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(54) Title: COMPOUNDS USEFUL AS INHIBITORS OF JANUS KINASES

(57) Abstract: The present invention relates to compounds useful as inhibitors of protein kinases, particularly of JAK family kinases. The invention also provides pharmaceutically acceptable compositions comprising said compounds and methods of using the compositions in the treatment of various disease, conditions, or disorders.

COMPOUNDS USEFUL AS INHIBITORS OF JANUS KINASES

TECHNICAL FIELD OF THE INVENTION

[0100] The present invention relates to compounds useful as inhibitors of Janus kinases (JAK). The invention also provides pharmaceutically acceptable compositions comprising the compounds of the invention and methods of using the compositions in the treatment of various disorders.

BACKGROUND OF THE INVENTION

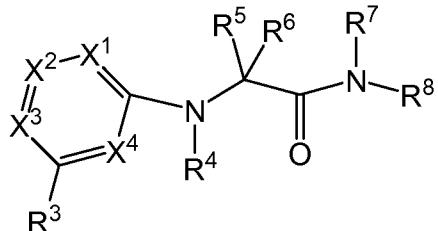
[0101] The Janus kinases (JAK) are a family of tyrosine kinases consisting of JAK1, JAK2, JAK3 and TYK2. The JAKs play a critical role in cytokine signaling. The down-stream substrates of the JAK family of kinases include the signal transducer and activator of transcription (STAT) proteins. JAK/STAT signaling has been implicated in the mediation of many abnormal immune responses such as allergies, asthma, autoimmune diseases such as transplant rejection, rheumatoid arthritis, psoriasis, amyotrophic lateral sclerosis and multiple sclerosis as well as in solid and hematologic malignancies such as leukemias and lymphomas. JAK2 has also been implicated in myeloproliferative disorders, which include polycythemia vera, essential thrombocythemia, chronic idiopathic myelofibrosis, myeloid metaplasia with myelofibrosis, chronic myeloid leukemia, chronic myelomonocytic leukemia, chronic eosinophilic leukemia, hypereosinophilic syndrome and systematic mast cell disease.

[0102] Accordingly, there is a great need to develop compounds useful as inhibitors of protein kinases. In particular, it would be desirable to develop compounds that are useful as inhibitors of JAK family kinases.

SUMMARY OF THE INVENTION

[0103] It has now been found that compounds of this invention, and pharmaceutically acceptable compositions thereof, are effective as inhibitors of protein

kinases, particularly the JAK family kinases. These compounds have the general formula I:



I

or a pharmaceutically acceptable salt thereof, wherein X¹, X², X³, X⁴, R³, R⁴, R⁵, R⁶, R⁷ and R⁸ are as defined herein.

[0104] These compounds, and pharmaceutically acceptable compositions thereof, are useful for treating or lessening the severity of a variety of disorders, including proliferative disorders, cardiac disorders, neurodegenerative disorders, autoimmune disorders, conditions associated with organ transplantation, inflammatory disorders, or immunologically mediated disorders in a patient.

[0105] The compounds and compositions provided by this invention are also useful for the study of JAK kinases in biological and pathological phenomena; the study of intracellular signal transduction pathways mediated by such kinases; and the comparative evaluation of new kinase inhibitors.

DETAILED DESCRIPTION OF THE INVENTION

Definitions and General Terminology

[0106] As used herein, the following definitions shall apply unless otherwise indicated. For purposes of this invention, the chemical elements are identified in accordance with the Periodic Table of the Elements, CAS version, and the Handbook of Chemistry and Physics, 75th Ed. 1994. Additionally, general principles of organic chemistry are described in "Organic Chemistry", Thomas Sorrell, University Science Books, Sausalito: 1999, and "March's Advanced Organic Chemistry", 5th Ed., Smith, M.B. and March, J., eds. John Wiley & Sons, New York: 2001, the entire contents of which are hereby incorporated by reference.

[0107] As described herein, compounds of the invention may optionally be substituted with one or more substituents, such as are illustrated generally above, or as

exemplified by particular classes, subclasses, and species of the invention. It will be appreciated that the phrase “optionally substituted” is used interchangeably with the phrase “substituted or unsubstituted.” In general, the term “substituted”, whether preceded by the term “optionally” or not, refers to the replacement of one or more hydrogen radicals in a given structure with the radical of a specified substituent. Unless otherwise indicated, an optionally substituted group may have a substituent at each substitutable position of the group. When more than one position in a given structure can be substituted with more than one substituent selected from a specified group, the substituent may be either the same or different at each position.

[0108] As described herein, when the term “optionally substituted” precedes a list, said term refers to all of the subsequent substitutable groups in that list. If a substituent radical or structure is not identified or defined as “optionally substituted”, the substituent radical or structure is unsubstituted. For example, if X is halogen; optionally substituted C₁₋₃alkyl or phenyl; X may be either optionally substituted alkyl or optionally substituted phenyl. Likewise, if the term “optionally substituted” follows a list, said term also refers to all of the substitutable groups in the prior list unless otherwise indicated. For example: if X is halogen, C₁₋₃alkyl or phenyl wherein X is optionally substituted by J^X, then both C₁₋₃alkyl and phenyl may be optionally substituted by J^X. As is apparent to one having ordinary skill in the art, groups such as H, halogen, NO₂, CN, NH₂, OH, or OCF₃ would not be included because they are not substitutable groups.

[0109] Combinations of substituents envisioned by this invention are preferably those that result in the formation of stable or chemically feasible compounds. The term “stable”, as used herein, refers to compounds that are not substantially altered when subjected to conditions to allow for their production, detection, and, preferably, their recovery, purification, and use for one or more of the purposes disclosed herein. In some embodiments, a stable compound or chemically feasible compound is one that is not substantially altered when kept at a temperature of 40°C or less, in the absence of moisture or other chemically reactive conditions, for at least a week.

[0110] The term “aliphatic” or “aliphatic group”, as used herein, means a straight-chain (i.e., unbranched) or branched, substituted or unsubstituted hydrocarbon chain that is completely saturated or that contains one or more units of unsaturation. Unless otherwise specified, aliphatic groups contain 1-20 aliphatic carbon atoms. In

some embodiments, aliphatic groups contain 1-10 aliphatic carbon atoms. In other embodiments, aliphatic groups contain 1-8 aliphatic carbon atoms. In still other embodiments, aliphatic groups contain 1-6 aliphatic carbon atoms, and in yet other embodiments, aliphatic groups contain 1-4 aliphatic carbon atoms. Suitable aliphatic groups include, but are not limited to, linear or branched, substituted or unsubstituted alkyl, alkenyl, or alkynyl groups. Further examples of aliphatic groups include methyl, ethyl, propyl, butyl, isopropyl, isobutyl, vinyl, and sec-butyl.

[0111] The term “cycloaliphatic” (or “carbocycle” or “cycloalkyl”) refers to a hydrocarbon that is completely saturated or that contains one or more units of unsaturation, but which is not aromatic, that has a single point of attachment to the rest of the molecule, and wherein any individual ring in said bicyclic ring system has 3-7 members. Unless otherwise specified, the term “cycloaliphatic” refers to a monocyclic C₃-C₈ hydrocarbon or bicyclic C₈-C₁₂ hydrocarbon. Suitable cycloaliphatic groups include, but are not limited to, cycloalkyl, cycloalkenyl, and cycloalkynyl. Further examples of aliphatic groups include cyclopropyl, cyclobutyl, cyclopentyl, cyclopentenyl, cyclohexyl, cyclohexenyl, cycloheptyl, and cycloheptenyl.

[0112] The term “heterocycle”, “heterocyclyl” or “heterocyclic” as used herein refers to a monocyclic, bicyclic, or tricyclic ring system in which one or more ring members are an independently selected heteroatom and that is completely saturated or that contains one or more units of unsaturation, but which is not aromatic, that has a single point of attachment to the rest of the molecule. In some embodiments, the “heterocycle”, “heterocyclyl” or “heterocyclic” group has three to fourteen ring members in which one or more ring members is a heteroatom independently selected from oxygen, sulfur, nitrogen, or phosphorus, and each ring in the system contains 3 to 7 ring members.

[0113] Examples of heterocyclic rings include, but are not limited to, the following monocycles: 2-tetrahydrofuranyl, 3-tetrahydrofuranyl, 2-tetrahydrothiophenyl, 3-tetrahydrothiophenyl, 2-morpholino, 3-morpholino, 4-morpholino, 2-thiomorpholino, 3-thiomorpholino, 4-thiomorpholino, 1-pyrrolidinyl, 2-pyrrolidinyl, 3-pyrrolidinyl, 1-tetrahydropiperazinyl, 2-tetrahydropiperazinyl, 3-tetrahydropiperazinyl, 1-piperidinyl, 2-piperidinyl, 3-piperidinyl, 1-pyrazolinyl, 3-pyrazolinyl, 4-pyrazolinyl, 5-pyrazolinyl, 1-piperidinyl, 2-piperidinyl, 3-piperidinyl, 4-piperidinyl, 2-thiazolidinyl, 3-thiazolidinyl,

4-thiazolidinyl, 1-imidazolidinyl, 2-imidazolidinyl, 4-imidazolidinyl, 5-imidazolidinyl; and the following bicycles: 3-1H-benzimidazol-2-one, 3-(1-alkyl)-benzimidazol-2-one, indolinyl, tetrahydroquinolinyl, tetrahydroisoquinolinyl, benzothiolane, benzodithiane, and 1,3-dihydro-imidazol-2-one.

[0114] The term "heteroatom" means one or more of oxygen, sulfur, nitrogen, phosphorus, or silicon, including any oxidized form of nitrogen, sulfur, phosphorus, or silicon, the quaternized form of any basic nitrogen, or a substitutable nitrogen of a heterocyclic ring, for example N (as in 3,4-dihydro-2H-pyrrolyl), NH (as in pyrrolidinyl) or NR⁺ (as in N-substituted pyrrolidinyl).

[0115] The term "unsaturated", as used herein, means that a moiety has one or more units of unsaturation.

[0116] The term "aryl" used alone or as part of a larger moiety as in "aralkyl", "aralkoxy", or "aryloxyalkyl", refers to monocyclic, bicyclic, and tricyclic carbocyclic ring systems having a total of six to fourteen ring members, wherein at least one ring in the system is aromatic, wherein each ring in the system contains 3 to 7 ring members and that has a single point of attachment to the rest of the molecule. The term "aryl" may be used interchangeably with the term "aryl ring". Examples of aryl rings would include phenyl, naphthyl, and anthracene.

[0117] The term "heteroaryl", used alone or as part of a larger moiety as in "heteroaralkyl" or "heteroarylalkoxy", refers to monocyclic, bicyclic, and tricyclic ring systems having a total of five to fourteen ring members, wherein at least one ring in the system is aromatic, at least one ring in the system contains one or more heteroatoms, wherein each ring in the system contains 3 to 7 ring members and that has a single point of attachment to the rest of the molecule. The term "heteroaryl" may be used interchangeably with the term "heteroaryl ring" or the term "heteroaromatic".

[0118] Further examples of heteroaryl rings include the following monocycles: 2-furanyl, 3-furanyl, N-imidazolyl, 2-imidazolyl, 4-imidazolyl, 5-imidazolyl, 3-isoxazolyl, 4-isoxazolyl, 5-isoxazolyl, 2-oxazolyl, 4-oxazolyl, 5-oxazolyl, N-pyrrolyl, 2-pyrrolyl, 3-pyrrolyl, 2-pyridyl, 3-pyridyl, 4-pyridyl, 2-pyrimidinyl, 4-pyrimidinyl, 5-pyrimidinyl, pyridazinyl (e.g., 3-pyridazinyl), 2-thiazolyl, 4-thiazolyl, 5-thiazolyl, tetrazolyl (e.g., 5-tetrazolyl), triazolyl (e.g., 2-triazolyl and 5-triazolyl), 2-thienyl, 3-thienyl, pyrazolyl (e.g., 2-pyrazolyl), isothiazolyl, 1,2,3-oxadiazolyl, 1,2,5-

oxadiazolyl, 1,2,4-oxadiazolyl, 1,2,3-triazolyl, 1,2,3-thiadiazolyl, 1,3,4-thiadiazolyl, 1,2,5-thiadiazolyl, pyrazinyl, 1,3,5-triazinyl, and the following bicycles: benzimidazolyl, benzofuryl, benzothiophenyl, indolyl (e.g., 2-indolyl), purinyl, quinolinyl (e.g., 2-quinolinyl, 3-quinolinyl, 4-quinolinyl), and isoquinolinyl (e.g., 1-isoquinolinyl, 3-isoquinolinyl, or 4-isoquinolinyl).

[0119] In some embodiments, an aryl (including aralkyl, aralkoxy, aryloxyalkyl and the like) or heteroaryl (including heteroaralkyl and heteroarylalkoxy and the like) group may contain one or more substituents. Suitable substituents on the unsaturated carbon atom of an aryl or heteroaryl group are selected from those listed in the definitions of R^2 and R^4 below. Other suitable substituents include: halogen; $-R^{\circ}$; $-OR^{\circ}$; $-SR^{\circ}$; 1,2-methylenedioxy; 1,2-ethylenedioxy; phenyl (Ph) optionally substituted with R° ; $-O(Ph)$ optionally substituted with R° ; $-(CH_2)_{1-2}(Ph)$, optionally substituted with R° ; $-CH=CH(Ph)$, optionally substituted with R° ; $-NO_2$; $-CN$; $-N(R^{\circ})_2$; $-NR^{\circ}C(O)R^{\circ}$; $-NR^{\circ}C(S)R^{\circ}$; $-NR^{\circ}C(O)N(R^{\circ})_2$; $-NR^{\circ}C(S)N(R^{\circ})_2$; $-NR^{\circ}CO_2R^{\circ}$; $-NR^{\circ}NR^{\circ}C(O)R^{\circ}$; $-NR^{\circ}NR^{\circ}C(O)N(R^{\circ})_2$; $-NR^{\circ}NR^{\circ}CO_2R^{\circ}$; $-C(O)C(O)R^{\circ}$; $-C(O)CH_2C(O)R^{\circ}$; $-CO_2R^{\circ}$; $-C(O)R^{\circ}$; $-C(S)R^{\circ}$; $-C(O)N(R^{\circ})_2$; $-C(S)N(R^{\circ})_2$; $-OC(O)N(R^{\circ})_2$; $-OC(O)R^{\circ}$; $-C(O)N(OR^{\circ})R^{\circ}$; $-C(NOR^{\circ})R^{\circ}$; $-S(O)_2R^{\circ}$; $-S(O)_3R^{\circ}$; $-SO_2N(R^{\circ})_2$; $-S(O)R^{\circ}$; $-NR^{\circ}SO_2N(R^{\circ})_2$; $-NR^{\circ}SO_2R^{\circ}$; $-N(OR^{\circ})R^{\circ}$; $-C(=NH)-N(R^{\circ})_2$; or $-(CH_2)_{0-2}NHC(O)R^{\circ}$; wherein each independent occurrence of R° is selected from hydrogen, optionally substituted C₁₋₆ aliphatic, an unsubstituted 5-6 membered heteroaryl or heterocyclic ring, phenyl, $-O(Ph)$, or $-CH_2(Ph)$, or, two independent occurrences of R° , on the same substituent or different substituents, taken together with the atom(s) to which each R° group is bound, form a 5-8-membered heterocyclyl, aryl, or heteroaryl ring or a 3-8-membered cycloalkyl ring, wherein said heteroaryl or heterocyclyl ring has 1-3 heteroatoms independently selected from nitrogen, oxygen, or sulfur. Optional substituents on the aliphatic group of R° are selected from NH₂, NH(C₁₋₄aliphatic), N(C₁₋₄aliphatic)₂, halogen, C₁₋₄aliphatic, OH, O(C₁₋₄aliphatic), NO₂, CN, CO₂H, CO₂(C₁₋₄aliphatic), O(haloC₁₋₄ aliphatic), or haloC₁₋₄aliphatic, wherein each of the foregoing C₁₋₄aliphatic groups of R° is unsubstituted.

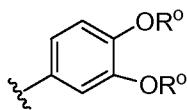
[0120] In some embodiments, an aliphatic or heteroaliphatic group, or a non-aromatic heterocyclic ring may contain one or more substituents. Suitable substituents on the saturated carbon of an aliphatic or heteroaliphatic group, or of a non-aromatic

heterocyclic ring are selected from those listed above for the unsaturated carbon of an aryl or heteroaryl group and additionally include the following: =O, =S, =NNHR*, =NN(R*)₂, =NNHC(O)R*, =NNHCO₂(alkyl), =NNHSO₂(alkyl), or =NR*, where each R* is independently selected from hydrogen or an optionally substituted C₁₋₆ aliphatic. Optional substituents on the aliphatic group of R* are selected from NH₂, NH(C₁₋₄ aliphatic), N(C₁₋₄ aliphatic)₂, halogen, C₁₋₄ aliphatic, OH, O(C₁₋₄ aliphatic), NO₂, CN, CO₂H, CO₂(C₁₋₄ aliphatic), O(halo C₁₋₄ aliphatic), or halo(C₁₋₄ aliphatic), wherein each of the foregoing C₁₋₄aliphatic groups of R* is unsubstituted.

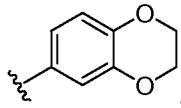
[0121] In some embodiments, optional substituents on the nitrogen of a non-aromatic heterocyclic ring include -R⁺, -N(R⁺)₂, -C(O)R⁺, -CO₂R⁺, -C(O)C(O)R⁺, -C(O)CH₂C(O)R⁺, -SO₂R⁺, -SO₂N(R⁺)₂, -C(=S)N(R⁺)₂, -C(=NH)-N(R⁺)₂, or -NR⁺SO₂R⁺; wherein R⁺ is hydrogen, an optionally substituted C₁₋₆ aliphatic, optionally substituted phenyl, optionally substituted -O(Ph), optionally substituted -CH₂(Ph), optionally substituted -(CH₂)₁₋₂(Ph); optionally substituted -CH=CH(Ph); or an unsubstituted 5-6 membered heteroaryl or heterocyclic ring having one to four heteroatoms independently selected from oxygen, nitrogen, or sulfur, or, two independent occurrences of R⁺, on the same substituent or different substituents, taken together with the atom(s) to which each R⁺ group is bound, form a 5-8-membered heterocyclyl, aryl, or heteroaryl ring or a 3-8-membered cycloalkyl ring, wherein said heteroaryl or heterocyclyl ring has 1-3 heteroatoms independently selected from nitrogen, oxygen, or sulfur. Optional substituents on the aliphatic group or the phenyl ring of R⁺ are selected from NH₂, NH(C₁₋₄ aliphatic), N(C₁₋₄ aliphatic)₂, halogen, C₁₋₄ aliphatic, OH, O(C₁₋₄ aliphatic), NO₂, CN, CO₂H, CO₂(C₁₋₄ aliphatic), O(halo C₁₋₄ aliphatic), or halo(C₁₋₄ aliphatic), wherein each of the foregoing C₁₋₄aliphatic groups of R⁺ is unsubstituted.

[0122] As detailed above, in some embodiments, two independent occurrences of R° (or R⁺, or any other variable similarly defined herein), may be taken together with the atom(s) to which each variable is bound to form a 5-8-membered heterocyclyl, aryl, or heteroaryl ring or a 3-8-membered cycloalkyl ring. Exemplary rings that are formed when two independent occurrences of R° (or R⁺, or any other variable similarly defined herein) are taken together with the atom(s) to which each variable is bound include, but are not limited to the following: a) two independent occurrences of R° (or R⁺, or any other variable similarly defined herein) that are bound to

the same atom and are taken together with that atom to form a ring, for example, $N(R^o)_2$, where both occurrences of R^o are taken together with the nitrogen atom to form a piperidin-1-yl, piperazin-1-yl, or morpholin-4-yl group; and b) two independent occurrences of R^o (or R^+ , or any other variable similarly defined herein) that are bound to different atoms and are taken together with both of those atoms to form a ring, for example where a phenyl group is substituted with two occurrences of OR^o



, these two occurrences of R^o are taken together with the oxygen atoms to which they are bound to form a fused 6-membered oxygen containing ring:

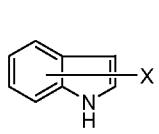
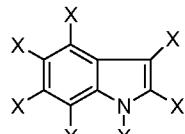


. It will be appreciated that a variety of other rings can be formed when two independent occurrences of R^o (or R^+ , or any other variable similarly defined herein) are taken together with the atom(s) to which each variable is bound and that the examples detailed above are not intended to be limiting.

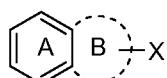
[0123] In some embodiments, an alkyl or aliphatic chain can be optionally interrupted with another atom or group. This means that a methylene unit of the alkyl or aliphatic chain is optionally replaced with said other atom or group. Examples of such atoms or groups would include, but are not limited to, $-NR-$, $-O-$, $-S-$, $-CO_2-$, $-OC(O)-$, $-C(O)CO-$, $-C(O)-$, $-C(O)NR-$, $-C(N-CN)$, $-NRCO-$, $-NRC(O)O-$, $-SO_2NR-$, $-NRSO_2-$, $-NRC(O)NR-$, $-OC(O)NR-$, $-NRSO_2NR-$, $-SO-$, or $-SO_2-$, wherein R is defined herein. Unless otherwise specified, the optional replacements form a chemically stable compound. Optional interruptions can occur both within the chain and at either end of the chain; i.e. both at the point of attachment and/or also at the terminal end. Two optional replacements can also be adjacent to each other within a chain so long as it results in a chemically stable compound. Unless otherwise specified, if the replacement or interruption occurs at the terminal end, the replacement atom is bound to an H on the terminal end. For example, if $-CH_2CH_2CH_3$ were optionally interrupted with $-O-$, the resulting compound could be $-OCH_2CH_3$, $-CH_2OCH_3$, or $-CH_2CH_2OH$.

[0124] As described herein, a bond drawn from a substituent to the center of one ring within a multiple-ring system (as shown below), represents substitution of the substituent at any substitutable position in any of the rings within the multiple ring

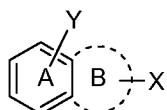
system. For example, Figure **a** represents possible substitution in any of the positions shown in Figure **b**.

Figure **a**Figure **b**

[0125] This also applies to multiple ring systems fused to optional ring systems (which would be represented by dotted lines). For example, in Figure **c**, X is an optional substituent both for ring A and ring B.

Figure **c**

[0126] If, however, two rings in a multiple ring system each have different substituents drawn from the center of each ring, then, unless otherwise specified, each substituent only represents substitution on the ring to which it is attached. For example, in Figure **d**, Y is an optionally substituent for ring A only, and X is an optional substituent for ring B only.

Figure **d**

[0127] Unless otherwise stated, structures depicted herein are also meant to include all isomeric (e.g., enantiomeric, diastereomeric, and geometric (or conformational)) forms of the structure; for example, the R and S configurations for each asymmetric center, (Z) and (E) double bond isomers, and (Z) and (E) conformational isomers. Therefore, single stereochemical isomers as well as enantiomeric, diastereomeric, and geometric (or conformational) mixtures of the present compounds are within the scope of the invention.

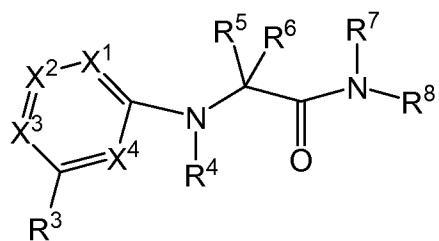
[0128] Unless otherwise stated, all tautomeric forms of the compounds of the invention are within the scope of the invention. Additionally, unless otherwise stated, structures depicted herein are also meant to include compounds that differ only in the presence of one or more isotopically enriched atoms. For example, compounds having

the present structures except for the replacement of hydrogen by deuterium or tritium, or the replacement of a carbon by a ¹³C- or ¹⁴C-enriched carbon are within the scope of this invention. Such compounds are useful, for example, as analytical tools, probes in biological assays, or as JAK inhibitors with improved therapeutic profile.

Description of Compounds of the Invention

[0129]

The present invention relates to a compound of formula I:



I

or a pharmaceutically acceptable salt thereof, wherein:

X¹ is N or CR¹;

X² is N or CR²; wherein no more than one of X¹ or X² is N;

X³ is N or CR²³;

X⁴ is N or CR²⁴; wherein at least one of X³ and X⁴ is N;

R¹ is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

R² is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

or R¹ and R², taken together, form a 5-7 membered aryl or heteroaryl ring optionally substituted with 1-4 occurrences of R⁹;

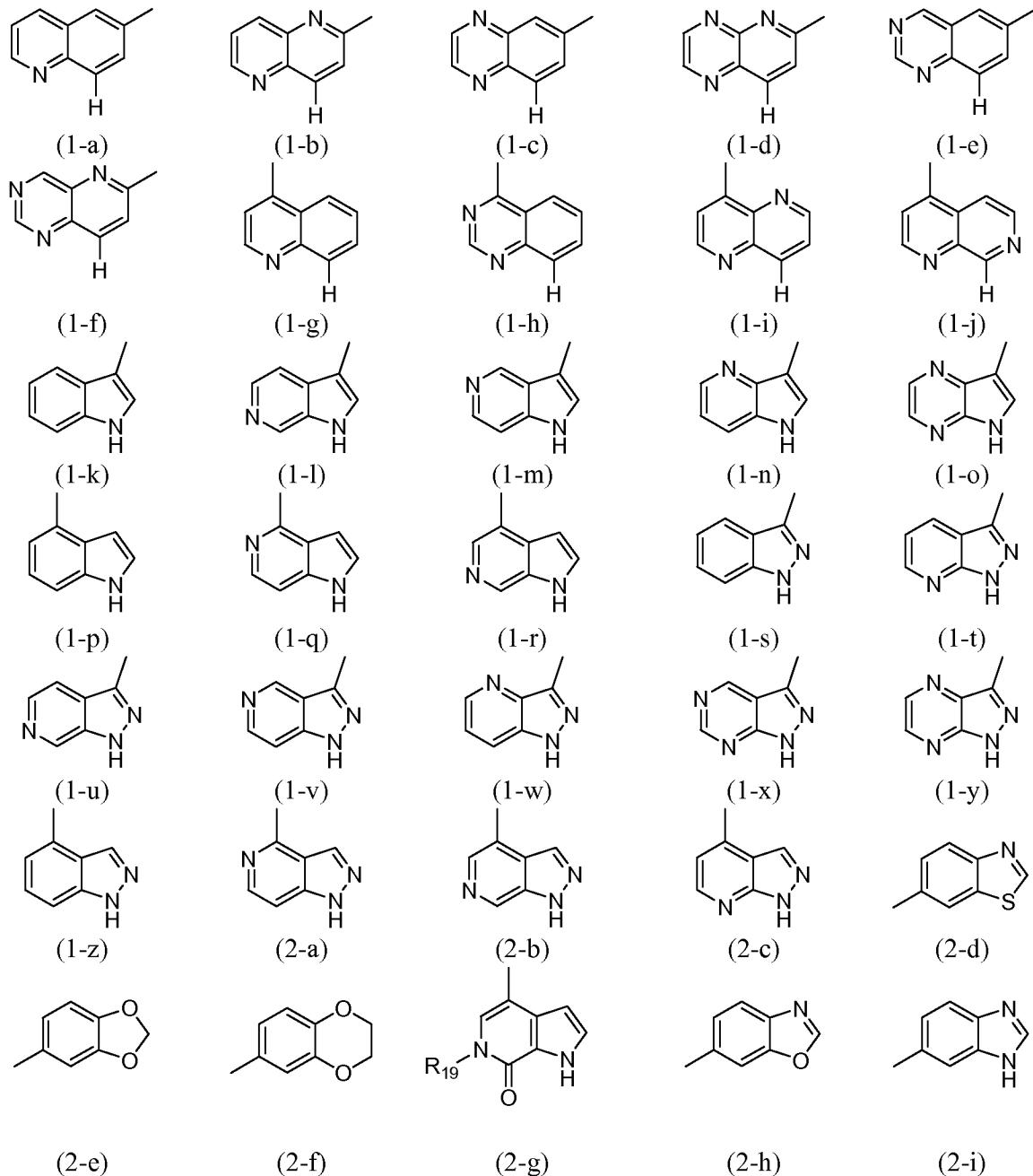
each R⁹ is independently selected from halogen, OCH₃, OH, NO₂, NH₂, SH, SCH₃, NCH₃, CN or unsubstituted C₁₋₂aliphatic;

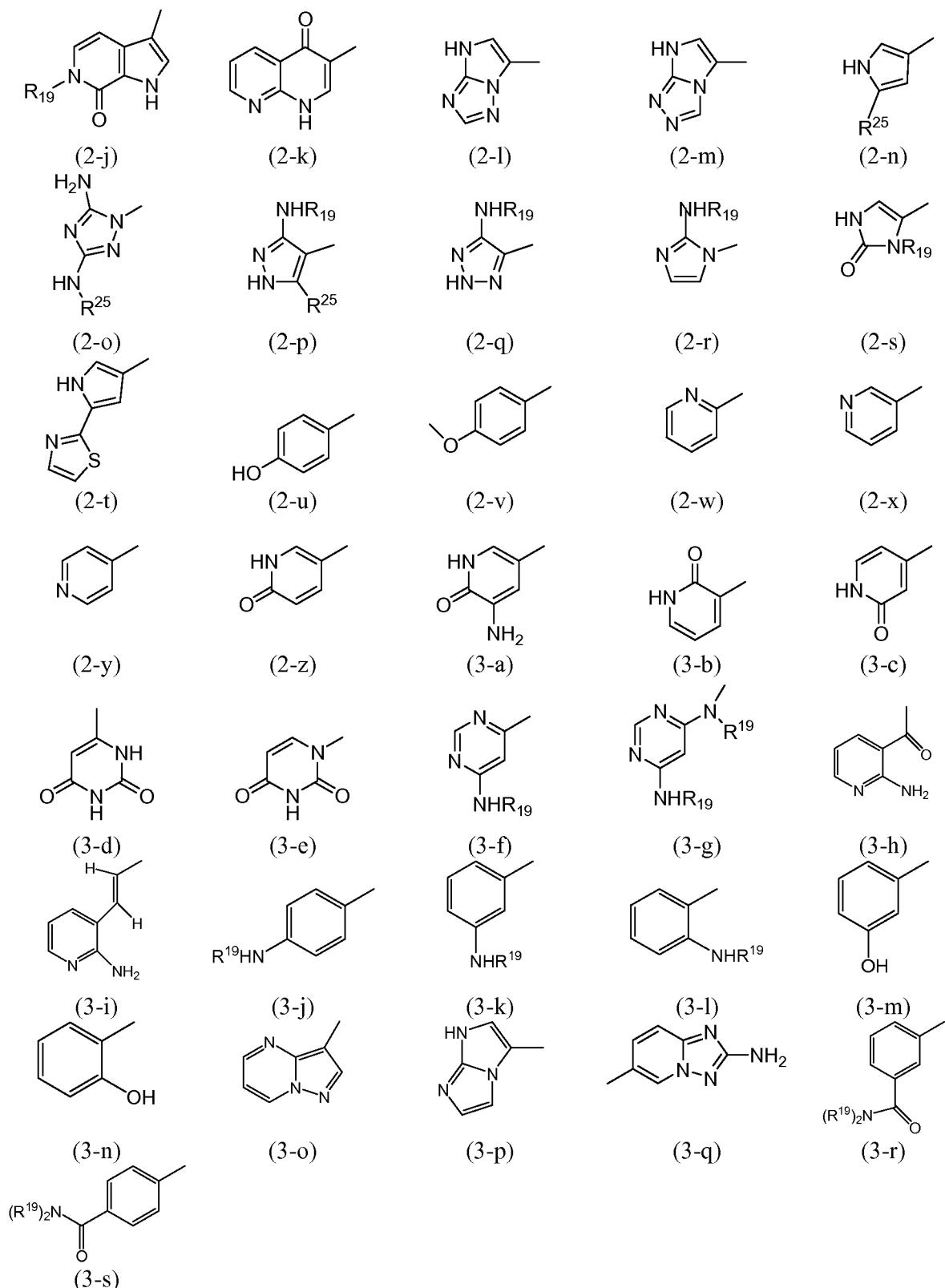
R²³ is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

R²⁴ is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

R' is a C₁₋₃ aliphatic optionally substituted with 1-4 occurrences of R¹⁰;

each R^{10} is independently selected from halogen, CF_3 , OCH_3 , OH, SH, NO_2 , NH_2 , SCH_3 , NCH_3 , CN or unsubstituted C_{1-2} aliphatic, or two R^{10} groups, together with the carbon to which they are attached, form a cyclopropyl ring or $C=O$;
 R^3 is selected from





R^{19} is selected from H; a C_{3-7} cycloaliphatic optionally substituted with 1-4 occurrences of halogen, OH, NO_2 , NH_2 , SH or CN; or a C_{1-6} aliphatic, wherein up to two methylene units of said C_{1-6} aliphatic are optionally and independently replaced by G^R and wherein said C_{1-6} aliphatic is optionally substituted with 1-4 R^{20} ;

G^R is -NH-, -NR²¹-, -O-, -S-, -CO₂-, -OC(O)-, -C(O)CO-, -C(O)-, -C(O)NH-, -C(O)NR²¹-, -NC(=N-CN)N-, -NHCO-, -NR²¹CO-, -NHC(O)O-, -NR²¹C(O)O-, -SO₂NH-, -SO₂NR²¹-, -NHSO₂-, -NR²¹SO₂-, -NHC(O)NH-, -NR²¹C(O)NH-, -NHC(O)NR²¹-, -NR²¹C(O)NR²¹, -OC(O)NH-, -OC(O)NR²¹-, -NHSO₂NH-, -NR²¹SO₂NH-, -NHSO₂NR²¹-, -NR²¹SO₂NR²¹-, -SO-, or -SO₂;

R^{21} is C_{1-6} aliphatic or C_{3-7} cycloaliphatic optionally substituted with 1-6 occurrences of halogen, $N(R^X)_2$, R^X , -OR^X, -SR^X, -NO₂, -CF₃, -CN, -CO₂R^X, -COR^X, OCOR^X, CONHR^X, or NHCOR^X;

each R^X is independently selected from H or an unsubstituted C_{1-6} aliphatic;

each R^{20} is independently selected from halogen, OH, OR²², NO_2 , NH_2 , NHR^{22} , $N(R^{22})_2$, SH, SR²², CN, or R^{22} ; or two R^{20} , together with the carbon(s) to which they are attached, form a cyclopropyl ring or C=O;

each R^{22} is independently selected from a C_{1-6} aliphatic or C_{3-7} cycloaliphatic optionally substituted with 1-6 occurrences of halogen, OH, NO_2 , NH_2 , SH or CN;

R^{25} is -(U)_m-Y;

U is a C_{1-6} aliphatic, wherein up to two methylene units are optionally and independently replaced by G^U and wherein U is optionally substituted with 1-4 J^U ;

G^U is -NH-, -NR²⁶-, -O-, -S-, -CO₂-, -OC(O)-, -C(O)CO-, -C(O)-, -C(O)NH-, -C(O)NR²⁶-, -NC(=N-CN)N-, -NHCO-, -NR²⁶CO-, -NHC(O)O-, -NR²⁶C(O)O-, -SO₂NH-, -SO₂NR²⁶-, -NHSO₂-, -NR²⁶SO₂-, -NHC(O)NH-, -NR²⁶C(O)NH-, -NHC(O)NR²⁶-, -NR²⁶C(O)NR²⁶, -OC(O)NH-, -OC(O)NR²⁶-, -NHSO₂NH-, -NR²⁶SO₂NH-, -NHSO₂NR²⁶-, -NR²⁶SO₂NR²⁶-, -SO-, or -SO₂;

R^{26} is a C_{1-6} aliphatic, C_{3-10} cycloaliphatic, C_{6-10} aryl, 5-10 membered heteroaryl, or 5-10 membered heterocycl; wherein said aliphatic, cycloaliphatic, aryl, heteroaryl or heterocycl is optionally substituted with halogen, R^X , -OR^X, -SR^X, -NO₂, -CF₃, -CN, -CO₂R^X, -COR^X, OCOR^X, CONHR^X, or NHCOR^X;

each J^U is independently selected from halogen, L, -(L_n)-R', -(L_n)-N(R')₂, -(L_n)-SR', -(L_n)-OR', -(L_n)-(C₃₋₁₀ cycloaliphatic), -(L_n)-(C₆₋₁₀ aryl), -(L_n)-(5-10 membered

heteroaryl), -(L_n)-(5-10 membered heterocyclyl), oxo, C₁₋₄haloalkoxy, C₁₋₄haloalkyl, -(L_n)-NO₂, -(L_n)-CN, -(L_n)-OH, -(L_n)-CF₃, -CO₂R', -CO₂H, -COR', -COH, -OC(O)R', -C(O)NHR', C(O)N(R')₂, -NHC(O)R', or NR'C(O)R'; or two J^U groups, on the same substituent or different substituents, together with the atom(s) to which each J^U group is bound, form a 5-7 membered saturated, unsaturated, or partially saturated ring;

m is 0 or 1;

Y is H, halogen, CN, NO₂, NH₂, NHR, N(R)₂, or a group selected from a C₁₋₆aliphatic, a C₃₋₁₀ cycloaliphatic, a C₆₋₁₀ aryl, a 5-10 membered heteroaryl, or a 5-10 membered heterocyclyl, wherein said group is optionally substituted with 1-8 occurrences of J^Y;

each J^Y is independently selected from halogen, L, -(L_n)-R²⁶, -(L_n)-N(R²⁶)₂, -(L_n)-SR²⁶, -(L_n)-OR²⁶, -(L_n)-(C₃₋₁₀ cycloaliphatic), -(L_n)-(C₆₋₁₀ aryl), -(L_n)-(5-10 membered heteroaryl), -(L_n)-(5-10 membered heterocyclyl), oxo, C₁₋₄haloalkoxy, C₁₋₄haloalkyl, -(L_n)-NO₂, -(L_n)-CN, -(L_n)-OH, -(L_n)-CF₃, -CO₂R²⁶, -CO₂H, -COR²⁶, -COH, -OC(O)R²⁶, -C(O)NHR²⁶, C(O)N(R²⁶)₂, -NHC(O)R²⁶, or NR²⁶C(O)R²⁶; or two J^Y groups, on the same substituent or different substituents, together with the atom(s) to which each J^Y group is bound, form a 5-7 membered saturated, unsaturated, or partially saturated ring;

each L is independently a C₁₋₆ aliphatic wherein up to three methylene units are replaced by -NH-, -NR^L-, -O-, -S-, -CO₂-, -OC(O)-, -C(O)CO-, -C(O)-, -C(O)NH-, -C(O)NR^L-, -NC(=N-CN)N, -NHCO-, -NR^LCO-, -NHC(O)O-, -NR^LC(O)O-, -SO₂NH-, -SO₂NR^L-, -NHSO₂-, -NR^LSO₂-, -NHC(O)NH-, -NR^LC(O)NH-, -NHC(O)NR^L-, -NR^LC(O)NR^L, -OC(O)NH-, -OC(O)NR^L-, -NHSO₂NH-, -NR^LSO₂NH-, -NHSO₂NR^L-, -NR^LSO₂NR^L-, -SO-, or -SO₂-;

each n is independently 0 or 1;

R^L is selected from C₁₋₆ aliphatic, C₃₋₁₀ cycloaliphatic, C₆₋₁₀ aryl, 5-10 membered heteroaryl, or 5-10 membered heterocyclyl; or two R^L groups, on the same substituent or different substituents, together with the atom(s) to which each R^L group is bound, form a 3-8 membered heterocyclyl;

each R is independently selected from a C₁₋₆ aliphatic or a C₃₋₆ cycloaliphatic optionally substituted with 1-6 occurrences of halogen, OH, NO₂, NH₂, SH or CN, or two R

groups, together with the atom to which the R groups are bound, form a 5-7 membered saturated, unsaturated, or partially saturated ring; wherein each substitutable carbon of an R³ ring is optionally and independently substituted with halogen; -R°; -OR°; -SR°; 1,2-methylenedioxy; 1,2-ethylenedioxy; phenyl (Ph) optionally substituted with R°; -O(Ph) optionally substituted with R°; -(CH₂)₁₋₂(Ph), optionally substituted with R°; -CH=CH(Ph), optionally substituted with R°; -NO₂; -CN; -N(R°)₂; -NR°C(O)R°; -NR°C(S)R°; -NR°C(O)N(R°)₂; -NR°C(S)N(R°)₂; -NR°CO₂R°; -NR°NR°C(O)R°; -NR°NR°C(O)N(R°)₂; -NR°NR°CO₂R°; -C(O)C(O)R°; -C(O)CH₂C(O)R°; -CO₂R°; -C(O)R°; -C(S)R°; -C(O)N(R°)₂; -C(S)N(R°)₂; -OC(O)N(R°)₂; -OC(O)R°; -C(O)N(OR°) R°; -C(NOR°) R°; -S(O)₂R°; -S(O)₃R°; -SO₂N(R°)₂; -S(O)R°; -NR°SO₂N(R°)₂; -NR°SO₂R°; -N(OR°)R°; -C(=NH)-N(R°)₂; or -(CH₂)₀₋₂NHC(O)R°; wherein each independent occurrence of R° is selected from hydrogen, optionally substituted C₁₋₆ aliphatic, an unsubstituted 5-6 membered heteroaryl or heterocyclic ring, phenyl, -O(Ph), or -CH₂(Ph), or, two independent occurrences of R°, on the same substituent or different substituents, taken together with the atom(s) to which each R° group is bound, form a 5-8-membered heterocyclyl, aryl, or heteroaryl ring or a 3-8-membered cycloalkyl ring, wherein said heteroaryl or heterocyclyl ring has 1-3 heteroatoms independently selected from nitrogen, oxygen, or sulfur; and wherein each of said optional substituents on the aliphatic group of R° is independently selected from NH₂, NH(C₁₋₄aliphatic), N(C₁₋₄aliphatic)₂, halogen, C₁₋₄aliphatic, OH, O(C₁₋₄aliphatic), NO₂, CN, CO₂H, CO₂(C₁₋₄aliphatic), O(haloC₁₋₄ aliphatic), or haloC₁₋₄aliphatic, wherein each of the foregoing C₁₋₄aliphatic groups of R° is unsubstituted; wherein each substitutable nitrogen of a non-aromatic heterocyclic ring of R³ is optionally and independently substituted with -R⁺, -N(R⁺)₂, -C(O)R⁺, -CO₂R⁺, -C(O)C(O)R⁺, -C(O)CH₂C(O)R⁺, -SO₂R⁺, -SO₂N(R⁺)₂, -C(=S)N(R⁺)₂, -C(=NH)-N(R⁺)₂, or -NR⁺SO₂R⁺; wherein R⁺ is hydrogen, an optionally substituted C₁₋₆ aliphatic, optionally substituted phenyl, optionally substituted -O(Ph), optionally substituted -CH₂(Ph), optionally substituted -(CH₂)₁₋₂(Ph); optionally substituted -CH=CH(Ph); or an unsubstituted 5-6 membered heteroaryl or heterocyclic ring

having one to four heteroatoms independently selected from oxygen, nitrogen, or sulfur, or, two independent occurrences of R^+ , on the same substituent or different substituents, taken together with the atom(s) to which each R^+ group is bound, form a 5-8-membered heterocyclyl, aryl, or heteroaryl ring or a 3-8-membered cycloalkyl ring, wherein said heteroaryl or heterocyclyl ring has 1-3 heteroatoms independently selected from nitrogen, oxygen, or sulfur; wherein each of said optional substituents on the aliphatic group or the phenyl ring of R^+ is independently selected from NH_2 , $NH(C_{1-4}$ aliphatic), $N(C_{1-4}$ aliphatic)₂, halogen, C_{1-4} aliphatic, OH, $O(C_{1-4}$ aliphatic), NO_2 , CN, CO_2H , $CO_2(C_{1-4}$ aliphatic), $O(halo\ C_{1-4}$ aliphatic), or $halo(C_{1-4}$ aliphatic), wherein each of the foregoing C_{1-4} aliphatic groups of R^+ is unsubstituted;

R^4 is H or is a $-C_{1-2}$ aliphatic optionally substituted with 1-3 occurrences of R^{11} ; each R^{11} is independently selected from halogen, CF_3 , OCH_3 , OH, SH, NO_2 , NH_2 , SCH_3 , NCH_3 , CN, $CON(R^{15})_2$ or unsubstituted C_{1-2} aliphatic, or two R^{11} groups, together with the carbon to which they are attached, form a cyclopropyl ring or $C=O$;

R^{15} is H or unsubstituted C_{1-2} alkyl;

R^5 is H or a C_{1-6} aliphatic optionally substituted with 1-5 occurrences of R^{12} ;

R^6 is H or a C_{1-6} aliphatic optionally substituted with 1-5 occurrences of R^{13} ;

each R^{12} is independently selected from halogen, OCH_3 , OH, NO_2 , NH_2 , SH, SCH_3 , NCH_3 , CN or unsubstituted C_{1-2} aliphatic, or two R^{12} groups, together with the carbon to which they are attached, form a cyclopropyl ring;

each R^{13} is independently selected from halogen, OCH_3 , OH, NO_2 , NH_2 , SH, SCH_3 , NCH_3 , CN or unsubstituted C_{1-2} aliphatic, or two R^{13} groups, together with the carbon to which they are attached, form a cyclopropyl ring; or

R^5 and R^6 are taken together to form a 3-7 membered carbocyclic or heterocyclic saturated ring optionally substituted with 1-5 occurrences of R^{12} ; or

R^4 and R^6 , taken together with the nitrogen to which R^4 is attached, form a 3-8 membered saturated, partially saturated or aromatic nitrogen-containing ring comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R^{14} ; or

R^1 and R^4 , taken together with the nitrogen to which R^4 is attached, form a 3-8 membered saturated, partially saturated or aromatic nitrogen-containing ring

comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R¹⁴; or each R¹⁴ is independently selected from halogen, R'', NH₂, NHR'', N(R'')₂, SH, SR'', OH, OR'', NO₂, CN, CF₃, COOR'', COOH, COR'', OC(O)R'' or NC(O)R''; or any two R¹³ groups, on the same substituent or different substituents, together with the atom(s) to which each R¹⁴ group is bound, form a 3-7 membered saturated, unsaturated, or partially saturated carbocyclic or heterocyclic ring optionally substituted with 1-3 occurrences of R¹⁶;

R'' is a C₁₋₃ aliphatic optionally substituted with 1-4 occurrences of R¹⁰;

each R¹⁶ is independently selected from halogen, CF₃, OCH₃, OH, SH, NO₂, NH₂, SCH₃, NCH₃, CN, CON(R¹⁵)₂ or unsubstituted C₁₋₂ aliphatic, or two R¹⁶ groups, together with the carbon to which they are attached, form a cyclopropyl ring or C=O;

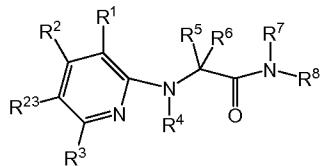
R⁷ is H or C₁₋₄ aliphatic optionally substituted with 1-3 occurrences of R¹⁷;

each R¹⁷ is independently selected from halogen, CF₃, OCH₃, OH, SH, NO₂, NH₂, SCH₃, NCH₃, CN, CON(R¹⁵)₂ or unsubstituted C₁₋₂ aliphatic, or two R¹⁷ groups, together with the carbon to which they are attached, form a cyclopropyl ring or C=O;

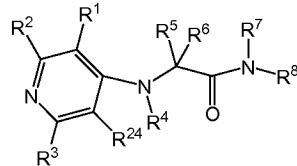
R⁸ is C₁₋₄ aliphatic optionally substituted with 1-6 occurrences of R¹⁸; and

each R¹⁸ is independently selected from halogen, CF₃, OCH₃, OH, SH, NO₂, NH₂, SCH₃, NCH₃, CN, CON(R¹⁵)₂ or unsubstituted C₁₋₂ aliphatic, or two R¹⁸ groups, together with the carbon to which they are attached, form a cyclopropyl ring or C=O.

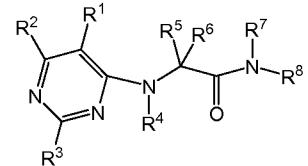
[0130] In one embodiment, a compound of the invention has one of formulae I-A, I-B, I-C, I-D, I-E, I-F, I-G, I-H or I-i:



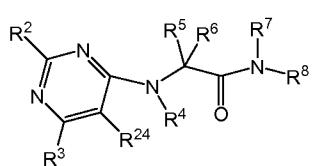
I-A



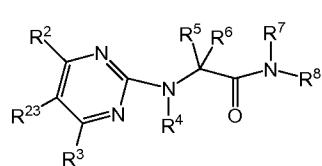
I-B



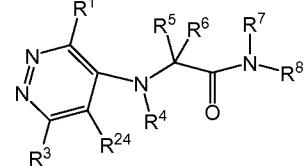
I-C



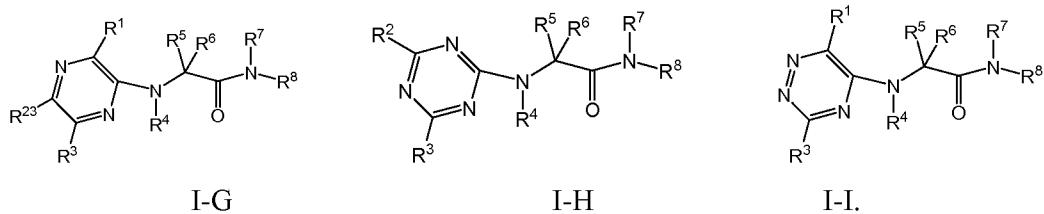
I-D



I-E



I-F



[0131] In one embodiment, said compound is selected from one of formulae I-A, I-B, I-C or I-D. In a further embodiment, said compound is selected from one of formulae I-C or I-D. In yet a further embodiment, said compound has formula I-D.

[0132] In another embodiment, said compound is selected from one of formulae I-A, I-B, I-C, I-F, I-G or I-I and R¹ is H, Cl, F, R', OH or OR'. In a further embodiment, R¹ is H, CH₃, Cl or F.

[0133] In another embodiment, said compound is selected from one of formulae I-A, I-B, I-C, I-D, I-E or I-H, and R^2 is H, Cl, F, R' , OH or OR' . In a further embodiment, R^2 is H, CH_3 , Cl or F. In yet another embodiment, said compound is of formula I-C, and R^1 is H, Cl or F and R^2 is H.

[0134] In another embodiment, said compound is selected from one of formulae I-A, I-E or I-G, and R^{23} is H, Cl, F, R', OH or OR'. In a further embodiment, R^{23} is H, CH_3 , Cl or F. In yet a further embodiment, R^{23} is H.

[0135] In another embodiment, said compound is selected from one of formulae I-B, I-D or I-F, and R^{24} is H, Cl, F, R' , OH or OR' . In a further embodiment, R^{24} is H, CH_3 , Cl or F. In yet another embodiment, said compound is of formula I-D, and R^2 and R^{24} are both H.

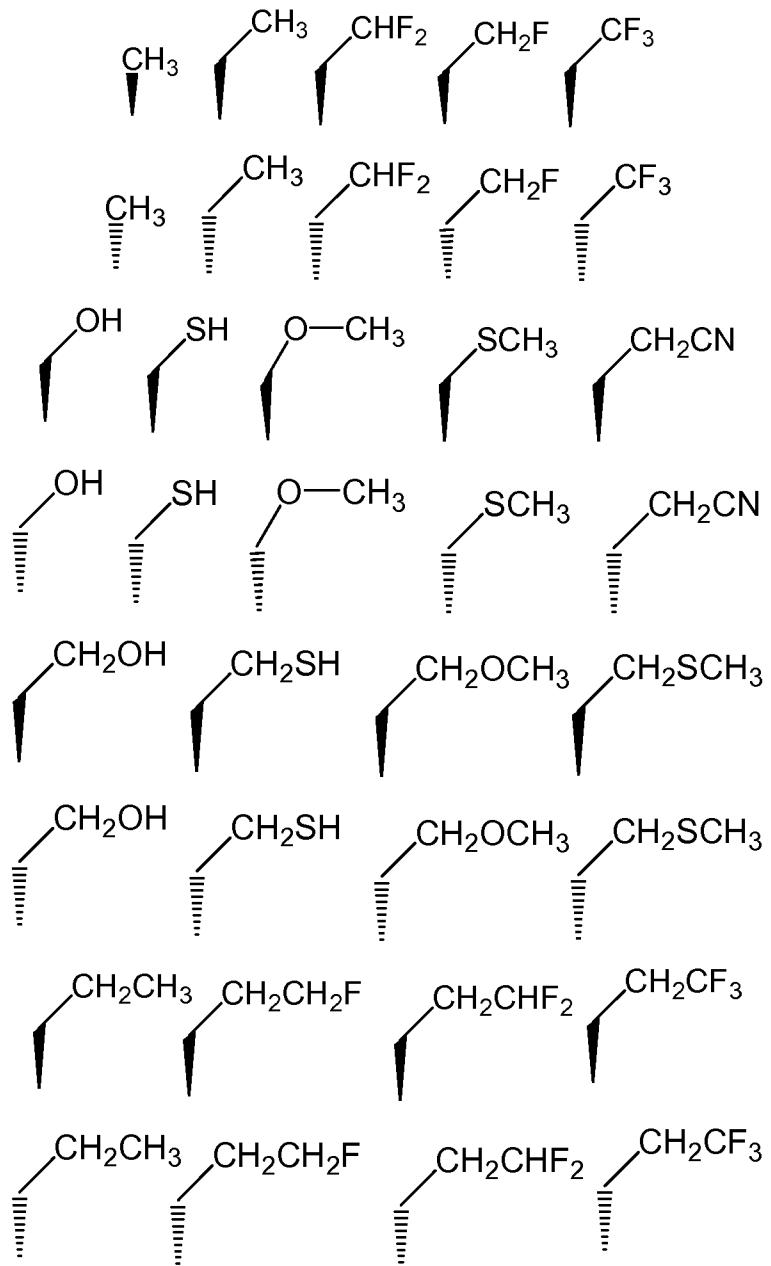
[0136] In another embodiment, X^1 is CR^1 and X^2 is CR^2 , and R^1 and R^2 , taken together, form a 5-7 membered aryl or heteroaryl ring optionally substituted with 1-4 occurrences of R^9 .

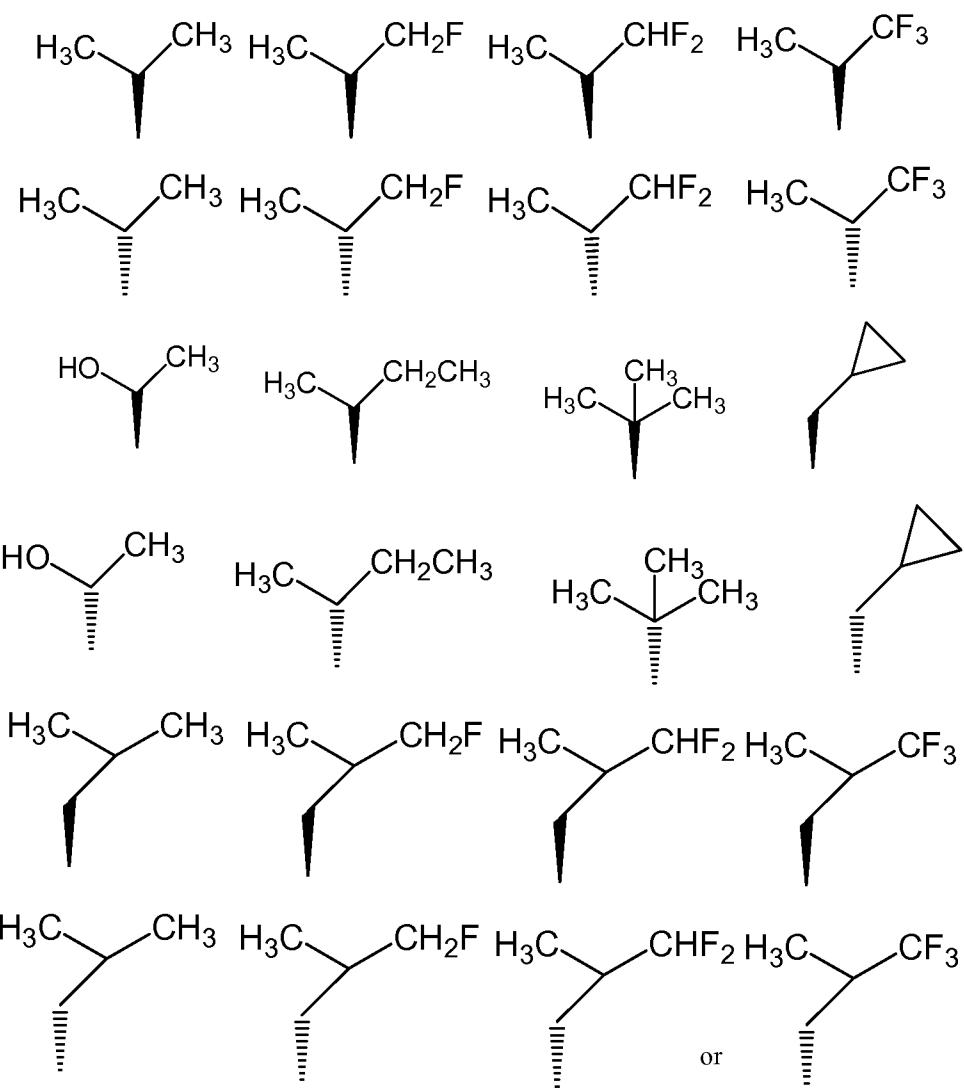
[0137] In another embodiment of any of the above-disclosed embodiments, R^4 is H, CH_3 , CH_2CH_3 or $CH(CH_3)_2$. In a further embodiment, R^4 is H or CH_3 . In yet a further embodiment, R^4 is H.

[0138] In an alternative embodiment, R¹ and R⁴, taken together with the nitrogen to which R⁴ is attached, form a 3-8 membered saturated, partially saturated or aromatic nitrogen-containing ring comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R¹⁴.

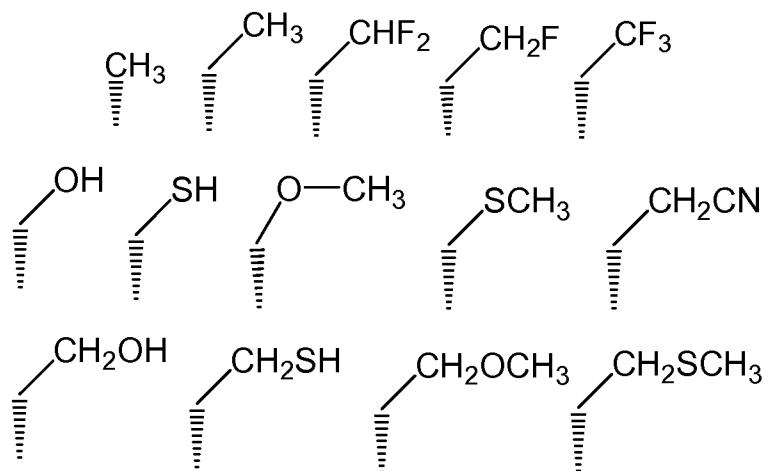
[0139] In another embodiment of any of the above-disclosed embodiments, R⁵ is H or a C₁₋₂ alkyl optionally substituted with up to 3 occurrences of R¹². In a further embodiment, R⁵ is H or an unsubstituted C₁₋₂ alkyl.

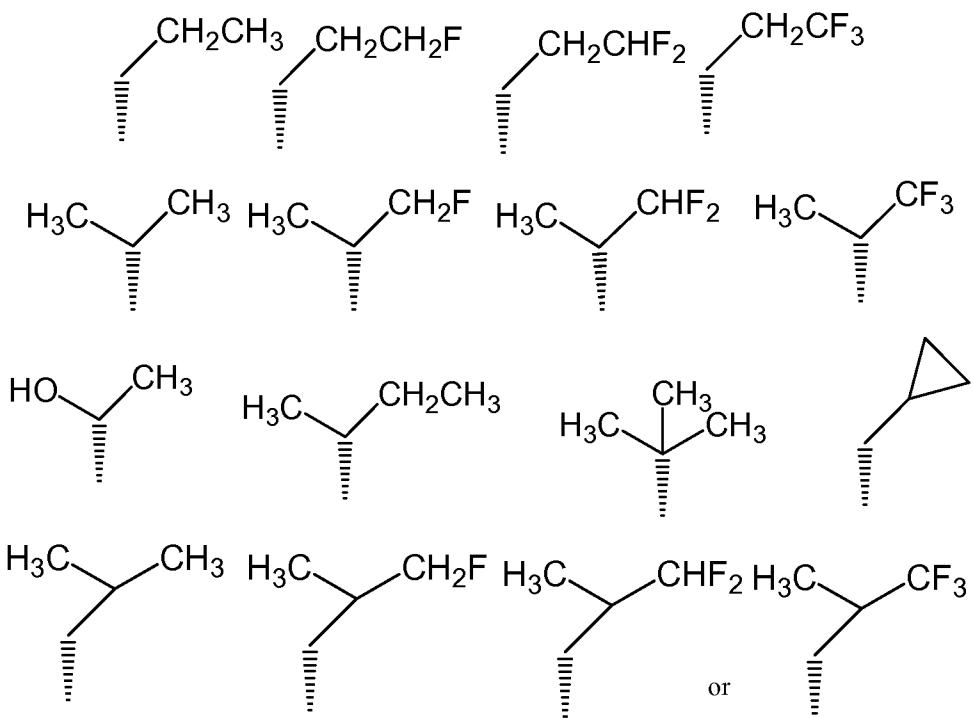
[0140] In another embodiment of any of the above-disclosed embodiments, R⁶ is a C₁₋₄ aliphatic optionally substituted with 1-5 occurrences of R¹³. In a further embodiment, R⁵ is H and R⁶ is selected from



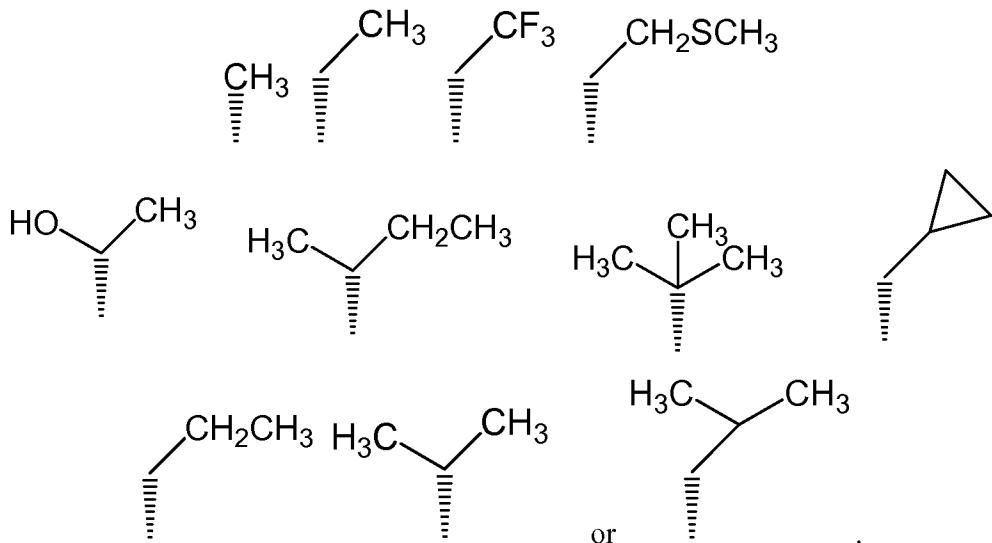


[0141] In a further embodiment, R^6 is selected from

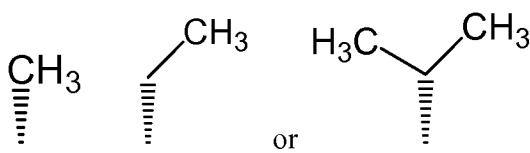




[0142] In yet a further embodiment, R^6 is selected from

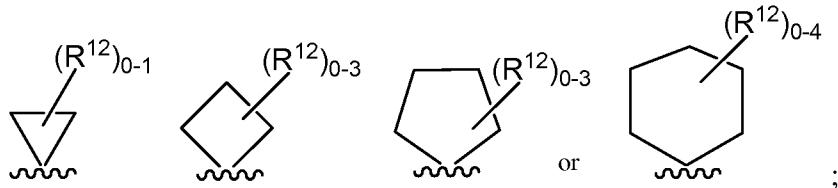


[0143] In a still further embodiment, R^6 is selected from



[0144]

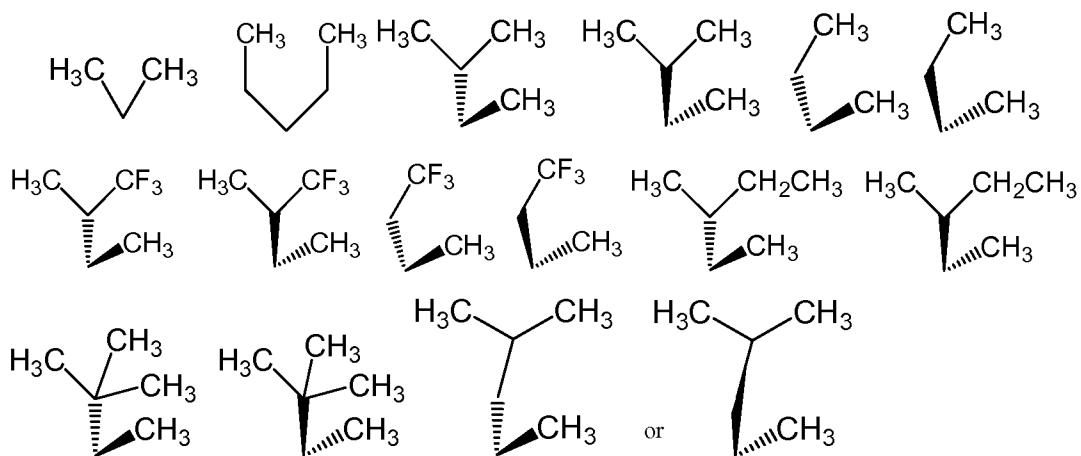
In another embodiment, R^5 and R^6 are taken together to form a ring selected from



wherein one or more carbon atoms in of said ring are optionally and independently replaced by N, O or S.

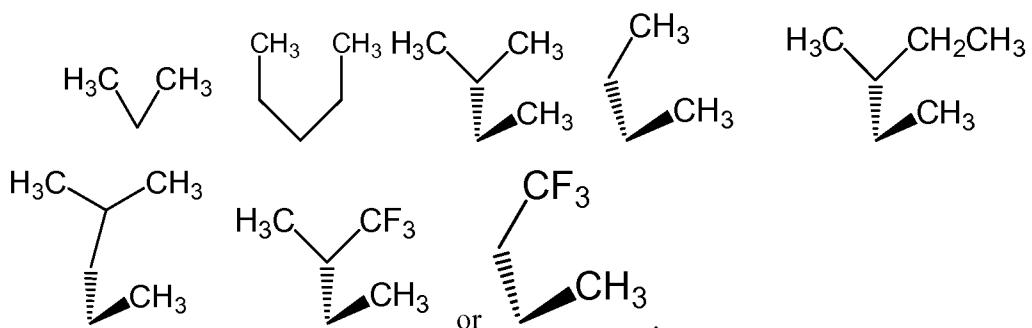
[0145]

In another embodiment, R^5 and R^6 are



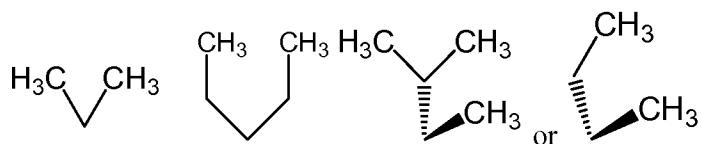
[0146]

In a further embodiment, R^5 and R^6 are



[0147]

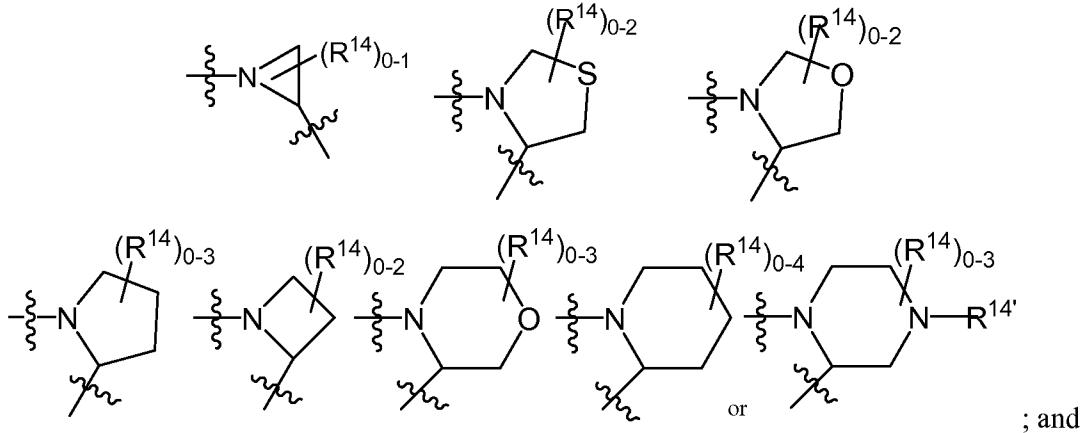
In yet a further embodiment, R^5 and R^6 are



[0148]

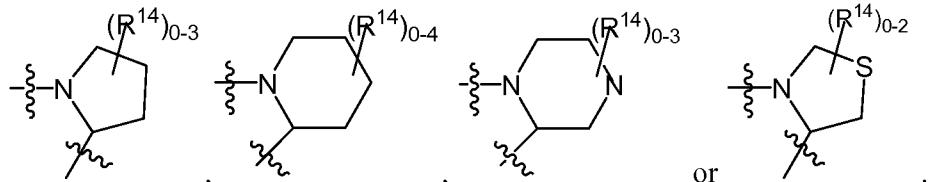
In another embodiment, R^4 and R^6 , taken together with the nitrogen to which R^4 is attached, form a 3-8 membered saturated, partially saturated or aromatic

nitrogen-containing ring comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R¹⁴. In a further embodiment, R⁴ and R⁶ taken together is selected from

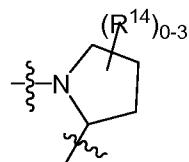


R¹⁴, is H or R¹⁴.

[0149] In a further embodiment, R⁴ and R⁶ taken together is



[0150] In yet a further embodiment, R⁴ and R⁶ taken together is



[0151] In a further embodiment, the ring formed by R⁴ and R⁶ is unsubstituted. In another embodiment, the ring formed by R⁴ and R⁶ is substituted with one occurrence of R¹⁴. In a further embodiment, R¹⁴ is OH, CH₃, F, OR' or NHR'. In yet a further embodiment, R' is C₁₋₂ alkyl or C₂₋₃ alkenyl. In a still further embodiment, R¹⁴ is OH.

[0152] In another embodiment of any of the above-disclosed embodiments, R⁷ is H or C₁₋₂ alkyl optionally substituted with 1-3 occurrences of R¹⁷. In a further embodiment, R⁷ is H or unsubstituted C₁₋₂ alkyl.

[0153] In another embodiment of any of the above-disclosed embodiments, R⁸ is a C₁₋₄ aliphatic or cycloaliphatic optionally substituted with up to 6 occurrences of R¹⁸. In a further embodiment, R⁸ is a C₂₋₃ aliphatic or cycloaliphatic optionally substituted with up to 6 occurrences of R¹⁸. In a further embodiment, R¹⁸ is F. In yet a further embodiment, R⁸ is CH₂CH₃, CH₂CF₃, CH₂CHF₂, CH₂CH₂F, CH₂CH₂CH₃, CH₂CH₂CF₃, CH₂CH₂CH₂F or CH₂CH₂CHF₂. In a still further embodiment, R⁸ is CH₂CH₃, CH₂CF₃, CH₂CH₂CH₃ or CH₂CH₂CF₃. In yet a further embodiment, R⁸ is CH₂CF₃.

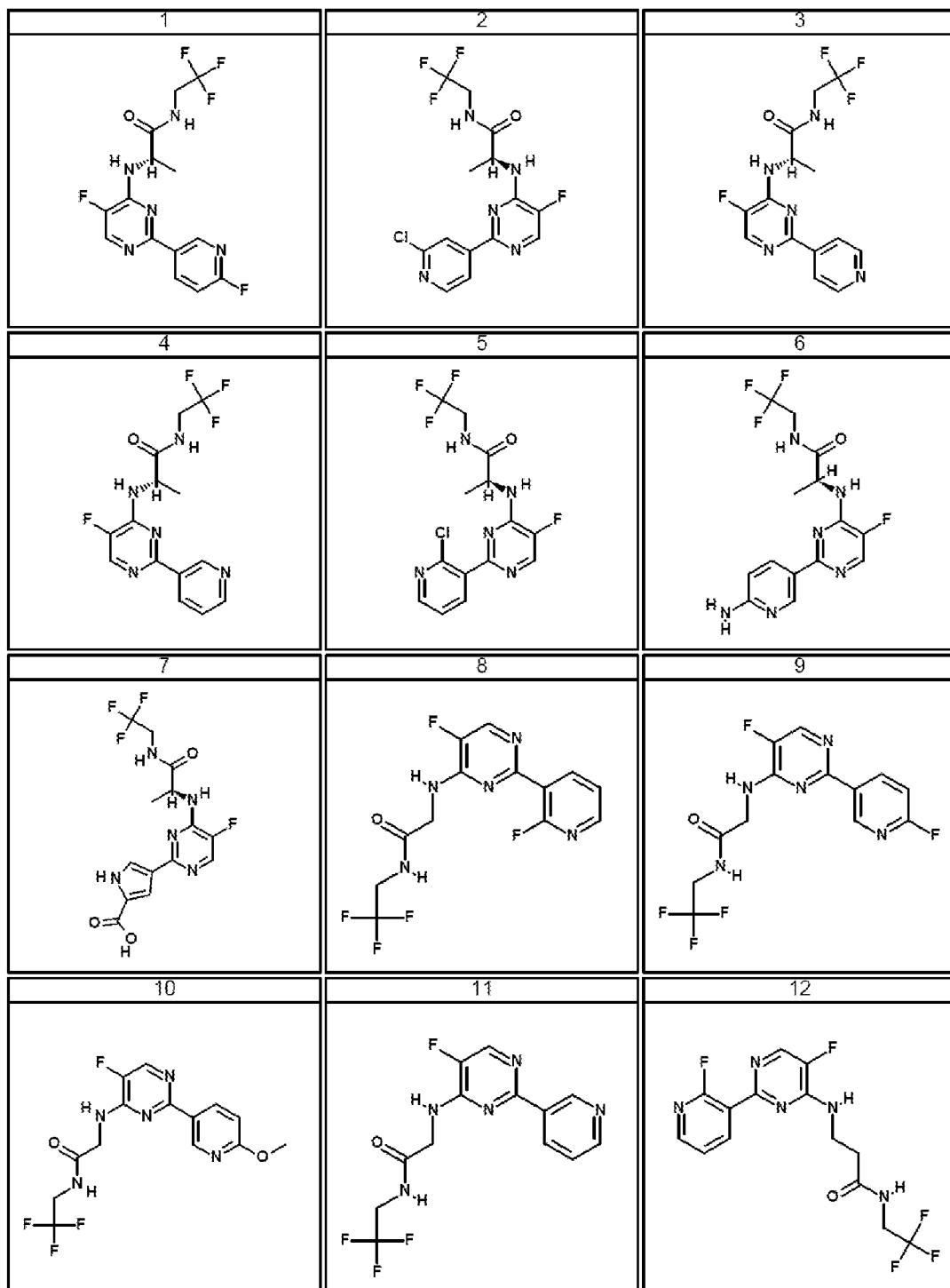
[0154] In another embodiment of any of the above-disclosed embodiments, R³ is selected from (1-a), (1-c), (1-k), (2-d), (2-e), (2-f), (2-n), (2-o), (2-u), (2-v), (2-x), (2-y), (2-z) and (3-a). In a further embodiment, R³ is selected from (1-a), (1-c), (1-k), (2-d), (2-e), (2-n), (2-o), (2-u), (2-x) and (2-z). In yet a further embodiment, R³ is selected from (1-a), (1-c), (2-d), (2-e), (2-n), (2-o), (2-u) and (2-x). In a still further embodiment, R³ is selected from (1-c), (2-d), (2-n) and (2-o).

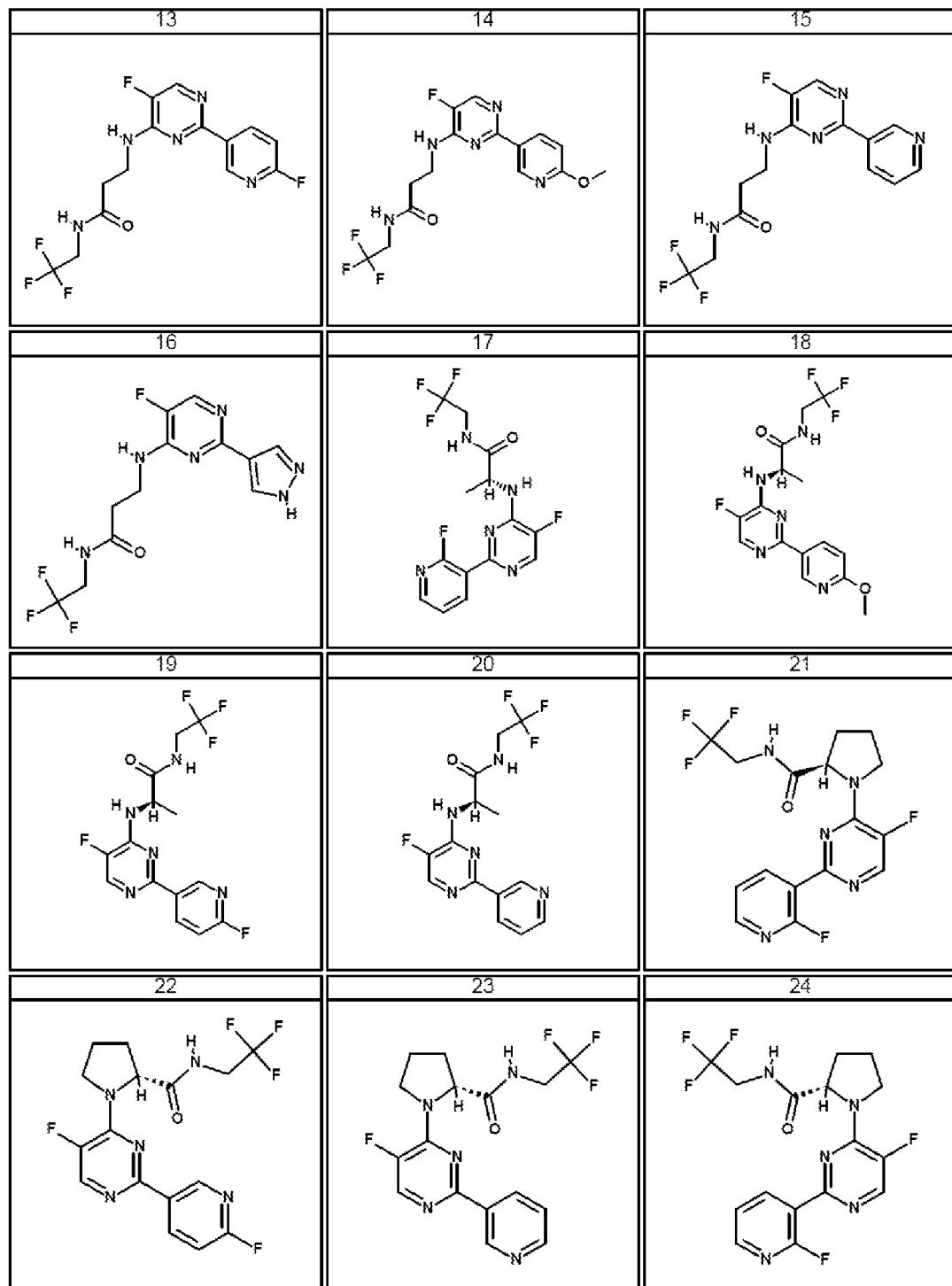
[0155] In another embodiment, R³ is unsubstituted. In an alternative embodiment, up to two substitutable carbons and up to one substitutable nitrogens of a non-aromatic heterocyclic ring of the R³ ring are substituted. In a further embodiment, one substitutable carbon and up to one substitutable nitrogens of a non-aromatic heterocyclic ring of the R³ ring are substituted. In yet a further embodiment, one substitutable carbon of the R³ ring is substituted.

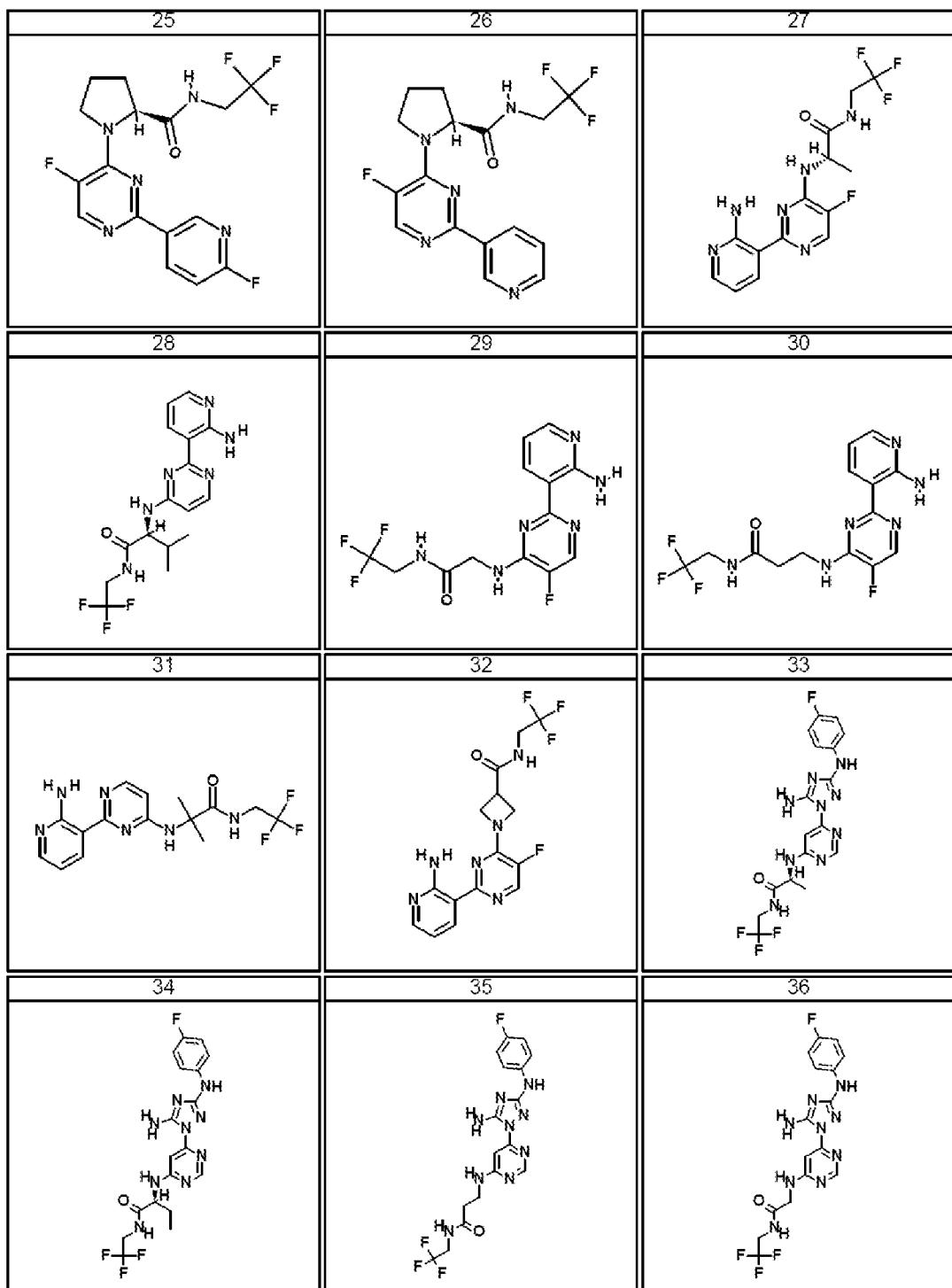
[0156] In another embodiment, R³ is (2-n) and R²⁵ is C(O)NR₂. In another embodiment, R³ is (2-o) and R²⁵ is an optionally substituted aryl or heteroaryl. In a further embodiment, R²⁵ is an optionally substituted phenyl. In another embodiment, R³ is (1-c) or (2-d) and R³ is unsubstituted.

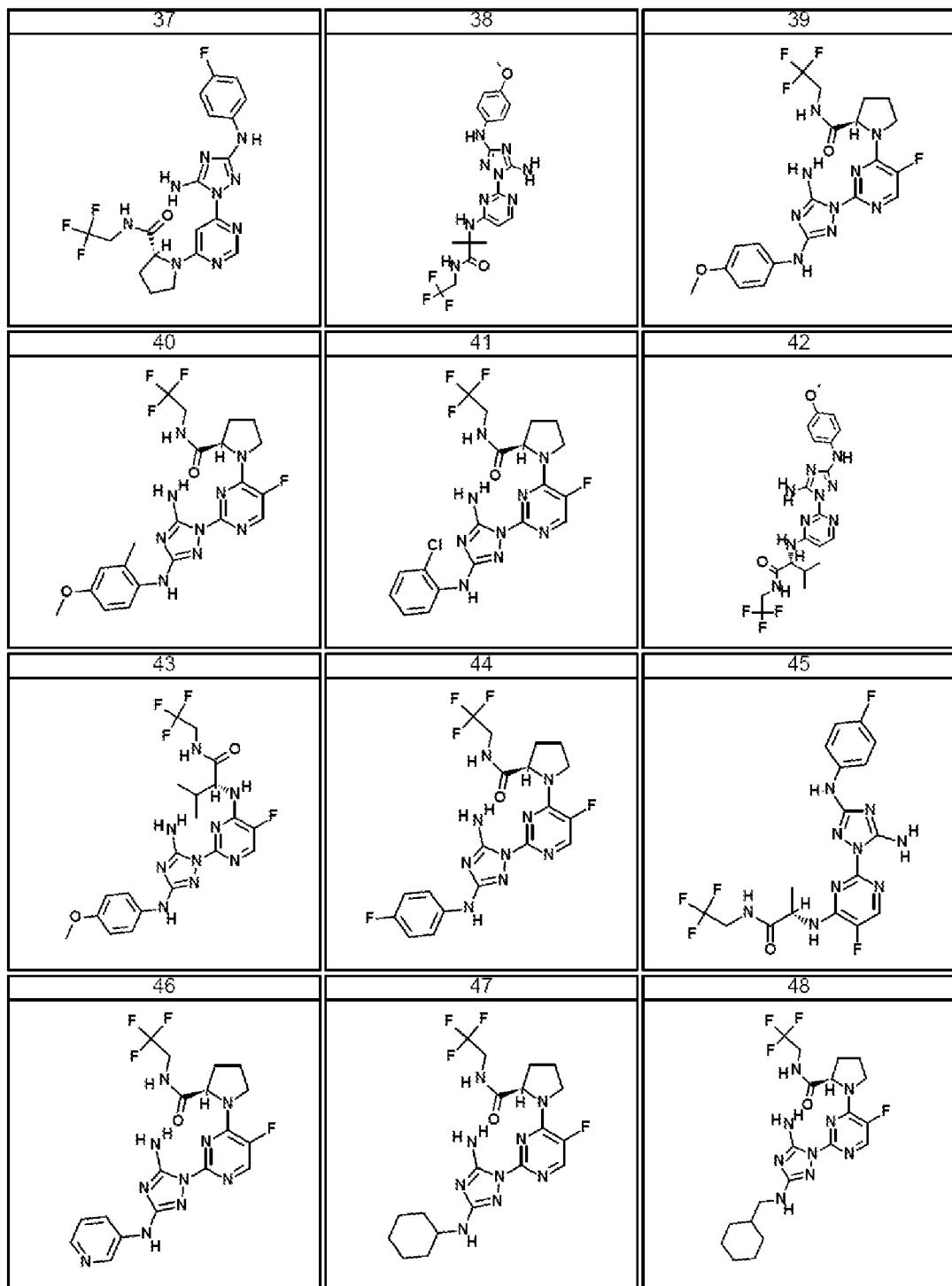
[0157] In another embodiment, the invention provides a compound of Table 1:

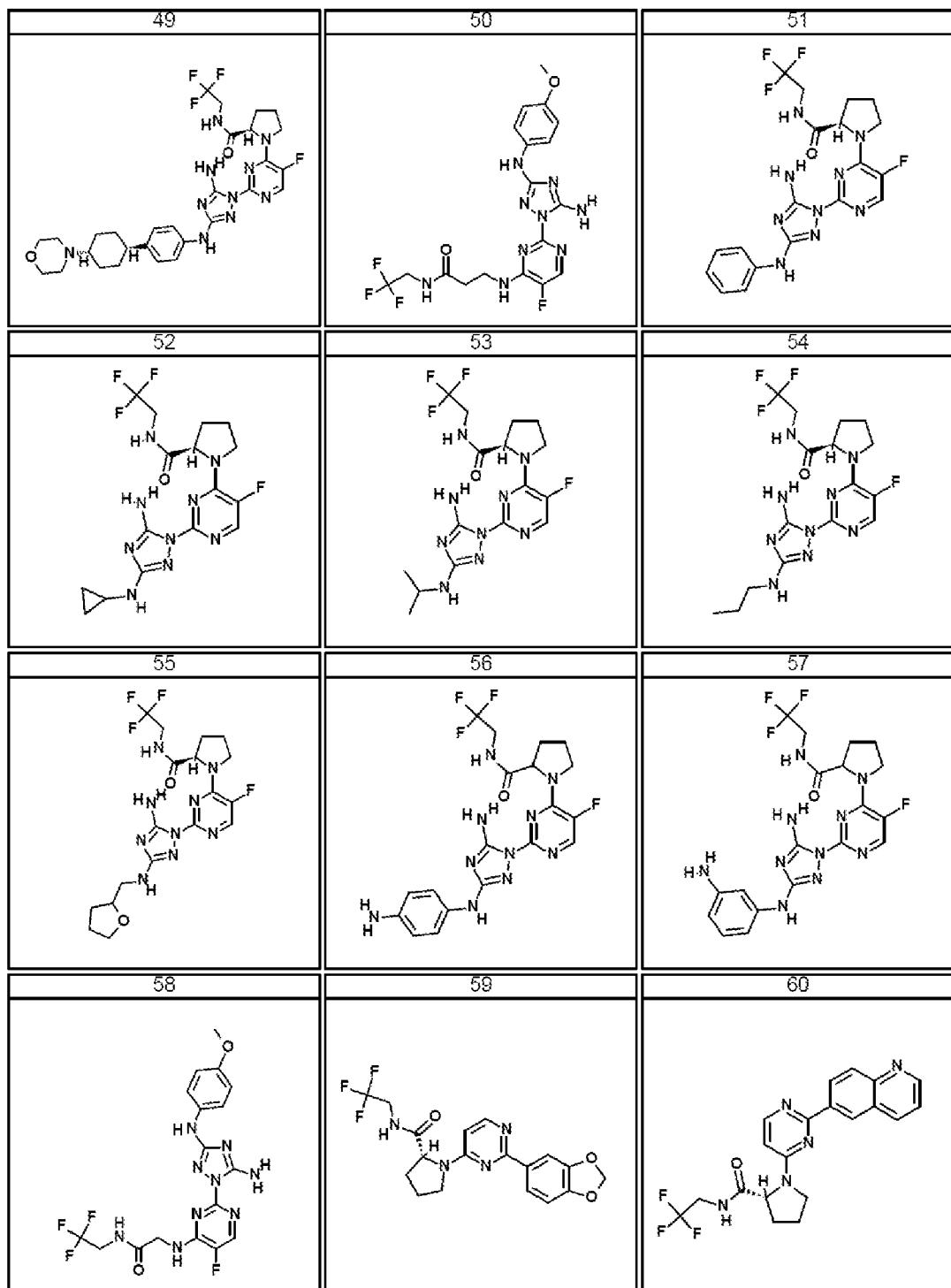
Table 1

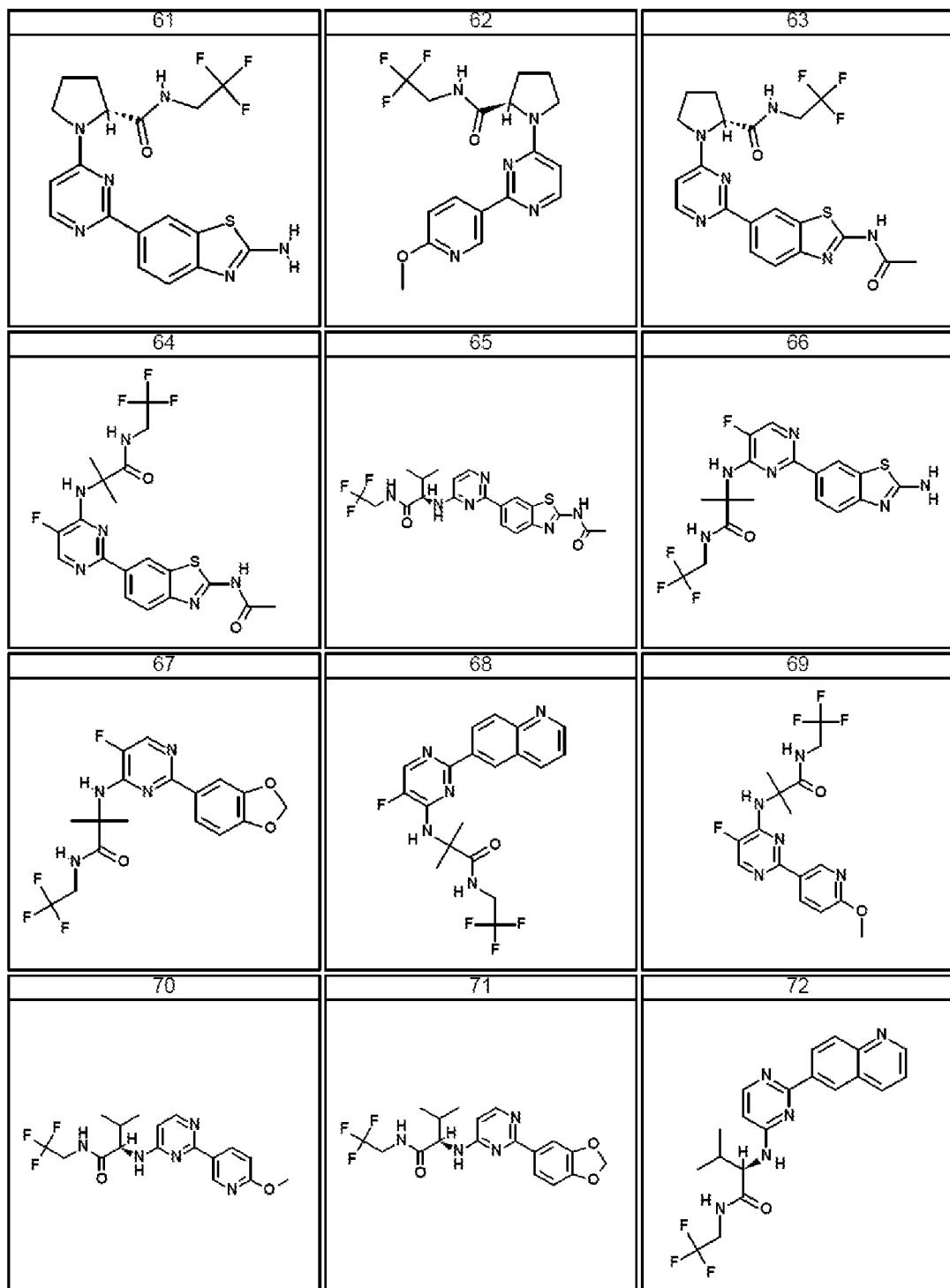


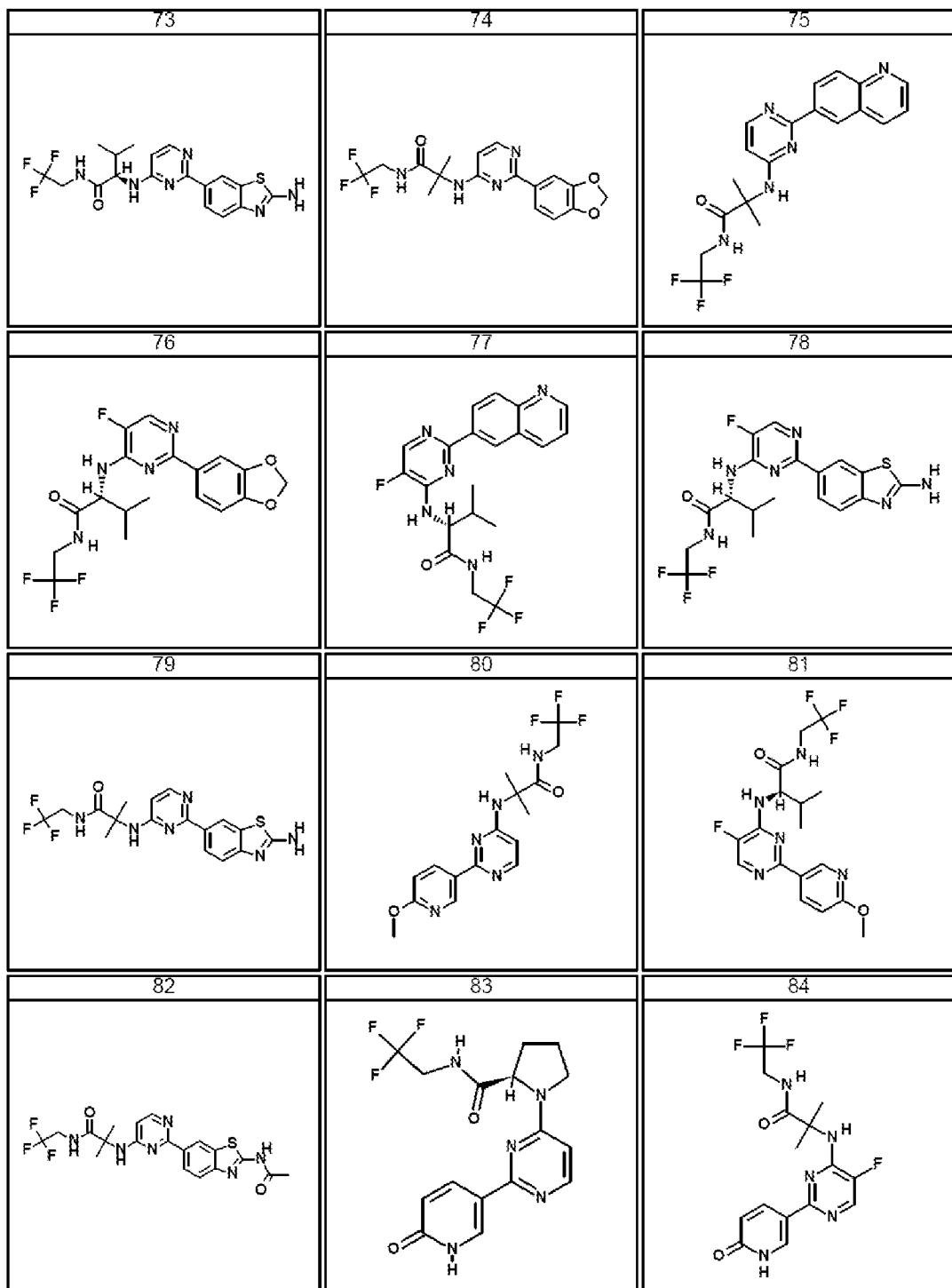


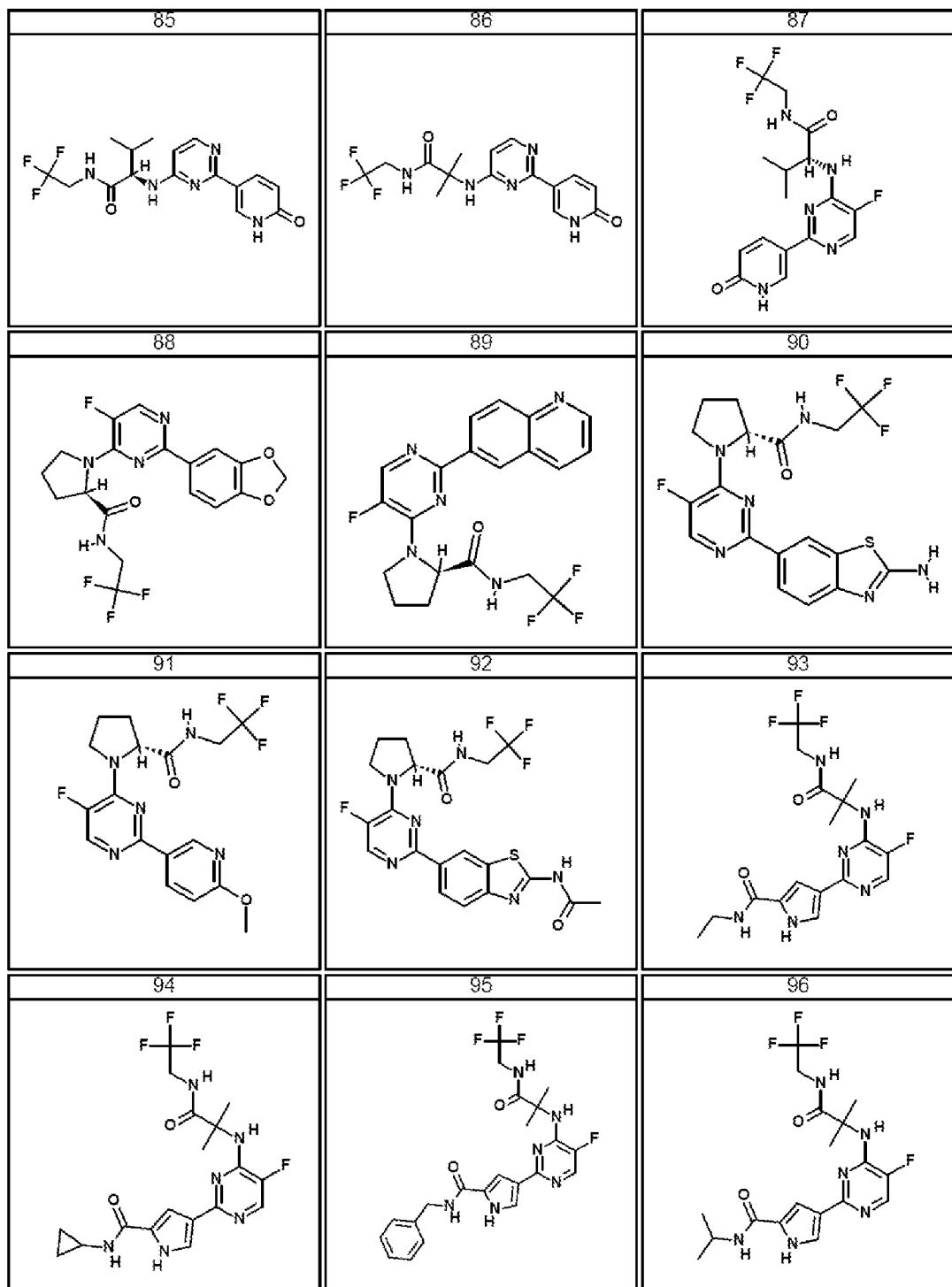


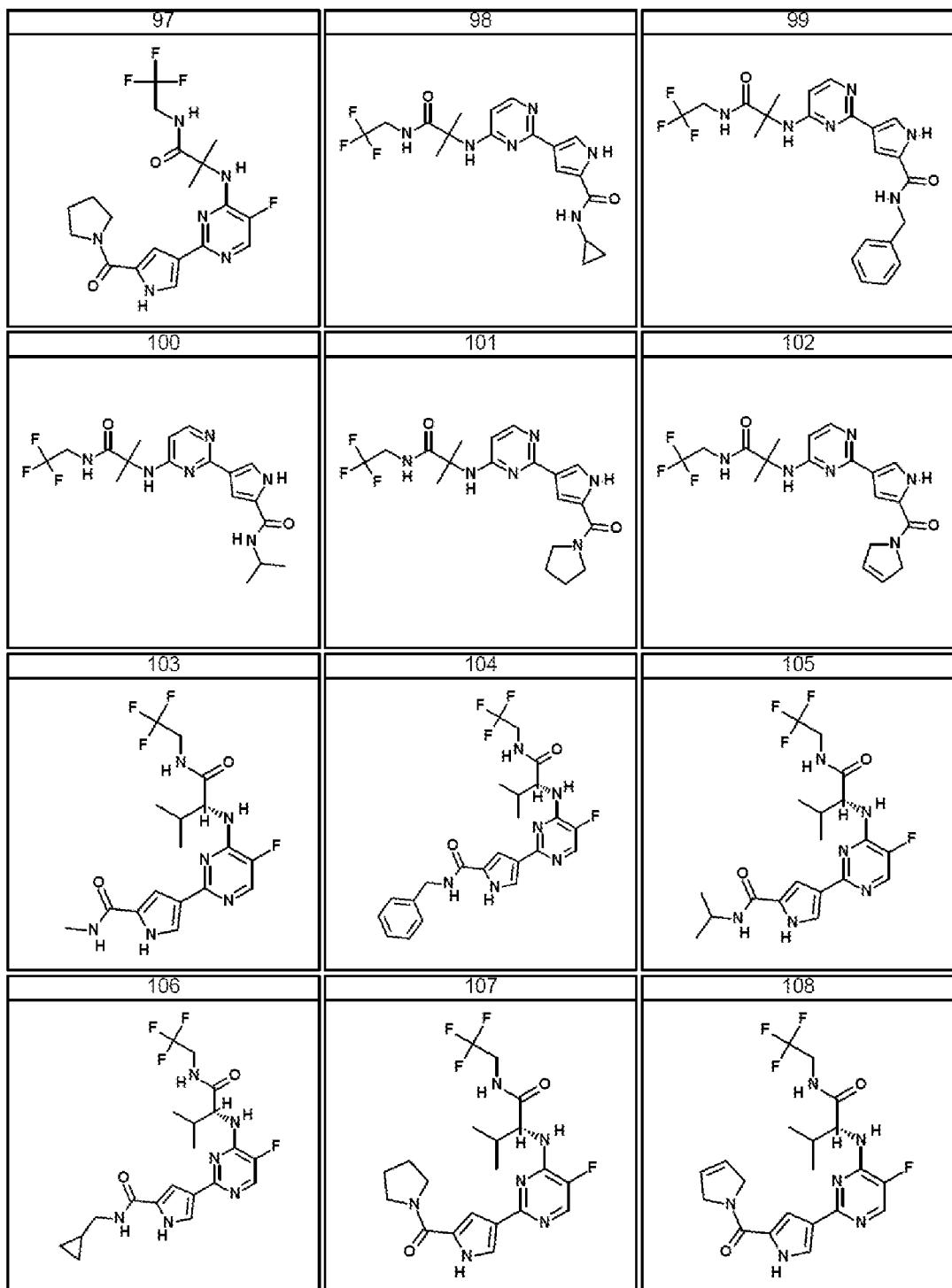


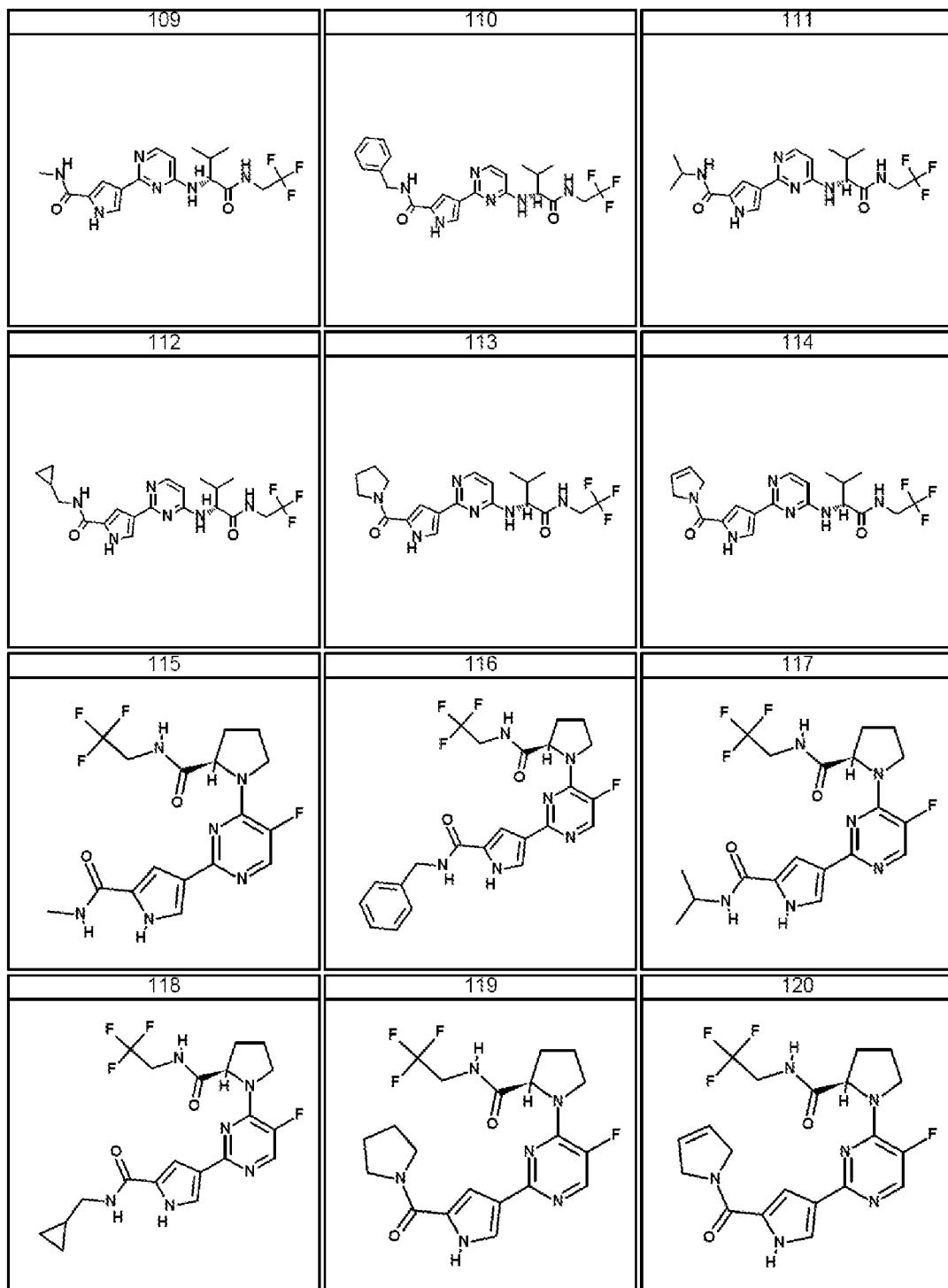


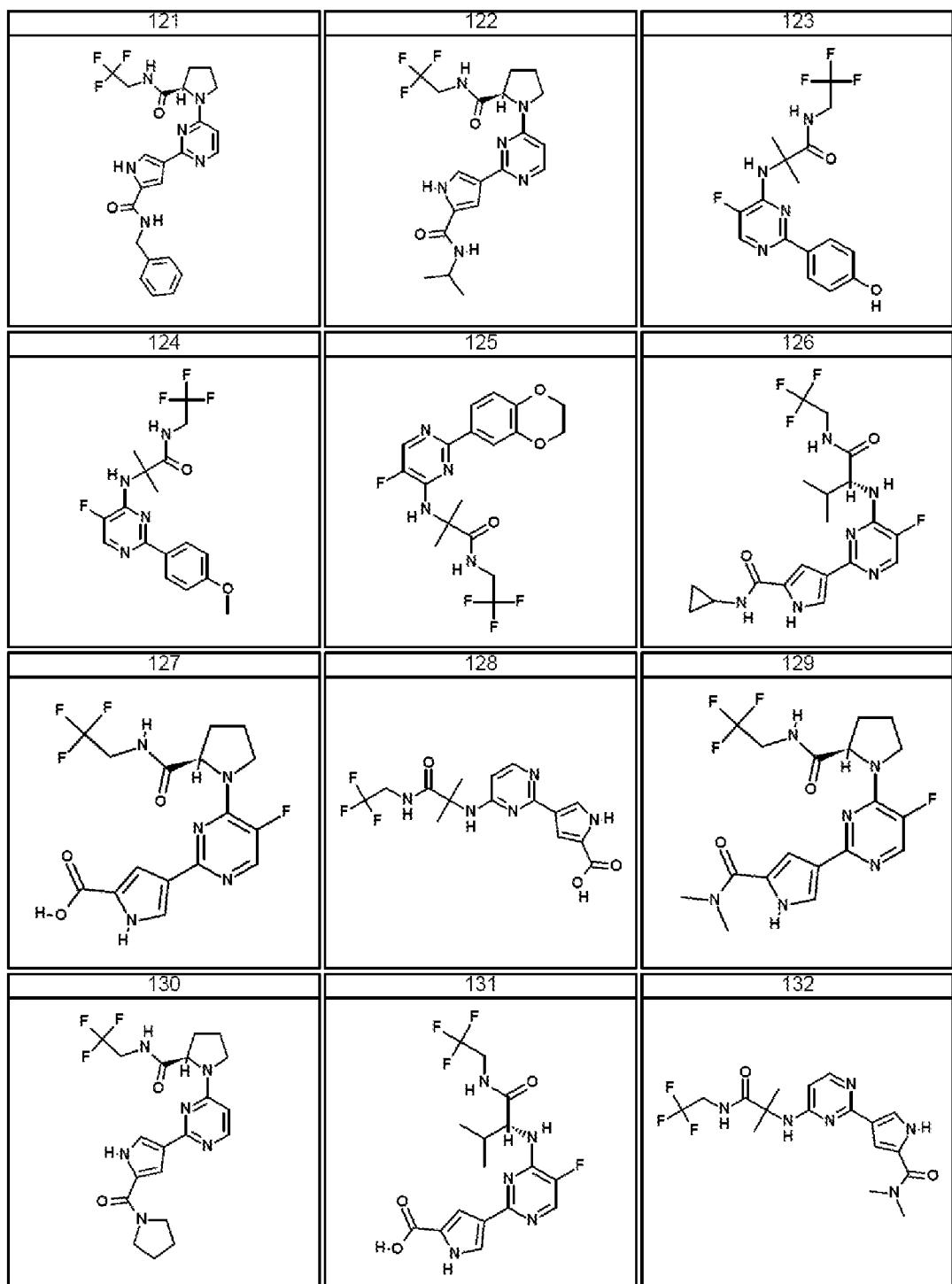


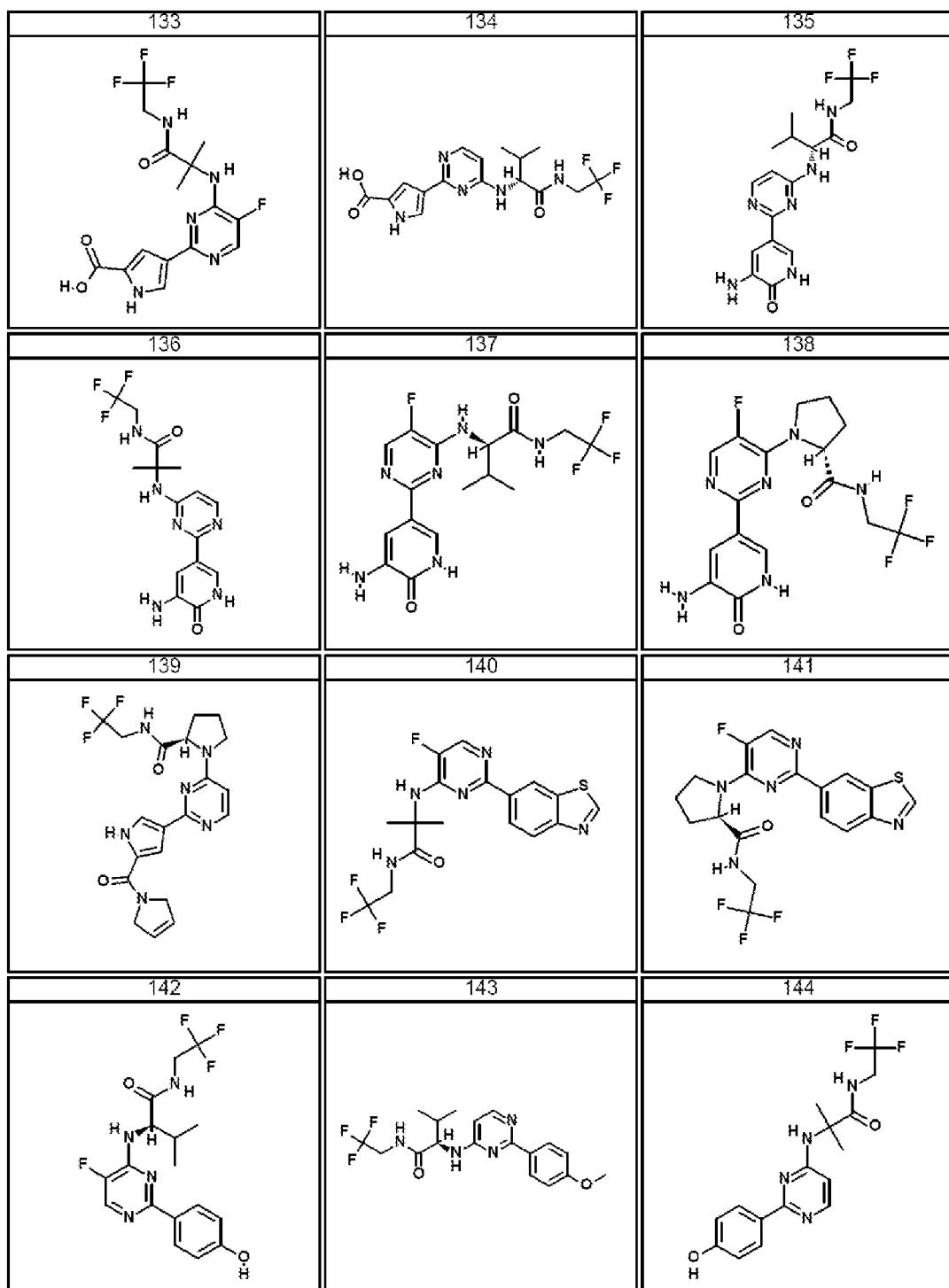


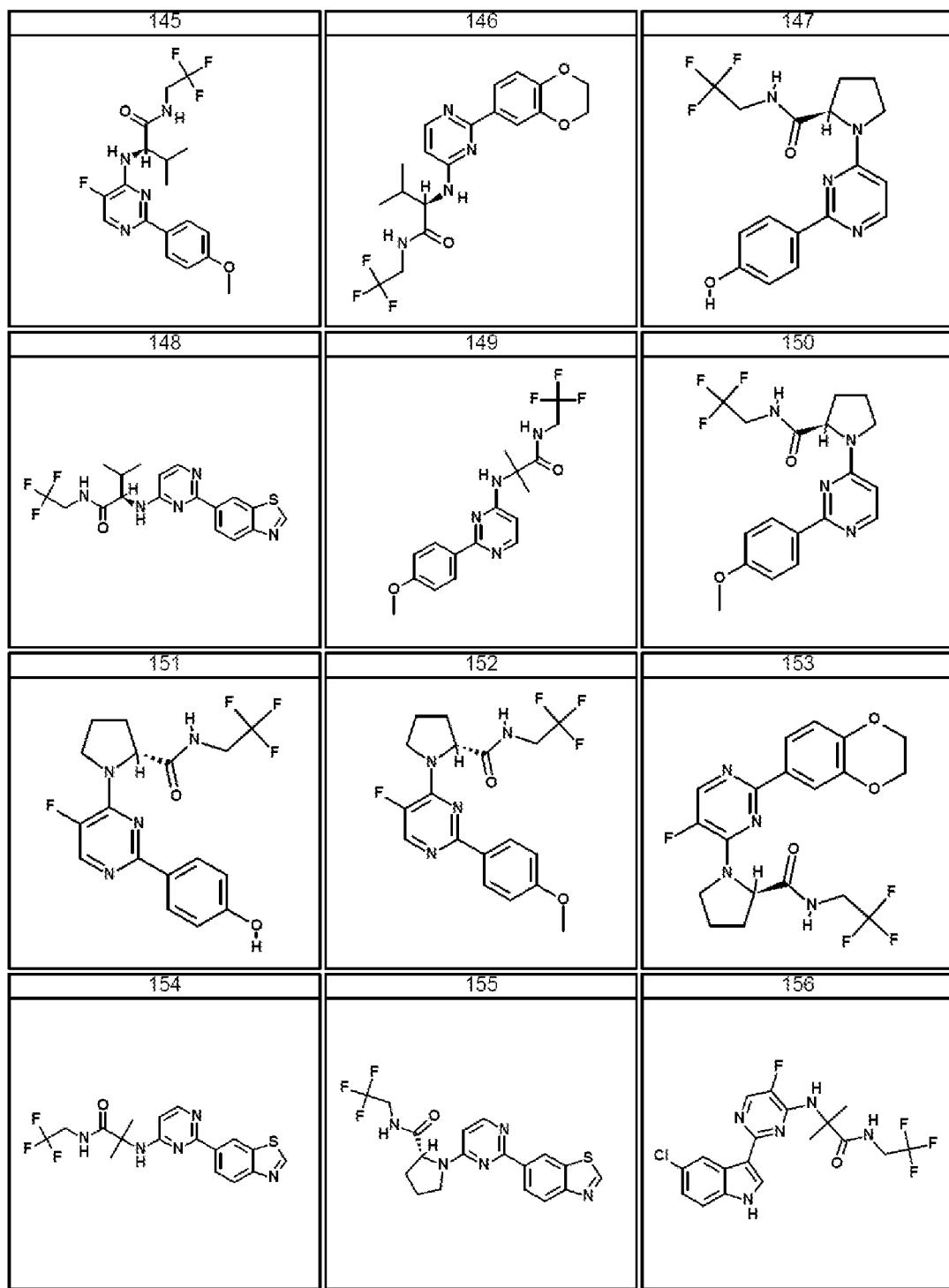


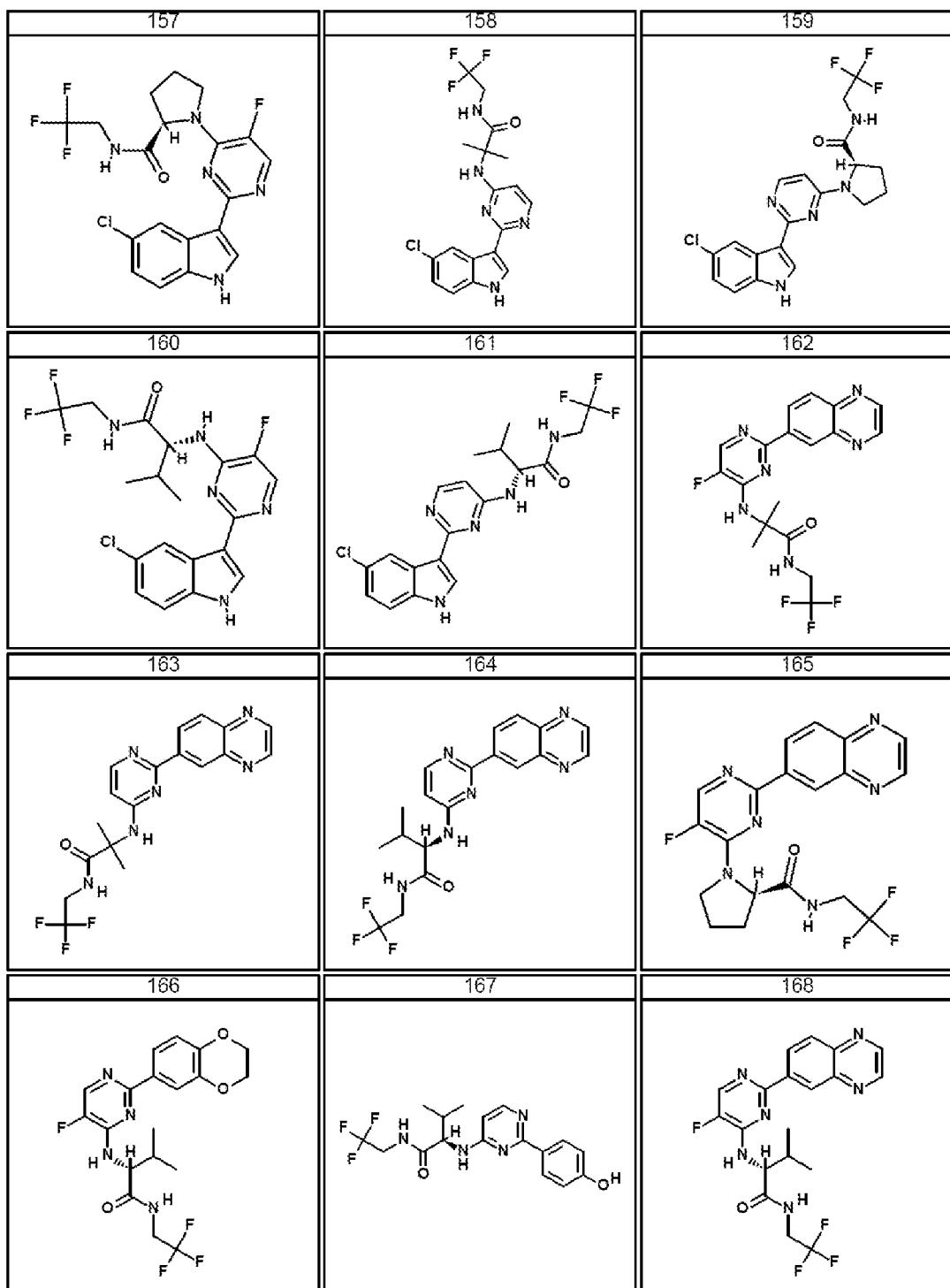












*Uses, Formulation and Administration**Pharmaceutically acceptable compositions*

[0158] In another embodiment, the invention provides a pharmaceutical composition comprising a compound of formula I.

[0159] In a further embodiment, the composition additionally comprising a therapeutic agent selected from a chemotherapeutic or anti-proliferative agent, an anti-inflammatory agent, an immunomodulatory or immunosuppressive agent, a neurotrophic factor, an agent for treating cardiovascular disease, an agent for treating destructive bone disorders, an agent for treating liver disease, an anti-viral agent, an agent for treating blood disorders, an agent for treating diabetes, or an agent for treating immunodeficiency disorders.

[0160] According to another embodiment, the invention provides a composition comprising a compound of this invention or a pharmaceutically acceptable derivative thereof and a pharmaceutically acceptable carrier, adjuvant, or vehicle. The amount of compound in the compositions of this invention is such that is effective to measurably inhibit a protein kinase, particularly a JAK family kinase, in a biological sample or in a patient. Preferably the composition of this invention is formulated for administration to a patient in need of such composition. Most preferably, the composition of this invention is formulated for oral administration to a patient.

[0161] The term “patient”, as used herein, means an animal, preferably a mammal, and most preferably a human.

[0162] Accordingly, in another aspect of the present invention, pharmaceutically acceptable compositions are provided, wherein these compositions comprise any of the compounds as described herein, and optionally comprise a pharmaceutically acceptable carrier, adjuvant or vehicle. In certain embodiments, these compositions optionally further comprise one or more additional therapeutic agents.

[0163] It will also be appreciated that certain of the compounds of present invention can exist in free form for treatment, or where appropriate, as a pharmaceutically acceptable derivative thereof. According to the present invention, a pharmaceutically acceptable derivative includes, but is not limited to, pharmaceutically acceptable prodrugs, salts, esters, salts of such esters, or any other adduct or derivative which upon administration to a patient in need is capable of providing, directly or

indirectly, a compound as otherwise described herein, or a metabolite or residue thereof. As used herein, the term "inhibitorily active metabolite or residue thereof" means that a metabolite or residue thereof is also an inhibitor of a JAK family kinase.

[0164] As used herein, the term "pharmaceutically acceptable salt" refers to those salts which are, within the scope of sound medical judgement, suitable for use in contact with the tissues of humans and lower animals without undue toxicity, irritation, allergic response and the like.

[0165] Pharmaceutically acceptable salts are well known in the art. For example, S. M. Berge *et al.*, describe pharmaceutically acceptable salts in detail in *J. Pharmaceutical Sciences*, 1977, 66, 1-19, incorporated herein by reference.

Pharmaceutically acceptable salts of the compounds of this invention include those derived from suitable inorganic and organic acids and bases. Examples of pharmaceutically acceptable, nontoxic acid addition salts are salts of an amino group formed with inorganic acids such as hydrochloric acid, hydrobromic acid, phosphoric acid, sulfuric acid and perchloric acid or with organic acids such as acetic acid, oxalic acid, maleic acid, tartaric acid, citric acid, succinic acid or malonic acid or by using other methods used in the art such as ion exchange. Other pharmaceutically acceptable salts include adipate, alginate, ascorbate, aspartate, benzenesulfonate, benzoate, bisulfate, borate, butyrate, camphorate, camphorsulfonate, citrate, cyclopentanepropionate, digluconate, dodecylsulfate, ethanesulfonate, formate, fumarate, glucoheptonate, glycerophosphate, gluconate, hemisulfate, heptanoate, hexanoate, hydroiodide, 2-hydroxy-ethanesulfonate, lactobionate, lactate, laurate, lauryl sulfate, malate, maleate, malonate, methanesulfonate, 2-naphthalenesulfonate, nicotinate, nitrate, oleate, oxalate, palmitate, pamoate, pectinate, persulfate, 3-phenylpropionate, phosphate, picrate, pivalate, propionate, stearate, succinate, sulfate, tartrate, thiocyanate, p-toluenesulfonate, undecanoate, valerate salts, and the like. Salts derived from appropriate bases include alkali metal, alkaline earth metal, ammonium and $N^{+}(C_{1-4}alkyl)_4$ salts. This invention also envisions the quaternization of any basic nitrogen-containing groups of the compounds disclosed herein. Water or oil-soluble or dispersable products may be obtained by such quaternization. Representative alkali or alkaline earth metal salts include sodium, lithium, potassium, calcium, magnesium, and the like. Further pharmaceutically acceptable salts include, when appropriate, nontoxic ammonium,

quaternary ammonium, and amine cations formed using counterions such as halide, hydroxide, carboxylate, sulfate, phosphate, nitrate, loweralkyl sulfonate and aryl sulfonate.

[0166] As described above, the pharmaceutically acceptable compositions of the present invention additionally comprise a pharmaceutically acceptable carrier, adjuvant, or vehicle, which, as used herein, includes any and all solvents, diluents, or other liquid vehicle, dispersion or suspension aids, surface active agents, isotonic agents, thickening or emulsifying agents, preservatives, solid binders, lubricants and the like, as suited to the particular dosage form desired. Remington's Pharmaceutical Sciences, Sixteenth Edition, E. W. Martin (Mack Publishing Co., Easton, Pa., 1980) discloses various carriers used in formulating pharmaceutically acceptable compositions and known techniques for the preparation thereof. Except insofar as any conventional carrier medium is incompatible with the compounds of the invention, such as by producing any undesirable biological effect or otherwise interacting in a deleterious manner with any other component(s) of the pharmaceutically acceptable composition, its use is contemplated to be within the scope of this invention.

[0167] Some examples of materials which can serve as pharmaceutically acceptable carriers include, but are not limited to, ion exchangers, alumina, aluminum stearate, lecithin, serum proteins, such as human serum albumin, buffer substances such as phosphates, glycine, sorbic acid, or potassium sorbate, partial glyceride mixtures of saturated vegetable fatty acids, water, salts or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium hydrogen phosphate, sodium chloride, zinc salts, colloidal silica, magnesium trisilicate, polyvinyl pyrrolidone, polyacrylates, waxes, polyethylene-polyoxypropylene-block polymers, wool fat, sugars such as lactose, glucose and sucrose; starches such as corn starch and potato starch; cellulose and its derivatives such as sodium carboxymethyl cellulose, ethyl cellulose and cellulose acetate; powdered tragacanth; malt; gelatin; talc; excipients such as cocoa butter and suppository waxes; oils such as peanut oil, cottonseed oil; safflower oil; sesame oil; olive oil; corn oil and soybean oil; glycols; such a propylene glycol or polyethylene glycol; esters such as ethyl oleate and ethyl laurate; agar; buffering agents such as magnesium hydroxide and aluminum hydroxide; alginic acid; pyrogen-free water; isotonic saline; Ringer's solution; ethyl alcohol, and phosphate buffer solutions, as well as other non-

toxic compatible lubricants such as sodium lauryl sulfate and magnesium stearate, as well as coloring agents, releasing agents, coating agents, sweetening, flavoring and perfuming agents, preservatives and antioxidants can also be present in the composition, according to the judgment of the formulator.

[0168] The term "measurably inhibit", as used herein means a measurable change in kinase activity, particularly JAK kinase activity, between a sample comprising a compound of this invention and a JAK kinase and an equivalent sample comprising JAK kinase in the absence of said compound.

[0169] The compositions of the present invention may be administered orally, parenterally, by inhalation spray, topically, rectally, nasally, buccally, vaginally or via an implanted reservoir. The term "parenteral" as used herein includes subcutaneous, intravenous, intramuscular, intra-articular, intra-synovial, intrasternal, intrathecal, intraocular, intrahepatic, intralesional and intracranial injection or infusion techniques. Preferably, the compositions are administered orally, intraperitoneally or intravenously. Sterile injectable forms of the compositions of this invention may be aqueous or oleaginous suspension. These suspensions may be formulated according to techniques known in the art using suitable dispersing or wetting agents and suspending agents. The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's solution and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium.

[0170] For this purpose, any bland fixed oil may be employed including synthetic mono- or di-glycerides. Fatty acids, such as oleic acid and its glyceride derivatives are useful in the preparation of injectables, as are natural pharmaceutically-acceptable oils, such as olive oil or castor oil, especially in their polyoxyethylated versions. These oil solutions or suspensions may also contain a long-chain alcohol diluent or dispersant, such as carboxymethyl cellulose or similar dispersing agents that are commonly used in the formulation of pharmaceutically acceptable dosage forms including emulsions and suspensions. Other commonly used surfactants, such as Tweens, Spans and other emulsifying agents or bioavailability enhancers which are

commonly used in the manufacture of pharmaceutically acceptable solid, liquid, or other dosage forms may also be used for the purposes of formulation.

[0171] The pharmaceutically acceptable compositions of this invention may be orally administered in any orally acceptable dosage form including, but not limited to, capsules, tablets, aqueous suspensions or solutions. In the case of tablets for oral use, carriers commonly used include lactose and corn starch. Lubricating agents, such as magnesium stearate, are also typically added. For oral administration in a capsule form, useful diluents include lactose and dried cornstarch. When aqueous suspensions are required for oral use, the active ingredient is combined with emulsifying and suspending agents. If desired, certain sweetening, flavoring or coloring agents may also be added.

[0172] Alternatively, the pharmaceutically acceptable compositions of this invention may be administered in the form of suppositories for rectal administration. These can be prepared by mixing the agent with a suitable non-irritating excipient that is solid at room temperature but liquid at rectal temperature and therefore will melt in the rectum to release the drug. Such materials include cocoa butter, beeswax and polyethylene glycols.

[0173] The pharmaceutically acceptable compositions of this invention may also be administered topically, especially when the target of treatment includes areas or organs readily accessible by topical application, including diseases of the eye, the skin, or the lower intestinal tract. Suitable topical formulations are readily prepared for each of these areas or organs.

[0174] Topical application for the lower intestinal tract can be effected in a rectal suppository formulation (see above) or in a suitable enema formulation. Topically-transdermal patches may also be used.

[0175] For topical applications, the pharmaceutically acceptable compositions may be formulated in a suitable ointment containing the active component suspended or dissolved in one or more carriers. Carriers for topical administration of the compounds of this invention include, but are not limited to, mineral oil, liquid petrolatum, white petrolatum, propylene glycol, polyoxyethylene, polyoxypropylene compound, emulsifying wax and water. Alternatively, the pharmaceutically acceptable compositions can be formulated in a suitable lotion or cream containing the active components suspended or dissolved in one or more pharmaceutically acceptable carriers.

Suitable carriers include, but are not limited to, mineral oil, sorbitan monostearate, polysorbate 60, cetyl esters wax, cetearyl alcohol, 2-octyldodecanol, benzyl alcohol and water.

[0176] For ophthalmic use, the pharmaceutically acceptable compositions may be formulated, e.g., as micronized suspensions in isotonic, pH adjusted sterile saline or other aqueous solution, or, preferably, as solutions in isotonic, pH adjusted sterile saline or other aqueous solution, either with or without a preservative such as benzylalkonium chloride. Alternatively, for ophthalmic uses, the pharmaceutically acceptable compositions may be formulated in an ointment such as petrolatum. The pharmaceutically acceptable compositions of this invention may also be administered by nasal aerosol or inhalation. Such compositions are prepared according to techniques well-known in the art of pharmaceutical formulation and may be prepared as solutions in saline, employing benzyl alcohol or other suitable preservatives, absorption promoters to enhance bioavailability, fluorocarbons, and/or other conventional solubilizing or dispersing agents.

[0177] Most preferably, the pharmaceutically acceptable compositions of this invention are formulated for oral administration.

[0178] Liquid dosage forms for oral administration include, but are not limited to, pharmaceutically acceptable emulsions, microemulsions, solutions, suspensions, syrups and elixirs. In addition to the active compounds, the liquid dosage forms may contain inert diluents commonly used in the art such as, for example, water or other solvents, solubilizing agents and emulsifiers such as ethyl alcohol, isopropyl alcohol, ethyl carbonate, ethyl acetate, benzyl alcohol, benzyl benzoate, propylene glycol, 1,3-butylene glycol, dimethylformamide, oils (in particular, cottonseed, groundnut, corn, germ, olive, castor, and sesame oils), glycerol, tetrahydrofurfuryl alcohol, polyethylene glycols and fatty acid esters of sorbitan, and mixtures thereof. Besides inert diluents, the oral compositions can also include adjuvants such as wetting agents, emulsifying and suspending agents, sweetening, flavoring, and perfuming agents.

[0179] Injectable preparations, for example, sterile injectable aqueous or oleaginous suspensions may be formulated according to the known art using suitable dispersing or wetting agents and suspending agents. The sterile injectable preparation may also be a sterile injectable solution, suspension or emulsion in a nontoxic

parenterally acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's solution, U.S.P. and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose any bland fixed oil can be employed including synthetic mono- or diglycerides. In addition, fatty acids such as oleic acid are used in the preparation of injectables.

[0180] The injectable formulations can be sterilized, for example, by filtration through a bacterial-retaining filter, or by incorporating sterilizing agents in the form of sterile solid compositions which can be dissolved or dispersed in sterile water or other sterile injectable medium prior to use.

[0181] In order to prolong the effect of a compound of the present invention, it is often desirable to slow the absorption of the compound from subcutaneous or intramuscular injection. This may be accomplished by the use of a liquid suspension of crystalline or amorphous material with poor water solubility. The rate of absorption of the compound then depends upon its rate of dissolution that, in turn, may depend upon crystal size and crystalline form. Alternatively, delayed absorption of a parenterally administered compound form is accomplished by dissolving or suspending the compound in an oil vehicle. Injectable depot forms are made by forming microencapsule matrices of the compound in biodegradable polymers such as polylactide-polyglycolide. Depending upon the ratio of compound to polymer and the nature of the particular polymer employed, the rate of compound release can be controlled. Examples of other biodegradable polymers include poly(orthoesters) and poly(anhydrides). Depot injectable formulations are also prepared by entrapping the compound in liposomes or microemulsions that are compatible with body tissues.

[0182] Compositions for rectal or vaginal administration are preferably suppositories which can be prepared by mixing the compounds of this invention with suitable non-irritating excipients or carriers such as cocoa butter, polyethylene glycol or a suppository wax which are solid at ambient temperature but liquid at body temperature and therefore melt in the rectum or vaginal cavity and release the active compound.

[0183] Solid dosage forms for oral administration include capsules, tablets, pills, powders, and granules. In such solid dosage forms, the active compound is mixed with at least one inert, pharmaceutically acceptable excipient or carrier such as sodium

citrate or dicalcium phosphate and/or a) fillers or extenders such as starches, lactose, sucrose, glucose, mannitol, and silicic acid, b) binders such as, for example, carboxymethylcellulose, alginates, gelatin, polyvinylpyrrolidinone, sucrose, and acacia, c) humectants such as glycerol, d) disintegrating agents such as agar--agar, calcium carbonate, potato or tapioca starch, alginic acid, certain silicates, and sodium carbonate, e) solution retarding agents such as paraffin, f) absorption accelerators such as quaternary ammonium compounds, g) wetting agents such as, for example, cetyl alcohol and glycerol monostearate, h) absorbents such as kaolin and bentonite clay, and i) lubricants such as talc, calcium stearate, magnesium stearate, solid polyethylene glycols, sodium lauryl sulfate, and mixtures thereof. In the case of capsules, tablets and pills, the dosage form may also comprise buffering agents.

[0184] Solid compositions of a similar type may also be employed as fillers in soft and hard-filled gelatin capsules using such excipients as lactose or milk sugar as well as high molecular weight polyethylene glycols and the like. The solid dosage forms of tablets, dragees, capsules, pills, and granules can be prepared with coatings and shells such as enteric coatings and other coatings well known in the pharmaceutical formulating art. They may optionally contain opacifying agents and can also be of a composition that they release the active ingredient(s) only, or preferentially, in a certain part of the intestinal tract, optionally, in a delayed manner. Examples of embedding compositions that can be used include polymeric substances and waxes. Solid compositions of a similar type may also be employed as fillers in soft and hard-filled gelatin capsules using such excipients as lactose or milk sugar as well as high molecular weight polyethylene glycols and the like.

[0185] The active compounds can also be in micro-encapsulated form with one or more excipients as noted above. The solid dosage forms of tablets, dragees, capsules, pills, and granules can be prepared with coatings and shells such as enteric coatings, release controlling coatings and other coatings well known in the pharmaceutical formulating art. In such solid dosage forms the active compound may be admixed with at least one inert diluent such as sucrose, lactose or starch. Such dosage forms may also comprise, as is normal practice, additional substances other than inert diluents, e.g., tableting lubricants and other tableting aids such as a magnesium stearate and microcrystalline cellulose. In the case of capsules, tablets and pills, the dosage forms

may also comprise buffering agents. They may optionally contain opacifying agents and can also be of a composition that they release the active ingredient(s) only, or preferentially, in a certain part of the intestinal tract, optionally, in a delayed manner. Examples of embedding compositions that can be used include polymeric substances and waxes.

[0186] Dosage forms for topical or transdermal administration of a compound of this invention include ointments, pastes, creams, lotions, gels, powders, solutions, sprays, inhalants or patches. The active component is admixed under sterile conditions with a pharmaceutically acceptable carrier and any needed preservatives or buffers as may be required. Ophthalmic formulation, ear drops, and eye drops are also contemplated as being within the scope of this invention. Additionally, the present invention contemplates the use of transdermal patches, which have the added advantage of providing controlled delivery of a compound to the body. Such dosage forms can be made by dissolving or dispersing the compound in the proper medium. Absorption enhancers can also be used to increase the flux of the compound across the skin. The rate can be controlled by either providing a rate controlling membrane or by dispersing the compound in a polymer matrix or gel.

[0187] The compounds of the invention are preferably formulated in dosage unit form for ease of administration and uniformity of dosage. The expression "dosage unit form" as used herein refers to a physically discrete unit of agent appropriate for the patient to be treated. It will be understood, however, that the total daily usage of the compounds and compositions of the present invention will be decided by the attending physician within the scope of sound medical judgment. The specific effective dose level for any particular patient or organism will depend upon a variety of factors including the disorder being treated and the severity of the disorder; the activity of the specific compound employed; the specific composition employed; the age, body weight, general health, sex and diet of the patient; the time of administration, route of administration, and rate of excretion of the specific compound employed; the duration of the treatment; drugs used in combination or coincidental with the specific compound employed, and like factors well known in the medical arts.

[0188] The amount of the compounds of the present invention that may be combined with the carrier materials to produce a composition in a single dosage form

will vary depending upon the host treated, the particular mode of administration. Preferably, the compositions should be formulated so that a dosage of between 0.01 - 100 mg/kg body weight/day of the inhibitor can be administered to a patient receiving these compositions.

[0189] Depending upon the particular condition, or disease, to be treated or prevented, additional therapeutic agents, which are normally administered to treat or prevent that condition, may also be present in the compositions of this invention. As used herein, additional therapeutic agents that are normally administered to treat or prevent a particular disease, or condition, are known as "appropriate for the disease, or condition, being treated".

[0190] For example, chemotherapeutic agents or other anti-proliferative agents may be combined with the compounds of this invention to treat proliferative diseases and cancer. Examples of known chemotherapeutic agents include, but are not limited to, Gleevec™, adriamycin, dexamethasone, vincristine, cyclophosphamide, fluorouracil, topotecan, taxol, interferons, and platinum derivatives.

[0191] Other examples of agents the inhibitors of this invention may also be combined with include, without limitation: treatments for Alzheimer's Disease such as Aricept® and Excelon®; treatments for Parkinson's Disease such as L-DOPA/carbidopa, entacapone, ropinrole, pramipexole, bromocriptine, pergolide, trihexyphenidyl, and amantadine; agents for treating Multiple Sclerosis (MS) such as beta interferon (e.g., Avonex® and Rebif®), Copaxone®, and mitoxantrone; treatments for asthma such as albuterol and Singulair®; agents for treating schizophrenia such as zyprexa, risperdal, seroquel, and haloperidol; anti-inflammatory agents such as corticosteroids, TNF blockers, IL-1 RA, azathioprine, cyclophosphamide, and sulfasalazine; immunomodulatory and immunosuppressive agents such as cyclosporin, tacrolimus, rapamycin, mycophenolate mofetil, interferons, corticosteroids, cyclophosphamide, azathioprine, and sulfasalazine; neurotrophic factors such as acetylcholinesterase inhibitors, MAO inhibitors, interferons, anti-convulsants, ion channel blockers, riluzole, and anti-Parkinsonian agents; agents for treating cardiovascular disease such as beta-blockers, ACE inhibitors, diuretics, nitrates, calcium channel blockers, and statins; agents for treating liver disease such as corticosteroids, cholestyramine, interferons, and anti-viral agents; agents for treating blood disorders such as corticosteroids, anti-

leukemic agents, and growth factors; and agents for treating immunodeficiency disorders such as gamma globulin.

[0192] Therapeutic agents that may be used in combination with a compound of the invention include one or more agents for treating rheumatoid arthritis, psoriasis, psoriatic arthritis, ankylosing spondylitis, reactive arthritis, arthritis associated with Crohn's disease and arthritis associated with ulcerative colitis. Agents that may be used for treating arthritis (e.g., rheumatoid arthritis, psoriatic arthritis, reactive arthritis, or arthritis associated with Crohn's disease or ulcerative colitis) include, without limitation, non-steroidal anti-inflammatory drugs (NSAIDS; e.g., aspirin, ibuprofen, naproxen, ketoprofen, indomethacin, tolmetin, sulindac, piroxicam, diclofenac and celecoxib), local injection and/or oral administration of anti-inflammatory steroids (e.g., cortisone or prednisone), methotrexate, oral administration and/or intramuscular injections of gold compounds, antimalarials (e.g., hydroxychloroquine), cyclosporin, leflunomide, azathioprine, sulfasalazine, d-penicillamine, cyclophosphamide, mycophenolate, a p38 antagonist (e.g., VX-702), a biological agent, or combinations thereof. Biological agents include, without limitation, tumor necrosis factor α (TNF α) antagonists, interleukin-1 α (IL-1 α) antagonists, CD28 antagonists and CD20 antagonists. In a further embodiment, biological agents include etanercept (ENBRELTM), adalimumab (HUMIRATM), infliximab (REMICADETM), anakinra (KINERETTM), abatacept (ORENCIATM), rituximab (RITUXANTM) and certolizumab pegol (CIMZIATM). Therapies that may be used to treat psoriasis include, without limitation, topical agents such as corticosteroids, calcipotriene, coal tar, anthralin and salicylic acid; phototherapy in association with coal tar or psoralen; and systemic agents such as methotrexate, retinoids (e.g., etretinate and isotretinoin), hydroxyurea and biological agents such as etanercept, infliximab, adalimumab, alafacet (AMEVIVETM) and efalizumab (RAPTIVATM).

[0193] The amount of additional therapeutic agent present in the compositions of this invention will be no more than the amount that would normally be administered in a composition comprising that therapeutic agent as the only active agent. Preferably the amount of additional therapeutic agent in the presently disclosed compositions will range from about 50% to 100% of the amount normally present in a composition comprising that agent as the only therapeutically active agent.

Uses of the Compounds and Compositions

[0194] In one embodiment, the invention provides a method of inhibiting JAK kinase activity in a patient, comprising administering to said patient a compound or composition of the invention.

[0195] In another embodiment, the invention comprises a method of treating or lessening the severity of a JAK-mediated condition or disease in a patient. The term “JAK-mediated disease”, as used herein means any disease or other deleterious condition in which a JAK family kinase, in particular JAK2 or JAK3, is known to play a role. In a further embodiment, the invention comprises a method of treating a JAK3-mediated disease. Such conditions include, without limitation, immune responses such as allergic or type I hypersensitivity reactions, asthma, autoimmune diseases such as transplant rejection, graft versus host disease, rheumatoid arthritis, amyotrophic lateral sclerosis, and multiple sclerosis, neurodegenerative disorders such as familial amyotrophic lateral sclerosis (FALS), as well as in solid and hematologic malignancies such as leukemias and lymphomas.

[0196] In another embodiment, the invention provides a method of treating or lessening the severity of a disease or condition selected from a proliferative disorder, a cardiac disorder, a neurodegenerative disorder, an autoimmune disorder, a condition associated with organ transplant, an inflammatory disorder, an immune disorder or an immunologically mediated disorder, comprising administering to said patient a compound or composition of the invention.

[0197] In a further embodiment, the method comprises the additional step of administering to said patient an additional therapeutic agent selected from a chemotherapeutic or anti-proliferative agent, an anti-inflammatory agent, an immunomodulatory or immunosuppressive agent, a neurotrophic factor, an agent for treating cardiovascular disease, an agent for treating diabetes, or an agent for treating immunodeficiency disorders, wherein said additional therapeutic agent is appropriate for the disease being treated and said additional therapeutic agent is administered together with said composition as a single dosage form or separately from said composition as part of a multiple dosage form.

[0198] In one embodiment, the disease or disorder is allergic or type I hypersensitivity reactions, asthma, diabetes, Alzheimer’s disease, Huntington’s disease,

Parkinson's disease, AIDS-associated dementia, amyotrophic lateral sclerosis (ALS, Lou Gehrig's disease), multiple sclerosis (MS), schizophrenia, cardiomyocyte hypertrophy, reperfusion/ischemia, stroke, baldness, transplant rejection, graft versus host disease, rheumatoid arthritis, amyotrophic lateral sclerosis, and multiple sclerosis, and solid and hematologic malignancies such as leukemias and lymphomas. In a further embodiment, said disease or disorder is asthma. In another embodiment, said disease or disorder is transplant rejection. In another embodiment, said disease or disorder is rheumatoid arthritis.

[0199] In another embodiment, a compound or composition of this invention may be used to treat a myeloproliferative disorder. In one embodiment, the myeloproliferative disorder is polycythemia vera, essential thrombocythemia, or chronic idiopathic myelofibrosis. In another embodiment, the myeloproliferative disorder is myeloid metaplasia with myelofibrosis, chronic myeloid leukemia (CML), chronic myelomonocytic leukemia, chronic eosinophilic leukemia, hypereosinophilic syndrome, systematic mast cell disease, atypical CML or juvenile myelomonocytic leukemia.

[0200] In another embodiment, the invention provides for the use of a compound of formula I to treat a JAK-mediated disease. In a further embodiment, the invention provides for the use of said compound to treat any of the diseases discussed above. In another embodiment, the invention provides for the use of a compound of formula I for the manufacture of a medicament for treating a JAK-mediated disease. In a further embodiment, the invention provides for the use of said compound for the manufacture of a medicament for treating any of the diseases discussed above.

[0201] In another embodiment, the invention provides a method of inhibiting JAK kinase activity in a biological sample, comprising contacting said biological sample with a compound or composition of the invention.

[0202] The term "biological sample", as used herein, means an *ex vivo* sample, and includes, without limitation, cell cultures or extracts thereof; tissue or organ samples or extracts thereof; biopsied material obtained from a mammal or extracts thereof; and blood, saliva, urine, feces, semen, tears, or other body fluids or extracts thereof.

[0203] Inhibition of kinase activity, particularly JAK kinase activity, in a biological sample is useful for a variety of purposes that are known to one of skill in the

art. Examples of such purposes include, but are not limited to, blood transfusion, organ-transplantation, biological specimen storage, and biological assays.

[0204] In certain embodiments of the present invention an "effective amount" of the compound or pharmaceutically acceptable composition is that amount effective for treating or lessening the severity of one or more of the aforementioned disorders. The compounds and compositions, according to the method of the present invention, may be administered using any amount and any route of administration effective for treating or lessening the severity of the disorder or disease. The exact amount required will vary from subject to subject, depending on the species, age, and general condition of the subject, the severity of the infection, the particular agent, its mode of administration, and the like.

[0205] In an alternate embodiment, the methods of this invention comprise the additional step of separately administering to said patient an additional therapeutic agent. When these additional therapeutic agents are administered separately they may be administered to the patient prior to, sequentially with or following administration of the compositions of this invention.

[0206] The compounds of this invention or pharmaceutical compositions thereof may also be used for coating an implantable medical device, such as prostheses, artificial valves, vascular grafts, stents and catheters. Vascular stents, for example, have been used to overcome restenosis (re-narrowing of the vessel wall after injury). However, patients using stents or other implantable devices risk clot formation or platelet activation. These unwanted effects may be prevented or mitigated by pre-coating the device with a pharmaceutically acceptable composition comprising a compound of this invention.

[0207] Suitable coatings and the general preparation of coated implantable devices are described in US Patents 6,099,562; 5,886,026; and 5,304,121. The coatings are typically biocompatible polymeric materials such as a hydrogel polymer, polymethyldisiloxane, polycaprolactone, polyethylene glycol, polylactic acid, ethylene vinyl acetate, and mixtures thereof. The coatings may optionally be further covered by a suitable topcoat of fluorosilicone, polysaccharides, polyethylene glycol, phospholipids or combinations thereof to impart controlled release characteristics in the composition. Implantable devices coated with a compound of this invention are another embodiment

of the present invention. The compounds may also be coated on implantable medical devices, such as beads, or co-formulated with a polymer or other molecule, to provide a "drug depot", thus permitting the drug to be released over a longer time period than administration of an aqueous solution of the drug.

Methodology for Synthesis and Characterization of Compounds

[0208] The compounds of this invention may be prepared in general by methods known to those skilled in the art for analogous compounds or by those methods depicted in the Examples below. See, e.g., the examples described in WO 2005/095400, which is herein incorporated by reference in its entirety.

[0209] All references provided in the Examples are herein incorporated by reference. As used herein, all abbreviations, symbols and conventions are consistent with those used in the contemporary scientific literature. See, e.g., Janet S. Dodd, ed., *The ACS Style Guide: A Manual for Authors and Editors*, 2nd Ed., Washington, D.C.: American Chemical Society, 1997, herein incorporated in its entirety by reference.

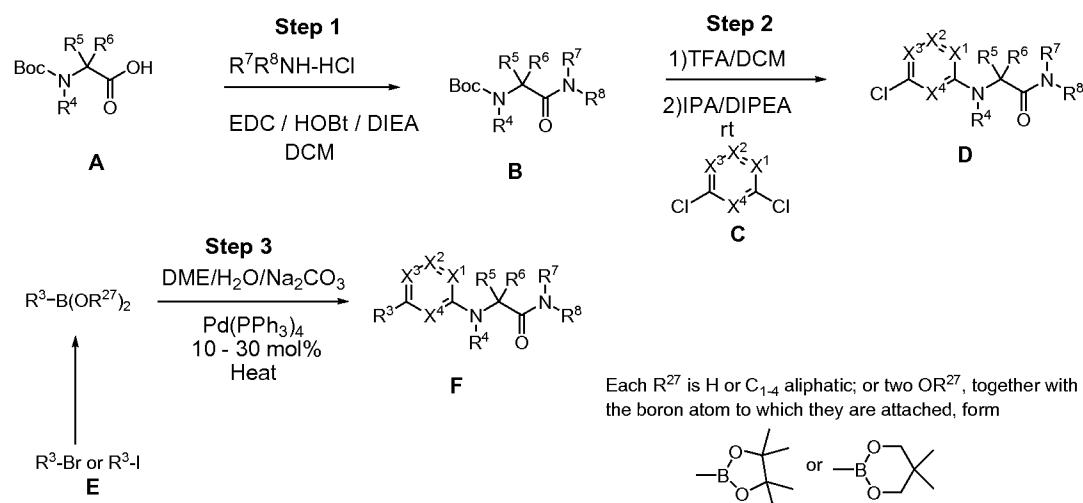
EXAMPLES

Example 1: Preparation of Compounds of the Invention

General Synthetic Schemes

[0210]

Scheme I



[0211] Compounds of formula F may be prepared as outlined in Scheme I using methods previously described in WO2005/095400.

[0212] Specifically, compounds of formulae A and C as well as $R^7R^8NH\text{-HCl}$ may be obtained commercially or prepared by one having ordinary skill in the art. Compounds of formula E and/or $R^3\text{-B(OR}^{27})_2$ may be obtained commercially or prepared by one having ordinary skill in the art, such as described in the cited references in Table 2. Further derivatives of R^3 or other substituents may be made using known methods.

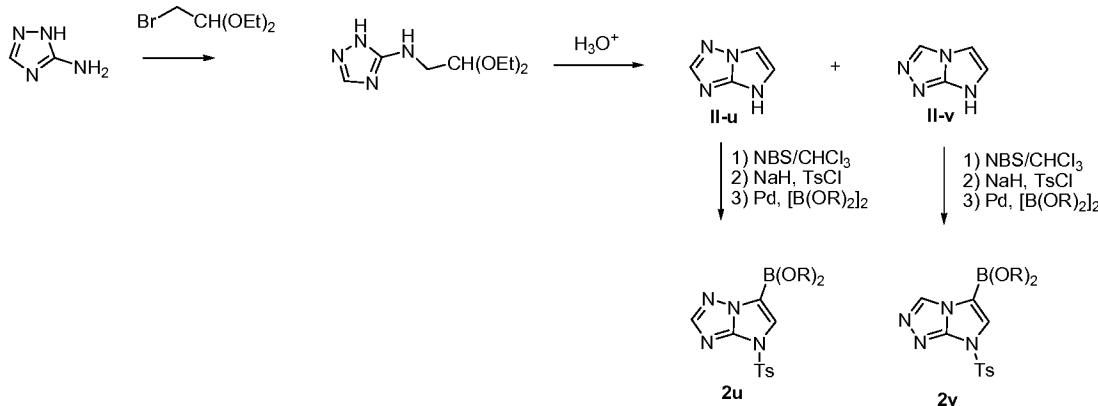
Table 2

R³	Reference
1-b	WO 2004056369; WO 2004050659; Mobinikhaledi et al., N. Asian J. Chem. 2003, 15, 455-458; Van den Haak et al., J. Org. Chem. 1982, 47, 1673-7
1-d	WO 2001053262
1-e	DiMauro et al. J. Med. Chem. 2006, 49, 5671; PCT WO 2006039718
1-f	Sako, Science of Synthesis 2004, 16, 1155-1267; Pomorski et al., Roczniki Chemii 1973, 47, 549-52
1-h	Sugimoto et al. Helv. Chim. Acta 2001, 84, 1112-1118.
1-i	WO 2006105289; WO 2006032466
1-j	Wozniak, Zeszyty Naukowe Uniwersytetu Jagiellonskiego, Prace Chemiczne 1978, 23, 55-66; Wozniak, Ibid. 1978, 23, 43-53
1-l	Gallou et al. Synlett. 2005, 2400-2402; Kelly et al. J. Med. Chem. 1997, 40, 2430-2433
1-m	Kelly et al. J. Med. Chem. 1997, 40, 2430-2433; Ciriano et al. J. Organomet. Chem. 1993, 445, 273-81; Yakhontov et al. Tetrahedron Lett. 1969, 1909-12
1-n	Kelly et al. J. Med. Chem. 1997, 40, 2430-2433; Yakhontov et al. Tetrahedron Lett. 1969, 1909-12
1-o	WO 2006015124
1-r	FR 2867778 A1; US 2005090529; Prokopov, A. A.; Yakhontov, L. N. Khimiya Geterotsiklichesikh Soedinenii 1979, 86-8
1-s	WO 2006050006; US 2005009876; US 2004127536; WO 2003053344; US 2002099208; WO 2002010137; Welch et al. Synthesis 1992, 937-9
1-t	WO 2006058120
1-u	FR 2845388 A1; WO 2003053344; US 2002099208; Milhavet et al. Arch. Pharmazie 1989, 322, 885-7; Chapman et al. J. Chem. Soc. Perkin Trans. 1 1980, 2398-2404
1-v	WO 2003101968
1-w	WO 2003101968
1-x	US 2002156081; WO 2002080926; WO 2001019829; WO 9816184
1-y	WO 2006058120
1-z	WO 2006046031; WO 2006046040
2-a	WO 2006077319
2-b	WO 2005110410
2-c	Duca et al. Biopolymers 2005, 80, 312-318
2-g	Zhang et al. J. Org. Chem. 2002, 67, 2345-2347

R³	Reference
2-h	JP 2005289921
2-i	Bilodeau et al. Bioorg. Med. Chem. Lett. 2003, 13, 2485-8; US 6465484; US 6162804; WO 2000012089; Wang et al. Tetrahedron Lett. 2003, 44, 8967-8969
2-j	EP 1122254
2-k	Dudash et al. Bioorg. Med. Chem. Lett. 15 (2005) 4790
2-l	Scheme II
2-m	Scheme II
2-o	WO2004/046120; WO 2006/034116; WO2005/095400
2-p	US 2006106218; US 2005256130; WO 2005056015; US 2004162282; WO 2003105853; Tavares et al. J. Med. Chem. 2004, 47, 588-599; WO 2003026650; WO 2002069901; Fraley et al. Bioorg. Med. Chem. Lett. 2002, 12, 2767-2770; WO 9928317; WO 9854093; US 5846990; WO 9729748; WO 9506034; JP 06056792; JP 01271751; Springer et al. J. Med. Chem. 1982, 25, 235-242; US 4281000
2-q	Lebedev et al. Vestnik Moskovskogo Universiteta, Seriya 2: Khimiya 1988, 29, 506-510; Kolobov et al. Khimiya Geterotsiklicheskikh Soedinenii 1987, 1503-8
2-r	J. Org. Chem. 2005, 70, 3997; Heterocycles 2005, 65, 2721
2-s	Heterocycles 1987, 26, 3153; Talanta 1993, 40, 577
2-t	Eur. J. Chem. 2000, 13, 2449
3-a	Durrant et al. Heterocycles 2006, 70, 509
3-c	Fraley et al. Bioorg. Med. Chem. Lett. 2002, 12, 3537-3541; US 2002041880; US 7087755; US 2006084650; WO 2004081008
3-d	Cheung et al. J. Org. Chem. 2005, 70, 3741-3744
3-f	Matulenko et al., Bioorg. Med. Chem. 2007, 15, 1586-1605; Hirayama et al., Chem. Pharm. 1976, 24, 26-36
3-h	Scheme III
3-o	Scheme IV
3-p	J. Heterocyclic Chem. 1986, 23, 541
3-q	Scheme V

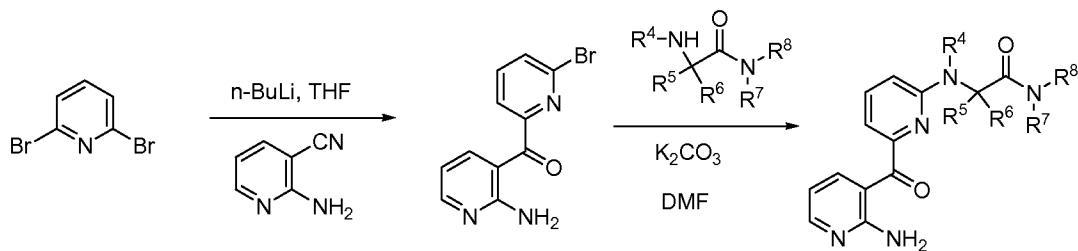
[0213] Compounds 1-32 and 59-168 were prepared according to Scheme I.

[0214] Scheme II



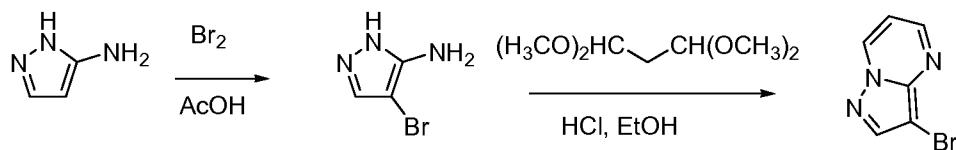
[0215] **II-l** and **II-m** were prepared according to the method described in *Tetrahedron* **1976**, 32 341-348. The resulting mixture was separated and the compounds reacted as shown in Scheme II to give the corresponding boronates.

[0216] Scheme III

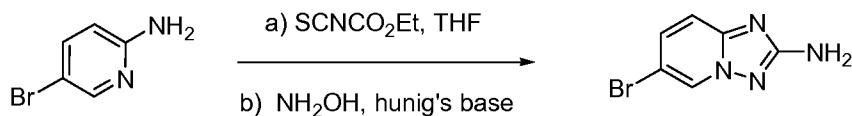


[0217] Compounds of formula I wherein R³ is 3-h may be prepared according to Scheme III.

[0218] Scheme IV

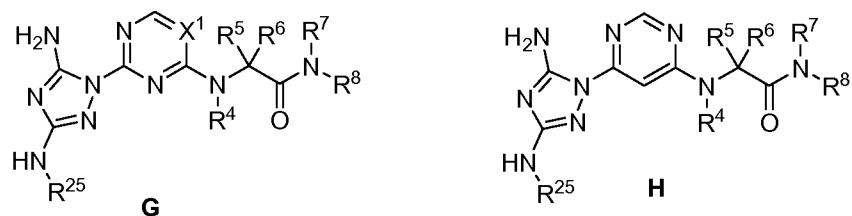


[0219] Scheme V



[0220] Compounds of formula I wherein R³ is 3-o or 3-q may be prepared according to Scheme IV or Scheme V, respectively.

[0221] Scheme VI



[0222] Compounds of formulae **G** and **H** may be prepared using methods previously described in WO2004/046120, WO 2006/034116 and WO2005/095400.

[0223] Compounds 33-58 were prepared according to Scheme VI.

Example 2: Analytical Results

[0224] Table 2 below depicts exemplary ^1H -NMR data (NMR) and liquid chromatographic mass spectral data, reported as mass plus proton (M+H), as determined by electrospray, and retention time (RT) for certain compounds of the present invention, wherein compound numbers in Table 2 corresponds to the compounds depicted in Table 1 (empty cells indicate that the test was not performed):

Table 3

Cmpd #	M+H	RT	NMR
1	362.3	2.4	H NMR (500 MHz, DMSO-d6) d 9.02 (d, $J = 2.3$ Hz, 1H), 8.76 (t, $J = 6.3$ Hz, 1H), 8.67 (dt, $J = 11.9, 4.2$ Hz, 1H), 8.32 (d, $J = 3.7$ Hz, 1H), 8.03 (d, $J = 6.3$ Hz, 1H), 7.25 (dd, $J = 8.6, 2.6$ Hz, 1H), 4.63 (m, 1H), 3.93-3.86 (m, 2H), 1.44 (d, $J = 7.2$ Hz, 3H)
2	378.3	2.6	
3	344.2	1.3	H NMR (500 MHz, DMSO-d6) d 8.79-8.76 (m, 3H), 8.40 (d, $J = 3.6$ Hz, 1H), 8.26 (d, $J = 6.1$ Hz, 2H), 8.14 (d, $J = 6.2$ Hz, 1H), 4.63 (m, 1H), 3.93-3.86 (m, 2H), 1.44 (d, $J = 7.2$ Hz, 3H)
4	344.2	1.4	H NMR (500 MHz, DMSO-d6) d 9.39 (d, $J = 1.7$ Hz, 1H), 8.76 (t, $J = 6.3$ Hz, 1H), 8.70 (dd, $J = 4.9, 1.6$ Hz, 1H), 8.63 (d, $J = 8.0$ Hz, 1H), 8.35 (d, $J = 3.7$ Hz, 1H), 8.05 (d, $J = 6.3$ Hz, 1H), 7.58 (dd, $J = 7.9, 5.0$ Hz, 1H), 4.63 (m, 1H), 3.93-3.86 (m, 2H), 1.44 (d, $J = 7.2$ Hz, 3H)
5	378.3	2.1	
6	359.3	1.4	H NMR (500 MHz, DMSO-d6) d 8.70 (t, $J = 6.3$ Hz, 1H), 8.58 (d, $J = 1.7$ Hz, 1H), 8.54 (dd, $J = 9.3, 1.8$ Hz, 1H), 8.28 (d, $J = 3.6$ Hz, 1H), 8.08 (d, $J = 6.0$ Hz, 3H), 6.99 (d, $J = 9.3$ Hz, 1H), 4.63 (m, 1H), 3.93-3.86 (m, 2H), 1.44 (d, $J = 7.2$ Hz, 3H)
7	376.0	1.6	H NMR (500 MHz, DMSO-d6) 12.28 (s, 1H), 8.79 (d, $J = 6.3$ Hz, 1H), 8.5 (bs, 1H) 8.33 (d, $J = 4.1$ Hz, 1H), 7.65 (s, 1H), 7.32 (s, 1H), 4.73 (t, $J = 7.0$ Hz, 1H), 3.97 - 3.83 (m, 2H), 1.44 (d, $J = 7.2$ Hz, 3H)
8	348.3	1.8	
9	348.3	2.1	
10	360.4	1.9	
11	330.3	1.3	
12	362.4	1.7	
13	362.4	2.1	
14	374.4	1.8	
15	344.3	1.5	
16	333.3	0.7	
17	362.4	1.9	
18	374.4	2.0	
19	362.4	2.3	
20	344.3	1.4	

Cmpd #	M+H	RT	NMR
21	388.4	2.0	
22	388.4	2.4	
23	370.4	1.7	
24	388.4	2.0	
25	388.4	2.4	
26	370.4	1.6	
27	359.1	2.0	H NMR (500 MHz, DMSO-d6) 8.86 (d, $J = 7.8$ Hz, 1H), 8.79 (t, $J = 6.3$ Hz, 1H), 8.36 (d, $J = 3.5$ Hz, 1H), 8.29 (d, $J = 5.8$ Hz, 1H), 8.14 (dd, $J = 1.7, 5.9$ Hz, 1H), 6.96 - 6.94 (m, 1H), 4.58 (t, $J = 6.8$ Hz, 1H), 3.93 - 3.86 (m, 2H) 1.45 (d, $J = 7.2$ Hz, 3H)
28	369.4	1.7	
29	345.1	1.5	
30	359.1	1.6	
31	355.1	1.5	
32	371.3	1.8	
33	440.4	2.4	
34	454.4	2.5	
35	440.4	2.1	
36	426.4	2.2	
37	466.4	2.5	
38	466.4	2.0	
39	496.4	2.3	
40	510.4	2.3	
41	500.3	2.6	
42	480.4	2.1	
43	498.4	2.5	
44	484.1	2.7	
45	458.1	2.5	
46	467.1	1.5	
47	472.3	2.3	
48	486.4	2.5	
49	633.2	1.7	
50	470.5	2.3	
51	466.1	2.6	
52	430.1	1.9	
53	432.1	1.9	
54	432.1	2.0	
55	474.1	1.9	
56	481.1	1.6	
57	481.1	1.6	
58	456.1	2.0	
59	395.2	1.7	
60	402.2	2.3	
61	423.2	2.1	
62	382.3	2.4	

Cmpd #	M+H	RT	NMR
63	465.3	1.6	
64	471.0	2.4	H NMR (300 MHz, DMSO) 12.42 (s, 1H), 8.70 (d, J = 1.5 Hz, 1H), 8.36 - 8.25 (m, 3H), 7.74 (d, J = 8.5 Hz, 1H), 7.65 (s, 1H), 3.82 - 3.70 (m, 2H), 2.22 (s, 3H), 1.57 (s, 6H).
65	467.1	2.4	
66	429.1	2.2	
67	401.2	2.8	H NMR (300 MHz, DMSO) 8.29 (t, J = 6.4 Hz, 1H), 8.24 (d, J = 3.9 Hz, 1H), 7.78 (dd, J = 1.7, 8.2 Hz, 1H), 7.63 (br, 2H), 6.95 (d, J = 8.2 Hz, 1H), 6.07 (s, 2H), 3.79 - 3.68 (m, 2H), 1.53 (s, 6H).
68	408.3	2.4	
69	388.2	2.6	H NMR (300 MHz, DMSO) 8.91 (d, J = 2.0 Hz, 1H), 8.37 - 8.26 (m, 3H), 7.68 (s, 1H), 6.86 (dd, J = 0.6, 8.7 Hz, 1H), 3.80 - 3.68 (m, 2H), 1.54 (s, 6H).
70	384.3	2.6	
71	397.3	2.7	
72	404.3	2.5	
73	425.2	2.3	H NMR (300 MHz, DMSO) 9.22 - 9.11 (m, 1H), 9.05 - 9.01 (m, 1H), 8.56 (d, J = 1.8 Hz, 1H), 8.21 - 7.99 (m, 4H), 7.49 (d, J = 8.6 Hz, 1H), 6.85 (d, J = 6.8 Hz, 1H), 4.76 - 4.71 (m, 1H), 4.13 - 3.76 (m, 2H), 2.19 - 2.10 (m, 1H), 1.00 (d, J = 6.7 Hz, 6H).
74	383.2	2.3	H NMR (300 MHz, DMSO) 8.87 (br, 1H), 8.41 (t, J = 6.2 Hz, 1H), 8.18 (d, J = 6.7 Hz, 1H), 7.80 (dd, J = 1.8, 8.3 Hz, 1H), 7.65 (d, J = 1.7 Hz, 1H), 7.10 (d, J = 8.3 Hz, 1H), 6.66 (d, J = 6.6 Hz, 1H), 6.14 (d, J = 7.6 Hz, 2H), 3.84 - 3.72 (m, 2H), 1.54 (s, 6H).
75	390.2	2.2	
76	415.3	3.0	
77	422.2	2.7	H NMR (300 MHz, DMSO) 9.01 (dd, J = 1.6, 4.4 Hz, 1H), 8.96 - 8.91 (m, 2H), 8.72 (dd, J = 1.9, 8.9 Hz, 1H), 8.63 (d, J = 7.9 Hz, 1H), 8.37 (d, J = 3.7 Hz, 1H), 8.11 (d, J = 8.9 Hz, 1H), 7.73 - 7.67 (m, 2H), 4.53 - 4.48 (m, 1H), 4.06 - 3.85 (m, 2H), 2.31 - 2.19 (m, 1H), 1.05 (d, J = 6.7 Hz, 3H), 1.03 (d, J = 6.7 Hz, 3H).
78	443.1	2.5	
79	410.9	1.3	
80	370.2	1.7	
81	402.1	2.3	
82	453.1	1.6	
83	368.1	1.7	
84	374.1	1.7	
85	370.1	1.9	
86	356.1	1.6	
87	388.1	2.0	
88	413.1	2.8	
89	420.2	2.6	
90	441.1	2.4	
91	400.2	2.7	

Cmpd #	M+H	RT	NMR
92	483.1	2.5	
93	417.3	2.0	H NMR (300 MHz, DMSO) 11.62 (br, 1H), 8.29 - 8.25 (m, 1H), 8.20 (m, 1H), 8.11 (m, 1H), 7.33 (s, 1H), 7.24 (s, 1H), 3.80 - 3.68 (m, 2H), 3.29 - 3.20 (m, 2H), 1.53 (s, 6H), 1.10 (t, J = 7.1 Hz, 3H).
94	429.2	2.1	H NMR (300 MHz, DMSO) 11.78 (br, 1H), 8.27 - 8.09 (m, 3H), 7.32 (s, 1H), 7.24 (s, 1H), 3.85 - 3.68 (m, 2H), 2.54 (m, 1H), 1.53 (s, 6H), 0.68 - 0.59 (m, 2H), 0.55 - 0.50 (m, 2H).
95		2.4	
96	431.3	2.2	H NMR (300 MHz, DMSO) 11.70 (br, 1H), 8.28 - 8.17 (m, 2H), 7.86 (d, J = 8.7 Hz, 1H), 7.30 (d, J = 2.4 Hz, 2H), 4.41 - 3.50 (m, 3H, obscured by water), 1.53 (s, 6H), 1.14 (d, J = 6.6 Hz, 6H).
97	443.3	2.1	H NMR (300 MHz, DMSO) 11.93 (br, 1H), 8.36 - 8.31 (m, 3H), 7.46 (s, 1H), 7.17 (s, 1H), 3.77 - 3.68 (m, 4H), 3.50 (br, 2H), 2.03 - 1.97 (m, 4H), 1.53 (s, 6H).
98	411.3	1.9	
99	461.1	2.4	
100	413.3	2.0	
101	425.3	2.0	
102	423.3	2.0	
103	417.2	2.2	H NMR (300 MHz, DMSO) 11.92 (br, 1H), 8.84 - 8.80 (m, 1H), 8.23 (br, 1H), 7.63 (s, 1H), 7.29 (s, 1H), 4.53 (t, J = 7.9 Hz, 1H), 4.10 - 3.93 (m, 1H), 3.88 - 3.78 (m, 1H), 2.76 (d, J = 4.5 Hz, 3H), 2.42 - 2.15 (m, 1H), 0.98 (d, J = 6.6 Hz, 3H), 0.97 (d, J = 6.6 Hz, 3H).
104	493.2	2.7	H NMR (300 MHz, DMSO) 11.99 (br, 1H), 8.84 - 8.80 (m, 1H), 8.68 (t, J = 6.0 Hz, 1H), 8.24 (d, J = 3.9 Hz, 1H), 7.67 (s, 1H), 7.33 (d, J = 1.8 Hz, 1H), 7.32 - 7.21 (m, 5H), 4.52 (t, J = 7.9 Hz, 1H), 4.46 (d, J = 6.2 Hz, 2H), 4.07 - 3.93 (m, 1H), 3.87 - 3.73 (m, 1H), 2.28 - 2.15 (m, 1H), 0.98 (d, J = 6.6 Hz, 3H), 0.97 (d, J = 6.6 Hz, 3H).
105	445.3	2.4	H NMR (300 MHz, DMSO) 11.84 (br, 1H), 8.85 - 8.81 (m, 1H), 8.21 (s, 1H), 7.86 (d, J = 7.8 Hz, 1H), 7.61 (s, 1H), 7.36 (d, J = 1.6 Hz, 1H), 4.50 (t, J = 7.7 Hz, 1H), 4.11 - 3.78 (m, obscured by water), 2.24 - 2.14 (m, 1H), 1.15 (d, J = 6.6 Hz, 3H), 1.15 (d, J = 6.6 Hz, 3H), 0.98 (d, J = 6.6 Hz, 3H), 0.97 (d, J = 6.6 Hz, 3H).
106	457.3	2.5	
107	457.3	2.4	H NMR (300 MHz, DMSO) 12.01 (br, 1H), 8.88 (s, 1H), 8.29 (s, 1H), 7.72 (s, 1H), 7.20 (s, 1H), 4.48 (t, J = 7.8 Hz, 1H), 4.06 - 3.74 (m, obscured by water), 1.99 - 1.87 (m, 4H), 1.00 - 0.96 (m, 6H).
108	455.2	2.4	H NMR (300 MHz, DMSO) 12.13 (br, 1H), 8.92 - 8.88 (m, 1H), 8.32 (d, J = 4.2 Hz, 1H), 7.78 (s, 1H), 7.28 (s, 1H), 6.01 (s, 2H), 4.51 (br, 2H), 4.50 (t, J = 7.7 Hz, 1H), 4.32 (br, 2H), 4.11 - 3.97 (m, 1H), 3.89 - 3.71 (m, 1H), 2.28 - 2.16 (m, 1H), 1.00 (d, J = 6.6 Hz, 3H), 0.98 (d, J = 6.6 Hz, 3H).

Cmpd #	M+H	RT	NMR
109	399.2	2.0	
110	475.2	2.5	
111	427.3	2.2	
112	439.3	2.3	
113	439.3	2.2	
114	437.3	2.2	
115	415.2	2.0	
116	491.3	2.5	
117	443.2	2.3	
118	455.3	2.4	
119	455.3	2.3	
120	453.2	2.3	
121	473.2	2.4	
122	425.3	2.1	
123	373.2	2.3	H NMR (300 MHz, DMSO) 9.86 (br, 1H), 8.31 - 8.24 (m, 2H), 8.00 (d, J = 8.7 Hz, 2H), 7.69 (s, 1H), 6.78 (d, J = 8.8 Hz, 2H), 3.80 - 3.68 (m, 2H), 1.54 (s, 6H).
124	387.2	2.8	H NMR (300 MHz, DMSO) 8.31 - 8.24 (m, 2H), 8.13 - 8.09 (m, 2H), 7.64 (s, 1H), 7.00 - 6.95 (m, 2H), 3.81 (s, 3H), 3.77 - 3.68 (m, 2H), 1.54 (s, 6H).
125	415.2	2.7	H NMR (300 MHz, DMSO) 8.30 - 8.23 (m, 2H), 7.69 - 7.62 (m, 3H), 6.87 (d, J = 8.3 Hz, 1H), 4.27 (s, 4H), 3.80 - 3.68 (m, 2H), 1.53 (s, 6H).
126	443.3	2.3	H NMR (300 MHz, DMSO) 11.89 (br, 1H), 8.83 - 8.79 (m, 1H), 8.19 (d, J = 4.3 Hz, 1H), 8.10 (d, J = 3.5 Hz, 1H), 7.59 (s, 1H), 7.31 (s, 1H), 4.50 (t, J = 7.7 Hz, 1H), 4.19 - 3.52 (m, obscured by water), 2.83 - 2.76 (m, 1H), 2.23 - 2.16 (m, 1H), 0.97 (dd, J = 4.5, 6.6 Hz, 6H), 0.69 - 0.65 (m, 2H), 0.56 - 0.51 (m, 2H).
127	402.0	1.6	
128	372.2	1.5	
129	429.1	1.6	
130	437.3	2.0	
131	403.1	1.7	H NMR (300 MHz, DMSO) 12.40 (br, 1H), 11.97 (br, 1H), 8.82 (t, J = 6.3 Hz, 1H), 8.11 (d, J = 3.8 Hz, 1H), 7.55 (m, 1H), 7.23 (dd, J = 1.6, 2.5 Hz, 1H), 4.48 (t, J = 7.8 Hz, 1H), 4.08 - 3.94 (m, 1H), 3.87 - 3.73 (m, 1H), 2.22 - 2.07 (m, 1H), 0.98 (d, J = 6.6 Hz, 3H), 0.96 (d, J = 6.6 Hz, 3H).
132	399.1	1.5	H NMR (300 MHz, DMSO) 11.67 - 11.56 (m, 1H), 8.13 (m, 2H), 8.03 (d, J = 5.9 Hz, 1H), 7.39 (s, 1H), 7.04 (s, 1H), 6.30 (m, 1H), 3.79 - 3.67 (m, 2H), 3.14 (br, 6H), 1.45 (s, 6H).
133	390.0	1.4	
134	386.1	1.7	

Cmpd #	M+H	RT	NMR
135	385.2	1.5	H NMR (300 MHz, DMSO) 11.63 (d, $J = 4.5$ Hz, 1H), 8.73 - 8.69 (m, 1H), 8.04 (d, $J = 5.9$ Hz, 1H), 7.62 (d, $J = 3.7$ Hz, 1H), 7.37 (m, 2H), 6.48 (m, 1H), 5.03 (br, 2H), 4.40 (br, 1H), 4.09 - 3.95 (m, 1H), 3.92 - 3.79 (m, 1H), 2.13 - 2.01 (m, 1H), 0.97 (d, $J = 6.3$ Hz, 3H), 0.95 (d, $J = 6.3$ Hz, 3H).
136	371.1	1.3	H NMR (300 MHz, DMSO) 11.55 (d, $J = 5.6$ Hz, 1H), 8.13 (m, 1H), 8.07 (d, $J = 5.9$ Hz, 1H), 7.50 (d, $J = 3.7$ Hz, 1H), 7.44 (s, 1H), 7.33 (d, $J = 2.2$ Hz, 1H), 6.35 (d, $J = 5.8$ Hz, 1H), 5.00 (s, 2H), 3.82 - 3.71 (m, 2H), 1.45 (s, 6H).
137	403.1	1.6	
138	401.2	1.4	
139	435.2	2.1	
140	414.0	2.5	
141	426.0	2.7	
142	387.4	2.5	H NMR (300 MHz, DMSO) 9.86 (br, 1H), 8.81 (t, $J = 6.4$ Hz, 1H), 8.24 (d, $J = 4.0$ Hz, 1H), 8.12 (dd, $J = 1.9, 6.9$ Hz, 2H), 7.61 (m, 1H), 6.83 - 6.79 (m, 2H), 4.50 (t, $J = 7.7$ Hz, 1H), 4.07 - 3.74 (m, 2H), 2.28 - 2.14 (m, 1H), 0.99 (d, $J = 6.6$ Hz, 3H), 0.98 (d, $J = 6.6$ Hz, 3H).
143	383.2	2.7	H NMR (300 MHz, DMSO) 8.97 (m, 2H), 8.23 (d, $J = 9.0$ Hz, 2H), 8.16 (d, $J = 6.7$ Hz, 1H), 7.13 (d, $J = 8.9$ Hz, 2H), 6.82 (d, $J = 6.6$ Hz, 1H), 4.74 (m, 1H), 4.10 - 3.69 (m, 5H), 2.19 - 2.07 (m, 1H), 0.98 (d, $J = 6.8$ Hz, 6H).
144	355.0	2.0	
145	401.2	3.0	H NMR (300 MHz, DMSO) 8.82 (t, $J = 6.2$ Hz, 1H), 8.26 - 8.21 (m, 3H), 7.65 - 7.52 (m, 1H), 7.00 (d, $J = 9.0$ Hz, 2H), 4.49 (t, $J = 7.6$ Hz, 1H), 4.05 - 3.85 (m, 2H), 3.82 (s, 3H), 2.38 - 2.12 (m, 1H), 1.00 (d, $J = 6.6$ Hz, 3H), 0.98 (d, $J = 6.3$ Hz, 3H).
146	411.3	2.7	H NMR (300 MHz, DMSO) 9.08 (m, 2H), 8.14 (d, $J = 6.7$ Hz, 1H), 7.80 - 7.77 (m, 2H), 7.05 (d, $J = 8.4$ Hz, 1H), 6.82 (m, 1H), 4.77 (m, 1H), 4.34 (d, $J = 4.7$ Hz, 4H), 4.16 - 3.78 (m, 2H), 2.16 - 2.05 (m, 1H), 0.97 (d, $J = 6.8$ Hz, 6H).
147	367.1	2.2	H NMR (300 MHz, DMSO) 10.39 (br, 1H), 8.93 (m, 1H), 8.29 (d, $J = 6.9$ Hz, 1H), 8.08 (d, $J = 8.7$ Hz, 2H), 6.90 (d, $J = 8.4$ Hz, 2H), 6.78 (d, $J = 7.4$ Hz, 1H), 4.80 (m, 1H), 4.03 - 3.89 (m, 2H), 3.74 - 3.63 (m, 2H), 2.44 - 2.31 (m, 1H), 2.07 - 1.97 (m, 3H).
148	409.8	2.6	
149	369.2	2.5	H NMR (300 MHz, DMSO) 8.39 (m, 1H), 8.18 - 8.13 (m, 3H), 7.11 (d, $J = 8.9$ Hz, 2H), 6.65 (m, 1H), 3.86 (s, 3H), 3.81 - 3.62 (m, 2H), 1.54 (s, 6H).
150	381.2	2.6	H NMR (300 MHz, DMSO) 8.92 (t, $J = 6.3$ Hz, 1H), 8.32 (d, $J = 6.7$ Hz, 1H), 8.18 (d, $J = 8.7$ Hz, 2H), 7.09 (d, $J = 8.5$ Hz, 2H), 6.78 (d, $J = 7.1$ Hz, 1H), 4.79 (m, 1H), 4.00 - 3.91 (m, 2H), 3.86 (s, 3H), 3.72 - 3.55 (m, 2H), 2.38 - 2.26 (m, 1H), 2.07 - 2.04 (m, 3H).

Cmpd #	M+H	RT	NMR
151	385.1	2.4	H NMR (300 MHz, DMSO) 9.78 (br, 1H), 8.75 (m, 1H), 8.25 (d, J = 5.8 Hz, 1H), 8.07 (d, J = 8.4 Hz, 2H), 6.79 (d, J = 8.6 Hz, 2H), 4.71 (m, 1H), 4.23 - 3.58 (m, obscured by water), 2.32 - 2.07 (m, 1H), 2.02 (m, 3H).
152	399.2	2.9	H NMR (300 MHz, DMSO) 8.78 - 8.74 (m, 1H), 8.28 (d, J = 5.9 Hz, 1H), 8.17 (d, J = 8.7 Hz, 2H), 6.98 (d, J = 8.8 Hz, 2H), 4.73 - 4.70 (m, 1H), 3.96 - 3.79 (m, 7H), 2.27 (m, 1H), 1.97 (m, 3H).
153	427.2	2.8	H NMR (300 MHz, DMSO) 8.77 - 8.73 (m, 1H), 8.25 (d, J = 5.8 Hz, 1H), 7.72 (m, 2H), 6.88 (d, J = 8.5 Hz, 1H), 4.77 - 4.65 (m, 1H), 4.28 (s, 4H), 4.02 - 3.51 (m, obscured by water), 2.27 (m, 1H), 1.96 (m, 3H).
154	395.7	2.3	
155	408.0	2.4	
156	430.0	3.0	
157	442.0	3.0	
158	412.0	2.7	H NMR (300 MHz, DMSO) 12.38 (br, 1H), 8.58 - 8.23 (m, 2H), 8.14 (d, J = 6.5 Hz, 1H), 7.54 (d, J = 8.6 Hz, 1H), 7.26 (d, J = 8.0 Hz, 1H), 6.64 - 6.58 (m, 1H), 3.87 - 3.75 (m, 2H), 1.63 (s, 6H).
159	424.0	2.8	
160	444.0	3.2	H NMR (300 MHz, DMSO) 11.83 (s, 1H), 8.81 (t, J = 6.4 Hz, 1H), 8.43 (d, J = 2.1 Hz, 1H), 8.29 (d, J = 4.1 Hz, 1H), 8.22 (d, J = 2.8 Hz, 1H), 7.66 - 7.57 (m, 1H), 7.47 (d, J = 8.6 Hz, 1H), 7.18 (dd, J = 2.2, 8.6 Hz, 1H), 4.56 (t, J = 7.8 Hz, 1H), 4.22 - 3.82 (m, obscured by water), 2.31 - 2.18 (m, 1H), 1.03 (d, J = 6.9 Hz, 3H), 1.00 (d, J = 7.1 Hz, 3H).
161	426.0	2.9	H NMR (300 MHz, DMSO) 12.47 (br, 1H), 9.20 - 8.95 (m, 1H), 8.50 (s, 1H), 8.34 (s, 1H), 8.13 (d, J = 6.3 Hz, 1H), 7.59 (d, J = 8.9 Hz, 1H), 7.30 (d, J = 8.3 Hz, 1H), 6.81 (br, 1H), 4.83 (m, 1H), 4.16 - 3.85 (m, 2H), 2.33 - 2.27 (m, 1H), 1.05 (d, J = 6.9 Hz, 3H), 1.02 (d, J = 6.7 Hz, 3H).
162	409.2	2.4	H NMR (300 MHz, DMSO) 8.98 (dd, J = 1.8, 8.8 Hz, 2H), 8.86 (d, J = 1.7 Hz, 1H), 8.64 (dd, J = 1.9, 8.9 Hz, 1H), 8.41 - 8.35 (m, 2H), 8.13 (d, J = 8.8 Hz, 1H), 7.77 (s, 1H), 3.83 - 3.72 (m, 2H), 1.60 (s, 6H).
163	391.3	2.1	H NMR (300 MHz, DMSO) 9.01 (d, J = 5.3 Hz, 2H), 8.94 (s, 1H), 8.64 (d, J = 9.0 Hz, 1H), 8.36 - 8.31 (m, 3H), 8.18 (d, J = 9.0 Hz, 1H), 6.68 (m, 1H), 3.82 - 3.74 (m, obscured by water), 1.57 (s, 6H).
164	405.2	2.4	
165	421.2	2.5	H NMR (300 MHz, DMSO) 9.04 - 8.91 (m, 4H), 8.70 (d, J = 7.8 Hz, 1H), 8.42 (d, J = 5.6 Hz, 1H), 8.15 (d, J = 8.7 Hz, 1H), 4.79 (m, 1H), 4.09 - 3.82 (m, 4H), 2.40 - 2.27 (m, 1H), 2.15 - 2.01 (m, 3H).

Cmpd #	M+H	RT	NMR
166	429.2	2.1	H NMR (300 MHz, DMSO) 8.82 (t, $J = 6.3$ Hz, 1H), 8.22 (d, $J = 3.7$ Hz, 1H), 7.80 - 7.75 (m, 2H), 7.34 (d, $J = 7.7$ Hz, 1H), 6.89 (d, $J = 8.3$ Hz, 1H), 4.50 (t, $J = 7.6$ Hz, 1H), 4.28 (s, 4H), 4.10 - 3.74 (m, 2H), 2.28 - 2.13 (m, 1H), 0.99 (d, $J = 6.6$ Hz, 3H), 0.97 (d, $J = 6.6$ Hz, 3H).
167	368.8	1.7	H NMR (300 MHz, DMSO) 9.75 (s, 1H), 8.75 (t, $J = 6.4$ Hz, 1H), 8.19 - 8.08 (m, 3H), 7.44 - 7.36 (m, 1H), 6.80 (d, $J = 8.8$ Hz, 2H), 6.52 (d, $J = 5.5$ Hz, 1H), 4.67 - 4.57 (m, 1H), 4.07 - 3.76 (m, 2H), 2.14 - 2.01 (m, 1H), 0.97 (d, $J = 6.8$ Hz, 3H), 0.96 (d, $J = 6.8$ Hz, 3H).
168	423.3	2.4	H NMR (300 MHz, DMSO) 9.01 - 8.95 (m, 4H), 8.76 (dd, $J = 1.9, 8.8$ Hz, 1H), 8.40 (d, $J = 3.7$ Hz, 1H), 8.16 (d, $J = 8.8$ Hz, 1H), 7.65 (d, $J = 7.6$ Hz, 1H), 4.59 (t, $J = 7.6$ Hz, 1H), 4.13 - 3.81 (m, 2H), 2.30 - 2.19 (m, 1H), 1.04 (d, $J = 6.6$ Hz, 3H), 1.02 (d, $J = 6.6$ Hz, 3H).

Example 3: JAK3 Inhibition Assay

[0225] Compounds were screened for their ability to inhibit JAK3 using the assay shown below. Reactions were carried out in a kinase buffer containing 100 mM HEPES (pH 7.4), 1 mM DTT, 10 mM MgCl₂, 25 mM NaCl, and 0.01% BSA. Substrate concentrations in the assay were 5 μ M ATP (200 uCi/ μ mole ATP) and 1 μ M poly(Glu)₄Tyr. Reactions were carried out at 25°C and 1 nM JAK3.

[0226] To each well of a 96 well polycarbonate plate was added 1.5 μ l of a candidate JAK3 inhibitor along with 50 μ l of kinase buffer containing 2 μ M poly(Glu)₄Tyr and 10 μ M ATP. This was then mixed and 50 μ l of kinase buffer containing 2 nM JAK3 enzyme was added to start the reaction. After 20 minutes at room temperature (25°C), the reaction was stopped with 50 μ l of 20% trichloroacetic acid (TCA) that also contained 0.4 mM ATP. The entire contents of each well were then transferred to a 96 well glass fiber filter plate using a TomTek Cell Harvester. After washing, 60 μ l of scintillation fluid was added and ³³P incorporation detected on a Perkin Elmer TopCount.

[0227] The following compounds inhibited JAK3 with a Ki of less than or equal to 1.0 μ M: 29, 33, 34, 35, 36, 37, 42, 56, 68, 74, 75, 97, 101, 102, 108, 114, 120, 123, 132, 139, 140, 144, 148, 154, 155, 162 and 163. The following compounds inhibited JAK3 with a Ki of greater than 1.0 μ M and less than or equal to 10 μ M: 4, 11, 26, 27, 28, 30, 31, 32, 38, 39, 43, 44, 45, 49, 50, 51, 57, 58, 59, 60, 61, 64, 65, 66, 67, 72,

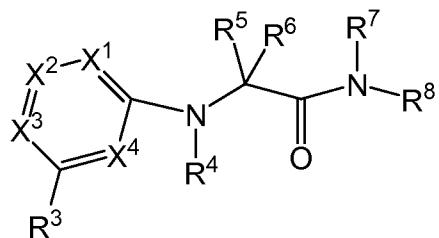
73, 77, 78, 79, 82, 86, 93, 94, 98, 104, 107, 109, 110, 112, 113, 119, 121, 130, 133, 136, 141, 147, 156, 158, 164, 167 and 168. The following compounds inhibited JAK3 with a K_i of greater than 10 μM and less than or equal to 50 μM : 2, 6, 8, 15, 20, 63, 71, 76, 80, 83, 84, 85, 88, 89, 96, 99, 100, 103, 106, 115, 116, 118, 126, 129, 135, 137, 142, 151, 159, 161 and 165. The following compounds did not inhibit JAK3 at concentrations of 50 μM : 1, 3, 5, 7, 9, 10, 12, 13, 14, 16, 17, 18, 19, 21, 22, 23, 24, 25, 62, 69, 70, 81, 87, 90, 91, 92, 95, 105, 111, 117, 122, 124, 125, 127, 128, 131, 134, 138, 143, 145, 146, 149, 150, 152, 153, 157, 160 and 166. The following compounds did not inhibit JAK3 at concentrations of 5.0 μM : 40, 41, 46, 47, 48, 52, 53, 54 and 55.

[0228] While we have described a number of embodiments of this invention, it is apparent that our basic examples may be altered to provide other embodiments which utilize the compounds and methods of this invention. Therefore, it will be appreciated that the scope of this invention is to be defined by the appended claims rather than by the specific embodiments that have been represented by way of example above.

CLAIMS

We claim:

1. A compound of formula (I):



I

or a pharmaceutically acceptable salt thereof, wherein:

X^1 is N or CR^1 ;

X^2 is N or CR^2 ; wherein no more than one of X^1 or X^2 is N;

X^3 is N or CR^{23} ;

X^4 is N or CR^{24} ; wherein at least one of X^3 and X^4 is N;

R^1 is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

R^2 is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

or R^1 and R^2 , taken together, form a 5-7 membered aryl or heteroaryl ring optionally substituted with 1-4 occurrences of R^9 ;

each R^9 is independently selected from halogen, OCH₃, OH, NO₂, NH₂, SH, SCH₃, NCH₃, CN or unsubstituted C₁₋₂aliphatic;

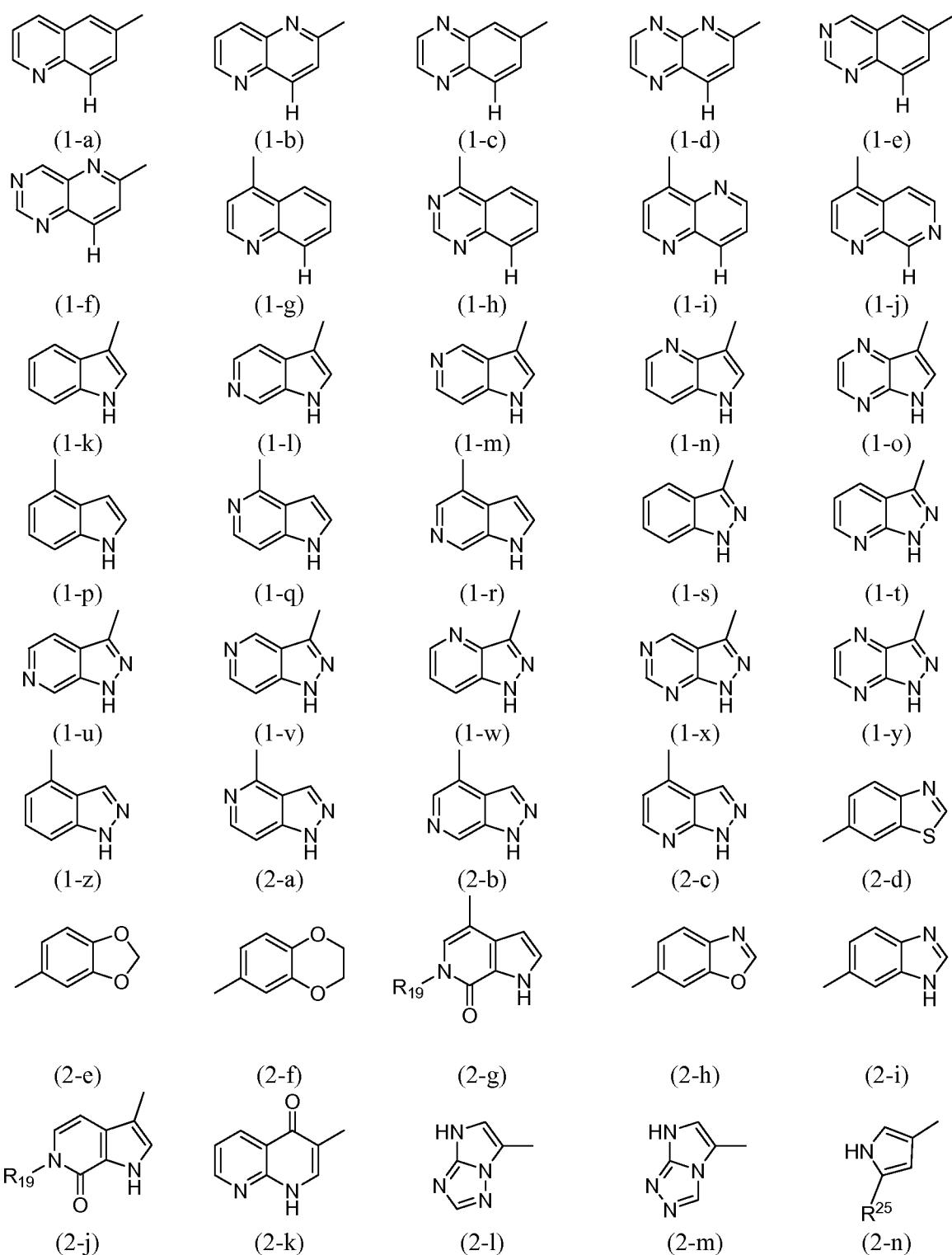
R^{23} is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

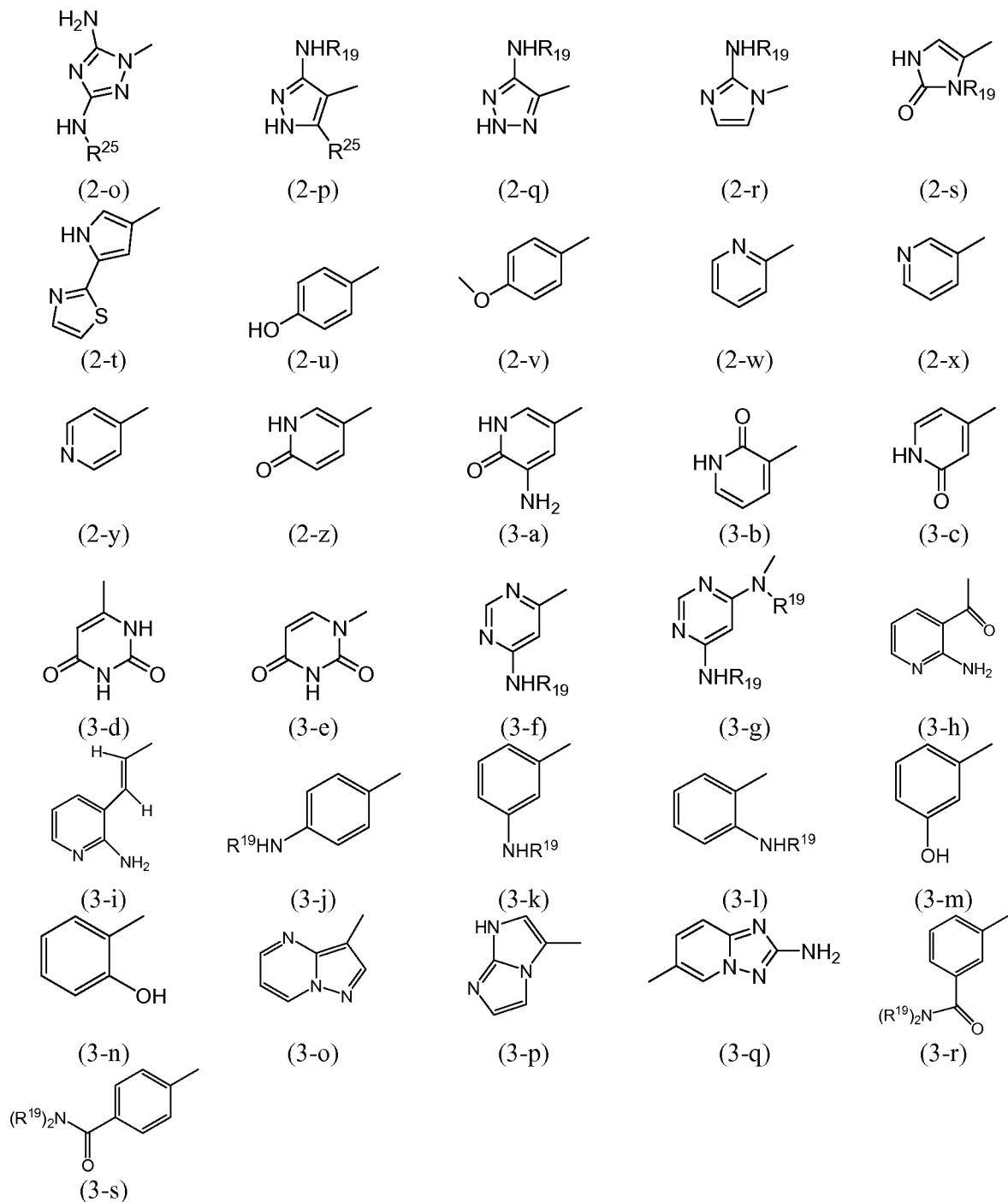
R^{24} is H, halo, R', OH, OR', COR', COOH, COOR', CONH₂, CONHR', CON(R')₂, or CN;

R' is a C₁₋₃ aliphatic optionally substituted with 1-4 occurrences of R^{10} ;

each R^{10} is independently selected from halogen, CF₃, OCH₃, OH, SH, NO₂, NH₂, SCH₃, NCH₃, CN or unsubstituted C₁₋₂ aliphatic, or two R^{10} groups, together with the carbon to which they are attached, form a cyclopropyl ring or C=O;

R^3 is selected from





R¹⁹ is selected from H; a C₃₋₇ cycloaliphatic optionally substituted with 1-4 occurrences of halogen, OH, NO₂, NH₂, SH or CN; or a C₁₋₆ aliphatic, wherein up to two methylene units of said C₁₋₆ aliphatic are optionally and independently replaced by G^R and wherein said C₁₋₆ aliphatic is optionally substituted with 1-4 R²⁰;

G^R is $-\text{NH}-$, $-\text{NR}^{21}-$, $-\text{O}-$, $-\text{S}-$, $-\text{CO}_2-$, $-\text{OC(O)}-$, $-\text{C(O)CO}-$, $-\text{C(O)}-$, $-\text{C(O)NH}-$, $-\text{C(O)NR}^{21}-$, $-\text{NC(=N-CN)N}-$, $-\text{NHCO}-$, $-\text{NR}^{21}\text{CO}-$, $-\text{NHC(O)O}-$, $-\text{NR}^{21}\text{C(O)O}-$, $-\text{SO}_2\text{NH}-$, $-\text{SO}_2\text{NR}^{21}-$, $-\text{NHSO}_2-$, $-\text{NR}^{21}\text{SO}_2-$, $-\text{NHC(O)NH}-$, $-\text{NR}^{21}\text{C(O)NH}-$, $-\text{NHC(O)NR}^{21}-$, $-\text{NR}^{21}\text{C(O)NR}^{21}-$, $-\text{OC(O)NH}-$, $-\text{OC(O)NR}^{21}-$, $-\text{NHSO}_2\text{NH}-$, $-\text{NR}^{21}\text{SO}_2\text{NH}-$, $-\text{NHSO}_2\text{NR}^{21}-$, $-\text{NR}^{21}\text{SO}_2\text{NR}^{21}-$, $-\text{SO}-$, or $-\text{SO}_2-$;

R^{21} is C_{1-6} aliphatic or C_{3-7} cycloaliphatic optionally substituted with 1-6 occurrences of halogen, $\text{N}(\text{R}^X)_2$, R^X , $-\text{OR}^X$, $-\text{SR}^X$, $-\text{NO}_2$, $-\text{CF}_3$, $-\text{CN}$, $-\text{CO}_2\text{R}^X$, $-\text{COR}^X$, OCOR^X , CONHR^X , or NHCOR^X ;

each R^X is independently selected from H or an unsubstituted C_{1-6} aliphatic;

each R^{20} is independently selected from halogen, OH, OR^{22} , NO_2 , NH_2 , NHR^{22} , $\text{N}(\text{R}^{22})_2$, SH , SR^{22} , CN , or R^{22} ; or two R^{20} , together with the carbon(s) to which they are attached, form a cyclopropyl ring or C=O ;

each R^{22} is independently selected from a C_{1-6} aliphatic or C_{3-7} cycloaliphatic optionally substituted with 1-6 occurrences of halogen, OH, NO_2 , NH_2 , SH or CN ;

R^{25} is $-(\text{U})_m-\text{Y}$;

U is a C_{1-6} aliphatic, wherein up to two methylene units are optionally and independently replaced by G^U and wherein U is optionally substituted with 1-4 J^U ;

G^U is $-\text{NH}-$, $-\text{NR}^{26}-$, $-\text{O}-$, $-\text{S}-$, $-\text{CO}_2-$, $-\text{OC(O)}-$, $-\text{C(O)CO}-$, $-\text{C(O)}-$, $-\text{C(O)NH}-$, $-\text{C(O)NR}^{26}-$, $-\text{NC(=N-CN)N}-$, $-\text{NHCO}-$, $-\text{NR}^{26}\text{CO}-$, $-\text{NHC(O)O}-$, $-\text{NR}^{26}\text{C(O)O}-$, $-\text{SO}_2\text{NH}-$, $-\text{SO}_2\text{NR}^{26}-$, $-\text{NHSO}_2-$, $-\text{NR}^{26}\text{SO}_2-$, $-\text{NHC(O)NH}-$, $-\text{NR}^{26}\text{C(O)NH}-$, $-\text{NHC(O)NR}^{26}-$, $-\text{NR}^{26}\text{C(O)NR}^{26}-$, $-\text{OC(O)NH}-$, $-\text{OC(O)NR}^{26}-$, $-\text{NHSO}_2\text{NH}-$, $-\text{NR}^{26}\text{SO}_2\text{NH}-$, $-\text{NHSO}_2\text{NR}^{26}-$, $-\text{NR}^{26}\text{SO}_2\text{NR}^{26}-$, $-\text{SO}-$, or $-\text{SO}_2-$;

R^{26} is a C_{1-6} aliphatic, C_{3-10} cycloaliphatic, C_{6-10} aryl, 5-10 membered heteroaryl, or 5-10 membered heterocycl; wherein said aliphatic, cycloaliphatic, aryl, heteroaryl or heterocycl is optionally substituted with halogen, R^X , $-\text{OR}^X$, $-\text{SR}^X$, $-\text{NO}_2$, $-\text{CF}_3$, $-\text{CN}$, $-\text{CO}_2\text{R}^X$, $-\text{COR}^X$, OCOR^X , CONHR^X , or NHCOR^X ;

each J^U is independently selected from halogen, L , $-(\text{L}_n)-\text{R}'$, $-(\text{L}_n)-\text{N}(\text{R}')_2$, $-(\text{L}_n)-\text{SR}'$, $-(\text{L}_n)-\text{OR}'$, $-(\text{L}_n)-(C_{3-10}$ cycloaliphatic), $-(\text{L}_n)-(C_{6-10}$ aryl), $-(\text{L}_n)-(5-10$ membered heteroaryl), $-(\text{L}_n)-(5-10$ membered heterocycl), oxo, C_{1-4} haloalkoxy, C_{1-4} haloalkyl, $-(\text{L}_n)-\text{NO}_2$, $-(\text{L}_n)-\text{CN}$, $-(\text{L}_n)-\text{OH}$, $-(\text{L}_n)-\text{CF}_3$, $-\text{CO}_2\text{R}'$, $-\text{CO}_2\text{H}$, $-\text{COR}'$, $-\text{COH}$, $-\text{OC(O)R}'$, $-\text{C(O)NHR}'$, $\text{C(O)N}(\text{R}')_2$, $-\text{NHC(O)R}'$, or $\text{NR}'\text{C(O)R}'$; or two J^U groups, on the same substituent or different substituents,

together with the atom(s) to which each J^U group is bound, form a 5-7 membered saturated, unsaturated, or partially saturated ring;

m is 0 or 1;

Y is H, halogen, CN, NO_2 , NH_2 , NHR , $N(R)_2$, or a group selected from a C_{1-6} aliphatic, a C_{3-10} cycloaliphatic, a C_{6-10} aryl, a 5-10 membered heteroaryl, or a 5-10 membered heterocyclyl, wherein said group is optionally substituted with 1-8 occurrences of J^Y ;

each J^Y is independently selected from halogen, L , $-(L_n)-R^{26}$, $-(L_n)-N(R^{26})_2$, $-(L_n)-SR^{26}$, $-(L_n)-OR^{26}$, $-(L_n)-(C_{3-10}$ cycloaliphatic), $-(L_n)-(C_{6-10}$ aryl), $-(L_n)-(5-10$ membered heteroaryl), $-(L_n)-(5-10$ membered heterocyclyl), oxo, C_{1-4} haloalkoxy, C_{1-4} haloalkyl, $-(L_n)-NO_2$, $-(L_n)-CN$, $-(L_n)-OH$, $-(L_n)-CF_3$, $-CO_2R^{26}$, $-CO_2H$, $-COR^{26}$, $-COH$, $-OC(O)R^{26}$, $-C(O)NHR^{26}$, $C(O)N(R^{26})_2$, $-NHC(O)R^{26}$, or $NR^{26}C(O)R^{26}$; or two J^Y groups, on the same substituent or different substituents, together with the atom(s) to which each J^Y group is bound, form a 5-7 membered saturated, unsaturated, or partially saturated ring;

each L is independently a C_{1-6} aliphatic wherein up to three methylene units are replaced by $-NH-$, $-NR^L-$, $-O-$, $-S-$, $-CO_2-$, $-OC(O)-$, $-C(O)CO-$, $-C(O)-$, $-C(O)NH-$, $-C(O)NR^L-$, $-NC(=N-CN)N$, $-NHCO-$, $-NR^LCO-$, $-NHC(O)O-$, $-NR^LC(O)O-$, $-SO_2NH-$, $-SO_2NR^L-$, $-NHSO_2-$, $-NR^LSO_2-$, $-NHC(O)NH-$, $-NR^LC(O)NH-$, $-NHC(O)NR^L-$, $-NR^LC(O)NR^L$, $-OC(O)NH-$, $-OC(O)NR^L-$, $-NHSO_2NH-$, $-NR^LSO_2NH-$, $-NHSO_2NR^L-$, $-NR^LSO_2NR^L-$, $-SO-$, or $-SO_2-$;

each n is independently 0 or 1;

R^L is selected from C_{1-6} aliphatic, C_{3-10} cycloaliphatic, C_{6-10} aryl, 5-10 membered heteroaryl, or 5-10 membered heterocyclyl; or two R^L groups, on the same substituent or different substituents, together with the atom(s) to which each R^L group is bound, form a 3-8 membered heterocyclyl;

each R is independently selected from a C_{1-6} aliphatic or a C_{3-6} cycloaliphatic optionally substituted with 1-6 occurrences of halogen, OH , NO_2 , NH_2 , SH or CN , or two R groups, together with the atom to which the R groups are bound, form a 5-7 membered saturated, unsaturated, or partially saturated ring;

wherein each substitutable carbon of an R^3 ring is optionally and independently substituted with halogen; $-R^\circ$; $-OR^\circ$; $-SR^\circ$; 1,2-methylenedioxy; 1,2-

ethylenedioxy; phenyl (Ph) optionally substituted with R°; -O(Ph) optionally substituted with R°; -(CH₂)₁₋₂(Ph), optionally substituted with R°; -CH=CH(Ph), optionally substituted with R°; -NO₂; -CN; -N(R°)₂; -NR°C(O)R°; -NR°C(S)R°; -NR°C(O)N(R°)₂; -NR°C(S)N(R°)₂; -NR°CO₂R°; -NR°NR°C(O)R°; -NR°NR°C(O)N(R°)₂; -NR°NR°CO₂R°; -C(O)C(O)R°; -C(O)CH₂C(O)R°; -CO₂R°; -C(O)R°; -C(S)R°; -C(O)N(R°)₂; -C(S)N(R°)₂; -OC(O)N(R°)₂; -OC(O)R°; -C(O)N(OR°)R°; -C(NOR°)R°; -S(O)₂R°; -S(O)₃R°; -SO₂N(R°)₂; -S(O)R°; -NR°SO₂N(R°)₂; -NR°SO₂R°; -N(OR°)R°; -C(=NH)-N(R°)₂; or -(CH₂)₀₋₂NHC(O)R°; wherein each independent occurrence of R° is selected from hydrogen, optionally substituted C₁₋₆ aliphatic, an unsubstituted 5-6 membered heteroaryl or heterocyclic ring, phenyl, -O(Ph), or -CH₂(Ph), or, two independent occurrences of R°, on the same substituent or different substituents, taken together with the atom(s) to which each R° group is bound, form a 5-8-membered heterocyclyl, aryl, or heteroaryl ring or a 3-8-membered cycloalkyl ring, wherein said heteroaryl or heterocyclyl ring has 1-3 heteroatoms independently selected from nitrogen, oxygen, or sulfur; and wherein each of said optional substituents on the aliphatic group of R° is independently selected from NH₂, NH(C₁₋₄aliphatic), N(C₁₋₄aliphatic)₂, halogen, C₁₋₄aliphatic, OH, O(C₁₋₄aliphatic), NO₂, CN, CO₂H, CO₂(C₁₋₄aliphatic), O(haloC₁₋₄ aliphatic), or haloC₁₋₄aliphatic, wherein each of the foregoing C₁₋₄aliphatic groups of R° is unsubstituted; wherein each substitutable nitrogen of a non-aromatic heterocyclic ring of R³ is optionally and independently substituted with -R⁺, -N(R⁺)₂, -C(O)R⁺, -CO₂R⁺, -C(O)C(O)R⁺, -C(O)CH₂C(O)R⁺, -SO₂R⁺, -SO₂N(R⁺)₂, -C(=S)N(R⁺)₂, -C(=NH)-N(R⁺)₂, or -NR⁺SO₂R⁺; wherein R⁺ is hydrogen, an optionally substituted C₁₋₆ aliphatic, optionally substituted phenyl, optionally substituted -O(Ph), optionally substituted -CH₂(Ph), optionally substituted -(CH₂)₁₋₂(Ph); optionally substituted -CH=CH(Ph); or an unsubstituted 5-6 membered heteroaryl or heterocyclic ring having one to four heteroatoms independently selected from oxygen, nitrogen, or sulfur, or, two independent occurrences of R⁺, on the same substituent or different substituents, taken together with the atom(s) to which each R⁺ group is bound, form a 5-8-membered heterocyclyl, aryl, or heteroaryl ring or a 3-8-

membered cycloalkyl ring, wherein said heteroaryl or heterocycl ring has 1-3 heteroatoms independently selected from nitrogen, oxygen, or sulfur; wherein each of said optional substituents on the aliphatic group or the phenyl ring of R^+ is independently selected from NH_2 , $NH(C_{1-4}$ aliphatic), $N(C_{1-4}$ aliphatic)₂, halogen, C_{1-4} aliphatic, OH , $O(C_{1-4}$ aliphatic), NO_2 , CN , CO_2H , $CO_2(C_{1-4}$ aliphatic), $O(halo C_{1-4}$ aliphatic), or $halo(C_{1-4}$ aliphatic), wherein each of the foregoing C_{1-4} aliphatic groups of R^+ is unsubstituted;

R^4 is H or is a $-C_{1-2}$ aliphatic optionally substituted with 1-3 occurrences of R^{11} ;

each R^{11} is independently selected from halogen, CF_3 , OCH_3 , OH , SH , NO_2 , NH_2 , SCH_3 , NCH_3 , CN , $CON(R^{15})_2$ or unsubstituted C_{1-2} aliphatic, or two R^{11} groups, together with the carbon to which they are attached, form a cyclopropyl ring or $C=O$;

R^{15} is H or unsubstituted C_{1-2} alkyl;

R^5 is H or a C_{1-6} aliphatic optionally substituted with 1-5 occurrences of R^{12} ;

R^6 is H or a C_{1-6} aliphatic optionally substituted with 1-5 occurrences of R^{13} ;

each R^{12} is independently selected from halogen, OCH_3 , OH , NO_2 , NH_2 , SH , SCH_3 , NCH_3 , CN or unsubstituted C_{1-2} aliphatic, or two R^{12} groups, together with the carbon to which they are attached, form a cyclopropyl ring;

each R^{13} is independently selected from halogen, OCH_3 , OH , NO_2 , NH_2 , SH , SCH_3 , NCH_3 , CN or unsubstituted C_{1-2} aliphatic, or two R^{13} groups, together with the carbon to which they are attached, form a cyclopropyl ring; or

R^5 and R^6 are taken together to form a 3-7 membered carbocyclic or heterocyclic saturated ring optionally substituted with 1-5 occurrences of R^{12} ; or

R^4 and R^6 , taken together with the nitrogen to which R^4 is attached, form a 3-8 membered saturated, partially saturated or aromatic nitrogen-containing ring comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R^{14} ; or

R^1 and R^4 , taken together with the nitrogen to which R^4 is attached, form a 3-8 membered saturated, partially saturated or aromatic nitrogen-containing ring comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R^{14} ; or

each R^{14} is independently selected from halogen, R'' , NH_2 , NHR'' , $N(R'')_2$, SH , SR'' , OH , OR'' , NO_2 , CN , CF_3 , $COOR''$, $COOH$, COR'' , $OC(O)R''$ or $NC(O)R''$; or any two

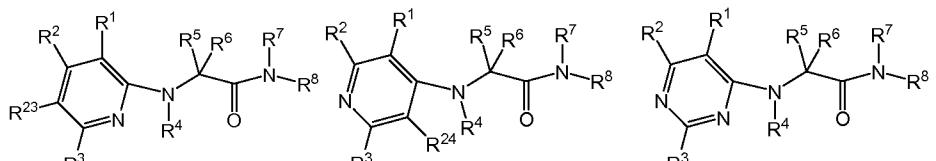
R^{14} groups, on the same substituent or different substituents, together with the atom(s) to which each R^{14} group is bound, form a 3-7 membered saturated, unsaturated, or partially saturated carbocyclic or heterocyclic ring optionally substituted with 1-3 occurrences of R^{16} ;

R" is a C₁₋₃ aliphatic optionally substituted with 1-4 occurrences of R¹⁰;
 each R¹⁶ is independently selected from halogen, CF₃, OCH₃, OH, SH, NO₂, NH₂, SCH₃,
 NCH₃, CN, CON(R¹⁵)₂ or unsubstituted C₁₋₂ aliphatic, or two R¹⁶ groups, together
 with the carbon to which they are attached, form a cyclopropyl ring or C=O;

R^7 is H or C_{1-4} aliphatic optionally substituted with 1-3 occurrences of R^{17} ;
 each R^{17} is independently selected from halogen, CF_3 , OCH_3 , OH, SH, NO_2 , NH_2 , SCH_3 ,
 NCH_3 , CN, $CON(R^{15})_2$ or unsubstituted C_{1-2} aliphatic, or two R^{17} groups, together
 with the carbon to which they are attached, form a cyclopropyl ring or $C=O$;

R^8 is C_{1-4} aliphatic optionally substituted with 1-6 occurrences of R^{18} ; and each R^{18} is independently selected from halogen, CF_3 , OCH_3 , OH , SH , NO_2 , NH_2 , SCH_3 , NCH_3 , CN , $CON(R^{15})_2$ or unsubstituted C_{1-2} aliphatic, or two R^{18} groups, together with the carbon to which they are attached, form a cyclopropyl ring or $C=O$.

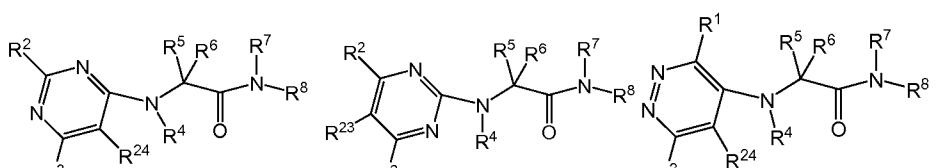
2. The compound according to claim 1, wherein said compound is selected from one of formulae I-a to I-i:



J-a.

J-h

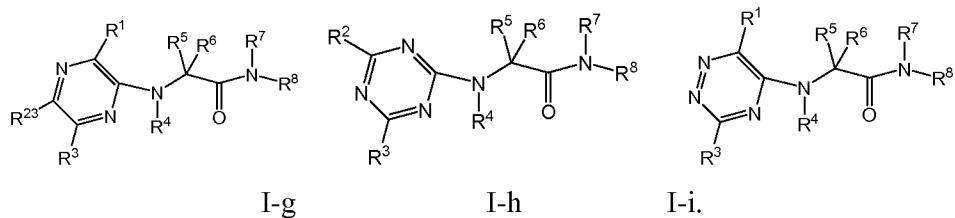
J-C



L-d

Le

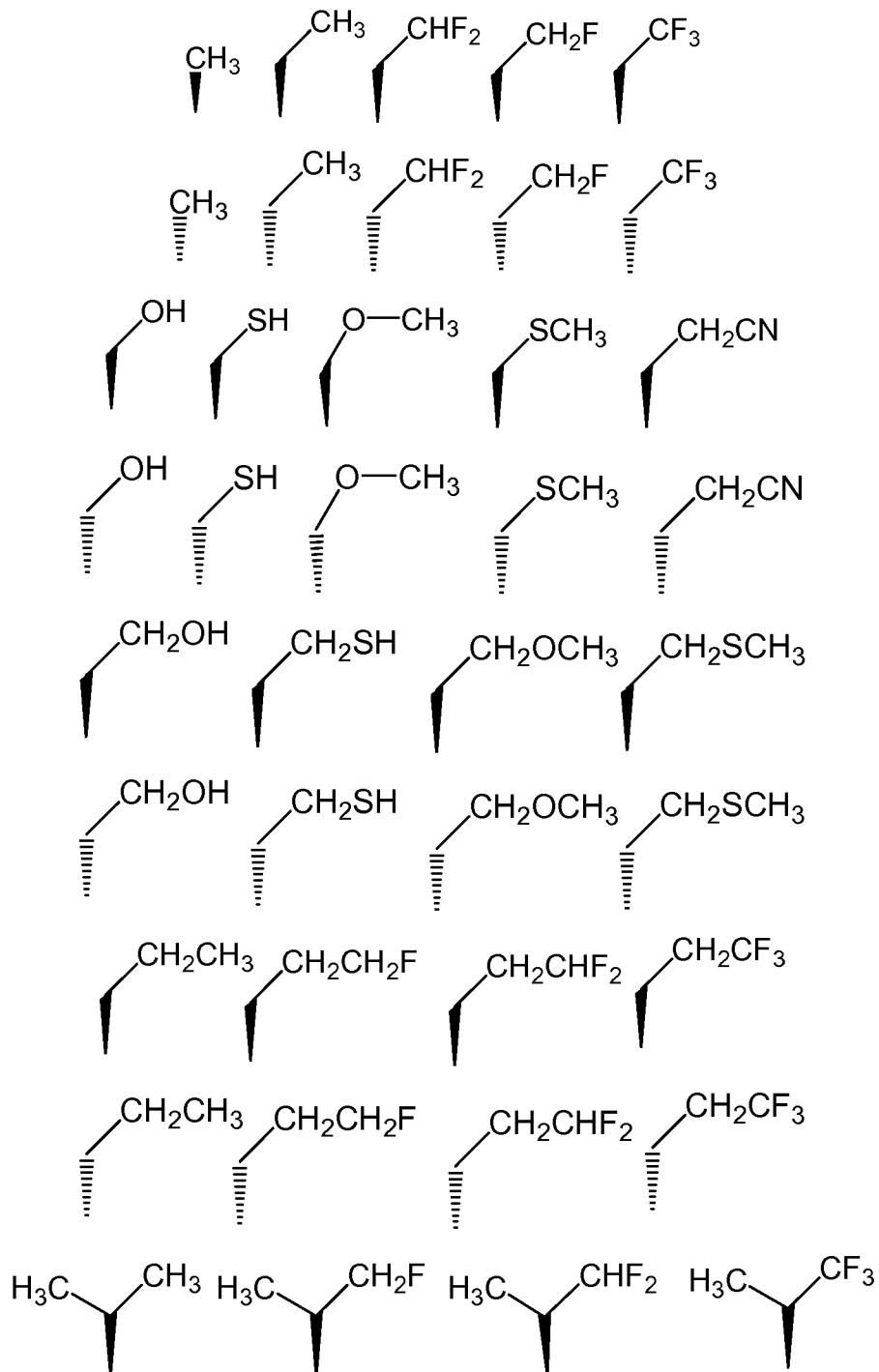
L-f

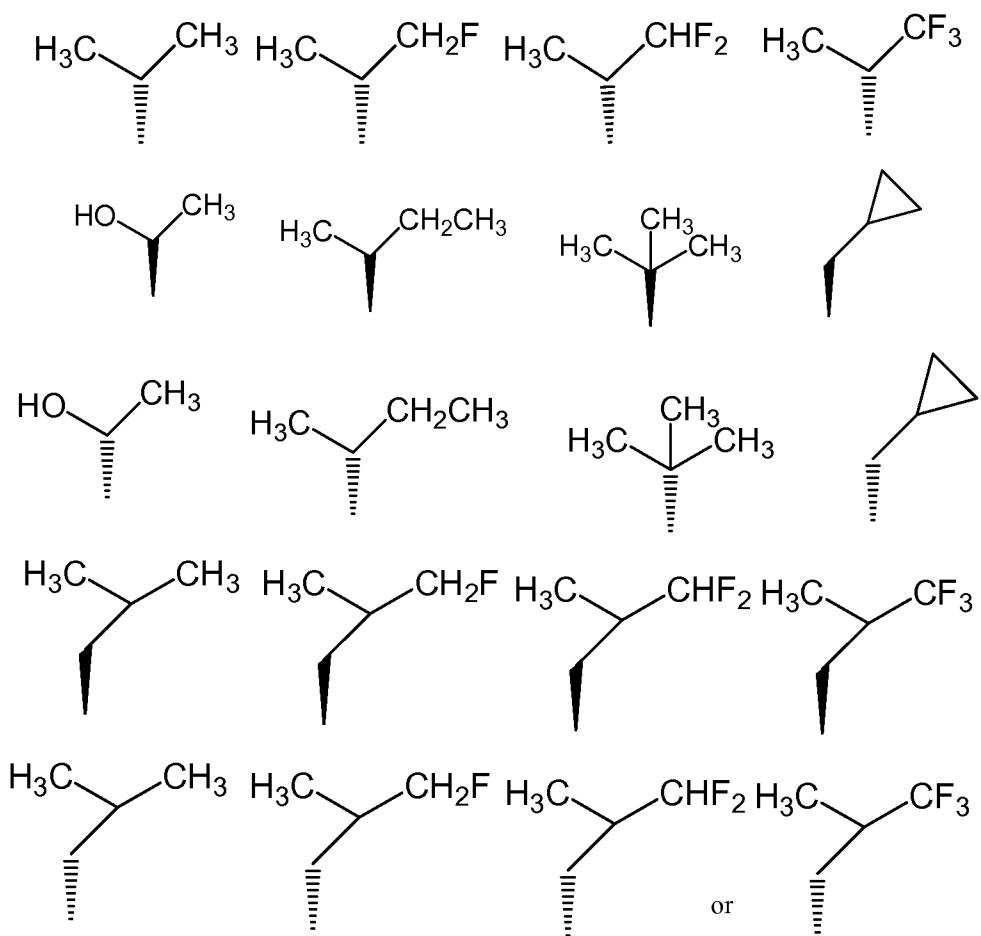


3. The compound according to claim 2, wherein said compound is selected from one of formulae I-a, I-b, I-c or I-d.
4. The compound according to claim 3, wherein said compound is selected from one of formulae I-c or I-d.
5. The compound according to claim 2, wherein said compound is selected from one of formulae I-a, I-b, I-c, I-f, I-g or I-i and R¹ is H, Cl, F, R', OH or OR'.
6. The compound according to claim 5, wherein R¹ is H, CH₃, Cl or F.
7. The compound according to claim 2, wherein said compound is selected from one of formulae I-a, I-b, I-c, I-d, I-e or I-h, and R² is H, Cl, F, R', OH or OR'.
8. The compound according to claim 7, wherein R² is H, CH₃, Cl or F.
9. The compound according to claim 2, wherein said compound is of formula I-c, and R¹ is H, Cl or F and R² is H.
10. The compound according to claim 2, wherein said compound is selected from one of formulae I-a, I-e or I-g, and R²³ is H, Cl, F, R', OH or OR'.
11. The compound according to claim 10, wherein R²³ is H, CH₃, Cl or F.
12. The compound according to claim 11, wherein R²³ is H.

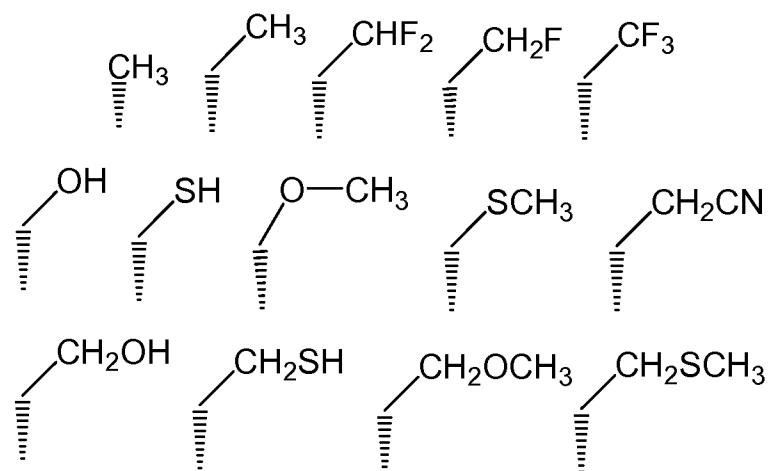
13. The compound according to claim 2, wherein said compound is selected from one of formulae I-b, I-d or I-f, and R²⁴ is H, Cl, F, R', OH or OR'.
14. The compound according to claim 13, wherein R²⁴ is H, CH₃, Cl or F.
15. The compound according to claim 2, wherein said compound is of formula I-d, and R² and R²⁴ are both H.
16. The compound according to claim 1, wherein X¹ is CR¹ and X² is CR², and R¹ and R², taken together, form a 5-7 membered aryl or heteroaryl ring optionally substituted with 1-4 occurrences of R⁹.
17. The compound according to any one of claims 1-16, wherein R⁴ is H, CH₃, CH₂CH₃ or CH(CH₃)₂.
18. The compound according to claim 17, wherein R⁴ is H or CH₃.
19. The compound according to claim 18, wherein R⁴ is H.
20. The compound according to any one of claims 1-16, wherein R¹ and R⁴, taken together with the nitrogen to which R⁴ is attached, form a 3-8 membered saturated, partially saturated or aromatic nitrogen-containing ring comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R¹⁴.
21. The compound according to any one of claims 1-20, wherein R⁵ is H or a C₁₋₂ alkyl optionally substituted with up to 3 occurrences of R¹².
22. The compound according to claim 21, wherein R⁵ is H or a C₁₋₂ alkyl.
23. The compound according to any one of claims 1-22, wherein R⁶ is a C₁₋₄ aliphatic optionally substituted with 1-5 occurrences of R¹³.

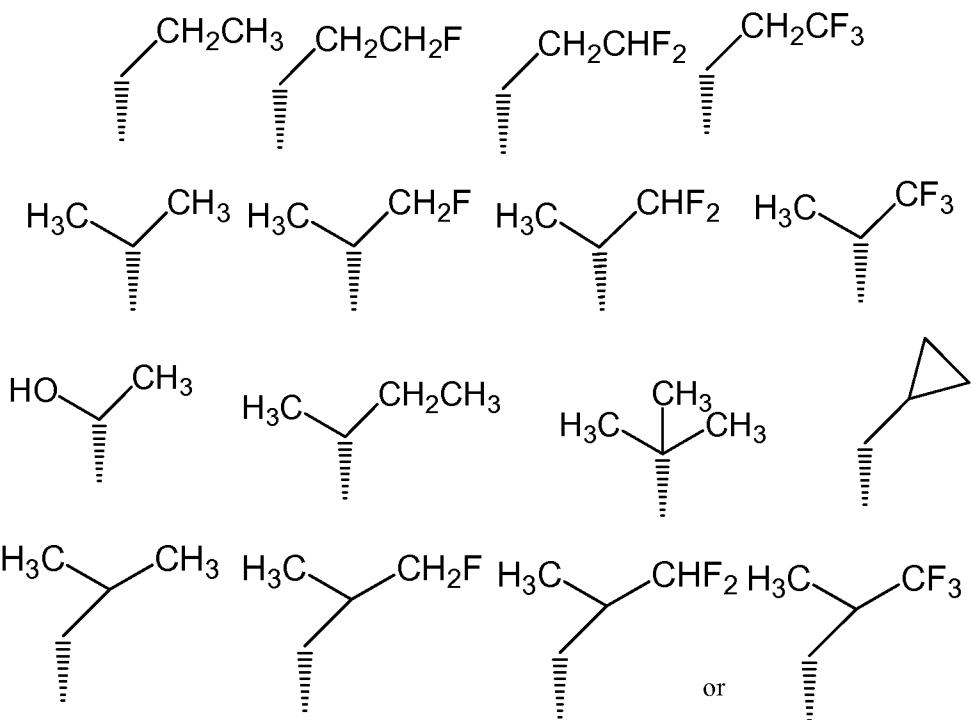
24. The compound according to claim 23, wherein R⁵ is H and R⁶ is selected from



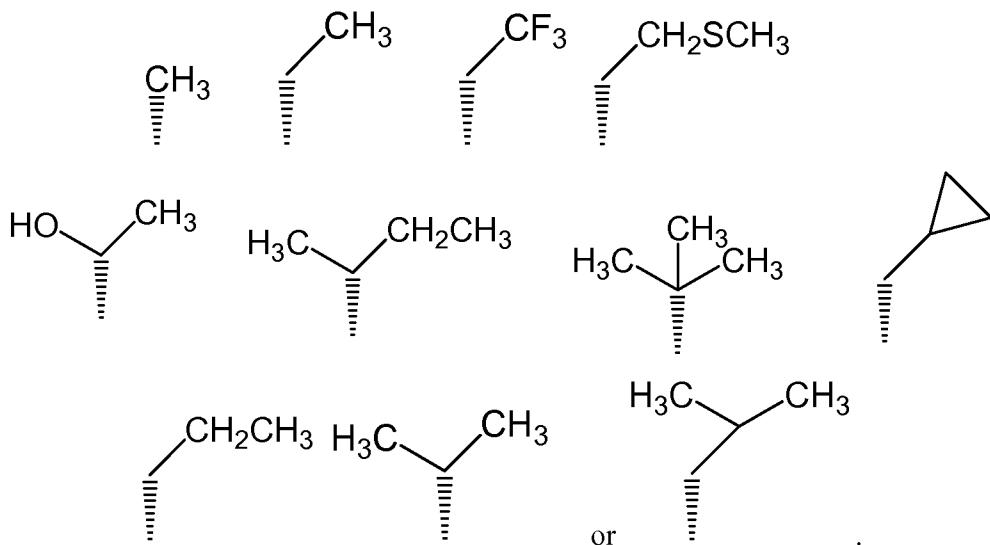


25. The compound according to claim 24, wherein R^6 is selected from

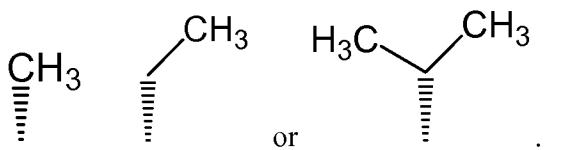




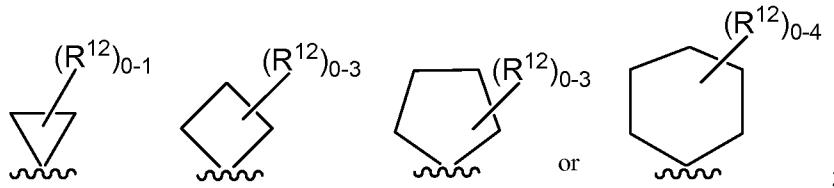
26. The compound according to claim 25, wherein R^6 is selected from



27. The compound according to claim 26, wherein R^6 is selected from

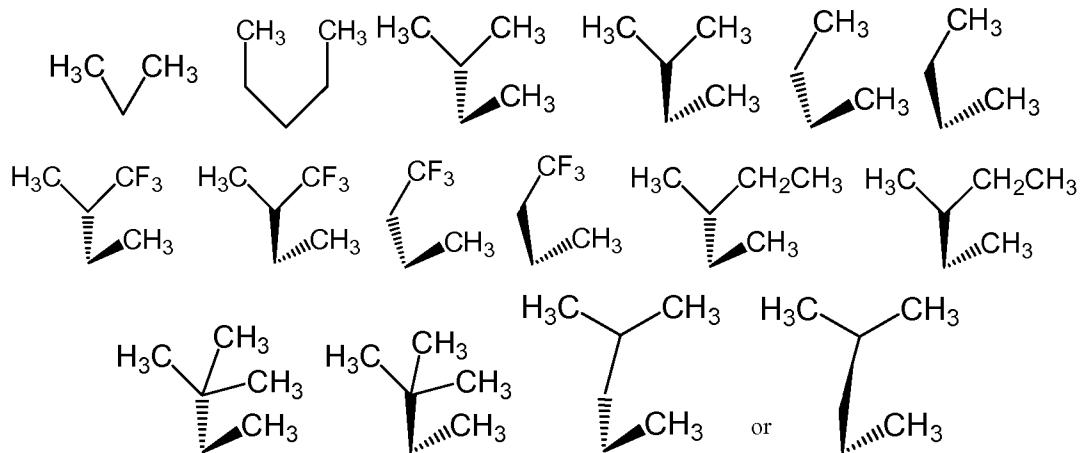


28. The compound according to any one of claims 1-19, wherein R⁵ and R⁶ are taken together to form a ring selected from

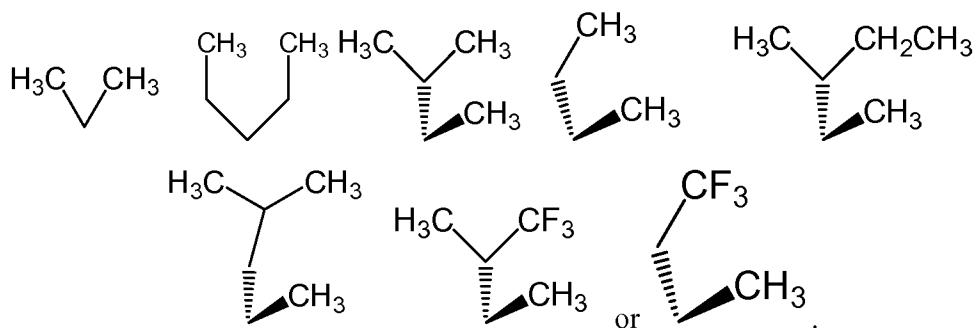


wherein one or more carbon atoms in of said ring are optionally and independently replaced by N, O or S.

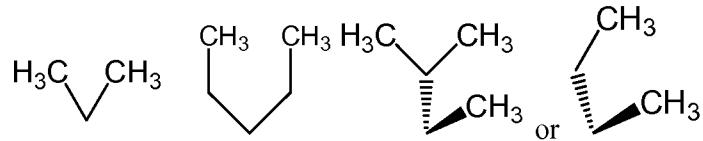
29. The compound according to any one of claims 1-19, wherein R⁵ and R⁶ are



30. The compound according to claim 29, wherein R⁵ and R⁶ are

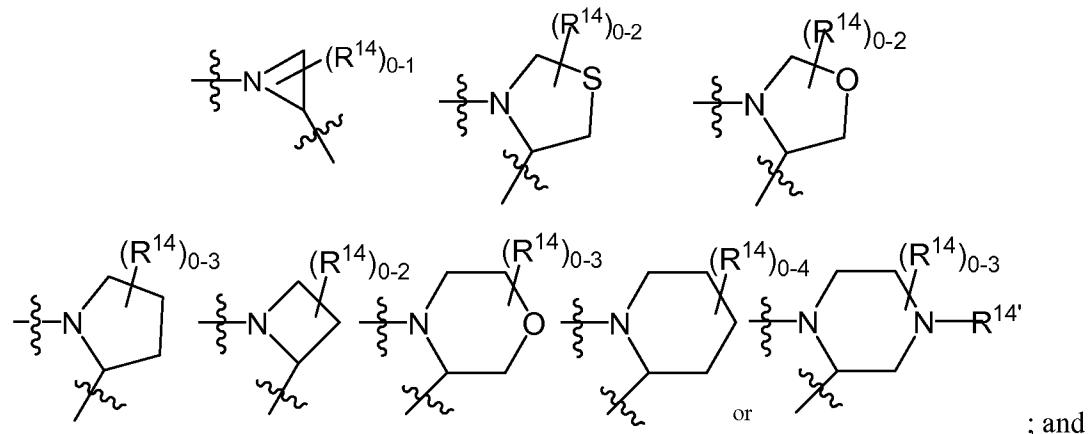


31. The compound according to claim 30, wherein R⁵ and R⁶ are

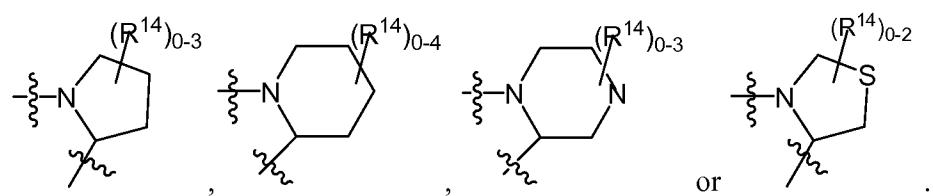


32. The compound according to any one of claims 1-19, wherein R⁴ and R⁶, taken together with the nitrogen to which R⁴ is attached, form a 3-8 membered saturated, partially saturated or aromatic nitrogen-containing ring comprising up to two additional heteroatoms selected from N, O or S and optionally substituted with 1-4 occurrences of R¹⁴.

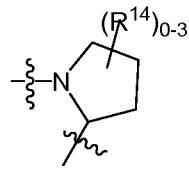
33. The compound according to claim 32, wherein R⁴ and R⁶ taken together is selected from



34. The compound according to claim 33, wherein R⁴ and R⁶ taken together is



35. The compound according to claim 34, wherein R⁴ and R⁶ taken together is



36. The compound according to claim 35, wherein R¹⁴ is absent.
37. The compound according to claim 35, wherein the ring formed by R⁴ and R⁶ is substituted with one occurrence of R¹⁴.
38. The compound according to claim 37, wherein R¹⁴ is OH, CH₃, F, OR' or NHR'.
39. The compound according to claim 38, wherein R' is C₁₋₂ alkyl or C₂₋₃ alkenyl.
40. The compound according to claim 38, wherein R¹⁴ is OH.
41. The compound according to any one of claims 1-40, wherein R⁷ is H or C₁₋₂ alkyl optionally substituted with 1-3 occurrences of R¹⁷.
42. The compound according to claim 41, wherein R⁷ is H or unsubstituted C₁₋₂ alkyl.
43. The compound according to any one of claims 1-42, wherein R⁸ is a C₁₋₄ aliphatic or cycloaliphatic optionally substituted with up to 6 occurrences of R¹⁸.
44. The compound according to claim 43, wherein R⁸ is a C₂₋₃ aliphatic or cycloaliphatic optionally substituted with up to 6 occurrences of R¹⁸.
45. The compound according to claim 44, wherein R¹⁸ is F.
46. The compound according to claim 45, wherein R⁸ is CH₂CH₃, CH₂CF₃, CH₂CHF₂, CH₂CH₂F, CH₂CH₂CH₃, CH₂CH₂CF₃, CH₂CH₂CH₂F or CH₂CH₂CHF₂.

47. The compound according to claim 46, wherein R^8 is CH_2CH_3 , CH_2CF_3 , $CH_2CH_2CH_3$ or $CH_2CH_2CF_3$.
48. The compound according to claim 47, wherein R^8 is CH_2CF_3 .
49. The compound according to any one of claims 1-48, wherein R^3 is selected from (1-a), (1-c), (1-k), (2-d), (2-e), (2-k), (2-w), (2-x), (3-d), (3-e), (3-g), (3-h), (3-i) and (3-j).
50. The compound according to claim 49, wherein R^3 is selected from (1-a), (1-c), (1-k), (2-d), (2-e), (2-n), (2-o), (2-u), (2-x) and (2-z).
51. The compound according to claim 50, wherein R^3 is selected from (1-a), (1-c), (2-d), (2-e), (2-n), (2-o), (2-u) and (2-x).
52. The compound according to claim 51, wherein R^3 is selected from (1-c), (2-d), (2-n) and (2-o).
53. The compound according to claim 1, wherein R^3 is unsubstituted.
54. The compound according to claim 1, wherein up to two substitutable carbons and up to one substitutable nitrogens of a non-aromatic heterocyclic ring of the R^3 ring are substituted.
55. The compound according to claim 54, wherein one substitutable carbon and up to one substitutable nitrogens of a non-aromatic heterocyclic ring of the R^3 ring are substituted.
56. The compound according to claim 55, wherein one substitutable carbon of the R^3 ring is substituted.
57. The compound according to claim 52, wherein R^3 is (2-n) and R^{25} is $C(O)NR_2$.

58. The compound according to claim 52, wherein R³ is (2-o) and R²⁵ is an optionally substituted aryl or heteroaryl.

59. The compound according to claim 58, wherein R²⁵ is an optionally substituted phenyl.

60. The compound according to claim 52, wherein R³ is (1-c) or (2-d) and R³ is unsubstituted.

61. The compound according to claim 1, wherein said compound is selected from Table 1.

62. A pharmaceutical composition comprising a compound according to any one of claims 1-61 and a pharmaceutically acceptable carrier, adjuvant, or vehicle.

63. The composition according to claim 62, additionally comprising a therapeutic agent selected from a chemotherapeutic or anti-proliferative agent, an anti-inflammatory agent, an immunomodulatory or immunosuppressive agent, a neurotrophic factor, an agent for treating cardiovascular disease, an agent for treating destructive bone disorders, an agent for treating liver disease, an anti-viral agent, an agent for treating blood disorders, an agent for treating diabetes, or an agent for treating immunodeficiency disorders.

64. A method of inhibiting JAK kinase activity in a biological sample, comprising contacting said biological sample with a compound according to any one of claims 1-61 or with a composition according to either of claims 62 or 63.

65. A method of inhibiting JAK kinase activity in a patient, comprising administering to said patient a compound according to any one of claims 1-61 or with a composition according to either of claims 62 or 63.

66. A method of treating or lessening the severity of a disease or condition selected from a proliferative disorder, a cardiac disorder, a neurodegenerative disorder, an autoimmune disorder, a condition associated with organ transplantation, an inflammatory disorder, or an immunologically mediated disorder in a patient, comprising the step of administering to said patient a compound according to any one of claims 1-61 or with a composition comprising said compound.
67. The method of claim 66, comprising the additional step of administering to said patient an additional therapeutic agent selected from a chemotherapeutic or anti-proliferative agent, an anti-inflammatory agent, an immunomodulatory or immunosuppressive agent, a neurotrophic factor, an agent for treating cardiovascular disease, an agent for treating diabetes, or an agent for treating immunodeficiency disorders, wherein said additional therapeutic agent is appropriate for the disease being treated.
68. The method according to claim 67, wherein the disease or disorder is allergic or type I hypersensitivity reactions, asthma, diabetes, Alzheimer's disease, Huntington's disease, Parkinson's disease, AIDS-associated dementia, amyotrophic lateral sclerosis (AML, Lou Gehrig's disease), multiple sclerosis (MS), schizophrenia, cardiomyocyte hypertrophy, reperfusion/ischemia, stroke, baldness, transplant rejection, graft versus host disease, rheumatoid arthritis, psoriasis, psoriatic arthritis, ankylosing spondylitis, a solid malignancy, a hematologic malignancy, a leukemia, a lymphoma and a myeloproliferative disorder.
69. The method according to claim 68, wherein said disease or disorder is asthma.
70. The method according to claim 68, wherein said disease or disorder is transplant rejection.
71. The method according to claim 68, wherein said disease or disorder is rheumatoid arthritis.

72. The method according to claim 68, wherein said disease or disorder is psoriasis.