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(54) Title: PIPERAZINE ENAMINES AS ANTIVIRAL AGENTS

(57) Abstract: This disclosure provides compounds having drug and bio-affecting properties, their pharmaceutical compositions and method of use. In particular, the disclosure is concerned with indole and azaindole piperazine enamine derivatives that possess unique antiviral activity. More particularly, the present disclosure relates to compounds useful for the treatment of HIV and AIDS.



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CROSS-REFERENCE TO RELATED APPLICATIONS

FIELD OF THE DISCLOSURE

15 BACKGROUND ART

HIV-1 (human immunodeficiency virus -1) infection remains a major medical problem, with an estimated 40 million people infected worldwide at the end of 2005. The number of cases of HIV and AIDS (acquired immunodeficiency syndrome) has risen rapidly. In 2005, approximately 5.0 million new infections were reported, and 3.1 million people died from AIDS. Currently available drugs for the treatment of HIV include nucleoside reverse transcriptase (RT) inhibitors or approved single pill combinations: zidovudine (or AZT or Retrovir[®]), didanosine (or Videx[®]), stavudine (or Zerit[®]), lamivudine (or 3TC or Epivir[®]), zalcitabine (or DDC or Hivid[®]), abacavir succinate (or Ziagen[®]), Tenofovir disoproxil fumarate salt (or Viread[®]), emtricitabine (or FTC), Combivir[®] (contains -3TC plus AZT), Trizivir[®] (contains abacavir, lamivudine, and zidovudine), Epzicom[®] (contains abacavir and lamivudine), Truvada[®] (contains Viread[®] and emtricitabine); non-nucleoside reverse transcriptase inhibitors: nevirapine (or Viramune[®]), delavirdine (or Rescriptor[®]) and efavirenz (or Sustiva[®]), and peptidomimetic protease inhibitors or approved formulations: saquinavir, indinavir, ritonavir, nelfinavir, amprenavir, lopinavir, and Kaletra[®] (lopinavir and Ritonavir). Each of these drugs can only transiently restrain

viral replication if used alone. However, when used in combination, these drugs have a profound effect on viremia and disease progression. In fact, significant reductions in death rates among AIDS patients have been recently documented as a consequence of the widespread application of combination therapy. However, despite these

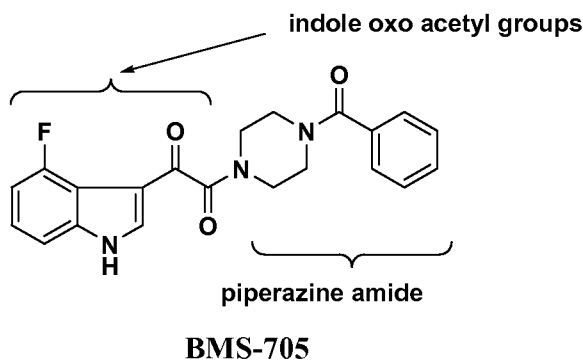
5 impressive results, 30 to 50% of patients ultimately fail combination drug therapies. Insufficient drug potency, non-compliance, restricted tissue penetration and drug-specific limitations within certain cell types (e.g. most nucleoside analogs cannot be phosphorylated in resting cells) may account for the incomplete suppression of sensitive viruses. Furthermore, the high replication rate and rapid turnover of HIV-1

10 combined with the frequent incorporation of mutations, leads to the appearance of drug-resistant variants and treatment failures when sub-optimal drug concentrations are present. Therefore, novel anti-HIV agents exhibiting distinct resistance patterns, and favorable pharmacokinetic as well as safety profiles are needed to provide more treatment options. Improved HIV fusion inhibitors and HIV entry coreceptor

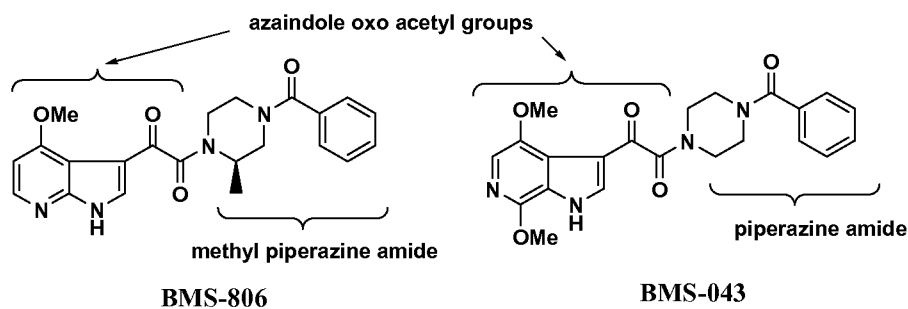
15 antagonists are two examples of new classes of anti-HIV agents currently being studied by a number of investigators.

The properties of a class of HIV entry inhibitors called HIV attachment inhibitors has been improved in an effort to obtain compounds with maximized utility

20 and efficacy as antiviral agents. A disclosure describing indoles of which the structure shown below for BMS-705 is representative has been disclosed [Antiviral Indoleoxoacetyl Piperazine Derivatives].



25 Two other compounds, referred to in the literature as BMS-806 and BMS-043 have been described in both the academic and patent art:



Some description of their properties in human clinical trials have been disclosed in literature.

5

It should be noted that in all three of these structures, a piperazine amide (In these three structures a piperazine phenyl amide) is present and this group is directly attached to an oxoacetyl moiety. The oxoacetyl group is attached at the 3-position of 4-Fluoro indole in BMS-705 and to the 3 position of substituted azaindoles in BMS-806 and BMS-043.

10

In an effort to obtain improved anti-HIV compounds, later publications described in part, modified substitution patterns on the indoles and azaindoles. Examples of such effort include: (1) novel substituted indoleoxoacetic piperazine derivatives, (2) substituted piperazinyloxoacetylindole derivatives, and (3) substituted azaindoleoxoacetic piperazine derivatives.

15

Replacement of these groups with other heteraromatics or substituted heteroaromatics or bicyclic hydrocarbons was also shown to be feasible. Examples include: (1) indole, azaindole and related heterocyclic amidopiperazine derivatives; (2) bicyclo 4.4.0 antiviral derivatives; and (3) diazaindole derivatives.

20

A select few replacements for the piperazine amide portion of the molecules have also been described in the art and among these examples are (1) some piperidine alkenes; (2) some pyrrolidine amides; (3) some N-aryl or heteroaryl piperazines; (4) some piperazinyl ureas; and (5) some carboline containing compounds.

25

Method(s) for preparing prodrugs for this class of compounds was disclosed in Prodrugs of Piperazine and Substituted Piperidine Antiviral Agents (Ueda et al., U.S. non- provisional application Ser. No. 11/066,745, filed 02/25/2005 or US20050209246A1 or WO2005090367A1).

5

A published PCT patent application WO2003103607A1 (June 11, 2003) disclosures an assay useful for assaying some HIV inhibitors.

Several published patent applications describe combination studies with
10 piperazine benzamide inhibitors, for example, US20050215543
(WO2005102328A1), US20050215544 (WO2005102391A1), and US20050215545
(WO2005102392A2).

A publication on new compounds in this class of attachment inhibitors
15 (Jinsong Wang et. al. Org. Biol. Chem. 2005, 3, 1781-1786.) and a patent application
on some more remotely related compounds have appeared WO2005/016344
published on February 24, 2005.

Published patent applications WO2005/016344 and WO2005/121094 also
20 describe piperazine derivatives which are HIV inhibitors. The compounds described
in these applications are structurally distinct from the compounds of the present
disclosure.

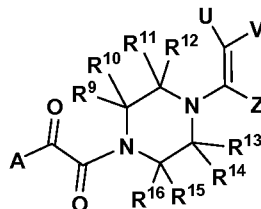
Nothing in these references can be construed to disclose or suggest the novel
25 compounds of this disclosure and their use to inhibit HIV infection.

SUMMARY OF THE DISCLOSURE

The present disclosure relates to compounds of Formula I, the
30 pharmaceutically acceptable salts and/or solvates (e.g., hydrates) thereof, their
pharmaceutical formulations, and their use in patients suffering from or susceptible to
a virus such as HIV. The compounds of Formula I, their pharmaceutically acceptable

salts and/or solvate are effective anticiral agents, particularly as inhibitors of HIV.
They are useful for the treatment of HIV and AIDS.

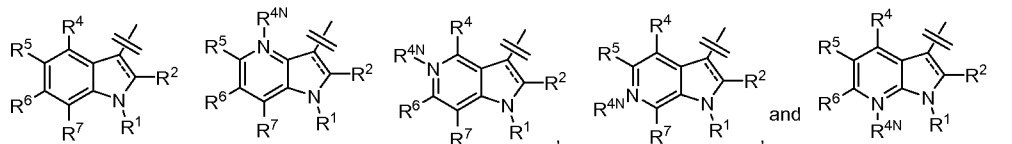
A first embodiment of the disclosure are compounds of Formula I, including
5 pharmaceutically acceptable salts thereof,



I

wherein:

10 A is selected from the group consisting of:



R¹ is hydrogen or C₁-C₄alkyl;

15

R² is hydrogen;

R⁴ is selected from the group consisting of hydrogen, halogen, hydroxy, and
O(C₁-C₄alkyl);

20

R⁵ is hydrogen, halogen, or (C₁-C₄alkyl);

R⁶ is selected from the group consisting of hydrogen, halogen, halogen, or
(C₁-C₄ alkyl);

25

R^7 is independently selected from the group consisting of hydrogen, halogen, and B;

R^{4N} does not exist;

wherein - - represents a carbon-carbon bond or does not exist;

5

U and V are independently selected from hydrogen, cyano, COOH, phenyl or pyridyl with the proviso that at least one must be cyano or COOH;

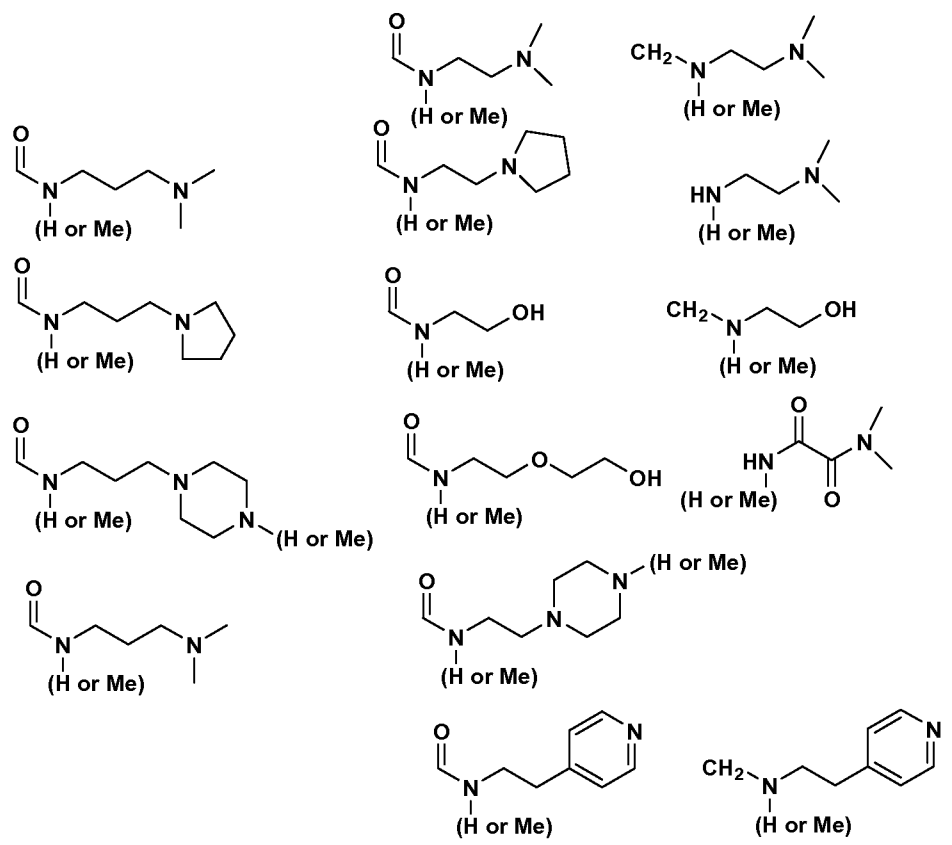
10 Z is selected from the group consisting of CF_3 , C_4-C_7 alkyl, phenyl, C_4-C_7 cycloalkyl, C_4-C_7 cycloalkenyl, pyridinyl, C_2-C_5 alkoxy, a 5 membered monocyclic heteroaryl containing 1 to 2 nitrogens, an N linked 6 membered heteroalicyclic containing 1 or 2 nitrogens a C_4-C_6 lactam attached via the lactam nitrogen, or cyano wherein said aryl or heteroaryl or lactam are independently optionally substituted with one to two groups selected from halogen or C_1-C_3 alkyl;

15

B is selected from the group consisting of chloro, methoxy, tetrazolyl, -triazolyl, pyrazolyl, imidazolyl, pyrrolyl, pyrazinyl, and XR^{8a} , wherein said are optionally substituted with one to three same or different halogens or from one to three same or different substituents selected from the group F;

20

F is selected from the group consisting of (C_{1-3}) alkyl, heteroalicyclic, hydroxymethyl, halogen, -COOH, -COO (C_{1-3}) alkyl, amino, -NHCH₃, -N(CH₃)₂,



R^{8a} is a member selected from the group consisting of $\text{C}(\text{O})\text{CH}_3$, $\text{C}(\text{O})\text{NH}_2$, $\text{C}(\text{O})\text{NHCH}_3$, and $\text{C}(\text{O})\text{N}(\text{CH}_3)_2$;

5

R^9 , R^{10} , R^{11} , R^{12} , R^{13} , R^{14} , R^{15} , R^{16} , are each independently selected from the group consisting of hydrogen and methyl; with the proviso that no more than two can be methyl;

10 X is selected from the group consisting of NH and NCH_3 .

Another embodiment of the present disclosure is a method for treating mammals infected with a virus, especially wherein said virus is HIV, comprising administering to said mammal an antiviral effective amount of a compound of Formula I, and one or more pharmaceutically acceptable carriers, excipients or diluents; optionally the compound of Formula I can be administered in combination with an antiviral effective amount of an AIDS treatment agent selected from the

15

group consisting of: (a) an AIDS antiviral agent; (b) an anti-infective agent; (c) an immunomodulator; and (d) HIV entry inhibitors.

Another embodiment of the present disclosure is a pharmaceutical
5 composition comprising an antiviral effective amount of a compound of Formula I and one or more pharmaceutically acceptable carriers, excipients, diluents and optionally in combination with an antiviral effective amount of an AIDS treatment agent selected from the group consisting of: (a) an AIDS antiviral agent; (b) an anti-infective agent; (c) an immunomodulator; and (d) HIV entry inhibitors.
10

DETAILED DESCRIPTION OF THE DISCLOSURE

Since the compounds of the present disclosure, may possess asymmetric centers and therefore occur as mixtures of diastereomers and enantiomers, the present
15 disclosure includes the individual diastereoisomeric and enantiomeric forms of the compounds of Formula I in addition to the mixtures thereof.

Definitions

20 The term "C₁₋₆ alkyl" as used herein and in the claims (unless specified otherwise) mean straight or branched chain alkyl groups such as methyl, ethyl, propyl, isopropyl, butyl, isobutyl, t-butyl, amyl, hexyl and the like.

"Halogen" refers to chlorine, bromine, iodine or fluorine.
25

An "aryl" group refers to an all carbon monocyclic or fused-ring polycyclic(i.e., rings which share adjacent pairs of carbon atoms) groups having a completely conjugated pi-electron system. Examples, without limitation, of aryl groups are phenyl, naphthalenyl and anthracenyl. The aryl group may be substituted
30 or unsubstituted. When substituted the substituted group(s) is preferably one or more selected from alkyl, cycloalkyl, aryl, heteroaryl, heteroalicyclic, hydroxy, alkoxy, aryloxy, heteroaryloxy, heteroalicycloxy, thiohydroxy, thioaryloxy,

thioheteroaryloxy, thioheteroalicycloxy, cyano, halogen, nitro, carbonyl, O-carbamyl, N-carbamyl, C-amido, N-amido, C-carboxy, O-carboxy, sulfinyl, sulfonyl, sulfonamido, trihalomethyl, ureido, amino and $-NR^xR^y$, wherein R^x and R^y are independently selected from the group consisting of hydrogen, alkyl, cycloalkyl, aryl, carbonyl, C-carboxy, sulfonyl, trihalomethyl, and, combined, a five- or six-member heteroalicyclic ring.

As used herein, a "heteroaryl" group refers to a monocyclic or fused ring (i.e., rings which share an adjacent pair of atoms) group having in the ring(s) one or more atoms selected from the group consisting of nitrogen, oxygen and sulfur and, in addition, having a completely conjugated pi-electron system. Unless otherwise indicated, the heteroaryl group may be attached at either a carbon or nitrogen atom within the heteroaryl group. It should be noted that the term heteroaryl is intended to encompass an N-oxide of the parent heteroaryl if such an N-oxide is chemically feasible as is known in the art. Examples, without limitation, of heteroaryl groups are furyl, thienyl, benzothienyl, thiazolyl, imidazolyl, oxazolyl, oxadiazolyl, thiadiazolyl, benzothiazolyl, triazolyl, tetrazolyl, isoxazolyl, isothiazolyl, pyrrolyl, pyranyl, tetrahydropyranyl, pyrazolyl, pyridyl, pyrimidinyl, quinoliny, isoquinoliny, purinyl, carbazolyl, benzoxazolyl, benzimidazolyl, indolyl, isoindolyl, pyrazinyl, diazinyl, pyrazine, triazinyl, tetrazinyl, and tetrazolyl. When substituted the substituted group(s) is preferably one or more selected from alkyl, cycloalkyl, aryl, heteroaryl, heteroalicyclic, hydroxy, alkoxy, aryloxy, heteroaryloxy, heteroalicycloxy, thioalkoxy, thiohydroxy, thioaryloxy, thioheteroaryloxy, thioheteroalicycloxy, cyano, halogen, nitro, carbonyl, O-carbamyl, N-carbamyl, C-amido, N-amido, C-carboxy, O-carboxy, sulfinyl, sulfonyl, sulfonamido, trihalomethyl, ureido, amino, and $-NR^xR^y$, wherein R^x and R^y are as defined above.

As used herein, a "heteroalicyclic" group refers to a monocyclic or fused ring group having in the ring(s) one or more atoms selected from the group consisting of nitrogen, oxygen and sulfur. Rings are selected from those which provide stable arrangements of bonds and are not intended to encompass systems which would not exist. The rings may also have one or more double bonds. However, the rings do not have a completely conjugated pi-electron system. Examples, without limitation, of

heteroalicyclic groups are azetidiny, piperidyl, piperaziny, imidazolinyl, thiazolidinyl, 3-pyrrolidin-1-yl, morpholinyl, thiomorpholinyl and tetrahydropyranyl. When substituted the substituted group(s) is preferably one or more selected from alkyl, cycloalkyl, aryl, heteroaryl, heteroalicyclic, hydroxy, alkoxy, aryloxy, heteroaryloxy, heteroalicycloxy, thiohydroxy, thioalkoxy, thioaryloxy, thioheteroaryloxy, thioheteroalicycloxy, cyano, halogen, nitro, carbonyl, thiocarbonyl, O-carbamyl, N-carbamyl, O-thiocarbamyl, N-thiocarbamyl, C-amido, C-thioamido, N-amido, C-carboxy, O-carboxy, sulfinyl, sulfonyl, sulfonamido, trihalomethanesulfonamido, trihalomethanesulfonyl, silyl, guanyl, guanidino, ureido, phosphonyl, amino and $-NR^xR^y$, wherein R^x and R^y are as defined above.

An "alkyl" group refers to a saturated aliphatic hydrocarbon including straight chain and branched chain groups. Preferably, the alkyl group has 1 to 20 carbon atoms (whenever a numerical range; e.g., "1-20", is stated herein, it means that the group, in this case the alkyl group may contain 1 carbon atom, 2 carbon atoms, 3 carbon atoms, etc. up to and including 20 carbon atoms). More preferably, it is a medium size alkyl having 1 to 10 carbon atoms. Most preferably, it is a lower alkyl having 1 to 4 carbon atoms. The alkyl group may be substituted or unsubstituted. When substituted, the substituent group(s) is preferably one or more individually selected from trihaloalkyl, cycloalkyl, aryl, heteroaryl, heteroalicyclic, hydroxy, alkoxy, aryloxy, heteroaryloxy, heteroalicycloxy, thiohydroxy, thioalkoxy, thioaryloxy, thioheteroaryloxy, thioheteroalicycloxy, cyano, halo, nitro, carbonyl, thiocarbonyl, O-carbamyl, N-carbamyl, O-thiocarbamyl, N-thiocarbamyl, C-amido, C-thioamido, N-amido, C-carboxy, O-carboxy, sulfinyl, sulfonyl, sulfonamido, trihalomethanesulfonamido, trihalomethanesulfonyl, and combined, a five- or six-member heteroalicyclic ring.

A "cycloalkyl" group refers to an all-carbon monocyclic or fused ring (i.e., rings which share and adjacent pair of carbon atoms) group wherein one or more rings does not have a completely conjugated pi-electron system. Examples, without limitation, of cycloalkyl groups are cyclopropane, cyclobutane, cyclopentane, cyclopentene, cyclohexane, cyclohexadiene, cycloheptane, cycloheptatriene and adamantane. A cycloalkyl group may be substituted or unsubstituted. When

substituted, the substituent group(s) is preferably one or more individually selected from alkyl, aryl, heteroaryl, heteroalicyclic, hydroxy, alkoxy, aryloxy, heteroaryloxy, heteroalicycloxy, thiohydroxy, thioalkoxy, thioaryloxy, thioheteroaryloxy, thioheteroalicycloxy, cyano, halo, nitro, carbonyl, thiocarbonyl, O-carbamyl, N-carbamyl, O-thiocarbamyl, N-thiocarbamyl, C-amido, C-thioamido, N-amido, C-carboxy, O-carboxy, sulfinyl, sulfonyl, sulfonamido, trihalo- methanesulfonamido, trihalomethanesulfonyl, silyl, guanyl, guanidino, ureido, phosphonyl, amino and $-NR^xR^y$ with R^x and R^y as defined above.

10 An “alkenyl” group refers to an alkyl group, as defined herein, having at least two carbon atoms and at least one carbon-carbon double bond.

 An “alkynyl” group refers to an alkyl group, as defined herein, having at least two carbon atoms and at least one carbon-carbon triple bond.

15 A “hydroxy” group refers to an $-OH$ group.

 An “alkoxy” group refers to both an $-O$ -alkyl and an $-O$ -cycloalkyl group as defined herein.

20 An “aryloxy” group refers to both an $-O$ -aryl and an $-O$ -heteroaryl group, as defined herein.

 A “heteroaryloxy” group refers to a heteroaryl- O - group with heteroaryl as defined herein.

 A “heteroalicycloxy” group refers to a heteroalicyclic- O - group with heteroalicyclic as defined herein.

30 A “thiohydroxy” group refers to an $-SH$ group.

 A “thioalkoxy” group refers to both an S -alkyl and an $-S$ -cycloalkyl group, as defined herein.

A “thioaryloxy” group refers to both an –S-aryl and an –S-heteroaryl group, as defined herein.

5 A “thioheteroaryloxy” group refers to a heteroaryl-S- group with heteroaryl as defined herein.

A “thioheteroalicycloxy” group refers to a heteroalicyclic-S- group with heteroalicyclic as defined herein.

10 A “carbonyl” group refers to a --C(=O)R group, where R” is selected from the group consisting of hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, aryl, heteroaryl (bonded through a ring carbon) and heteroalicyclic (bonded through a ring carbon), as each is defined herein.

15 An “aldehyde” group refers to a carbonyl group where R” is hydrogen.

A “thiocarbonyl” group refers to a --C(=S)R group, with R” as defined herein.

20 A “Keto” group refers to a --CC(=O)C-- group wherein the carbon on either or both sides of the C=O may be alkyl, cycloalkyl, aryl or a carbon of a heteroaryl or heteroalicyclic group.

25 A “trihalomethanecarbonyl” group refers to a $\text{Z}_3\text{CC(=O)--}$ group with said Z being a halogen.

A “C-carboxy” group refers to a --C(=O)O-R groups, with R” as defined herein.

30 An “O-carboxy” group refers to a $\text{R}''\text{C(=O)O--}$ group, with R” as defined herein.

A “carboxylic acid” group refers to a C-carboxy group in which R” is hydrogen.

A “trihalomethyl” group refers to a $-CZ_3$, group wherein Z is a halogen group
5 as defined herein.

A “trihalomethanesulfonyl” group refers to an $Z_3CS(=O)_2$ - groups with Z as defined above.

10 A “trihalomethanesulfonamido” group refers to a $Z_3CS(=O)_2NR^x$ - group with Z as defined above and R^x being H or (C_{1-6}) alkyl.

A “sulfinyl” group refers to a $-S(=O)-R$ ” group, with R” being (C_{1-6}) alkyl.

15 A “sulfonyl” group refers to a $-S(=O)_2R$ ” group with R” being (C_{1-6}) alkyl.

A “S-sulfonamido” group refers to a $-S(=O)_2NR^XR^Y$, with R^X and R^Y independently being H or (C_{1-6}) alkyl.

20 A “N-Sulfonamido” group refers to a $R”S(=O)_2NR_x$ - group, with R_x being H or (C_{1-6}) alkyl;

A “O-carbamyl” group refers to a $-OC(=O)NR^XR^Y$ group, with R^X and R^Y independently being H or (C_{1-6}) alkyl.

25

A “N-carbamyl” group refers to a $R^XOC(=O)NR^Y$ group, with R^X and R^Y independently being H or (C_{1-6}) alkyl.

A “O-thiocarbamyl” group refers to a $-OC(=S)NR^XR^Y$ group, with R^X and R^Y
30 independently being H or (C_{1-6}) alkyl.

A “N-thiocarbamyl” group refers to a $R^XOC(=S)NR^Y$ - group, with R^X and R^Y independently being H or (C_{1-6}) alkyl.

An “amino” group refers to an -NH_2 group.

A “C-amido” group refers to a $\text{-C(=O)NR}^x\text{R}^y$ group, with R^x and R^y independently being H or (C_{1-6}) alkyl.

5

A “C-thioamido” group refers to a $\text{-C(=S)NR}^x\text{R}^y$ group, with R^x and R^y independently being H or (C_{1-6}) alkyl.

A “N-amido” group refers to a $\text{R}^x\text{C(=O)NR}^y\text{-}$ group, with R^x and R^y independently being H or (C_{1-6}) alkyl.

10

An “ureido” group refers to a $\text{-NR}^x\text{C(=O)NR}^y\text{R}^{y2}$ group, with R^x , R^y , and R^{y2} independently being H or (C_{1-6}) alkyl.

A “guanidino” group refers to a $\text{-R}^x\text{NC(=N)NR}^y\text{R}^{y2}$ group, with R^x , R^y , and R^{y2} independently being H or (C_{1-6}) alkyl.

15

A “guanyl” group refers to a $\text{R}^x\text{R}^y\text{NC(=N)-}$ group, with R^x and R^y independently being H or (C_{1-6}) alkyl.

20

A “cyano” group refers to a -CN group.

A “silyl” group refers to a -Si(R'')_3 , with R'' being (C_{1-6}) alkyl or phenyl.

A “phosphonyl” group refers to a $\text{P(=O)(OR}^x)_2$ with R^x being (C_{1-6}) alkyl.

25

A “hydrazino” group refers to a $\text{-NR}^x\text{NR}^y\text{R}^{y2}$ group, with R^x , R^y , and R^{y2} independently being H or (C_{1-6}) alkyl.

Any two adjacent R groups may combine to form an additional aryl, cycloalkyl, heteroaryl or heterocyclic ring fused to the ring initially bearing those R groups.

30

It is known in the art that nitrogen atoms in heteroaryl systems can be “participating in a heteroaryl ring double bond”, and this refers to the form of double bonds in the two tautomeric structures which comprise five-member ring heteroaryl groups. This dictates whether nitrogens can be substituted as well understood by chemists in the art. The disclosure and claims of the present disclosure are based on the known general principles of chemical bonding. It is understood that the claims do not encompass structures known to be unstable or not able to exist based on the literature.

Physiologically acceptable salts and prodrugs of compounds disclosed herein are within the scope of this disclosure. The term “pharmaceutically acceptable salt” as used herein and in the claims is intended to include nontoxic base addition salts. Suitable salts include those derived from organic and inorganic acids such as, without limitation, hydrochloric acid, hydrobromic acid, phosphoric acid, sulfuric acid, methanesulfonic acid, acetic acid, tartaric acid, lactic acid, sulfinic acid, citric acid, maleic acid, fumaric acid, sorbic acid, aconitic acid, salicylic acid, phthalic acid, and the like. The term “pharmaceutically acceptable salt” as used herein is also intended to include salts of acidic groups, such as a carboxylate, with such counterions as ammonium, alkali metal salts, particularly sodium or potassium, alkaline earth metal salts, particularly calcium or magnesium, and salts with suitable organic bases such as lower alkylamines (methylamine, ethylamine, cyclohexylamine, and the like) or with substituted lower alkylamines (e.g. hydroxyl-substituted alkylamines such as diethanolamine, triethanolamine or tris(hydroxymethyl)-aminomethane), or with bases such as piperidine or morpholine.

In the method of the present disclosure, the term “antiviral effective amount” means the total amount of each active component of the method that is sufficient to show a meaningful patient benefit, i.e., healing of acute conditions characterized by inhibition of the HIV infection. When applied to an individual active ingredient, administered alone, the term refers to that ingredient alone. When applied to a combination, the term refers to combined amounts of the active ingredients that result in the therapeutic effect, whether administered in combination, serially or

simultaneously. The terms "treat, treating, treatment" as used herein and in the claims means preventing or ameliorating diseases associated with HIV infection.

The present disclosure is also directed to combinations of the compounds with one or more agents useful in the treatment of AIDS. For example, the compounds of this disclosure may be effectively administered, whether at periods of pre-exposure and/or post-exposure, in combination with effective amounts of the AIDS antivirals, immunomodulators, antiinfectives, or vaccines, such as those in the following table.

10

ANTIVIRALS

	<i>Drug Name</i>	<i>Manufacturer</i>	<i>Indication</i>
15	097	Hoechst/Bayer	HIV infection, AIDS, ARC (non-nucleoside reverse transcriptase (RT) inhibitor)
20	Amprenavir 141 W94 GW 141	Glaxo Wellcome	HIV infection, AIDS, ARC (protease inhibitor)
25	Abacavir (1592U89) GW 1592	Glaxo Wellcome	HIV infection, AIDS, ARC (RT inhibitor)
30	Acemannan	Carrington Labs (Irving, TX)	ARC
35	Acyclovir	Burroughs Wellcome	HIV infection, AIDS, ARC, in combination with AZT
	AD-439	Tanox Biosystems	HIV infection, AIDS, ARC
40	AD-519	Tanox Biosystems	HIV infection, AIDS, ARC

	Adefovir dipivoxil AL-721	Gilead Sciences Ethigen (Los Angeles, CA)	HIV infection ARC, PGL HIV positive, AIDS
5	Alpha Interferon	Glaxo Wellcome	Kaposi's sarcoma, HIV in combination w/Retrovir
10	Ansamycin LM 427	Adria Laboratories (Dublin, OH) Erbamont (Stamford, CT)	ARC
15	Antibody which Neutralizes pH Labile alpha aberrant Interferon	Advanced Biotherapy Concepts (Rockville, MD)	AIDS, ARC
20	AR177	Aronex Pharm	HIV infection, AIDS, ARC
	Beta-fluoro-ddA	Nat'l Cancer Institute	AIDS-associated diseases
25	BMS-232623 (CGP-73547)	Bristol-Myers Squibb/ Novartis	HIV infection, AIDS, ARC (protease inhibitor)
30	BMS-234475 (CGP-61755)	Bristol-Myers Squibb/ Novartis	HIV infection, AIDS, ARC (protease inhibitor)
	CI-1012	Warner-Lambert	HIV-1 infection
35	Cidofovir	Gilead Science	CMV retinitis, herpes, papillomavirus
	Curdlan sulfate	AJI Pharma USA	HIV infection
40	Cytomegalovirus Immune globin	MedImmune	CMV retinitis

	Cytovene	Syntex	Sight threatening
5	Ganciclovir		CMV peripheral CMV retinitis
10	Delaviridine	Pharmacia-Upjohn	HIV infection, AIDS, ARC (RT inhibitor)
	Dextran Sulfate	Ueno Fine Chem. Ind. Ltd. (Osaka, Japan)	AIDS, ARC, HIV positive asymptomatic
15	ddC Dideoxycytidine	Hoffman-La Roche	HIV infection, AIDS, ARC
20	ddI Dideoxyinosine	Bristol-Myers Squibb	HIV infection, AIDS, ARC; combination with AZT/d4T
25	DMP-450	AVID (Camden, NJ)	HIV infection, AIDS, ARC (protease inhibitor)
30	Efavirenz (DMP 266, Sustiva®) (-)-6-Chloro-4-(S)- cyclopropylethynyl- 4(S)-trifluoro- methyl-1,4-dihydro- 2H-3,1-benzoxazin- 2-one, STOCRINE	Bristol Myers Squibb	HIV infection, AIDS, ARC (non-nucleoside RT inhibitor)
35	EL10	Elan Corp, PLC (Gainesville, GA)	HIV infection
40	Famciclovir	Smith Kline	herpes zoster, herpes simplex
	FTC	Emory University	HIV infection, AIDS, ARC (reverse transcriptase inhibitor)

	GS 840	Gilead	HIV infection, AIDS, ARC (reverse transcriptase inhibitor)
5			
	HBV097	Hoechst Marion Roussel	HIV infection, AIDS, ARC (non-nucleoside reverse transcriptase inhibitor)
10			
	Hypericin	VIMRx Pharm.	HIV infection, AIDS, ARC
15	Recombinant Human Interferon Beta	Triton Biosciences (Alameda, CA)	AIDS, Kaposi's sarcoma, ARC
	Interferon alfa-n3	Interferon Sciences	ARC, AIDS
20	Indinavir	Merck	HIV infection, AIDS, ARC, asymptomatic HIV positive, also in combination with AZT/ddI/ddC
25			
	ISIS 2922	ISIS Pharmaceuticals	CMV retinitis
	KNI-272	Nat'l Cancer Institute	HIV-assoc. diseases
30	Lamivudine, 3TC	Glaxo Wellcome	HIV infection, AIDS, ARC (reverse transcriptase inhibitor); also with AZT
35			
	Lobucavir	Bristol-Myers Squibb	CMV infection
40	Nelfinavir	Agouron Pharmaceuticals	HIV infection, AIDS, ARC (protease inhibitor)

	Nevirapine	Boeheringer Ingleheim	HIV infection, AIDS, ARC (RT inhibitor)
5	Novapren	Novaferon Labs, Inc. (Akron, OH)	HIV inhibitor
10	Peptide T Octapeptide Sequence	Peninsula Labs (Belmont, CA)	AIDS
15	Trisodium Phosphonoformate	Astra Pharm. Products, Inc.	CMV retinitis, HIV infection, other CMV infections
	PNU-140690	Pharmacia Upjohn	HIV infection, AIDS, ARC (protease inhibitor)
20	Probucol	Vyrex	HIV infection, AIDS
	RBC-CD4	Sheffield Med. Tech (Houston, TX)	HIV infection, AIDS, ARC
25	Ritonavir	Abbott	HIV infection, AIDS, ARC (protease inhibitor)
30	Saquinavir	Hoffmann- LaRoche	HIV infection, AIDS, ARC (protease inhibitor)
35	Stavudine; d4T Didehydrodeoxy- thymidine	Bristol-Myers Squibb	HIV infection, AIDS, ARC
	Valaciclovir	Glaxo Wellcome	Genital HSV & CMV infections
40	Virazole Ribavirin	Viratek/ICN (Costa Mesa, CA)	asymptomatic HIV positive, LAS, ARC

	VX-478	Vertex	HIV infection, AIDS, ARC
5	Zalcitabine	Hoffmann-LaRoche	HIV infection, AIDS, ARC, with AZT
10	Zidovudine; AZT	Glaxo Wellcome	HIV infection, AIDS, ARC, Kaposi's sarcoma, in combination with other therapies
15	Tenofovir disoproxil, fumarate salt (Viread [®])	Gilead	HIV infection, AIDS, (reverse transcriptase inhibitor)
20	Emtriva [®] (Emtricitabine)	Gilead	HIV infection, AIDS, (reverse transcriptase inhibitor)
25	Combivir [®]	GSK	HIV infection, AIDS, (reverse transcriptase inhibitor)
30	Abacavir succinate (or Ziagen [®])	GSK	HIV infection, AIDS, (reverse transcriptase inhibitor)
35	Reyataz [®] (or atazanavir)	Bristol-Myers Squibb	HIV infection AIDS, protease inhibitor
	Fuzeon [®] (or T-20)	Roche / Trimeris	HIV infection AIDS, viral Fusion inhibitor
40	Lexiva [®] (or Fosamprenavir calcium)	GSK/Vertex	HIV infection AIDS, viral protease inhibitor
45			

	Maraviroc; (UK 427857)	Pfizer	HIV infection AIDs, (CCR5 antagonist, in development)
5	Trizivir [®]	GSK	HIV infection AIDs, (three drug combination)
10	PA-457	Panacos	HIV infection AIDs, (maturation Inhibitor, in development)
15	Sch-417690 (vicriviroc)	Schering-Plough	HIV infection AIDs, (CCR5 antagonist, in development)
20	TAK-652	Takeda	HIV infection AIDs, (CCR5 antagonist, in development)
	GSK 873140 ONO-4128)	GSK/ONO	HIV infection AIDs, (CCR5 antagonist, in development)
25	BMS-707035	Bristol-Myers Squibb	HIV infection AIDs, (viral integrase Inhibitor)
30	Integrase Inhibitor MK-0518	Merck	HIV infection AIDs, viral integrase inhibitor in development
35	Truvada [®]	Gilead	Combination of Tenofovir disoproxil fumarate salt (Viread [®]) and Emtriva [®] (Emtricitabine)
40	Integrase Inhibitor GS917/JTK-303	Gilead/Japan Tobacco	HIV Infection AIDs, viral integrase inhibitor in development
45	Triple drug combination	Gilead/Bristol-Myers Squibb	Combination of Tenofovir disoproxil fumarate salt (Viread [®]), Emtriva [®] (Emtricitabine), and Sustiva [®] (Efavirenz)

IMMUNOMODULATORS

	<i>Drug Name</i>	<i>Manufacturer</i>	<i>Indication</i>
5	AS-101	Wyeth-Ayerst	AIDS
	Bropirimine	Pharmacia Upjohn	Advanced AIDS
10	Acemannan	Carrington Labs, Inc. (Irving, TX)	AIDS, ARC
	CL246,738	American Cyanamid Lederle Labs	AIDS, Kaposi's sarcoma
15	FP-21399	Fuki ImmunoPharm	Blocks HIV fusion with CD4+ cells
20	Gamma Interferon	Genentech	ARC, in combination w/TNF (tumor necrosis factor)
25	Granulocyte Macrophage Colony Stimulating Factor	Genetics Institute Sandoz	AIDS
	Granulocyte Macrophage Colony Stimulating Factor	Hoechst-Roussel Immunex	AIDS
30	Granulocyte Macrophage Colony Stimulating Factor	Schering-Plough	AIDS, combination w/AZT
35	HIV Core Particle Immunostimulant	Rorer	Seropositive HIV

	IL-2 Interleukin-2	Cetus	AIDS, in combination w/AZT
5	IL-2 Interleukin-2	Hoffman-LaRoche Immunex	AIDS, ARC, HIV, in combination w/AZT
10	IL-2 Interleukin-2 (aldeslukin)	Chiron	AIDS, increase in CD4 cell counts
	Immune Globulin Intravenous (human)	Cutter Biological (Berkeley, CA)	Pediatric AIDS, in combination w/AZT
15	IMREG-1	Imreg (New Orleans, LA)	AIDS, Kaposi's sarcoma, ARC, PGL
20	IMREG-2	Imreg (New Orleans, LA)	AIDS, Kaposi's sarcoma, ARC, PGL
	Imuthiol Diethyl Dithio Carbamate	Merieux Institute	AIDS, ARC
25	Alpha-2 Interferon	Schering Plough	Kaposi's sarcoma w/AZT, AIDS
	Methionine- Enkephalin	TNI Pharmaceutical (Chicago, IL)	AIDS, ARC
30	MTP-PE Muramyl-Tripeptide	Ciba-Geigy Corp.	Kaposi's sarcoma
35	Granulocyte Colony Stimulating Factor	Amgen	AIDS, in combination w/AZT
	Remune	Immune Response Corp.	Immunotherapeutic
40	rCD4 Recombinant Soluble Human CD4	Genentech	AIDS, ARC

	rCD4-IgG hybrids		AIDS, ARC
5	Recombinant Soluble Human CD4	Biogen	AIDS, ARC
10	Interferon Alfa 2a	Hoffman-La Roche	Kaposi's sarcoma AIDS, ARC, in combination w/AZT
	SK&F106528 Soluble T4	Smith Kline	HIV infection
15	Thymopentin	Immunobiology Research Institute (Annandale, NJ)	HIV infection
20	Tumor Necrosis Factor; TNF	Genentech	ARC, in combination w/gamma Interferon

ANTI-INFECTIVES

	<i>Drug Name</i>	<i>Manufacturer</i>	<i>Indication</i>
25	Clindamycin with Primaquine	Pharmacia Upjohn	PCP
30	Fluconazole	Pfizer	Cryptococcal meningitis, candidiasis
	Pastille Nystatin Pastille	Squibb Corp.	Prevention of oral candidiasis
35	Ornidyl Eflornithine	Merrell Dow	PCP
40	Pentamidine Isethionate (IM & IV)	LyphoMed (Rosemont, IL)	PCP treatment
	Trimethoprim		Antibacterial

	Trimethoprim/sulfa		Antibacterial
	Piritrexim	Burroughs Wellcome	PCP treatment
5	Pentamidine Isethionate for Inhalation	Fisons Corporation	PCP prophylaxis
10	Spiramycin	Rhone-Poulenc diarrhea	Cryptosporidial
15	Intraconazole- R51211	Janssen-Pharm.	Histoplasmosis; cryptococcal meningitis
	Trimetrexate	Warner-Lambert	PCP
	Daunorubicin	NeXstar, Sequus	Kaposi's sarcoma
20	Recombinant Human Erythropoietin	Ortho Pharm. Corp.	Severe anemia assoc. with AZT therapy
25	Recombinant Human Growth Hormone	Serono	AIDS-related wasting, cachexia
30	Megestrol Acetate	Bristol-Myers Squibb	Treatment of anorexia assoc. W/AIDS
	Testosterone	Alza, Smith Kline	AIDS-related wasting
35	Total Enteral Nutrition	Norwich Eaton Pharmaceuticals	Diarrhea and malabsorption related to AIDS

Additionally, the compounds of the disclosure herein may be used in combination with another class of agents for treating AIDS which are called HIV entry inhibitors. Examples of such HIV entry inhibitors are discussed in DRUGS OF

THE FUTURE 1999, 24(12), pp. 1355-1362; CELL, Vol. 9, pp. 243-246, Oct. 29, 1999; and DRUG DISCOVERY TODAY, Vol. 5, No. 5, May 2000, pp. 183-194 and *Inhibitors of the entry of HIV into host cells*. Meanwell, Nicholas A.; Kadow, John F. Current Opinion in Drug Discovery & Development (2003), 6(4), 451-461.

- 5 Specifically the compounds can be utilized in combination with other attachment inhibitors, fusion inhibitors, and chemokine receptor antagonists aimed at either the CCR5 or CXCR4 coreceptor.

10 It will be understood that the scope of combinations of the compounds of this disclosure with AIDS antivirals, immunomodulators, anti-infectives, HIV entry inhibitors or vaccines is not limited to the list in the above Table but includes, in principle, any combination with any pharmaceutical composition useful for the treatment of AIDS.

15 Preferred combinations are simultaneous or alternating treatments with a compound of the present disclosure and an inhibitor of HIV protease and/or a non-nucleoside inhibitor of HIV reverse transcriptase. An optional fourth component in the combination is a nucleoside inhibitor of HIV reverse transcriptase, such as AZT, 3TC, ddC or ddI. A preferred inhibitor of HIV protease is Reyataz[®] (active
20 ingredient Atazanavir). Typically a dose of 300 to 600mg is administered once a day. This may be co-administered with a low dose of Ritonavir (50 to 500mgs). Another preferred inhibitor of HIV protease is Kaletra[®]. Another useful inhibitor of HIV protease is indinavir, which is the sulfate salt of N-(2(R)-hydroxy-1-(S)-indanyl)-2(R)-phenylmethyl-4-(S)-hydroxy-5-(1-(4-(3-pyridyl-methyl)-2(S)-N'-(t-
25 butylcarboxamido)-piperaziny)))-pentaneamide ethanolate, and is synthesized according to U.S. 5,413,999. Indinavir is generally administered at a dosage of 800 mg three times a day. Other preferred protease inhibitors are nelfinavir and ritonavir. Another preferred inhibitor of HIV protease is saquinavir which is administered in a dosage of 600 or 1200 mg tid. Preferred non-nucleoside inhibitors of HIV reverse
30 transcriptase include efavirenz. The preparation of ddC, ddI and AZT are also described in EPO 0,484,071. These combinations may have unexpected effects on limiting the spread and degree of infection of HIV. Preferred combinations include those with the following (1) indinavir with efavirenz, and, optionally, AZT and/or

3TC and/or ddI and/or ddC; (2) indinavir, and any of AZT and/or ddI and/or ddC and/or 3TC, in particular, indinavir and AZT and 3TC; (3) stavudine and 3TC and/or zidovudine; (4) zidovudine and lamivudine and 141W94 and 1592U89; (5) zidovudine and lamivudine.

5

In such combinations the compound of the present disclosure and other active agents may be administered separately or in conjunction. In addition, the administration of one element may be prior to, concurrent to, or subsequent to the administration of other agent(s).

10

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30

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administration of one element may be prior to, concurrent to, or subsequent to the administration of other agent(s).

Abbreviations

5

The following abbreviations, most of which are conventional abbreviations well known to those skilled in the art, are used throughout the description of the disclosure and the examples. Some of the abbreviations used are as follows:

10	h	=	hour(s)
	rt	=	room temperature
	mol	=	mole(s)
	mmol	=	millimole(s)
	g	=	gram(s)
15	mg	=	milligram(s)
	mL	=	milliliter(s)
	TFA	=	trifluoroacetic Acid
	DCE	=	1,2-Dichloroethane
	CH ₂ Cl ₂	=	dichloromethane
20	TPAP	=	tetrapropylammonium perruthenate
	THF	=	tetrahydrofuran
	DEPBT	=	3-(diethoxyphosphoryloxy)-1,2,3-benzotriazin-4(3H)-one
	DMAP	=	4-dimethylaminopyridine
25	P-EDC	=	polymer supported 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide
	EDC	=	1-(3-dimethylaminopropyl)-3-ethylcarbodiimide
	DMF	=	<i>N,N</i> -dimethylformamide
	Hunig's Base	=	<i>N,N</i> -diisopropylethylamine
30	MCPBA	=	<i>meta</i> -chloroperbenzoic Acid
	azaindole	=	1 <i>H</i> -pyrrolo-pyridine
	4-azaindole	=	1 <i>H</i> -pyrrolo[3,2- <i>b</i>]pyridine
	5-azaindole	=	1 <i>H</i> -pyrrolo[3,2- <i>c</i>]pyridine

	6-azaindole	=	1 <i>H</i> -pyrrolo[2,3- <i>c</i>]pyridine
	7-azaindole	=	1 <i>H</i> -pyrrolo[2,3- <i>b</i>]pyridine
	PMB	=	4-methoxybenzyl
	DDQ	=	2, 3-dichloro-5, 6-dicyano-1, 4-benzoquinone
5	OTf	=	trifluoromethanesulfonyl
	NMM	=	4-methylmorpholine
	PIP-COPh	=	1-benzoylpiperazine
	NaHMDS	=	sodium hexamethyldisilazide
	EDAC	=	1-(3-dimethylaminopropyl)-3-ethylcarbodiimide
10	TMS	=	trimethylsilyl
	DCM	=	dichloromethane
	DCE	=	dichloroethane
	MeOH	=	methanol
	THF	=	tetrahydrofuran
15	EtOAc	=	ethyl acetate
	LDA	=	lithium diisopropylamide
	TMP-Li	=	2,2,6,6-tetramethylpiperidinyllithium
	DME	=	dimethoxyethane
	DIBALH	=	diisobutylaluminum hydride
20	HOBT	=	1-hydroxybenzotriazole
	CBZ	=	benzyloxycarbonyl
	PCC	=	pyridinium chlorochromate

25 The compounds of the present disclosure may be administered orally,
 parenterally (including subcutaneous injections, intravenous, intramuscular,
 intrasternal injection or infusion techniques), by inhalation spray, or rectally, in
 dosage unit formulations containing conventional non-toxic pharmaceutically
 acceptable carriers, adjuvants and diluents.

30 Thus, in accordance with the present disclosure, there is further provided a
 method of treating and a pharmaceutical composition for treating viral infections
 such as HIV infection and AIDS. The treatment involves administering to a patient
 in need of such treatment a pharmaceutical composition comprising a pharmaceutical

carrier and a therapeutically effective amount of a compound of the present disclosure.

The pharmaceutical composition may be in the form of orally administrable
5 suspensions or tablets; nasal sprays, sterile injectable preparations, for example, as sterile injectable aqueous or oleagenous suspensions or suppositories.

When administered orally as a suspension, these compositions are prepared according to techniques well known in the art of pharmaceutical formulation and may
10 contain microcrystalline cellulose for imparting bulk, alginic acid or sodium alginate as a suspending agent, methylcellulose as a viscosity enhancer, and sweeteners/flavoring agents known in the art. As immediate release tablets, these compositions may contain microcrystalline cellulose, dicalcium phosphate, starch, magnesium stearate and lactose and/or other excipients, binders, extenders,
15 disintegrants, diluents, and lubricants known in the art.

The injectable solutions or suspensions may be formulated according to known art, using suitable non-toxic, parenterally acceptable diluents or solvents, such as mannitol, 1,3-butanediol, water, Ringer's solution or isotonic sodium chloride
20 solution, or suitable dispersing or wetting and suspending agents, such as sterile, bland, fixed oils, including synthetic mono- or diglycerides, and fatty acids, including oleic acid.

The compounds of this disclosure can be administered orally to humans in a
25 dosage range of 1 to 100 mg/kg body weight in divided doses. One preferred dosage range is 1 to 10 mg/kg body weight orally in divided doses. Another preferred dosage range is 1 to 20 mg/kg body weight in divided doses. It will be understood, however, that the specific dose level and frequency of dosage for any particular patient may be varied and will depend upon a variety of factors including the activity
30 of the specific compound employed, the metabolic stability and length of action of that compound, the age, body weight, general health, sex, diet, mode and time of administration, rate of excretion, drug combination, the severity of the particular condition, and the host undergoing therapy.

CHEMISTRY

The present disclosure comprises compounds of Formula I, their pharmaceutical formulations, and their use in patients suffering from or susceptible to HIV infection. The compounds of Formula I include pharmaceutically acceptable salts thereof. General procedures to construct compounds of Formula I and intermediates useful for their synthesis are described in the following Schemes.

Preparation of Compounds of Formula I

10

It should be noted that in many cases reactions are depicted for only one position of an intermediate, such as the C-7 position of indole or azaindole, for example. It is to be understood that such reactions could be used at other positions, such as C-2, C-4, C-5 and C-6 position of indole or azaindole, of the various intermediates. Reaction conditions and methods given in the specific examples are broadly applicable to compounds with other substitution and other transformations in this application.

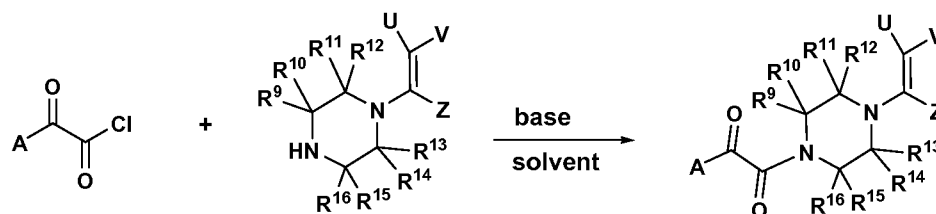
Preparation of template A-CO-CO-Cl and A-CO-CO-OH has been described in detail in WO-00076521, WO-00162255, WO-00204440, WO-02062423, WO-02085301, WO-03068221 and US-2004/0063744.

Standard conditions such as reacting amine with acyl halide (**Scheme I**) and carboxyl acid (**Scheme II**) can be used to convert the ketone to the desired amide products. Some general references of these methodologies and directions for use are contained in "Comprehensive Organic Transformation" by Richard C. Larock, Wiley-VCH, New York, 1989, 972 (Carboxylic acids to amides), 979 (Acid halides to amides).

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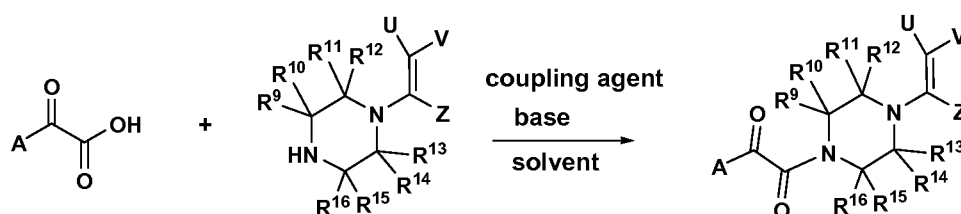
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Scheme I



5 **Scheme I** depicts a general method for forming an amide from piperazine enamine and acyl chloride. An appropriate base (from catalytic to an excess amount) selected from sodium hydride, potassium carbonate, triethylamine, DBU, pyridine, DMAP or di-isopropyl ethyl amine was added into a solution of amine and acyl chloride in an appropriate solvent selected from dichloromethane, chloroform, benzene, toluene, THF, diethyl ether, dioxane, acetone, N,N-dimethylformamide or pyridine at room temperature. Then reaction was carried out at either room temperature or evaluated temperature up to 150^oC over a period of time (30 minutes to 16 hours) to afford the structure of Formula I. Some selected references involving such reactions include a) *Indian J. Chem., Sect B* **1990**, 29, 1077; 2) *Chem. Sci.* **1998**, 53, 1216; 3) *Chem. Pharm. Bull.* **1992**, 40, 1481; 4) *Chem. Heterocycl. Compd.* **2002**, 38, 539.

Scheme II



20

Alternatively, as shown in **Scheme II**, a piperazine enamine can be coupled with an acid using standard amide bond or peptide bond forming coupling reagents. Many reagents for amide bond couplings are known by an organic chemist skilled in the art and nearly all of these are applicable for realizing coupled amide products. The combination of EDAC and triethylamine in tetrahydrofuran or BOPCl and diisopropyl ethyl amine in chloroform have been utilized most frequently but DEPBT, or other coupling reagents such as PyBop could be utilized. Another useful

25

coupling condition employs HATU ((a) *J.Chem.Soc. Chem Comm.* **1994**, 201; (b) *J. Am. Chem. Soc.* 1994, 116,11580). Additionally, DEPBT (3-(diethoxyphosphoryloxy)-1,2,3-benzotriazin-4(3*H*)-one) and *N,N*-diisopropylethylamine, commonly known as Hunig's base, represents another
5 efficient method to form the amide bond and provide compounds of Claim I. DEPBT is either purchased from Adrich or prepared according to the procedure described in *Organic Lett.*, **1999**, 1, 91. Typically an inert solvent such as DMF or THF is used but other aprotic solvents could be used.

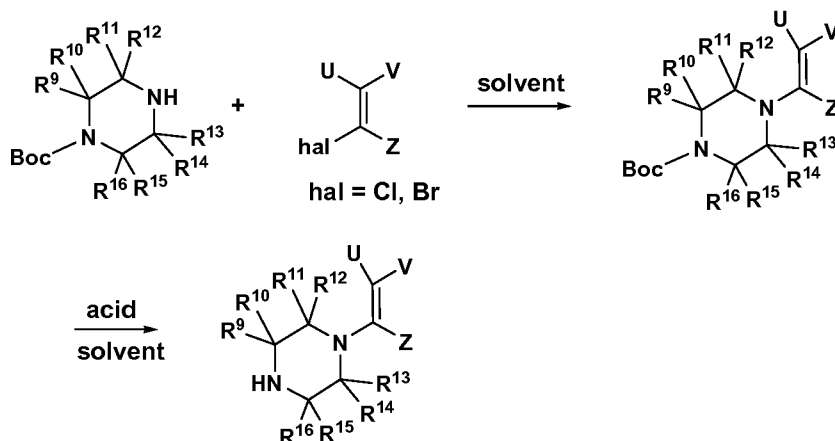
10 Piperazine enamine may be prepared by methods described in the **Scheme III, Scheme IV, Scheme V and Scheme VI.**

Scheme III presents a general route towards piperazine enamine intermediate, exemplified by using *N*-Boc piperazine as the starting material. In an aprotic (e.g.,
15 THF, DMF, DMSO, benzene) or protic solvent (e.g., MeOH, EtOH, PrOH, BuOH), at temperature from room temperature to 150°C, in the absence or presense of base such as NaH, pyridine, Et₃N, di-Pr₂NEt, Na₂CO₃, K₂CO₃, *N*-Boc piperazine can react with a vinyl halide to offer *N*-Boc piperazine enamine. The following well
20 established deprotection of Boc group under acidic solution would provide piperazine enamine. TFA and HCl are the typical solvents, while the most commonly used solvents are ether and dichloromethane, but other acidic agents and solvents could be used. Some selected references involving such reactions include 1) *Bioorg. Med. Chem. Lett.* **1996**, 6, 2777; 2) *Zh. Org. Khim.* **1996**, 32, 1010; 3) *J. Fluorine Chem.* **1996**, 76, 177; 4) *Synth. Commun.* **1996**, 26, 3549; 5) *J. Heterocycl. Chem.* **1994**,
25 31, 841; 6) *J. Org. Chem.* **1964**, 29, 794.

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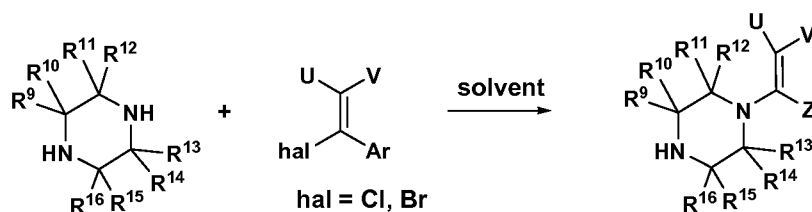
Scheme III



- 5 Unprotected piperazine can react with vinyl halide directly to offer piperazine enamine, as shown in **Scheme IV**. The conditions described in **Scheme III** can be applied in **Scheme IV**. In an aprotic (e.g., THF, DMF, DMSO, benzene) or protic solvent (e.g., MeOH, EtOH, PrOH, BuOH), at temperature from room temperature to 150°C, in the absence or presense of base such as NaH, pyridine, Et₃N, di-Pr₂NEt,
- 10 Na₂CO₃, K₂CO₃, a piperazine derivative can react with a vinyl halide to afford piperazine enamine. Some selected references involving such reactions include 1) *Farmaco* **1995**, 50, 703; 2) *Eur. J. Med. Chem.* **1993**, 28, 647; 3) *Heterocycles* **1990**, 31, 1967; 4) *J. Heterocycl. Chem.* **2003**, 40, 617.

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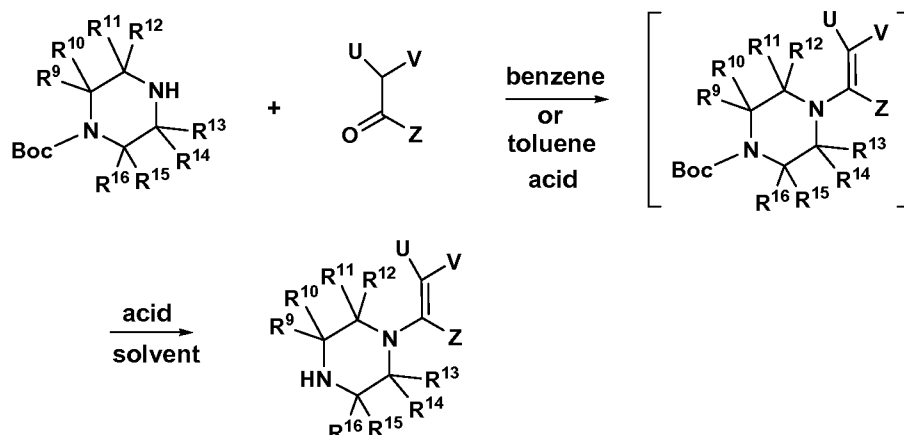
Scheme IV



- An alternate method for preparing compounds of piperazine enamine is shown in **Scheme V**, below. Reaction of a known or synthesized ketone derivative with a N-Boc piperazine derivative, under conditions using acid such as TsOH or TiCl₄ in benzene or toluene will afford the desired N-Boc piperazine enamine intermediate. The intermediate could be isolated and further standeard deprotection of Boc group under acidic condition, such as TFA or HCl in methylene chloride or
- 20

ether or alcohol, would afford desired piperazine enamine. The deprotection of Boc group could occur in situ as well to offer piperazine enamine as shown in **Scheme V**. Some selected references involving condensation of piperazine with ketone include 1) *Tetrahedron Lett.* **2003**, 44, 1067; 2) *Synthesis* **2002**, 355.

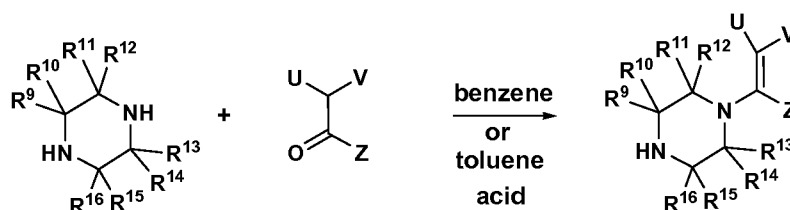
5

Scheme V

10 Similarly, as shown in **Scheme VI**, reaction of a known or synthesized ketone derivative with a un-protected piperazine derivative, under conditions using acid such as TsOH or TiCl₄ in benzene or toluene, will afford the desired piperazine enamine.

Scheme VI

15

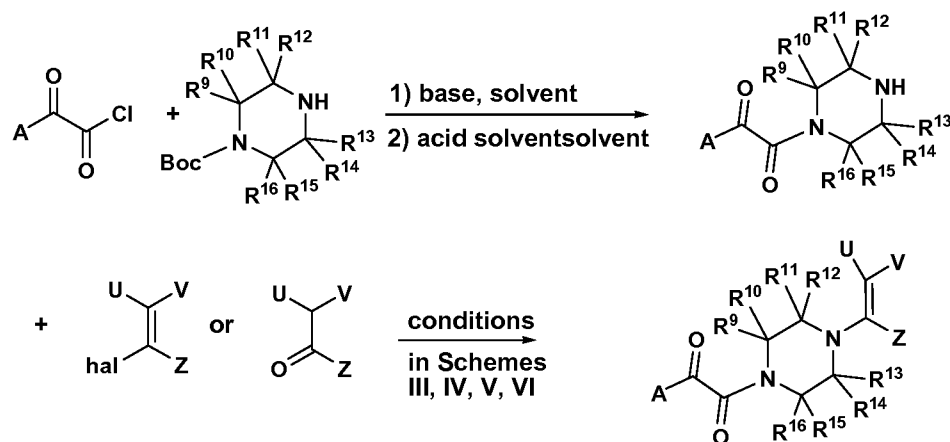


As described in **Scheme I- VI**, the compound of **Formula I** could be prepared following a sequence of a) preparation of piperazine enamine, and then b) coupling of 2-keto acyl acids or acyl halides with piperazine enamine. This sequence could be switched, which involves sequential reaction of 2-keto acyl acids or acyl halides with nitrogen protected or non protected piperazine derivatives, followed by deprotection of N atom in the N-protected cases and formation of piperazine enamine, as shown in **Scheme VII** and **Scheme IX**.

20

Scheme VII presents a general route towards the structure of **Formula I**, exemplified by using N-Boc piperazine and 2-keto acyl chloride as the starting materials. An appropriate base (from catalytic to an excess amount) selected from sodium hydride, potassium carbonate, triethylamine, DBU, pyridine, DMAP or diisopropyl ethyl amine was added into a solution of N-Boc and acyl chloride in an appropriate solvent selected from dichloromethane, chloroform, benzene, toluene, THF, diethyl ether, dioxane, acetone, N,N-dimethylformamide or pyridine at room temperature. Then reaction was carried out at either room temperature or elevated temperature up to 150°C over a period of time (30 minutes to 16 hours) to afford a piperazine 2-keto amide derivative. The Boc group can be removed under acidic solution would provide a 2-keto piperazine amide intermediate. TFA and HCl are the typical solvents, while the most commonly used solvents are ether and dichloromethane, but other acidic agents and solvents could be used. Finally, using conditions described in **Schemes III-VI**, 2-keto piperazine amide intermediate reacts with a vinyl halide or a ketone derivative to form compound of **Formula I**.

Scheme VII



20

Scheme IX describes a general route towards the structure of **Formula I**, exemplified by using N-Boc piperazine and 2-keto acid as the starting materials. N-Boc piperazine couples with a 2-keto acid using standard amide bond or peptide bond forming coupling reagents. Many reagents for amide bond couplings are known by an organic chemist skilled in the art and nearly all of these are applicable for realizing coupled amide products. The combination of EDAC and triethylamine in

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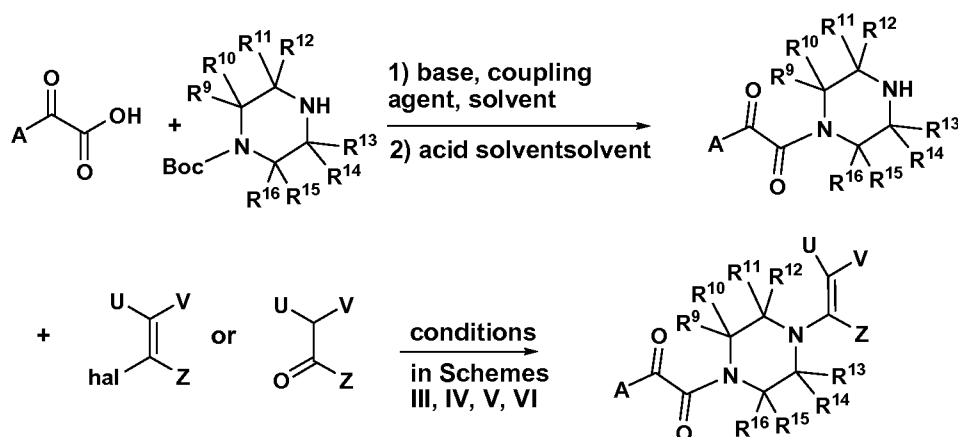
tetrahydrofuran or BOPCl and diisopropyl ethyl amine in chloroform have been utilized most frequently but DEPBT, or other coupling reagents such as PyBop could be utilized. Another useful coupling condition employs HATU ((a) *J.Chem.Soc. Chem Comm.* **1994**, 201; (b) *J. Am. Chem. Soc.* 1994, 116,11580). Additionally,

5 DEPBT (3-(diethoxyphosphoryloxy)-1,2,3-benzotriazin-4(3*H*)-one) and *N,N*-diisopropylethylamine, commonly known as Hunig's base, represents another efficient method to form the amide bond and provide compounds of Claim I. DEPBT is either purchased from Adrich or prepared according to the procedure described in

10 *Organic Lett.*, **1999**, 1, 91. Typically an inert solvent such as DMF or THF is used but other aprotic solvents could be used. The Boc group is removed under acidic solution would provide a 2-keto pierazine amide intermediate. TFA and HCl are the typical solvents, while the most commonly used solvents are ether and dichloromethane, but other acidic agents and solvents could be used. Finally, using

15 conditions described in **Schemes III-VI**, 2-keto pierazine amide intermediate reacts with a vinyl halide or a ketone derivative to form compound of **Formula I**.

Scheme IX



20

It should be noted that the above reactions are depicted for only C-& position of a starting indole system. It is to be understood that such reactions could be used at other positions of a variety of indole or azaindole systems during the construction of compounds of **Formula I**. Reaction conditions and methods given in the specific

25 examples are broadly applicable to compounds with other substitution and to other transformations in this application.

EXPERIMENTAL PROCEDURES

The following examples represent typical syntheses of the compounds of Formula I as described generally above. These examples are illustrative only and are not intended to limit the disclosure in any way. The reagents and starting materials are readily available to one of ordinary skill in the art.

*Chemistry*10 *Typical Procedures and Characterization of Selected Examples:*

Unless otherwise stated, solvents and reagents were used directly as obtained from commercial sources, and reactions were performed under a nitrogen atmosphere. Flash chromatography was conducted on Silica gel 60 (0.040-0.063 particle size; EM Science supply). ¹H NMR spectra were recorded on Bruker DRX-500f at 500 MHz (or Bruker DPX-300B or Varian Gemini 300 at 300 MHz as stated). The chemical shifts were reported in ppm on the δ scale relative to δ TMS = 0. The following internal references were used for the residual protons in the following solvents: CDCl₃ (δ _H 7.26), CD₃OD (δ _H 3.30), and DMSO-*d*₆ (δ _H 2.50). Standard acronyms were employed to describe the multiplicity patterns: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), b (broad), app (apparent). The coupling constant (*J*) is in Hertz. All Liquid Chromatography (LC) data were recorded on a Shimadzu LC-10AS liquid chromatograph using a SPD-10AV UV-Vis detector with Mass Spectrometry (MS) data determined using a Micromass Platform for LC in electrospray mode.

All Liquid Chromatography (LC) data were recorded on a Shimadzu LC-10AS liquid chromatograph using a SPD-10AV UV-Vis detector with Mass Spectrometry (MS) data determined using a Micromass Platform for LC in electrospray mode.

LC/MS Methods (i.e., compound identification)

Column A: Xterra MS C18 5um 4.6x30mm column

5 Column B: Phenomenex 5u C18 4.6x30mm column

Column C: Xterra MS C18 4.6x30mm column

Column D: Phenomenex 4.6x50mm C18 5um column

10

Column E: Xterra 4.6x30mm S5 column

Column F: Phenomenex 10u 3.0x50mm column

15 Column G: Xterra C18 S7 3.0x50mm column

Gradient: 100% Solvent A / 0% Solvent B to 0% Solvent A / 100%
Solvent B

20 Gradient time: 2 minutes

Hold time 1 minute

Flow rate: 5 ml/min

25

Detector Wavelength: 220 nm

Solvent system I

30 Solvent A: 10% MeOH / 90% H₂O / 0.1% Trifluoroacetic Acid

Solvent B: 10% H₂O / 90% MeOH / 0.1% Trifluoroacetic Acid

Solvent system II

Solvent A: 5% MeCN / 95% H₂O / 10mm ammonium acetate

5 Solvent B: 95% MeCN / 5% H₂O / 10mm ammonium acetate

All the LC-MS in the following sections, except which are specified using solvent system II, were obtained by using solvent system I.

10 Compounds purified by preparative HPLC were diluted in methanol (1.2 ml) and purified using the following methods on a Shimadzu LC-10A automated preparative HPLC system.

Preparative HPLC Method (i.e., compound purification)

15

Purification Method: Initial gradient (40% B, 60% A) ramp to final gradient (100% B, 0% A) over 20 minutes, hold for 3 minutes (100% B, 0% A)

Solvent A: 10% MeOH / 90% H₂O / 0.1% Trifluoroacetic Acid

20

Solvent B: 10% H₂O / 90% MeOH / 0.1% Trifluoroacetic Acid

Column: YMC C18 S5 20x100 mm column

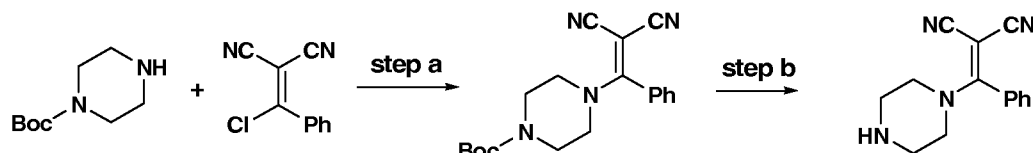
25 Detector Wavelength: 220 nm

30

*Typical Procedures and Characterization of Selected Examples:**Typical procedure to prepare amide derivatives from amino-indole procursors*5 *General Procedures:**Preparation of piperazine enamine*

Procedure A:

10

*Preparation of 2-(phenyl(piperazin-1-yl)methylene)malononitrile:*

15 *Step a:* Triethyl amine (1 ml) was added into a solution of N-Boc piperazine (1 g) and 2-(chloro(phenyl)methylene)malononitrile (1 g) in EtOH (20 ml). After 16 hours at 115°C, the reaction mixture was cooled down and some of desired product, tert-butyl 4-(2,2-dicyano-1-phenylvinyl)piperazine-1-carboxylate, precipitated out from the solution. After filtration, the mother solution was concentrated to offer a residue which was purified using silica gel chromatography to afford more tert-butyl

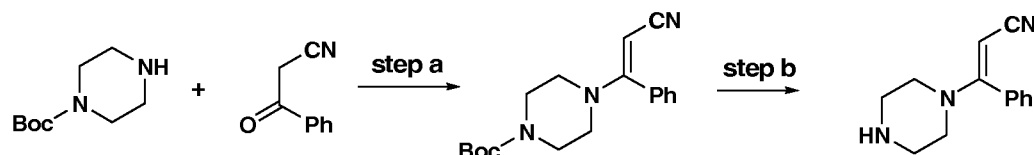
20 4-(2,2-dicyano-1-phenylvinyl)piperazine-1-carboxylate. ¹H NMR (500 MHz, DMSO-d₆) □ 7.53 (m, 5H), 3.93 (b, 2H), 3.61 (b, 2H), 3.36 (b, 2H), 3.15 (b, 2H), 1.39(s, 9H); ¹³C NMR (125 MHz, DMSO-d₆) □ 170.9, 153.6, 132.6, 131.7, 129.1, 129.0, 117.4, 116.7, 79.4, 51.5, 50.33, 42.9, 27.9. MS *m/z*: (M+H)⁺ calcd for C₁₉H₂₃N₄O₂ 339.18, found 339.17. Retention time 1.46 min (column A).

25

Step b: tert-Butyl 4-(2,2-dicyano-1-phenylvinyl)piperazine-1-carboxylate (2 g) was dissolved in a 33.3% solution of TFA in methylene chloride (20 ml). After 16 hour at room temperature, solvents were removed under vacuum to offer a residue

30 which was purified using silica gel chromatography to give 2-(phenyl(piperazin-1-yl)methylene)malononitrile (1 g). ¹H NMR (500 MHz, CD₃OD) □ 7.62 (m, 5H), 3.70 (b, 4H), 3.47 (b, 4H); ¹³C NMR (125 MHz, CD₃OD) □ 172.9, 132.7, 132.5, 129.6, 116.6, 116.0, 55.2, 43.4. MS *m/z*: (M+H)⁺ calcd for C₁₄H₁₅N₄ 239.13, found 239.13. Retention time 0.56 min (column A).

Procedure B:

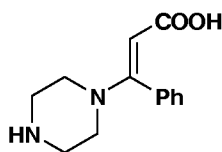


5 *Preparation of 3-phenyl-3-(piperazin-1-yl)acrylonitrile:*

Step a: TsOH-H₂O (1 g) was added into a solution of N-Boc piperazine (50 g) and 3-oxo-3-phenylpropanenitrile (19.49 g) in benzene (200 ml). The reaction mixture was heated up to 115°C for 16 hours and resultant water was collected by
 10 Dean-Stark trap. After the solution was concentrated, a residue was obtained and further purification using silica gel chromatography provided tert-butyl 4-(2-cyano-1-phenylvinyl)piperazine-1-carboxylate. ¹H NMR (500 MHz, CD₃OD) δ 7.91 (m, 5H), 5.24 (s, 1H), 3.89 - 3.50 (m, 8H), 1.88 (s, 9H); ¹³C NMR (125 MHz, CD₃OD) δ 167.6, 155.7, 135.4, 130.6, 129.4, 121.8, 81.1, 67.1, 45.4, 28.0. MS *m/z*: (M+H)⁺
 15 calcd for C₁₈H₂₄N₃O₂ 314.19, found 314.25. Retention time 1.81 min (column D).

Step b: tert-Butyl 4-(2-cyano-1-phenylvinyl)piperazine-1-carboxylate (600 mg) was dissolved in a 10% solution of TFA in methylene chloride (11 ml). After 1 hour at room temperature, the reaction mixture was partitioned between saturated
 20 NaHCO₃ (20 ml) and EtOAc (20 ml), and the aqueous phase was extracted with EtOAc (3 x 20 ml). Then the combined organic layer was dried over MgSO₄ and concentrated to offer a residue which was purified using silica gel chromatography to give 3-phenyl-3-(piperazin-1-yl)acrylonitrile. MS *m/z*: (M+H)⁺ calcd for C₁₃H₁₆N₃ 214.13, found 214.15. Retention time 0.91 min (column E).

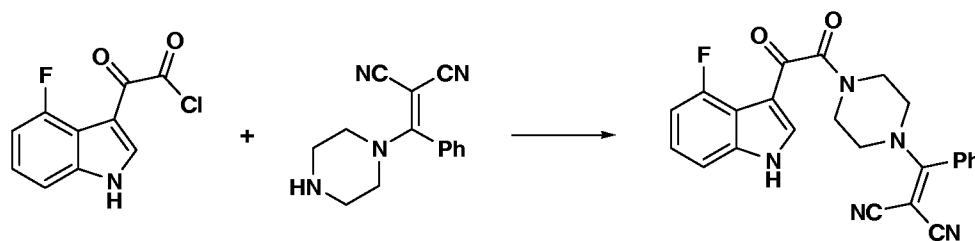
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3-Phenyl-3-(piperazin-1-yl)acrylic acid was prepared via the same procedure from ethyl 3-oxo-3-phenylpropanoate. MS m/z : $(M+H)^+$ calcd for $C_{13}H_{17}N_2O_2$ 233.13, found 233.07. Retention time 0.64 min (column A).

5 Preparation of Compound of Formula I:

Procedure A:

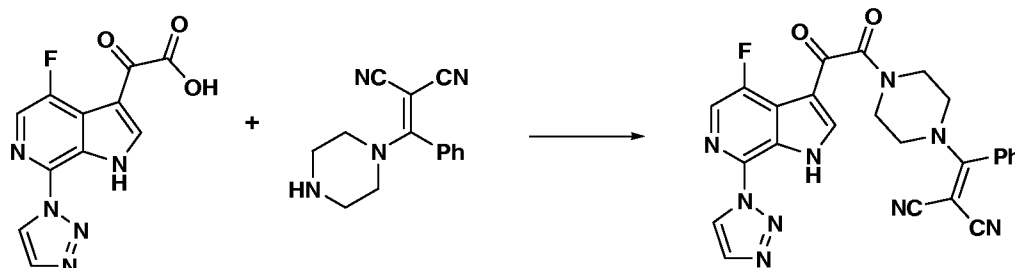


10

Preparation of 2-((4-(2-(4-fluoro-1H-indol-3-yl)-2-oxoacetyl)piperazin-1-yl)(phenyl)methylene)malononitrile:

Triethyl amine (2 ml) was added into a solution of 2-(4-fluoro-1H-indol-3-yl)-2-oxoacetyl chloride (284 mg) and 2-(phenyl(piperazin-1-yl)methylene)malononitrile (300 mg) in dry THF (20 ml). After 16 hours, the reaction mixture was partitioned between saturated $NaHCO_3$ (20 ml) and EtOAc (20 ml), and the aqueous phase was extracted with EtOAc (3 x 20 ml). Then the combined organic layer was dried over $MgSO_4$ and concentrated to offer a residue which was purified using Shimadzu automated preparative HPLC System to afford 2-((4-(2-(4-fluoro-1H-indol-3-yl)-2-oxoacetyl)piperazin-1-yl)(phenyl)methylene)malononitrile.

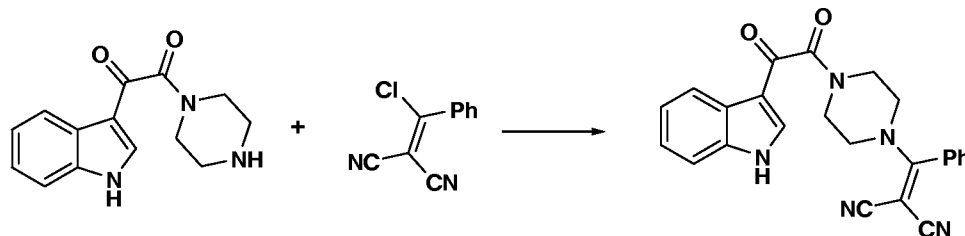
25 Procedure B:



Preparation of 2-((4-(2-(4-fluoro-7-(1H-1,2,3-triazol-1-yl)-1H-pyrrolo[2,3-c]pyridin-3-yl)-2-oxoacetyl)piperazin-1-yl)(phenyl)methylene)malononitrile: 2-(4-fluoro-7-(1H-1,2,3-triazol-1-yl)-1H-pyrrolo[2,3-c]pyridin-3-yl)-2-oxoacetic acid (70 mg), 2-(phenyl(piperazin-1-yl)methylene)malononitrile (55 mg), 3-
 5 (diethoxyphosphoryloxy)-1,2,3-benzotriazin-4(3H)-one (DEPBT) (200 mg) and Hunig's Base (0.1 ml) were combined in 1.5 ml of DMF. The mixture was stirred at room temperature for 16 hours. Then, DMF was removed *via* evaporation at reduced pressure and the residue was partitioned between ethyl acetate (10 ml) and water (10 ml). The organic layer was washed saturated NaHCO₃ solution (3 x 100 ml), and
 10 brine (10 ml). The organic phase was dried over anhydrous MgSO₄. Concentration in *vacuo* provided a crude product, which was purified using Shimadzu automated preparative HPLC System to afford 2-((4-(2-(4-fluoro-7-(1H-1,2,3-triazol-1-yl)-1H-pyrrolo[2,3-c]pyridin-3-yl)-2-oxoacetyl)piperazin-1-yl)(phenyl)methylene)malononitrile.

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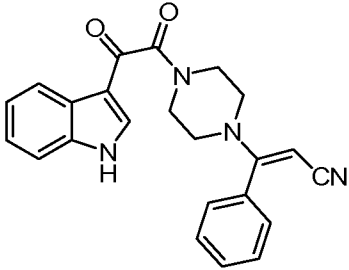
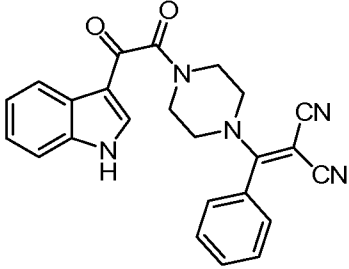
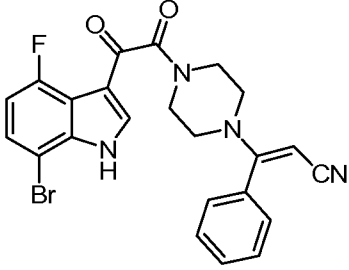
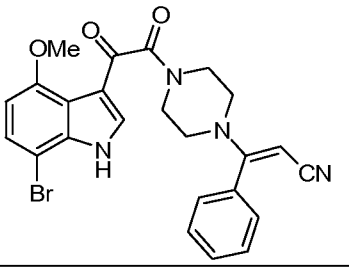
Procedure C:

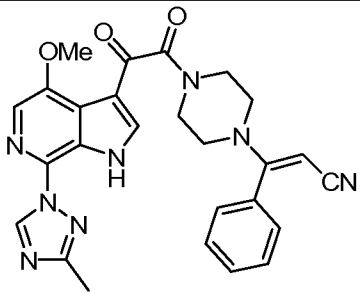
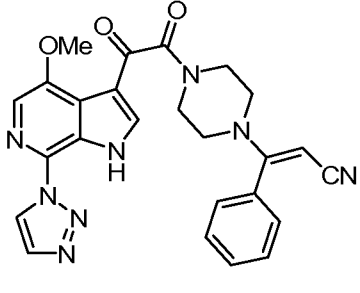
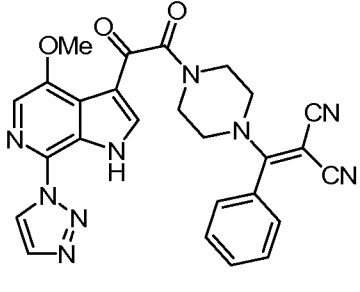


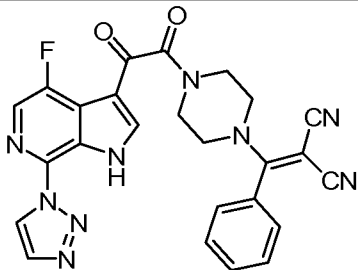
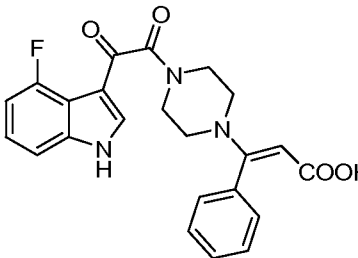
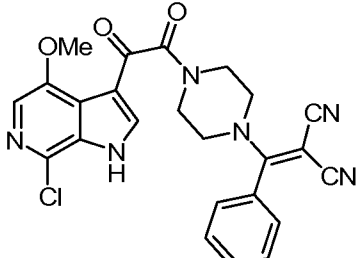
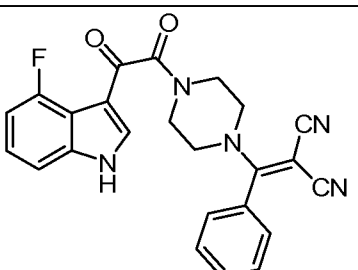
Preparation of 2-((4-(2-(1H-indol-3-yl)-2-oxoacetyl)piperazin-1-yl)(phenyl)methylene)malononitrile:
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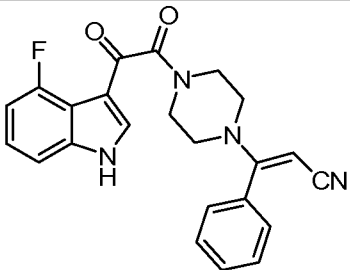
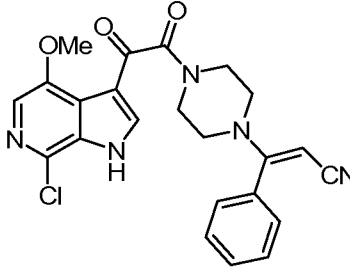
Triethyl amine (1 ml) was added into a solution of 1-(1H-indol-3-yl)-2-(piperazin-1-yl)ethane-1,2-dione (150 mg) and 2-(chloro(phenyl)methylene)malononitrile (110 mg) in EtOH (20 ml). After 16 hours
 25 at 115°C, the reaction mixture was cooled down. Then the solvents were removed to offer a residue which was purified using Shimadzu automated preparative HPLC System to afford 2-((4-(2-(1H-indol-3-yl)-2-oxoacetyl)piperazin-1-yl)(phenyl)methylene)malononitrile.

Characterization of the compounds of formula I: Table A

Compd. Number	Product's Structure	MS (M+H) ⁺ Calcd.	MS (M+H) ⁺ Observ. And Retention Time and NMR	Method Used
EN-01		385.17	385.27 Rf = 1.48min (column A)	Procedure A
EN-02		410.16	410.24 Rf = 1.43min (column A)	Procedure C
EN-03		481.07	481.22 Rf = 1.70min (column A) ¹ H NMR (500 MHz, CD ₃ OD and CDCl ₃) δ 8.17 - 7.39 (m, 8H), 6.90 (m, 1H), 3.97 (m, 2H), 3.76 (m, 2H), 3.33 (m, 2H), 3.25 (m, 2H).	Procedure A
EN-04		493.09	493.25 Rf = 1.67min (column A)	Procedure A

EN-05		497.21	497.20 Rf = 1.57min (column G)	Procedure B
EN-06		483.19	483.02 Rf = 1.43min (column A) ¹ H NMR (500 MHz, DMSO-d ₆) δ12.6 (b, 1H), 8.91(s, 1H), 8.23 (s, 1H), 8.06 (s, 1H), 7.97 (s, 1H), 7.49 (b, 5H), 7.43 (s, 1H), 4.01 (s, 3H), 5.66 (b, 2H), 3.44 (b, 2H), 3.21 (b, 2H), 3.12 (b, 2H).	Procedure B Procedure C
EN-07		508.18	508.00 Rf = 1.33min (column A) ¹ H NMR (500 MHz, DMSO-d ₆) δ12.65 (b,1H), 8.93 (s, 1H), 8.25 (s, 1H), 8.07 (s, 1H), 7.98 (s, 1H), 7.58 (b, 5H), 4.20 - 3.20 (m, 8H); ¹³ C NMR (125 MHz, DMSO-d ₆) δ185.0, 171.3, 166.1, 149.8,	Procedure C

			139.4, 133.8, 132.5, 129.2, 124.5, 122.9, 122.4, 121.2, 117.4, 116.7, 114.2, 56.9, 51.9, 50.4, 44.4.	
EN-08		496.16	496.22 R _f = 1.17min (column B, solvent system II)	Procedure B
EN-09		MW(M +Na)+ = 444.13	444.03 R _f = 1.52min (column A)	Procedure A
EN-10		475.13	475.11 R _f = 2.63min (column F) Gradient time = 3 min Flow rate = 4 ml/min	Procedure B
EN-11		428.15	428.18 R _f = 1.93min (column E) ¹ H NMR (500 MHz, DMSO-d ₆) δ12.62 (b, 1H), 8.29(s, 1H), 7.57 (b, 5H), 7.36 (m, 1H), 7.26 (m, 1H), 7.00 (m, 1H), 4.11 - 3.44 (m, 8H); ¹³ C NMR (125 MHz,	Procedure A

			DMSO-d ₆) δ 184.1, 171.4, 166.4, 156.6, 154.6, 140.1, 138.4, 132.5, 131.9, 129.2, 124.6, 117.3, 116.6, 112.5, 112.4, 109.1, 108.1, 107.9, 107.0, 52.0, 50.6, 48.6.	
EN-12		403.16	403.12 Rf = 1.97min (column E)	Procedure A
EN-13		450.13	450.11 Rf = 2.74min (column F) Gradient time = 3 min Flow rate = 4 ml/min	Procedure B

Biology

- “ μ M” means micromolar;
- 5 • “mL” means milliliter;
- “ μ l” means microliter;
- “mg” means milligram;

The materials and experimental procedures used to obtain the results reported
10 in Tables 1-2 are described below.

Cells:

- *Virus production*-Human embryonic Kidney cell line, 293T, was propagated in Dulbecco's Modified Eagle Medium (Invitrogen, Carlsbad, CA) containing 10% fetal Bovine serum (FBS, Sigma, St. Louis, MO).
- *Virus infection*- Human epithelial cell line, HeLa, expressing the HIV-1 receptor CD4 was propagated in Dulbecco's Modified Eagle Medium (Invitrogen, Carlsbad, CA) containing 10% fetal Bovine serum (FBS, Sigma, St. Louis, MO) and supplemented with 0.2 mg/mL Geneticin (Invitrogen, Carlsbad, CA).

10

Virus-Single-round infectious reporter virus was produced by co-transfecting human embryonic Kidney 293 cells with an HIV-1 envelope DNA expression vector and a proviral cDNA containing an envelope deletion mutation and the luciferase reporter gene inserted in place of HIV-1 nef sequences (Chen et al, Ref. 41). Transfections were performed using lipofectAMINE PLUS reagent as described by the manufacturer (Invitrogen, Carlsbad, CA).

15

Experiment

1. HeLa CD4 cells were plated in 96 well plates at a cell density of 1×10^4 cells per well in 100 μ l Dulbecco's Modified Eagle Medium containing 10 % fetal Bovine serum and incubated overnight.
2. Compound was added in a 2 μ l dimethylsulfoxide solution, so that the final assay concentration would be $\leq 10 \mu$ M.
3. 100 μ l of single-round infectious reporter virus in Dulbecco's Modified Eagle Medium was then added to the plated cells and compound at an approximate multiplicity of infection (MOI) of 0.01, resulting in a final volume of 200 μ l per well.

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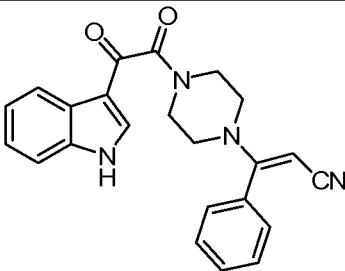
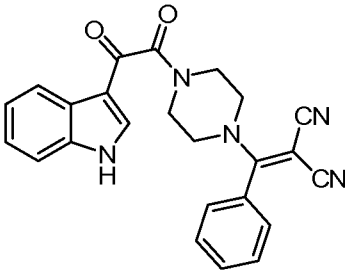
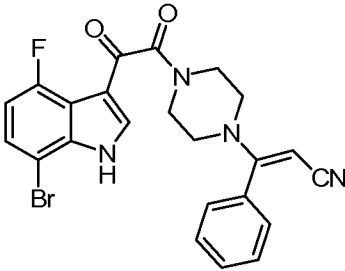
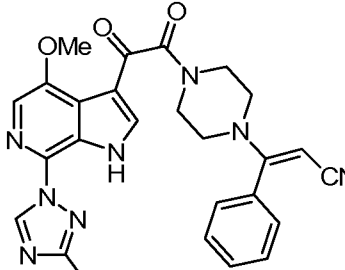
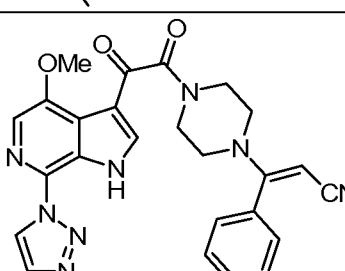
4. Virally-infected cells were incubated at 37 degrees Celsius, in a CO₂ incubator, and harvested 72 h after infection.
5. Viral infection was monitored by measuring luciferase expression from viral
5 DNA in the infected cells using a luciferase reporter gene assay kit, as described by the manufacturer (Roche Molecular Biochemicals, Indianapolis, IN). Infected cell supernatants were removed and 50 µl of lysis buffer was added per well. After 15 minutes, 50 µl of freshly-reconstituted luciferase assay reagent was added per well. Luciferase activity was then quantified by measuring
10 luminescence using a Wallac microbeta scintillation counter.
6. The percent inhibition for each compound was calculated by quantifying the level of luciferase expression in cells infected in the presence of each compound as a percentage of that observed for cells infected in the absence of compound and
15 subtracting such a determined value from 100.
7. An EC₅₀ provides a method for comparing the antiviral potency of the compounds of this disclosure. The effective concentration for fifty percent inhibition (EC₅₀) was calculated with the Microsoft Excel Xlfit curve fitting software. For each
20 compound, curves were generated from percent inhibition calculated at 10 different concentrations by using a four parameter logistic model (model 205). The EC₅₀ data for the compounds is shown in Table 2. Table 1 is the key for the data in Table 2.

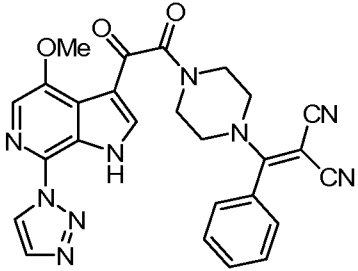
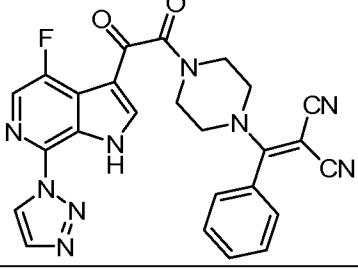
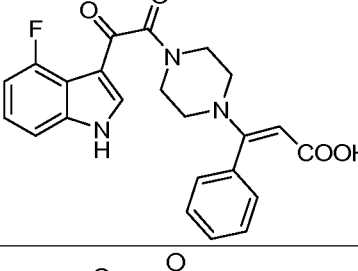
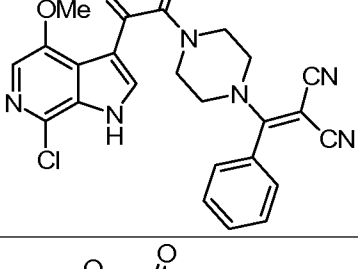
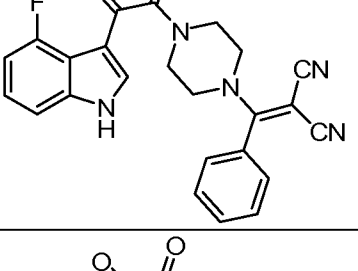
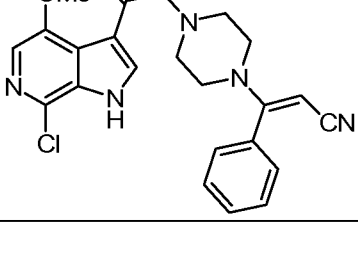
25 RESULTS

Table 1. Biological Data Key for EC₅₀s

<i>Compounds with EC₅₀s > 5 µM</i>	<i>Compounds with EC₅₀s > 1 µM but < 5 µM</i>	<i>Compounds with EC₅₀ < 1 µM</i>
Group C	Group B	Group A

Table 2

<i>Compd. Number</i>	<i>Structure</i>	<i>EC₅₀</i> <i>Group from Table 1</i>
EN-01		A
EN-02		A
EN-03		A
EN-05		A
EN-06		A

EN-07		A
EN-08		A
EN-09		A
EN-10		A
EN-11		A
EN-13		A

The compounds of the present disclosure may be administered orally, parenterally (including subcutaneous injections, intravenous, intramuscular, intrasternal injection or infusion techniques), by inhalation spray, or rectally, in dosage unit formulations containing conventional non-toxic pharmaceutically acceptable carriers, adjuvants and diluents.

Thus, in accordance with the present disclosure, there is further provided a method of treating and a pharmaceutical composition for treating viral infections such as HIV infection and AIDS. The treatment involves administering to a patient in need of such treatment a pharmaceutical composition comprising a pharmaceutical carrier and a therapeutically effective amount of a compound of the present disclosure.

The pharmaceutical composition may be in the form of orally administrable suspensions or tablets; nasal sprays, sterile injectable preparations, for example, as sterile injectable aqueous or oleagenous suspensions or suppositories.

When administered orally as a suspension, these compositions are prepared according to techniques well known in the art of pharmaceutical formulation and may contain microcrystalline cellulose for imparting bulk, alginic acid or sodium alginate as a suspending agent, methylcellulose as a viscosity enhancer, and sweeteners/flavoring agents known in the art. As immediate release tablets, these compositions may contain microcrystalline cellulose, dicalcium phosphate, starch, magnesium stearate and lactose and/or other excipients, binders, extenders, disintegrants, diluents, and lubricants known in the art.

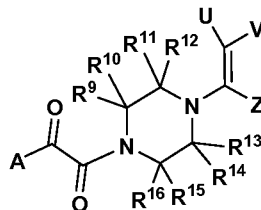
The injectable solutions or suspensions may be formulated according to known art, using suitable non-toxic, parenterally acceptable diluents or solvents, such as mannitol, 1,3-butanediol, water, Ringer's solution or isotonic sodium chloride solution, or suitable dispersing or wetting and suspending agents, such as sterile, bland, fixed oils, including synthetic mono- or diglycerides, and fatty acids, including oleic acid.

The compounds of this disclosure can be administered orally to humans in a dosage range of 1 to 100 mg/kg body weight in divided doses. One preferred dosage range is 1 to 10 mg/kg body weight orally in divided doses. Another preferred dosage range is 1 to 20 mg/kg body weight in divided doses. It will be understood,
5 however, that the specific dose level and frequency of dosage for any particular patient may be varied and will depend upon a variety of factors including the activity of the specific compound employed, the metabolic stability and length of action of that compound, the age, body weight, general health, sex, diet, mode and time of administration, rate of excretion, drug combination, the severity of the particular
10 condition, and the host undergoing therapy.

CLAIMS

What is claimed is:

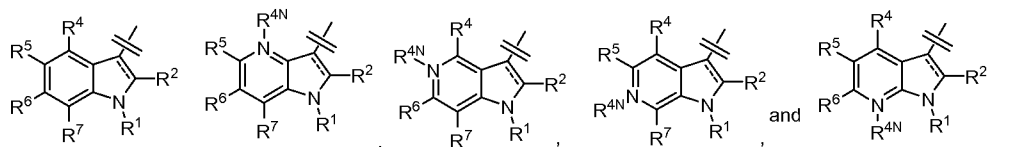
1. A compound of Formula I, or pharmaceutically acceptable salts thereof,



I

wherein:

A is selected from the group consisting of:



R¹ is hydrogen or C₁-C₄alkyl;

15 R^2 is hydrogen;

R⁴ is selected from the group consisting of hydrogen, halogen, hydroxy, and O(C₁-C₄alkyl);

20 R⁵ is hydrogen, halogen, or (C₁-C₄alkyl);

R⁶ is selected from the group consisting of hydrogen, halogen, halogen, or (C₁-C₄ alkyl);

25 R⁷ is independently selected from the group consisting of hydrogen, halogen, and B;

R^{4N} does not exist;

wherein - - represents a carbon-carbon bond or does not exist;

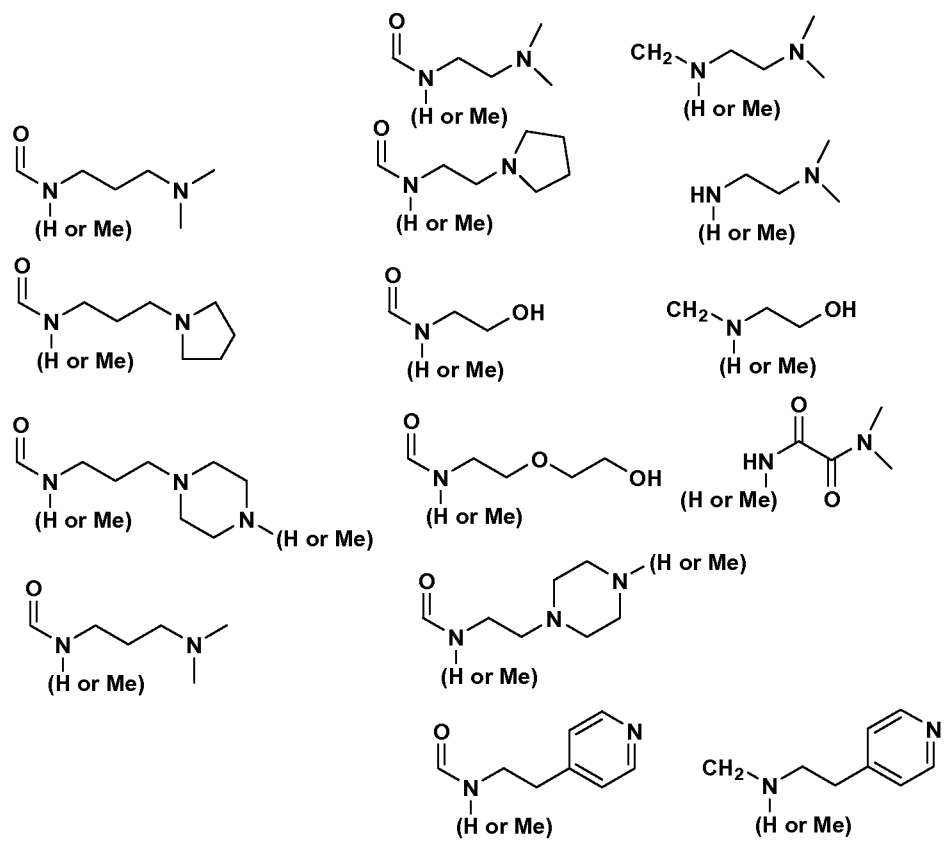
U and V are independently selected from hydrogen, cyano, COOH, phenyl or pyridyl
5 with the proviso that at least one must be cyano or COOH;

Z is selected from the group consisting of CF₃, C₄-C₇ alkyl, phenyl, C₄-C₇ cycloalkyl,
C₄-C₇ cycloalkenyl, pyridinyl, C₂-C₅ alkoxy, a 5 membered monocyclic heteroaryl
containing 1 to 2 nitrogens, an N linked 6 membered heteroalicyclic containing 1 or 2
10 nitrogens a C₄-C₆ lactam attached via the lactam nitrogen, or cyano wherein said aryl
or heteroaryl or lactam are independently optionally substituted with one to two
groups selected from halogen or C₁-C₃ alkyl;

B is selected from the group consisting of chloro, methoxy, tetrazolyl, -triazolyl,
15 pyrazolyl, imidazolyl, pyrrolyl, pyrazinyl, and XR^{8a}, wherein said are optionally
substituted with one to three same or different halogens or from one to three same or
different substituents selected from the group F;

F is selected from the group consisting of (C₁₋₃)alkyl, heteroalicyclic, hydroxymethyl,
20 halogen, -COOH, -COO(C₁₋₃)alkyl, amino, -NHCH₃, -N(CH₃)₂,

58



R^{8a} is a member selected from the group consisting of C(O)CH₃, C(O)NH₂, C(O)NHCH₃, and C(O)N(CH₃)₂;

5

R⁹, R¹⁰, R¹¹, R¹², R¹³, R¹⁴, R¹⁵, R¹⁶, are each independently selected from the group consisting of hydrogen and methyl; with the proviso that no more than two can be methyl;

10 X is selected from the group consisting of NH and NCH₃.

2. The compound of claim 1 wherein:
one of U or V is cyano and the other is either hydrogen or cyano; and
Z is phenyl.

15

3. The compound of claim 2 wherein:

B is selected from the group consisting methoxy or –triazolyl wherein said are optionally substituted with one substituent selected from the group F.

4. A pharmaceutical composition which comprises an antiviral effective amount
5 of a compound of Formula I, or pharmaceutically acceptable salts thereof, as claimed in claim 1, and one or more pharmaceutically acceptable carriers, excipients or diluents.
5. A pharmaceutical composition which comprises an antiviral effective amount
10 of a compound of Formula I, or pharmaceutically acceptable salts thereof, as claimed in claim 2, and one or more pharmaceutically acceptable carriers, excipients or diluents.
6. A pharmaceutical composition which comprises an antiviral effective amount
15 of a compound of Formula I, or pharmaceutically acceptable salts thereof, as claimed in claim 3, and one or more pharmaceutically acceptable carriers, excipients or diluents.
7. The composition of claim 4 further comprising a second compound having
20 anti-HIV activity.
8. The pharmaceutical composition of claim 4, useful for treating infection by HIV, which additionally comprises an antiviral effective amount of an AIDS treatment agent selected from the group consisting of:
25 (a) an AIDS antiviral agent;
(b) an anti-infective agent;
(c) an immunomodulator; and
(d) HIV entry inhibitors.
- 30 9. A method for treating a mammal infected with a virus comprising administering to said mammal an antiviral effective amount of a compound of Formula I, or pharmaceutically acceptable salts thereof, as claimed in claim 1, and one or more pharmaceutically acceptable carriers, excipients or diluents.

10. The method of claim 9, comprising administering to said mammal an antiviral effective amount of a compound of Formula I in combination with an antiviral effective amount of an AIDS treatment agent selected from the group consisting of: an AIDS antiviral agent; an anti-infective agent; an immunomodulator; and an HIV
5 entry inhibitor.
11. The method of claim 10 wherein said virus is HIV.