

HEPATITIS C VIRUS INHIBITORS

RELATED APPLICATION

This application is related to U.S. Provisional Application Serial No. 61/297,918
5 filed January 25, 2010 and U.S. Provisional Application Serial No. 61/314,304 filed
March 16, 2010. The entire teachings of the above applications are incorporated herein by
reference.

TECHNICAL FIELD

The present invention relates to novel antiviral agents. More specifically, the
10 present invention relates to compounds which can inhibit the function of the NS5A protein
encoded by Hepatitis C virus (HCV), compositions comprising such compounds, methods
for inhibiting HCV viral replication, methods for treating or preventing HCV infection,
and processes for making the compounds.

BACKGROUND OF THE INVENTION

15 Infection with HCV is a major cause of human liver disease throughout the world.
In the U.S., an estimated 4.5 million Americans are chronically infected with HCV.
Although only 30% of acute infections are symptomatic, greater than 85% of infected
individuals develop chronic, persistent infection. Treatment costs for HCV infection have
been estimated at \$5.46 billion for the US in 1997. Worldwide over 200 million people are
20 estimated to be infected chronically. HCV infection is responsible for 40-60% of all
chronic liver disease and 30% of all liver transplants. Chronic HCV infection accounts for
30% of all cirrhosis, end-stage liver disease, and liver cancer in the U.S. The CDC
estimates that the number of deaths due to HCV will minimally increase to 38,000/year by
the year 2010.

25 Due to the high degree of variability in the viral surface antigens, existence of
multiple viral genotypes, and demonstrated specificity of immunity, the development of a
successful vaccine in the near future is unlikely. Alpha-interferon (alone or in combination
with ribavirin) has been widely used since its approval for treatment of chronic HCV
infection. However, adverse side effects are commonly associated with this treatment: flu-
30 like symptoms, leukopenia, thrombocytopenia, depression from interferon, as well as
anemia induced by ribavirin (Lindsay, K. L. (1997) Hepatology 26 (suppl 1): 71S-77S).

This therapy remains less effective against infections caused by HCV genotype 1 (which constitutes ~75% of all HCV infections in the developed markets) compared to infections caused by the other 5 major HCV genotypes. Unfortunately, only ~50-80% of the patients respond to this treatment (measured by a reduction in serum HCV RNA levels and

5 normalization of liver enzymes) and, of responders, 50-70% relapse within 6 months of cessation of treatment. Recently, with the introduction of pegylated interferon (Peg-IFN), both initial and sustained response rates have improved substantially, and combination treatment of Peg-IFN with ribavirin constitutes the gold standard for therapy. However, the side effects associated with combination therapy and the impaired response in patients
10 with genotype 1 present opportunities for improvement in the management of this disease.

First identified by molecular cloning in 1989 (Choo, Q-L et al (1989) Science 244:359-362), HCV is now widely accepted as the most common causative agent of post-transfusion non-A, non-B hepatitis (NANBH) (Kuo, G et al (1989) Science 244:362-364).

Due to its genome structure and sequence homology, this virus was assigned as a new
15 genus in the *Flaviviridae* family. Like the other members of the *Flaviviridae*, such as flaviviruses (e.g. yellow fever virus and Dengue virus types 1-4) and pestiviruses (e.g. bovine viral diarrhea virus, border disease virus, and classic swine fever virus) (Choo, Q-L et al (1989) Science 244:359-362; Miller, R.H. and R.H. Purcell (1990) Proc. Natl. Acad. Sci. USA 87:2057-2061), HCV is an enveloped virus containing a single strand RNA
20 molecule of positive polarity. The HCV genome is approximately 9.6 kilobases (kb) with a long, highly conserved, noncapped 5' nontranslated region (NTR) of approximately 340 bases which functions as an internal ribosome entry site (IRES) (Wang CY et al 'An RNA pseudoknot is an essential structural element of the internal ribosome entry site located within the hepatitis C virus 5' noncoding region RNA – A Publication of the RNA Society.
25 l(5): 526-537, 1995 Jul.). This element is followed by a region which encodes a single long open reading frame (ORF) encoding a polypeptide of ~3000 amino acids comprising both the structural and nonstructural viral proteins.

Upon entry into the cytoplasm of the cell, this RNA is directly translated into a polypeptide of ~3000 amino acids comprising both the structural and nonstructural viral
30 proteins. This large polypeptide is subsequently processed into the individual structural and nonstructural proteins by a combination of host and virally-encoded proteinases (Rice, C.M. (1996) in B.N. Fields, D.M.Knipe and P.M. Howley (eds) Virology 2nd Edition, p931-960; Raven Press, N.Y.). There are three structural proteins, C, E1 and E2. The P7 protein is of unknown function and is comprised of a highly variable sequence. There are

several non-structural proteins. NS2 is a zinc-dependent metalloproteinase that functions in conjunction with a portion of the NS3 protein. NS3 incorporates two catalytic functions (separate from its association with NS2): a serine protease at the N-terminal end, which requires NS4A as a cofactor, and an ATP-ase-dependent helicase function at the carboxyl terminus. NS4A is a tightly associated but non-covalent cofactor of the serine protease. NS5A is a membrane-anchored phosphoprotein that is observed in basally phosphorylated (56 kDa) and hyperphosphorylated (58 kDa) forms. While its function has not fully been elucidated, NS5A is believed to be important in viral replication. The NS5B protein (591 amino acids, 65 kDa) of HCV (Behrens, S.E. *et al* (1996) *EMBO J.* 15: 2-22) encodes an RNA-dependent RNA polymerase (RdRp) activity and contains canonical motifs present in other RNA viral polymerases. The NS5B protein is fairly well conserved both intra-typically (~95-98% amino acid (aa) identity across 1b isolates) and inter-typically (~85% aa identity between genotype 1a and 1b isolates). The essentiality of the HCV NS5B RdRp activity for the generation of infectious progeny virions has been formally proven in chimpanzees (A. A. Kolykhalov *et al.* (2000) *Journal of Virology*, 74(4): 2046-2051). Thus, inhibition of NS5B RdRp activity (inhibition of RNA replication) is predicted to be useful to treat HCV infection.

Following the termination codon at the end of the long ORF, there is a 3' NTR which roughly consists of three regions: an ~40 base region which is poorly conserved among various genotypes, a variable length poly(U)/polypyrimidine tract, and a highly conserved 98 base element also called the "3' X-tail" (Kolykhalov, A. *et al* (1996) *J. Virology* 70:3363-3371; Tanaka, T. *et al* (1995) *Biochem Biophys. Res. Commun.* 215:744-749; Tanaka, T. *et al* (1996) *J. Virology* 70:3307-3312; Yamada, N. *et al* (1996) *Virology* 223:255-261). The 3' NTR is predicted to form a stable secondary structure which is essential for HCV growth in chimps and is believed to function in the initiation and regulation of viral RNA replication.

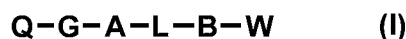
Compounds useful for treating HCV-infected patients are desired which selectively inhibit HCV viral replication. In particular, compounds which are effective to inhibit the function of the NS5A protein are desired. The HCV NS5A protein is described, for example, in Tan, S.-L., Katzel, M.G. *Virology* 2001, 284, 1; and in Rice, C. M. *Nature* 2005, 435, 374.

Based on the foregoing, there exists a significant need to identify compounds with the ability to inhibit HCV.

SUMMARY OF THE INVENTION

The present invention relates to novel antiviral compounds represented herein below, pharmaceutical compositions comprising such compounds, and methods for the treatment or prophylaxis of viral (particularly HCV) infection in a subject in need of such therapy with said compounds. Compounds of the present invention interfere with the life cycle of the hepatitis C virus and are also useful as antiviral agents.

In its principal aspect, the present invention provides a compound of Formula (I):



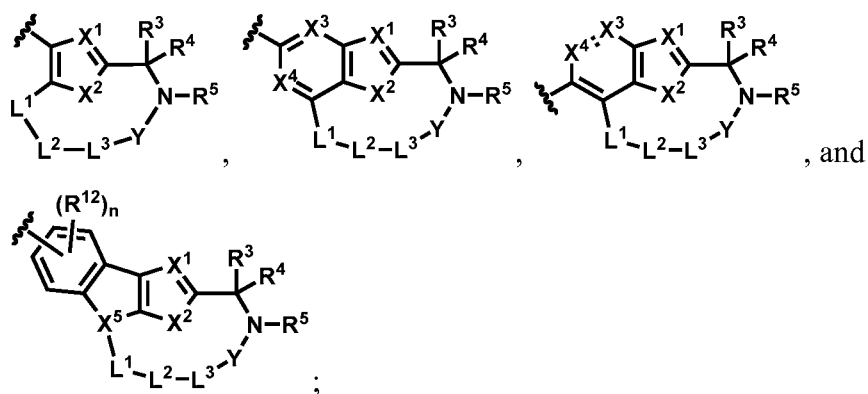
or a pharmaceutically acceptable salt thereof, wherein:

A and B are each independently absent or a monocyclic or polycyclic group independently selected from the group consisting of aryl, heteroaryl, heterocyclic, C₃-C₈ cycloalkyl and C₃-C₈ cycloalkenyl, each optionally substituted; preferably, A and B are each independently optionally substituted aryl or optionally substituted heteroaryl;

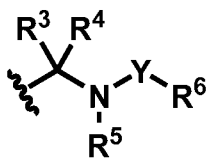
L is absent or an aliphatic group; preferably, L is selected from the group consisting of O, -NH-, -C(O)-, -C(O)NH-, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl, -(C₁-C₄ alkyl)-N(R)-(C₁-C₄ alkyl)-, and heterocyclic, each optionally substituted;

wherein at least one of A B and L is present;

W is selected from the group consisting of:

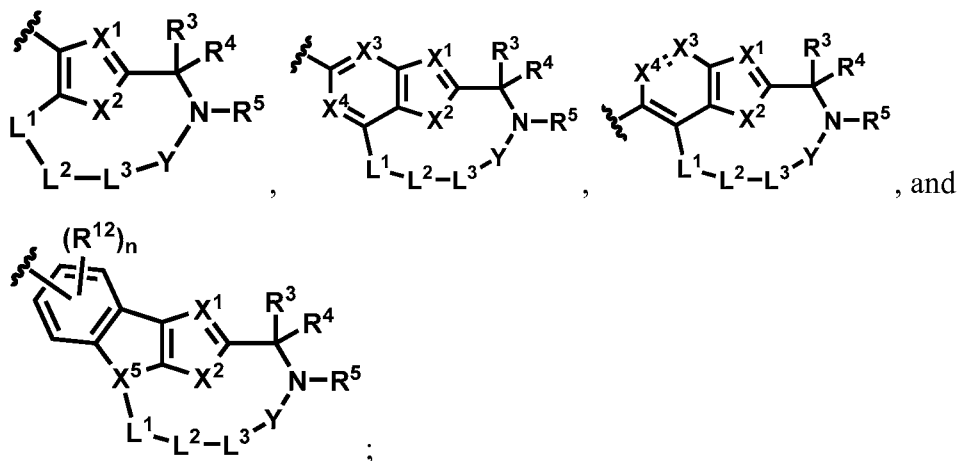


G is absent, -C(O)NH-, an optionally substituted 5-membered heteroaryl containing one or more nitrogen atoms, or an optionally substituted 5-membered heteroaryl fused to a mono- or bicyclic ring, wherein the mono- or bicyclic ring is aromatic or non-aromatic, wherein the mono- or bicyclic ring is attached to one of groups A, L and B and wherein the 5-membered heteroaryl contains one or more nitrogen atoms; preferably, G is optionally substituted imidazolyl, optionally substituted benzimidazolyl or optionally substituted imidazopyridyl;



Q is hydrogen or

Alternatively, G and Q can be taken together to form a group selected from:



- 5 X^1 at each occurrence is independently N or $C(R^{11})$; preferably, X^1 is N;
 X^2 at each occurrence is independently $N(R^1)$, O or S; preferably, X^2 is NH;
 X^3 and X^4 are each independently N or $C(R^{12})$; preferably, X^3 and X^4 are each independently CH;

- X^5 at each occurrence is independently N or linear aliphatic group containing one
 10 to three carbon atoms and zero to two heteroatoms independently selected from O, N and S; wherein the said linear aliphatic group optionally contains one or two double bonds; in another embodiment, X^5 at each occurrence is independently N, C_1 - C_3 alkylene, C_2 - C_3 alkenylene, or C_2 - C_3 alkynylene; in yet another embodiment, X^5 at each occurrence is independently C_1 - C_3 alkylene, C_2 - C_3 alkenylene, or C_2 - C_3 alkynylene;

- 15 R^1 at each occurrence is independently hydrogen, hydroxy, $O(C_1$ - C_4 alkyl) or optionally substituted C_1 - C_4 alkyl;

R^{11} at each occurrence is independently hydrogen, halogen or optionally substituted C_1 - C_4 alkyl;

- R^{12} at each occurrence is independently hydrogen, halogen, hydroxy, optionally
 20 substituted C_1 - C_4 alkyl, or $O(C_1$ - C_4 alkyl);

n is 1, 2, or 3;

L^1 and L^3 at each occurrence are each independently an aliphatic group, or one of L^1 and L^3 is absent and the other of L^1 and L^3 is an aliphatic group; preferably, L^1 and L^3

at each occurrence are each independently a linear aliphatic group, or one of L^1 and L^3 is absent and the other of L^1 and L^3 is a linear aliphatic group;

L^2 at each occurrence is independently absent, or selected from the group consisting of aryl, heteroaryl, heterocyclic, C_3 - C_8 cycloalkyl, and C_3 - C_8 cycloalkenyl, each optionally substituted;

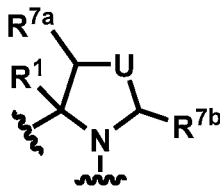
Y at each occurrence is independently $C(O)$ or $S(O)_2$; preferably, Y is $C(O)$;

wherein $-L^1-L^2-L^3-$ together form a linker; preferably, $-L^1-L^2-L^3-$ together form a linker of from 6 to 16 bond lengths;

R^3 and R^4 are each independently selected from the group consisting of hydrogen, optionally substituted C_1 - C_8 alkyl, optionally substituted C_2 - C_8 alkenyl, and optionally substituted C_3 - C_8 cycloalkyl; preferably hydrogen or optionally substituted C_1 - C_4 alkyl; alternatively, R^3 and R^4 can be taken together with the carbon atom to which they are attached to form optionally substituted C_3 - C_8 cycloalkyl or optionally substituted heterocyclic;

R^5 is independently hydrogen, optionally substituted C_1 - C_8 alkyl, or optionally substituted C_3 - C_8 cycloalkyl; preferably hydrogen or optionally substituted C_1 - C_4 alkyl;

Alternatively R^3 , R^4 and R^5 are taken together with the carbon atom and nitrogen



atom to which they are attached to form

U is absent or independently selected from O, S, $S(O)$, SO_2 , $NC(O)-(C_1-C_4 \text{ alkyl})$, $C(O)$, protected carbonyl, OCH_2 , OCH_2CH_2 , SCH_2 , SCH_2CH_2 , $C(R^7)_2$, $C(R^7)_2C(R^7)_2$, and $C=C(R^2)_2$; preferably CH_2 , $C=N-OMe$, or $C=CH_2$;

R^2 at each occurrence is independently hydrogen, halogen, optionally substituted C_1 - C_4 alkyl, optionally substituted aryl, or optionally substituted heteroaryl;

R^7 at each occurrence is independently selected from the group consisting of hydrogen, halogen, cyano, hydroxy, $O(C_1-C_4 \text{ alkyl})$, $S(C_1-C_4 \text{ alkyl})$, amino optionally substituted with one or two C_1 - C_4 alkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted C_1 - C_4 alkyl, and optionally substituted C_3 - C_8 cycloalkyl; preferably, R^7 is hydrogen, halogen, methyl, or cyclopropyl;

Alternatively two geminal R^7 groups are taken together with the carbon atom to which they are attached to form a spiro, optionally substituted 3- to 7-membered cyclic group selected from the group consisting of C_3 - C_7 cycloalkyl, C_3 - C_7 cycloalkenyl or 3- to

7-membered heterocyclic ring; preferably, R⁷ is spiro and optionally substituted cyclopropyl;

R^{7a} and R^{7b} at each occurrence are each independently selected from the group consisting of hydrogen, optionally substituted aryl, optionally substituted C₁-C₄ alkyl, and
5 optionally substituted C₃-C₈ cycloalkyl; preferably, R^{7a} and R^{7b} at each occurrence are each independently hydrogen, cyclopropyl, or methyl;

Alternatively, CHR^{7a}-U or CHR^{7b}-U are taken together to form a group selected from CH=CH, fused and optionally substituted C₃-C₈ cycloalkyl, fused and optionally substituted aryl, or fused and optionally substituted heterocyclic; preferably, CHR^{7a}-U or
10 CHR^{7b}-U are taken together to form a fused and optionally substituted cyclopropyl;

Yet alternatively, U, R^{7a}, and R^{7b} are taken together with the carbon atoms to which they are attached to form a bridged, optionally substituted 4- to 7-membered cyclic group selected from the group consisting of C₄-C₇ cycloalkyl, C₄-C₇ cycloalkenyl and 4- to 7-membered heterocyclic; preferably, U, R^{7a}, and R^{7b} are taken together with the carbon
15 atoms to which they are attached to form a bridged cyclopentyl; and

R⁶ at each occurrence is independently selected from the group consisting of O(C₁-C₈ alkyl), amino, C₁-C₈ alkyl, C₂-C₈ alkenyl, C₂-C₈ alkynyl, C₃-C₈ cycloalkyl, C₃-C₈ cycloalkenyl, heterocyclic, aryl, and heteroaryl, each optionally substituted; preferably, R⁶ at each occurrence is independently optionally substituted C₁-C₈ alkyl; more preferably, R⁶
20 at each occurrence is independently C₁-C₈ alkyl optionally substituted with amino, hydroxy, protected amino or O(C₁-C₄ alkyl).

Each preferred group stated above can be taken in combination with one, any or all other preferred groups.

In another aspect, the present invention provides a pharmaceutical composition
25 comprising a therapeutically effective amount of a compound or combination of compounds of the present invention, or a pharmaceutically acceptable salt thereof, in combination with a pharmaceutically acceptable carrier or excipient.

In yet another aspect, the present invention provides a method of inhibiting the replication of a RNA-containing virus comprising contacting said virus with a
30 therapeutically effective amount of a compound or a combination of compounds of the present invention, or a pharmaceutically acceptable salt thereof. Particularly, this invention is directed to methods of inhibiting the replication of HCV.

In still another aspect, the present invention provides a method of treating or preventing infection caused by an RNA-containing virus comprising administering to a

patient in need of such treatment a therapeutically effective amount of a compound or combination of compounds of the present invention, or a pharmaceutically acceptable salt thereof. Particularly, this invention is directed to methods of treating or preventing infection caused by HCV.

5 Yet another aspect of the present invention provides the use of a compound or combination of compounds of the present invention, or a therapeutically acceptable salt thereof, as defined hereinafter, in the preparation of a medicament for the treatment or prevention of infection caused by RNA-containing virus, specifically HCV.

DETAILED DESCRIPTION OF THE INVENTION

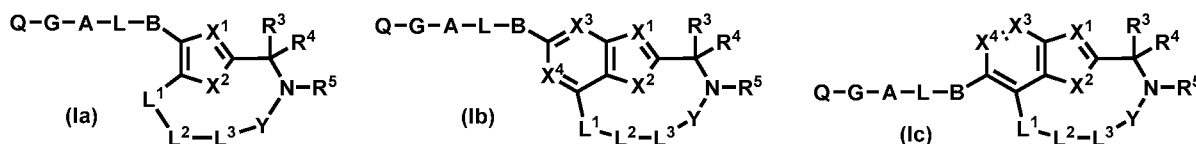
10 The present invention relates to compounds of Formula (I) as illustrated above, or a pharmaceutically acceptable salt thereof.

The compounds of the invention have utility in inhibiting the replication of RNA-containing virus, including, for example, HCV. Other compounds useful for inhibiting the replication of RNA-containing viruses and/or for the treatment or prophylaxis of HCV infection have been described in copending U.S. Application Serial No. 12/702,673 filed February 9, 2010 entitled "Linked Dibenzimidazole Derivatives"; U.S. Application Serial No. 12/702,692 filed February 9, 2010 entitled "Linked Dibenzimidazole Derivatives"; U.S. Application Serial No. 12/702,802 filed February 9, 2010 entitled "Linked Dibenzimidazole Derivatives"; U.S. Application Serial No. 12/707,190 filed February 17, 2010 entitled "Linked Diimidazole Antivirals"; U.S. Application Serial No. 12/707,200 filed February 17, 2010 entitled "Linked Diimidazole Derivatives"; U.S. Application Serial No. 12/707,210 filed February 17, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/714,583 filed March 1, 2010 entitled "Novel Benzimidazole Derivatives"; and U.S. Application Serial No. 12/714,576 filed March 1, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/816,148 filed June 15, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/816,171 filed June 15, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/879,025 filed September 10, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/879,026 filed September 10, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/879,027 filed September 10, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/879,028 filed September 10, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/879,029 filed September 10, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/879,031

filed September 10, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Application Serial No. 12/967,486 filed December 14, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Provisional Application Serial No. 61/322,438 filed April 9, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Provisional Application Serial No. 61/351,327 filed June 4, 2010
 5 entitled "Hepatitis C Virus Inhibitors"; U.S. Provisional Application Serial No. 61/372,999 filed August 12, 2010 entitled "Hepatitis C Virus Inhibitors"; U.S. Provisional Application Serial No. 61/415,447 filed November 19, 2010 entitled "Hepatitis C Virus Inhibitors"; and the contents of each of which are expressly incorporated by reference herein.

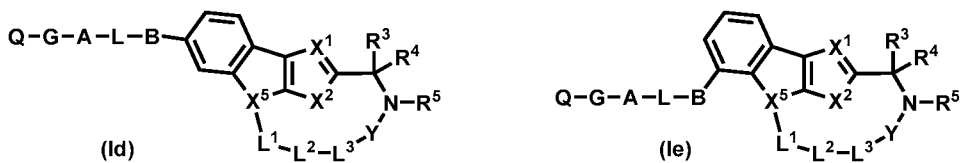
10 As discussed above, a general strategy for the development of antiviral agents is to inactivate virally encoded proteins, including NS5A, that are essential for the replication of the virus. The relevant patent disclosures describing the synthesis of HCV NS5A inhibitors are: US 2009/0202478; US 2009/0202483; US 2010/0233120; US 2010/0260708; WO 2004/014852; WO 2006/079833; WO 2006/133326; WO
 15 2007/031791; WO 2007/070556; WO 2007/070600; WO 2007/082554; WO 2008/021927; WO 2008/021928; WO 2008/021936; WO 2008/048589; WO 2008/064218; WO 2008/070447; WO 2008/144380; WO 2008/154601; WO 2009/020825; WO 2009/020828; WO 2009/034390; WO 2009/102318; WO 2009/102325; WO 2009/102694; WO 2010/017401; WO 2010/039793; WO 2010/065668; WO 2010/065674; WO 2010/065681; WO 2010/091413; WO 2010/096777; WO 2010/096462; WO 2010/096302; WO2010/099527; WO 2010/111483; WO 2010/111534; WO 2010/117635; WO 2010/111673; WO 2010/117704; WO 2010/132538; WO 2010/132601; WO 2010/138488; WO 2010/138368; WO 2010/138790; WO 2010/138791; and WO 2010/148006, the contents of each of which are expressly incorporated by reference herein.

25 In one embodiment, the present invention relates to compounds represented by Formula (Ia), (Ib) or (Ic), and pharmaceutically acceptable salts thereof:



wherein A, B, G, L, Q, Y, L¹, L², L³, X¹, X², X³, X⁴, R³, R⁴, and R⁵ are as previously
 30 defined.

In an additional embodiment, the present invention relates to compounds represented by Formula (Id) or (Ie), and pharmaceutically acceptable salts thereof:



wherein A, B, G, L, Q, Y, L^1 , L^2 , L^3 , X^1 , X^2 , X^5 , R^3 , R^4 , and R^5 are as previously defined.

5 In one embodiment, the present invention relates to compounds of Formulas (I) and (Ia ~ Ie), and pharmaceutically acceptable salts thereof, wherein L is absent or selected from the group consisting of optionally substituted C_1 - C_4 alkyl, optionally substituted C_2 - C_4 alkenyl, and optionally substituted C_2 - C_4 alkynyl.

10 In yet another embodiment, the present invention relates to compounds of Formulae (Ia ~ Ie), and pharmaceutically acceptable salts thereof; wherein X^1 is N, X^2 is NH, and X^3 and X^4 are CH.

In yet another embodiment, the present invention relates to compounds of Formula (Ib) or Formula (Ic), and pharmaceutically acceptable salts thereof; wherein X^1 is N, X^2 is O or S, X^3 and X^4 are CH.

15 In yet another embodiment, the present invention relates to compounds of Formula (Ia), (Id) or (Ie), and pharmaceutically acceptable salts thereof; wherein X^1 is N and X^2 is O or S.

20 In yet another embodiment, the present invention relates to compounds of Formula (Ib) or (Ic), and pharmaceutically acceptable salts thereof; wherein X^1 is N, X^2 is NH, X^3 is N, and X^4 is N or CH.

In yet another embodiment, the present invention relates to compounds of Formula (Ib) or (Ic), and pharmaceutically acceptable salts thereof; wherein X^1 is N, X^2 is NH, X^3 is CH, and X^4 is N.

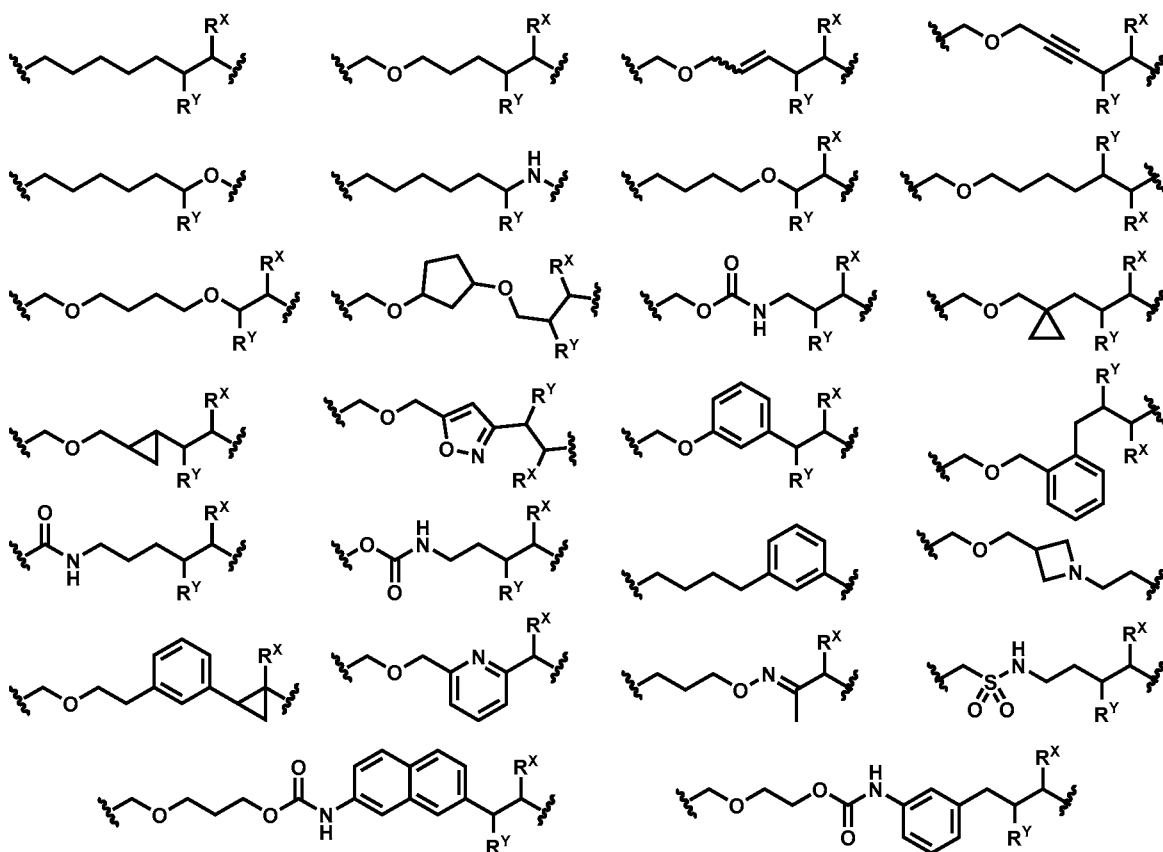
25 In yet another embodiment, the present invention relates to compounds of Formula (Ia ~ Ie), and pharmaceutically acceptable salts thereof; wherein L^1 and L^3 at each occurrence are each independently a linear aliphatic group, or one of L^1 and L^3 at each occurrence is a linear aliphatic group and the other of L^1 and L^3 is absent.

30 In yet another embodiment, the present invention relates to compounds of Formula (Ia ~ Ie) and pharmaceutically acceptable salts thereof; wherein one of L^1 and L^3 is a linear aliphatic group, and the other of L^1 and L^3 is an aliphatic group containing an optionally substituted cycloalkyl, heterocyclic or cycloalkenyl.

In yet another embodiment, the present invention relates to compounds of Formulae (**Ia ~ Ie**), and pharmaceutically acceptable salts thereof; wherein the linker $-L^1-L^2-L^3-$ is a linear aliphatic group and wherein said linker is from 8 to 14 bond lengths.

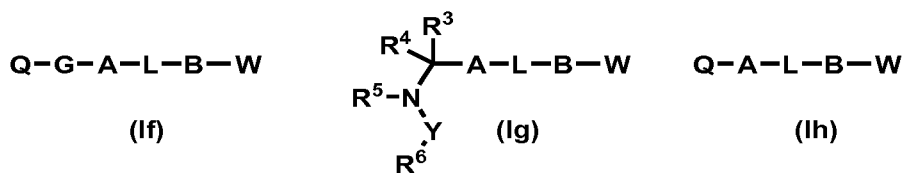
- 5 In yet another embodiment, the present invention relates to compounds of Formulae (**Ia ~ Ie**), and pharmaceutically acceptable salts thereof; wherein the linker $-L^1-L^2-L^3-$ together is a combination of a linear aliphatic group(s) and a cyclic group, and wherein said linker is from 8 to 16 bond lengths. In another aspect of the invention, $-L^1-L^2-L^3-$ together form a linker of from 8 to 12 bond lengths.

- 10 In still another embodiment, the present invention relates to compounds of Formulae (**Ia ~ Ie**), and pharmaceutically acceptable salts thereof; wherein the linker $-L^1-L^2-L^3-$ is selected from the following groups:



- 15 wherein R^X is hydrogen, amino, hydroxy, protected amino or $O(C_1-C_4 \text{ alkyl})$; R^Y is hydrogen, C_1-C_8 alkyl, C_2-C_8 alkenyl, C_2-C_8 alkynyl, C_3-C_8 cycloalkyl, C_3-C_8 cycloalkenyl, heterocyclic, aryl, or heteroaryl, each optionally substituted; preferably optionally substituted C_1-C_8 alkyl; and wherein each of the above shown groups is further optionally substituted.

In yet another embodiment, the present invention relates to compounds of Formula (If), (Ig) or (Ih), and pharmaceutically acceptable salts thereof:



wherein A, B, L, W, Y, R³, R⁴, R⁵, and R⁶ are as previously defined; G in Formula (If) is present and as previously defined; in Formula (If) and (Ih), Q is hydrogen.

In yet another embodiment, the present invention relates to compounds of Formula (Ih), and pharmaceutically acceptable salts thereof; wherein one of A, B and L is absent, and the other two of A, B and L are present and as previously defined.

In yet an additional embodiment, the present invention relates to compounds of Formula (If) and (Ig), and pharmaceutically acceptable salts thereof; wherein one of A, B and L is absent, and the other two of A, B and L are present and as previously defined.

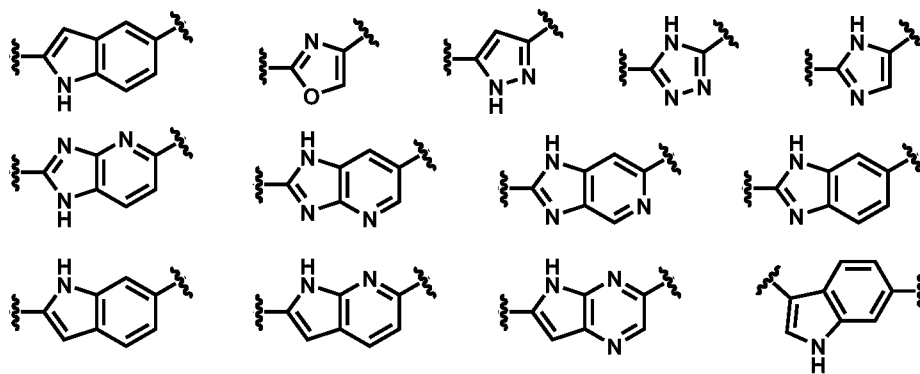
In yet another embodiment, the present invention relates to compounds of Formula (Ih), and pharmaceutically acceptable salts thereof; wherein two of A, B and L are absent, and the other one of A, B and L is present and as previously defined.

In yet another embodiment, the present invention relates to compounds of Formula (Ih), and pharmaceutically acceptable salts thereof; wherein each of A, B and L are present and as previously defined.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ If), and pharmaceutically acceptable salts thereof; wherein G is optionally substituted five-membered heteroaryl containing one or more nitrogen atoms, and is each C-attached to Q and to one of groups A, L and B.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ If), and pharmaceutically acceptable salts thereof; wherein G is optionally substituted 5/6-membered ring fused heteroaryl, wherein the 5-membered ring of said 5/6-membered fused heteroaryl is a heteroaryl containing one or more nitrogen atoms and wherein the 5-membered ring is C-attached, and wherein the 6-membered ring of said 5/6-membered fused heteroaryl is aryl or heteroaryl and is C-attached to one of groups A, L and B.

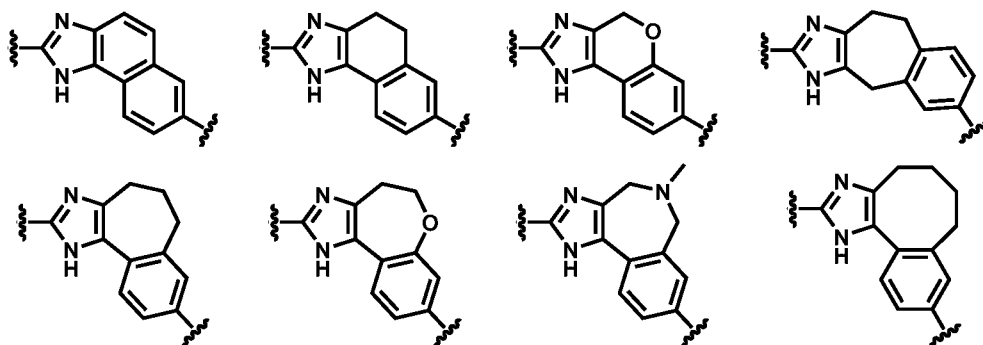
In still another embodiment, the present invention relates to compounds of Formula (I), (Ia ~ If), and pharmaceutically acceptable salts thereof; wherein G is illustrated by the following heteroaryl groups:



wherein each of the above shown heteroaryl groups is optionally substituted.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ If), and pharmaceutically acceptable salts thereof; wherein G is optionally substituted imidazolyl, benzimidazolyl or imidazopyridyl.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ If), and pharmaceutically acceptable salts thereof; wherein G is selected from the following heteroaryl groups:



wherein each of the above shown heteroaryl groups is optionally substituted.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L is a linear aliphatic group, A and B are each independently optionally substituted phenyl, monocyclic heteroaryl, naphthyl, or bicyclic heteroaryl.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L is a linear aliphatic group, A and B are each independently optionally substituted phenyl.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein A and B are each independently optionally substituted phenyl; L is $-\text{CH}_2\text{N}(\text{R})\text{CH}_2-$, wherein R is optionally substituted aryl or heteroaryl; preferably, optionally, A and B are each optionally substituted phenyl.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L is an optionally substituted heterocyclic, A and B are each independently optionally substituted phenyl, monocyclic heteroaryl, naphthyl, or bicyclic heteroaryl.

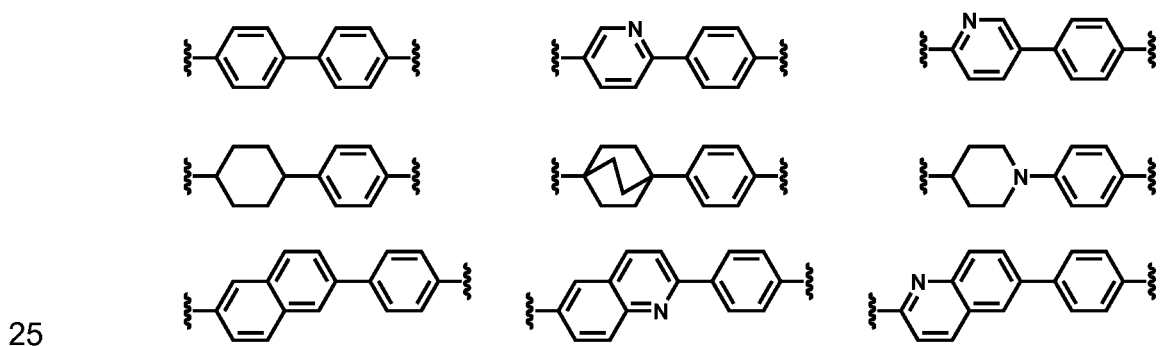
5 In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein A and B are each independently optionally substituted phenyl; L is a pyrrolidinyl group substituted with a phenyl or heteroaryl, wherein said phenyl or heteroaryl may be optionally further substituted.

10 In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L is absent, A and B are each independently optionally substituted phenyl, monocyclic heteroaryl, naphthyl, or bicyclic heteroaryl.

In still another embodiment, the present invention relates to compounds of
15 Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L is absent, one of A and B is a C₃-C₈ cycloalkyl, and the other of A and B is an optionally substituted aryl or heteroaryl.

In still another embodiment, the present invention relates to compounds of
20 Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L is absent, one of A and B is a heterocyclic, and the other of A and B is an optionally substituted aryl or heteroaryl.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L is absent, A and B are taken together to form a linker selected from the following groups:

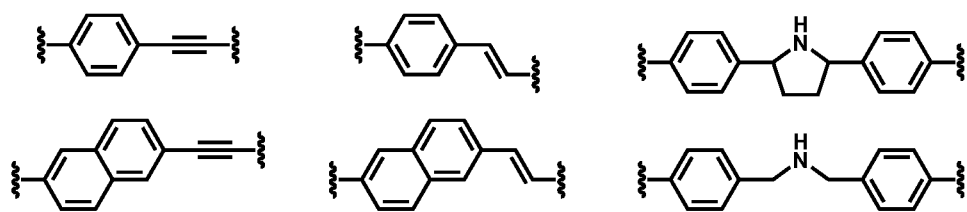


wherein each of the above shown cyclic groups is optionally substituted.

In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein L

is optionally substituted C₂-C₄ alkenyl or optionally substituted C₂-C₄ alkynyl; and wherein one of A and B is absent, and the other of A and B is independently optionally substituted phenyl, monocyclic heteroaryl, naphthyl, or bicyclic heteroaryl.

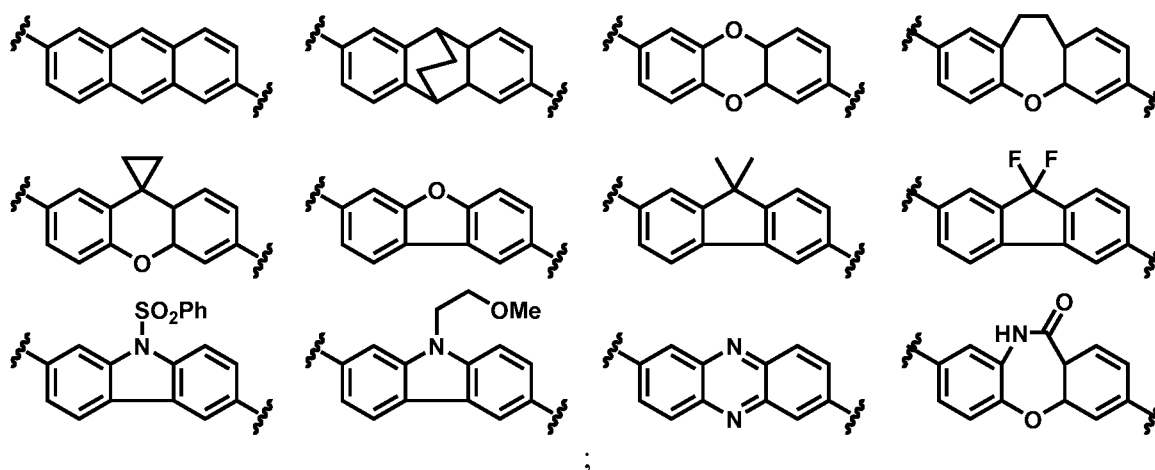
- 5 In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein A, L and B are taken together to form a linker selected from the following groups:



wherein each of the above shown groups is optionally substituted.

- 10 In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein A and L are each absent, and B is a fused polycyclic aryl or heteroaryl.

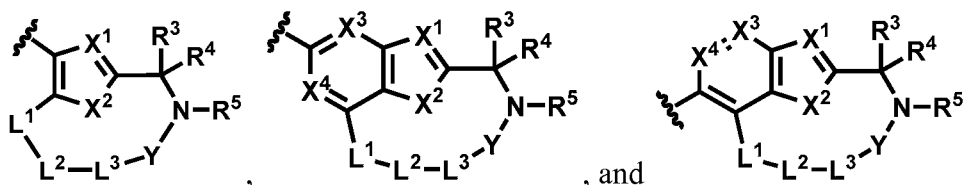
- 15 In still another embodiment, the present invention relates to compounds of Formula (I), Formulae (Ia ~ Ih), and pharmaceutically acceptable salts thereof; wherein A and L are each absent, and B is a fused polycyclic aryl or heteroaryl selected from the following groups:



wherein each of the above shown cyclic groups is optionally substituted.

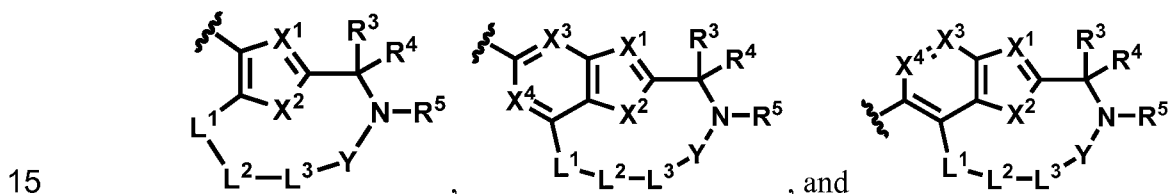
- 20 In one aspect, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein L is absent or selected from the group consisting of O, C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl. In yet another aspect, the invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein L is absent or selected from the group consisting of C₁-C₄ alkyl, C₂-C₄ alkenyl, C₂-C₄ alkynyl.

In yet another aspect, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein W is selected from the group consisting of:



5 In an additional embodiment, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein G is absent or an optionally substituted 5-membered heteroaryl containing one or more nitrogen atoms or an optionally substituted 5/6-membered fused heteroaryl, wherein the 5-membered ring of said 5/6-membered fused heteroaryl contains one or more nitrogen atoms and is attached to group Q, and wherein the 6-membered ring of said 5/6-membered fused heteroaryl is attached one of groups A, L and B and is aryl or heteroaryl.

In yet an additional embodiment, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein G and Q can be taken together to form a group selected from:



In a further aspect, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein R¹ at each occurrence is independently hydrogen, or optionally substituted C₁-C₄ alkyl.

20 In an additional embodiment, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein R⁷ at each occurrence is independently selected from the group consisting of hydrogen, halogen, cyano, hydroxy, O(C₁-C₄ alkyl), S(C₁-C₄ alkyl), amino optionally substituted with one or two C₁-C₄ alkyl, optionally substituted aryl, and optionally substituted heteroaryl, optionally substituted C₁-C₄ alkyl.

25 In yet an additional embodiment, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein R^{7a} and R^{7b} at each occurrence are each independently selected from the group consisting of hydrogen, optionally substituted aryl, and optionally substituted C₁-C₄ alkyl.

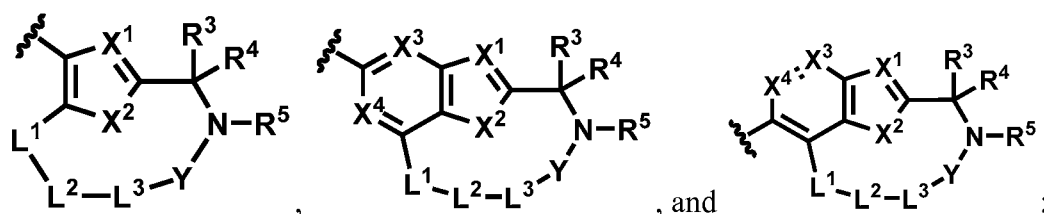
In an additional embodiment, the present invention relates to compounds of Formula (I), and pharmaceutically acceptable salts thereof, wherein:

A and B are each independently absent or a monocyclic or polycyclic group independently selected from the group consisting of aryl, heteroaryl, heterocyclic, C₃-C₈ cycloalkyl, and C₃-C₈ cycloalkenyl, each optionally substituted;

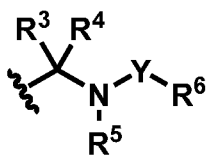
L is absent or selected from the group consisting of O, optionally substituted C₁-C₄ alkyl, optionally substituted C₂-C₄ alkenyl, and optionally substituted C₂-C₄ alkynyl; in yet another embodiment, L is absent or selected from the group consisting of optionally substituted C₁-C₄ alkyl, optionally substituted C₂-C₄ alkenyl, and optionally substituted C₂-C₄ alkynyl;

wherein at least one of A, B and L is present;

W is selected from the group consisting of:

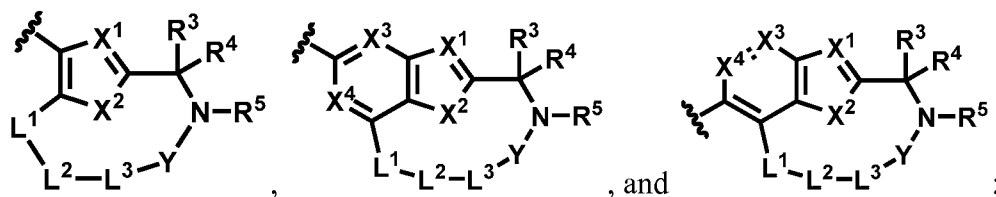


G is absent or an optionally substituted 5-membered heteroaryl containing one or more nitrogen atoms or optionally substituted 5/6-membered fused heteroaryl, wherein the 5-membered ring of said 5/6-membered fused heteroaryl contains one or more nitrogen atoms and is attached to group Q, and wherein the 6-membered ring of said 5/6-membered fused heteroaryl is attached to one of groups A, L and B and is aryl or heteroaryl; preferably optionally substituted imidazolyl, optionally substituted benzimidazolyl or optionally substituted imidazopyridyl;



Q is hydrogen or

Alternatively, G and Q can be taken together to form a group selected from:



X¹ at each occurrence is independently N or C(R¹¹);

X² at each occurrence is independently N(R¹), O or S;

X^3 and X^4 are each independently selected from N or $C(R^{12})$;

R^1 at each occurrence is independently hydrogen or optionally substituted C_1 - C_4 alkyl;

R^{11} at each occurrence is independently hydrogen, halogen or optionally substituted

5 C_1 - C_4 alkyl;

R^{12} at each occurrence is independently hydrogen, halogen, hydroxy, optionally substituted C_1 - C_4 alkyl, or $O(C_1$ - C_4 alkyl).

L^1 and L^3 at each occurrence are each independently an aliphatic group; in another embodiment, L^1 and L^3 at each occurrence are each independently a linear aliphatic group

10 L^2 at each occurrence is independently absent, or selected from the group consisting of aryl, heteroaryl, heterocyclic, C_3 - C_8 cycloalkyl, and C_3 - C_8 cycloalkenyl, each optionally substituted;

Y at each occurrence is independently $C(O)$ or $S(O)_2$;

wherein $-L^1-L^2-L^3-$ together form a linker of preferably from 6 to 16 bond lengths;

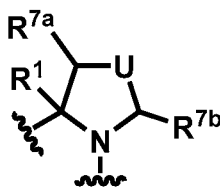
15 in another aspect, $-L^1-L^2-L^3-$ together form a linker of preferably from 6 to 12 bond lengths

R^3 and R^4 are each independently selected from the group consisting of hydrogen, optionally substituted C_1 - C_8 alkyl, optionally substituted C_2 - C_8 alkenyl, and optionally substituted C_3 - C_8 cycloalkyl; preferably hydrogen or optionally substituted C_1 - C_4 alkyl;

20 alternatively, R^3 and R^4 can be taken together with the carbon atom to which they are attached to form optionally substituted C_3 - C_8 cycloalkyl or optionally substituted heterocyclic;

R^5 is independently hydrogen, optionally substituted C_1 - C_8 alkyl, or optionally substituted C_3 - C_8 cycloalkyl; preferably hydrogen or optionally substituted C_1 - C_4 alkyl;

25 Alternatively R^3 , R^4 and R^5 are taken together with the carbon atom and nitrogen



atom to which they are attached to form

U is absent or independently selected from O, S, $S(O)$, SO_2 , $NC(O)-(C_1-C_4$ alkyl), $C(O)$, protected carbonyl, OCH_2 , OCH_2CH_2 , SCH_2 , SCH_2CH_2 , $C(R^7)_2$, $C(R^7)_2C(R^7)_2$, or $C=C(R^2)_2$; preferably CH_2 , $C=N-OMe$, or $C=CH_2$;

30 R^2 at each occurrence is independently hydrogen, halogen, optionally substituted C_1 - C_4 alkyl, optionally substituted aryl, or optionally substituted heteroaryl;

R^7 at each occurrence is independently selected from the group consisting of hydrogen, halogen, cyano, hydroxy, $O(C_1-C_4 \text{ alkyl})$, $S(C_1-C_4 \text{ alkyl})$, amino optionally substituted with one or two $C_1-C_4 \text{ alkyl}$, optionally substituted aryl, optionally substituted heteroaryl, and optionally substituted $C_1-C_4 \text{ alkyl}$;

- 5 Alternatively two geminal R^7 groups are taken together with the carbon atom to which they are attached to form a spiro, optionally substituted 3- to 7-membered cycloalkyl, cycloalkenyl or heterocyclic ring;

R^{7a} and R^{7b} at each occurrence are each independently selected from the group consisting of hydrogen, optionally substituted aryl, and optionally substituted $C_1-C_4 \text{ alkyl}$;

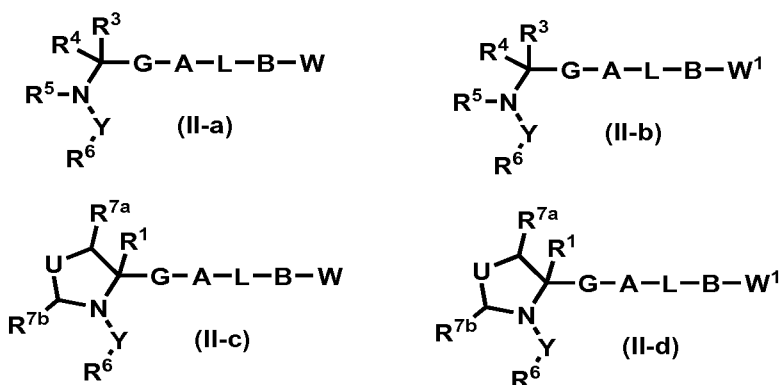
- 10 Alternatively, $CHR^{7a}-U$ or $CHR^{7b}-U$ are taken together to form a group selected from $CH=CH$, fused and optionally substituted $C_3-C_8 \text{ cycloalkyl}$, fused and optionally substituted aryl, or fused and optionally substituted heterocyclic;

Yet alternatively, U , R^{7a} , and R^{7b} are taken together with the carbon atoms to which they are attached to form a bridged, optionally substituted 4- to 7-membered ring

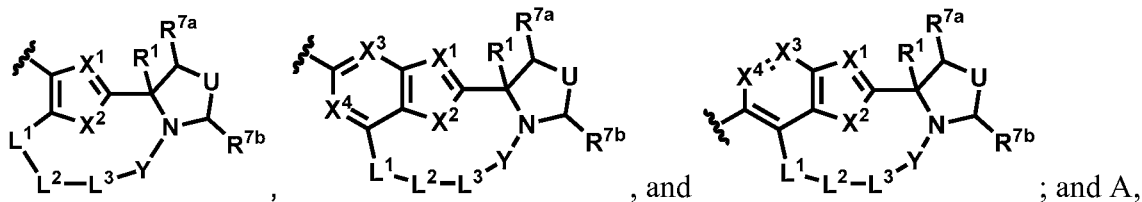
15 including cycloalkyl, cycloalkenyl and heterocyclic; and

- R^6 at each occurrence is independently selected from the group consisting of $O(C_1-C_8 \text{ alkyl})$, amino, $C_1-C_8 \text{ alkyl}$, $C_2-C_8 \text{ alkenyl}$, $C_2-C_8 \text{ alkynyl}$, $C_3-C_8 \text{ cycloalkyl}$, $C_3-C_8 \text{ cycloalkenyl}$, heterocyclic, aryl, and heteroaryl, each optionally substituted; preferably optionally substituted $C_1-C_8 \text{ alkyl}$; more preferably $C_1-C_8 \text{ alkyl}$ optionally substituted with
- 20 amino, hydroxy, protected amino or $O(C_1-C_4 \text{ alkyl})$.

In still another embodiment, the present invention relates to compounds of Formulae (II-a ~ II-d), or a pharmaceutically acceptable salt thereof;



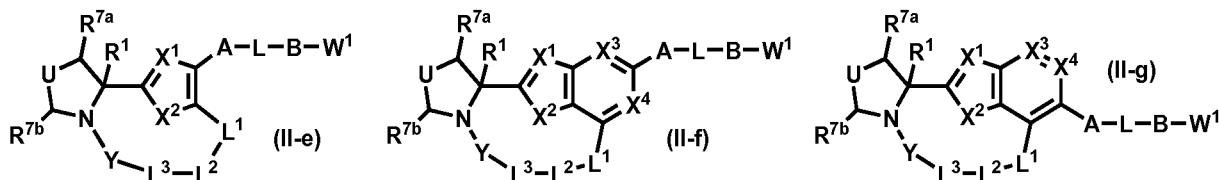
wherein W^1 is independently selected from the group consisting of:



B, G, L, U, W, Y, X^1 , X^2 , X^3 , X^4 , R^1 , R^3 , R^4 , R^5 , R^6 , R^{7a} , and R^{7b} are as previously defined.

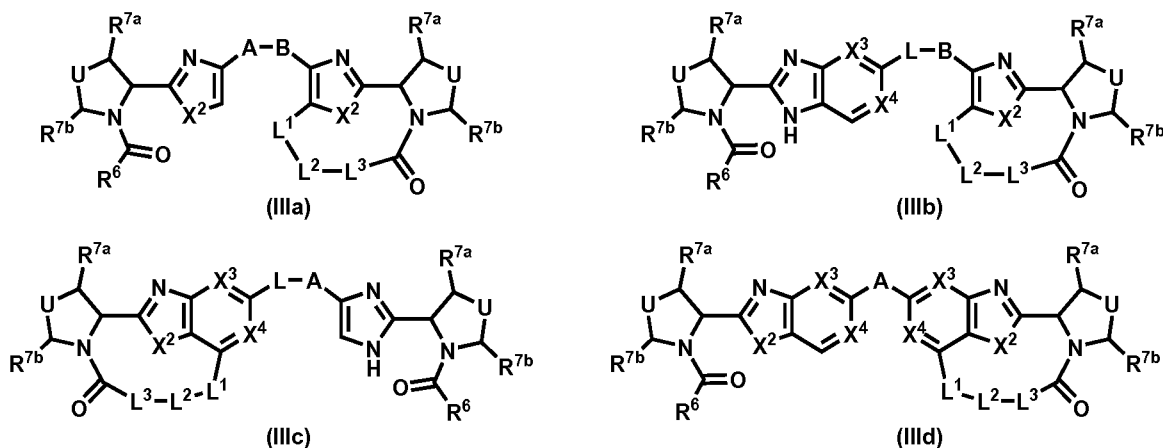
- In still another embodiment, the present invention relates to compounds of
 5 Formulae (II-a ~ II-d), or a pharmaceutically acceptable salt thereof; wherein Y is C(O); R^6 is C_1 - C_8 alkyl optionally substituted with amino, hydroxy, protected amino or O(C_1 - C_4 alkyl).

In still another embodiment, the present invention relates to compounds of
 Formulae (II-e ~ II-g), or a pharmaceutically acceptable salt thereof;



wherein A, B, L, U, W, W^1 , Y, L^1 , L^2 , L^3 , X^1 , X^2 , X^3 , X^4 , R^1 , R^{7a} , and R^{7b} are as previously defined.

- In still another embodiment, the present invention relates to compounds of
 15 Formulae (IIIa ~ IIId), or a pharmaceutically acceptable salt thereof;



wherein U, X^2 , X^3 , X^4 , R^{7a} , and R^{7b} are as previously defined; R^6 is C_1 - C_8 alkyl optionally substituted with amino, hydroxy, protected amino, or O(C_1 - C_4 alkyl); in Formula (IIIa), A and B are each independently phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IIIb) and (IIIc), L is O, optionally

substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl; in Formula (IIIb), B is phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IIIc) and (IIId), A is phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IIIa), (IIIb), (IIIc) and (IIId), the linker -L¹-L²-L³- is from 6 to 16, preferably, 6 to 14 bond lengths. In yet another aspect, L is optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl; and the linker -L¹-L²-L³- is from 6 to 12, preferably, 8 to 12 bond lengths.

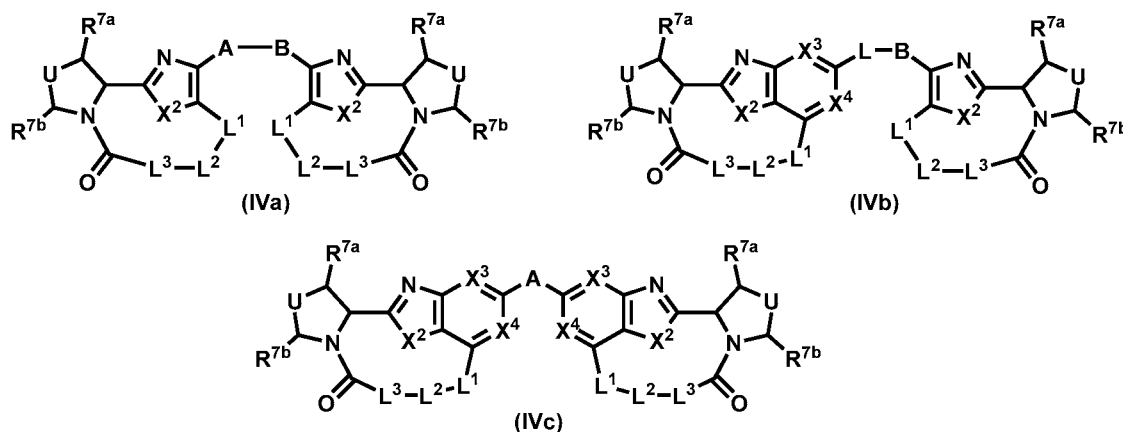
In one embodiment, the present invention relates to compounds of Formulae (IIIa), and pharmaceutically acceptable salts thereof, wherein A and B are each independently optionally substituted phenyl.

In an additional aspect, the present invention relates to compounds of Formulae (IIIb), and pharmaceutically acceptable salts thereof wherein L is optionally substituted C₂-C₄ alkenyl, B is optionally substituted phenyl and A is absent.

In yet an additional aspect, the present invention relates to compounds of Formula (IIIc), and pharmaceutically acceptable salts thereof wherein L is optionally substituted C₂-C₄ alkenyl, A is optionally substituted phenyl and B is absent.

In yet an additional aspect, the present invention relates to compounds of Formula (IIId), and pharmaceutically acceptable salts thereof, wherein A is bicyclic aryl or bicyclic heteroaryl.

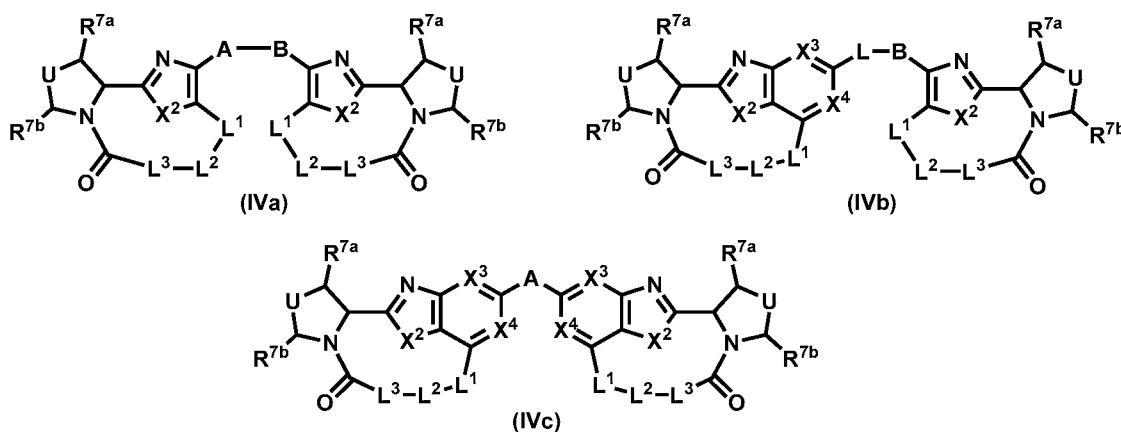
In still another embodiment, the present invention relates to compounds of Formulae (IVa), (IVb) or (IVc), or a pharmaceutically acceptable salt thereof;



wherein U, X², X³, X⁴, R^{7a}, and R^{7b} are as previously defined; in Formula (IVa), A and B are each independently phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IVb), L is O, optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl; in Formula (IVb), B is phenyl,

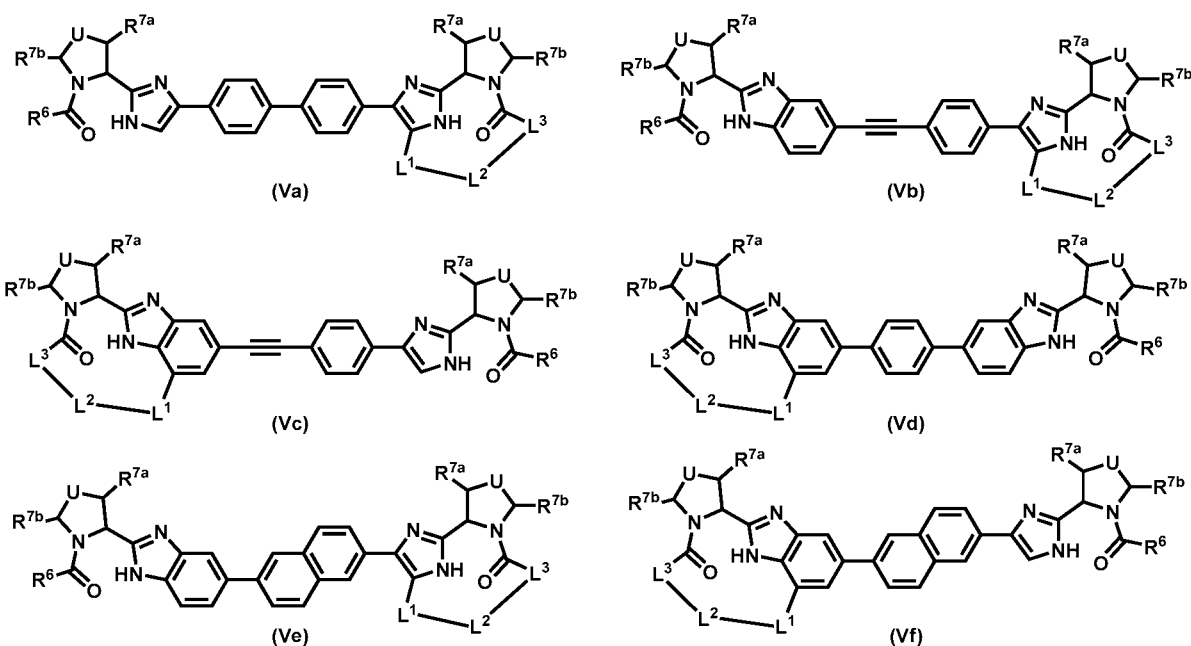
monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IVc), A is phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IVa), (IVb) and (IVc), the linker -L¹-L²-L³- is from 6 to 16, preferably 6 to 14 bond lengths. In yet another aspect, L is optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl; and the linker -L¹-L²-L³- is from 8 to 12 bond lengths.

In yet another embodiment, the present invention relates to compounds of Formulae (IVa), (IVb) or (IVc), and pharmaceutically acceptable salts thereof;



wherein U, X², X³, X⁴, R^{7a}, and R^{7b} are as previously defined; in Formula (IVa), A and B are each independently phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IVb), L is O, optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl and B is phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted; in Formula (IVc), A is phenyl, monocyclic heteroaryl, bicyclic aryl or bicyclic heteroaryl, each optionally substituted; in Formula (IVa), (IVb) and (IVc), the linker -L¹-L²-L³- is from 6 to 16 bond lengths. In yet another aspect, L is optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl; and the linker -L¹-L²-L³- is from 6 to 12 bond lengths.

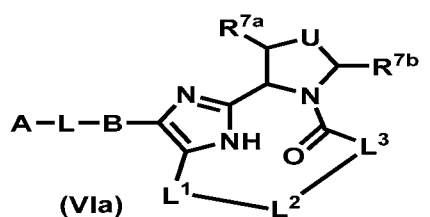
In still another embodiment, the present invention relates to compounds of Formulae (Va ~ Vf), and pharmaceutically acceptable salts thereof;



wherein R^6 is C_1 - C_8 alkyl optionally substituted with amino, hydroxy, protected amino, or $O(C_1$ - C_4 alkyl); U at each occurrence is independently CH_2 , CHF, CHMe, CF_2 , $C=CH_2$,

- 5 $C=CF_2$, or $C(R^7)_2$; R^7 is hydrogen, halogen or optionally substituted C_3 - C_8 cycloalkyl; alternatively the two geminal R^7 groups are taken together with the carbon atom to which they are attached to form a spiro, 3- to 7-membered, optionally substituted C_3 - C_7 cycloalkyl or optionally substituted 3-7 membered heterocyclic; R^{7a} is hydrogen; and R^{7b} is hydrogen, methyl, or optionally substituted C_3 - C_8 cycloalkyl; or alternatively, R^{7a} and U
- 10 or U and R^{7b} are taken together with the carbon to which they are attached to form a fused, optionally substituted cyclopropyl, and the other of R^{7b} or R^{7a} is hydrogen; or yet alternatively U, R^{7a} and R^{7b} are taken together with the carbon to which they are attached to form a bridged, optionally substituted C_4 - C_7 cycloalkyl; and the linker $-L^1-L^2-L^3-$ is from 6 to 14 bond lengths. In yet another aspect, L is optionally substituted C_2 - C_4 alkenyl,
- 15 or optionally substituted C_2 - C_4 alkynyl; and the linker $-L^1-L^2-L^3-$ is from 8 to 12 bond lengths.

In still another embodiment, the present invention relates to compounds of Formula (VIa), and pharmaceutically acceptable salts thereof;



wherein U, R^{7a}, and R^{7b} are as previously defined; A and B are each independently an optionally substituted aryl or optionally substituted heteroaryl, L is absent or a linear aliphatic group.

In still another embodiment, the present invention relates to compounds of

5 Formula (VIa), and pharmaceutically acceptable salts thereof; wherein:

A is a monocyclic or polycyclic group independently selected from the group consisting of aryl, heteroaryl, heterocyclic, C₃-C₈ cycloalkyl and C₃-C₈ cycloalkenyl, wherein the monocyclic or polycyclic group is further substituted by -NHC(O)-R^a;

R^a is an optionally substituted phenyl;

10 U at each occurrence is independently CH₂, CHF, CHMe, CF₂, C=CH₂, C=CF₂, or C(R⁷)₂;

R⁷ is hydrogen, halogen or optionally substituted C₃-C₈ cycloalkyl;

alternatively, the two geminal R⁷ groups are taken together with the carbon to which they are attached to form a spiro, 3- to 7-membered, optionally substituted C₃-C₈ cycloalkyl or optionally substituted 3- to 8-membered heterocyclic;

15 R^{7a} is hydrogen; and

R^{7b} is hydrogen, methyl, or optionally substituted C₃-C₈ cycloalkyl;

or alternatively, R^{7a} and U or U and R^{7b} are taken together with the carbon atom to which they are attached to form a fused, optionally substituted cyclopropyl, and the other of R^{7b} or R^{7a} is hydrogen;

20 or yet alternatively U, R^{7a} and R^{7b} are taken together with the carbon to which they are attached to form a bridged, optionally substituted C₄-C₇ cycloalkyl;

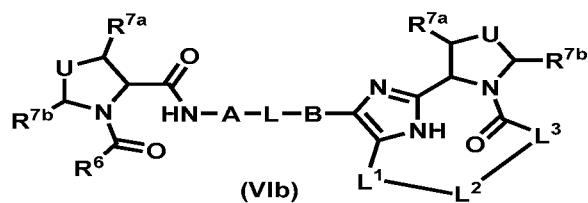
the linker -L¹-L²-L³- is from 6 to 14 bond lengths; and

B and L are as previously defined.

25 In yet another aspect, the present invention relates to compounds of Formula (VIa), and pharmaceutically acceptable salts thereof, wherein L is absent or optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl; and the linker -L¹-L²-L³- is from 8 to 12 bond lengths.

In still another embodiment, the present invention relates to compounds of

30 Formula (VIb), and pharmaceutically acceptable salts thereof;



wherein U, R⁶, R^{7a}, R⁷ and R^{7b} are as previously defined; A and B are each independently an optionally substituted aryl or optionally substituted heteroaryl, L is absent or a linear aliphatic group.

5 In still another embodiment, the present invention relates to compounds of Formula (VIb), and pharmaceutically acceptable salts thereof; wherein:

A and B are each independently an optionally substituted aryl;

R⁶ is C₁-C₈ alkyl optionally substituted with amino, hydroxy, protected amino, or O(C₁-C₄ alkyl);

10 U at each occurrence is independently CH₂, CHF, CHMe, CF₂, C=CH₂, C=CF₂, or C(R⁷)₂;

R⁷ is hydrogen, halogen or optionally substituted C₃-C₈ cycloalkyl;

alternatively the two geminal R⁷ groups are taken together with the carbon atom to which they are attached to form a spiro, 3- to 7-membered, optionally substituted
15 cycloalkyl or optionally substituted heterocyclic;

R^{7a} is hydrogen;

R^{7b} is hydrogen, methyl, or optionally substituted C₃-C₈ cycloalkyl;

or alternatively, R^{7a} and U or U and R^{7b} are taken together with the carbon atom to which they are attached to form a fused, optionally substituted cyclopropyl, and the other
20 of R^{7b} or R^{7a} is hydrogen;

or yet alternatively U, R^{7a} and R^{7b} are taken together with the carbon to which they are attached to form a bridged, optionally substituted C₄-C₇ cycloalkyl;

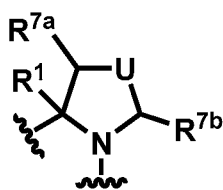
the linker -L¹-L²-L³- is from 6 to 14 bond lengths;

and L, L¹, L², L₃ are as previously defined.

25 In yet another aspect, the present invention relates to compounds of Formula (VIb), and pharmaceutically acceptable salts thereof, wherein L is absent or optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl; and the linker -L¹-L²-L³- is from 8 to 12 bond lengths.

In still another embodiment, the present invention relates to compounds of
30 Formula (I), Formulae (Ia ~ Ih), Formulae (IIa ~ IIg), Formulae (IIIa ~ IIIId), Formulae

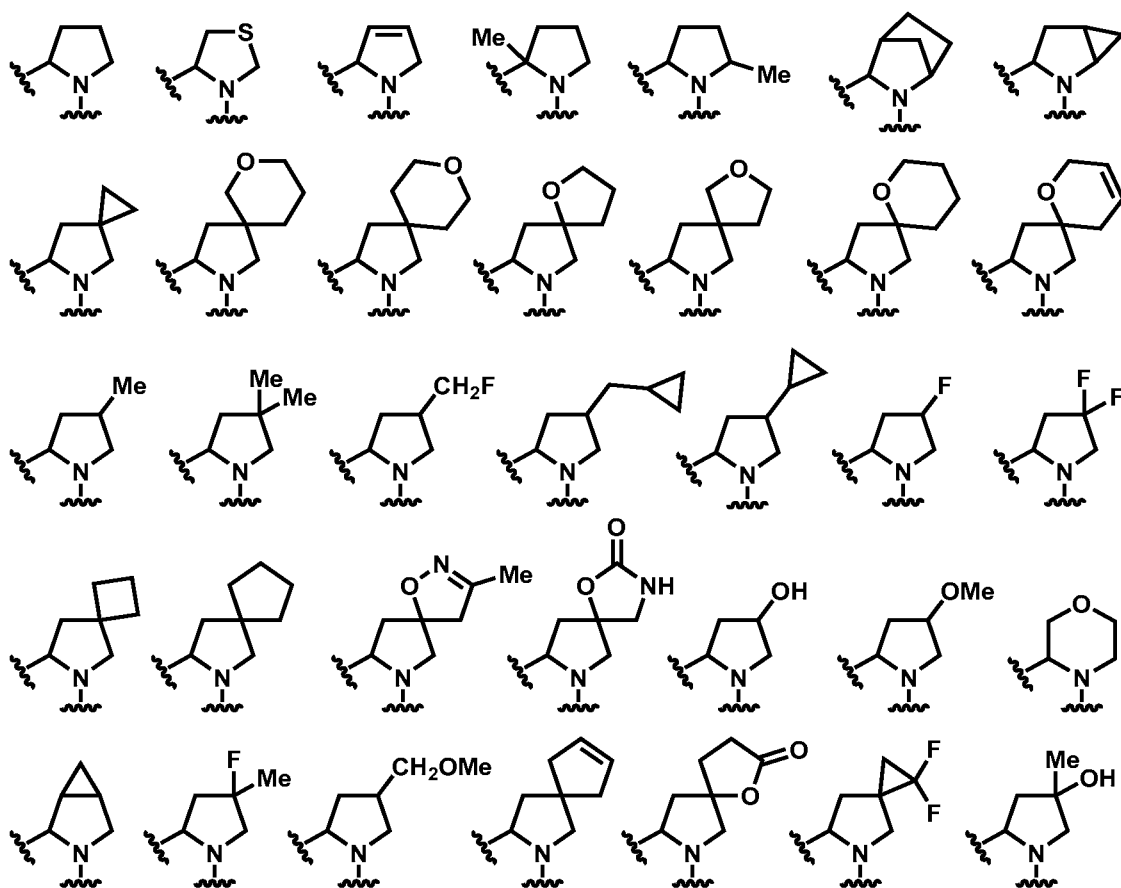
(IVa ~ IVc), Formulae (Va ~ Vf) or Formulae (VIa ~ VIb), or a pharmaceutically



acceptable salt thereof; wherein

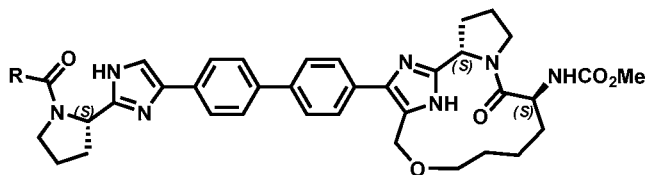
at each occurrence is independently

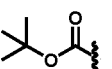
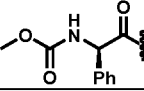
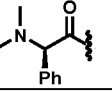
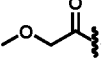
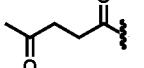
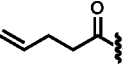
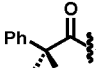
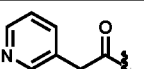
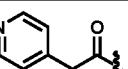
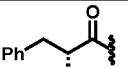
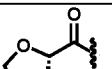
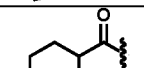
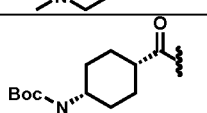
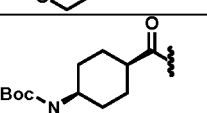
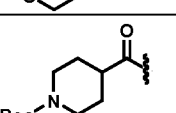
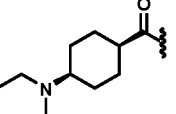
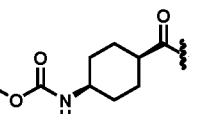
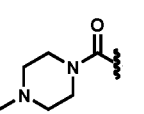
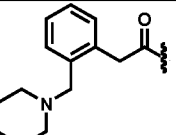
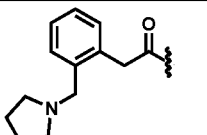
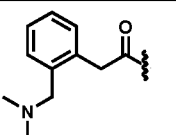
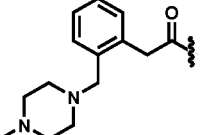
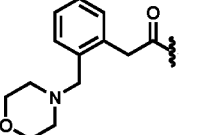
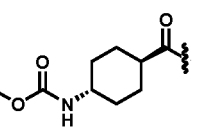
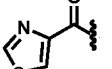
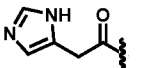
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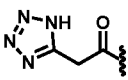
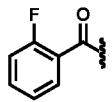
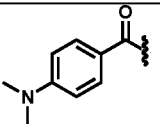
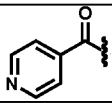
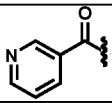
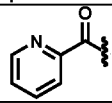
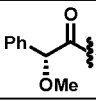
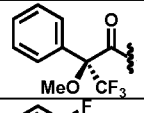
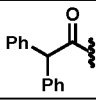
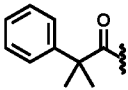
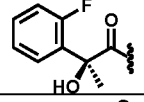
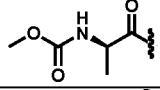
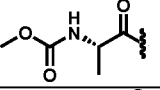
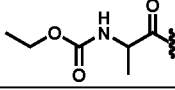
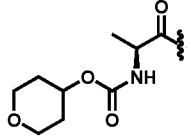
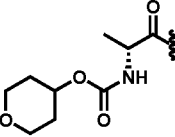
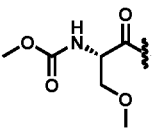
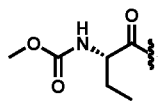
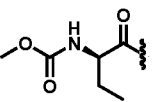
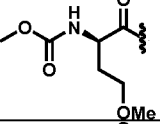
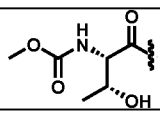
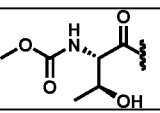
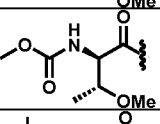
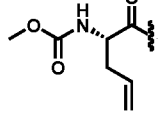
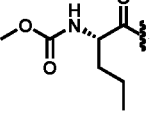
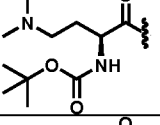
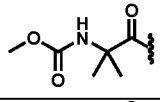
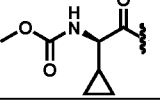
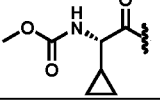
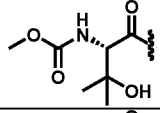
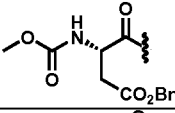
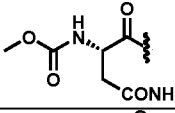
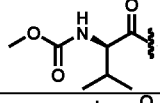
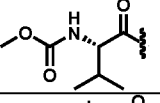
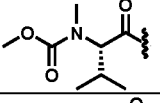
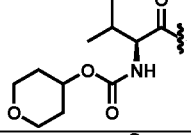
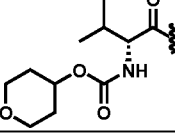
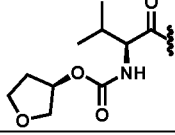
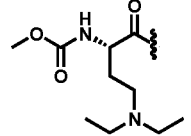
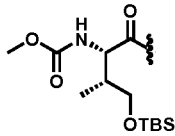
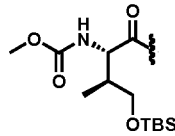
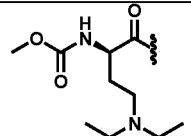
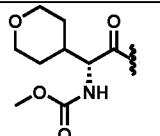
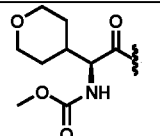
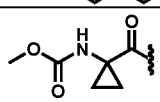
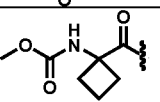
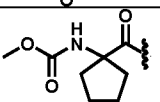


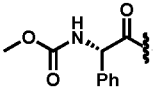
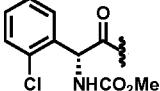
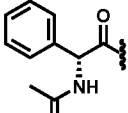
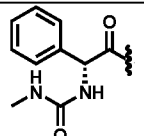
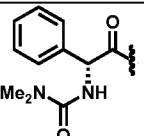
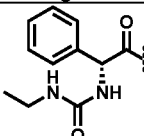
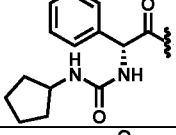
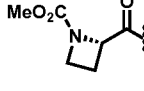
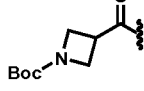
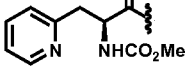
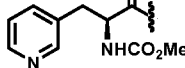
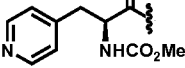
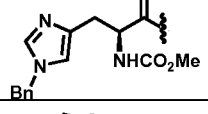
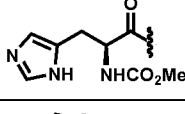
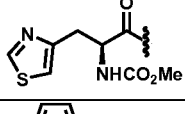
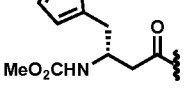
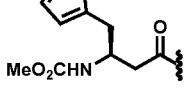
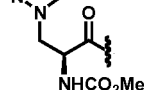
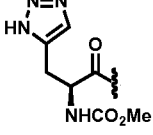
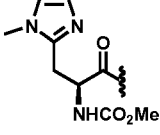
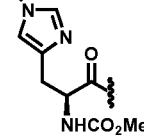
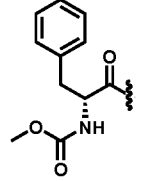
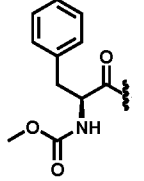
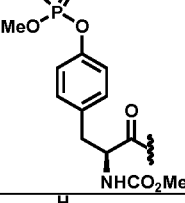
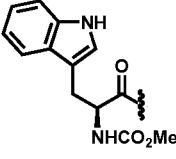
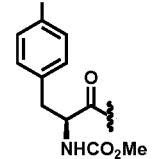
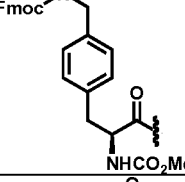
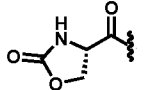
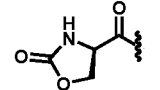
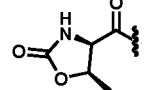
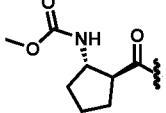
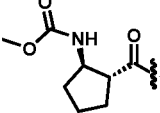
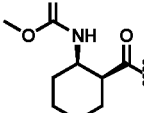
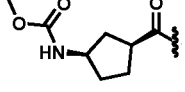
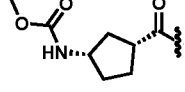
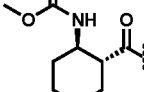
5 Representative compounds of the present invention are those selected from compounds 1-376 compiled in Tables 1-12:

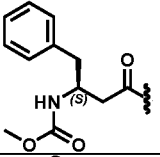
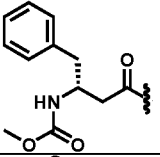
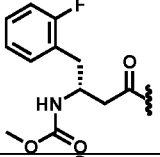
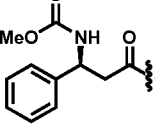
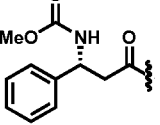
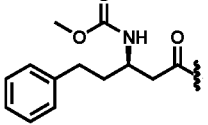
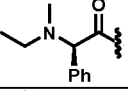
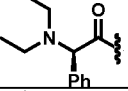
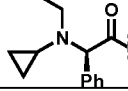
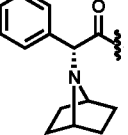
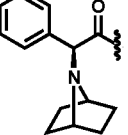
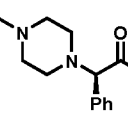
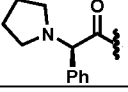
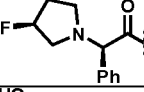
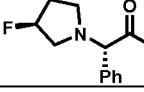
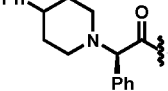
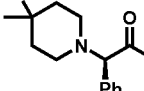
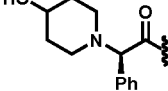
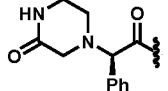
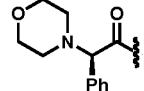
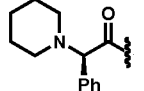
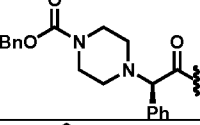
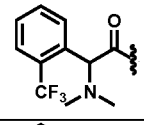
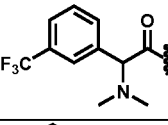
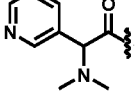
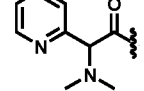
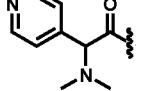
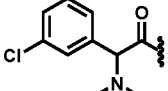
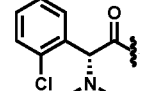
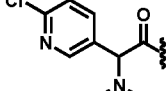
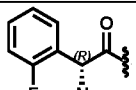
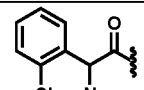
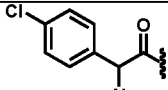
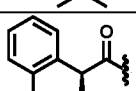
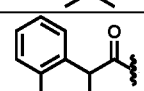
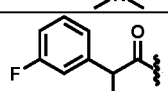
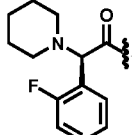
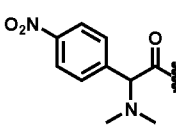
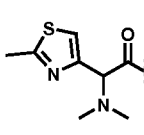
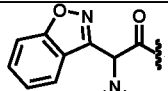
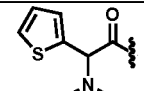
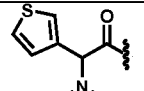
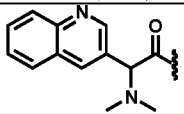
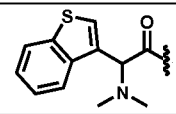
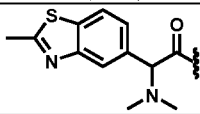
Table 1: Compounds 1-219.



Entry		Entry		Entry	
1		2		3	
4		5		6	
7		8		9	
10		11		12	
13		14		15	
16		17		18	
19		20		21	
22		23		24	
25		26		27	
28		29		30	
31		32		33	
34		35		36	
37		38		39	
40		41		42	
43		44		45	
46		47		48	

49		50		51	
52		53		54	
55		56		57	
58		59		60	
61		62		63	
64		65		66	
67		68		69	
70		71		72	
73		74		75	
76		77		78	
79		80		81	
82		83		84	
85		86		87	
88		89		90	
91		92		93	
94		95		96	

97		98		99	
100		101		102	
103		104		105	
106		107		108	
109		110		111	
112		113		114	
115		116		117	
118		119		120	
121		122		123	
124		125		126	
127		128		129	
130		131		132	

133		134		135	
136		137		138	
139		140		141	
142		143		144	
145		146		147	
148		149		150	
151		152		153	
154		155		156	
157		158		159	
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169		170		171	
172		173		174	
175		176		177	

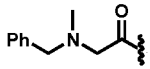
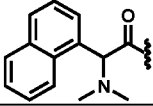
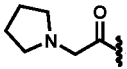
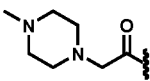
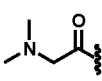
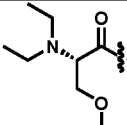
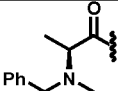
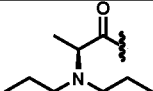
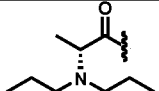
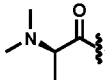
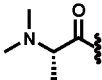
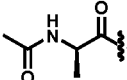
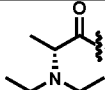
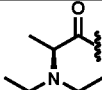
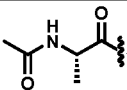
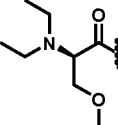
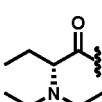
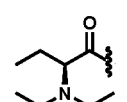
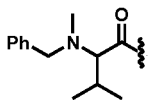
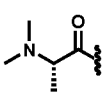
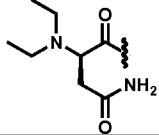
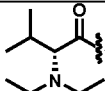
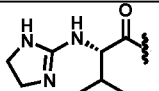
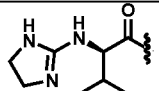
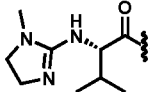
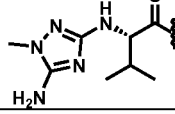
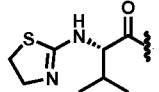
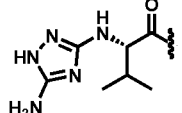
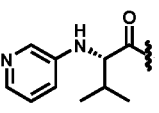
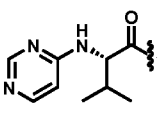
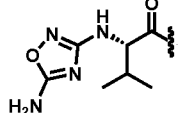
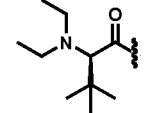
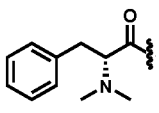
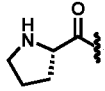
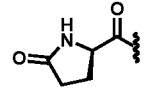
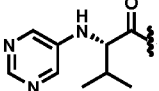
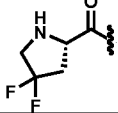
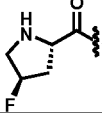
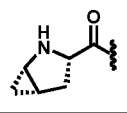
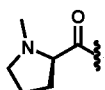
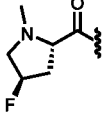
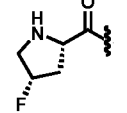
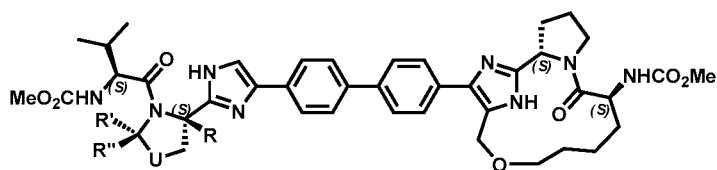
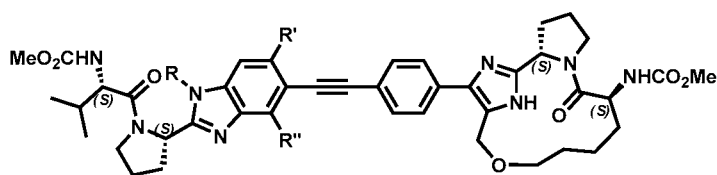
178		179		180	
181		182		183	
184		185		186	
187		188		189	
190		191		192	
193		194		195	
196		197		198	
199		200		201	
202		203		204	
205		206		207	
208		209		210	
211		212		213	
214		215		216	
217		218		219	

Table 2: Compounds 220-229.



Entry	R	R'	R''	U	Entry	R	R'	R''	U
220	Me	H	H	CH ₂	221	H	H	H	CF ₂
222	Me	H	H	S	223	H	H	H	
224	H	Me	H	CH ₂	225	H	H	H	
226	H	Ph	H	CH ₂	227	H	H	H	
228	H	H	Ph	CH ₂	229	H	H	H	

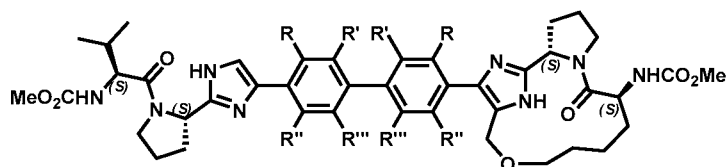
Table 3: Compounds 230-239.



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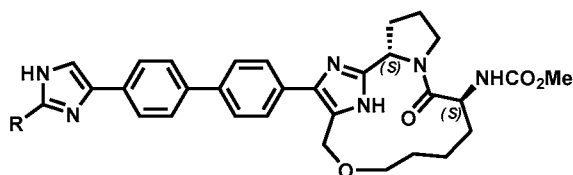
Entry	R	R'	R''	Entry	R	R'	R''
230	Me	H	H	231	H	CO ₂ Me	H
232	H	F	H	233	H	H	CO ₂ Me
234	H	H	F	235	H	OMe	H
236	H	Cl	H	237	H	H	OMe
238	H	H	Cl	239	H	CF ₃	H

Table 4: Compounds 240-249.



Entry	R	R'	R''	R'''	Entry	R	R'	R''	R'''
240	F	H	H	H	241	F	F	H	H
242	Me	H	H	H	243	Me	Me	H	H
244	H	H	Me	Me	245	H	H	Et	Et
246	CF ₃	H	H	H	247	CF ₃	H	CF ₃	H
248	Cl	H	H	H	249	Cl	H	Cl	H

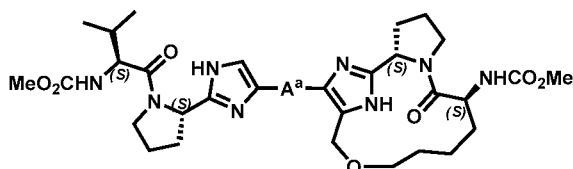
Table 5: Compounds 250-264.



Entry	R	Entry	R	Entry	R
250		251		252	
253		254		255	
256		257		258	
259		260		261	
262		263		264	

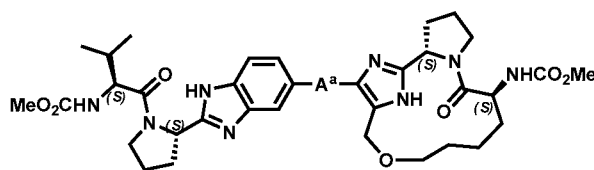
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Table 6: Compounds 265-282.



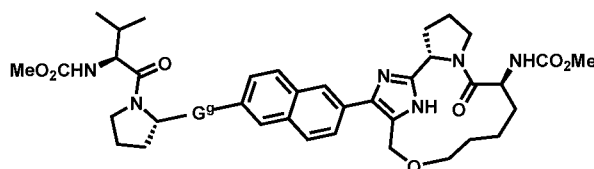
Entry	A ^a	Entry	A ^a	Entry	A ^a
265		266		267	
268		269		270	
271		272		273	
274		275		276	
277		278		279	
280		281		282	

Table 7: Compounds 283-303.



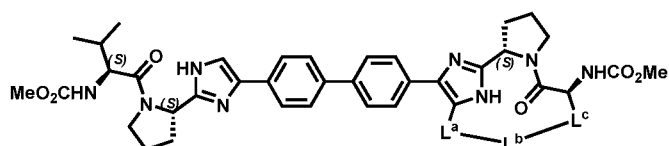
Entry	A ^a	Entry	A ^a	Entry	A ^a
283		284		285	
286		287		288	
289		290		291	
292		293		294	
295		296		297	
298		299		300	
301		302		303	

Table 8: Compounds 304-315.



Entry	G ^g	Entry	G ^g	Entry	G ^g
304		305		306	
307		308		309	
310		311		312	
313		314		315	

Table 9: Compounds 316-333.



Entry	L ^a -L ^b -L ^c	Entry	L ^a -L ^b -L ^c	Entry	L ^a -L ^b -L ^c
316		317		318	
319		320		321	
322		323		324	
325		326		327	
328		329		330	
331		332		333	

Table 10: Compounds 334-343.

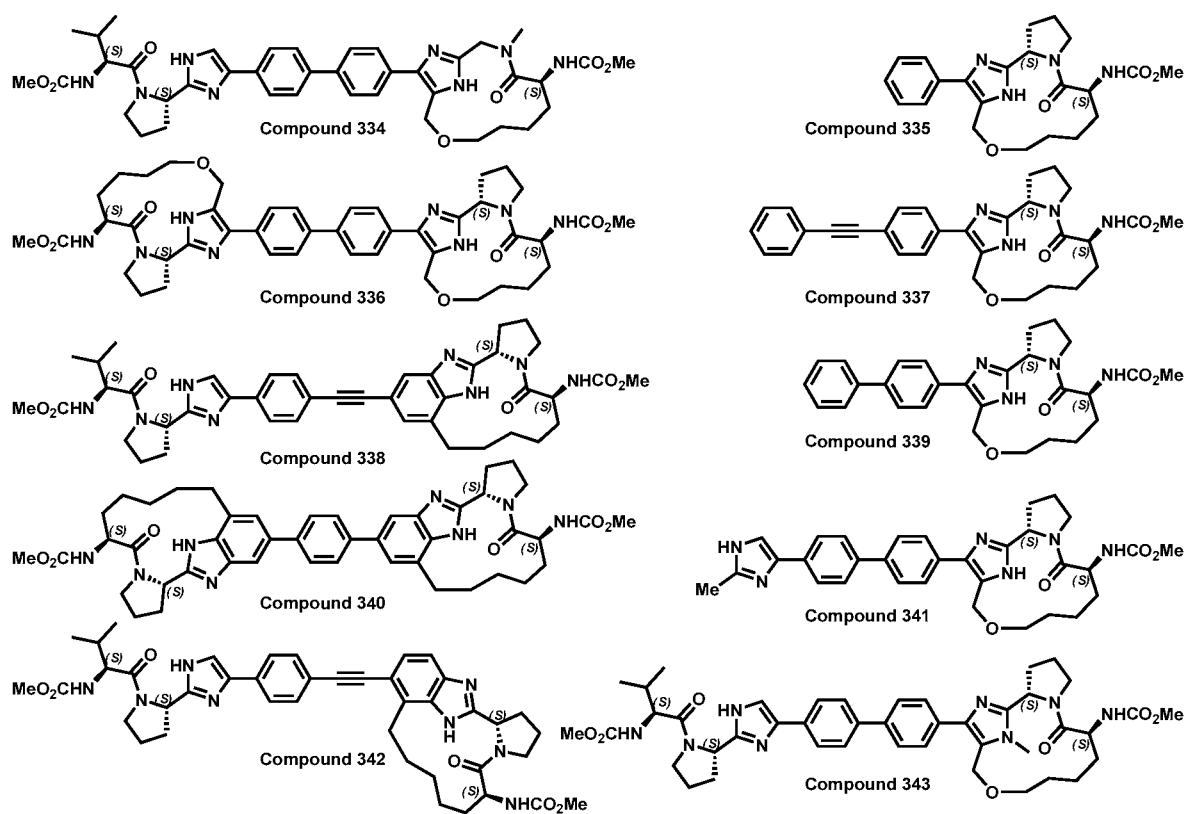


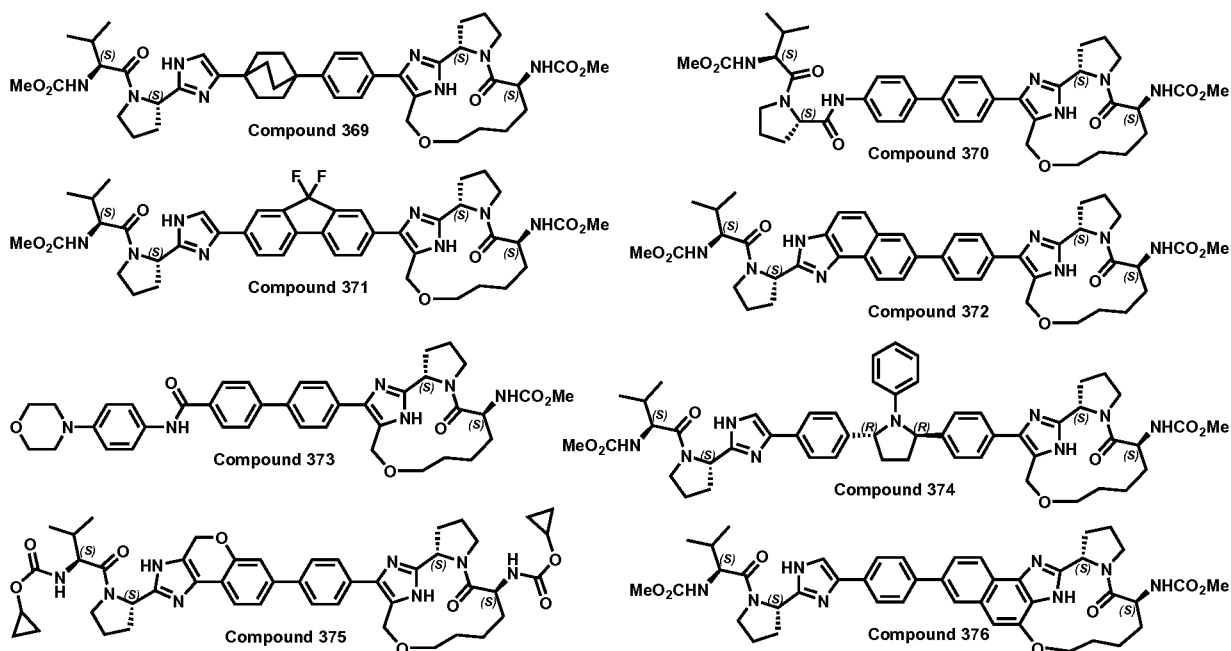
Table 11: Compounds 344-368

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Table 12: Compounds 369-376.



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It will be appreciated that the description of the present invention herein should be construed in congruity with the laws and principals of chemical bonding. In some instances it may be necessary to remove a hydrogen atom in order to accommodate a substituent at any given location.

It is intended that the definition of any substituent or variable (e.g., R^1 , R^2 , X, u, m, etc.) at a particular location in a molecule be independent of its definitions elsewhere in that molecule. For example, when u is 2, each of the two R^1 groups may be the same or different.

5 It will be yet appreciated that the compounds of the present invention may contain one or more asymmetric carbon atoms and may exist in racemic, diastereoisomeric, and optically active forms. It will still be appreciated that certain compounds of the present invention may exist in different tautomeric forms. All tautomers are contemplated to be within the scope of the present invention.

10 It should be understood that the compounds encompassed by the present invention are those that are suitably stable for use as pharmaceutical agent.

 It will be further appreciated that reference herein to therapy and/or treatment includes, but is not limited to, prevention, retardation, prophylaxis, therapy and/or cure of the disease. It will further be appreciated that references herein to treatment or prophylaxis
15 of HCV infection includes treatment or prophylaxis of HCV-associated disease such as liver fibrosis, cirrhosis and hepatocellular carcinoma.

 A further embodiment of the present invention includes pharmaceutical compositions comprising any single compound or a combination of two or more compounds delineated herein, or a pharmaceutically acceptable salt thereof, with a
20 pharmaceutically acceptable carrier or excipient.

 Yet a further embodiment of the present invention is a pharmaceutical composition comprising any single compound or a combination of two or more compounds delineated herein, or a pharmaceutically acceptable salt thereof, in combination with one or more agents known in the art, with a pharmaceutically acceptable carrier or excipient.

25 It will be further appreciated that compounds of the present invention can be administered as the sole active pharmaceutical agent, or used in combination with one or more agents to treat or prevent hepatitis C infections or the symptoms associated with HCV infection. Other agents to be administered in combination with a compound or combination of compounds of the present invention include therapies for disease caused
30 by HCV infection that suppresses HCV viral replication by direct or indirect mechanisms. These agents include, but are not limited to, host immune modulators (for example, interferon-alpha, pegylated interferon-alpha, consensus interferon, interferon-beta, interferon-gamma, CpG oligonucleotides and the like); antiviral compounds that inhibit host cellular functions such as inosine monophosphate dehydrogenase (for example,

ribavirin and the like); cytokines that modulate immune function (for example, interleukin 2, interleukin 6, and interleukin 12); a compound that enhances the development of type 1 helper T cell response; interfering RNA; anti-sense RNA; vaccines comprising HCV antigens or antigen adjuvant combinations directed against HCV; agents that interact with host cellular components to block viral protein synthesis by inhibiting the internal ribosome entry site (IRES) initiated translation step of HCV viral replication or to block viral particle maturation and release with agents targeted toward the viroporin family of membrane proteins such as, for example, HCV P7 and the like; and any agent or combination of agents that inhibit the replication of HCV by targeting other proteins of the viral genome involved in the viral replication and/or interfere with the function of other viral targets, such as inhibitors of NS3/NS4A protease, NS3 helicase, NS5B polymerase, NS4A protein and NS5A protein.

According to yet another embodiment, the pharmaceutical compositions of the present invention may further comprise other inhibitor(s) of targets in the HCV life cycle, including, but not limited to, helicase, polymerase, metalloprotease, NS4A protein, NS5A protein, and internal ribosome entry site (IRES).

Accordingly, one embodiment of the present invention is directed to a method for treating or preventing an infection caused by an RNA-containing virus comprising co-administering to a patient in need of such treatment one or more agents selected from the group consisting of a host immune modulator and a second or more antiviral agents, or a combination thereof, with a therapeutically effective amount of a compound or combination of compounds of the present invention, or a pharmaceutically acceptable salt thereof. Examples of the host immune modulator are, but not limited to, interferon-alpha, pegylated-interferon-alpha, interferon-beta, interferon-gamma, a cytokine, a vaccine, and a vaccine comprising an antigen and an adjuvant, and said second antiviral agent inhibits replication of HCV either by inhibiting host cellular functions associated with viral replication or by targeting proteins of the viral genome. A non-limiting example of the RNA-containing virus is hepatitis C virus (HCV).

A further embodiment of the present invention is directed to a method of treating or preventing infection caused by an RNA-containing virus comprising co-administering to a patient in need of such treatment an agent or combination of agents that treat or alleviate symptoms of HCV infection including cirrhosis and inflammation of the liver, with a therapeutically effective amount of a compound or combination of compounds of

the present invention, or a pharmaceutically acceptable salt thereof. A non-limiting example of the RNA-containing virus is hepatitis C virus (HCV).

Yet another embodiment of the present invention provides a method of treating or preventing infection caused by an RNA-containing virus comprising co-administering to a patient in need of such treatment one or more agents that treat patients for disease caused by hepatitis B (HBV) infection, with a therapeutically effective amount of a compound or a combination of compounds of the present invention, or a pharmaceutically acceptable salt thereof. An agent that treats patients for disease caused by hepatitis B (HBV) infection may be for example, but not limited thereto, L-deoxythymidine, adefovir, lamivudine or tenfovir, or any combination thereof. A non-limiting example of the RNA-containing virus is hepatitis C virus (HCV).

A further embodiment of the present invention provides a method of treating or preventing infection caused by an RNA-containing virus comprising co-administering to a patient in need of such treatment one or more agents that treat patients for disease caused by human immunodeficiency virus (HIV) infection, with a therapeutically effective amount of a compound or a combination of compounds of the present invention, or a pharmaceutically acceptable salt thereof. The agent that treats patients for disease caused by human immuno-deficiency virus (HIV) infection may include, but is not limited thereto, ritonavir, lopinavir, indinavir, nelfmavir, saquinavir, amprenavir, atazanavir, tipranavir, TMC-114, fosamprenavir, zidovudine, lamivudine, didanosine, stavudine, tenofovir, zalcitabine, abacavir, efavirenz, nevirapine, delavirdine, TMC-125, L-870812, S-1360, enfuvirtide (T-20) or T-1249, or any combination thereof. A non-limiting example of the RNA-containing virus is hepatitis C virus (HCV).

It can occur that a patient may be co-infected with hepatitis C virus and one or more other viruses, including but not limited to human immunodeficiency virus (HIV), hepatitis A virus (HAV) and hepatitis B virus (HBV). Thus also contemplated herein is combination therapy to treat such co-infections by co-administering a compound according to the present invention with at least one of an HIV inhibitor, an HAV inhibitor and an HBV inhibitor.

In addition, the present invention provides the use of a compound or a combination of compounds of the invention, or a therapeutically acceptable salt thereof, and one or more agents selected from the group consisting of a host immune modulator and one or more additional antiviral agents, or a combination thereof, to prepare a medicament for the treatment of an infection caused by an RNA-containing virus in a patient, particularly

hepatitis C virus. Examples of the host immune modulator are, but not limited to, interferon-alpha, pegylated-interferon-alpha, interferon-beta, interferon-gamma, a cytokine, a vaccine, and a vaccine comprising an antigen and an adjuvant. Preferably said additional antiviral agent inhibits replication of HCV either by inhibiting host cellular
5 functions associated with viral replication or by targeting proteins of the viral genome.

When used in the above or other treatments, combination of compound or compounds of the present invention, together with one or more agents as defined herein above, can be employed in pure form or, where such forms exist, or as a pharmaceutically acceptable salt thereof. Alternatively, such combination of therapeutic agents can be
10 administered as a pharmaceutical composition containing a therapeutically effective amount of the compound or combination of compounds of interest, or their pharmaceutically acceptable salt thereof, in combination with one or more agents as defined hereinabove, and a pharmaceutically acceptable carrier. Such pharmaceutical compositions can be used for inhibiting the replication of an RNA-containing virus,
15 particularly Hepatitis C virus (HCV), by contacting said virus with said pharmaceutical composition. In addition, such compositions are useful for the treatment or prevention of an infection caused by an RNA-containing virus, particularly Hepatitis C virus (HCV).

Hence, a still further embodiment of the invention is directed to a method of treating or preventing infection caused by an RNA-containing virus, particularly a
20 hepatitis C virus (HCV), comprising administering to a patient in need of such treatment a pharmaceutical composition comprising a compound or combination of compounds of the invention or a pharmaceutically acceptable salt thereof, and one or more agents as defined herein above, with a pharmaceutically acceptable carrier.

When administered as a combination, the therapeutic agents can be formulated as
25 separate compositions which are given at the same time or within a predetermined period of time, or the therapeutic agents can be given as a single unit dosage form.

Antiviral agents contemplated for use in such combination therapy include agents (compounds or biologicals) that are effective to inhibit the formation and/or replication of a virus in a mammal, including, but not limited to, agents that interfere with either host or
30 viral mechanisms necessary for the formation and/or replication of a virus in a mammal. Such agents can be selected from another anti-HCV agent; an HIV inhibitor; an HAV inhibitor; and an HBV inhibitor.

Other agents that can be administered in combination with a compound of the present invention include a cytochrome P450 monooxygenase inhibitor (also referred to

herein as a CYP inhibitor), which is expected to inhibit metabolism of the compounds of the invention. Therefore, the cytochrome P450 monooxygenase inhibitor would be in an amount effective to inhibit metabolism of the compounds of this invention. Accordingly, the CYP inhibitor is administered in an amount sufficient to improve one or more

5 pharmacokinetic (PK) features including, but not limited to, plasma concentration, bioavailability, area under the plasma concentration time curve (AUC), elimination half-life, and systemic clearance, of a compound of the invention when one or more of its PK features of said compound is improved in comparison to that in the absence of the CYP inhibitor.

10 In one embodiment, the invention provides methods for improving the pharmacokinetics of compounds of the invention. The advantages of improving the pharmacokinetics of drugs are recognized in the art (see, for example, US Pat.Publication No's.US 2004/0091527; US 2004/0152625; and US 2004/0091527). Accordingly, one embodiment of this invention provides a method comprising administering an inhibitor of
15 CYP3A4 and a compound of the invention. Another embodiment of this invention provides a method comprising administering a compound of the invention and an inhibitor of isozyme 3A4 ("CYP3A4"), isozyme 2C19 ("CYP2C19"), isozyme 2D6 ("CYP2D6"), isozyme 1A2 ("CYP1A2"), isozyme 2C9 ("CYP2C9"), or isozyme 2E1 ("CYP2E1"). In a preferred embodiment, the CYP inhibitor preferably inhibits CYP3A4. Any CYP inhibitor
20 that improves the pharmacokinetics of the relevant compound of the invention may be used in a method of this invention. These CYP inhibitors include, but are not limited to, ritonavir (see, for example, WO 94/14436), ketoconazole, troleandomycin, 4-methyl pyrazole, cyclosporin, clomethiazole, cimetidine, itraconazole, fluconazole, miconazole, fluvoxamine, fluoxetine, nefazodone, sertraline, indinavir, nelfinavir, amprenavir,
25 fosamprenavir, saquinavir, lopinavir, delavirdine, diltiazem, erythromycin, VX-944, and VX-497. Preferred CYP inhibitors include ritonavir, ketoconazole, troleandomycin, 4-methyl pyrazole, cyclosporin, and clomethiazole.

It will be understood that the administration of the combination of the invention by means of a single patient pack, or patient packs of each formulation, containing within a
30 package insert instructing the patient to the correct use of the invention is a desirable additional feature of this invention.

According to a further aspect of the invention is a pack comprising at least a compound of the invention and a CYP inhibitor and an information insert containing directions on the use of the combination of the invention. In an alternative embodiment of

this invention, the pack further comprises one or more of additional agent as described herein. The additional agent or agents may be provided in the same pack or in separate packs.

Another aspect of this involves a packaged kit for a patient to use in the treatment of HCV infection or in the prevention of HCV infection, comprising: a single or a plurality of pharmaceutical formulation of each pharmaceutical component; a container housing the pharmaceutical formulation(s) during storage and prior to administration; and instructions for carrying out drug administration in a manner effective to treat or prevent HCV infection.

Accordingly, this invention provides kits for the simultaneous or sequential administration of a compound of the invention and a CYP inhibitor (and optionally an additional agent) or derivatives thereof are prepared in a conventional manner. Typically, such a kit will comprise, e. g. a composition of a compound of the invention and optionally the additional agent (s) in a pharmaceutically acceptable carrier (and in one or in a plurality of pharmaceutical formulations) and written instructions for the simultaneous or sequential administration.

In another embodiment, a packaged kit is provided that contains one or more dosage forms for self administration; a container means, preferably sealed, for housing the dosage forms during storage and prior to use; and instructions for a patient to carry out drug administration. The instructions will typically be written instructions on a package insert, a label, and/or on other components of the kit, and the dosage form or forms are as described herein. Each dosage form may be individually housed, as in a sheet of a metal foil- plastic laminate with each dosage form isolated from the others in individual cells or bubbles, or the dosage forms may be housed in a single container, as in a plastic bottle.

The present kits will also typically include means for packaging the individual kit components, i.e., the dosage forms, the container means, and the written instructions for use. Such packaging means may take the form of a cardboard or paper box, a plastic or foil pouch, etc.

DEFINITIONS

Listed below are definitions of various terms used to describe this invention. These definitions apply to the terms as they are used throughout this specification and claims, unless otherwise limited in specific instances, either individually or as part of a larger group.

The term "aryl," as used herein, refers to a mono- or polycyclic carbocyclic ring system comprising at least one aromatic ring, including, but not limited to, phenyl, naphthyl, tetrahydronaphthyl, indanyl, indenyl. A polycyclic aryl is a polycyclic ring system that comprises at least one aromatic ring. Polycyclic aryls can comprise fused rings, covalently attached rings or a combination thereof.

The term "heteroaryl," as used herein, refers to a mono- or polycyclic aromatic radical having one or more ring atom selected from S, O and N; and the remaining ring atoms are carbon, wherein any N or S contained within the ring may be optionally oxidized. Heteroaryl includes, but is not limited to, pyridinyl, pyrazinyl, pyrimidinyl, pyrrolyl, pyrazolyl, imidazolyl, thiazolyl, oxazolyl, isooxazolyl, thiadiazolyl, oxadiazolyl, thiophenyl, furanyl, quinolinyl, isoquinolinyl, benzimidazolyl, benzooxazolyl, quinoxalinyl. A polycyclic heteroaryl can comprise fused rings, covalently attached rings or a combination thereof.

In accordance with the invention, aromatic groups can be substituted or unsubstituted.

The term "bicyclic aryl" or "bicyclic heteroaryl" refers to a ring system consisting of two rings wherein at least one ring is aromatic; and the two rings can be fused or covalently attached.

The terms "C₁-C₄ alkyl," "C₁-C₆ alkyl," "C₁-C₈ alkyl," "C₂-C₄ alkyl," or "C₃-C₆ alkyl," as used herein, refer to saturated, straight- or branched-chain hydrocarbon radicals containing between one and four, one and six, one and eight carbon atoms, or the like, respectively. Examples of C₁-C₈ alkyl radicals include, but are not limited to, methyl, ethyl, propyl, isopropyl, *n*-butyl, *tert*-butyl, neopentyl, *n*-hexyl, heptyl and octyl radicals.

The terms "C₂-C₈ alkenyl," "C₂-C₄ alkenyl," "C₃-C₄ alkenyl," or "C₃-C₆ alkenyl," as used herein, refer to straight- or branched-chain hydrocarbon radicals containing from two to eight, or two to four carbon atoms, or the like, having at least one carbon-carbon double bond by the removal of a single hydrogen atom. Alkenyl groups include, but are not limited to, for example, ethenyl, propenyl, butenyl, 1-methyl-2-buten-1-yl, heptenyl, octenyl, and the like.

The terms "C₂-C₈ alkynyl," "C₂-C₄ alkynyl," "C₃-C₄ alkynyl," or "C₃-C₆ alkynyl," as used herein, refer to straight- or branched-chain hydrocarbon radicals containing from two to eight, or two to four carbon atoms, or the like, having at least one carbon-carbon triple bond by the removal of a single hydrogen atom. Representative alkynyl groups

include, but are not limited to, for example, ethynyl, 1-propynyl, 1-butynyl, heptynyl, octynyl, and the like.

The term "C₃-C₈ cycloalkyl", or "C₄-C₇ cycloalkyl," as used herein, refers to a monocyclic or polycyclic saturated carbocyclic ring compound, and the carbon atoms may be optionally oxo-substituted. Examples of C₃-C₈ cycloalkyl include, but not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cyclooctyl; and examples of C₄-C₇ cycloalkyl include, but not limited to, cyclopentyl, cyclohexyl, bicyclo [2.2.1] heptyl, and the like.

The term "C₃-C₈ cycloalkenyl" or "C₅-C₇ cycloalkenyl," as used herein, refers to monocyclic or polycyclic carbocyclic ring compound having at least one carbon-carbon double bond and the carbon atoms may be optionally oxo-substituted. Examples of C₃-C₈ cycloalkenyl include, but not limited to, cyclopropenyl, cyclobutenyl, cyclopentenyl, cyclohexenyl, cycloheptenyl, cyclooctenyl, and the like; and examples of C₅-C₇ cycloalkenyl include, but not limited to, cyclopentenyl, cyclohexenyl, cycloheptenyl, and the like.

The term "arylalkyl," as used herein, refers to an aryl-substituted alkyl group. More preferred arylalkyl groups are aryl-C₁-C₆-alkyl groups.

The term "heteroarylalkyl," as used herein, refers to a heteroaryl-substituted alkyl group. More preferred heteroarylalkyl groups are heteroaryl-C₁-C₆-alkyl groups.

It is understood that any alkyl, alkenyl, alkynyl, cycloalkyl, heterocyclic and cycloalkenyl moiety described herein can also be an aliphatic group or an alicyclic group.

An "aliphatic" group is a non-aromatic moiety comprised of any combination of carbon atoms, hydrogen atoms, halogen atoms, oxygen, nitrogen or other atoms, and optionally contains one or more units of unsaturation, e.g., double and/or triple bonds.

Examples of aliphatic groups are functional groups, such as, O, OH, NH, NH₂, C(O), S(O)₂, C(O)O, C(O)NH, OC(O)O, OC(O)NH, OC(O)NH₂, S(O)₂NH, S(O)₂NH₂, NHC(O)NH₂, NHC(O)C(O)NH, NHS(O)₂NH, NHS(O)₂NH₂, C(O)NHS(O)₂, C(O)NHS(O)₂NH or C(O)NHS(O)₂NH₂, and the like, groups comprising one or more functional groups, non-aromatic hydrocarbons (optionally substituted), and groups wherein one or more carbons of a non-aromatic hydrocarbon (optionally substituted) is replaced by a functional group. Carbon atoms of an aliphatic group can be optionally oxo-substituted. An aliphatic group may be straight chained, branched, cyclic, or a combination thereof and preferably contains between about 1 and about 24 carbon atoms, more typically between about 1 and about 12 carbon atoms. In addition to aliphatic

hydrocarbon groups, as used herein, aliphatic groups expressly include, for example, alkoxyalkyls, polyalkoxyalkyls, such as polyalkylene glycols, polyamines, and polyimines, for example. Aliphatic groups may be optionally substituted. A linear aliphatic group is a non-cyclic aliphatic group. It is to be understood that when an

5 aliphatic group or a linear aliphatic group is said to “contain” or “include” or “comprise” one or more specified functional groups, the linear aliphatic group can be selected from one or more of the specified functional groups or a combination thereof, or a group wherein one or more carbons of a non-aromatic hydrocarbon (optionally substituted) is replaced by a specified functional group. In some examples, the linear aliphatic group can

10 be represented by the formula M-V-M', where M and M' are each independently absent or an alkyl, alkenyl or alkynyl, each optionally substituted, and V is a functional group. In some examples, V is selected from the group consisting of C(O), S(O)₂, C(O)O, C(O)N(R¹¹), OC(O)O, OC(O)N(R¹¹), S(O)₂N(R¹¹), N(R¹¹)C(O)N(R¹¹), N(R¹¹)C(O)C(O)N(R¹¹), N(R¹¹)S(O)₂N(R¹¹), C(O)N(R¹¹)S(O)₂ or

15 C(O)N(R¹¹)S(O)₂N(R¹¹); wherein R¹¹ is as previously defined. In another aspect of the invention, an exemplary linear aliphatic group is an alkyl, alkenyl or alkynyl, each optionally substituted, which is interrupted or terminated by a functional group such as described herein.

The term “alicyclic,” as used herein, denotes a monovalent group derived from a

20 monocyclic or bicyclic saturated carbocyclic ring compound by the removal of a single hydrogen atom, and the carbon atoms may be optionally oxo-substituted. Examples include, but not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, bicyclo [2.2.1] heptyl, and bicyclo [2.2.2] octyl. Such alicyclic groups may be further substituted.

The terms “heterocyclic” or “heterocycloalkyl” can be used interchangeably and

25 referred to a non-aromatic ring or a bi- or tri-cyclic group fused system, where (i) each ring system contains at least one heteroatom independently selected from oxygen, sulfur and nitrogen, (ii) each ring system can be saturated or unsaturated (iii) the nitrogen and sulfur heteroatoms may optionally be oxidized, (iv) the nitrogen heteroatom may optionally be quaternized, (v) any of the above rings may be fused to an aromatic ring, and

30 (vi) the remaining ring atoms are carbon atoms which may be optionally oxo-substituted. Representative heterocycloalkyl groups include, but are not limited to, 1,3-dioxolane, pyrrolidinyl, pyrazolinyl, pyrazolidinyl, imidazolinyl, imidazolidinyl, piperidinyl, piperazinyl, oxazolidinyl, isoxazolidinyl, morpholinyl, thiazolidinyl, isothiazolidinyl, quinoxalinyl, pyridazinonyl, and tetrahydrofuryl. Such heterocyclic groups may be further

substituted. Heteroaryl or heterocyclic groups can be C-attached or N-attached (where possible).

It is understood that any alkyl, alkenyl, alkynyl, alicyclic, cycloalkyl, cycloalkenyl, aryl, heteroaryl, heterocyclic, aliphatic moiety or the like, described herein can also be a
 5 divalent or multivalent group when used as a linkage to connect two or more groups or substituents, which can be at the same or different atom(s).

The term "substituted" refers to substitution by independent replacement of one, two, or three or more of the hydrogen atoms with substituents including, but not limited to, -F, -Cl, -Br, -I, -OH, protected hydroxy, -NO₂, -N₃, -CN, -NH₂, protected amino, oxo,
 10 thioxo, -NH-C₁-C₁₂-alkyl, -NH-C₂-C₈-alkenyl, -NH-C₂-C₈-alkynyl, -NH-C₃-C₁₂-cycloalkyl, -NH-aryl, -NH-heteroaryl, -NH-heterocycloalkyl, -dialkylamino, -diarylamino, -diheteroarylamino, -O-C₁-C₁₂-alkyl, -O-C₂-C₈-alkenyl, -O-C₂-C₈-alkynyl, -O-C₃-C₁₂-cycloalkyl, -O-aryl, -O-heteroaryl, -O-heterocycloalkyl, -C(O)-C₁-C₁₂-alkyl, -C(O)-C₂-C₈-alkenyl, -C(O)-C₂-C₈-alkynyl, -C(O)-C₃-C₁₂-cycloalkyl, -C(O)-aryl, -C(O)-heteroaryl, -
 15 C(O)-heterocycloalkyl, -CONH₂, -CONH-C₁-C₁₂-alkyl, -CONH-C₂-C₈-alkenyl, -CONH-C₂-C₈-alkynyl, -CONH-C₃-C₁₂-cycloalkyl, -CONH-aryl, -CONH-heteroaryl, -CONH-heterocycloalkyl, -OCO₂-C₁-C₁₂-alkyl, -OCO₂-C₂-C₈-alkenyl, -OCO₂-C₂-C₈-alkynyl, -OCO₂-C₃-C₁₂-cycloalkyl, -OCO₂-aryl, -OCO₂-heteroaryl, -OCO₂-heterocycloalkyl, -CO₂-C₁-C₁₂ alkyl, -CO₂-C₂-C₈ alkenyl, -CO₂-C₂-C₈ alkynyl, CO₂-C₃-C₁₂-cycloalkyl, -CO₂-
 20 aryl, CO₂-heteroaryl, CO₂-heterocycloalkyl, -OCONH₂, -OCONH-C₁-C₁₂-alkyl, -OCONH-C₂-C₈-alkenyl, -OCONH-C₂-C₈-alkynyl, -OCONH-C₃-C₁₂-cycloalkyl, -OCONH-aryl, -OCONH-heteroaryl, -OCONH-heterocycloalkyl, -NHC(O)H, -NHC(O)-C₁-C₁₂-alkyl, -NHC(O)-C₂-C₈-alkenyl, -NHC(O)-C₂-C₈-alkynyl, -NHC(O)-C₃-C₁₂-cycloalkyl, -NHC(O)-aryl, -NHC(O)-heteroaryl, -NHC(O)-heterocycloalkyl, -NHCO₂-C₁-C₁₂-alkyl, -NHCO₂-
 25 C₂-C₈-alkenyl, -NHCO₂-C₂-C₈-alkynyl, -NHCO₂-C₃-C₁₂-cycloalkyl, -NHCO₂-aryl, -NHCO₂-heteroaryl, -NHCO₂-heterocycloalkyl, -NHC(O)NH₂, -NHC(O)NH-C₁-C₁₂-alkyl, -NHC(O)NH-C₂-C₈-alkenyl, -NHC(O)NH-C₂-C₈-alkynyl, -NHC(O)NH-C₃-C₁₂-cycloalkyl, -NHC(O)NH-aryl, -NHC(O)NH-heteroaryl, -NHC(O)NH-heterocycloalkyl, -NHC(S)NH₂, -NHC(S)NH-C₁-C₁₂-alkyl, -NHC(S)NH-C₂-C₈-alkenyl, -NHC(S)NH-C₂-C₈-alkynyl, -NHC(S)NH-C₃-C₁₂-cycloalkyl, -NHC(S)NH-aryl, -NHC(S)NH-heteroaryl, -
 30 NHC(S)NH-heterocycloalkyl, -NHC(NH)NH₂, -NHC(NH)NH-C₁-C₁₂-alkyl, -NHC(NH)NH-C₂-C₈-alkenyl, -NHC(NH)NH-C₂-C₈-alkynyl, -NHC(NH)NH-C₃-C₁₂-cycloalkyl, -NHC(NH)NH-aryl, -NHC(NH)NH-heteroaryl, -NHC(NH)NH-heterocycloalkyl, -NHC(NH)-C₁-C₁₂-alkyl, -NHC(NH)-C₂-C₈-alkenyl, -NHC(NH)-C₂-C₈-

alkynyl, -NHC(NH)-C₃-C₁₂-cycloalkyl, -NHC(NH)-aryl, -NHC(NH)-heteroaryl, -NHC(NH)-heterocycloalkyl, -C(NH)NH-C₁-C₁₂-alkyl, -C(NH)NH-C₂-C₈-alkenyl, -C(NH)NH-C₂-C₈-alkynyl, -C(NH)NH-C₃-C₁₂-cycloalkyl, -C(NH)NH-aryl, -C(NH)NH-heteroaryl, -C(NH)NH-heterocycloalkyl, -S(O)-C₁-C₁₂-alkyl, -S(O)-C₂-C₈-alkenyl, -S(O)-C₂-C₈-alkynyl, -S(O)-C₃-C₁₂-cycloalkyl, -S(O)-aryl, -S(O)-heteroaryl, -S(O)-heterocycloalkyl, -SO₂NH₂, -SO₂NH-C₁-C₁₂-alkyl, -SO₂NH-C₂-C₈-alkenyl, -SO₂NH-C₂-C₈-alkynyl, -SO₂NH-C₃-C₁₂-cycloalkyl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -SO₂NH-heterocycloalkyl, -NHSO₂-C₁-C₁₂-alkyl, -NHSO₂-C₂-C₈-alkenyl, -NHSO₂-C₂-C₈-alkynyl, -NHSO₂-C₃-C₁₂-cycloalkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHSO₂-heterocycloalkyl, -CH₂NH₂, -CH₂SO₂CH₃, -aryl, -arylalkyl, -heteroaryl, -heteroarylalkyl, -heterocycloalkyl, -C₃-C₁₂-cycloalkyl, polyalkoxyalkyl, polyalkoxy, -methoxymethoxy, -methoxyethoxy, -SH, -S-C₁-C₁₂-alkyl, -S-C₂-C₈-alkenyl, -S-C₂-C₈-alkynyl, -S-C₃-C₁₂-cycloalkyl, -S-aryl, -S-heteroaryl, -S-heterocycloalkyl, or methylthio-methyl. It is understood that the aryls, heteroaryls, alkyls, and the like can be further substituted.

The term "halogen," as used herein, refers to an atom selected from fluorine, chlorine, bromine and iodine.

The term "hydrogen" includes hydrogen and deuterium. In addition, the recitation of an atom includes other isotopes of that atom so long as the resulting compound is pharmaceutically acceptable.

As described above, -L¹-L²-L³- taken together is a linker group of preferably from 6 to 16, 8 to 12, 8 to 16 or 6 to 14 bond lengths. The preferred 6 to 16, 8 to 12, 8 to 16 or 6 to 14 bond lengths is inclusive of the bonds between the linker and Y and between the linker and the carbon of the 6-membered or 5-membered ring of W (to which carbon, the linker is attached). It is to be understood that when the linker includes a cyclic group, the preferred 6 to 16, 8 to 12, 8 to 16 or 6 to 14 bond length is the shortest possible distance, as measured in bond lengths, between Y and the carbon of the 6-membered or 5-membered ring of group W.

The term "hydroxy activating group," as used herein, refers to a labile chemical moiety which is known in the art to activate a hydroxyl group so that it will depart during synthetic procedures such as in a substitution or an elimination reaction. Examples of hydroxyl activating group include, but not limited to, mesylate, tosylate, triflate, *p*-nitrobenzoate, phosphonate and the like.

The term "activated hydroxyl," as used herein, refers to a hydroxy group activated with a hydroxyl activating group, as defined above, including mesylate, tosylate, triflate, p-nitrobenzoate, phosphonate groups, for example.

The term "hydroxy protecting group," as used herein, refers to a labile chemical moiety which is known in the art to protect a hydroxyl group against undesired reactions during synthetic procedures. After said synthetic procedure(s) the hydroxy protecting group as described herein may be selectively removed. Hydroxy protecting groups as known in the art are described generally in T.H. Greene and P.G. M. Wuts, Protective Groups in Organic Synthesis, 3rd edition, John Wiley & Sons, New York (1999).

Examples of hydroxyl protecting groups include benzyloxycarbonyl, 4-methoxybenzyloxycarbonyl, tert-butoxy-carbonyl, isopropoxycarbonyl, diphenylmethoxycarbonyl, 2,2,2-trichloroethoxycarbonyl, allyloxycarbonyl, acetyl, formyl, chloroacetyl, trifluoroacetyl, methoxyacetyl, phenoxyacetyl, benzoyl, methyl, t-butyl, 2,2,2-trichloroethyl, 2-trimethylsilyl ethyl, allyl, benzyl, triphenyl-methyl (trityl), methoxymethyl, methylthiomethyl, benzyloxymethyl, 2-(trimethylsilyl)-ethoxymethyl, methanesulfonyl, trimethylsilyl, triisopropylsilyl, and the like.

The term "protected hydroxy," as used herein, refers to a hydroxy group protected with a hydroxy protecting group, as defined above, including benzoyl, acetyl, trimethylsilyl, triethylsilyl, methoxymethyl groups, for example.

The term "hydroxy prodrug group," as used herein, refers to a promoietty group which is known in the art to change the physicochemical, and hence the biological properties of a parent drug in a transient manner by covering or masking the hydroxy group. After said synthetic procedure(s), the hydroxy prodrug group as described herein must be capable of reverting back to hydroxy group in vivo. Hydroxy prodrug groups as known in the art are described generally in Kenneth B. Sloan, Prodrugs, Topical and Ocular Drug Delivery, (Drugs and the Pharmaceutical Sciences; Volume 53), Marcel Dekker, Inc., New York (1992).

The term "amino protecting group," as used herein, refers to a labile chemical moiety which is known in the art to protect an amino group against undesired reactions during synthetic procedures. After said synthetic procedure(s) the amino protecting group as described herein may be selectively removed. Amino protecting groups as known in the art are described generally in T.H. Greene and P.G. M. Wuts, Protective Groups in Organic Synthesis, 3rd edition, John Wiley & Sons, New York (1999). Examples of

amino protecting groups include, but are not limited to, methoxycarbonyl, t-butoxycarbonyl, 9-fluorenyl-methoxycarbonyl, benzyloxycarbonyl, and the like.

The term "protected amino," as used herein, refers to an amino group protected with an amino protecting group as defined above.

5 The term "leaving group" means a functional group or atom which can be displaced by another functional group or atom in a substitution reaction, such as a nucleophilic substitution reaction. By way of example, representative leaving groups include chloro, bromo and iodo groups; sulfonic ester groups, such as mesylate, tosylate, brosylate, nosylate and the like; and acyloxy groups, such as acetoxy, trifluoroacetoxy and
10 the like.

 The term "aprotic solvent," as used herein, refers to a solvent that is relatively inert to proton activity, i.e., not acting as a proton-donor. Examples include, but are not limited to, hydrocarbons, such as hexane and toluene, for example, halogenated hydrocarbons, such as, for example, methylene chloride, ethylene chloride, chloroform, and the like,
15 heterocyclic compounds, such as, for example, tetrahydrofuran and N-methylpyrrolidinone, and ethers such as diethyl ether, bis-methoxymethyl ether. Such compounds are well known to those skilled in the art, and it will be obvious to those skilled in the art that individual solvents or mixtures thereof may be preferred for specific compounds and reaction conditions, depending upon such factors as the solubility of
20 reagents, reactivity of reagents and preferred temperature ranges, for example. Further discussions of aprotic solvents may be found in organic chemistry textbooks or in specialized monographs, for example: Organic Solvents Physical Properties and Methods of Purification, 4th ed., edited by John A. Riddick *et al.*, Vol. II, in the Techniques of Chemistry Series, John Wiley & Sons, NY, 1986.

25 The term "protic solvent," as used herein, refers to a solvent that tends to provide protons, such as an alcohol, for example, methanol, ethanol, propanol, isopropanol, butanol, t-butanol, and the like. Such solvents are well known to those skilled in the art, and it will be obvious to those skilled in the art that individual solvents or mixtures thereof may be preferred for specific compounds and reaction conditions, depending upon such
30 factors as the solubility of reagents, reactivity of reagents and preferred temperature ranges, for example. Further discussions of protogenic solvents may be found in organic chemistry textbooks or in specialized monographs, for example: Organic Solvents Physical Properties and Methods of Purification, 4th ed., edited by John A. Riddick *et al.*, Vol. II, in the Techniques of Chemistry Series, John Wiley & Sons, NY, 1986.

Combinations of substituents and variables envisioned by this invention are only those that result in the formation of stable compounds. The term "stable," as used herein, refers to compounds which possess stability sufficient to allow manufacture and which maintains the integrity of the compound for a sufficient period of time to be useful for the purposes detailed herein (e.g., therapeutic or prophylactic administration to a subject).

The synthesized compounds can be separated from a reaction mixture and further purified by a method such as column chromatography, high pressure liquid chromatography, or recrystallization. As can be appreciated by the skilled artisan, further methods of synthesizing the compounds of the Formula herein will be evident to those of ordinary skill in the art. Additionally, the various synthetic steps may be performed in an alternate sequence or order to give the desired compounds. Synthetic chemistry transformations and protecting group methodologies (protection and deprotection) useful in synthesizing the compounds described herein are known in the art and include, for example, those such as described in R. Larock, Comprehensive Organic Transformations, 2nd Ed. Wiley-VCH (1999); T.W. Greene and P.G.M. Wuts, Protective Groups in Organic Synthesis, 3rd Ed., John Wiley and Sons (1999); L. Fieser and M. Fieser, Fieser and Fieser's Reagents for Organic Synthesis, John Wiley and Sons (1994); and L. Paquette, ed., Encyclopedia of Reagents for Organic Synthesis, John Wiley and Sons (1995), and subsequent editions thereof.

The term "subject," as used herein, refers to an animal. Preferably, the animal is a mammal. More preferably, the mammal is a human. A subject also refers to, for example, dogs, cats, horses, cows, pigs, guinea pigs, fish, birds and the like.

The compounds of this invention may be modified by appending appropriate functionalities to enhance selective biological properties. Such modifications are known in the art and may include those which increase biological penetration into a given biological system (e.g., blood, lymphatic system, central nervous system), increase oral availability, increase solubility to allow administration by injection, alter metabolism and alter rate of excretion.

The compounds described herein contain one or more asymmetric centers and thus give rise to enantiomers, diastereomers, and other stereoisomeric forms that may be defined, in terms of absolute stereochemistry, as (R)- or (S)-, or as (D)- or (L)- for amino acids. The present invention is meant to include all such possible isomers, as well as their racemic and optically pure forms. Optical isomers may be prepared from their respective optically active precursors by the procedures described above, or by resolving the racemic

mixtures. The resolution can be carried out in the presence of a resolving agent, by chromatography or by repeated crystallization or by some combination of these techniques which are known to those skilled in the art. Further details regarding resolutions can be found in Jacques, *et al.*, Enantiomers, Racemates, and Resolutions (John Wiley & Sons, 1981). When the compounds described herein contain olefinic double bonds, other unsaturation, or other centers of geometric asymmetry, and unless specified otherwise, it is intended that the compounds include both E and Z geometric isomers or cis- and trans-isomers. Likewise, all tautomeric forms are also intended to be included. Tautomers may be in cyclic or acyclic. The configuration of any carbon-carbon double bond appearing herein is selected for convenience only and is not intended to designate a particular configuration unless the text so states; thus a carbon-carbon double bond or carbon-heteroatom double bond depicted arbitrarily herein as *trans* may be *cis*, *trans*, or a mixture of the two in any proportion.

Certain compounds of the present invention may also exist in different stable conformational forms which may be separable. Torsional asymmetry due to restricted rotation about an asymmetric single bond, for example because of steric hindrance or ring strain, may permit separation of different conformers. The present invention includes each conformational isomer of these compounds and mixtures thereof.

As used herein, the term "pharmaceutically acceptable salt," refers to those salts which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of humans and lower animals without undue toxicity, irritation, allergic response and the like, and are commensurate with a reasonable benefit/risk ratio.

Pharmaceutically acceptable salts are well known in the art. For example, S. M. Berge, *et al.* describes pharmaceutically acceptable salts in detail in J. Pharmaceutical Sciences, 66: 1-19 (1977). The salts can be prepared *in situ* during the final isolation and purification of the compounds of the invention, or separately by reacting the free base function with a suitable organic acid. Examples of pharmaceutically acceptable salts include, but are not limited to, 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, 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, but are not limited to, adipate, alginate, ascorbate, aspartate, benzenesulfonate, benzoate, bisulfate, borate, butyrate, camphorate, camphorsulfonate, citrate, cyclopentane-propionate, 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. 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, alkyl having from 1 to 6 carbon atoms, sulfonate and aryl sulfonate.

As used herein, the term "pharmaceutically acceptable ester" refers to esters which hydrolyze *in vivo* and include those that break down readily in the human body to leave the parent compound or a salt thereof. Suitable ester groups include, for example, those derived from pharmaceutically acceptable aliphatic carboxylic acids, particularly alkanoic, alkenoic, cycloalkanoic and alkanedioic acids, in which each alkyl or alkenyl moiety advantageously has not more than 6 carbon atoms. Examples of particular esters include, but are not limited to, formates, acetates, propionates, butyrates, acrylates and ethylsuccinates.

The term "pharmaceutically acceptable prodrugs," as used herein, refers to those prodrugs of the compounds of the present invention which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of humans and lower animals with undue toxicity, irritation, allergic response, and the like, commensurate with a reasonable benefit/risk ratio, and effective for their intended use, as well as the zwitterionic forms, where possible, of the compounds of the present invention. "Prodrug," as used herein, means a compound which is convertible *in vivo* by metabolic means (e.g. by hydrolysis) to a compound of the invention. Various forms of prodrugs are known in the art, for example, as discussed in Bundgaard, (ed.), *Design of Prodrugs*, Elsevier (1985); Widder, *et al.* (ed.), *Methods in Enzymology*, vol. 4, Academic Press (1985); Krogsgaard-Larsen, *et al.*, (ed). "Design and Application of Prodrugs," *Textbook of Drug Design and Development*, Chapter 5, 113-191 (1991); Bundgaard, *et al.*, *Journal of Drug Deliver Reviews*, 8:1-38(1992); Bundgaard, *J. of Pharmaceutical Sciences*, 77:285 et seq. (1988); Higuchi and Stella (eds.) *Prodrugs as Novel Drug Delivery Systems*, American Chemical Society (1975); and Bernard Testa & Joachim Mayer, "Hydrolysis In Drug And

Prodrug Metabolism: Chemistry, Biochemistry And Enzymology,” John Wiley and Sons, Ltd. (2002).

The present invention also relates to solvates of the compounds of Formula (I), for example hydrates.

5 This invention also encompasses pharmaceutical compositions containing, and methods of treating viral infections through administering, pharmaceutically acceptable prodrugs of compounds of the invention. For example, compounds of the invention having free amino, amido, hydroxy or carboxylic groups can be converted into prodrugs. Prodrugs include compounds wherein an amino acid residue, or a polypeptide chain of two
10 or more (e.g., two, three or four) amino acid residues is covalently joined through an amide or ester bond to a free amino, hydroxy or carboxylic acid group of compounds of the invention. The amino acid residues include but are not limited to the 20 naturally occurring amino acids commonly designated by three letter symbols and also includes 4-hydroxyproline, hydroxylysine, demosine, isodemosine, 3-methylhistidine, norvalin, beta-
15 alanine, gamma-aminobutyric acid, citrulline, homocysteine, homoserine, ornithine and methionine sulfone. Additional types of prodrugs are also encompassed. For instance, free carboxyl groups can be derivatized as amides or alkyl esters. Free hydroxy groups may be derivatized using groups including but not limited to hemisuccinates, phosphate esters, dimethylaminoacetates, and phosphoryloxymethyloxycarbonyls, as outlined in
20 Advanced Drug Delivery Reviews, 1996, 19, 115. Carbamate prodrugs of hydroxy and amino groups are also included, as are carbonate prodrugs, sulfonate esters and sulfate esters of hydroxy groups. Derivatization of hydroxy groups as (acyloxy)methyl and (acyloxy)ethyl ethers wherein the acyl group may be an alkyl ester, optionally substituted with groups including but not limited to ether, amine and carboxylic acid functionalities,
25 or where the acyl group is an amino acid ester as described above, are also encompassed. Prodrugs of this type are described in *J. Med. Chem.* 1996, 39, 10. Free amines can also be derivatized as amides, sulfonamides or phosphonamides. All of these prodrug moieties may incorporate groups including but not limited to ether, amine and carboxylic acid functionalities.

30 PHARMACEUTICAL COMPOSITIONS

The pharmaceutical compositions of the present invention comprise a therapeutically effective amount of a compound of the present invention formulated together with one or more pharmaceutically acceptable carriers or excipients.

As used herein, the term "pharmaceutically acceptable carrier or excipient" means a non-toxic, inert solid, semi-solid or liquid filler, diluent, encapsulating material or formulation auxiliary of any type. Some examples of materials which can serve as pharmaceutically acceptable carriers are 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 as propylene 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.

The pharmaceutical compositions of this invention may be administered orally, parenterally, by inhalation spray, topically, rectally, nasally, buccally, vaginally or via an implanted reservoir, preferably by oral administration or administration by injection. The pharmaceutical compositions of this invention may contain any conventional non-toxic pharmaceutically-acceptable carriers, adjuvants or vehicles. In some cases, the pH of the formulation may be adjusted with pharmaceutically acceptable acids, bases or buffers to enhance the stability of the formulated compound or its delivery form. The term parenteral as used herein includes subcutaneous, intracutaneous, intravenous, intramuscular, intra-articular, intraarterial, intrasynovial, intrasternal, intrathecal, intralesional and intracranial injection or infusion techniques.

Liquid dosage forms for oral administration include 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.

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.

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.

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

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.

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.

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.

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, eye ointments, powders and solutions are also contemplated as being within the scope of this invention.

The ointments, pastes, creams and gels may contain, in addition to an active compound of this invention, excipients such as animal and vegetable fats, oils, waxes, paraffins, starch, tragacanth, cellulose derivatives, polyethylene glycols, silicones, bentonites, silicic acid, talc and zinc oxide, or mixtures thereof.

Powders and sprays can contain, in addition to the compounds of this invention, excipients such as lactose, talc, silicic acid, aluminum hydroxide, calcium silicates and polyamide powder, or mixtures of these substances. Sprays can additionally contain customary propellants such as chlorofluorohydrocarbons.

5 Transdermal patches have the added advantage of providing controlled delivery of a compound to the body. Such dosage forms can be made by dissolving or dispensing 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.

10 For pulmonary delivery, a therapeutic composition of the invention is formulated and administered to the patient in solid or liquid particulate form by direct administration e.g., inhalation into the respiratory system. Solid or liquid particulate forms of the active compound prepared for practicing the present invention include particles of respirable size: that is, particles of a size sufficiently small to pass through the mouth and larynx
15 upon inhalation and into the bronchi and alveoli of the lungs. Delivery of aerosolized therapeutics, particularly aerosolized antibiotics, is known in the art (see, for example U.S. Pat. No. 5,767,068 to VanDevanter *et al.*, U.S. Pat. No. 5,508,269 to Smith *et al.*, and WO 98/43650 by Montgomery, all of which are incorporated herein by reference). A discussion of pulmonary delivery of antibiotics is also found in U.S. Pat. No. 6,014,969,
20 incorporated herein by reference.

ANTIVIRAL ACTIVITY

An inhibitory amount or dose of the compounds of the present invention may range from about 0.01 mg/Kg to about 500 mg/Kg, alternatively from about 1 to about 50 mg/Kg. Inhibitory amounts or doses will also vary depending on route of administration,
25 as well as the possibility of co-usage with other agents.

According to the methods of treatment of the present invention, viral infections, conditions are treated or prevented in a patient such as a human or another animal by administering to the patient a therapeutically effective amount of a compound of the invention, in such amounts and for such time as is necessary to achieve the desired result.

30 By a "therapeutically effective amount" of a compound of the invention is meant an amount of the compound which confers a therapeutic effect on the treated subject, at a reasonable benefit/risk ratio applicable to any medical treatment. The therapeutic effect may be objective (i.e., measurable by some test or marker) or subjective (i.e., subject gives

an indication of or feels an effect). An effective amount of the compound described above may range from about 0.1 mg/Kg to about 500 mg/Kg, preferably from about 1 to about 50 mg/Kg. Effective doses will also vary depending on route of administration, as well as the possibility of co-usage with other agents. 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 therapeutically effective dose level for any particular patient 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 contemporaneously with the specific compound employed; and like factors well known in the medical arts.

The total daily dose of the compounds of this invention administered to a human or other animal in single or in divided doses can be in amounts, for example, from 0.01 to 50 mg/kg body weight or more usually from 0.1 to 25 mg/kg body weight. Single dose compositions may contain such amounts or submultiples thereof to make up the daily dose. In general, treatment regimens according to the present invention comprise administration to a patient in need of such treatment from about 10 mg to about 1000 mg of the compound(s) of this invention per day in single or multiple doses.

The compounds of the present invention described herein can, for example, be administered by injection, intravenously, intraarterially, subdermally, intraperitoneally, intramuscularly, or subcutaneously; or orally, buccally, nasally, transmucosally, topically, in an ophthalmic preparation, or by inhalation, with a dosage ranging from about 0.1 to about 500 mg/kg of body weight, alternatively dosages between 1 mg and 1000 mg/dose, every 4 to 120 hours, or according to the requirements of the particular drug. The methods herein contemplate administration of an effective amount of compound or compound composition to achieve the desired or stated effect. Typically, the pharmaceutical compositions of this invention will be administered from about 1 to about 6 times per day or alternatively, as a continuous infusion. Such administration can be used as a chronic or acute therapy. The amount of active ingredient that may be combined with pharmaceutically excipients or carriers to produce a single dosage form will vary depending upon the host treated and the particular mode of administration. A typical preparation will

contain from about 5% to about 95% active compound (w/w). Alternatively, such preparations may contain from about 20% to about 80% active compound.

Lower or higher doses than those recited above may be required. Specific dosage and treatment regimens for any particular patient will depend upon a variety of factors, including the activity of the specific compound employed, the age, body weight, general health status, sex, diet, time of administration, rate of excretion, drug combination, the severity and course of the disease, condition or symptoms, the patient's disposition to the disease, condition or symptoms, and the judgment of the treating physician.

Upon improvement of a patient's condition, a maintenance dose of a compound, composition or combination of this invention may be administered, if necessary. Subsequently, the dosage or frequency of administration, or both, may be reduced, as a function of the symptoms, to a level at which the improved condition is retained when the symptoms have been alleviated to the desired level. Patients may, however, require intermittent treatment on a long-term basis upon any recurrence of disease symptoms.

When the compositions of this invention comprise a combination of a compound of the Formula described herein and one or more additional therapeutic or prophylactic agents, both the compound and the additional agent should be present at dosage levels of between about 1 to 100%, and more preferably between about 5 to 95% of the dosage normally administered in a monotherapy regimen. The additional agents may be administered separately, as part of a multiple dose regimen, from the compounds of this invention. Alternatively, those agents may be part of a single dosage form, mixed together with the compounds of this invention in a single composition.

The said "additional therapeutic or prophylactic agents" includes but not limited to, immune therapies (eg. interferon), therapeutic vaccines, antifibrotic agents, anti-inflammatory agents such as corticosteroids or NSAIDs, bronchodilators such as beta-2 adrenergic agonists and xanthines (e.g. theophylline), mucolytic agents, anti-muscarinics, anti-leukotrienes, inhibitors of cell adhesion (e.g. ICAM antagonists), anti-oxidants (eg N-acetylcysteine), cytokine agonists, cytokine antagonists, lung surfactants and/or antimicrobial and anti-viral agents (eg ribavirin and amantidine). The compositions according to the invention may also be used in combination with gene replacement therapy.

COMBINATION AND ALTERNATION THERAPY FOR HCV

It has been recognized that drug-resistant variants of HCV can emerge after prolonged treatment with an antiviral agent. Drug resistance most typically occurs by mutation of a gene that encodes for a protein such as an enzyme used in viral replication, and most typically in the case of HCV, RNA polymerase, protease, or helicase.

Recently, it has been demonstrated that the efficacy of a drug against a viral infection, such as HIV, can be prolonged, augmented, or restored by administering the drug in combination or alternation with a second, and perhaps third, antiviral compound that induces a different mutation from that caused by the principal drug. Alternatively, the pharmacokinetics, biodistribution, or other parameter of the drug can be altered by such combination or alternation therapy. In general, combination therapy is typically preferred over alternation therapy because it induces multiple simultaneous stresses on the virus.

A compound of the present invention can also be administered in combination or alternation with antiviral agent. Exemplary antiviral agents include ribavirin, interferon, interleukin or a stabilized prodrug of any of them. More broadly described, the compound can be administered in combination or alternation with any of the anti-HCV drugs listed in Table 13 below.

Table 13: Table of anti-Hepatitis C Compounds in Current Clinical Development		
Drug name	Drug category	Pharmaceutical Company
PEGASYS pegylated interferon alfa-2a	Long acting interferon	Roche
INFERGEN interferon alfacon-1	Long acting interferon	InterMune
OMNIFERON natural interferon	Long acting interferon	Viragen
ALBUFERON	Long acting interferon	Human Genome Sciences
REBIF interferon beta-1a	Interferon	Ares-Serono
Omega Interferon	Interferon	BioMedicine
Oral Interferon alpha	Oral Interferon	Amarillo Biosciences
Interferon gamma-lb	Anti-fibrotic	InterMune
IP-501	Anti-fibrotic	InterMune
Merimebodib VX-497	IMPDH inhibitor (inosine monophosphate dehydrogenase)	Vertex
AMANTADINE (Symmetrel)	Broad Antiviral Agent	Endo Labs Solvay
IDN-6556	Apoptosis regulation	Idun Pharma.
XTL-002	Monoclonal Antibody	XTL
HCV/MF59	Vaccine	Chiron
CIVACIR	Polyclonal Antibody Therapeutic vaccine	NABI Innogenetics

VIRAMIDINE	Nucleoside Analogue	ICN
ZADAXIN (thymosin alfa-1)	Immunomodulator	Sci Clone
CEPLENE (histamine)	Immunomodulator	Maxim
VX 950/LY 570310	Protease inhibitor	Vertex/Eli Lilly
ISIS 14803	Antisense	Isis Pharmaceutical/Elan
IDN-6556	Caspase inhibitor	Idun Pharmaceuticals
JTK 003	Polymerase Inhibitor	AKROS Pharma
Tarvacin	Anti-Phospholipid Therapy	Peregrine
HCV-796	Polymerase Inhibitor	ViroPharma/Wyeth
CH-6	Protease inhibitor	Schering
ANA971	Isatoribine	ANADYS
ANA245	Isatoribine	ANADYS
CPG 10101 (Actilon)	Immunomodulator	Coley
Rituximab (Rituxam)	Anti-CD20 Monoclonal Antibody	Genetech/IDEC
NM283 (Valopicitabine)	Polymerase Inhibitor	Idenix Pharmaceuticals
HepX TM -C	Monoclonal Antibody	XTL
IC41	Therapeutic Vaccine	Intercell
Medusa Interferon	Longer acting interferon	Flamel Technology
E-1	Therapeutic Vaccine	Innogenetics
Multiferon	Long Acting Interferon	Viragen
BILN 2061	Protease inhibitor	Boehringer-Ingelheim
TMC435350	Protease inhibitor	Tibotec/Medivir
Telaprevir (VX-950)	Protease inhibitor	Vertex
Boceprevir (SCH 503034)	Protease inhibitor	Schering-Plough
ACH-1625	Protease inhibitor	Achillion
ABT-450	Protease inhibitor	Abbott/Enanta
BI-201335	Protease inhibitor	Boehringer-Ingelheim
PHX-1766	Protease inhibitor	Phenomix
VX-500	Protease inhibitor	Vertex
MK-7009	protease inhibitor	Merck
R7227 (ITMN-191)	protease inhibitor	InterMune
Narlaprevir (SCH 900518)	Protease inhibitor	Schering/Merck
Alinia (nitazoxanide)	To be determined	Romark
ABT-072	Polymerase Inhibitor	Abbott
ABT-333	Polymerase Inhibitor	Abbott
Filibuvir (PF-00868554)	Polymerase Inhibitor	Pfizer
VCH-916	Polymerase Inhibitor	Vertex
R7128 (PSI6130)	Polymerase Inhibitor	Roche/Pharmasset
IDX184	Polymerase Inhibitor	Idenix
INX-189	Polymerase Inhibitor	Inhibitex
PSI-7977	Polymerase Inhibitor	Pharmasset
PSI-938	Polymerase Inhibitor	Pharmasset
R1626	Polymerase inhibitor	Roche
MK-3281	Polymerase inhibitor	Merck
PSI-7851	Polymerase inhibitor	Pharmasset
ANA598	Polymerase inhibitor	Anadys Pharmaceuticals
BI-207127	Polymerase inhibitor	Boehringer-Ingelheim
GS-9190	Polymerase inhibitor	Gilead
VCH-759	Polymerase Inhibitor	Vertex
Clemizole	NS4B inhibitor	Eiger Biopharmaceuticals
A-832	NS5A inhibitor	ArrowTherapeutics
BMS-790052	NS5A inhibitor	Bristol-Myers-Squibb
BMS-824393	NS5A inhibitor	Bristol-Myers-Squibb
GS-5885	NS5A inhibitor	Gilead
ITX5061	Entry inhibitor	iTherx
GS-9450	Caspase inhibitor	Gilead
ANA773	TLR agonist	Anadys

CYT107	immunomodulator	Cytheris
SPC3649 (LNA-antimiR TM -122)	microRNA	Santaris Pharma
Debio 025	Cyclophilin inhibitor	Debiopharm
SCY-635	Cyclophilin inhibitor	Scynexis

Unless otherwise defined, all technical and scientific terms used herein are accorded the meaning commonly known to one of ordinary skill in the art. All publications, patents, published patent applications, and other references mentioned herein are hereby incorporated by reference in their entirety.

ABBREVIATIONS

Abbreviations which may be used in the descriptions of the scheme and the examples that follow are: Ac for acetyl; AcOH for acetic acid; AIBN for azobisisobutyronitrile; BINAP for 2,2'-bis(diphenylphosphino)-1,1'-binaphthyl; Boc₂O for di-*tert*-butyl-dicarbonate; Boc for *t*-butoxycarbonyl; Bpoc for 1-methyl-1-(4-biphenyl)ethyl carbonyl; BtOH for 1-hydroxy-benzotriazole; Bz for benzoyl; Bn for benzyl; BocNHOH for *tert*-butyl N-hydroxycarbamate; *t*-BuOK for potassium *tert*-butoxide; Bu₃SnH for tributyltin hydride; BOP for (benzotriazol-1-yloxy)tris(dimethylamino)phosphonium Hexafluorophosphate; Brine for sodium chloride solution in water; Cbz for carbobenzyloxy; CDI for carbonyldiimidazole; CH₂Cl₂ for dichloromethane; CH₃ for methyl; CH₃CN for acetonitrile; Cs₂CO₃ for cesium carbonate; CuCl for copper (I) chloride; CuI for copper (I) iodide; dba for dibenzylidene acetone; dppb for diphenylphosphino butane; DBU for 1,8-diazabicyclo[5.4.0]undec-7-ene; DCC for N,N'-dicyclohexylcarbodiimide; DEAD for diethylazodicarboxylate; DIAD for diisopropyl azodicarboxylate; DIBAL-H for diisobutylaluminium hydride; DIPEA or (i-Pr)₂EtN for N,N-diisopropylethyl amine; Dess-Martin periodinane for 1,1,1-tris(acetyloxy)-1,1-dihydro-1,2-benziodoxol-3-(1H)-one; DMAP for 4-dimethylaminopyridine; DME for 1,2-dimethoxy-ethane; DMF for N,N-dimethylformamide; DMSO for dimethyl sulfoxide; DMT for di(*p*-methoxyphenyl)phenylmethyl or dimethoxytrityl; DPPA for diphenylphosphoryl azide; EDC for N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide; EDC HCl for N-(3-dimethylamino-propyl)-N'-ethylcarbodiimide hydrochloride; EtOAc for ethyl acetate; EtOH for ethanol; Et₂O for diethyl ether; Fmoc for 9-fluorenylmethoxycarbonyl; Grubbs-1 catalyst for benzylidene-bis(tricyclohexylphosphine)dichlororuthenium; HATU for O-(7-azabenzotriazol-1-yl)-N,N,N',N'-tetramethyluronium hexafluorophosphate; HCl for hydrogen chloride; HOBT for 1-hydroxybenzotriazole; K₂CO₃ for potassium carbonate; *n*-

BuLi for *n*-butyl lithium; *i*-BuLi for *i*-butyl lithium; *t*-BuLi for *t*-butyl lithium; PhLi for phenyl lithium; LDA for lithium diisopropylamide; LiTMP for lithium 2,2,6,6-tetramethylpiperidinate; MeOH for methanol; Mg for magnesium; MOM for methoxymethyl; Ms for mesyl or -SO₂-CH₃; Ms₂O for methanesulfonic anhydride or
 5 mesyl-anhydride; NaBH₄ for sodium borohydride; NaBH₃CN for sodium cyanoborohydride; NaN(TMS)₂ for sodium bis(trimethylsilyl)amide; NaCl for sodium chloride; NaH for sodium hydride; NaHCO₃ for sodium bicarbonate or sodium hydrogen carbonate; Na₂CO₃ sodium carbonate; NaOH for sodium hydroxide; Na₂SO₄ for sodium sulfate; NaHSO₃ for sodium bisulfite or sodium hydrogen sulfite; Na₂S₂O₃ for sodium
 10 thiosulfate; NH₂NH₂ for hydrazine; NH₄HCO₃ for ammonium bicarbonate; NH₄Cl for ammonium chloride; NMMO for N-methylmorpholine N-oxide; NaIO₄ for sodium periodate; Ni for nickel; OH for hydroxyl; OsO₄ for osmium tetroxide; Pd for palladium; Ph for phenyl; PMB for p-methoxybenzyl; POPd for dihydrogen dichlorobis(di-*tert*-butylphosphinito-κP)palladate(II); Pd₂(dba)₃ for tris(dibenzylidene-acetone) dipalladium
 15 (0); Pd(PPh₃)₄ for tetrakis(triphenylphosphine)palladium (0); PdCl₂(PPh₃)₂ for trans-dichlorobis(triphenyl-phosphine)palladium (II); Pt for platinum; Rh for rhodium; rt for room temperature; Ru for ruthenium; SEM for (trimethylsilyl)ethoxymethyl; TBAF for tetrabutylammonium fluoride; TBS for *tert*-butyl dimethylsilyl; TEA or Et₃N for triethylamine; Teoc for 2-trimethylsilyl-ethoxy-carbonyl; TFA for trifluoroacetic acid;
 20 THF for tetrahydrofuran; TMEDA for N,N,N',N'-tetramethylethylenediamine; TPP or PPh₃ for triphenyl-phosphine; Troc for 2,2,2-trichloroethyl carbonyl; Ts for tosyl or -SO₂-C₆H₄CH₃; Ts₂O for tolylsulfonic anhydride or tosyl-anhydride; TsOH for p-tolylsulfonic acid; TMS for trimethylsilyl; TMSCl for trimethylsilyl chloride; or Zhan-1b catalyst for
 25 1,3-bis(2,4,6-trimethylphenyl)-4,5-dihydroimidazol-2-ylidene[2-(iso-propoxy)-5-(N,N-dimethylaminosulfonyl)phenyl]methylene ruthenium(II) dichloride.

SYNTHETIC METHODS

The compounds and processes of the present invention will be better understood in connection with the following synthetic schemes that illustrate the methods by which the compounds of the invention may be prepared. Starting materials can be obtained from
 30 commercial sources or prepared by well-established literature methods known to those of ordinary skill in the art. It will be readily apparent to one of ordinary skill in the art that the compounds defined above can be synthesized by substitution of the appropriate reactants and agents in the syntheses shown below. It will also be readily apparent to one

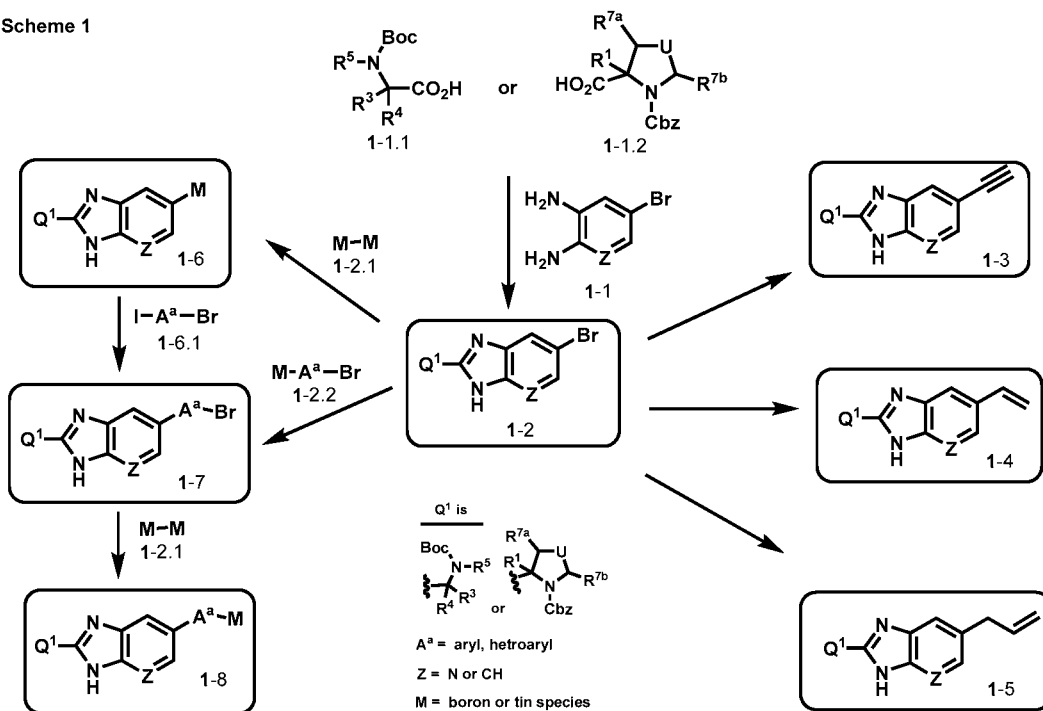
skilled in the art that the selective protection and deprotection steps, as well as the order of the steps themselves, can be carried out in varying order, depending on the nature of the variables to successfully complete the syntheses below. The variables are as defined above unless otherwise noted below.

- 5 The compounds of the present invention may be prepared via several different synthetic routes from a variety of 5/6-membered ring fused heteroaryl, 5-membered ring heteroaryl, and related intermediates. An exemplary method is shown in Schemes 1, 2, 3, and 4. A retro-synthesis of those title compounds include direct formation of a suitable heterocycle (5/6-membered ring fused heteroaryl or 5-membered ring heteroaryl)
- 10 optionally with a suitable macrocyclic linkage, followed by attachment of a suitable capping group (such as $\tilde{C}(O)R^6$), plus some functional group manipulations in between and/or after. Various 5/6-membered ring fused heteroaryl or 5-membered ring heteroaryl intermediates are known to those skilled in the art, for example see the encyclopedic volumes edited by A. R. Katritzky, *et al*, "Comprehensive Heterocyclic Chemistry" 1984;
- 15 "Comprehensive Heterocyclic Chemistry II" 1996; "Comprehensive Heterocyclic Chemistry III" 2008.

A general synthesis and further elaboration of some 6-membered ring fused with imidazole related intermediates are summarized in Scheme 1, in which Z is N or CH.

- The synthesis starts from the construction of an optionally substituted
- 20 imidazopyridine or benzimidazole **1-2**, which may be obtained by condensation of an amino acid or its derivatives **1-1.1** or **1-1.2** with 2,3-diaminopyridine or 1,2-diaminobenzene **1-1** under the conditions to those skilled in the art. The imidazole ring closure may be realized either in one pot by heat, optionally in the presence of an acid and/or with a dehydration reagent such as polyphosphoric acid; or in two steps: 1) amide
- 25 formation between diamine **1-1** and amino acid **1-1.1** or **1-1.2** in the presence of a condensation reagent such as EDC·HCl, DCC or the like; or through mixed anhydride approach by reacting acid **1-1.1** or **1-1.2** with a chloroformate such as methyl chloroformate, isobutyl chloroformate, or the like, in the presence of a base such as TEA, DIPEA, DMAP, N-methylmorpholine, or the like, followed by treating the mixed
- 30 anhydride with diamine **1-1**; and 2) the heterocyclic ring closure in the presence of an acid such as acetic acid, sulfuric acid or the like or a dehydration reagent such as HATU or the like, optionally with heat. Other imidazopyridines or benzimidazoles with more substitution may be prepared similarly using the procedures described hereinwith.

Scheme 1

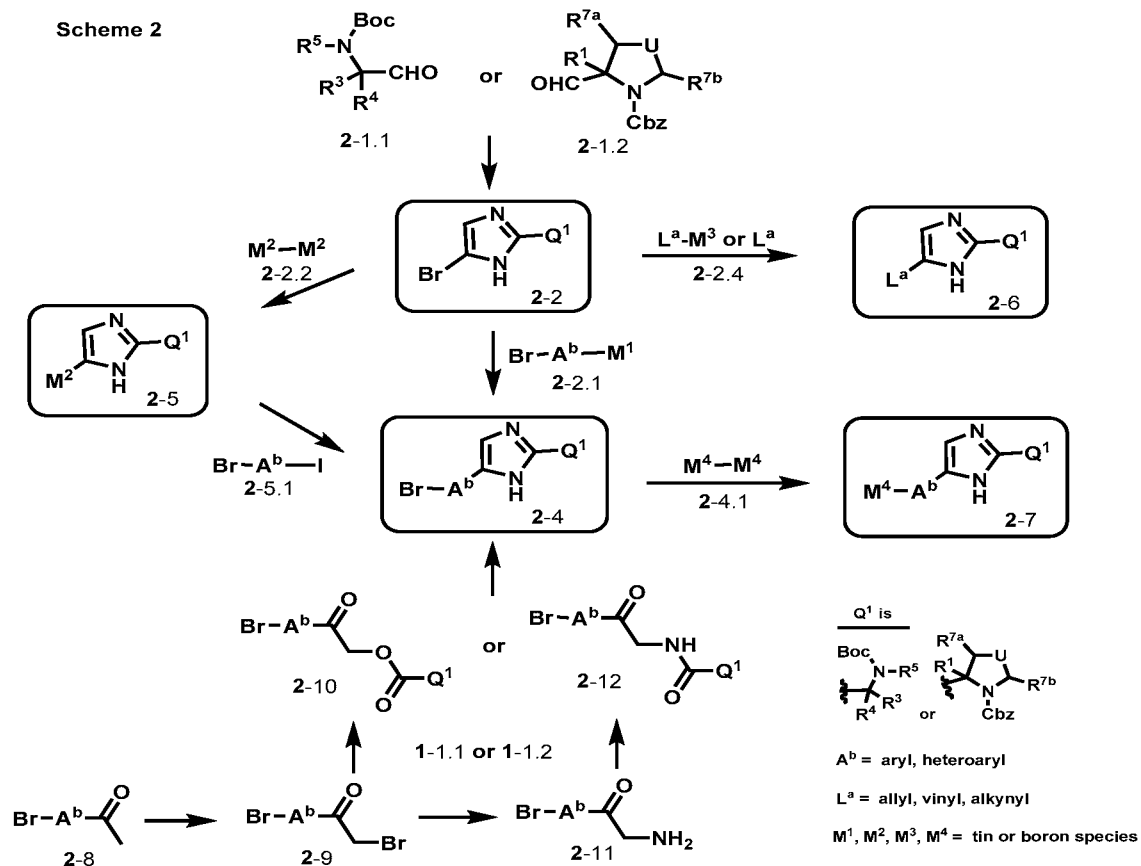


The imidazopyridine or benzimidazole **1-2** may be subjected to Suzuki, Stille or related coupling conditions known to those skilled in the art (see reviews: A. Suzuki, *Pure Applied Chem.*, 1991, 63, 419; A. Suzuki, *Handbook of Organopalladium Chemistry for Organic Synthesis*, 2002, 1, 249; A. Anastasia, et al, *Handbook of Organopalladium Chemistry for Organic Synthesis*, 2002, 1, 311; F. Bellina, et al, *Synthesis*, 2004, 2419; M. G. Organ, et al, *Synthesis* 2008, 2776; A. T. Lindhardt, et al, *Chem. - A European J.*, 2008, 14, 8756; E. A. B. Kantchev, et al, *Angew. Chem. Int. Ed.*, 2007, 46, 2768; V. Farina, et al, *Advances in Metal-Organic Chem.*, 1996, 5:1) with different coupling partners to provide a variety of key intermediates. For example, Sonogashira coupling between bromide **1-2** and trimethylsilylacetylene can generate alkyne **1-3** after removal of TMS by K₂CO₃ in MeOH. Alternatively, bromide **1-2** may be coupled with tributylvinylstanne through Stille reaction conditions known to those skilled in the art to provide alkene **1-4**. Analogously, a key allyl intermediate **1-5** may be prepared by Stille reaction from bromide **1-2** with an allylstanne such as allyltributylstanne.

Alternatively, bromide **1-2** may be converted to key intermediate **1-7** by selectively reacting with metallic reagent **1-2.2** under the Suzuki or Stille conditions which are known to those skilled in the art. Yet alternatively, intermediate **1-7** may be prepared by treating bromide **1-2** with dimetallic agent **1-2.1** to afford organometallic **1-6**, followed by coupling with bromoiodoaryl compound **1-6.1**, both may be under the previously described Suzuki or Stille reaction conditions. The bromide **1-7** may be further converted to

organometallic 1-8 with dimetallic agent 1-2.1 using the conditions described above to prepare 1-6.

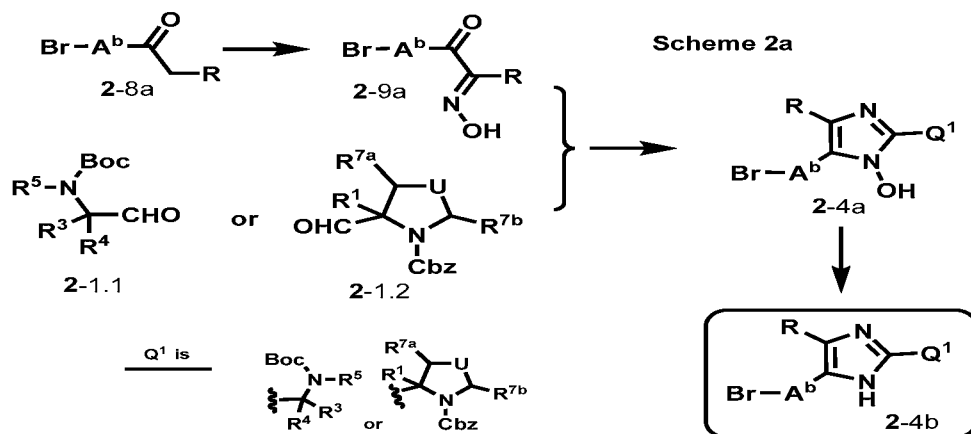
It should be noted that optionally the NH group of all the imidazopyridine or benzimidazole related intermediates listed above may be protected with an amino protecting group, such as SEM (i.e. SEM-Cl, NaH), Boc, Cbz, Teoc, Troc, or the like.



A typical synthesis of imidazole related intermediates are analogous to that of the imidazopyridine or benzimidazole intermediates. As shown in Scheme 2, bromo-imidazole 2-2 can be synthesized by condensation of amino acid derived aldehyde 2-1.1 or 2-1.2 and glyoxal in the presence of methanolic ammonia; followed by bromination of the imidazole ring under the conditions which are known to those skilled in the art. The bromination of the imidazole ring may be realized either in one pot by NBS, bromine, 2,4,4,6-tetrabromo-2,5-cyclohexadienone, or the like; or in two steps: 1) dibromide formation in the presence of excess bromination reagent such as NBS, bromine, 2,4,4,6-tetrabromo-2,5-cyclohexadienone, or the like, optionally with heat; and 2) reduction of the dibromide to monobromide in the presence of a reducing reagent such as NaHSO₃, Na₂S₂O₃, Na₂SO₃, or the like. Bromide 2-2 then may be served as a common intermediate further elaborable to many other imidazole derivatives using the chemistry discussed in

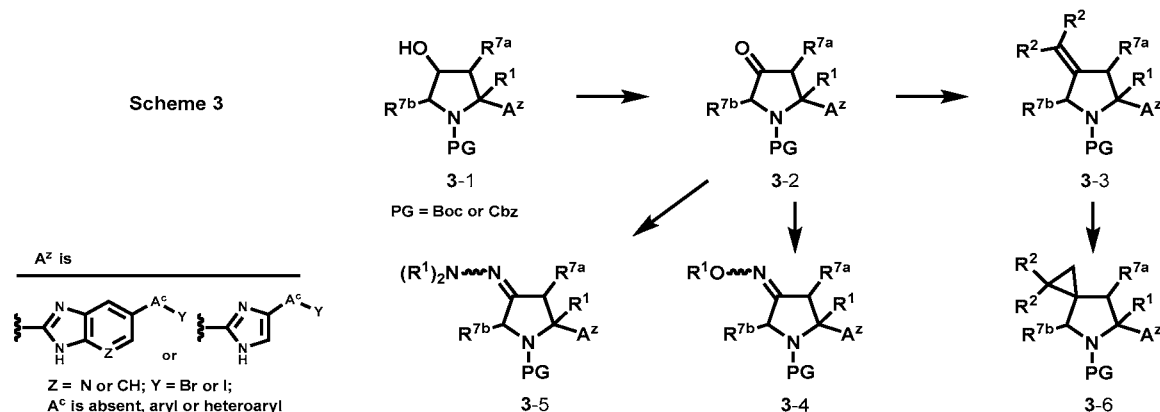
Scheme 1. For example, bromide **2-2** may be coupled with allytin or vinyltin or TMS-acetylene to provide intermediate **2-6**. Also, bromide **2-2** may be converted to key intermediate **2-4** by selectively reacting with metallic reagent **2-2.1** under the Suzuki or Stille conditions to provide key intermediate **2-4**. Yet alternatively, intermediate **2-4** may be prepared by treating bromide **2-2** with dimetallic agent **2-2.2** to afford organometallic **2-5**, followed by coupling with bromiodoaryl compound **2-5.1**, both may be under the previously described Suzuki or Stille reaction conditions. The bromide **2-4** may be further converted to organometallic **2-7** with dimetallic agent **2-4.1** using the conditions described above for the preparation of intermediate **2-5**.

Yet alternatively, aryl or heteroaryl bromide **2-4** may also be derived from bromoketone **2-9**, which can be prepared from the corresponding ketone **2-8** in the presence of a bromination reagent such as NBS, bromine, or the like, optionally in the presence of an acid and/or with heating. Bromoketone **2-9** may be either converted to the corresponding amine **2-11** through azide substitution followed by reduction, or coupled with protected amino acid **1-1.1** or **1-1.2** in the presence of a base such as Et₃N or DIPEA to afford keto-ester **2-10**. Similarly, amine **2-11** may be converted to the corresponding keto-amide **2-12** via condensation with appropriate amino acid under standard amide formation conditions. Both **2-12** and **2-13** may be transformed to key intermediate **2-4** via heating with NH₄OAc under thermal or microwave conditions.

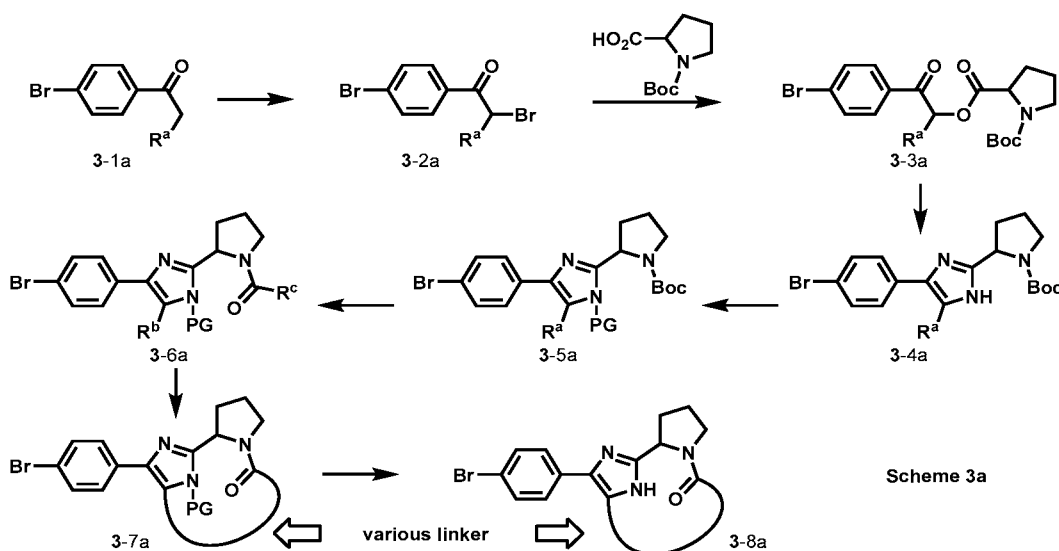


The synthesis of 4,5-disubstituted imidazole related intermediates are analogous to that described in Scheme 2. Alternatively, these imidazole intermediates can be synthesized from ketone **2-8a** (Scheme 2a) through nitrosation (sodium nitrite, HCl) to ketooxime **2-9a**, which can be cyclized with aldehyde **2-1.1** or **2-1.2** to 1-hydroxyimidazole **2-4a** in the presence of ammonia or ammonium hydroxide. Reduction

of **2-4a** with a suitable reducing reagent such as triethyl phosphite can lead to the requisite imidazole **2-4b**.



As shown in Scheme 3, a compound **3-1** containing a hydroxy group substituted at the C4-position of the pyrrolidine ring may be illustrated by intermediates **1-2**, **1-3**, **1-4**, **1-5**, **1-7**, **2-2**, **2-4**, and **2-6** when U is CH(OH) as shown in Schemes 1-2. Oxidation of **3-1** by a variety of oxidation agents such as Dess-Martin periodinane optionally in the presence of an acid such as acetic acid or camphorsulfonic acid may afford the ketone **3-2**. More reagents and conditions for the oxidation of an alcohol to a ketone can be found in *Comprehensive Organic transformations*, R. C. Larock Ed., Wiley-RCH, 1999, page 1236-1249. **3-2** may then serve as a universal intermediate for further derivatization to olefin **3-3**, oxime **3-4** and hydrazone **3-5**. The olefination of **3-2** may be realized by various types of Wittig Reaction or Peterson Reaction, a more detailed reagents and conditions can be found in *Comprehensive Organic transformations*, R. C. Larock Ed., Wiley-RCH, 1999, page 327-350. The olefin **3-3** may be converted to cyclopropane **3-6** through the well-known Simmons-Smith cyclopropanation, a more detailed reagents and conditions can be found in *Name Reactions and Reagents in Organic Synthesis* B. P. Munday, et al Ed., Wiley, 2005, page 600 and J. C. Lorenz, *et al*, *J. Org. Chem.*, 2004, 69, 327 and references cited therein.



Suitably substituted analogs of intermediates 1-2, 2-4, 2-4b or the compounds in Scheme 3 may be used as precursors to make a macrocyclic derivative after suitable manipulations and transformations of functional groups or protection groups. As

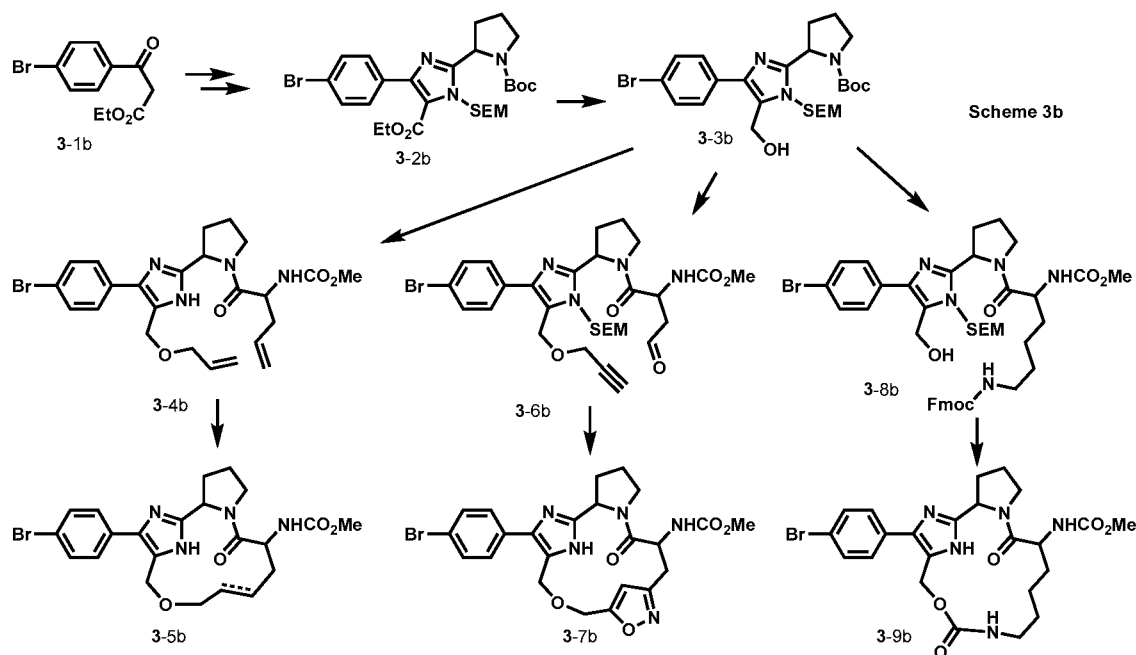
5 illustrated in Scheme 3a with phenyl-imidazole analogs. Bromination of ketone 3-1a (wherein R^a is an optionally substituted alkyl, optionally substituted alkenyl, optionally substituted alkynyl, or alkoxy carbonyl), may lead to bromide 3-2a. The latter is then esterified with Boc-protected proline to afford ketoester 3-3a, which can be converted to imidazole 3-4a (wherein PG is an amino protecting group) using the chemistry described

10 in Scheme 2. The imidazole moiety in 3-4a may be optionally protected to 3-5a, which can be converted to 3-6a in two steps: 1) deprotection of the Boc group and 2) the released amine functionality may be acylated with a carboxylic acid ($R^c\text{COOH}$, wherein R^c is R^6 as previously defined) under standard acylation conditions, for example a coupling reagent such as HATU in combination with an organic base such as DIPEA can be used in this

15 regard. Various carboxylic acids including amino acids in racemic or optical form are commercially available, and/or can be synthesized in racemic or optical form, see references cited in reviews by D. Seebach, et al, *Synthesis*, 2009, 1; C. Cativiela and M. D. Diaz-de-Villegas, *Tetrahedron: Asymmetry*, 2007, 18, 569; 2000, 11, 645; and 1998, 9, 3517; and experimental examples compiled in patent application

20 WO 08/021927 A2 by C. Bachand, et al, from BMS, which is incorporated herein by reference. The conversion from 3-5a to 3-6a may optionally involve one or more steps of functional group manipulation, thus R^b in 3-6a may be the same as or different from R^a as in 3-5a depending on the interchange of functional groups. These transformation step(s) may include, but not limited to alkylation, etherification, esterification, amidation,

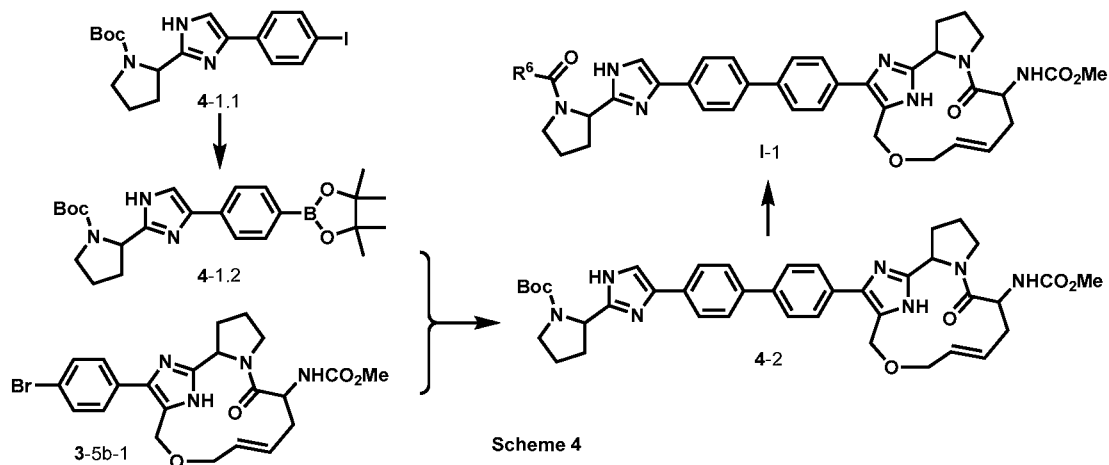
reduction, oxidation, olefination, halogenation, oximation, and/or hydroxylation. Two reactive groups in R^b and R^c in **3-6a** may undergo an intramolecular reaction to form a macrocyclic structure as seen in **3-7a** under appropriate reaction conditions, optionally in the presence of catalyst(s) and/or promoter(s). The reaction that can be used to succeed this intramolecular cyclization may include, but not limited to etherification, ester formation, reductive amination, amide formation, carbamate formation, urea formation, ring-closure-metathesis, Pd-catalyzed selective cross-couplings, oximation, various types of Diels-Alder reaction, and/or radical cyclization. Then the imidazole protection group may be optionally removed to **3-8a**.



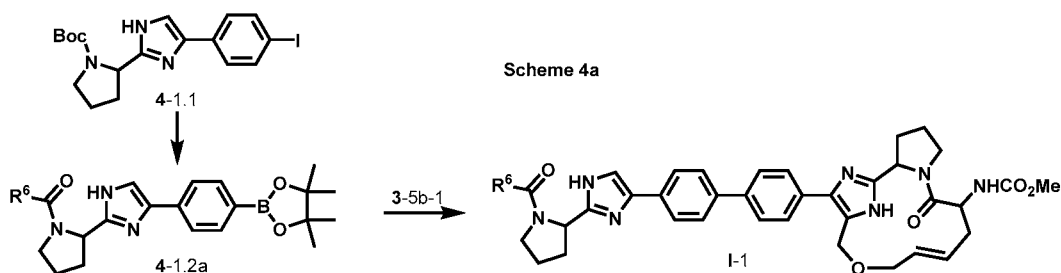
An example of strategies that may be used to form the macrocyclic structures are illustrated in Scheme 3b, wherein bromophenyl imidazole **3-2b** can be obtained from ketone **3-1b** using the procedures described above. **3-2b** can be reduced by DIBAL-H to alcohol **3-3b**, which is then served as a universal intermediate for further transformations. Thus, **3-4b** may be obtained from **3-3b** in three steps: 1) allylation with allyl bromide and sodium hydride in DMF; 2) simultaneously deprotection of boc and SEM with HCl under heat; and 3) capping the released pyrrolidine with methoxycarbonyl-protected allylglycine. The di-olefin **3-4b** can be converted to macrocyclic olefin **3-5b** (wherein the dotted bond may be nil or a single bond) through metal-catalyzed ring-closure-metathesis (RCM), which is well-known to those-in-the-art. Similarly **3-3b** can be alkylated with propargyl bromide, followed by a) selective deprotection of Boc; b) capping with an appropriately substituted amino acid (wherein the aldehyde group may be protected as acetal); and c)

deprotection of the acetal to release the aldehyde moiety, to afford **3-6b**. The aldehyde in **3-6b** may be converted to oxime by hydroxylamine, which can be converted in situ to its nitrile oxide by NCS type reagent, and the latter may react with the triple bond to fulfil the "click" reaction to afford the macrocyclic isoxazole derivative **3-7b** after removal of SEM-
5 protection. Alternatively **3-3b** can be selectively deprotected and capped with a protected lysine derivative to compound **3-8b**. After removal of Fmoc protection by piperidine, the free hydroxy and amino group may be united into a carbamate group by a reagent such as CDI, phosgene or the like to the macrocyclic carbamate **3-9b**.

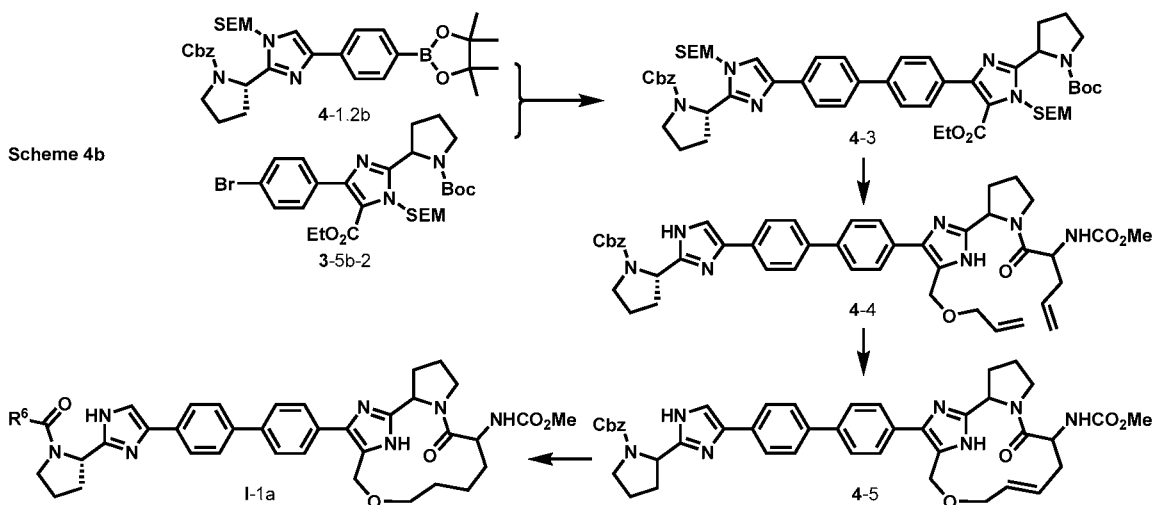
With a variety of suitably substituted imidazopyridines, benzimidazoles and
10 imidazoles such as those listed in Schemes 1-3, 2a, 3a and 3b in hand, the compounds of the present invention may be prepared through various coupling strategy or a combination of strategies to connect two fragments, optionally with a suitable cyclic or acyclic linker or formation of a cyclic or acyclic linker. The said strategy may include, but not limited to, Stille coupling, Suzuki coupling, Sonogashira coupling, Heck coupling, Buchwald
15 amidation, Buchwald amination, amide coupling, ester bond formation, William etherification, Buchwald etherification, alkylation, pericyclic reaction with different variations, or the like.



An example of the strategies that may be used to prepare the compounds of the
20 present invention is shown in Scheme 4. Both iodide **4-1.1** and its corresponding boronate derivative **4-1.2** can be prepared using similar procedures described previously. The bromide **3-5b-1** can be coupled with boronate **4-1.2** under Suzuki condition in the presence of a Pd-catalyst to generate a core structure **4-2**. Compound **4-2** then may be served as a common intermediate for further derivatizations to the title compounds **I-1**
25 using the procedures described in Schemes 3a and 3b.



Alternatively, as shown in Scheme 4a, the compounds of the present invention (for example **I-1**) may also be derived from key intermediates **4-1.2a** and **3-5b-1** using the Suzuki coupling procedures described previously. The intermediate **4-1.2a** has the desired acyl group already installed from **4-1.1** using similar sequences shown in Scheme 3b.



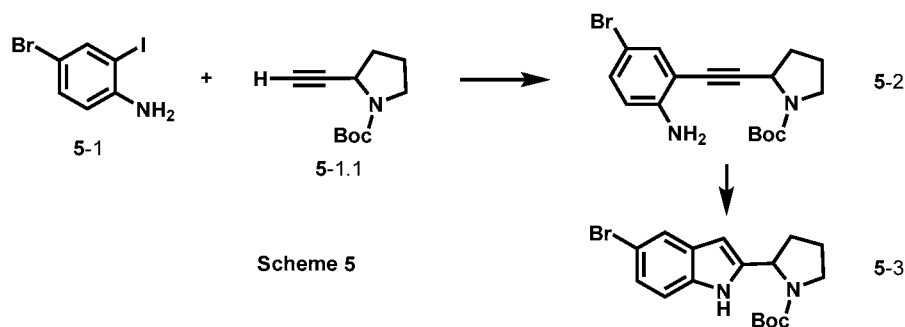
Yet alternatively, as shown in Scheme 4b, the compounds of the present invention (for example **I-1a**) may also be derived from key intermediate **4-3** after Suzuki coupling of **4-1.2b** and **3-5b-2** using the procedures described previously. Compound **4-3** can be converted to di-olefin **4-4** in a few steps: a) selectively reduced to alcohol; b) allylated to allylic ether; c) deprotected Boc and SEM; and d) capped with a carbamate-protected allyl glycine, using the procedures described previously. As discussed earlier, the di-olefin **4-4** can be converted to the title compound **I-1a** through RCM to macrocyclic intermediate **4-5** followed by de-Cbz under hydrogenation condition and capping with an acyl derivative (such as R^6COOH), all using the procedures described earlier.

The compounds of the present invention containing five-membered heteroaryl other than imidazole may be prepared using similar procedures described above in Schemes 1-4 and 4a. For example, some intermediates containing a desired, suitably substituted five-membered heteroaryl have been published in US 2008/0311075A1 by C. Bachand, et al from BMS, which is incorporated by reference. These intermediates are compiled in the following Table 14.

Table 14

Some intermediates and/or precursors that may be used for the synthesis of the compounds of the present invention have also been disclosed in the following patent publications: WO 2009/102568A1; WO 2009/102633A1; WO 2010/065668A1; WO 2010/065674A1; WO 2010/065681A1; WO 2010/09677A1; WO 2010/111483A1; WO 2010/111534A1; WO 2010/111673A1; WO 2010/120935A1; WO 2010/132538A1A1; WO 2010/132601A1; WO 2010/138368A1; WO 2010/138488A1; WO 2010/138790A1; WO 2010/138791A1; WO 2010/144646A2; US 2010/0215618A1; and WO 2011/004276A1, which are incorporated by reference.

The synthesis of the compounds of the present invention involves 5/6-membered fused heteroaryl intermediates other than benzimidazoles, various 5/6-membered fused heteroaryl are known in the literature. The synthesis of other 5/6-membered fused heteroaryl intermediates depends on the chemical features of each structure. For example, a typical synthesis of indole intermediate is illustrated in Scheme 5. The commercially available bromiodoaniline **5-1** may be coupled to the commercially available acetylene **5-1.1** under the Sonogashira conditions to give phenylacetylene **5-2**. The latter may be cyclized to indole **5-3** under heat or microwave condition in the presence of a copper catalyst.

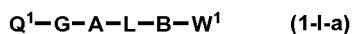


It will be appreciated that, with appropriate manipulation and protection of any chemical functionality, synthesis of compounds of Formula (I) is accomplished by

methods analogous to those above and to those described in the Experimental section. Suitable protecting groups can be found, but are not restricted to, those found in T W Greene and P G M Wuts "Protective Groups in Organic Synthesis", 3rd Ed (1999), J Wiley and Sons.

- 5 In some embodiments, the invention is directed to a process of making a compound of the invention comprising:

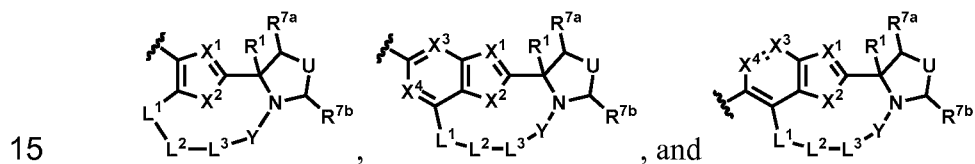
i) preparing a compound of Formula (1-I-a):



via a transition-metal catalyzed cross-coupling reaction, ring-closure metathesis or other intramolecular ring-closure reaction such as various type of Diels-Alder reaction, amide (lactam) formation, reductive amination, oximation, ester formation (lactonization), carbamate or urea formation;

wherein:

W^1 is independently selected from the group consisting of:

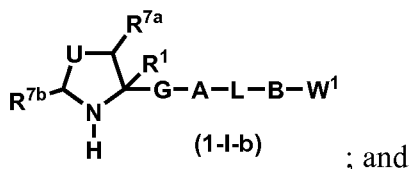


Q^1 is or hydrogen;

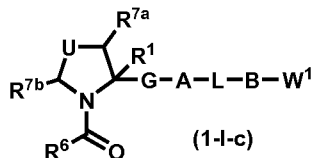
or Q^1 and G are taken together to form W^1 ; X^3 and X^4 at each occurrence are each independently N or C(R^{12}); and R^{12} at each occurrence is independently hydrogen, halogen, hydroxy, optionally substituted $\text{C}_1\text{-C}_4$ alkyl or $\text{O}(\text{C}_1\text{-C}_4 \text{ alkyl})$; Z^a is independently an amino protecting group or $-\text{C}(\text{O})\text{-R}^6$; wherein R^6 is $\text{C}_1\text{-C}_8$ alkyl optionally substituted with amino, hydroxy, protected amino, or $\text{O}(\text{C}_1\text{-C}_4 \text{ alkyl})$; and A, B, G, L, U, X^1 , X^2 , L^1 , L^2 , L^3 , R^1 , R^{7a} and R^{7b} are as defined in Formula (I);

20 ii) when Q^1 is , wherein Z^a is an amino protecting group, selectively deprotecting a compound of Formula (1-I-a) to give the corresponding amine of Formula (1-I-b):

25



iii) Capping the released amino group of a compound of Formula (1-I-b) with LG-C(O)-R⁶, wherein LG is a leaving group; to give the compound of Formula (1-I-c):



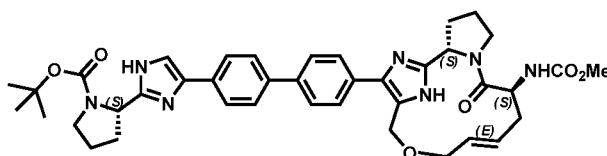
5 All references cited herein, whether in print, electronic, computer readable storage media or other form, are expressly incorporated by reference in their entirety, including but not limited to, abstracts, articles, journals, publications, texts, treatises, internet web sites, databases, patents, and patent publications.

EXAMPLES

10 The compounds and processes of the present invention will be better understood in connection with the following examples, which are intended as an illustration only and not limiting of the scope of the invention. Various changes and modifications to the disclosed embodiments will be apparent to those skilled in the art and such changes and modifications including, without limitation, those relating to the chemical structures, substituents, derivatives, formulations and/or methods of the invention may be made
15 without departing from the spirit of the invention and the scope of the appended claims.

Although the invention has been described with respect to various preferred embodiments, it is not intended to be limited thereto, but rather those skilled in the art will recognize that variations and modifications may be made therein which are within the
20 spirit of the invention and the scope of the appended claims.

Example 1.



Step 1a. Into a solution of ethyl 3-(4-bromophenyl)-3-oxopropanoate (25 g, 92.2 mmol) in 1,4-dioxane (20 mL) was added bromine (4.73 mL, 92.2 mmol) at 0 °C. The mixture
25 was stirred at 0 °C for 1.5 hours before all volatiles were evaporated off to the crude desired product as a yellow oil (32.8g, quantitative), which was used for the next step

without further purification. ^1H NMR (CDCl_3) 7.88 (d, 2H), 7.66 (d, 2H), 5.59 (s, 1H), 3.31 (q, 2H), 2.27 (t, 3H).

Step 1b. Into a solution of the compound from step 1a (32.8g, 92.2 mmol) in acetonitrile (200 mL) was added (S)-1-(tert-butoxycarbonyl)pyrrolidine-2-carboxylic acid (21.0 g, 96.8 mmol) and DIPEA (17.7 mL, 101.3 mmol). The mixture was stirred at rt for 14 hours before all volatile were evaporated. The residue was partitioned between water (100 mL) and EtOAc (300 mL) and the organic phase was separated, dried (Na_2SO_4) and concentrated to afford a brown slurry, which was filtered through a silica plug (20g) and eluted with EtOAc. The fractions with desired compound was collected and concentrated to afford a light yellow oil (42g, 94%), which was resuspended in toluene (200 mL) followed by addition of ammonium acetate (67g, 870 mmol). The mixture was stirred at 95 °C for 16 hours before being partitioned between aqueous NaHCO_3 and EtOAc. The organic phase was separated, dried (Na_2SO_4) and concentrated to afford a brown slurry, which was purified by chromatography (silica, EtOAc-hexanes) to afford a light yellow oil. It was recrystallized with EtOAc and hexanes to provide the desired compound as light yellow powder (16g, 39% over 2steps). ESIMS $m/z = 464.30, 466.30 [\text{M}+\text{H}]^+$.

Step 1c. Into a solution of the compound from step 1b (6g, 12.9 mmol) in DMF (50 mL) was added sodium hydride (55% in mineral oil, 620 mg, 13.2 mmol). The mixture was stirred at rt for 1 hour before addition of 2-(trimethylsilyl)ethoxymethyl chloride (2.3 mL, 12.9 mmol). It was stirred at rt for another 3 hours before being partitioned between aqueous NaHCO_3 and EtOAc. The organic phase was separated, dried (Na_2SO_4) and concentrated to afford a brown slurry, which was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as a light yellow oil (6.5 g, 84%). ESIMS $m/z = 594.43, 596.43 [\text{M}+\text{H}]^+$.

Step 1d. Into a solution of the compound from step 1c (6.5g, 11 mmol) in CH_2Cl_2 (60 mL) was added DIBAL-H solution (1M in hexane, 22 mL, 22 mmol) at -78 °C. The resulting mixture was stirred at -78 °C for 3 hours before additional DIBAL-H solution (1M in hexane, 11 mL, 11 mmol) was added. After another 1 hour stirring at -78 °C, aqueous sodium/potassium tartrate (22g in 20 mL of water) was added dropwise before the mixture was partitioned between water and EtOAc. The organic phase was separated, dried (Na_2SO_4) and concentrated to afford a brown slurry, which was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as a light yellow oil (4.0 g, 84%) with recovery of 1.5 g of the compound from step 1c. ESIMS $m/z = 552.41, 554.41 [\text{M}+\text{H}]^+$.

Step 1e. Into a solution of the compound from step 1d (1.5g, 2.71 mmol) in DMF (50 mL) was added sodium hydride (55% in mineral oil, 130 mg, 2.98 mmol) and allylbromide (0.24 mL, 2.84 mmol). The mixture was stirred at rt for 16 hours before being partitioned between water and EtOAc. The organic phase was separated, dried (Na₂SO₄) and concentrated to afford a brown slurry, which was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as a light yellow oil (1.62 g, quantitative). ESIMS m/z = 592.42, 594.42 [M+H]⁺.

Step 1f. Into a mixture of the compound from step 1e (98.6 mg, 0.167 mmol) in 1,4-dioxane (6 mL) was added hydrochloric acid (4M in 1,4-dioxane, 12 mL). The mixture was stirred at 50 °C for 5 hours before all volatiles were removed to afford the crude desired product as yellow powder, which was used directly used for the next step without further purification. ESIMS m/z = 362.24, 364.24 [M+H]⁺.

Step 1g. A mixture of the crude compound from step 1f (0.167 mmol at most) and (S)-2-(methoxycarbonylamino)pent-4-enoic acid (using procedures similar to that described in step 345e, 31.7 mg, 0.183 mmol) in CH₂Cl₂ (6 mL) was treated with HATU (63.3 mg, 0.167 mmol) in the presence of DIPEA (0.21 mL, 1.67 mmol) for 1 hour at rt. The volatiles were evaporated off to provide a brown sirup, which was purified by chromatography (silica, EtOAc-hexanes) to give the desired compound as a colorless oil (51.2 mg, 2 steps 59%). ESIMS m/z = 517.31, 519.31 [M+H]⁺.

Step 1h. Into a solution of the compound from step 1g (51.2 mg, 99.0 μmol) in toluene (22 mL) was added Zhan-1B catalyst (14.5 mg, 19.8 μmol). The mixture were degassed and heated at 50 °C under N₂ for 16 hours before the addition of another portion of Zhan-1B catalyst (14.5 mg, 19.8 μmol). It was degassed and heated at 50 °C under N₂ for another 4 hours before all volatiles were evaporated. The residue was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as a yellow brown foam (25.2 mg, 52%). ESIMS m/z = 489.22, 491.22 [M+H]⁺.

Step 1i. To a mixture of 2,4'-dibromoacetophenone (5.00 g, 18.0 mmol) and *N*-Boc-L-proline (3.87 g, 18.0 mmol) in CH₃CN (60 mL) was added triethylamine (5.40 mL, 37.8 mmol) slowly. The mixture was stirred at rt until the disappearance of the starting material. The volatiles were evaporated and the residue was partitioned (EtOAc - water). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, hexanes-ethyl acetate) to give the desired compound as a light yellow foam (6.73 g, 91%). ¹H NMR (CDCl₃) 7.76 (t, *J* = 8.0 Hz, 2H), 7.63 (dd, *J* = 5.0, 8.5 Hz, 2H), 5.51, 5.16 (2d, *J* = 16.0 Hz, 1H), 5.32, 5.28 (2d, *J* =

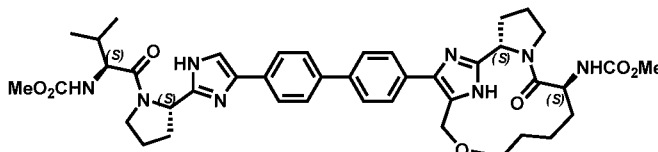
16.5 Hz, 1H), 4.48, 4.40 (dd, $J = 5.0, 8.5$ Hz, 1H), 3.56 (m, 1H), 3.43 (m, 1H), 2.30 (m, 2H), 2.06 (m, 1H), 1.92 (m, 1H), 1.46, 1.43 (2s, 9H).

Step 1j. To a solution of the compound from step 1i (6.73 g, 16.3 mmol) in toluene (100 mL) was added ammonium acetate (25.1 g, 0.327 mol) and the mixture was heated at 100 °C for 14 hours. The volatiles were evaporated and the residue was partitioned (EtOAc - aq. NaHCO₃). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, hexanes-ethyl acetate) to give the desired compound as a yellow foam (6.10 g, 95%). ESIMS $m/z = 392.24, 394.24$ [M+H]⁺. ¹H NMR (CDCl₃) 7.57 (bs, 1H), 7.48 (m, 3H), 7.23 (s, 1H), 4.97 (m, 1H), 3.42 (m, 2H), 2.99 (m, 1H), 2.16 (m, 2H), 1.97 (m, 1H), 1.46 (s, 9H).

Step 1k. To a mixture of the compound from step 1j (1.00 g, 2.55 mmol), bis(pinacolato)diboron (1.35 g, 5.33 mmol) and potassium acetate (0.640 g, 6.53 mmol) in 1,4-dioxane (20 mL) was added Pd(PPh₃)₄ (0.147 g, 0.128 mmol). The mixture was degassed and heated at 80 °C under N₂ for 14 hours. The volatiles were evaporated and the residue was partitioned (EtOAc - water). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, hexanes-ethyl acetate) to give the desired compound as a light yellow solid (0.978 g, 87%). ESIMS $m/z = 440.39$ [M+H]⁺. ¹H NMR (CDCl₃) 11.03, 10.55 (2s, 1H), 7.79 (m, 3H), 7.45 (m, 1H), 7.26 (m, 1H), 4.97 (m, 1H), 3.41 (m, 2H), 3.06, 2.91 (2m, 1H), 2.17 (m, 2H), 1.97 (m, 1H), 1.49 (s, 9H), 1.35 (s, 12H).

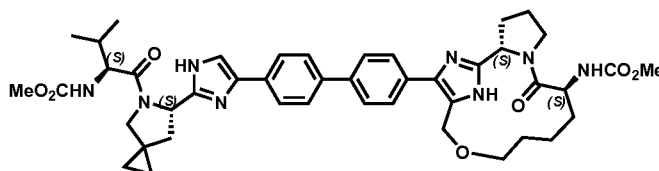
Step 1l. A mixture of the compounds from step 1h (25.2 mg, 51.5 μmol), and step 1k (49.6 mg, 0.113 mmol) and NaHCO₃ (34.6 mg, 0.412 mmol) in DME (6 mL) and H₂O (2 mL) was added Pd(PPh₃)₄ (2.9 mg, 2.5 μmol). The mixture were degassed and heated to 95 °C under N₂ for 3 hours. The volatiles were evaporated and the residue was partitioned (EtOAc - H₂O). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, hexanes-ethyl acetate) to give the title compound as a light yellow solid (19.1 mg, 51%). ESIMS $m/z = 722.60$ [M+H]⁺.

Example 83.



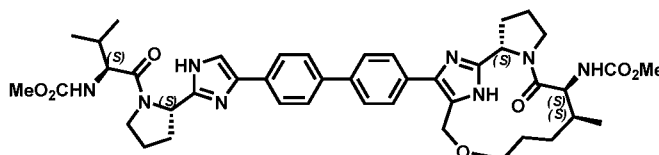
Into a solution of the compound from Example 344 (60.0 mg, 77.1 μmol) in MeOH (16 mL) was added palladium hydroxide (20 wt% on carbon, 30.0 mg). The mixture was hydrogenated with a hydrogen balloon at rt for 20 hours before filtration through Celite. The filtrate was concentrated and purified by chromatography (silica, CH_2Cl_2 -MeOH) to give the title compound as a light yellow solid (52.9 mg, 88%). ESIMS $m/z = 781.58 [\text{M}+\text{H}]^+$.

Example 258.



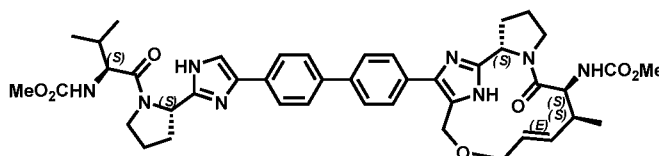
The title compound was prepared from the compound from Example 361 following
10 the procedures similar to that described in Example 344. ESIMS m/z = 807.46 $[M+H]^+$.

Example 317.



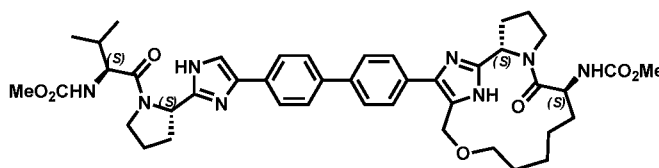
A mixture of the compound of Example 318 (15.0 mg, 18.9 μmol) and palladium hydroxide (20 wt% on carbon, 13.0 mg) in MeOH (4 mL) was hydrogenated under 60 psi H_2 at rt for 3 days before being filtered through a plug of Celite. The filtrate was concentrated and purified by chromatography (silica, CH_2Cl_2 -MeOH) to give the title compound as a white solid (11.5 mg, 77%). ESIMS m/z = 795.72 $[\text{M}+\text{H}]^+$.

Example 318.



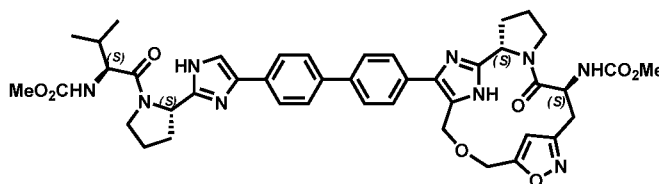
20 The title compound was prepared from the compound of Example 350 using procedures similar to that described in Example 344. ESIMS m/z = 793.71 $[M+H]^+$.

Example 322.



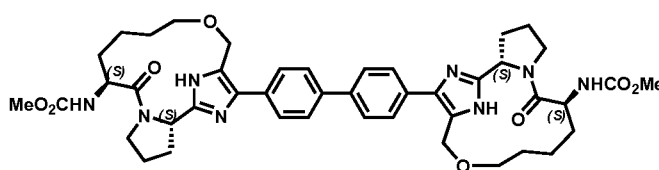
The title compound was prepared from the compound of Example 346 using procedures similar to that described in Example 344. ESIMS $m/z = 795.70$ $[M+H]^+$.

Example 333.



5 The title compound was prepared from the compound of Example 357 using procedures similar to that described in example 344. ESIMS $m/z = 820.75$ $[M+H]^+$.

Example 336.



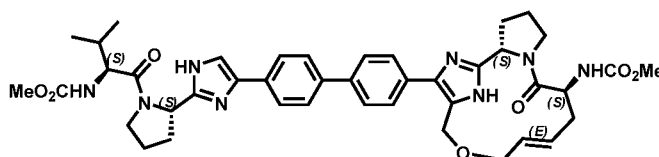
10 **Step 336a.** The desired compound was prepared from the compound from step 1h of Example 1 using procedures similar to that described in step 1k of Example 1. ESIMS $m/z = 537.26$ $[M+H]^+$.

Step 336b. The desired compound was prepared from the compounds from steps 1h and 336a (Example 336) using procedures similar to that described in step 1l of Example 1. ESIMS $m/z = 819.35$ $[M+H]^+$.

15 **Step 336c.** A mixture of the compound from step 336b (22 mg) and palladium (10 wt% on carbon, 5 mg) in ethanol (3 mL) was stirred under hydrogen (60 psi) at rt for 4 hours before being filtered through Celite. The filtrate was concentrated and purified by HPLC (C-18, methanol-water) to provide the title compound as a white solid (2 mg, 9.1%). ESIMS $m/z = 823.41$ $[M+H]^+$.

20

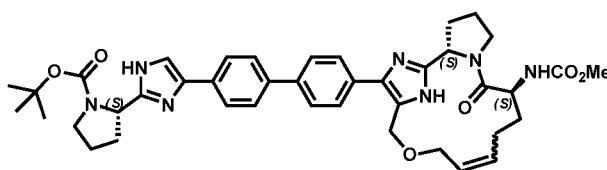
Example 344.



Step 344a. A solution of the compound from example 1 (89.1 mg, 0.123 mmol) in CH_2Cl_2 (3 mL) was treated with HCl in 1,4-dioxane (4 M, 3 mL) for 30 minutes. The volatiles were evaporated off to give the crude desired compound as a yellow solid which
25 was directly used in the next step. ESIMS $m/z = 622.41$ $[M+H]^+$.

Step 344b. A mixture of the crude compound from step 344a of Example 344 (0.123 mmol at most) and (S)-(methoxycarbonyl)amino-3-methyl-butiric acid (prepared according to WO 2008/021927, 23.7 mg, 0.136 mmol) in DMF (3 mL) was treated with HATU (46.9 mg, 0.123 mmol) in the presence of DIPEA (0.31 mL, 2.47 mmol) for 2 hours at rt. The volatiles were evaporated off to provide a brown sirup, which was purified by chromatography (silica, CH₂Cl₂-MeOH) to give the title compound as a light yellow solid (80.6 mg, 2 steps 84%). ESIMS $m/z = 779.58$ [M+H]⁺.

Example 345.



Step 345a. To a solution of (S)-5-tert-butoxy-4-(tert-butoxycarbonylamino)-5-oxopentanoic acid (1.986 g, 6.547 mmol) in THF (45 mL) and Et₃N (5.47 mL, 39.28 mmol) at -20 °C was added isobutyl chloroformate (2.57 mL, 19.64 mmol). The resulting suspension was warmed up to 0 °C and stirred at 0 °C for 20 minutes before being cooled down to -78 °C. NaBH₄ (2.477 g, 65.47 mmol) was added at -78 °C, followed by the addition of EtOH (19.1 mL). The suspension was allowed to warm to rt and stirred for 2 hours before being cooled down to 0 °C and quenched with 3 N HCl until pH ~2. The volatiles were evaporated off. The residue was partitioned (EtOAc - H₂O). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, hexanes-EtOAc) to give the desired compound as a colorless oil (1.740 g, 92%). ESIMS $m/z = 290.23$ [M+H]⁺.

Step 345b. To a solution of DMSO (0.98 mL, 13.82 mmol) in CH₂Cl₂ (12 mL) at -78 °C was added oxalyl chloride (0.60 mL, 6.911 mmol) dropwise. After 20 minutes at -78 °C, a solution of the compound from step 345a (1.000 g, 3.456 mmol) in CH₂Cl₂ (7 mL) was added at -78 °C. After 30 minutes at -78 °C, Et₃N (3.85 mL, 27.65 mmol) was added. The mixture was stirred at -78 °C for 20 minutes and warmed up to rt. After 20 minutes at rt, it was quenched with saturated NH₄Cl. The mixture was partitioned (EtOAc - H₂O). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was dried in vacuo to give the desired compound as a colorless oil (1.013 g), which was used directly for the next step.

Step 345c. To a suspension of methyl triphenylphosphonium bromide (6.173 g, 17.28 mmol) in THF (60 mL) was treated with *t*-BuOK (1M in THF, 17.28 mL, 17.28 mmol) at

rt for 1 hour before being cooled down to 0 °C. A solution of the compound from step 345b (1.013 g, 3.456 mmol at most) in THF (12 mL) was added at 0 °C. The mixture was stirred at rt for 15 hours before being quenched with saturated NH₄Cl solution. It was partitioned (EtOAc - H₂O) and the organics were washed with brine, dried (Na₂SO₄),
5 filtered and evaporated. The residue was purified by chromatography (silica, hexanes-ethyl acetate) to give the desired compound as a colorless oil (0.456 g, 46% over 2 steps) as a racemic mixture. ESIMS m/z = 286.25 [M+H]⁺.

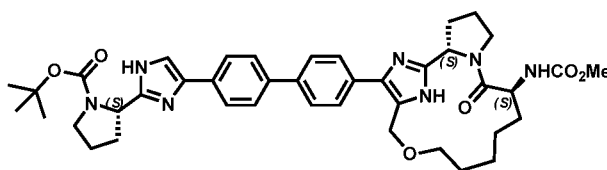
Step 345d. To a solution of the compound from step 345c (0.456 g, 1.598 mmol) in CH₂Cl₂ (1 mL) was added trifluoroacetic acid (5 mL) at rt. It was stirred at rt for 5 hours
10 before the volatiles were removed to afford the crude desired product as a light yellow solid, which was used directly for the next step without further purification.

Step 345e. A mixture of the crude compound from step 345d (1.598 mmol at most) and Na₂CO₃ (0.186 g, 1.758 mmol) in 1 M NaOH solution (3.20 mL) was treated with methyl chloroformate (0.13 mL, 1.734 mmol) at 0 °C for 10 minutes. It was then stirred at rt for
15 3.5 hours. The volatiles were evaporated off. The residue was partitioned (Et₂O - H₂O). The aqueous layer was acidified with 3 N HCl solution to pH~2 at 0 °C and then extracted with CH₂Cl₂ and EtOAc. The combined organic layers were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was dried under vacuum to give the desired compound as a slightly yellow oil (0.285 g, 95% over 2 steps). ¹H NMR (CD₃OD) 5.87-
20 5.79 (m, 1H), 5.07 (d, J = 15.8 Hz, 1H), 5.01 (d, J = 10.2 Hz, 1H), 4.14 (dd, J = 4.6, 9.3 Hz, 1H), 3.66 (s, 3H), 2.19-2.11 (m, 1H), 1.96-1.89 (m, 1H), 1.79-1.71 (m, 1H),

Step 345f. The desired compound was prepared from the crude compound from step 1f and the compound from step 345e using procedures similar to that described in step 1g. ESIMS m/z = 531.28, 533.28 [M+H]⁺.

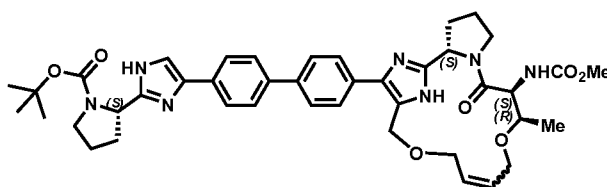
Step 345g. The desired compounds as an olefin isomeric mixture was prepared from the compound from step 345f using procedures similar to that described in step 1h. ESIMS m/z = 503.17, 505.17 [M+H]⁺.

Step 345h. The title compounds as an olefin isomeric mixture were prepared from the compounds from steps 345g and 1k using procedures similar to that described in step 1l.
30 ESIMS m/z = 736.57 [M+H]⁺.

Example 346.

A mixture of the compounds of Example 345 (13.0 mg, 17.6 μmol) and palladium (10 wt% on carbon, 5.8 mg) in MeOH (10 mL) was stirred with a hydrogen balloon at rt for 14 hours before being filtered through Celite. The filtrate was concentrated to give the crude title compound as a light yellow solid which was directly used in the next step.

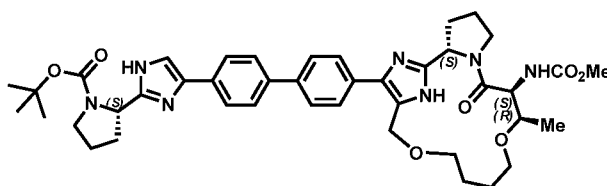
ESIMS $m/z = 738.60$ $[\text{M}+\text{H}]^+$.

Example 347.

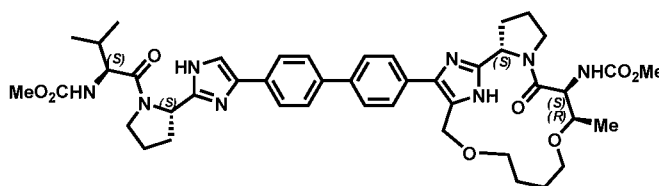
Step 347a. The desired compound was prepared from the crude compound from step 1f and (2S,3R)-3-(allyloxy)-2-(methoxycarbonylamino)butanoic acid (prepared from *O*-2-propen-1-yl-L-threonine, using procedures similar to that described in step 345e) using procedures similar to that described in step 1g. ESIMS $m/z = 561.29, 563.29$ $[\text{M}+\text{H}]^+$.

Step 347b. The desired compounds as an olefin isomeric mixture was prepared from the compound from step 347a using procedures similar to that described in step 1h. ESIMS $m/z = 533.22, 535.22$ $[\text{M}+\text{H}]^+$.

Step 347c. The title compounds as an olefin isomeric mixture were prepared from the compounds from steps 347b and 1k using procedures similar to that described in step 1l. ESIMS $m/z = 766.74$ $[\text{M}+\text{H}]^+$.

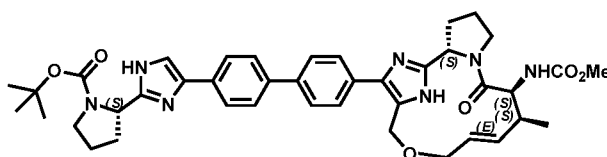
Example 348.

The title compound was prepared from the compounds of Example 347 using procedures similar to that described in example 83. ESIMS $m/z = 768.52$ $[\text{M}+\text{H}]^+$.

Example 349.

The title compound was prepared from the compound of Example 348 using procedures similar to that described in Example 344. ESIMS $m/z = 825.91 [M+H]^+$.

5

Example 350.

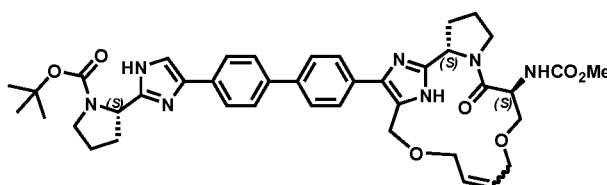
Step 350a. The desired compound was prepared from the crude compound from step 1f and *trans*-2-(methoxycarbonylamino)-3-methylpent-4-enoic acid (prepared from *trans*-2-amino-3-methyl-4-pentenoic acid (*Can. J. Chem.* **2005**, 83, 937-942), using procedures similar to that described in step 345e) using procedures similar to that described in step 1g. ESIMS $m/z = 531.37, 533.37 [M+H]^+$.

10

Step 350b. The desired compound was prepared from the compound from step 350a using procedures similar to that described in step 1h. ESIMS $m/z = 503.34, 505.34 [M+H]^+$.

15

Step 350c. The title compound was prepared from the compounds from steps 350b and 1k using procedures similar to that described in step 1l. ESIMS $m/z = 736.70 [M+H]^+$.

Example 351.

Step 351a. The desired compound was prepared from the crude compound from step 1f and (S)-3-(allyloxy)-2-(methoxycarbonylamino)propanoic acid (prepared from *O*-2-propen-1-yl-L-serine (*Org. & Biomolecular Chem.* **2005**, 3(10), 2016-2025), using procedures similar to that described in step 345e) using procedures similar to that described in step 1g. ESIMS $m/z = 547.41, 549.41 [M+H]^+$.

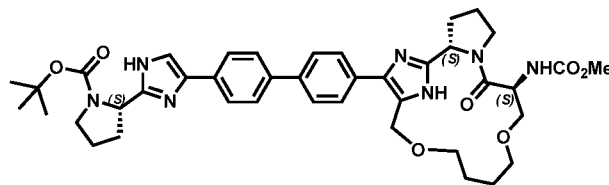
20

Step 351b. The desired compounds as an olefin isomeric mixture were prepared from the compound from step 351a using procedures similar to that described in step 1h. ESIMS $m/z = 519.24, 521.24 [M+H]^+$.

25

Step 351c. The title compounds as an olefin isomeric mixture were prepared from the compounds from steps 351b and 1k using procedures similar to that described in step 1l. ESIMS $m/z = 752.36 [M+H]^+$.

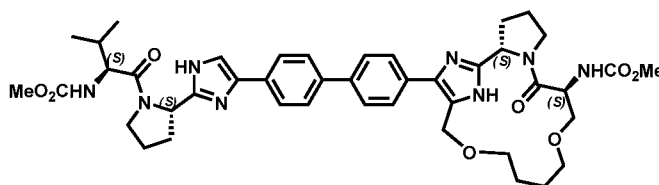
Example 352.



5

The title compound was prepared from the compounds of example 351 using procedures similar to that described in Example 83. ESIMS $m/z = 754.44 [M+H]^+$.

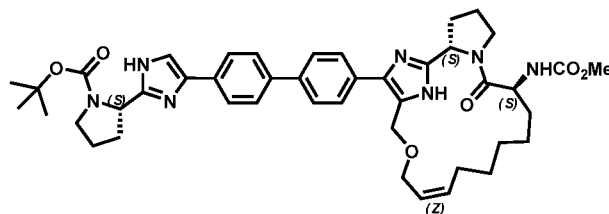
Example 353.



10

The title compound was prepared from the compounds of Example 352 using procedures similar to that described in Example 344. ESIMS $m/z = 811.55 [M+H]^+$.

Example 354.



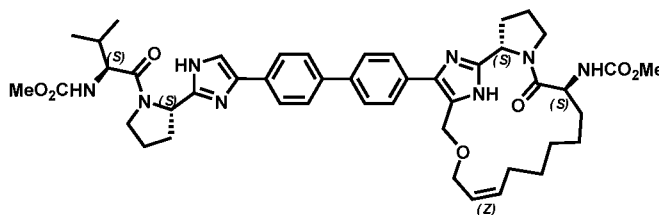
15

Step 354a. The desired compound was prepared from the crude compound from step 1f and (S)-2-(methoxycarbonylamino)-non-8-enoic acid (prepared from (S)-2-amino-8-nonenoic acid using procedures similar to that described in step 345e) using procedures similar to that described in step 1g. ESIMS $m/z = 573.37, 575.37 [M+H]^+$.

20

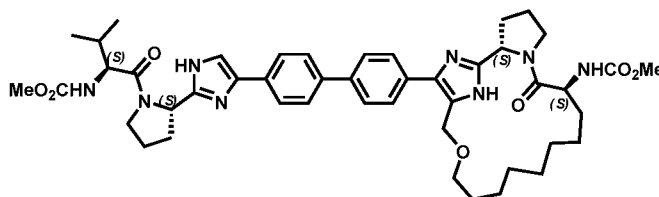
Step 354b. The desired compound was prepared from the compound from step 354a using procedures similar to that described in step 1h. ESIMS $m/z = 545.18, 547.18 [M+H]^+$.

Step 354c. The title compound was prepared from the compounds from steps 354b and 1k using procedures similar to that described in step 1l. ESIMS $m/z = 778.45 [M+H]^+$.

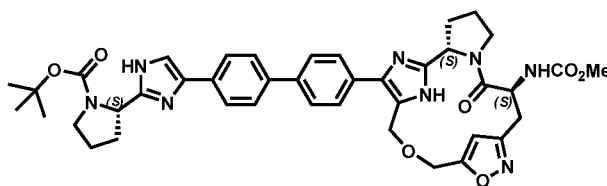
Example 355.

The title compound was prepared from the compound of Example 354 using procedures similar to that described in Example 344. ESIMS $m/z = 835.55$ $[M+H]^+$.

5

Example 356.

The title compound was prepared from the compound of Example 355 using procedures similar to that described in example 83. ESIMS $m/z = 837.51$ $[M+H]^+$.

Example 357.

10

Step 357a. A solution of the compound from step 1d (0.300 g, 0.543 mmol) in DMF (10 mL) was treated with sodium hydride (60% in mineral oil, 43.5 mg, 1.09 mmol) and propargyl bromide (0.12 mL, 1.09 mmol) at rt for 16 hours before being partitioned between water and EtOAc. The organic phase was separated, dried (Na_2SO_4) and concentrated to afford a brown slurry, which was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as a light yellow oil (0.277 g, 87%). ESIMS $m/z = 590.43, 592.43$ $[M+H]^+$.

15

Step 357b. The crude desired compound was prepared from the compound from step 357a using procedures similar to that described in step 1f. ESIMS $m/z = 360.22, 362.22$ $[M+H]^+$.

20

Step 357c. The desired compound was prepared from the crude compound from step 357b and (S)-4-(tert-butyldimethylsilyloxy)-2-(methoxycarbonylamino)butanoic acid (prepared from (S)-2-amino-4-(tert-butyldimethylsilyloxy)butanoic acid, using procedures similar to that described in step 345e, WO 2007/129036 and WO 2008/021927) using procedures similar to that described in step 1g. ESIMS $m/z = 633.63, 635.63$ $[M+H]^+$.

25

Step 357d. A solution of the compound from step 357c (0.100 g, 0.158 mmol) in THF (5 mL) was treated with AcOH (27.0 μ L, 0.474 mmol) and TBAF (1M in THF, 0.47 mL, 0.474 mmol) at rt for 2 hours. The volatiles were evaporated off and the residue was partitioned (EtOAc - H₂O). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, CH₂Cl₂-MeOH) to give the desired compound as a colorless oil (73.5 mg, 90%). ESIMS m/z = 519.48, 521.48 [M+H]⁺.

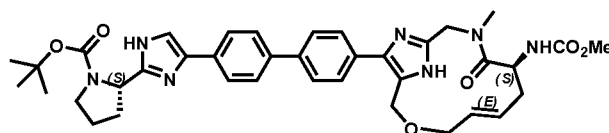
Step 357e. A solution of the compound from step 357d (73.5 mg, 0.142 mmol) in CH₂Cl₂ (4 mL) was treated with camphorsulfonic acid (32.9 mg, 0.142 mmol) and Dess-Martin periodinane (0.180 g, 0.425 mmol) at rt for 3 hours before being quenched by aqueous Na₂S₂O₃. The volatiles were evaporated and the residue was partitioned (EtOAc - H₂O). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, EtOAc-hexanes) to give the desired compound as a colorless oil (54.6 mg, 75%). ESIMS m/z = 517.30, 519.30 [M+H]⁺.

Step 357f. A solution of the compound from step 357e (54.6 mg, 0.106 mmol) in EtOH (3 mL) was treated with pyridine (25.6 μ L, 0.317 mmol) and hydroxylamine hydrochloride (22.0 mg, 0.317 mmol) at rt for 13 hours before being evaporated to dryness. The residue was purified by chromatography (silica, CH₂Cl₂-MeOH) to give the desired compound as a white solid (54.9 mg, 98%). ESIMS m/z = 532.28, 534.28 [M+H]⁺.

Step 357g. A solution of the compound from step 357f (54.9 mg, 0.103 mmol) in EtOAc (10 mL) and H₂O (30 μ L) was treated with NaHCO₃ (43.3 mg, 0.516 mmol) and N-chlorosuccinimide (45.3 mg, 0.310 mmol) at rt for 2 days before being partitioned (EtOAc - H₂O). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was purified by chromatography (silica, CH₂Cl₂-MeOH) to give the desired compound as a colorless oil (38.2 mg, 70%). ESIMS m/z = 530.31, 532.31 [M+H]⁺.

Step 357h. The title compound was prepared from the compounds from steps 357g and 1k using procedures similar to that described in step 1l. ESIMS m/z = 763.76 [M+H]⁺.

Example 358.



Step 358a. A solution of the compound from step 1a (2.480 g, 6.971 mmol) in acetonitrile (24 mL) was treated with *N*-Boc-sarcosine (1.715 g, 9.063 mmol) and DIPEA (3.64 mL, 20.91 mmol) at rt for 2 hours before the volatiles were evaporated. The residue was

partitioned (H₂O - EtOAc). The organic phase was washed with brine, dried (Na₂SO₄), filtered and concentrated to afford the desired compound as a dark yellow oil (3.360 g), which was used without further purification. ESIMS m/z = 458.14, 460.14 [M+H]⁺.

Step 358b. A mixture of the compound from step 358a (3.360 g, 6.971 mmol at most) and ammonium acetate (5.911 g, 76.68 mmol) in toluene (70 mL) was stirred at 100 °C for 19 hours before being allowed to cool down and partitioned between H₂O and EtOAc. The organic phase was washed with aqueous NaHCO₃ and brine, dried (Na₂SO₄), filtered and concentrated. The residue was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as an orange foam (0.874 g, 29% over 2 steps). ESIMS m/z = 438.06, 440.06 [M+H]⁺.

Step 358c. To a solution of the compound from step 358b (0.810 g, 1.848 mmol) in DMF (12 mL) was added sodium hydride (60% in mineral oil, 77.6 mg, 1.940 mmol) at rt. The mixture was stirred at room temperature for 1 hour before 2-(trimethylsilyl)-ethoxymethyl chloride (0.33 mL, 1.848 mmol) was added dropwise. It was stirred at rt for 2 hours before being quenched with saturated NH₄Cl solution and diluted with EtOAc. The organic phase was washed with brine, dried (Na₂SO₄), filtered and concentrated. The residue was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as a light yellow oil (0.700 g, 67%). ESIMS m/z = 568.14, 570.14 [M+H]⁺.

Step 358d. To a solution of the compound from step 358c (0.700 g, 1.231 mmol) in dichloromethane (12 mL) at -78 °C was added DIBAL-H solution (1M in hexane, 3.69 mL, 3.69 mmol). The mixture was stirred at -78 °C for 1 hour before additional DIBAL-H solution (1M in hexane, 1.23 mL, 1.23 mmol) was added. After another 4 hour at -78 °C, the mixture was poured into saturated aqueous potassium sodium tartrate solution (~40 mL). After 15 minutes at rt, the mixture was partitioned between water and EtOAc. The organic phase was washed with brine, dried (Na₂SO₄) and concentrated. The residue was purified by chromatography (silica, EtOAc-hexanes) to afford the desired compound as a light yellow foam (0.120 g, 19%). ESIMS m/z = 526.08, 528.08 [M+H]⁺.

Step 358e. To a solution of the compound from step 358d (0.120 g, 0.228 mmol) in DMF (4 mL) was added sodium hydride (60% in mineral oil, 13.7 mg, 0.342 mmol) at rt. After 30 minutes at rt, allylbromide (30 µL, 0.342 mmol) was added. The mixture was stirred at rt for 15 hours before being quenched with saturated NH₄Cl solution and diluted with EtOAc. The organic phase was washed with brine, dried (Na₂SO₄) and concentrated. The residue was chromatographed (silica, EtOAc-hexanes) to afford the desired compound as a colorless oil (90.0 mg, 78%). ESIMS m/z = 566.13, 568.13 [M+H]⁺.

Step 358f. To a mixture of the compound from step 358e (90.0 mg, 0.159 mmol) in 1,4-dioxane (1 mL) was added hydrochloric acid (4M in 1,4-dioxane, 6 mL). The mixture was stirred at 50 °C for 5 hours before all volatiles were removed to afford the crude desired product as a yellow solid, which was used directly for the next step without further

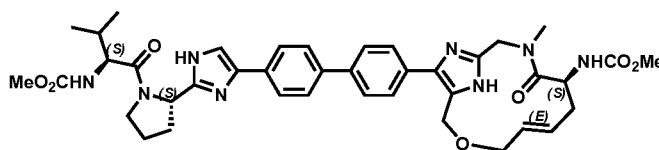
5 purification. ESIMS m/z = 336.09, 338.09 $[M+H]^+$.

Step 358g. A mixture of the crude compound from step 358f (0.159 mmol at most) and (*S*)-2-(methoxycarbonylamino)pent-4-enoic acid (prepared using procedures similar to that described in step 345e and WO 2008/021927, 30.3 mg, 0.175 mmol) in CH_2Cl_2 (4 mL) was treated with HATU (60.4 mg, 0.159 mmol) in the presence of DIPEA (0.28 mL, 1.588 mmol) for 1 hour at rt before more HATU (3.0 mg) was added. After another 20 minutes, the volatiles were evaporated off. The residue was purified by chromatography (silica, EtOAc-hexanes-MeOH) to give the desired compound as a white foam (70.3 mg, 90% over 2 steps). ESIMS m/z = 491.15, 493.15 $[M+H]^+$.

10 **Step 358h.** The desired compound as a brown solid (26.3 mg, 40%) was obtained from the compound from step 358g (70.3 mg, 0.143 mmol) using the procedures similar to that described in step 1h. ESIMS m/z = 463.10, 465.10 $[M+H]^+$.

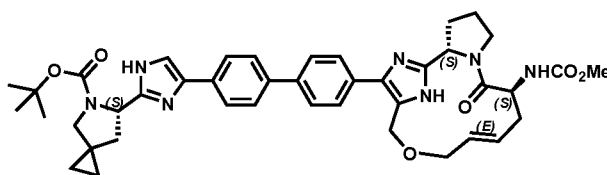
Step 358i. To a mixture of the compounds from step 358h (26.3 mg, 56.8 μ mol), step 1k (37.4 mg, 85.1 μ mol) and $NaHCO_3$ (19.1 mg, 0.227 mmol) in DME (3 mL) and H_2O (1 mL) was added $Pd(PPh_3)_4$ (6.6 mg, 5.7 μ mol). The resultant mixture was degassed and heated at 97 °C under N_2 for 3 hours. The volatiles were evaporated off. The residue was purified by chromatography (silica, hexanes-EtOAc-MeOH) to give the title compound as a yellow solid (23.3 mg, 59%). ESIMS m/z = 696.34 $[M+H]^+$.

Example 359.



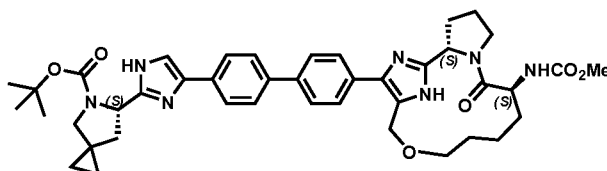
25 The title compound was prepared from the compound of Example 358 using procedures similar to that described in example 344. ESIMS m/z = 753.38 $[M+H]^+$.

Example 360.



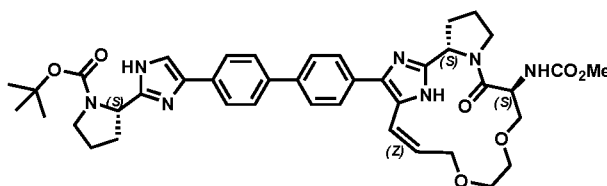
The title compound was prepared from the compound from step 1h and (S)-tert-butyl 6-(4-(4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)-1H-imidazol-2-yl)-5-azaspiro[2.4]heptane-5-carboxylate (prepared using procedures similar to that described in step 1i-1k from (S)-5-(tert-butoxycarbonyl)-5-azaspiro[2.4]heptane-6-carboxylic acid, WO 2009/102325) using procedure similar to that described in step 1l. ESIMS $m/z = 748.37$ $[M+H]^+$.

Example 361.



To a solution of the compound from Example 360 (19.0 mg, 25.4 μ mol) in MeOH (3 mL) was added palladium hydroxide (20 wt% on carbon, 7 mg). The mixture was stirred under hydrogen (60 psi) at rt for 15 hours before being diluted with dichloromethane and filtered through Celite. The filtrate was concentrated to give the title compound as a dark yellow solid (22.5 mg, quant.). ESIMS $m/z = 750.33$ $[M+H]^+$.

Example 362.



Step 362a. To a solution of *N*-Boc-L-serine (2.500 g, 12.18 mmol) in DMF (50 mL) at -20 °C was added sodium hydride (60% in mineral oil, 1.121 g, 28.02 mmol). The suspension was allowed to gradually warm up to rt and stirred for 20 minutes at rt. A solution of 2-(allyloxy)ethyl 4-methylbenzenesulfonate (prepared according to *J. Org. Chem.* **1999**, 64, 4798, 3.747 g, 14.62 mmol) was added. The mixture was stirred at rt for 17 hours before being cooled to 0 °C and quenched with H₂O (100 mL). It was extracted with *t*-butyl methyl ether, EtOAc. The aqueous layer was acidified with 3N HCl at 0 °C to pH ~2 before being extracted with EtOAc. The combined organic layers were washed with brine, dried (Na₂SO₄), filtered and concentrated. The residue was freed of DMF by passing N₂ through for 3 h and then dried under vacuum to afford the desired compound as a yellow oil (1.870 g, 53%). ESIMS $m/z = 290.09$ $[M+H]^+$.

Step 362b. A mixture of the compound from step 362a (1.870 g, 6.463 mmol) in CH₂Cl₂ (15 mL) was treated with HCl (4M in 1,4-dioxane, 20 mL) at rt for 2 hours before all

volatiles were evaporated off to afford the crude desired product as a yellow solid (1.428 g), which was used directly for the next step without further purification. ESIMS m/z = 190.11 $[M+H]^+$.

Step 362c. The desired compound as a yellow oil (1.192 g, 75% over 2 steps) was

5 prepared from the crude compound from step 26b (1.428 g, 6.463 mmol at most) using the procedures similar to that described in step 345e. ESIMS m/z = 270.53 $[M+H]^+$.

Step 362d. To a solution of the compound from the compound from step 1d (0.250 g, 0.452 mmol) in CH_2Cl_2 (5 mL) was added $NaHCO_3$ (0.500 g, 5.952 mmol) and Dess-

Martin periodinane (0.230 g, 0.543 mmol). The mixture was stirred at rt for 2 hours.

10 Another portion of Dess-Martin periodinane (46.0 mg, 0.108 mmol) was added. After 30 minutes at rt, it was quenched with aqueous $Na_2S_2O_3$ solution at 0 °C. After 10 minutes at rt, the mixture was partitioned (EtOAc - H_2O). The organics were washed with brine, dried (Na_2SO_4), filtered and evaporated. The residue was purified by chromatography (silica, hexanes-EtOAc) to give the desired compound as a white semi-solid (0.220 g, 88%).

15 ESIMS m/z = 552.11 $[M+H]^+$.

Step 362e. To a suspension of methyl triphenylphosphonium bromide (0.357 g, 0.999 mmol) in THF (11 mL) was added *t*-BuOK (1M in THF, 1.00 mL, 0.999 mmol) at rt. The mixture was stirred at rt for 1 hour before being cooled down to 0 °C. A solution of the compound from step 362d (0.220 g, 0.400 mmol) in THF (2 mL) was added at 0 °C. The

20 resultant mixture was stirred at rt for 20 hours before being quenched with saturated NH_4Cl solution. The mixture was partitioned (EtOAc - H_2O) and the organics were washed with brine, dried (Na_2SO_4), filtered and evaporated. The residue was purified by tchromatography (silica, hexanes-ethyl acetate) to give the desired compound as a colorless oil (0.209 g, 95%). ESIMS m/z = 548.14, 550.14 $[M+H]^+$.

25 **Step 362f.** To a solution of the compound from step 362e (0.209 g, 0.381 mmol) in 1,4-dioxane (3 mL) was added HCl (4M in 1,4-dioxane, 18 mL). The mixture was stirred at 50 °C for 5 hours before all volatiles were removed to afford the crude desired product as a yellow solid (0.227 g), which was used directly for the next step without further purification. ESIMS m/z = 318.19, 320.18 $[M+H]^+$.

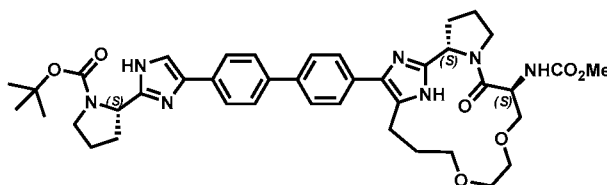
30 **Step 362g.** A mixture of the crude compound from step 362f (0.227 g, 0.381 mmol at most) and the compound from step 362c (0.113 g, 0.457 mmol) in CH_2Cl_2 (7 mL) was treated with HATU (0.145 g, 0.381 mmol) in the presence of DIPEA (0.66 mL, 3.810 mmol) for 1.5 hours at rt. The volatiles were evaporated off. The residue was purified by

chromatography (silica, EtOAc-hexanes) to give the desired compound as a white solid (0.165 g, 79% over 2 steps). ESIMS $m/z = 547.09, 549.09 [M+H]^+$.

Step 362h. To a solution of the compound from step 362g (0.165 g, 0.301 mmol) in toluene (150 mL) was added Zhan-1B catalyst (44.2 mg, 60.3 μmol). The mixture was degassed and heated at 50 °C under N_2 for 15 hours. The volatiles were evaporated off. The residue was purified by chromatography (silica, EtOAc-hexanes-MeOH) to afford the desired compound as a dark brown oil (0.118 g, 75%). ESIMS $m/z = 519.04, 521.04 [M+H]^+$.

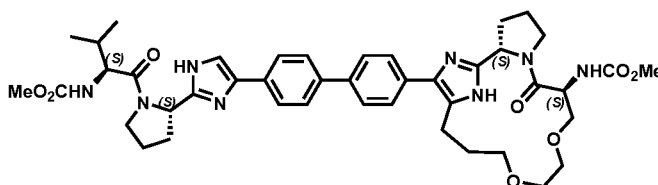
Step 362i. The title compound was prepared from the compounds from step 362h and step 1k following the procedure similar to that described in step 11. ESIMS $m/z = 752.39 [M+H]^+$.

Example 363.



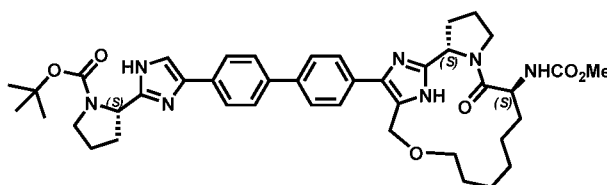
The title compound was prepared from the compound from Example 362 following the procedures similar to that described in Example 361. ESIMS $m/z = 754.39 [M+H]^+$.

Example 364.



The title compound was prepared from the compound from Example 363 following the procedures similar to that described in Example 344. ESIMS $m/z = 811.44 [M+H]^+$.

Example 365.



Step 365a. A solution of 5-bromo-1-pentene (1.00 g, 6.70 mmol) in acetone (70 mL) was treated with sodium iodide (11.0 g, 73.7 mmol) at rt for 36 hours before filtration through Celite. The filtrate was concentrated to a yellow solid. It was dissolved in diethyl ether (50 mL) and washed with water and brine. The organic phase was dried (Na_2SO_4), filtered

and evaporated to give a light yellow oil (680 mg, 50%), which was used directly in the next step.

Step 365b. Into a solution of lithium chloride (anhydrous, 509 mg, 12 mmol) in THF (12 mL) was charged 2-amino-N-((1R,2R)-1-hydroxy-1-phenylpropan-2-yl)-N-

5 methylacetamide hydrate (721 mg, 3.0 mmol), followed by LHMDs (1 M in THF, 9.6 mL, 9.6 mmol) while keeping temperature below -5 °C. It was stirred for 15 minutes before the compound from Step 365a (660 mg, 3.24 mmol) in THF (5 mL) was added. The mixture was stirred at -5 °C for 4 hours then rt overnight. It was quenched and acidified by HCl (4 N) to pH 2 before partition (EtOAc - H₂O). The acidic aqueous phase was basified
10 to pH 14 by adding NaOH (50%) and was extracted with CH₂Cl₂. The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was chromatographed (silica, CH₂Cl₂-MeOH-TEA) to give the desired compound as a light yellow oil (441 mg, 50%). ESIMS m/z = 290.21 [M+H]⁺.

Step 365c. A solution of the compound from step 365b (284 mg, 0.98 mmol) in H₂O (2
15 mL) and MeOH (3 mL) was treated with NaOH (1M, 2 mL) at 80 °C for 8 hours, then rt overnight. The crude product was partitioned (CH₂Cl₂-H₂O). The basic aqueous solution was treated with methyl chloroformate (0.1 mL, 1.2 mmol) at rt for 6 hours before partition (EtOAc - H₂O). The aqueous phase was acidified to pH 3 by HCl (4 N) and then extracted with EtOAc. The organics were washed with brine, dried (Na₂SO₄), filtered and
20 evaporated to give the desired compound as a light yellow oil (42 mg, two steps 22%).

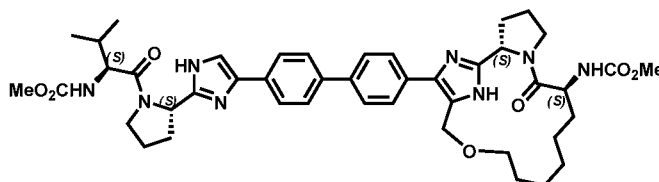
Step 365d. The desired compound as a yellow oil was prepared from the compounds from steps 1f and 365c using the procedures similar to that described in step 344b. ESIMS m/z = 545.30, 547.31 [M+H]⁺.

Step 365e. The desired compounds as a yellow oil in olefin isomeric mixture (32 mg,
25 62%) was prepared from the compound from step 365d (55 mg, 0.1 mmol) and Zhan-1B catalyst (14.6 mg, 0.02 mmol) in toluene (80 mL) at 50 °C for 15 hours using procedures similar to that described in step 26h. ESIMS m/z = 517.21, 519.20 [M+H]⁺.

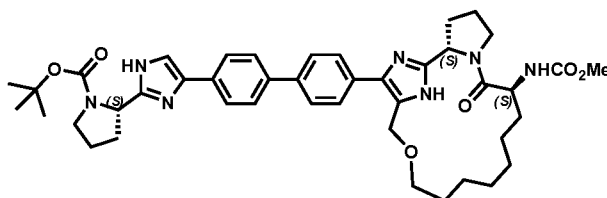
Step 365f. A mixture of the compounds from step 1k (54 mg, 0.123 mmol), step 365e (32 mg, 0.062 mmol), Pd(PPh₃)₄ (7 mg, 0.006 mmol) and NaHCO₃ (79 mg, 0.94 mmol) in
30 DME (5.2 mL) and H₂O (1.7 mL) was degassed and heated at 95 °C under N₂ for 1 hour. The volatiles were evaporated and the residue was partitioned (EtOAc - H₂O). The organics were washed with brine, dried (Na₂SO₄), filtered and evaporated. The residue was chromatographed (silica, MeOH-DCM) to give the desired compound as a yellow solid (28.3 mg, 61%). ESIMS m/z = 750.57 [M+H]⁺.

Step 365g. A mixture of the compound from step 365f (28 mg, 0.037 mmol) and Pd(OH)₂ (20 % on carbon, 4 mg) in MeOH (2 mL) was stirred at rt under H₂ (60 psi) overnight. It was filtered and concentrated to give the title compound as a yellow solid (27 mg, 96%). ESIMS $m/z = 752.50$ [M+H]⁺.

5

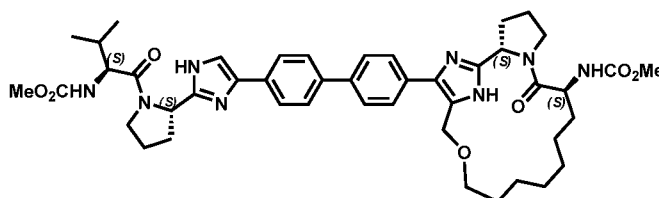
Example 366.

The title compound was prepared from the compound from Example 365 following the procedures similar to that described in Example 344. ESIMS $m/z = 809.61$ [M+H]⁺.

Example 367.

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The title compound was prepared from the compound from 6-bromohex-1-ene following the procedures similar to that described in Example 365. ESIMS $m/z = 766.59$ [M+H]⁺.

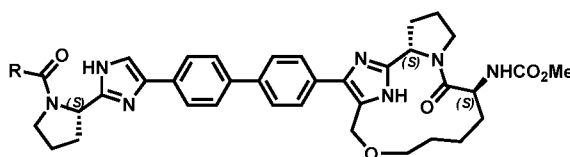
Example 368.

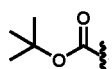
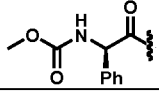
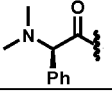
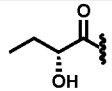
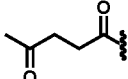
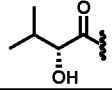
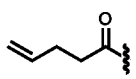
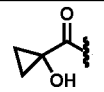
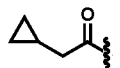
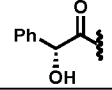
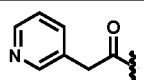
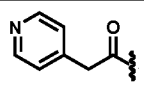
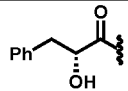
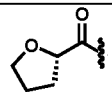
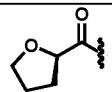
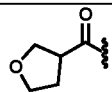
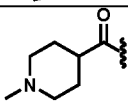
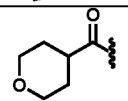
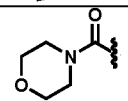
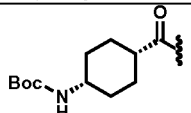
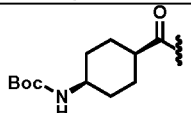
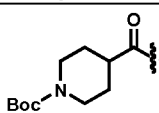
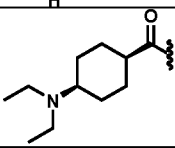
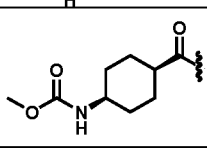
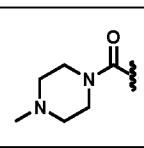
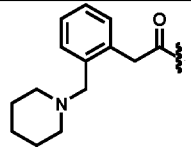
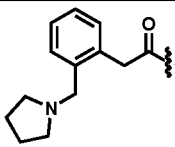
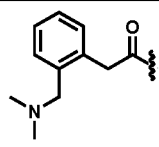
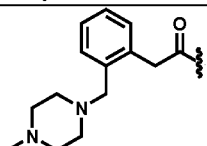
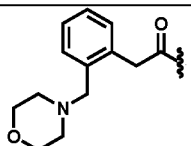
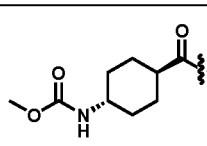
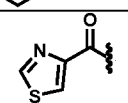
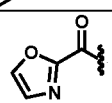
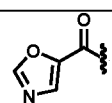
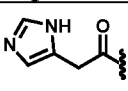
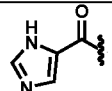
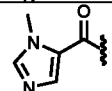
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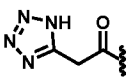
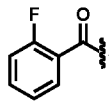
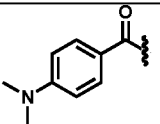
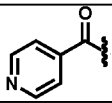
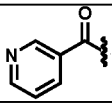
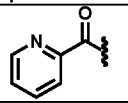
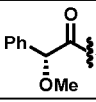
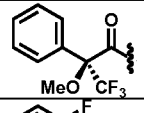
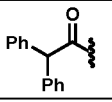
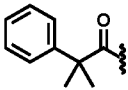
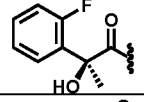
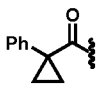
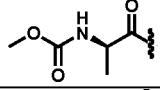
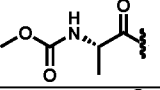
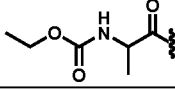
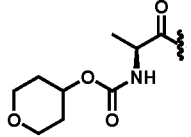
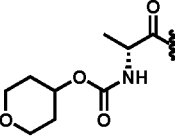
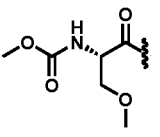
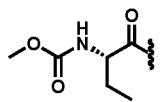
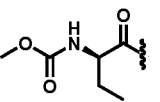
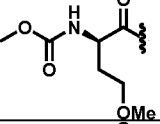
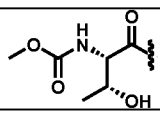
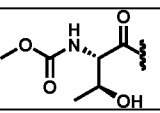
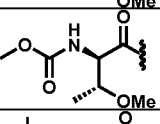
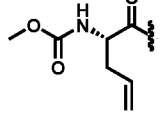
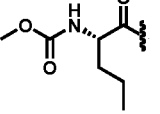
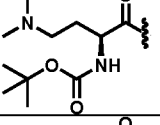
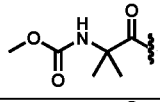
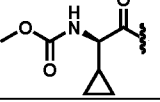
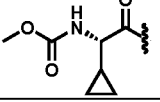
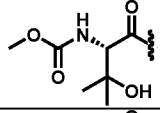
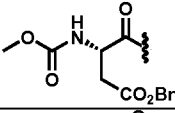
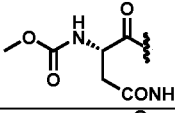
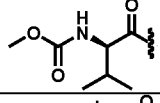
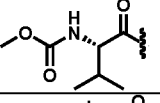
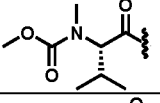
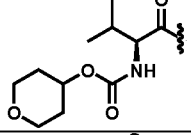
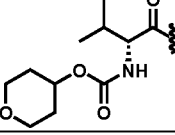
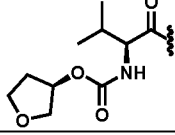
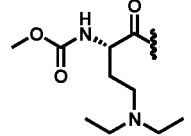
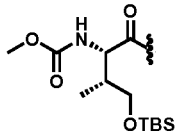
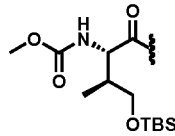
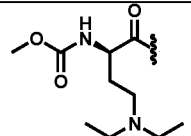
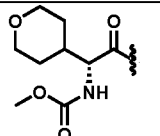
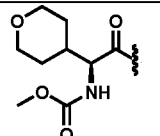
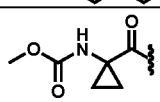
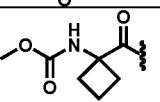
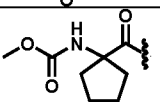
The title compound was prepared from the compound from example 367 following the procedures similar to that described in Example 344. ESIMS $m/z = 823.27$ [M+H]⁺.

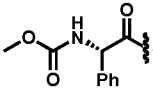
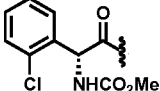
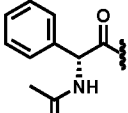
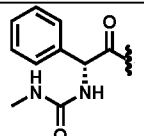
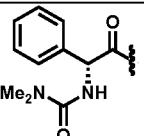
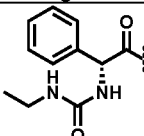
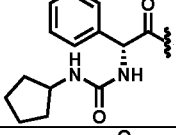
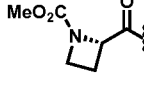
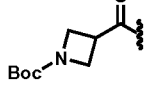
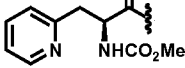
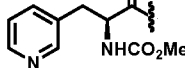
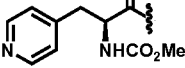
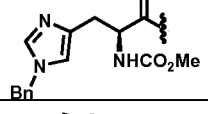
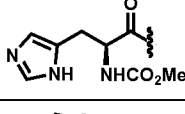
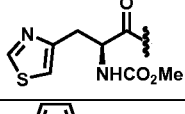
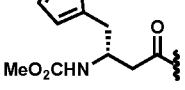
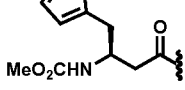
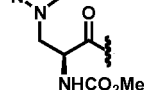
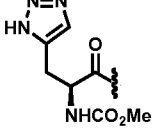
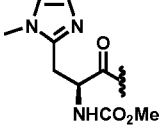
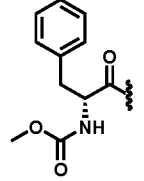
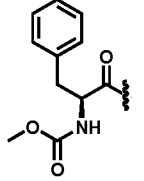
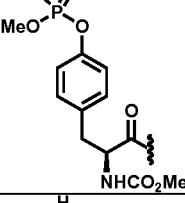
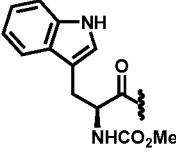
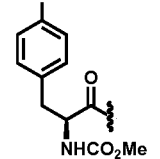
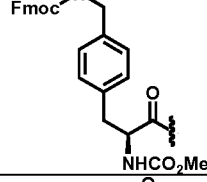
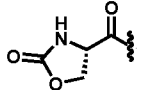
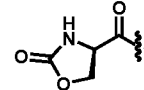
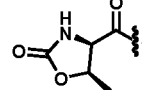
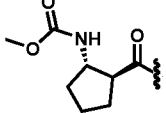
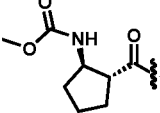
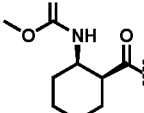
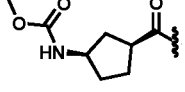
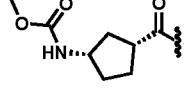
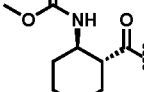
The title compounds of examples 2-82, 84-257, 259-316, 319-321, 323-332, 334-335, 337-343 and 369-376 may be prepared using the chemistry described above.

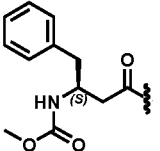
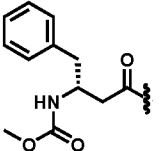
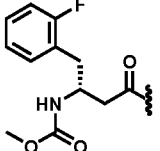
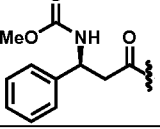
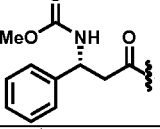
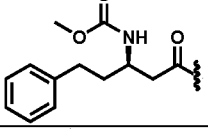
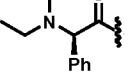
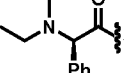
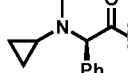
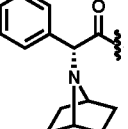
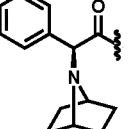
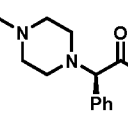
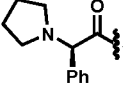
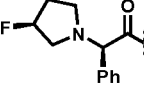
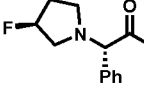
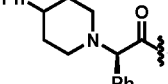
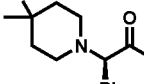
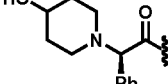
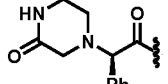
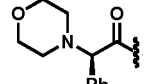
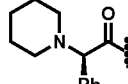
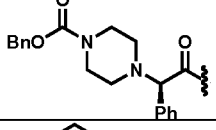
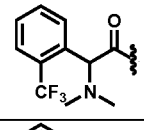
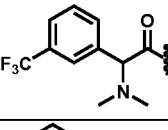
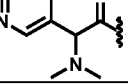
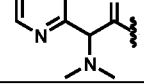
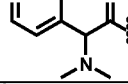
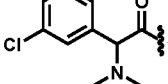
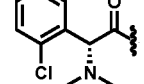
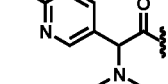
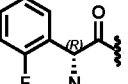
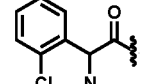
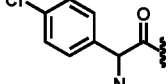
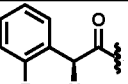
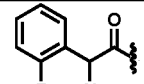
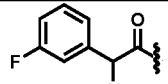
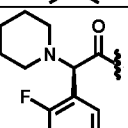
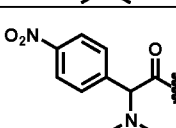
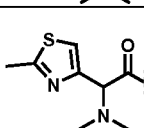
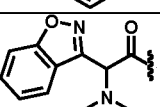
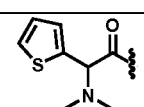
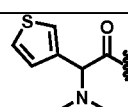
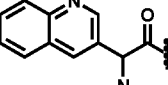
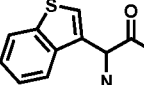
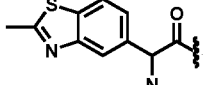
20

Table 1: Examples 1-219.

Entry		Entry		Entry	
1		2		3	
4		5		6	
7		8		9	
10		11		12	
13		14		15	
16		17		18	
19		20		21	
22		23		24	
25		26		27	
28		29		30	
31		32		33	
34		35		36	
37		38		39	
40		41		42	
43		44		45	
46		47		48	

49		50		51	
52		53		54	
55		56		57	
58		59		60	
61		62		63	
64		65		66	
67		68		69	
70		71		72	
73		74		75	
76		77		78	
79		80		81	
82		83		84	
85		86		87	
88		89		90	
91		92		93	
94		95		96	

97		98		99	
100		101		102	
103		104		105	
106		107		108	
109		110		111	
112		113		114	
115		116		117	
118		119		120	
121		122		123	
124		125		126	
127		128		129	
130		131		132	

133		134		135	
136		137		138	
139		140		141	
142		143		144	
145		146		147	
148		149		150	
151		152		153	
154		155		156	
157		158		159	
160		161		162	
163		164		165	
166		167		168	
169		170		171	
172		173		174	
175		176		177	

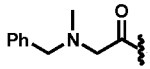
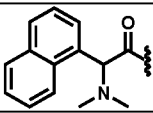
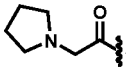
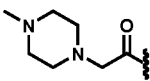
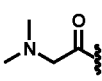
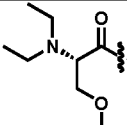
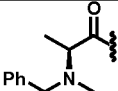
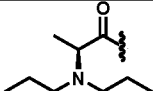
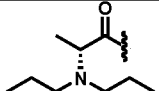
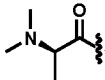
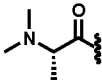
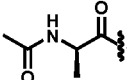
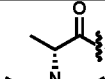
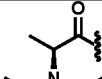
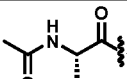
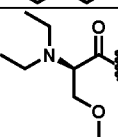
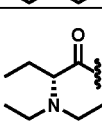
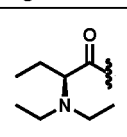
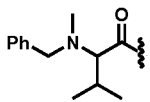
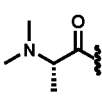
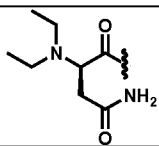
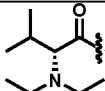
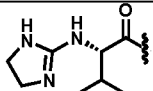
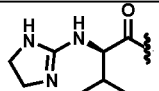
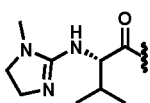
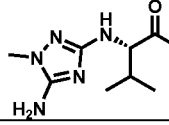
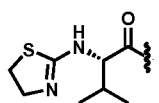
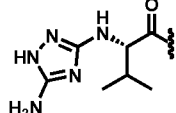
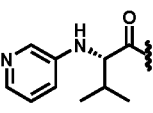
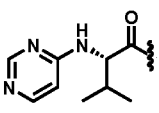
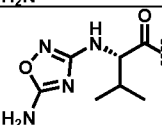
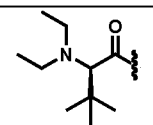
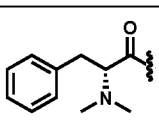
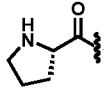
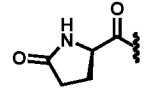
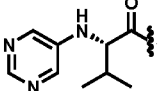
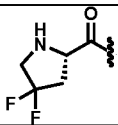
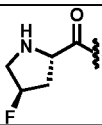
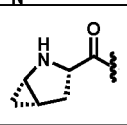
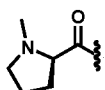
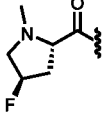
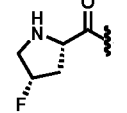
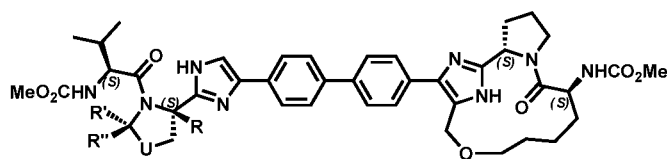
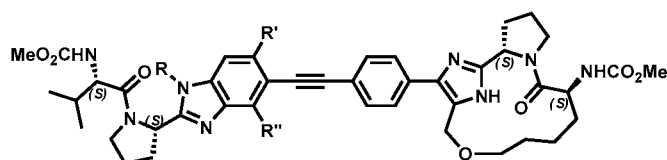
178		179		180	
181		182		183	
184		185		186	
187		188		189	
190		191		192	
193		194		195	
196		197		198	
199		200		201	
202		203		204	
205		206		207	
208		209		210	
211		212		213	
214		215		216	
217		218		219	

Table 2: Examples 220-229.



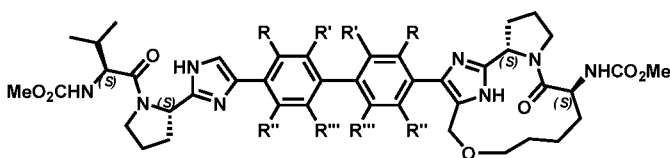
Entry	R	R'	R''	U	Entry	R	R'	R''	U
220	Me	H	H	CH ₂	221	H	H	H	CF ₂
222	Me	H	H	S	223	H	H	H	
224	H	Me	H	CH ₂	225	H	H	H	
226	H	Ph	H	CH ₂	227	H	H	H	
228	H	H	Ph	CH ₂	229	H	H	H	

Table 3: Examples 230-239.



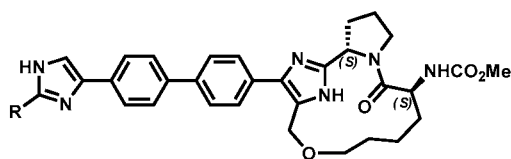
Entry	R	R'	R''	Entry	R	R'	R''
230	Me	H	H	231	H	CO ₂ Me	H
232	H	F	H	233	H	H	CO ₂ Me
234	H	H	F	235	H	OMe	H
236	H	Cl	H	237	H	H	OMe
238	H	H	Cl	239	H	CF ₃	H

Table 4: Examples 240-249.



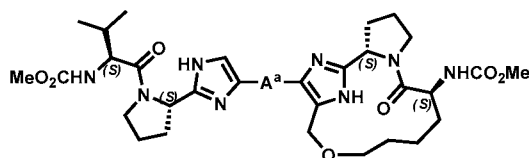
Entry	R	R'	R''	R'''	Entry	R	R'	R''	R'''
240	F	H	H	H	241	F	F	H	H
242	Me	H	H	H	243	Me	Me	H	H
244	H	H	Me	Me	245	H	H	Et	Et
246	CF ₃	H	H	H	247	CF ₃	H	CF ₃	H
248	Cl	H	H	H	249	Cl	H	Cl	H

Table 5: Examples 250-264.



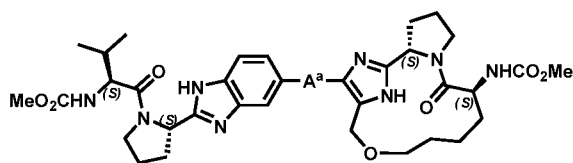
Entry	R	Entry	R	Entry	R
250		251		252	
253		254		255	
256		257		258	
259		260		261	
262		263		264	

Table 6: Examples 265-282.



Entry	A ^a	Entry	A ^a	Entry	A ^a
265		266		267	
268		269		270	
271		272		273	
274		275		276	
277		278		279	
280		281		282	

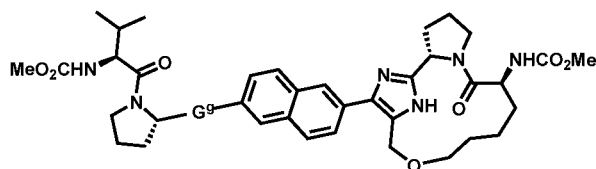
Table 7: Examples 283-303.



Entry	A ^a	Entry	A ^a	Entry	A ^a
283		284		285	
286		287		288	
289		290		291	
292		293		294	
295		296		297	
298		299		300	
301		302		303	

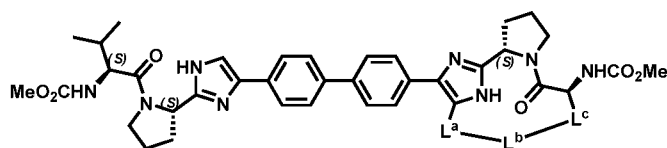
5

Table 8: Examples 304-315.



Entry	G ^g	Entry	G ^g	Entry	G ^g
304		305		306	
307		308		309	
310		311		312	
313		314		315	

Table 9: Examples 316-333.



Entry	L ^a -L ^b -L ^c	Entry	L ^a -L ^b -L ^c	Entry	L ^a -L ^b -L ^c
316		317		318	
319		320		321	
322		323		324	
325		326		327	
328		329		330	
331		332		333	

Table 10: Examples 334-343.

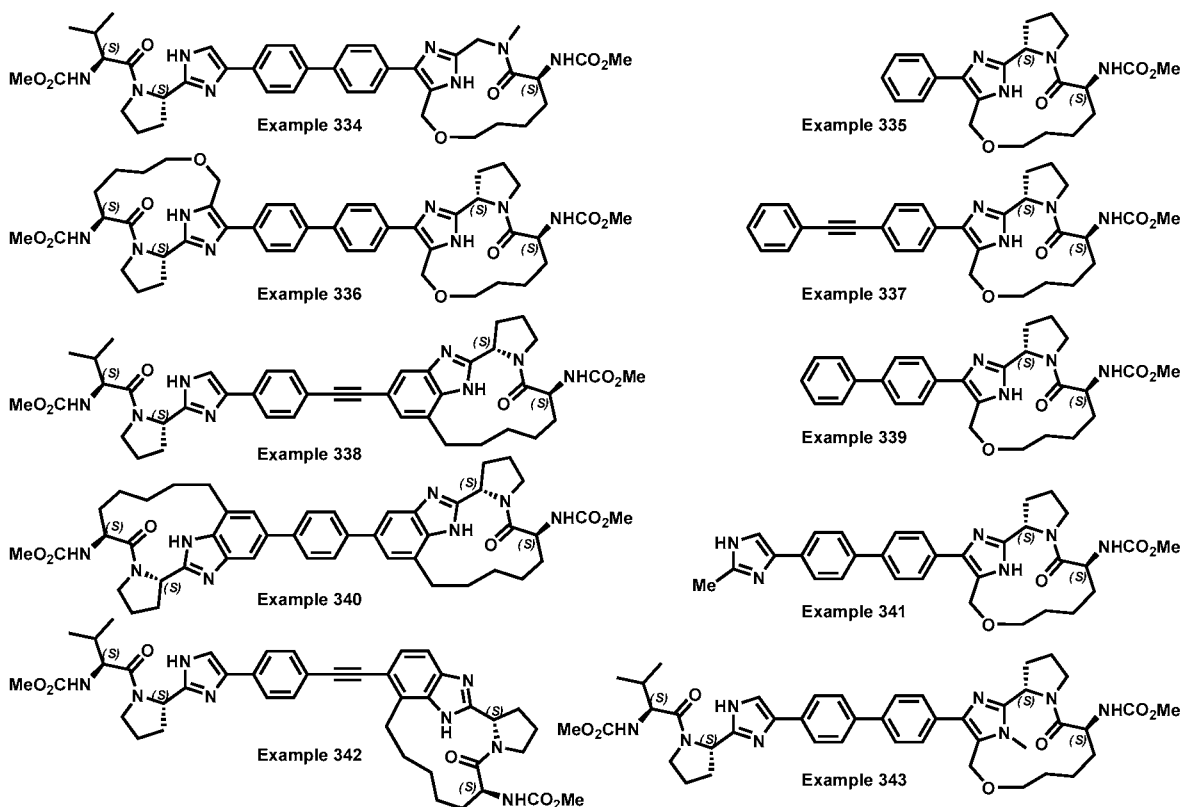
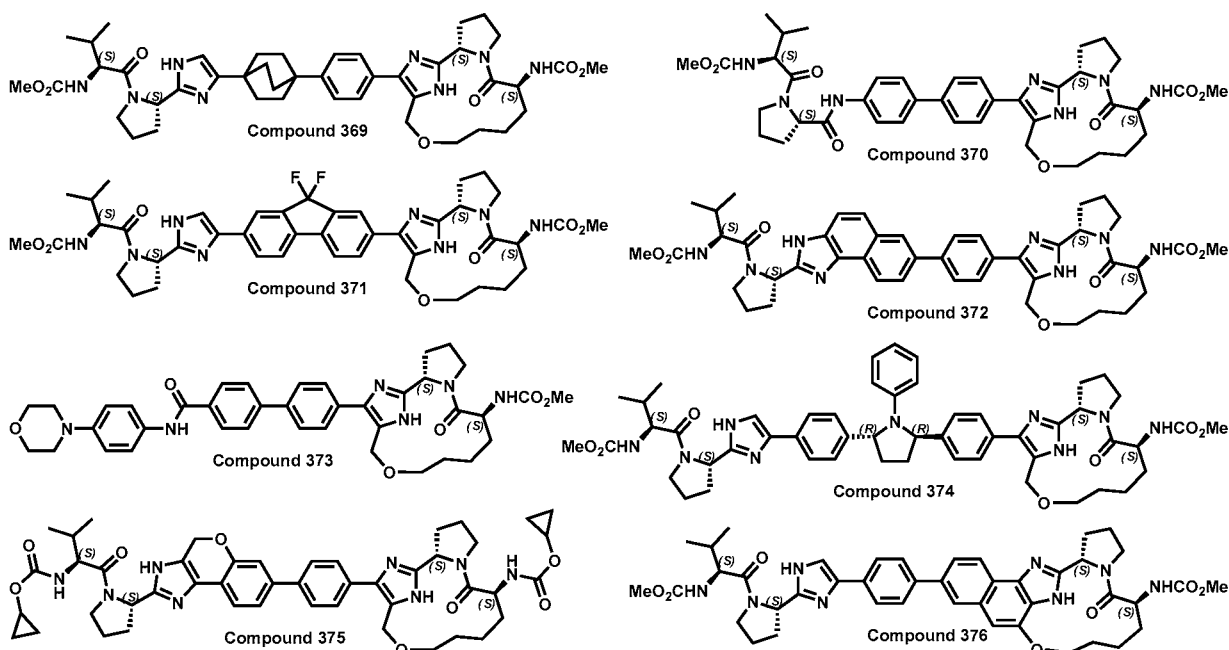


Table 12: Examples 369-376.



BIOLOGICAL ACTIVITY

5 1. HCV Replicon Cell Lines

HCV replicon cell lines (kindly provided by R. Bartenschlager) isolated from colonies as described by Lohman et al. (Lohman et al. (1999) Science 285: 110-113, expressly incorporated by reference in its entirety) and used for all experiments. The HCV replicon has the nucleic acid sequence set forth in EMBL Accession No.: AJ242651, the coding sequence of which is from nucleotides 1801 to 8406.

The coding sequence of the published HCV replicon was synthesized and subsequently assembled in a modified plasmid pBR322 (Promega, Madison, WI) using standard molecular biology techniques. One replicon cell line ("SGR 11-7") stably expresses HCV replicon RNA which consists of (i) the HCV 5'UTR fused to the first 12 amino acids of the capsid protein, (ii) the neomycin phosphotransferase gene (neo), (iii) the IRES from encephalomyocarditis virus (EMCV) and (iv) HCV NS2 to NS5B genes and the HCV 3'UTR. Another replicon cell line ("Huh-luc/neo-ET") described by Vrolijk et. al. (Vrolijk et. al. (2003) Journal of Virological Methods 110:201-209, expressly incorporated by reference in its entirety) stably expresses HCV replicon RNA which consists of (i) the HCV 5'UTR fused to the first 12 amino acids of the capsid protein, (ii) the firefly luciferase reporter gene, (iii) the ubiquitin gene, (iv) the neomycin phosphotransferase gene (neo), (v) the IRES from encephalomyocarditis virus (EMCV)

and (vi) HCV NS3 to NS5B genes that harbor cell culture adaptive mutations (E1202G, T1280I, K1846T) and the HCV 3'UTR.

These cell lines are maintained at 37°C, 5% CO₂, 100% relative humidity in DMEM (Cat# 11965-084, Invitrogen), with 10% fetal calf serum ("FCS", Invitrogen), 1% non-essential amino acids (Invitrogen), 1% of Glutamax (Invitrogen), 1% of 100X penicillin/streptomycin (Cat# 15140-122, Invitrogen) and Geneticin (Cat# 10131-027, Invitrogen) at 0.75 mg/ml or 0.5 mg/ml for 11-7 and Huh-luc/neo-ET cells, respectively.

2. HCV Replicon Assay - qRT-PCR

EC₅₀ values of single agent compounds were determined by HCV RNA detection using quantitative RT-PCR, according to the manufacturer's instructions, with a TAQMAN® One-Step RT-PCR Master Mix Reagents Kit (Cat# AB 4309169, Applied Biosystems) on an ABI Model 7500 thermocycler. EC₅₀ values of combinations are similarly determined by HCV RNA detection using quantitative RT-PCR. The TAQMAN primers to use for detecting and quantifying HCV RNA obtained from Integrated DNA Technologies. HCV RNA is normalized to GAPDH RNA levels in drug-treated cells, which is detected and quantified using the Human GAPDH Endogenous Control Mix (Applied Biosystems, AB 4310884E). Total cellular RNA is purified from 96-well plates using the RNAqueous 96 kit (Ambion, Cat# AM1812). Chemical agent cytotoxicity is evaluated using an MTS assay according to the manufacturer's directions (Promega).

3. HCV Replicon Assay - Luciferase

Since clinical drug resistance often develops in viral infections following single agent therapies, there is a need to assess the additive, antagonistic, or synergistic properties of combination therapies. We use the HCV replicon system to assess the potential use of the compound of the present invention or in combination therapies with Interferon alpha, cyclosporine analogs and inhibitors targeting other HCV proteins. The acute effects of a single or combinations of drugs are studied in the "Huh-luc/neo-ET" replicon with each chemical agent titrated in an X or Y direction in a 6 point two-fold dilution curve centered around the EC₅₀ of each drug. Briefly, replicon cells are seeded at 7,000 cells per well in 90 ul DMEM (without phenol red, Invitrogen Cat.# 31053-036) per well with 10% FCS, 1% non-essential amino acids, 1% of Glutamax and 1% of 100X penicillin/streptomycin and incubated overnight at 37°C, 5% CO₂, 100% relative humidity. 16-20h after seeding cells, test compounds previously solubilized and titrated in dimethyl sulfoxide ("DMSO") from each X plate and Y plate are diluted 1:100 in DMEM (without phenol red, Invitrogen Cat.# 31053-036) with 10% FCS, 1% non-essential amino

acids, 1% of Glutamax and 1% of 100X penicillin/streptomycin and added directly to the 96-well plate containing cells and growth medium at a 1:10 dilution for a final dilution of compound and DMSO of 1:1000 (0.2% DMSO final concentration). Drug treated cells are incubated at 37°C, 5% CO₂, 100% relative humidity for 72 hours before performing a luciferase assay using 100 ul per well BriteLite Plus (Perkin Elmer) according to the manufacturer's instructions. Data analysis utilizes the method published by Prichard and Shipman (Antiviral Research, 1990. 14:181-205). Using this method, the combination data are analyzed for antagonistic, additive, or synergistic combination effects across the entire combination surface created by the diluted compounds in combination.

The compounds of the present invention may inhibit HCV by mechanisms in addition to or other than NS5A inhibition. In one embodiment the compounds of the present invention inhibit HCV replicon and in another embodiment the compounds of the present invention inhibit NS5A.

The compounds of the present invention can be effective against the HCV 1b genotype. It should also be understood that the compounds of the present invention can inhibit multiple genotypes of HCV. In one embodiment compound of the present invention are active against the 1a, 1b, 2a, 2b, 3a, 4a, and 5a genotypes. Table 15 shows the EC₅₀ values of representative compounds of the present invention against the HCV 1b genotype from the above described qRT-PCR or luciferase assay. EC₅₀ ranges against HCV 1b are as follows: A >1 nM; B 100-1000 nM; C < 100 pM.

Table 15: Genotype-1b replicon EC₅₀

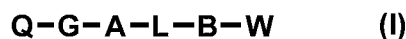
Example	Range	EC ₅₀	Example	Range	EC ₅₀	Example	Range	EC ₅₀
83	C		258	C	14 pM	317	C	
318	B		322	C		333	C	83 pM
336	B	175 pM	344	C	47 pM	349	C	
353	C	23 pM	355	C		356	C	27 pM
359	A		366	C		368	C	

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims.

CLAIMS

What is claimed:

1. A compound represented by Formula (I):



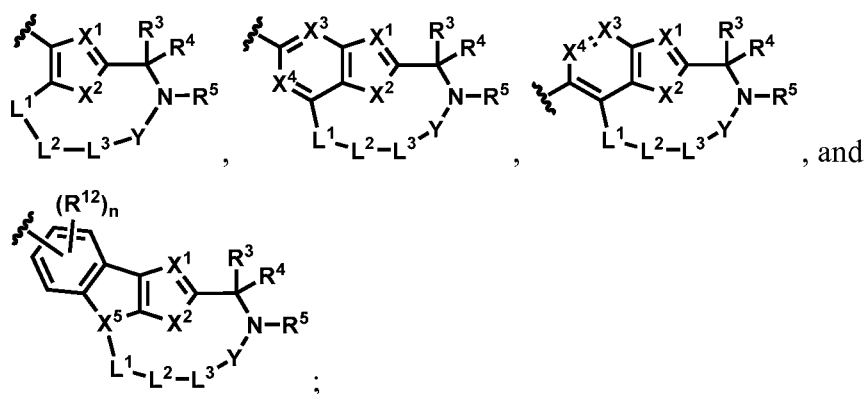
or a pharmaceutically acceptable salt thereof, wherein:

A and B are each independently absent or a monocyclic or polycyclic group independently selected from the group consisting of aryl, heteroaryl, heterocyclic, C₃-C₈ cycloalkyl, and C₃-C₈ cycloalkenyl, each optionally substituted;

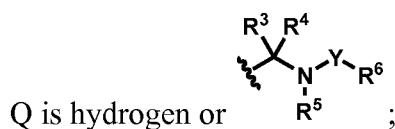
L is absent or an aliphatic group;

wherein at least one of A, B and L is present;

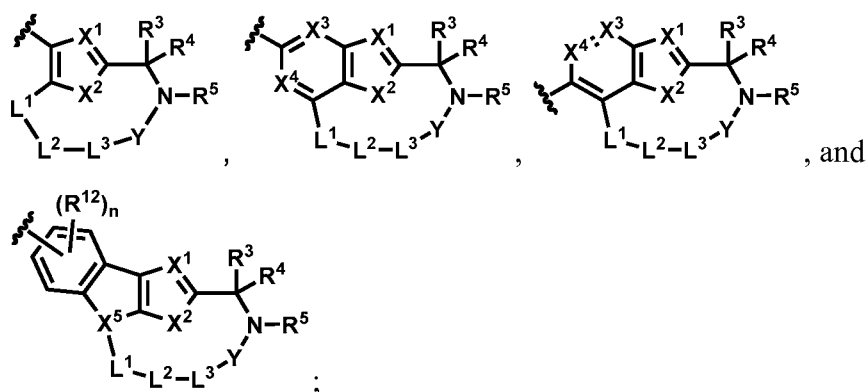
W is selected from the group consisting of:



G is absent, -C(O)NH-, an optionally substituted 5-membered heteroaryl containing one or more nitrogen atoms, or an optionally substituted 5-membered heteroaryl fused to a mono- or bicyclic ring, wherein the mono- or bicyclic ring is aromatic or non-aromatic, wherein the mono- or bicyclic ring is attached to one of groups A, L and B and wherein the 5-membered heteroaryl contains one or more nitrogen atoms;



Alternatively, G and Q can be taken together to form a group selected from:



X¹ at each occurrence is independently N or C(R¹¹);

X² at each occurrence is independently N(R¹), O or S;

5 X³ and X⁴ are each independently selected from N or C(R¹²);

X⁵ at each occurrence is independently N or a linear aliphatic group containing one to three carbon atoms and zero to two heteroatoms independently selected from O, N or S; wherein the said linear aliphatic group optionally contains one or two double bonds;

10 R¹ at each occurrence is independently hydrogen, hydroxy, O(C₁-C₄ alkyl) or optionally substituted C₁-C₄ alkyl;

R¹¹ at each occurrence is independently hydrogen, halogen or optionally substituted C₁-C₄ alkyl;

R¹² at each occurrence is indepenetly hydrogen, halogen, hydroxy, optionally substituted C₁-C₄ alkyl, or O(C₁-C₄ alkyl);

15 n is 1, 2, or 3;

L¹ and L³ at each occurrence are each independently an aliphatic group, or one of L¹ and L³ is absent and the other of L¹ and L³ is an aliphatic group;

20 L² at each occurrence is independently absent, or selected from the group consisting of aryl, heteroaryl, heterocyclic, C₃-C₈ cycloalkyl, and C₃-C₈ cycloalkenyl, each optionally substituted;

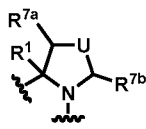
Y at each occurrence is independently C(O) or S(O)₂;

wherein -L¹-L²-L³- together form a linker of from 6 to 16 bond lengths;

25 R³ and R⁴ are each independently selected from the group consisting of hydrogen, optionally substituted C₁-C₈ alkyl, optionally substituted C₂-C₈ alkenyl, and optionally substituted C₃-C₈ cycloalkyl; alternatively, R³ and R⁴ can be taken together with the carbon atom to which they are attached to form optionally substituted C₃-C₈ cycloalkyl or optionally substituted heterocyclic;

R^5 at each occurrence is independently hydrogen, optionally substituted C_1 - C_8 alkyl, or optionally substituted C_3 - C_8 cycloalkyl;

Alternatively R^3 , R^4 and R^5 are taken together with the carbon atom and nitrogen



atom to which they are attached to form

- 5 U is absent or independently selected from O, S, S(O), SO₂, NC(O)-(C₁-C₄ alkyl), C(O), protected carbonyl, OCH₂, OCH₂CH₂, SCH₂, SCH₂CH₂, C(R⁷)₂, C(R⁷)₂C(R⁷)₂, and C=C(R²)₂;

R^2 at each occurrence is independently hydrogen, halogen, optionally substituted C_1 - C_4 alkyl, optionally substituted aryl, or optionally substituted heteroaryl;

- 10 R^7 at each occurrence is independently selected from the group consisting of hydrogen, halogen, cyano, hydroxy, O(C₁-C₄ alkyl), S(C₁-C₄ alkyl), amino optionally substituted with one or two C_1 -C₄ alkyl, optionally substituted aryl, optionally substituted heteroaryl, optionally substituted C_1 -C₄ alkyl, and optionally substituted C_3 - C_8 cycloalkyl;

- Alternatively two geminal R^7 groups are taken together with the carbon atom to
15 which they are attached to form a spiro, optionally substituted 3- to 7-membered cyclic group selected from the group consisting of C_3 - C_7 cycloalkyl, C_3 - C_7 cycloalkenyl or 3- to 7-membered heterocyclic;

- R^{7a} and R^{7b} at each occurrence are each independently selected from the group consisting of hydrogen, optionally substituted aryl, optionally substituted C_1 - C_4 alkyl, and
20 optionally substituted C_3 - C_8 cycloalkyl;

Alternatively, CHR^{7a}-U or CHR^{7b}-U are taken together to form a group selected from CH=CH, fused and optionally substituted C_3 - C_8 cycloalkyl, fused and optionally substituted aryl, or fused and optionally substituted heterocyclic;

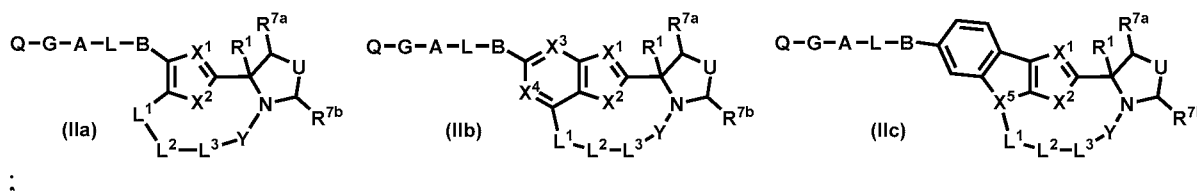
- Yet alternatively, U, R^{7a} , and R^{7b} are taken together with the carbon atoms to
25 which they are attached to form a bridged, optionally substituted 4- to 7-membered cyclic group selected from the group consisting of C_4 - C_7 cycloalkyl, C_4 - C_7 cycloalkenyl and 4- to 7-membered heterocyclic; and

- R^6 at each occurrence is independently selected from the group consisting of O(C₁- C_8 alkyl), amino, C_1 - C_8 alkyl, C_2 - C_8 alkenyl, C_2 - C_8 alkynyl, C_3 - C_8 cycloalkyl, C_3 - C_8
30 cycloalkenyl, heterocyclic, aryl, and heteroaryl, each optionally substituted.

2. The compound of claim 1, wherein L is selected from the group consisting of O, -NH-, -C(O)-, -C(O)NH-, C₁-C₄ alkyl, C₂-C₄ alkenyl, and C₂-C₄ alkynyl, and -(C₁-C₄ alkyl)-NH-(C₁-C₄ alkyl)-, each optionally substituted; or a pharmaceutically acceptable salt thereof.

5

3. The compound of claim 1, represented by Formula (IIa), (IIb) or (IIc):



;

or a pharmaceutically acceptable salt thereof.

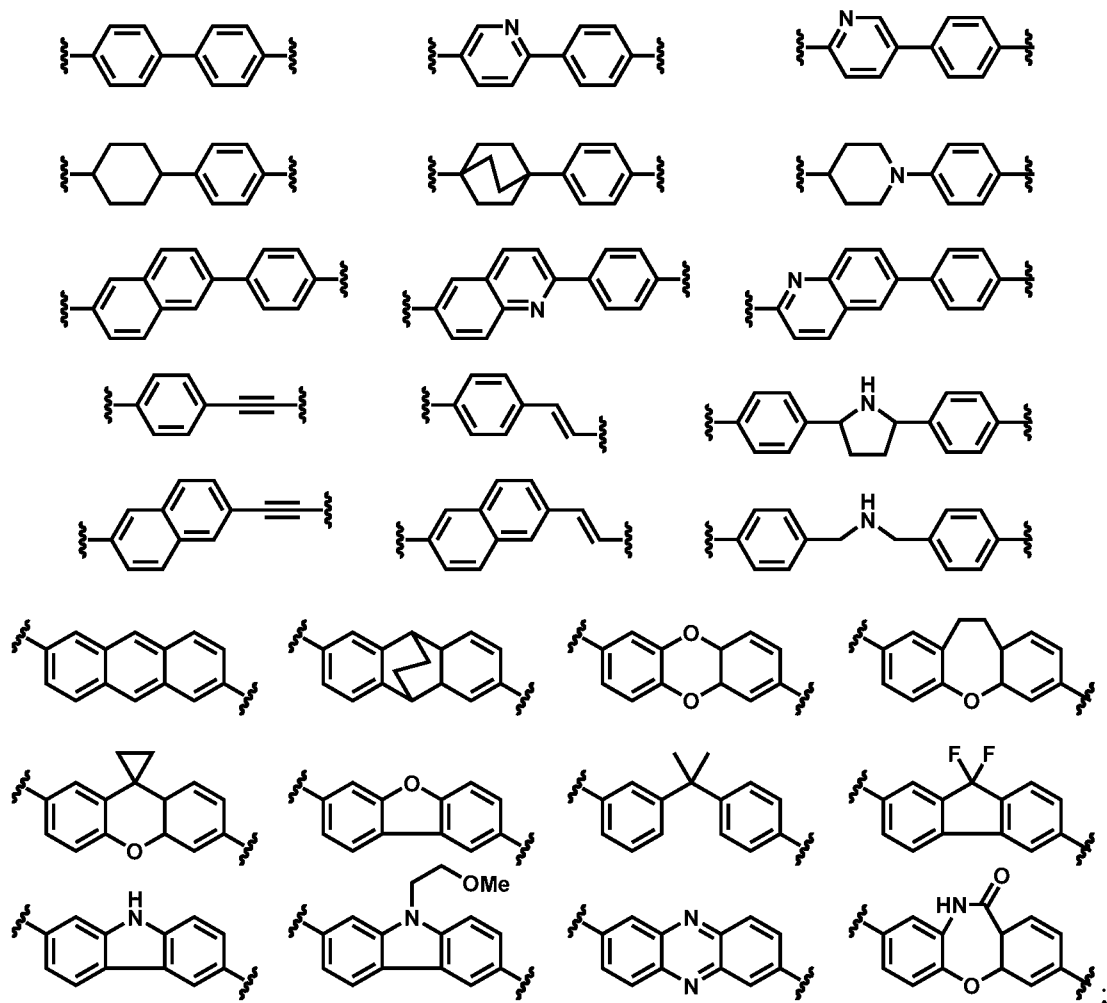
10

4. The compound of claim 3, wherein:

each L is absent or selected from the group consisting of O, -C(O)NH-, -(C₁-C₄ alkyl)-NH-(C₁-C₄ alkyl)-, heterocyclic, C₂-C₄ alkenyl, or C₂-C₄ alkynyl, each optionally substituted;

15

A and B are each independently absent, optionally substituted aryl, or optionally substituted heteroaryl; or alternatively A, L and B are taken together to form a linker selected from one of the groups illustrated below:



wherein each of the above shown groups is each optionally substituted;

L^1 and L^3 at each occurrence are each independently a linear aliphatic group, or one of L^1 and L^3 is a linear aliphatic group and the other one of L^1 and L^3 is absent;

5 wherein $-L^1-L^2-L^3-$ together form a linker of from 6 to 14 bond lengths;

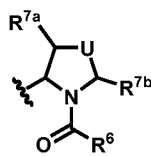
X^1 is N;

X^2 is NH, O, S or NMe;

X^3 is CH;

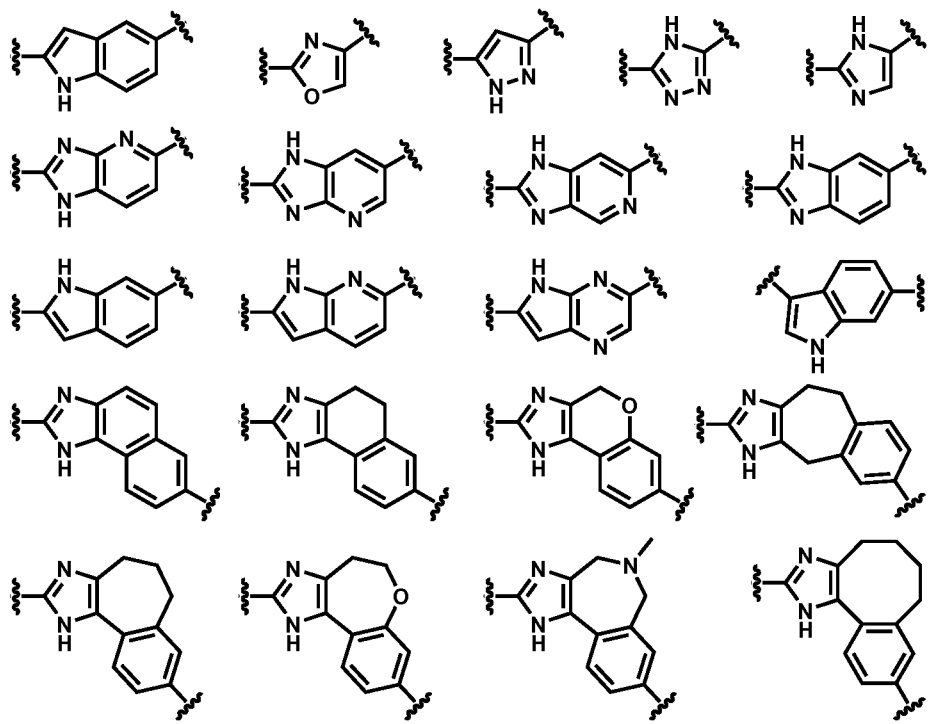
X^4 is CH; Y is C(O);

10 R^1 is hydrogen;



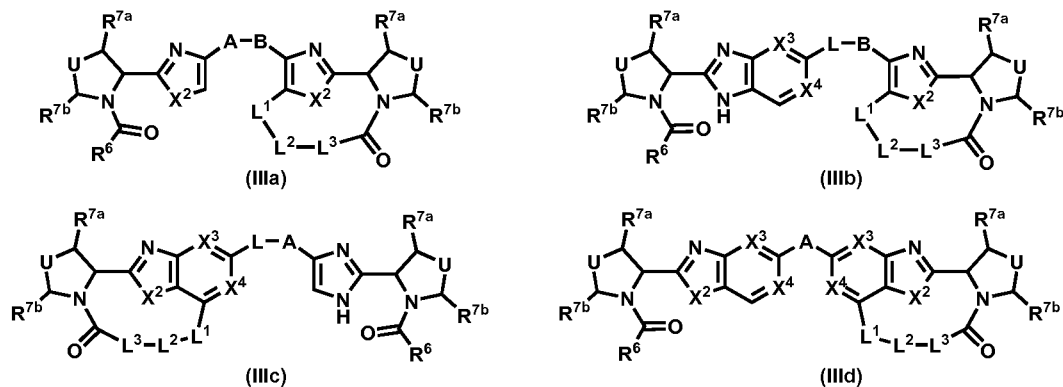
Q is hydrogen or $\text{O}=\text{C}-\text{R}^6$; and

G is absent, or selected from one of the groups illustrated below:



wherein each of the above shown heteroaryl groups is each optionally substituted; or a pharmaceutically acceptable salt thereof.

- 5 5. A compound of claim 1, represented by Formula (IIIa), (IIIb), (IIIc) or (IIId):



wherein:

R^6 is C_1 - C_8 alkyl optionally substituted with amino, hydroxy, protected amino, or $O(C_1$ - C_4 alkyl);

- 10 A and B are each independently phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted;

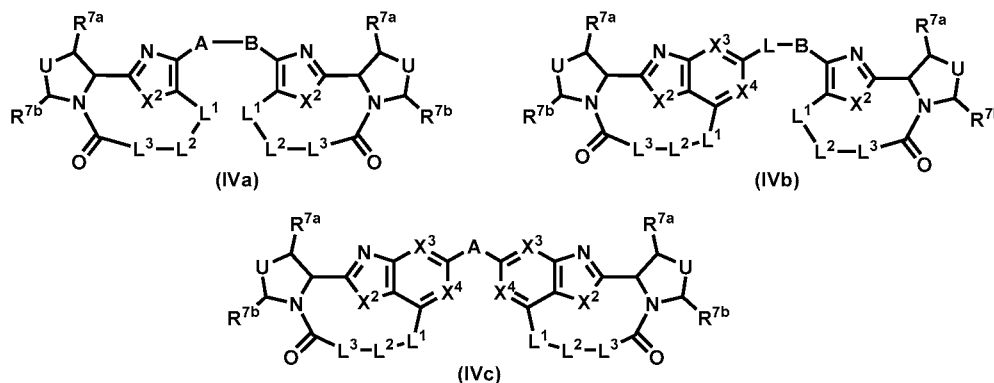
L is O, optionally substituted C_2 - C_4 alkenyl, or optionally substituted C_2 - C_4 alkynyl;

- 15 L^1 and L^3 at each occurrence are each independently a linear aliphatic group, or one of L^1 and L^3 is a linear aliphatic group and the other of L^1 and L^3 is absent;

X^3 and X^4 at each occurrence are each independently N or C(R^{12}); and

R^{12} at each occurrence is independently hydrogen, halogen, hydroxy, optionally substituted C_1 - C_4 alkyl or O(C_1 - C_4 alkyl); or a pharmaceutically acceptable salt thereof.

- 5 6. A compound of claim 1, represented by Formula (IVa), (IVb) or (IVc):



wherein:

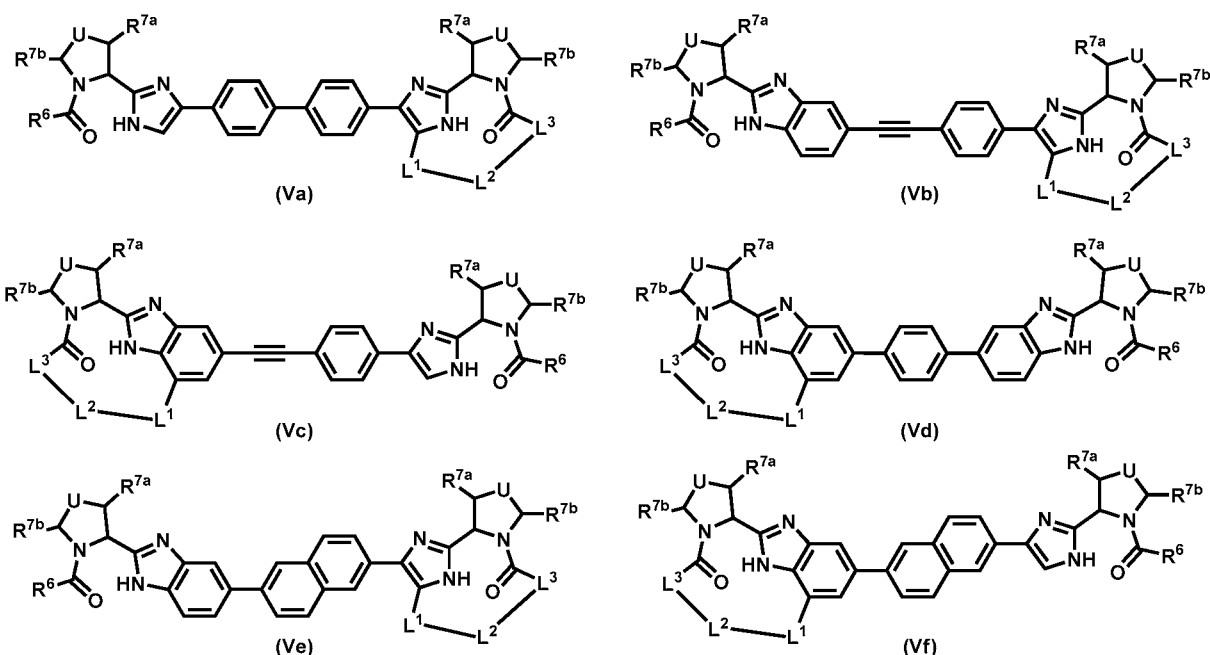
A and B are each independently phenyl, monocyclic heteroaryl, bicyclic aryl, or bicyclic heteroaryl, each optionally substituted;

- 10 L is O, optionally substituted C_2 - C_4 alkenyl, or optionally substituted C_2 - C_4 alkynyl; L^1 and L^3 at each occurrence are each independently a linear aliphatic group, or one of L^1 and L^3 a linear aliphatic group and the other one of L^1 and L^3 is absent;

X^3 and X^4 at each occurrence is each independently N or C(R^{12}); and

- 15 R^{12} at each occurrence is independently hydrogen, halogen, hydroxy, optionally substituted C_1 - C_4 alkyl or O(C_1 - C_4 alkyl); or a pharmaceutically acceptable salt thereof.

7. A compound of claim 1, represented by Formula (Va), (Vb), (Vc), (Vd), (Ve), or (Vf):



wherein:

L^1 and L^3 at each occurrence are each independently a linear aliphatic group, or one of L^1 and L^3 is a linear aliphatic group and the other one of L^1 and L^3 is optionally absent;

5 R^6 is C_1 - C_8 alkyl optionally substituted with amino, hydroxy, protected amino, or $O(C_1$ - C_4 alkyl);

U at each occurrence is independently CH_2 , CHF , $CHMe$, CF_2 , $C=CH_2$, $C=CF_2$, and $C(R^7)_2$,

10 R^7 is hydrogen, halogen or optionally substituted C_3 - C_8 cycloalkyl; alternatively the two geminal R^7 groups are taken together with the carbon to which they are attached to form a spiro, 3- to 7-membered, optionally substituted C_3 - C_7 cycloalkyl or optionally substituted 3- to 7- membered heterocyclic;

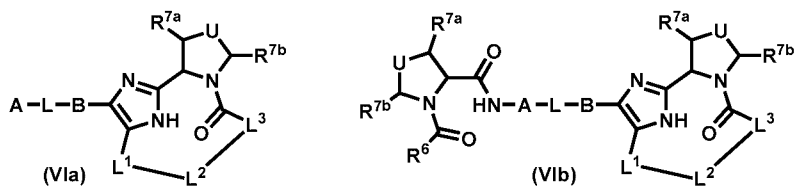
R^{7a} is hydrogen;

R^{7b} is hydrogen, methyl or optionally substituted C_3 - C_8 cycloalkyl;

15 or alternatively R^{7a} and U or U and R^{7b} are taken together with the carbon atoms to which they are attached to form a fused, optionally substituted cyclopropyl, and the other of R^{7b} or R^{7a} is hydrogen; or yet alternatively U , R^{7a} and R^{7b} are taken together with the carbon to which they are attached to form a bridged, optionally substituted C_4 - C_7 cycloalkyl; or a pharmaceutically acceptable salt thereof.

20

8. A compound of claim 1, represented by Formula (VIa) or (VIb):



wherein

A and B are each independently an optionally substituted aryl or optionally substituted heteroaryl;

5 L is absent or optionally substituted C₂-C₄ alkenyl, or optionally substituted C₂-C₄ alkynyl;

L¹ and L³ at each occurrence are each independently a linear aliphatic group, or one of L¹ and L³ is a linear aliphatic group and the other one of L¹ and L³ is optionally absent;

R⁶ is C₁-C₈ alkyl optionally substituted with amino, hydroxy, protected amino, or
 10 O(C₁-C₄ alkyl);

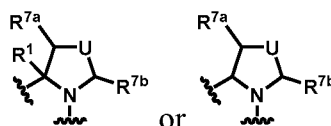
U at each occurrence is independently CH₂, CHF, CHMe, CF₂, C=CH₂, C=CF₂, or C(R⁷)₂,

R⁷ is hydrogen, halogen or optionally substituted C₃-C₈ cycloalkyl; alternatively the two geminal R⁷ groups are taken together with the carbon to which they are attached to
 15 form a spiro, 3- to 7-membered, optionally substituted C₃-C₇ cycloalkyl or optionally substituted 3- to 7-membered heterocyclic;

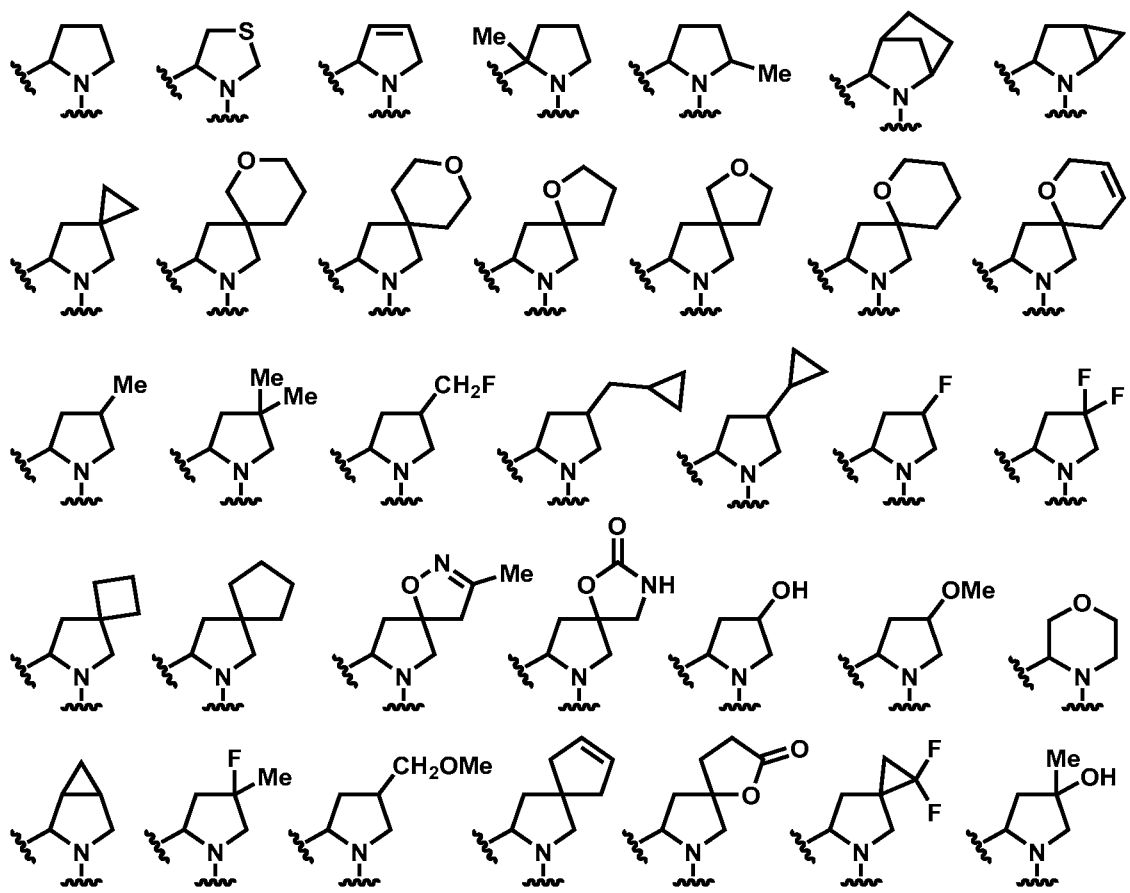
R^{7a} is hydrogen; and

R^{7b} is hydrogen, methyl or optionally substituted C₃-C₈ cycloalkyl;

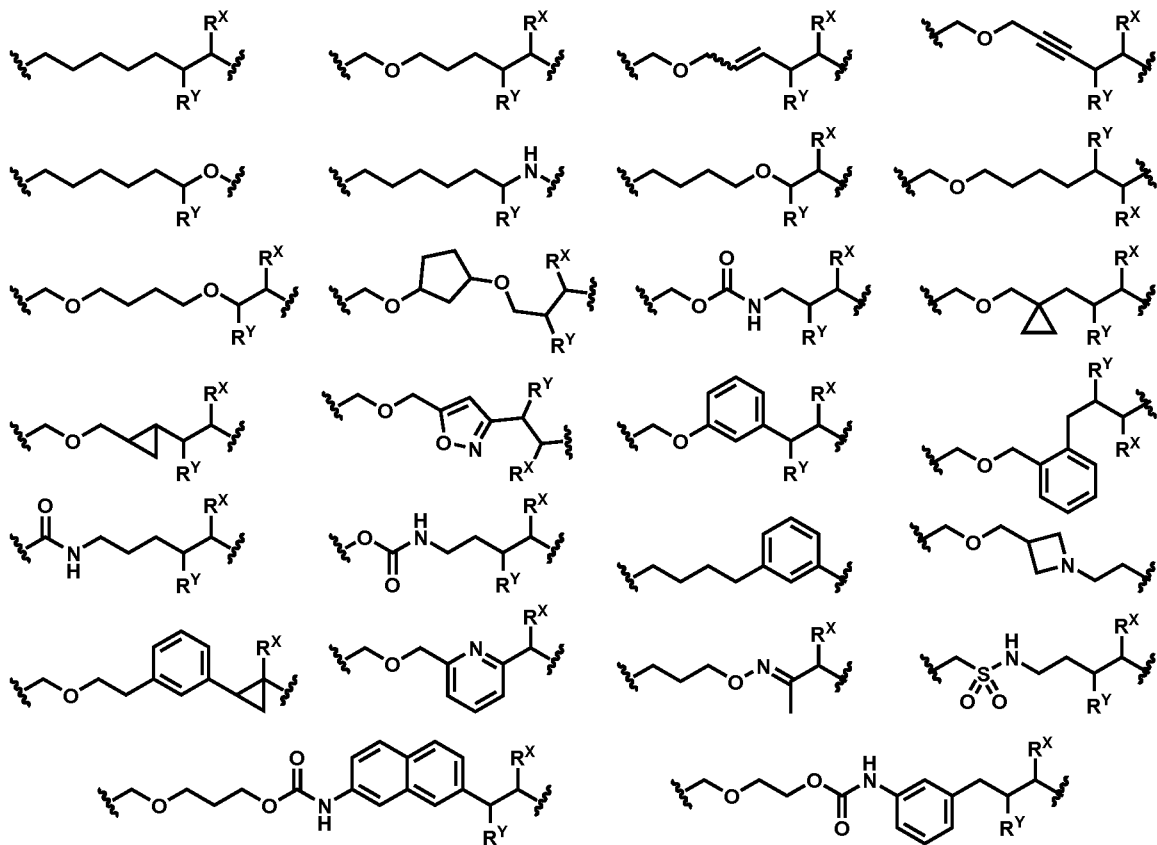
or alternatively R^{7a} and U or U and R^{7b} are taken together with the carbon atoms to
 20 which they are attached to form a fused, optionally substituted cyclopropyl, and the other of R^{7b} or R^{7a} is hydrogen; or yet alternatively, U, R^{7a} and R^{7b} are taken together with the carbon atoms to which they are attached to form a bridged, optionally substituted C₄-C₇ cycloalkyl; or a pharmaceutically acceptable salt thereof.



25 9. The compound of claim 1, wherein or is selected from:



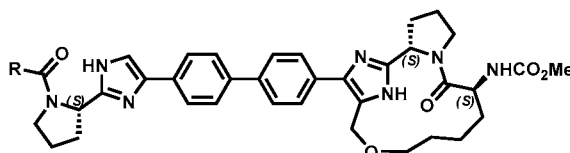
and $L^1-L^2-L^3$ is a linker of from 8 to 16 bond lengths and is selected from:



wherein R^X is hydrogen, amino, hydroxy, protected amino or $O(C_1-C_4 \text{ alkyl})$; R^Y is hydrogen or optionally substituted C_1-C_8 alkyl; each of the above shown groups is further optionally substituted; or a pharmaceutically acceptable salt thereof.

- 5 10. The compound of claim 1 selected from the group of compounds 1-376 compiled in the following tables:

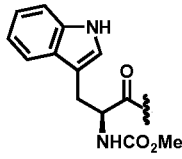
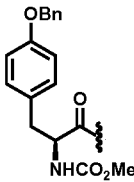
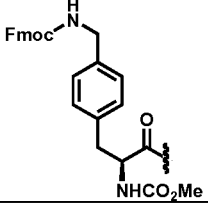
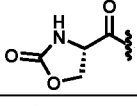
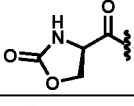
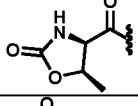
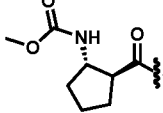
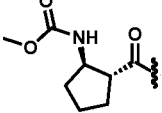
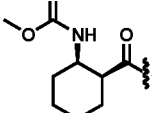
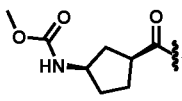
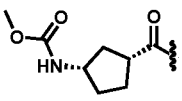
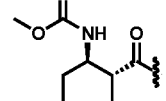
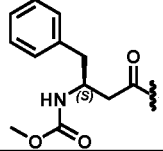
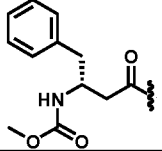
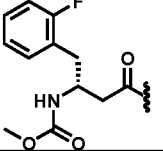
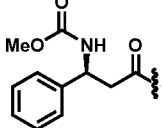
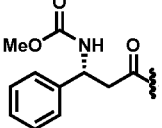
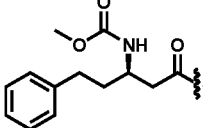
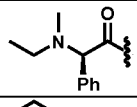
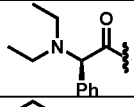
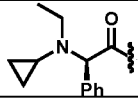
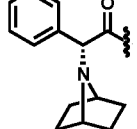
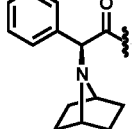
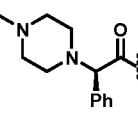
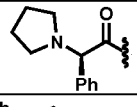
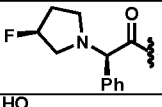
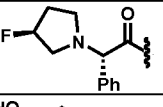
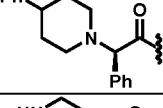
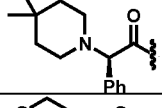
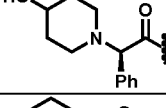
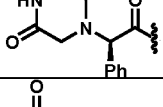
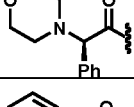
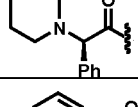
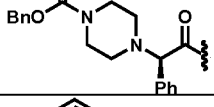
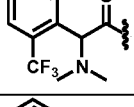
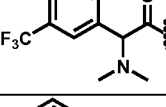
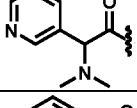
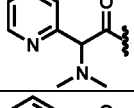
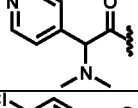
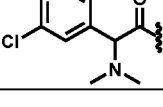
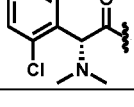
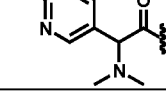
Compounds 1-219.

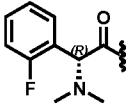
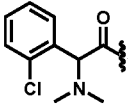
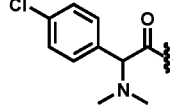
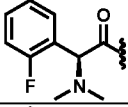
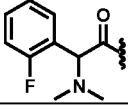
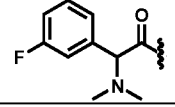
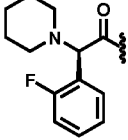
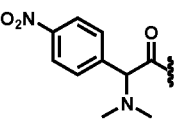
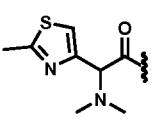
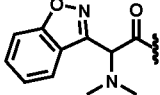
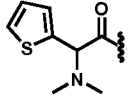
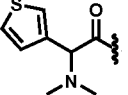
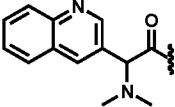
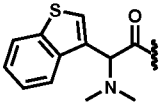
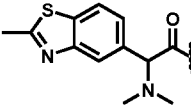
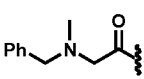
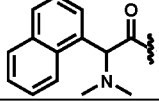
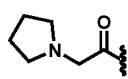
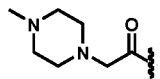
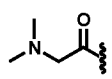
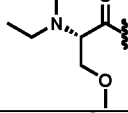
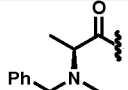
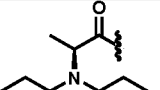
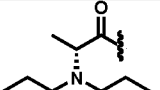
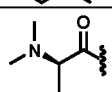
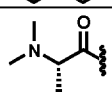
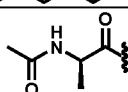
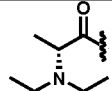
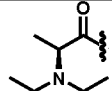
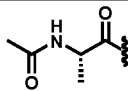
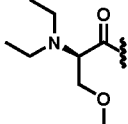
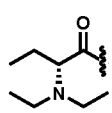
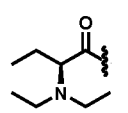
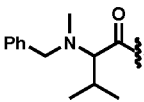
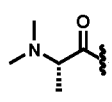
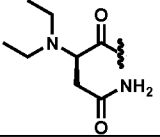
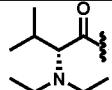
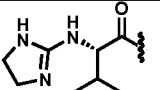
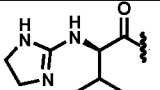
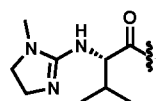
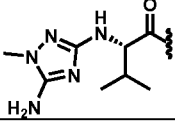
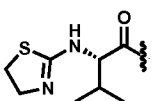
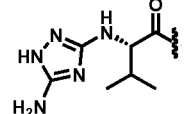
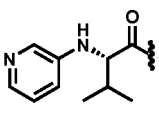
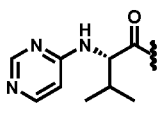
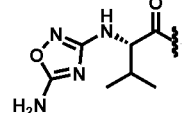
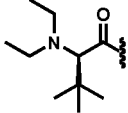
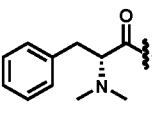


Entry		Entry		Entry	
1		2		3	
4		5		6	
7		8		9	
10		11		12	
13		14		15	
16		17		18	
19		20		21	
22		23		24	
25		26		27	
28		29		30	
31		32		33	
34		35		36	

37		38		39	
40		41		42	
43		44		45	
46		47		48	
49		50		51	
52		53		54	
55		56		57	
58		59		60	
61		62		63	
64		65		66	
67		68		69	
70		71		72	
73		74		75	
76		77		78	
79		80		81	
82		83		84	

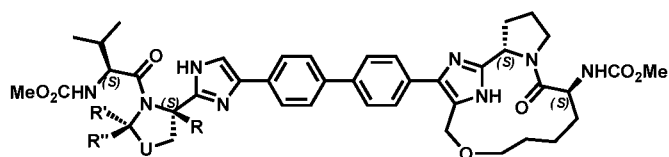
85		86		87	
88		89		90	
91		92		93	
94		95		96	
97		98		99	
100		101		102	
103		104		105	
106		107		108	
109		110		111	
112		113		114	
115		116		117	
118		119		120	

121		122		123	
124		125		126	
127		128		129	
130		131		132	
133		134		135	
136		137		138	
139		140		141	
142		143		144	
145		146		147	
148		149		150	
151		152		153	
154		155		156	
157		158		159	
160		161		162	

163		164		165	
166		167		168	
169		170		171	
172		173		174	
175		176		177	
178		179		180	
181		182		183	
184		185		186	
187		188		189	
190		191		192	
193		194		195	
196		197		198	
199		200		201	
202		203		204	
205		206		207	
208		209		210	

211		212		213	
214		215		216	
217		218		219	

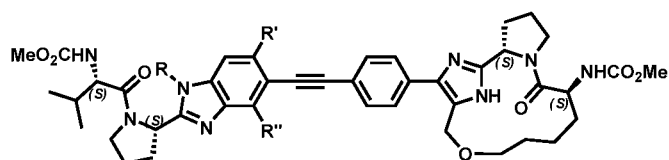
Compounds 220-229.



Entry	R	R'	R''	U	Entry	R	R'	R''	U
220	Me	H	H	CH ₂	221	H	H	H	CF ₂
222	Me	H	H	S	223	H	H	H	
224	H	Me	H	CH ₂	225	H	H	H	
226	H	Ph	H	CH ₂	227	H	H	H	
228	H	H	Ph	CH ₂	229	H	H	H	

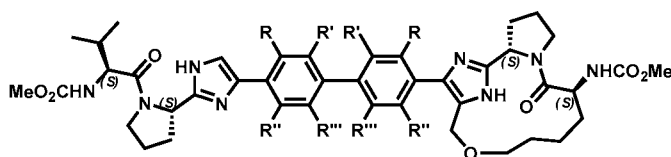
5

Compounds 230-239.



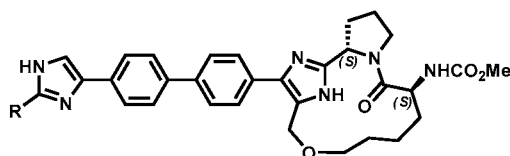
Entry	R	R'	R''	Entry	R	R'	R''
230	Me	H	H	231	H	CO ₂ Me	H
232	H	F	H	233	H	H	CO ₂ Me
234	H	H	F	235	H	OMe	H
236	H	Cl	H	237	H	H	OMe
238	H	H	Cl	239	H	CF ₃	H

Compounds 240-249.



Entry	R	R'	R''	R'''	Entry	R	R'	R''	R'''
240	F	H	H	H	241	F	F	H	H
242	Me	H	H	H	243	Me	Me	H	H
244	H	H	Me	Me	245	H	H	Et	Et
246	CF ₃	H	H	H	247	CF ₃	H	CF ₃	H
248	Cl	H	H	H	249	Cl	H	Cl	H

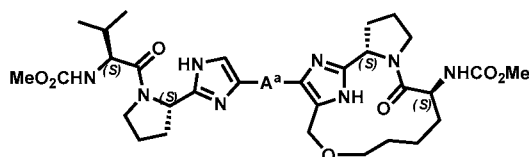
Compounds 250-264.



5

Entry	R	Entry	R	Entry	R
250		251		252	
253		254		255	
256		257		258	
259		260		261	
262		263		264	

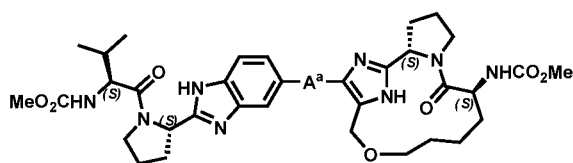
Compounds 265-282.



Entry	A ^a	Entry	A ^a	Entry	A ^a
265		266		267	

268		269		270	
271		272		273	
274		275		276	
277		278		279	
280		281		282	

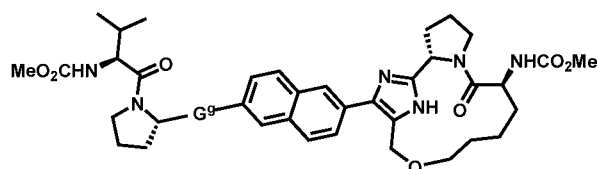
Compounds 283-303.



Entry	A ^a	Entry	A ^a	Entry	A ^a
283		284		285	
286		287		288	
289		290		291	
292		293		294	
295		296		297	
298		299		300	
301		302		303	

5

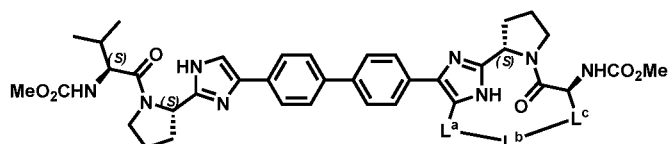
Compounds 304-315.



Entry	G ^g	Entry	G ^g	Entry	G ^g
304		305		306	

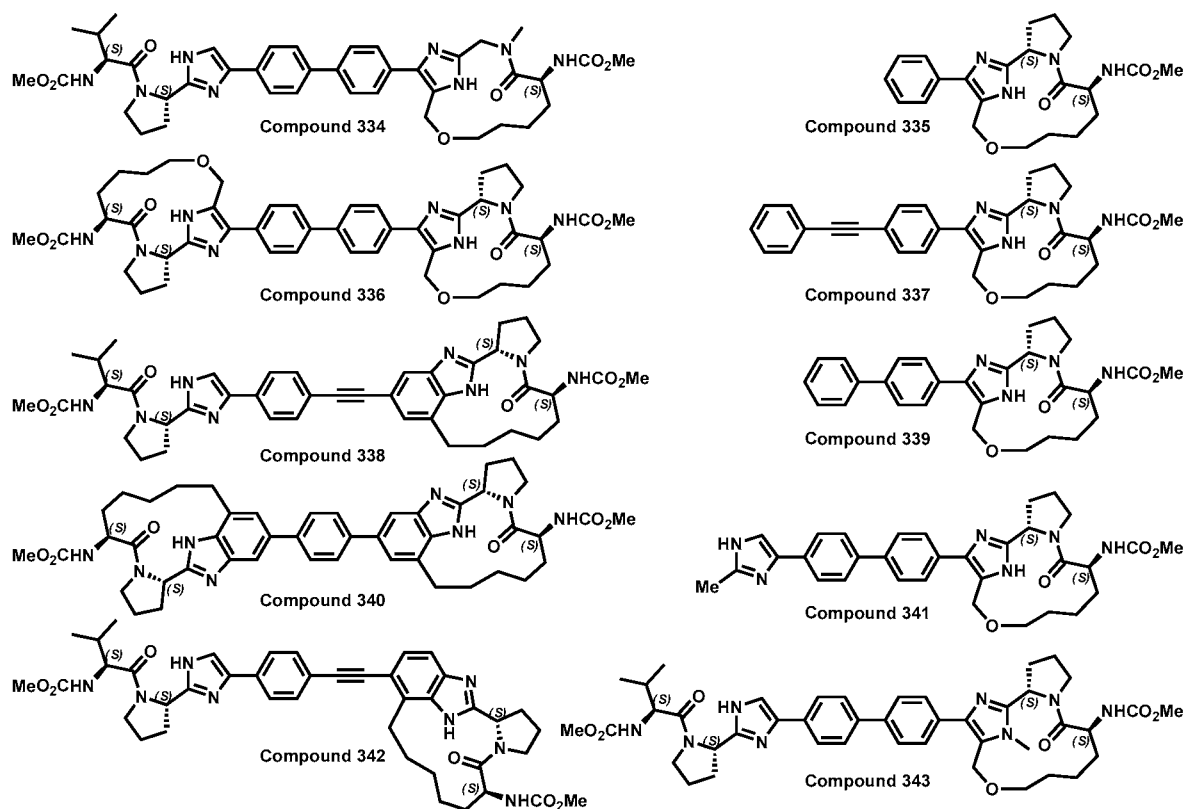
307		308		309	
310		311		312	
313		314		315	

Compounds 316-333.



Entry	L ^a -L ^b -L ^c	Entry	L ^a -L ^b -L ^c	Entry	L ^a -L ^b -L ^c
316		317		318	
319		320		321	
322		323		324	
325		326		327	
328		329		330	
331		332		333	

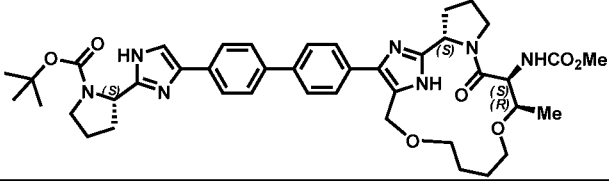
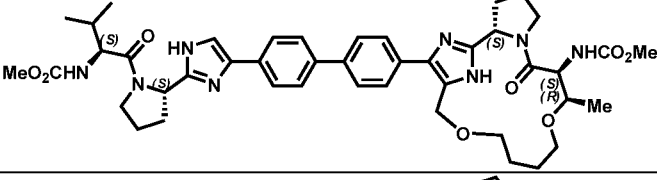
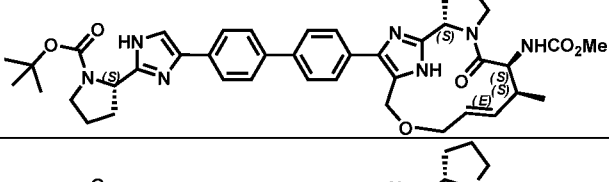
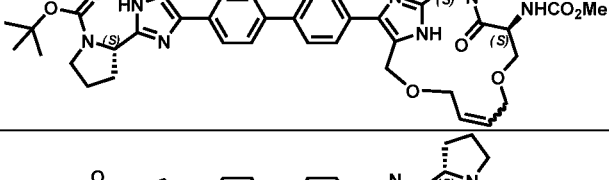
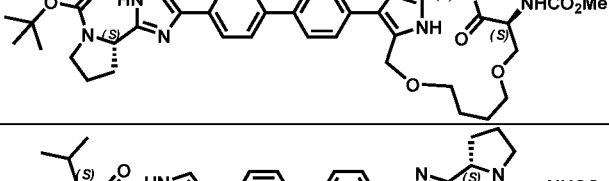
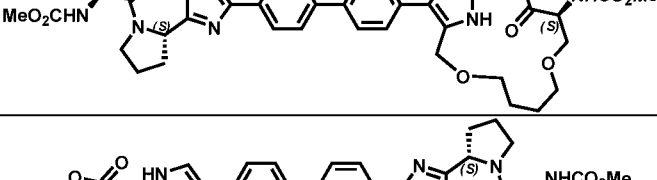
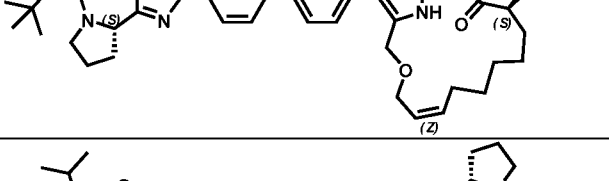
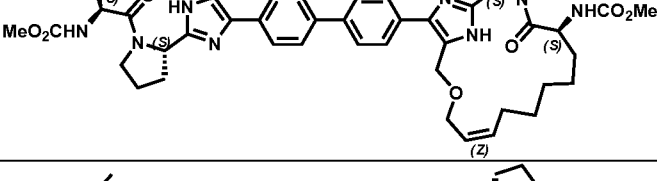
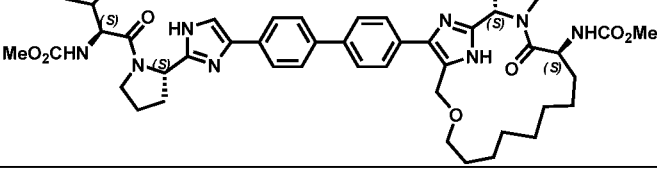
Compounds 334-343.

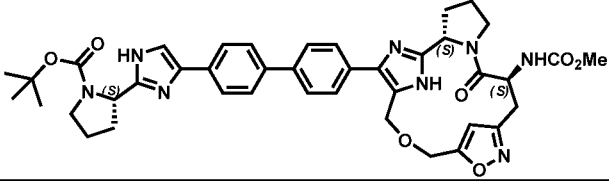
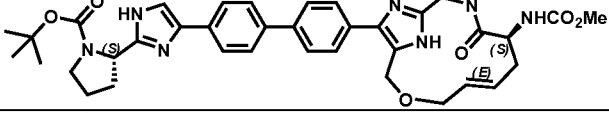
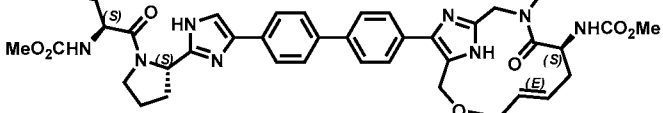
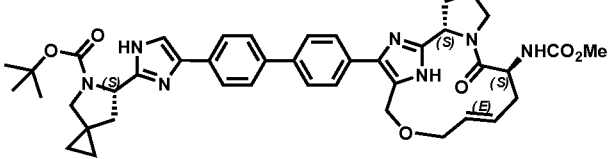
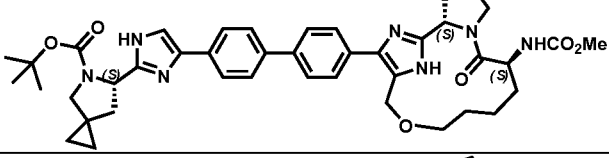
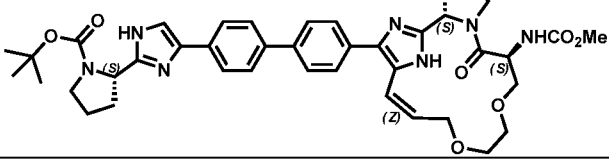
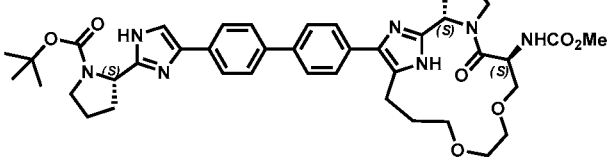
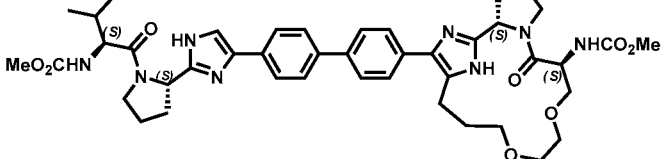
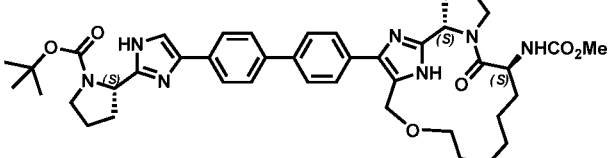


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Compounds 344-368

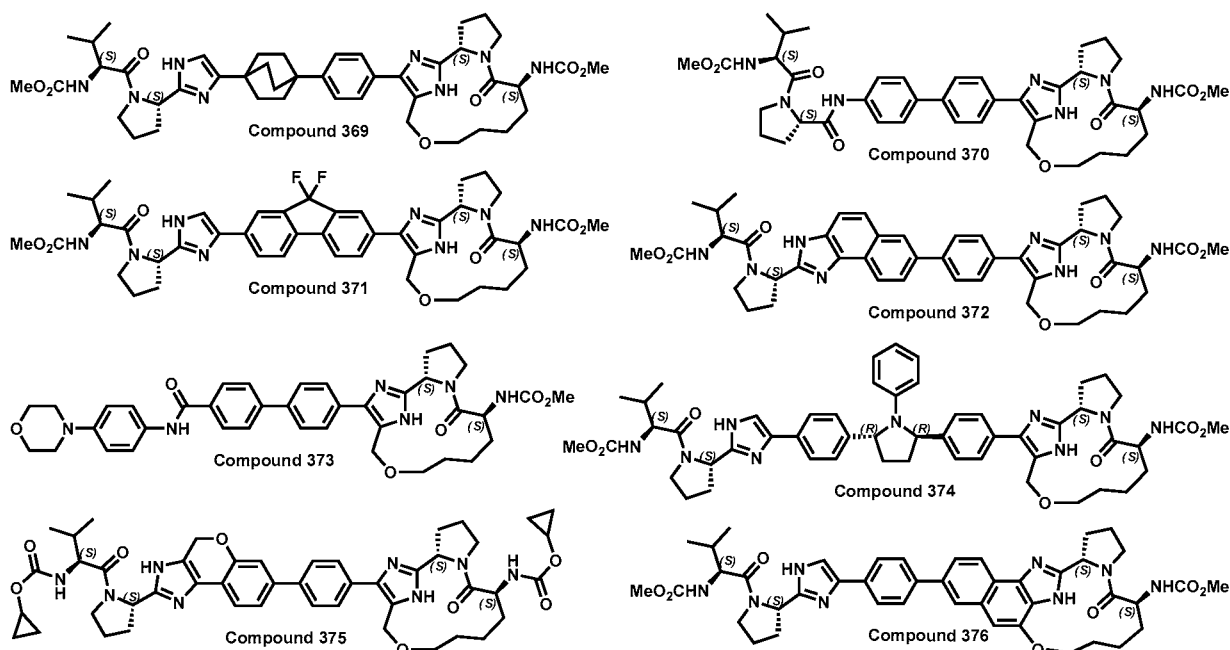
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Compounds 369-376.



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11. A pharmaceutical composition comprising a compound or a combination of compounds according to claim 1 or a pharmaceutically acceptable salt thereof, in combination with a pharmaceutically acceptable carrier or excipient.

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12. A method of inhibiting the replication of an RNA-containing virus comprising contacting said virus with a therapeutically effective amount of a compound or combination of compounds of claim 1, or a pharmaceutically acceptable salt thereof.

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13. A method of treating or preventing infection caused by an RNA-containing virus comprising administering to a patient in need of such treatment a therapeutically effective

amount of a compound or combination of compounds of claim 1, or a pharmaceutically acceptable salt thereof.

14. The method of claim 12, wherein the RNA-containing virus is hepatitis C virus.

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15. The method of claim 12, further comprising the step of co-administering one or more agents selected from the group consisting of a host immune modulator and an antiviral agent, or a combination thereof.

10 16. The method of claim 14, wherein the host immune modulator is selected from the group consisting of interferon-alpha, pegylated-interferon-alpha, interferon-beta, interferon-gamma, consensus interferon, a cytokine, and a vaccine.

15 17. The method of claim 14, wherein the antiviral agents inhibit replication of HCV by inhibiting host cellular functions associated with viral replication.

18. The method of claim 14, wherein the antiviral agents inhibit the replication of HCV by targeting proteins of the viral genome.

20 19. The method of claim 14, wherein said antiviral agent is an inhibitor of a HCV viral protein, a replication process or a combination thereof, wherein said targeting protein or replication process is selected from the group consisting of helicase, protease, polymerase, metalloprotease, NS4A, NS4B, NS5A, assembly, entry, and IRES.

25 20. The method of claim 12, further comprising the step of co-administering an agent or combination of agents that treat or alleviate symptoms of HCV infection selected from cirrhosis and inflammation of the liver.

30 21. The method of claim 12, further comprising the step of co-administering one or more agents that treat patients for disease caused by hepatitis B (HBV) infection.

22. The method of claim 12, further comprising the step of co-administering one or more agents that treat patients for disease caused by human immunodeficiency virus (HIV) infection.

23. The pharmaceutical composition of claim 10, further comprising an agent selected from interferon, pegylated interferon, ribavirin, amantadine, an HCV protease inhibitor, an HCV polymerase inhibitor, an HCV helicase inhibitor, or an internal ribosome entry site inhibitor.

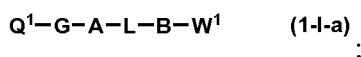
24. The composition of claim 10, further comprising a cytochrome P450 monooxygenase inhibitor or a pharmaceutically acceptable salt thereof.

25. The composition of claim 23, wherein the cytochrome P450 monooxygenase inhibitor is ritonavir.

26. A method of treating hepatitis C infection in a subject in need thereof comprising co-administering to said subject a cytochrome P450 monooxygenase inhibitor or a pharmaceutically acceptable salt thereof, and a compound of claim 1 or a pharmaceutically acceptable salt thereof.

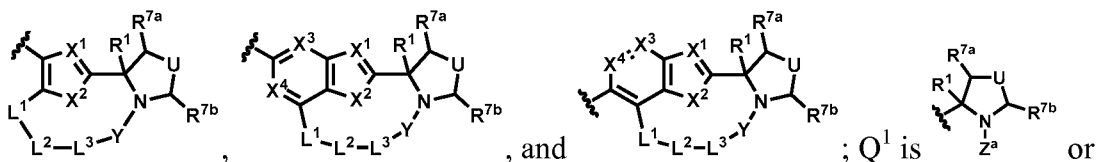
27. A process of making a compound according to any one of claims 1 to 9 comprising:

i) preparing a compound of Formula (1-I-a):



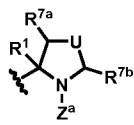
via a transition-metal catalyzed cross-coupling reaction, ring-closure metathesis or other intramolecular ring-closure reaction such as various type of Diels-Alder reaction, amide (lactam) formation, reductive amination, oximation, ester formation (lactonization), carbamate or urea formation; wherein:

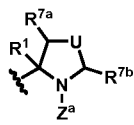
W^1 is independently selected from the group consisting of:

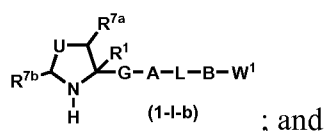


hydrogen; or Q^1 and G are taken together to form W^1 ; X^3 and X^4 at each occurrence are each independently N or C(R¹²); and R¹² at each occurrence is independently hydrogen, halogen, hydroxy, optionally substituted C₁-C₄ alkyl or O(C₁-C₄ alkyl); Z^a is

independently an amino protecting group or $-\text{C}(\text{O})-\text{R}^6$; wherein R^6 is $\text{C}_1\text{-C}_8$ alkyl optionally substituted with amino, hydroxy, protected amino, or $\text{O}(\text{C}_1\text{-C}_4 \text{ alkyl})$; and A, B, G, L, U, X^1 , X^2 , L^1 , L^2 , L^3 , R^1 , R^{7a} and R^{7b} are as defined in claim 1;



ii) when Q^1 is , wherein Z^a is an amino protecting group, selectively deprotecting a compound of Formula (1-I-a) to give the corresponding amine of Formula (1-I-b):



iii) Capping the released amino group of a compound of Formula (1-I-b) with $\text{LG}-\text{C}(\text{O})-\text{R}^6$, wherein LG is a leaving group; to give the compound of Formula (1-I-c):

