DMF (14.6 mL) and the reaction mixture was heated for 2 hours at 65 °C. The reaction mixture was then partitioned between DCM (50 mL) and water (50 mL). The layers were separated and the organic layer was dried over $MgSO_4$ and concentrated. The residue was purified by normal phase column chromatography (0-20% MeOH in EtOAc) to afford a white solid that was recrystallized from chloroform/hexanes to give the title compound (7-5) as a crystalline solid (970 mg, 75% yield). ^{1}H NMR ($CDCl_3$, 300 MHz) δ 9.08 (s, 2H), 8.53 (s, 1H), 8.22 (s, 1H), 8.11 (s, 1H), 7.81 (dd, *J*=3.1 and 1.1 Hz, 1H), 7.78 (t, *J*= 4.8 Hz, 1H), 7.43 (dd, *J*=3.3 and 1.1 Hz, 1H), 7.02 (d, *J*=7.9 Hz, 1H), 6.85 (d, *J*=7.7 Hz, 1H), 4.58 (d, *J*=5.3 Hz, 2H), 3.91 (s, 3H), 3.88 (s, 3H), 2.45 (s, 3H). HRMS (M+H) $C_{23}H_{21}N_5O_3S$ calc'd 448.1438, found 448.1443

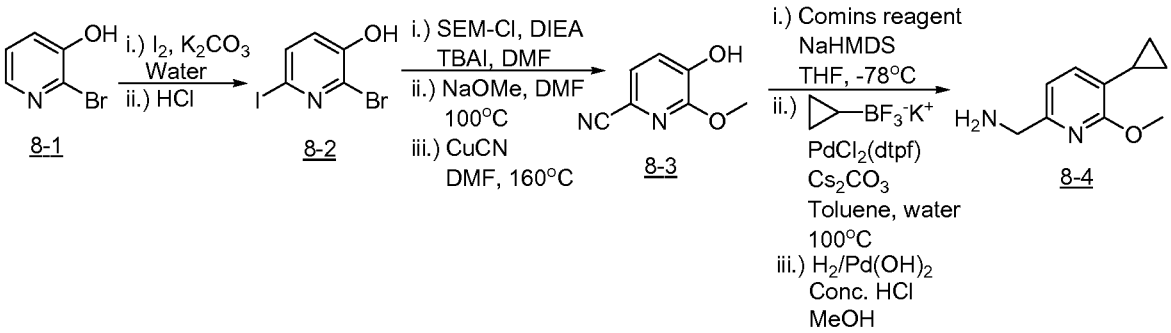
TABLE 3

The following compounds were prepared using the foregoing methodology, but substituting the appropriately substituted reagent, as described in the foregoing Reaction Schemes and Examples. The requisite starting materials were commercially available, described in the literature or readily synthesized by one skilled in the art of organic synthesis without undue experimentation.

Cmp	Structure	Name	HRMS *m/z* (M+H)

7-6		5'-chloro-N-[(5,6-dimethoxypyridin-2-yl)methyl]-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide	468.0912 found, 468.0892 required.
7-7		N-[(5-cyclopropyl-6-methoxypyridin-2-yl)methyl]-5'-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide	458.1638 found, 458.1645 required.
7-8		N-(3-chloro-4-methoxybenzyl)-5'-methyl-5-(5-methyl-1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide	465.1139 found, 465.1147 required.
7-9		N-(3-ethyl-4-methoxybenzyl)-5'-methyl-5-(4-methyl-1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide	459.1841 found, 459.1849 required.

EXAMPLE 8



2-bromo-3-hydroxy-6-iodopyridine (8-2)

To a solution of 2-bromo-3-hydroxy pyridine (8-1, 28 g, 161 mmol) in water (360 mL) was added K_2CO_3 (22.24 g, 161 mmol) and I_2 (20.42 g, 80 mmol). The system was stirred

for 1.5h at ambient temperature, cooled to 0°C and then treated with concentrated HCl until solids precipitated from solution (pH~ 6.0). The solids were isolated by filtration and dried to give the title compound (8-2) as a brown solid. ESI+ MS $[M+H]^+$ C_5H_3BrINO = 299.8

2-methoxy-3-hydroxy-6-cyanopyridine (8-3)

To a solution of 2-bromo-3-hydroxy-6-iodopyridine (8-2, 10 g, 33.3 mmol, 1.0 equiv) in DMF (104 ml) was added TBAI (1.23 g, 3.33 mmol, 0.1 equiv), diisopropylethylamine (17.5 mL, 100 mmol, 3.0 equiv) and SEM-Cl (8.87 mL, 50.0 mmol, 1.5 equiv). The system was stirred at ambient temperature for 24 hours. The reaction was partitioned between EtOAc and saturated $NaHCO_3$. The organic phase was washed with $NaHCO_3$ and dried over $MgSO_4$. After concentration, the residue was purified by normal phase column chromatography (0 to 50% EtOAc in hexanes) to afford a pale yellow oil. To this pale yellow oil in DMF (145 mL) was added a 4.37M solution of NaOMe in MeOH(6.65 mL, 29.1 mmol, 1.0 equiv) and the system was heated to 100°C for 1 hour. The system was cooled to ambient temperature and partitioned between EtOAc and saturated $NaHCO_3$. The organic phase was washed with brine and dried over $MgSO_4$. After concentration, the residue was purified by normal phase column chromatography (0 to 20% EtOAc in hexanes) to afford a clear oil. To this clear oil in DMF (69 mL) was added CuCN (3.71g, 41.4 mmol, 2.0 equiv) and the system was irradiated at 160°C for 0.5 hour. The reaction mixture was filtered through celite and partitioned between EtOAc and brine. The organic phase was dried over $MgSO_4$ and concentrated. The residue was purified by normal phase column chromatography (0 to 50% EtOAc in hexanes) to afford a yellow solid. ESI+ MS $[M+H]^+$ $C_7H_6N_2O_2$ = 151.0

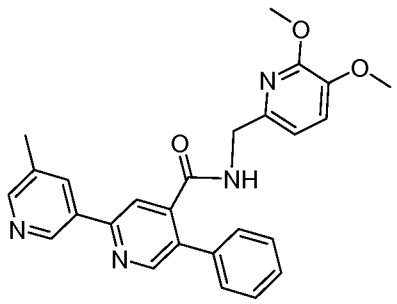
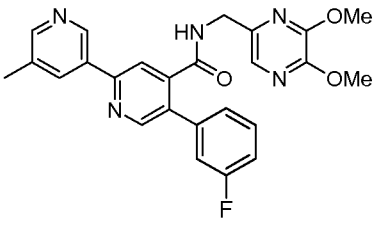
1-(5-cyclopropyl-6-methoxypyridin-2-yl)methanamine (8-4)

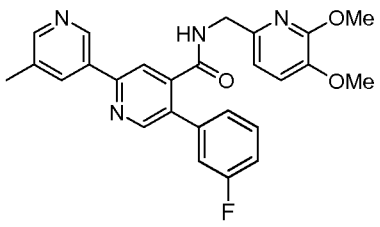
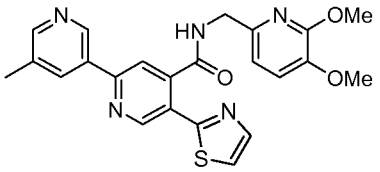
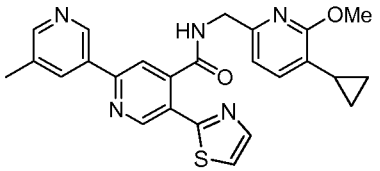
To a solution of 2-methoxy-3-hydroxy-6-cyanopyridine (8-3, 0.82 g, 5.43 mmol, 1.0 equiv) in THF (27 mL) at -78°C was added a 2.0M solution of NaHMDS in THF (4.07 mL, 8.14 mmol, 1.5 equiv) followed by Comins reagent (3.19 g, 8.14 mmol, 1.5 equiv) and the system was stirred at -78°C until disappearance of starting material was observed via thin layer chromatography (1:1 EtOAc in hexanes used as solvent system for TLC). The system was then partitioned between EtOAc and brine and dried over $MgSO_4$. After concentration, the residue was purified by normal phase column chromatography (0 to 50% EtOAc in hexanes) to afford a pale yellow oil. To this pale yellow oil in toluene (1.0 mL) and water (1.0 mL) was added

potassium cyclopropyltrifluoroborate salt (0.11 g, 0.744 mmol, 1.05 equiv) followed by 1,1'-bis(di-tert-butylphosphino)ferrocene palladium dichloride (0.03 eq, 0.021 mmol, 13.9 mg) and Cs_2CO_3 (0.690 g, 2.13 mmol, 3.0 equiv) and the system was heated at 100°C for 1.5 hours. The system was then partitioned between EtOAc and brine and dried over $MgSO_4$. After concentration, the residue was purified by normal phase column chromatography (0 to 20% EtOAc in hexanes) to afford a clear oil. To this clear oil in MeOH (1.72 mL) was added Pearlman's Catalyst (0.024 g, 0.03 mmol, 0.1 equiv) and concentrated HCl (0.23 mL, 2.76 mmol, 8.0 equiv). The system was then stirred under an atmosphere of hydrogen via a balloon overnight. The reaction contents were filtered through a pad of celite and basified using saturated Na_2CO_3. Methanol was then removed in vacuo and the mixture was then extracted using 4:1 Chloroform:Ethanol. The organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated to yield the desired product (8-4) as a yellow oil. ESI+ MS $[M+H]^+$ $C_{10}H_{14}N_2O$ = 162.0 [M-16 (-NH_2)]

TABLE 4

The following table shows representative data for the compounds of the Examples as orexin receptor antagonists as determined by the assays herein.

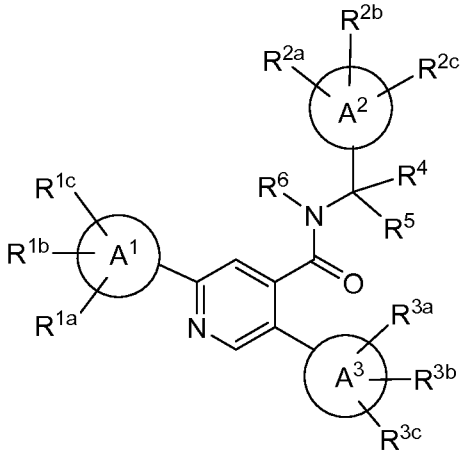
Cmpd	Structure	OX2R K_i (nM)
1-5		0.72
1-13		4.5

1-16		0.91
7-5		0.95
7-7		0.97

While the invention has been described and illustrated with reference to certain particular embodiments thereof, those skilled in the art will appreciate that various adaptations, changes, modifications, substitutions, deletions, or additions of procedures and protocols may be made without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A compound of the formula I:



I

wherein:

A^1 is selected from the group consisting of phenyl, naphthyl and heteroaryl;

A^2 is selected from the group consisting of phenyl, naphthyl and heteroaryl;

A^3 is selected from the group consisting of phenyl, naphthyl, C_{3-6}cycloalkyl, $-NR^{10}R^{11}$ and heterocycle;

R^{1a}, R^{1b} and R^{1c} may be absent if the valency of A^1 does not permit such substitution and are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) $-(C=O)_m-O_n-C_{1-6}$alkyl, where m is independently 0 or 1, n is independently 0 or 1 (wherein if m is 0 or n is 0, a bond is present) and where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(5) $-(C=O)_m-O_n-C_{3-6}$cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(6) $-(C=O)_m-C_{2-4}$alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(7) -(C=O)$_m$-C$_{2-4}$alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(8) -(C=O)$_m$-O$_n$-phenyl or -(C=O)$_m$-O$_n$-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(9) -(C=O)$_m$-O$_n$-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{13},

(10) -(C=O)$_m$-NR^{10}R^{11}, wherein R^{10} and R^{11} are independently selected from the group consisting of:

(a) hydrogen,

(b) C$_{1-6}$alkyl, which is unsubstituted or substituted with R^{13},

(c) C$_{3-6}$alkenyl, which is unsubstituted or substituted with R^{13},

(d) C$_{3-6}$alkynyl, which is unsubstituted or substituted with R^{13},

(e) C$_{3-6}$cycloalkyl which is unsubstituted or substituted with R^{13},

(f) phenyl, which is unsubstituted or substituted with R^{13}, and

(g) heterocycle, which is unsubstituted or substituted with R^{13},

(11) -S(O)$_2$-NR^{10}R^{11},

(12) -S(O)$_q$-R^{12}, where q is 0, 1 or 2 and where R^{12} is selected from the definitions of R^{10} and R^{11},

(13) -CO$_2$H,

(14) -CN, and

(15) -NO$_2$;

R^{2a}, R^{2b} and R^{2c} may be absent if the valency of A^2 does not permit such substitution and are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) -(C=O)$_m$-O$_n$-C$_{1-6}$alkyl, where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(5) -(C=O)$_m$-O$_n$-C$_{3-6}$cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(6) -(C=O)$_m$-C$_{2-4}$alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(7) -(C=O)$_m$-C$_{2-4}$alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{13},

(8) -(C=O)$_m$-O$_n$-phenyl or -(C=O)$_m$-O$_n$-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(9) -(C=O)$_m$-O$_n$-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{13},
(10) -(C=O)$_m$-NR^{10}R^{11},
(11) -S(O)$_2$-NR^{10}R^{11},
(12) -S(O)$_q$-R^{12},
(13) -CO$_2$H,
(14) -CN, and
(15) -NO$_2$;

R^{3a}, R^{3b} and R^{3c} may be absent if the valency of A^3 does not permit such substitution and are independently selected from the group consisting of:
(1) hydrogen,
(2) halogen,
(3) hydroxyl,
(4) -(C=O)$_m$-O$_n$-C$_{1-6}$alkyl, where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(5) -(C=O)$_m$-O$_n$-C$_{3-6}$cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(6) -(C=O)$_m$-C$_{2-4}$alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(7) -(C=O)$_m$-C$_{2-4}$alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(8) -(C=O)$_m$-O$_n$-phenyl or -(C=O)$_m$-O$_n$-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{13},
(9) -(C=O)$_m$-O$_n$-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{13},
(10) -(C=O)$_m$-NR^{10}R^{11},
(11) -S(O)$_2$-NR^{10}R^{11},
(12) -S(O)$_q$-R^{12},
(13) -CO$_2$H,
(14) -CN, and
(15) -NO$_2$;

R^4 and R^5 are independently selected from hydrogen and C_{1-6}alkyl, which is unsubstituted or substituted with one or more substituents selected from R^{13}, or R^4 and R^5 may be joined together to form a C_{3-6}cycloalkyl with the carbon atom to which they are attached, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{13};

R^6 is hydrogen, C_{1-6}alkyl or C_{3-6}cycloalkyl, which is unsubstituted or substituted with one or more substituents selected from R^{13};

R^{13} is selected from the group consisting of:

(1) halogen,
(2) hydroxyl,
(3) $-(C=O)_m-O_n-C_{1-6}$alkyl, where the alkyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(4) $-O_n-(C_{1-3})$perfluoroalkyl,
(5) $-(C=O)_m-O_n-C_{3-6}$cycloalkyl, where the cycloalkyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(6) $-(C=O)_m-C_{2-4}$alkenyl, where the alkenyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(7) $-(C=O)_m-C_{2-4}$alkynyl, where the alkynyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(8) $-(C=O)_m-O_n$-phenyl or $-(C=O)_m-O_n$-napthyl, where the phenyl or naphthyl is unsubstituted or substituted with one or more substituents selected from R^{14},
(9) $-(C=O)_m-O_n$-heterocycle, where the heterocycle is unsubstituted or substituted with one or more substituents selected from R^{14},
(10) $-(C=O)_m-NR^{10}R^{11}$,
(11) $-S(O)_2-NR^{10}R^{11}$,
(12) $-S(O)_q-R^{12}$,
(13) $-CO_2H$,
(14) -CN, and
(15) $-NO_2$;

R^{14} is selected from the group consisting of:

(1) hydroxyl,
(2) halogen,
(3) C_{1-6}alkyl,

(4) -C_{3-6}cycloalkyl,
(5) -O-C_{1-6}alkyl,
(6) -O(C=O)-C_{1-6}alkyl,
(7) -NH-C_{1-6}alkyl,
(8) phenyl,
(9) heterocycle,
(10) -CO_2H, and
(11) -CN;

or a pharmaceutically acceptable salt thereof.

2. The compound of Claim 1 wherein A^1 is phenyl.

3. The compound of Claim 1 wherein A^1 is pyridyl.

4. The compound of Claim 1 wherein A^2 is phenyl.

5. The compound of Claim 1 wherein A^2 is heteroaryl.

6. The compound of Claim 1 wherein A^3 is phenyl.

7. The compound of Claim 1 wherein A^3 is thiazolyl.

8. The compound of Claim 1 wherein R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:

(1) hydrogen,
(2) halogen,
(3) hydroxyl,
(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl, phenyl or napthyl,
(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl,
(6) heteroaryl, wherein heteroaryl is selected from pyrrolyl, imidazolyl, indolyl, pyridyl, and pyrimidinyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,
(7) phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl,

-O-C_{1-6}alkyl or-NO_2,

(8) -O-phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2, and

(9) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2.

9. The compound of Claim 8 wherein R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl or napthyl, and

(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl.

10. The compound of Claim 9 wherein R^{1a}, R^{1b} and R^{1c} are independently selected from the group consisting of:

(1) hydrogen,

(2) chloro,

(3) fluroro, and

(4) methyl.

11. The compound of Claim 1 wherein R^{2a}, R^{2b} and R^{2c} are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl or napthyl,

(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl,

(6) heteroaryl, wherein heteroaryl is selected from pyrrolyl, imidazolyl, indolyl, pyridyl, and pyrimidinyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,

(7) phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,

(8) -O-phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2, and

(9) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2.

12. The compound of Claim 11 wherein R^{2a}, R^{2b} and R^{2c} are independently selected from the group consisting of:

(1) hydrogen,

(2) chloro,

(3) fluoro,

(4) bromo,

(5) methoxy,

(6) t-butoxy,

(7) difluoromethyl, and

(8) trifluoromethyl,

(9) -N(CH_3).

13. The compound of Claim 1 wherein R^{3a}, R^{3b} and R^{3c} are independently selected from the group consisting of:

(1) hydrogen,

(2) halogen,

(3) hydroxyl,

(4) C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl, phenyl or napthyl,

(5) -O-C_{1-6}alkyl, which is unsubstituted or substituted with halogen, hydroxyl or phenyl,

(6) heteroaryl, wherein heteroaryl is selected from pyrrolyl, imidazolyl, indolyl, pyridyl, and pyrimidinyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,

(7) phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2,

(8) -O-phenyl, which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2, and

(9) -NH-C_{1-6}alkyl, or -N(C_{1-6}alkyl)(C_{1-6}alkyl), which is unsubstituted or substituted with halogen, hydroxyl, C_{1-6}alkyl, -O-C_{1-6}alkyl or-NO_2.

14. The compound of Claim 13 wherein R^{3a}, R^{3b} and R^{3c} are independently selected from the group consisting of:

(1) hydrogen,
(2) halogen, and
(3) C_{1-6}alkyl.

15. A compound which is selected from the group consisting of:
N-[(5,6-dimethoxypyridin-2-yl)methyl]-6-(2-fluorophenyl)-5'-methyl-3,3'-bipyridine-5-carboxamide;
N-(3,4-dimethoxybenzyl)-2,5-bis(3,5-dimethylphenyl) isonicotinamide;
N-(3,4-dimethoxybenzyl)-6-(3,5-dimethylphenyl)-3,3'-bipyridine-4-carboxamide;
N-(3,4-dimethoxybenzyl)-2-(3,5-dimethylphenyl)-5-(1-methyl-1H-pyrazol-4-yl)isonicotinamide;
N-(3,4-dimethoxybenzyl)-5-methyl-3,2':5',3"-terpyridine-4'-carboxamide;
6-(3-chloro-5-methylphenyl)-N-(3,4-dimethoxybenzyl)-3,3'-bipyridine-4-carboxamide;
N-[(5,6-dimethoxypyridin-3-yl)methyl]-2-(3,5-dimethylphenyl)-5-phenylisonicotinamide;
5"-chloro-N-[(5,6-dimethoxypyridin-2-yl)methyl]-2,3':6',3"-terpyridine-4'-carboxamide;
N-[(5,6-dimethoxypyrazin-2-yl)methyl]-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide;
N-(3-cyclopropyl-4-methoxybenzyl)-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide;
N-[(5,6-dimethoxypyridin-2-yl)methyl]-5-(2-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide;
N-[(5,6-dimethoxypyridin-2-yl)methyl]-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide;
5-(3-fluorophenyl)-N-[4-methoxy-3-(trifluoromethyl)benzyl]-5'-methyl-2,3'-bipyridine-4-carboxamide;
N-(3-chloro-4-methoxybenzyl)-5-(3-fluorophenyl)-5'-methyl-2,3'-bipyridine-4-carboxamide;
N-[(5,6-dimethoxypyridin-2-yl)methyl]-5'-methyl-5-pyrazin-2-yl-2,3'-bipyridine-4-carboxamide;
N-[(5,6-dimethoxy-2-pyridinyl)methyl]-5'-methyl-5-(1-pyrrolidinyl)-2,3'-bipyridine-4-carboxamide;

5-azetidin-1-yl-N-[(5,6-dimethoxypyridin-2-yl)methyl]-5'-methyl-2,3'-bipyridine-4-carboxamide;
N-[(5,6-dimethoxypyridin-2-yl)methyl]-5'-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide;
5'-chloro-N-[(5,6-dimethoxypyridin-2-yl)methyl]-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide;
N-[(5-cyclopropyl-6-methoxypyridin-2-yl)methyl]-5'-methyl-5-(1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide;
N-(3-chloro-4-methoxybenzyl)-5'-methyl-5-(5-methyl-1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide;
N-(3-ethyl-4-methoxybenzyl)-5'-methyl-5-(4-methyl-1,3-thiazol-2-yl)-2,3'-bipyridine-4-carboxamide;
or a pharmaceutically acceptable salt thereof.

16. A pharmaceutical composition which comprises an inert carrier and a compound of Claim 1 or a pharmaceutically acceptable salt thereof.

17. A compound of Claim 1 or a pharmaceutically acceptable salt thereof for use in medicine.

18. Use of a compound of Claim 1, or a pharmaceutically acceptable salt thereof, for the manufacture of a medicament for the treatment or prevention of a sleep disorder.

19. A method for enhancing the quality of sleep in a mammalian patient in need thereof which comprises administering to the patient a therapeutically effective amount of the compound of Claim 1 or a pharmaceutically acceptable salt thereof.

20. A method for treating insomnia in a mammalian patient in need thereof which comprises administering to the patient a therapeutically effective amount of the compound of Claim 1 or a pharmaceutically acceptable salt thereof.

21. A method for treating or controlling obesity in a mammalian patient in need thereof which comprises administering to the patient a therapeutically effective amount of the compound of Claim 1 or a pharmaceutically acceptable salt thereof.