

NOVEL COMPOUNDS AS INHIBITORS OF HEPATITIS C VIRUS NS3 SERINE PROTEASE

Field of the Invention

The present invention relates to novel hepatitis C virus ("HCV") protease inhibitors, pharmaceutical compositions containing one or more such inhibitors, methods of preparing such inhibitors and methods of using such inhibitors to treat hepatitis C and related disorders. This invention additionally
5 discloses novel compounds as inhibitors of the HCV NS3/NS4a serine protease. This application claims priority from U.S. provisional patent application, Serial Number 60/548,535 filed February 27, 2004.

Background of the Invention

10 Hepatitis C virus (HCV) is a (+)-sense single-stranded RNA virus that has been implicated as the major causative agent in non-A, non-B hepatitis (NANBH), particularly in blood-associated NANBH (BB-NANBH) (see, International Patent Application Publication No. WO 89/04669 and European Patent Application Publication No. EP 381 216). NANBH is to be
15 distinguished from other types of viral-induced liver disease, such as hepatitis A virus (HAV), hepatitis B virus (HBV), delta hepatitis virus (HDV), cytomegalovirus (CMV) and Epstein-Barr virus (EBV), as well as from other forms of liver disease such as alcoholism and primary biliar cirrhosis.

20 Recently, an HCV protease necessary for polypeptide processing and viral replication has been identified, cloned and expressed. (See, e.g., U.S. Patent No. 5,712,145). This approximately 3000 amino acid polyprotein contains, from the amino terminus to the carboxy terminus, a nucleocapsid protein (C), envelope proteins (E1 and E2) and several non-structural proteins (NS1, 2, 3, 4a, 5a and 5b). NS3 is an approximately 68 kda protein, encoded
25 by approximately 1893 nucleotides of the HCV genome, and has two distinct domains: (a) a serine protease domain consisting of approximately 200 of the N-terminal amino acids; and (b) an RNA-dependent ATPase domain at the C-terminus of the protein. The NS3 protease is considered a member of the

chymotrypsin family because of similarities in protein sequence, overall three-dimensional structure and mechanism of catalysis. Other chymotrypsin-like enzymes are elastase, factor Xa, thrombin, trypsin, plasmin, urokinase, tPA and PSA. The HCV NS3 serine protease is responsible for proteolysis of the polypeptide (polyprotein) at the NS3/NS4a, NS4a/NS4b, NS4b/NS5a and NS5a/NS5b junctions and is thus responsible for generating four viral proteins during viral replication. This has made the HCV NS3 serine protease an attractive target for antiviral chemotherapy. The inventive compounds can inhibit such protease. They also can modulate the processing of hepatitis C virus (HCV) polypeptide.

It has been determined that the NS4a protein, an approximately 6 kda polypeptide, is a co-factor for the serine protease activity of NS3. Autocleavage of the NS3/NS4a junction by the NS3/NS4a serine protease occurs intramolecularly (*i.e.*, *cis*) while the other cleavage sites are processed intermolecularly (*i.e.*, *trans*).

Analysis of the natural cleavage sites for HCV protease revealed the presence of cysteine at P1 and serine at P1' and that these residues are strictly conserved in the NS4a/NS4b, NS4b/NS5a and NS5a/NS5b junctions. The NS3/NS4a junction contains a threonine at P1 and a serine at P1'. The Cys→Thr substitution at NS3/NS4a is postulated to account for the requirement of *cis* rather than *trans* processing at this junction. See, *e.g.*, Pizzi *et al.* (1994) *Proc. Natl. Acad. Sci. (USA)* 91:888-892, Failla *et al.* (1996) *Folding & Design* 1:35-42. The NS3/NS4a cleavage site is also more tolerant of mutagenesis than the other sites. See, *e.g.*, Kollykhalov *et al.* (1994) *J. Virol.* 68:7525-7533. It has also been found that acidic residues in the region upstream of the cleavage site are required for efficient cleavage. See, *e.g.*, Komoda *et al.* (1994) *J. Virol.* 68:7351-7357.

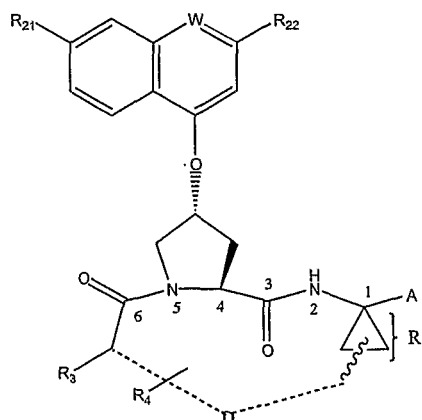
Inhibitors of HCV protease that have been reported include antioxidants (see, International Patent Application Publication No. WO 98/14181), certain peptides and peptide analogs (see, International Patent Application Publication No. WO 98/17679, Landro *et al.* (1997) *Biochem.* 36:9340-9348, Ingallinella *et al.* (1998) *Biochem.* 37:8906-8914, Llinàs-Brunet *et al.* (1998) *Bioorg. Med. Chem. Lett.* 8:1713-1718), inhibitors based

on the 70-amino acid polypeptide eglin c (Martin et al. (1998) Biochem.
37:11459-11468, inhibitors affinity selected from human pancreatic secretory
trypsin inhibitor (hPSTI-C3) and minibody repertoires (MBip) (Dimasi et al.
(1997) J. Virol. 71:7461-7469), cV_HE2 (a "camelized" variable domain
5 antibody fragment) (Martin et al. (1997) Protein Eng. 10:607-614), and α 1-
antichymotrypsin (ACT) (Elzouki et al.) (1997) J. Hepat. 27:42-28). A
ribozyme designed to selectively destroy hepatitis C virus RNA has recently
been disclosed (see, *BioWorld Today* 9(217): 4 (November 10, 1998)).

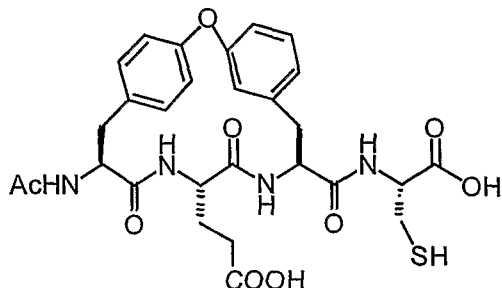
Reference is also made to the PCT Publications, No. WO 98/17679,
10 published April 30, 1998 (Vertex Pharmaceuticals Incorporated); WO
98/22496, published May 28, 1998 (F. Hoffmann-La Roche AG); and WO
99/07734, published February 18, 1999 (Boehringer Ingelheim Canada Ltd.).

HCV has been implicated in cirrhosis of the liver and in induction of
hepatocellular carcinoma. The prognosis for patients suffering from HCV
15 infection is currently poor. HCV infection is more difficult to treat than other
forms of hepatitis due to the lack of immunity or remission associated with
HCV infection. Current data indicates a less than 50% survival rate at four
years post cirrhosis diagnosis. Patients diagnosed with localized resectable
hepatocellular carcinoma have a five-year survival rate of 10-30%, whereas
20 those with localized unresectable hepatocellular carcinoma have a five-year
survival rate of less than 1%.

Reference is made to WO 00/59929 (US 6,608,027, Assignee:
Boehringer Ingelheim (Canada) Ltd.; Published October 12, 2000) which
discloses peptide derivatives of the formula:

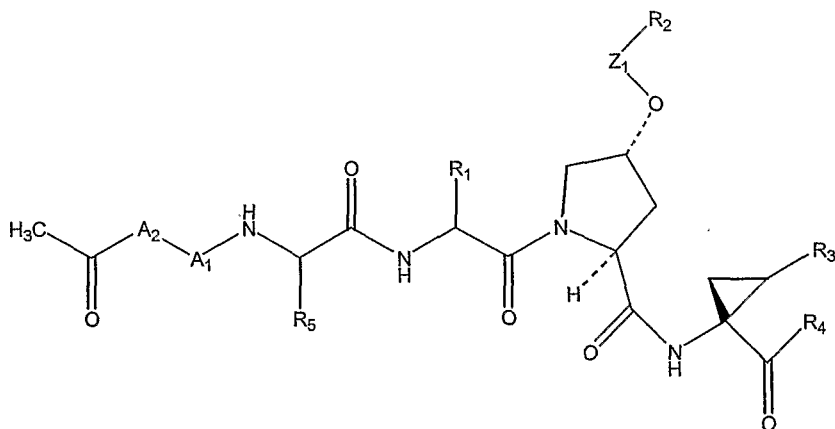


Reference is made to A. Marchetti *et al*, *Synlett*, S1, 1000-1002 (1999) describing the synthesis of bicyclic analogs of an inhibitor of HCV NS3 protease. A compound disclosed therein has the formula:

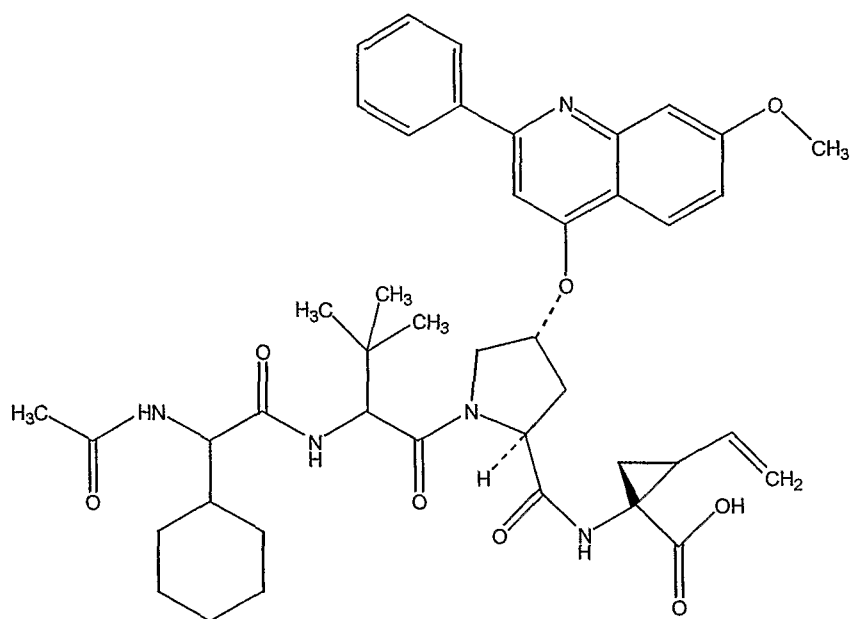


- 5 Reference is also made to W. Han *et al*, *Bioorganic & Medicinal Chem. Lett.*, (2000) 10, 711-713, which describes the preparation of certain α -ketoamides, α -ketoesters and α -diketones containing allyl and ethyl functionalities.

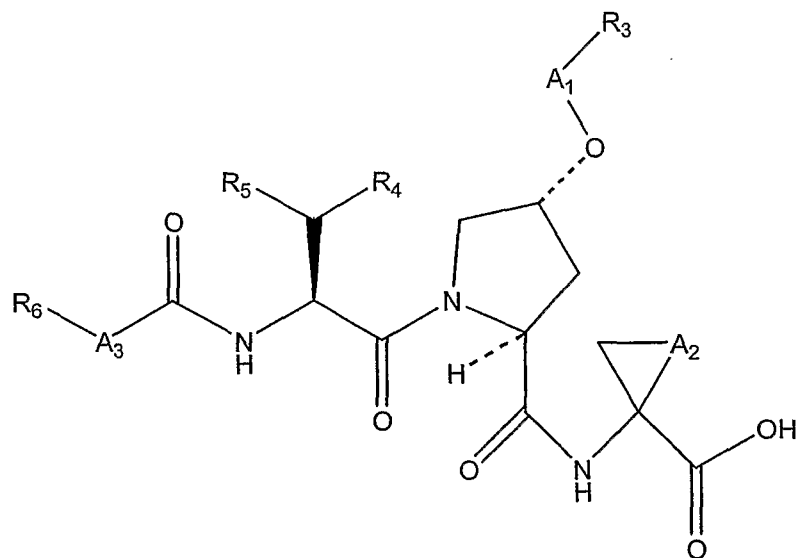
- 10 Reference is also made to WO 00/09558 (Assignee: Boehringer Ingelheim Limited; Published February 24, 2000) which discloses peptide derivatives of the formula:



where the various elements are defined therein. An illustrative compound of that series is:

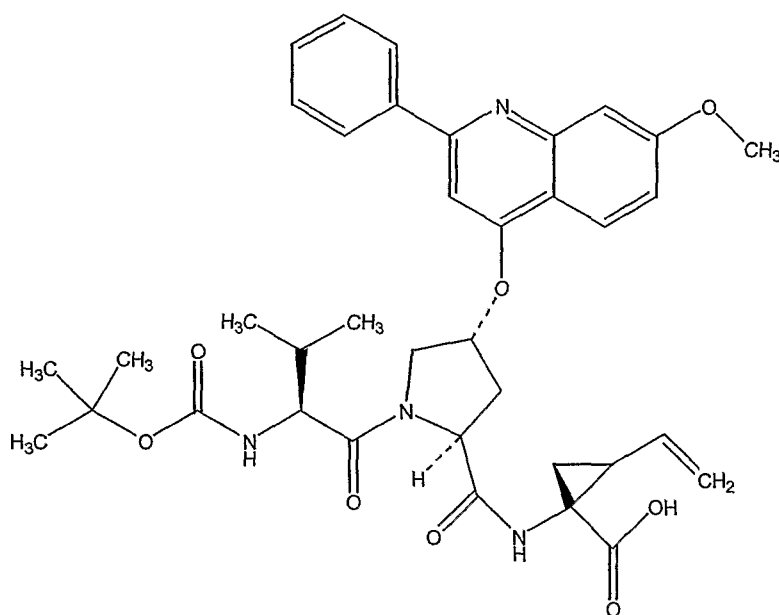


Reference is also made to WO 00/09543 (Assignee: Boehringer Ingelheim Limited; Published February 24, 2000) which discloses peptide derivatives of the formula:

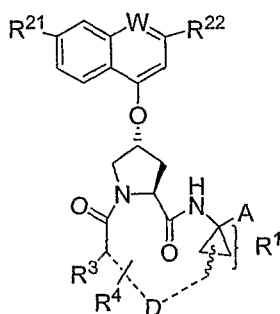


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where the various elements are defined therein. An illustrative compound of that series is:



Reference is also made to U.S. 6,608,027 (Boehringer Ingelheim, Canada) which discloses NS3 protease inhibitors of the type:



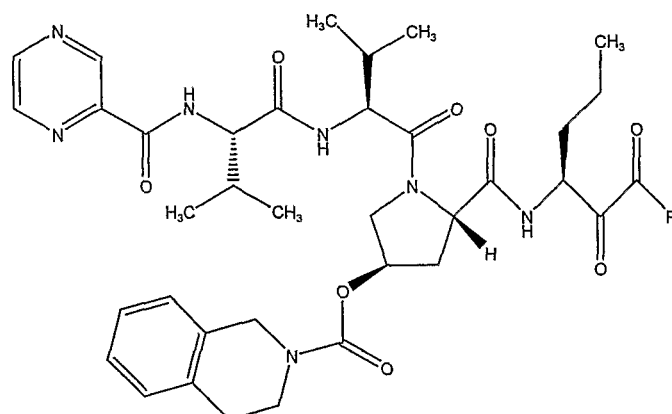
5 wherein the various moieties are defined therein.

Current therapies for hepatitis C include interferon- α (INF_α) and combination therapy with ribavirin and interferon. See, e.g., Berenguer *et al.* (1998) *Proc. Assoc. Am. Physicians* 110(2):98-112. These therapies suffer from a low sustained response rate and frequent side effects. See, e.g.,

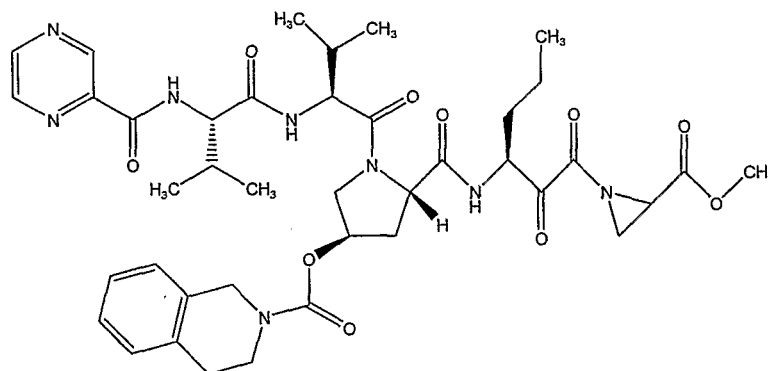
10 Hoofnagle *et al.* (1997) *N. Engl. J. Med.* 336:347. Currently, no vaccine is available for HCV infection.

Reference is further made to WO 01/74768 (Assignee: Vertex Pharmaceuticals Inc) published October 11, 2001, which discloses certain compounds of the following general formula (R is defined therein) as NS3-

15 serine protease inhibitors of Hepatitis C virus:



A specific compound disclosed in the afore-mentioned WO 01/74768 has the following formula:



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PCT Publications WO 01/77113; WO 01/081325; WO 02/08198; WO 02/08256; WO 02/08187; WO 02/08244; WO 02/48172; WO 02/08251; and pending U.S. patent application, Serial No. 10/052,386, filed January 18, 2002, disclose various types of peptides and/or other compounds as NS-3 serine protease inhibitors of hepatitis C virus. The disclosures of those applications are incorporated herein by reference thereto.

There is a need for new treatments and therapies for HCV infection. There is a need for compounds useful in the treatment or prevention or amelioration of one or more symptoms of hepatitis C.

There is a need for methods of treatment or prevention or amelioration of one or more symptoms of hepatitis C.

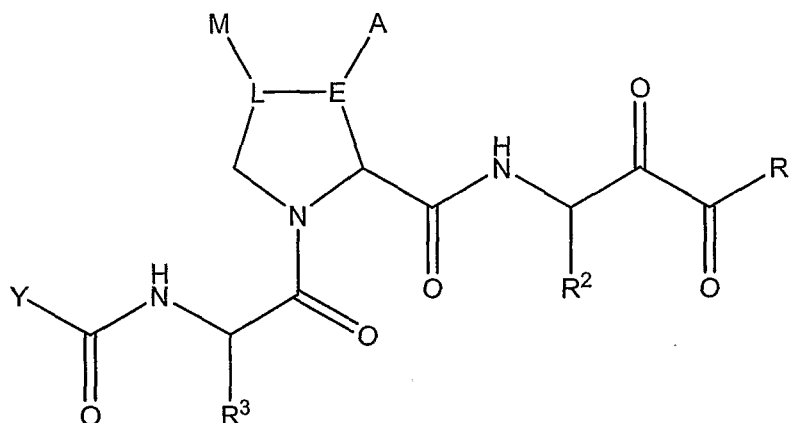
There is a need for methods for modulating the activity of serine proteases, particularly the HCV NS3/NS4a serine protease, using the compounds provided herein.

There is a need for methods of modulating the processing of the HCV polypeptide using the compounds provided herein.

Summary of the Invention

In its many embodiments, the present invention provides a novel class of inhibitors of the HCV protease, pharmaceutical compositions containing one or more of the compounds, methods of preparing pharmaceutical formulations comprising one or more such compounds, and methods of treatment or prevention of HCV or amelioration of one or more of the symptoms of hepatitis C using one or more such compounds or one or more such formulations. Also provided are methods of modulating the interaction of an HCV polypeptide with HCV protease. Among the compounds provided herein, compounds that inhibit HCV NS3/NS4a serine protease activity are preferred. The present invention discloses compounds, or enantiomers, stereoisomers, rotamers, tautomers, diastereomers or racemates of said compounds, or a pharmaceutically acceptable salt, solvate or ester of said compounds, said compounds having the general structure shown in structural

Formula 1:



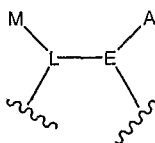
Formula I

wherein:

R^1 is H, OR^8 , NR^9R^{10} , or CHR^9R^{10} , wherein R^8 , R^9 and R^{10} can be the same or different, each being independently selected from the group consisting of H, alkyl-, alkenyl-, alkynyl-, aryl-, heteroalkyl-, heteroaryl-, cycloalkyl-, heterocyclyl-, arylalkyl-, and heteroarylalkyl;

A and M can be the same or different, each being independently selected from R, OR, NHR, NRR' , SR, SO_2R , and halo; or A and M are

connected to each other such that the moiety:



shown above in Formula I forms either a three, four, six, seven or eight-membered cycloalkyl, a four to eight-membered heterocyclyl, a six to ten-membered aryl, or a five to ten-membered heteroaryl;

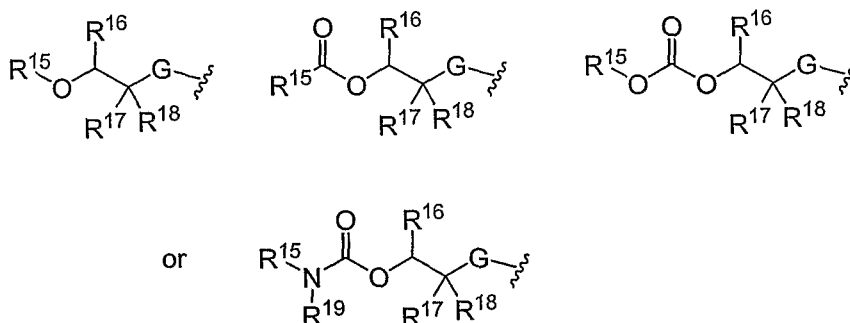
5 E is C(H) or C(R);

L is C(H), C(R), CH₂C(R), or C(R)CH₂;

R, R', R², and R³ can be the same or different, each being independently selected from the group consisting of H, alkyl-, alkenyl-, alkynyl-, cycloalkyl-, heteroalkyl-, heterocyclyl-, aryl-, heteroaryl-,

10 (cycloalkyl)alkyl-, (heterocyclyl)alkyl-, aryl-alkyl-, and heteroaryl-alkyl-; or alternately R and R' in NRR' are connected to each other such that NRR' forms a four to eight-membered heterocyclyl;

and Y is selected from the following moieties:



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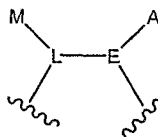
wherein G is NH or O; and R¹⁵, R¹⁶, R¹⁷, R¹⁸, and R¹⁹ can be the same or different, each being independently selected from the group consisting of H, alkyl, heteroalkyl, alkenyl, heteroalkenyl, alkynyl, heteroalkynyl, cycloalkyl, heterocyclyl, aryl, arylalkyl, heteroaryl, and heteroarylalkyl, or alternately, (i)

20 either R¹⁵ and R¹⁶ are connected to each other to form a four to eight-membered cyclic structure, or R¹⁵ and R¹⁹ are connected to each other to form a four to eight-membered cyclic structure, and (ii) likewise, independently, R¹⁷ and R¹⁸ are connected to each other to form a three to eight-membered cycloalkyl or heterocyclyl;

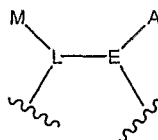
25 wherein each of said alkyl, aryl, heteroaryl, cycloalkyl or heterocyclyl can be unsubstituted or optionally independently substituted with one or more moieties selected from the group consisting of: hydroxy, alkoxy, aryloxy, thio,

alkylthio, arylthio, amino, amido, alkylamino, arylamino, alkylsulfonyl, arylsulfonyl, sulfonamido, alkylsulfonamido, arylsulfonamido, alkyl, aryl, heteroaryl, keto, carboxy, carbalkoxy, carboxamido, alkoxycarbonylamino, alkoxycarbonyloxy, alkylureido, arylureido, halo, cyano, and nitro.

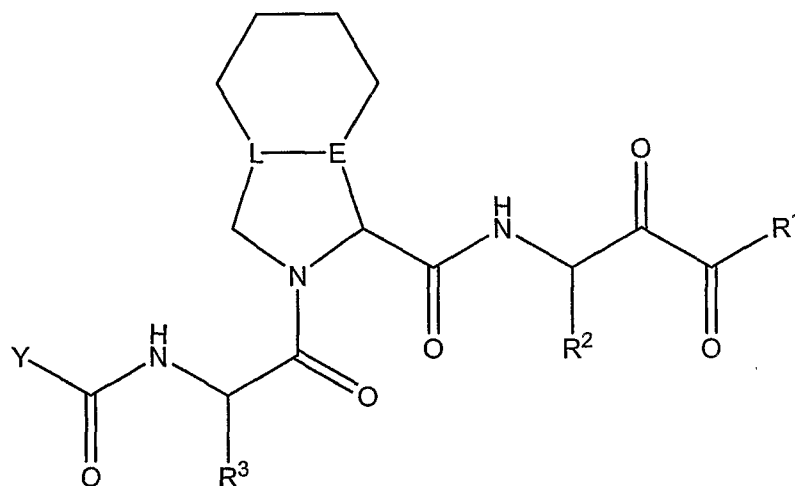
- 5 The above-noted statement "A and M are connected to each other such that the moiety:



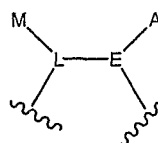
- shown above in Formula I forms either a three, four, six, seven or eight-membered cycloalkyl, a four to eight-membered heterocyclyl, a six to ten-membered aryl, or a five to ten-membered heteroaryl" can be illustrated in a non-limiting matter as follows. Thus, for example, in the case where A and M are connected such that the moiety:



- shown above in Formula I forms a six -membered cycloalkyl (cyclohexyl),
15 Formula I can be depicted as:



One with ordinary skill in the art will appreciate that similar depictions for Formula I can be arrived at when A and M shown above in the moiety:



are connected to form a three, four, seven or eight-membered cycloalkyl, a four to eight-membered heterocyclyl, a six to ten-membered aryl, or a five to ten-membered heteroaryl.

The statement above: "alternately, (i) either R¹⁵ and R¹⁶ are connected to each other to form a four to eight-membered cyclic structure, or R¹⁵ and R¹⁹ are connected to each other to form a four to eight-membered cyclic structure, and (ii) likewise, independently, R¹⁷ and R¹⁸ are connected to each other to form a three to eight-membered cycloalkyl or heterocyclyl" means the following possibilities: (i) that R¹⁵ and R¹⁶ are connected to form a cyclic structure while R¹⁵ and R¹⁹ are not; (ii) that R¹⁵ and R¹⁹ are connected to form a cyclic structure while R¹⁵ and R¹⁶ are not; and that (iii) R¹⁷ and R¹⁸ are independently connected to form a cyclic structure, irrespective of whether the possibilities in (i) and (ii) exist or not.

In the above-noted definitions of R, R', R², and R³ preferred alkyl is made of one to ten carbon atoms, preferred alkenyl or alkynyl is made of two to ten carbon atoms, preferred cycloalkyl is made of three to eight carbon atoms, and preferred heteroalkyl, heteroaryl or heterocycloalkyl has one to six oxygen, nitrogen, sulfur, or phosphorus atoms.

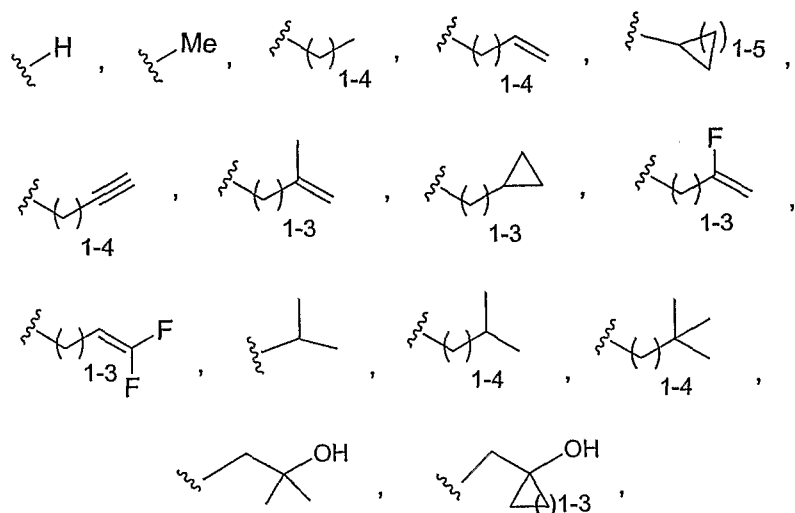
The compounds represented by Formula I, by themselves or in combination with one or more other suitable agents disclosed herein, can be useful for treating diseases such as, for example, HCV, HIV, AIDS (Acquired Immune Deficiency Syndrome), and related disorders, as well as for modulating the activity of hepatitis C virus (HCV) protease, preventing HCV, or ameliorating one or more symptoms of hepatitis C. Such modulation, treatment, prevention or amelioration can be done with the inventive compounds as well as with pharmaceutical compositions or formulations comprising such compounds. Without being limited to theory, it is believed that the HCV protease may be the NS3 or NS4a protease. The inventive compounds can inhibit such protease. They can also modulate the processing of hepatitis C virus (HCV) polypeptide.

Detailed Description

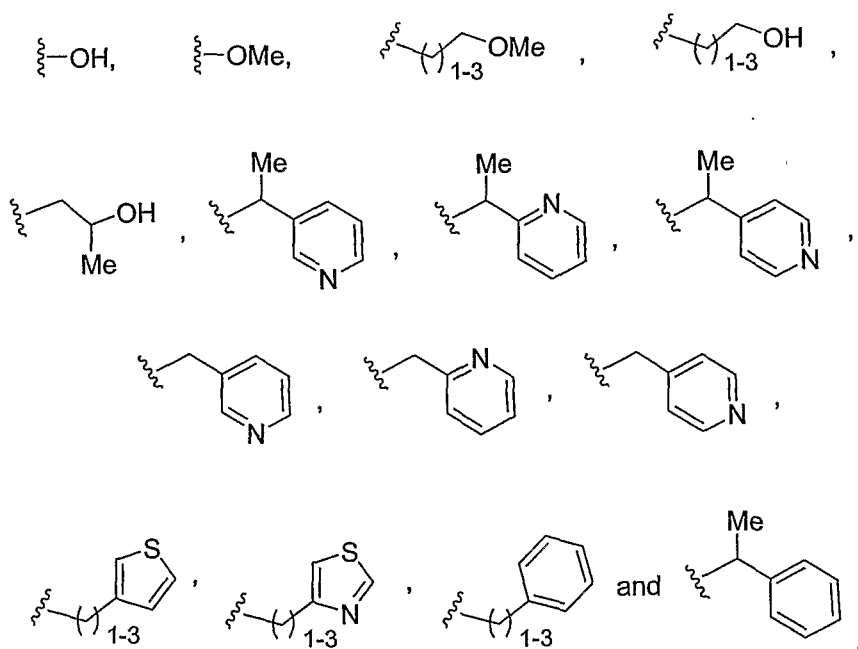
In an embodiment, the present invention discloses compounds which are represented by structural Formula 1 or a pharmaceutically acceptable salt, solvate or ester thereof, wherein the various moieties are as defined above.

- 5 In another embodiment, R^1 is NR^9R^{10} , and R^9 is H, R^{10} is H, or R^{14} wherein R^{14} is H, alkyl, aryl, heteroalkyl, heteroaryl, cycloalkyl, alkyl-aryl, alkyl-heteroaryl, aryl-alkyl, alkenyl, alkynyl or heteroaryl-alkyl.

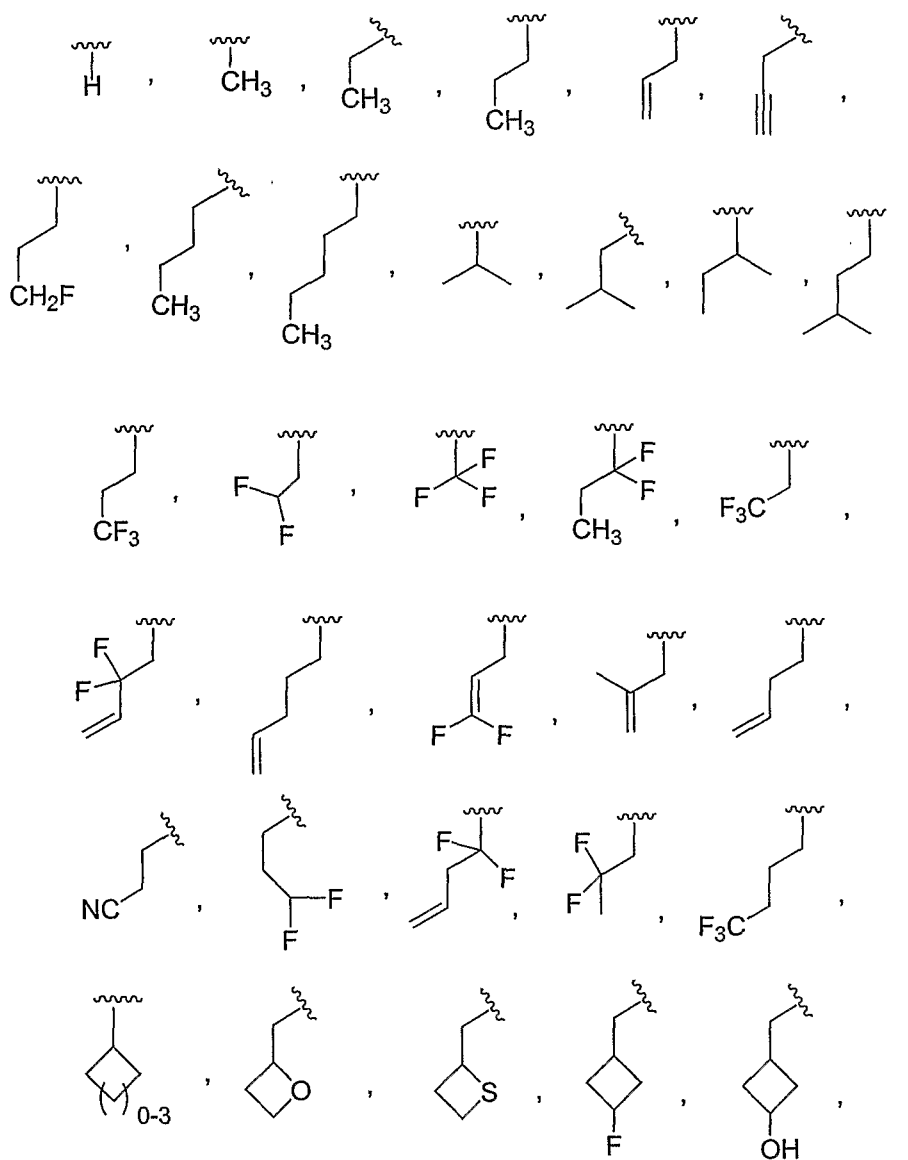
In another embodiment, R^{14} is selected from the group consisting of:



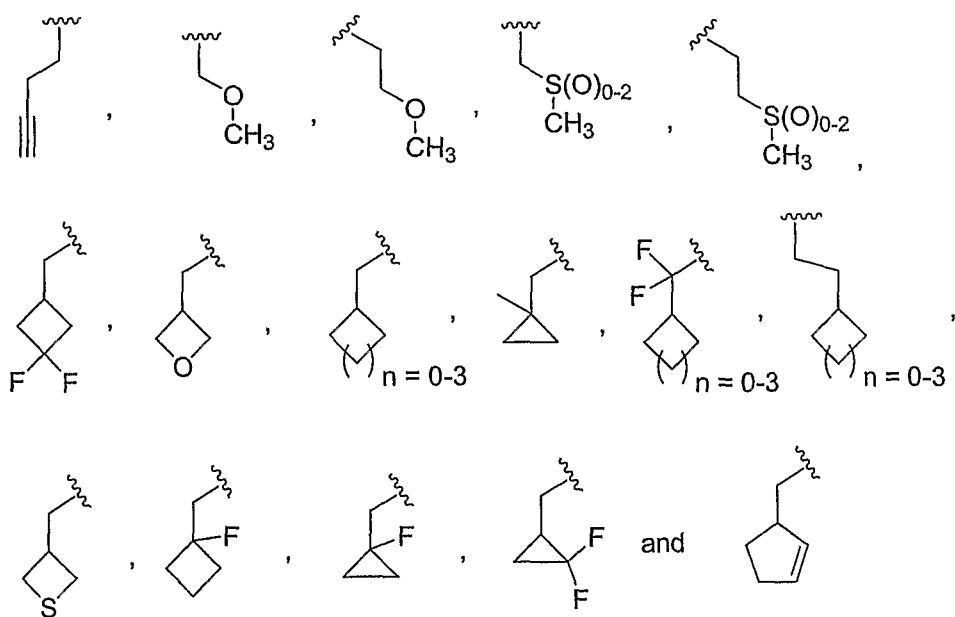
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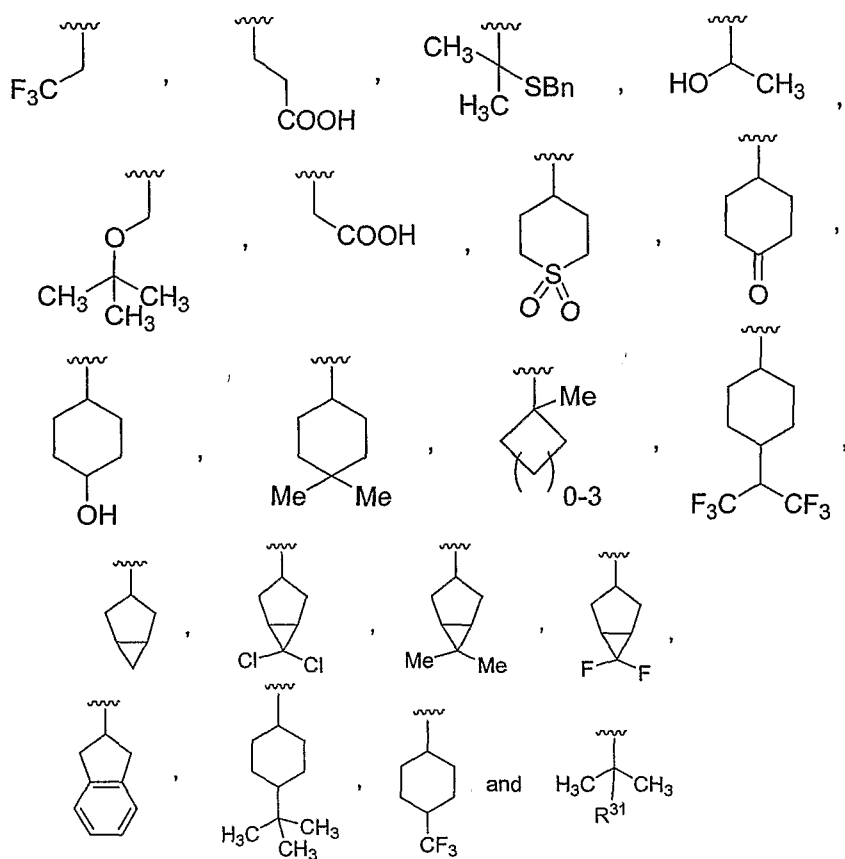


In another embodiment, R^2 is selected from the group consisting of the following moieties:



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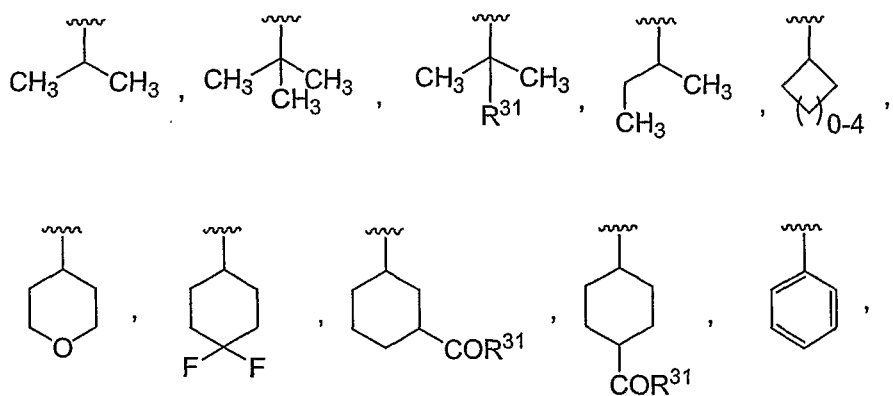


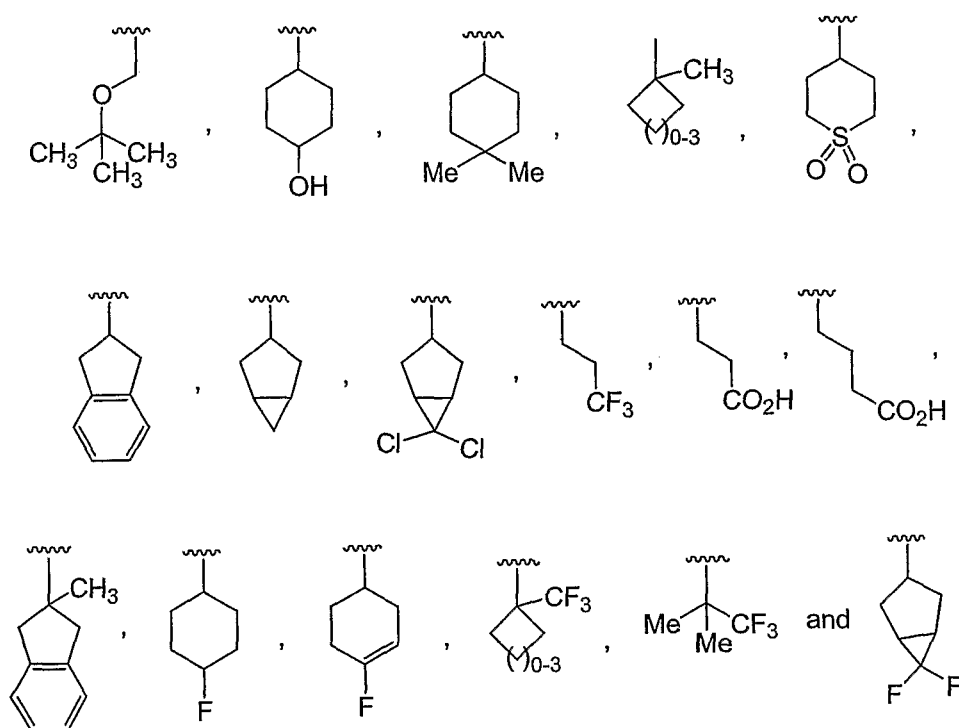
wherein R³¹ is OH or O-alkyl; and

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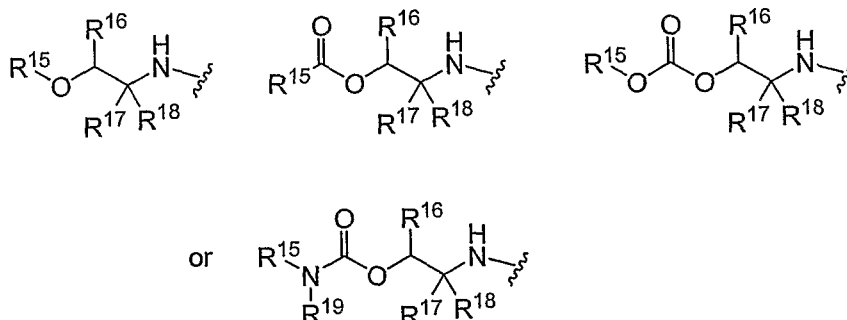
R³² is H, C(O)CH₃, C(O)OtBu or C(O)N(H)tBu.

In an additional embodiment, R³ is selected from the group consisting of the following moieties:





In another embodiment, Y is selected from the following moieties:



5

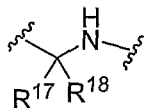
wherein R^{15} , R^{16} , R^{17} , R^{18} , and R^{19} can be the same or different, each being independently selected from the group consisting of H, alkyl, heteroalkyl, alkenyl, heteroalkenyl, alkynyl, heteroalkynyl, cycloalkyl, heterocycl, aryl, and heteroaryl, or alternately, (i) either R^{15} and R^{16} are connected to form a four to eight-membered cyclic structure, or R^{15} and R^{19} are connected to form a four to eight-membered cyclic structure, and (ii) likewise, independently, R^{17} and R^{18} are connected to form a three to eight-membered cycloalkyl or heterocycl;

wherein each of said alkyl, aryl, heteroaryl, cycloalkyl or heterocycl can be unsubstituted or optionally independently substituted with one or more moieties selected from the group consisting of: hydroxy, alkoxy, aryloxy, thio, alkylthio, arylthio, amino, amido, alkylamino, arylamino, alkylsulfonyl, arylsulfonyl, sulfonamido, alkylsulfonamido, arylsulfonamido, keto, carboxy,

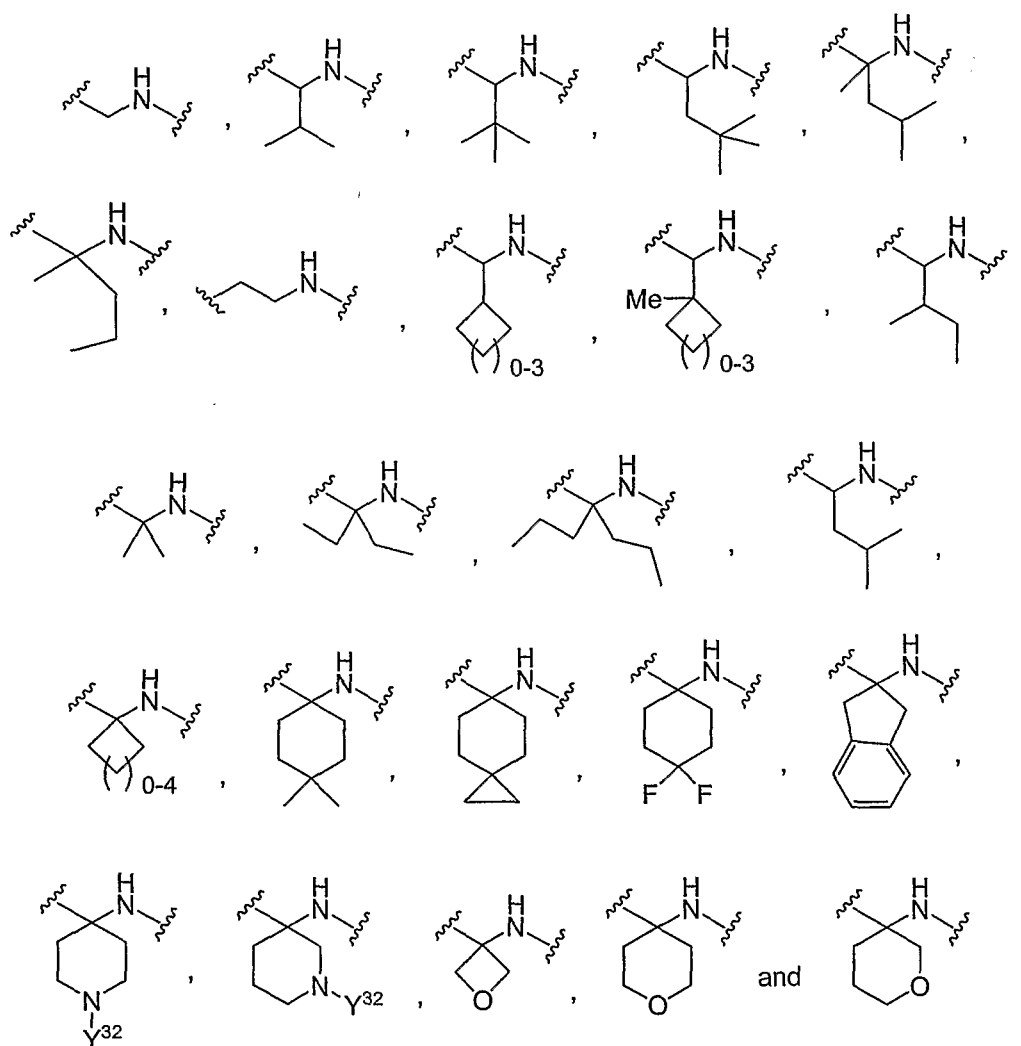
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carbalkoxy, carboxamido, alkoxy-carbonylamino, alkoxy-carbonyloxy, alkylureido, arylureido, halo, cyano, and nitro.

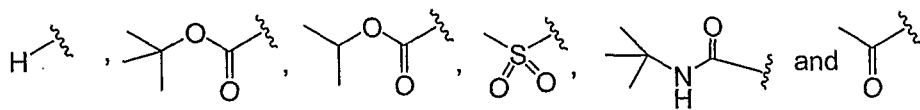
In an additional embodiment, the moiety:



5 is selected from the group consisting of:

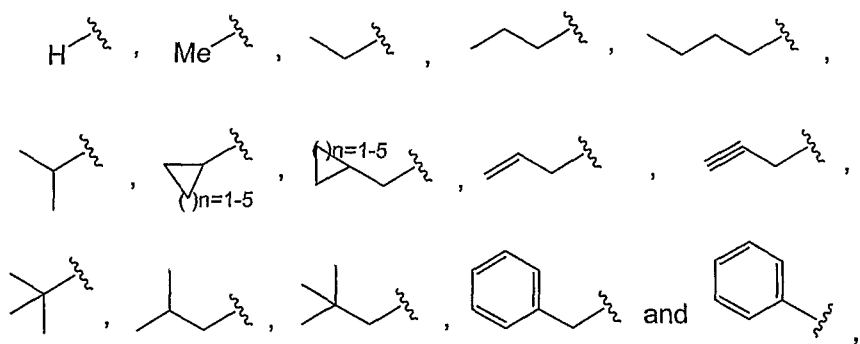


wherein Y^{32} is selected from the group consisting of:

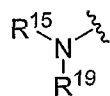


R^{16} is selected from H, methyl, phenyl, benzyl; and

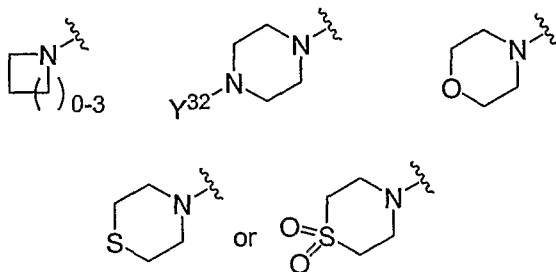
R^{15} and R^{19} maybe the same or different, each being independently selected from the following:



or alternately, the moiety:



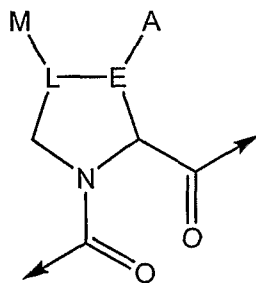
is selected from the following moieties:



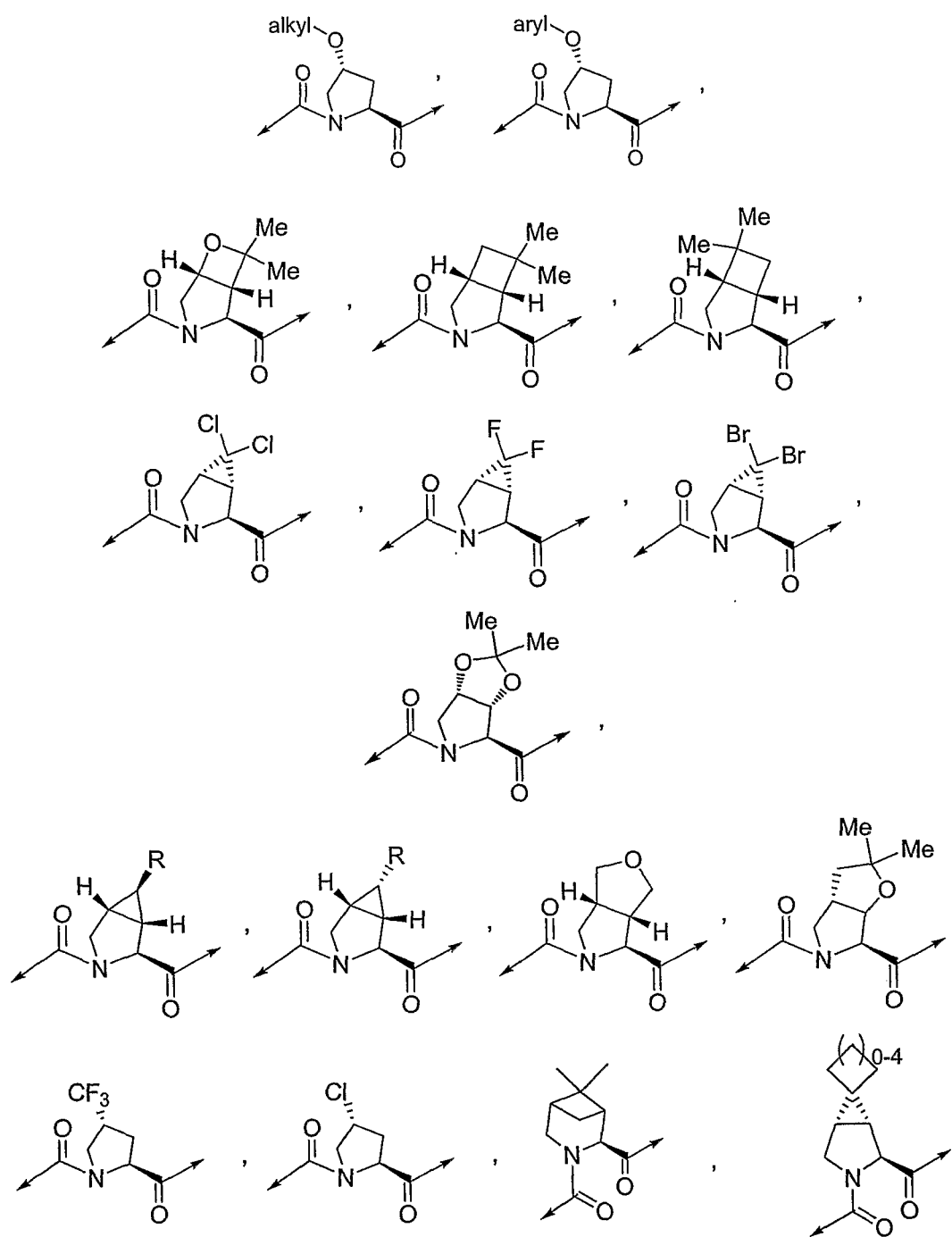
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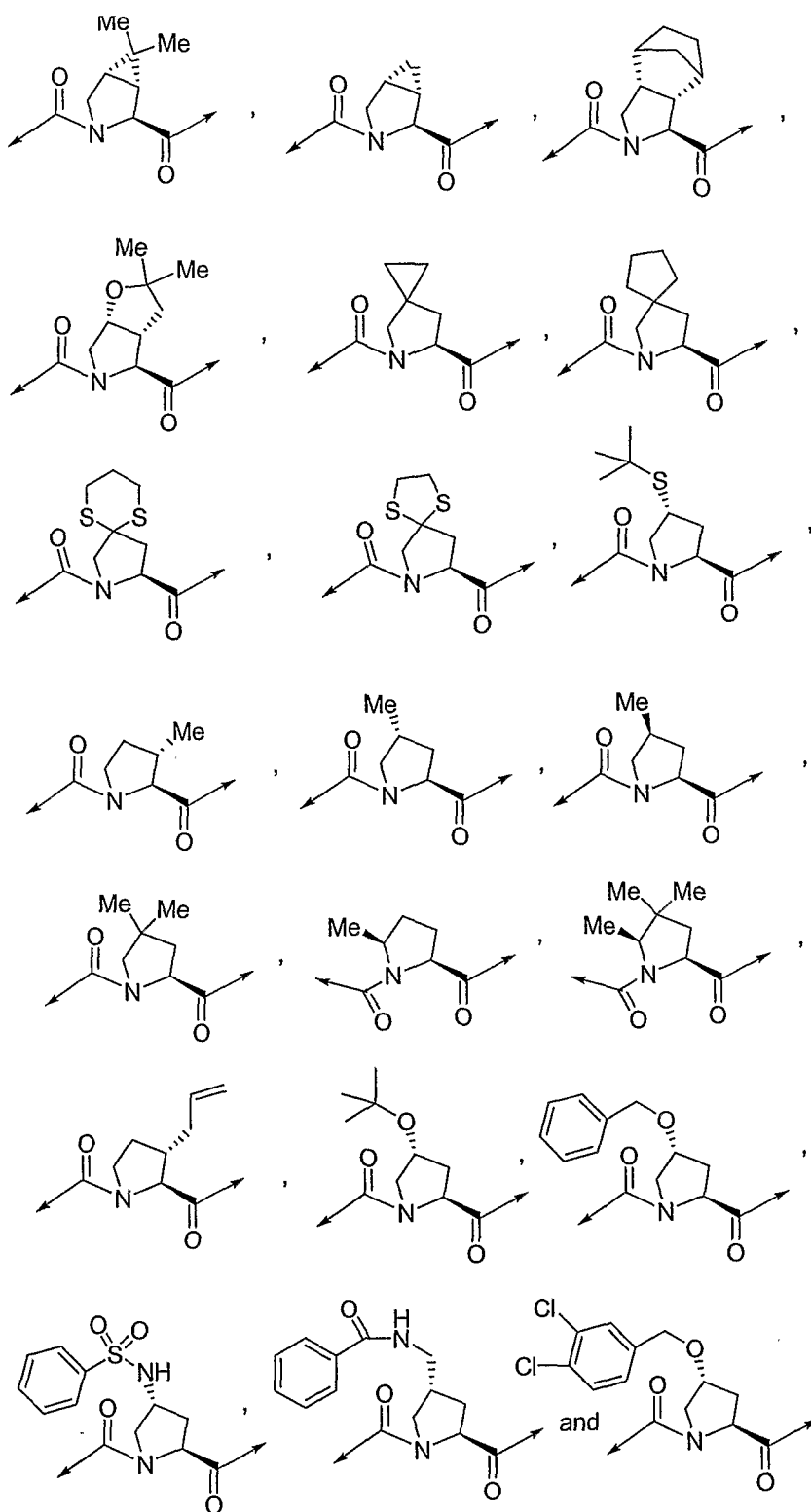
In an additional embodiment, R^{16} is H.

In another embodiment, the moiety:

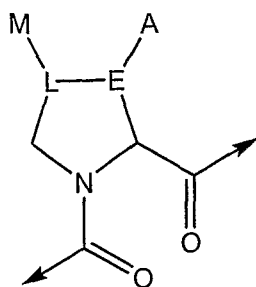


is selected from the following structures:

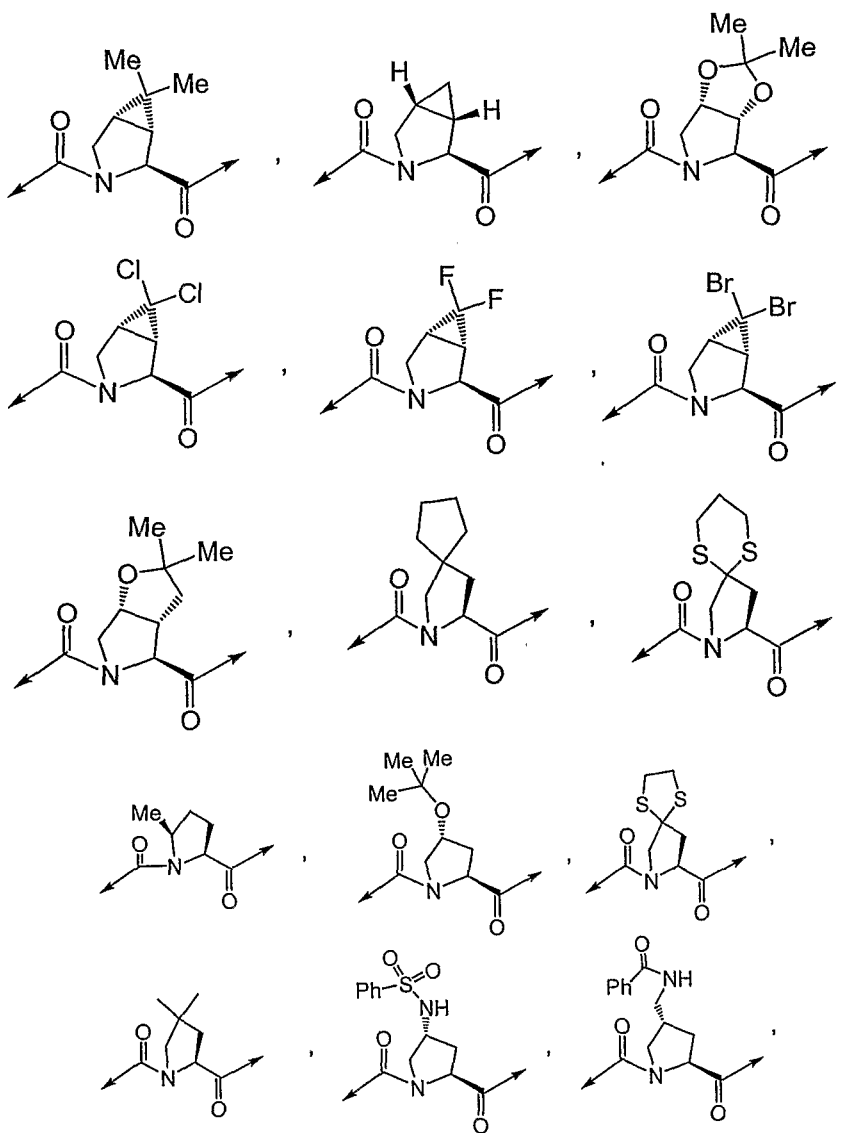
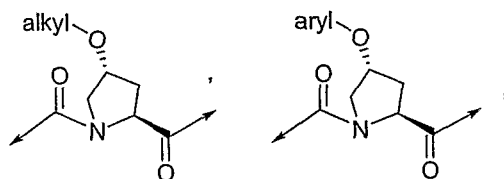


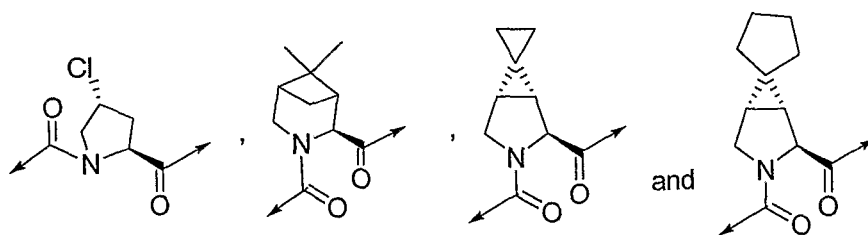


In an additional embodiment, the moiety:

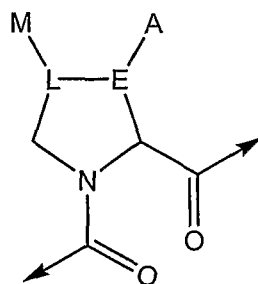


is selected from the following structures:

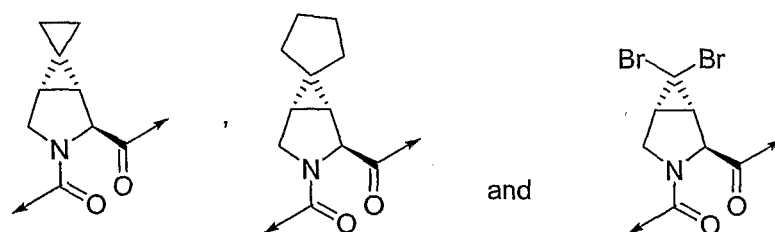
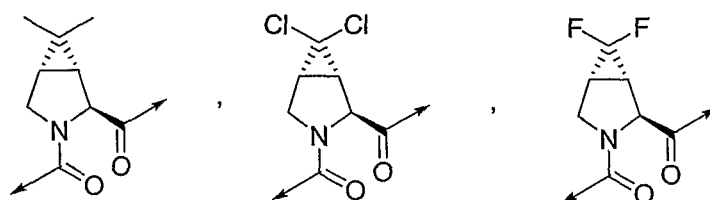




In a still additional embodiment, the moiety:

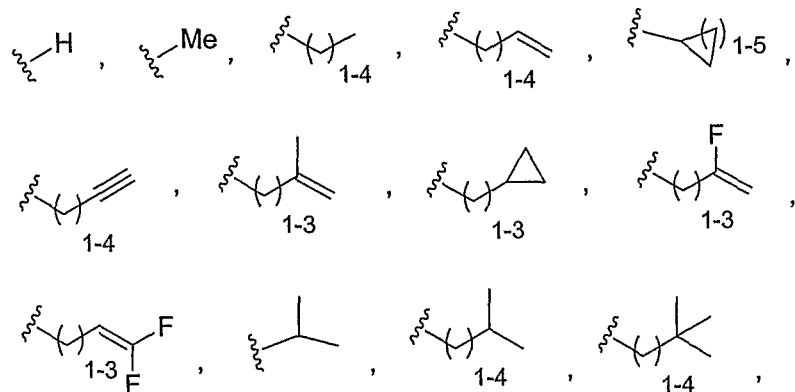


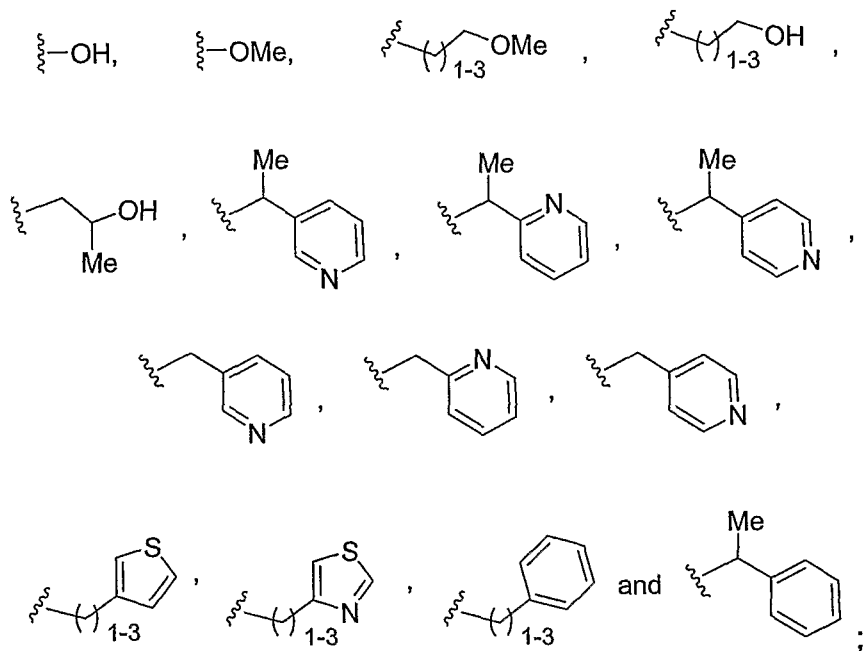
is selected from the following structures:



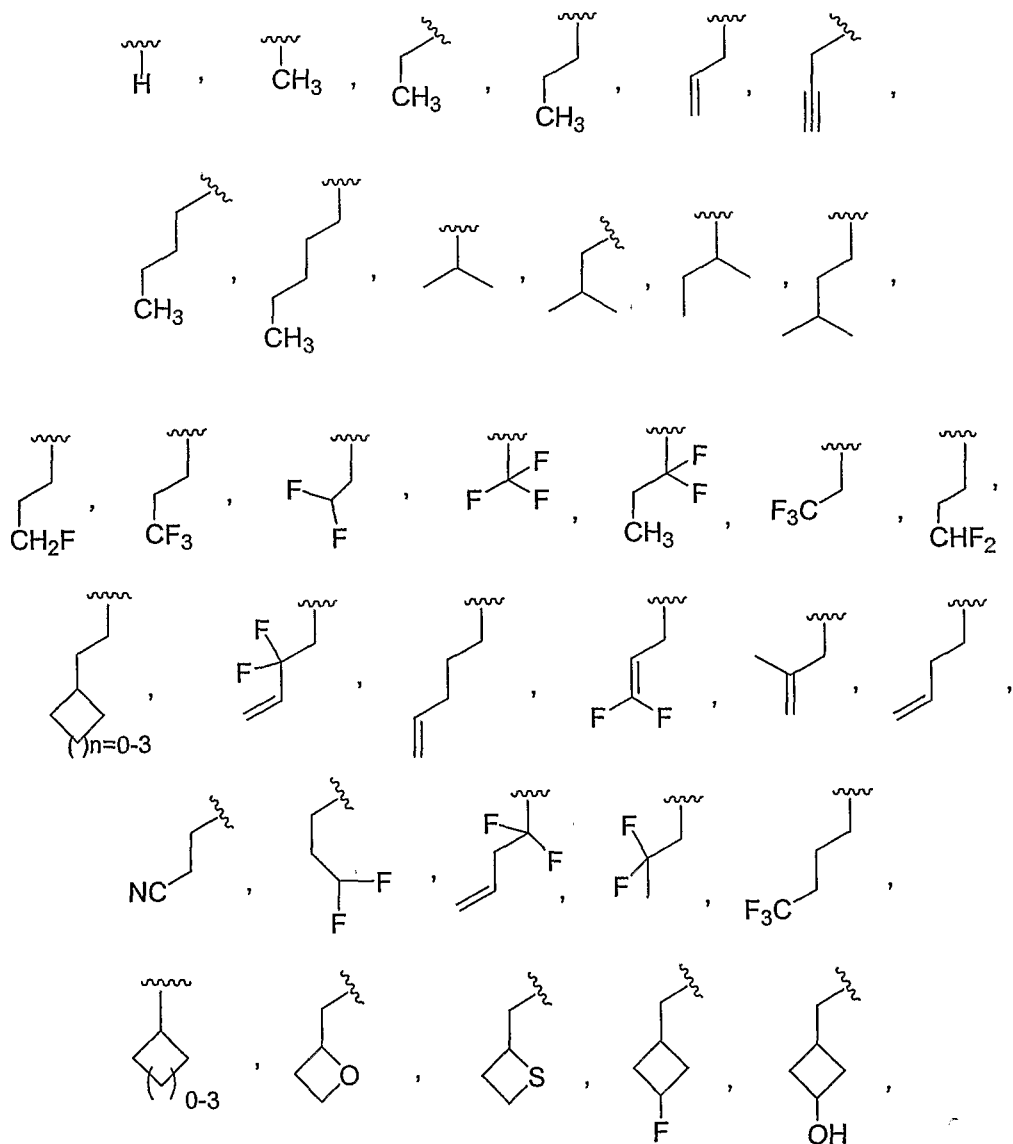
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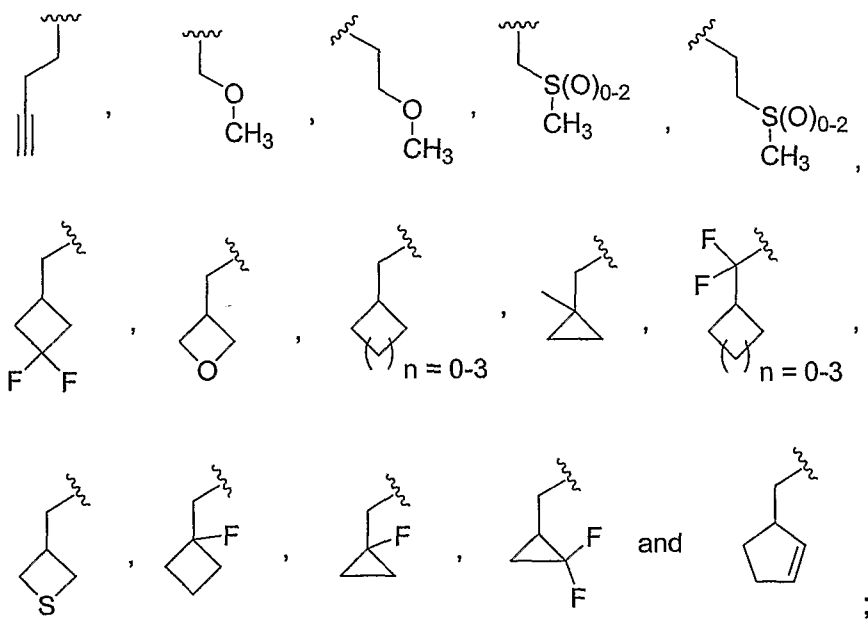
In a further additional embodiment, R^1 is NHR^{14} , where R^{14} is selected from the group consisting of:



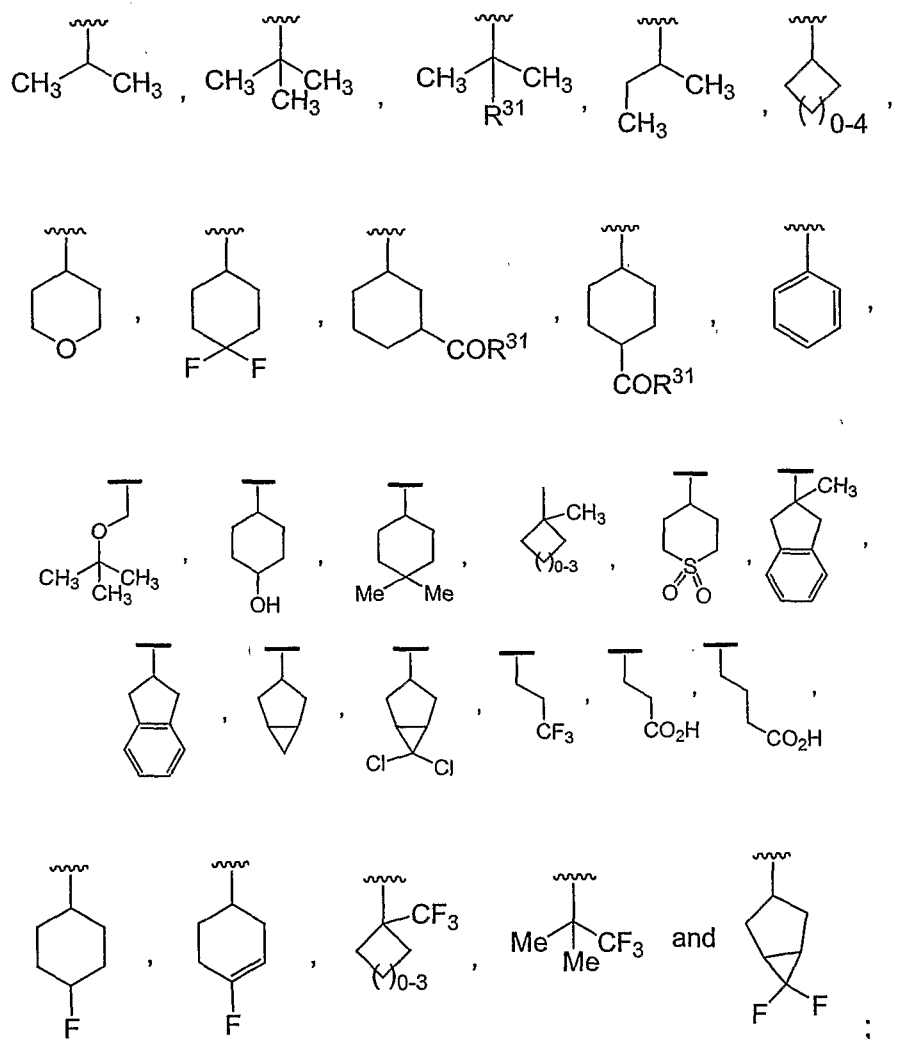


R² is selected from the group consisting of the following moieties:

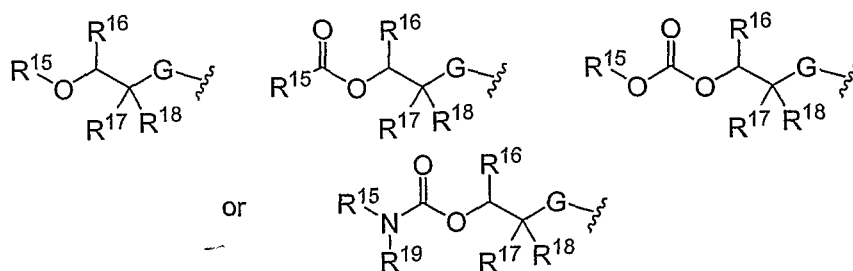




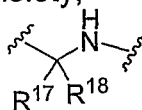
R³ is selected from the group consisting of the following moieties:



Y is selected from the group consisting of:

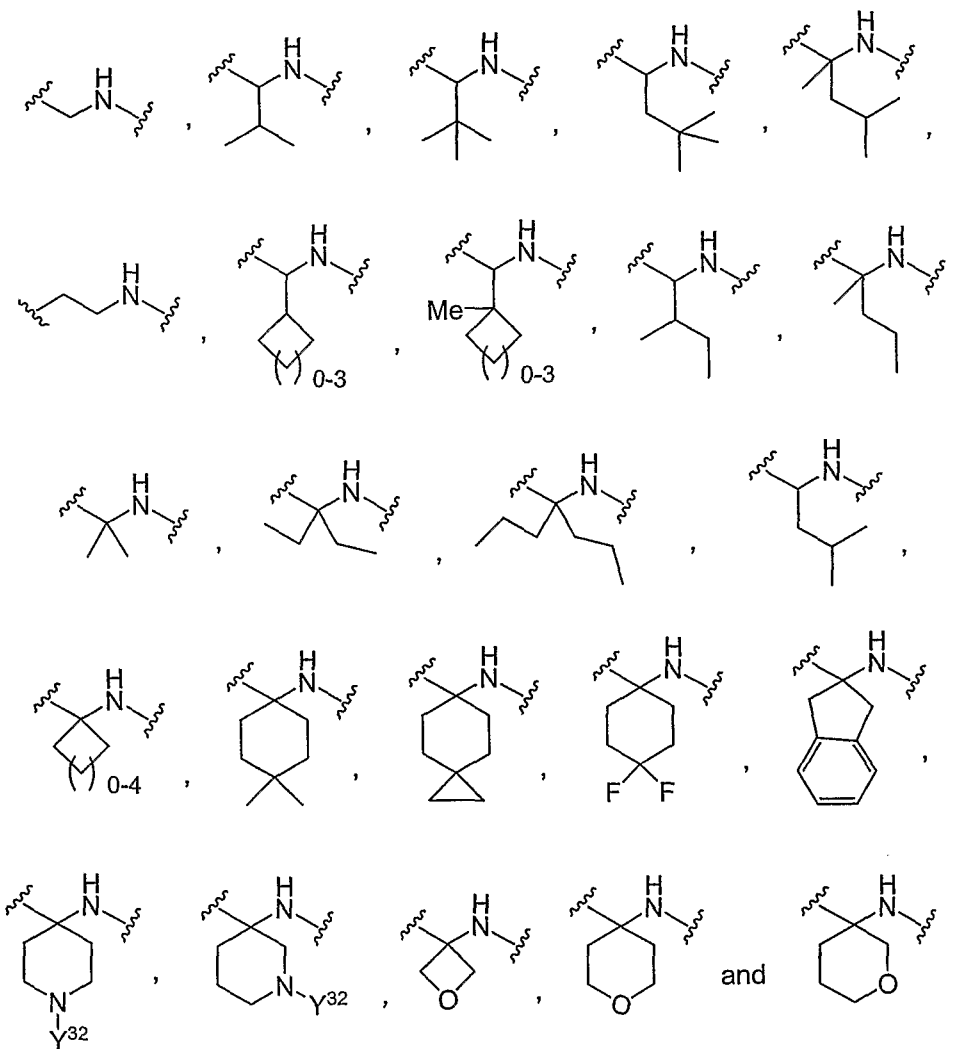


wherein G = NH, and the moiety,

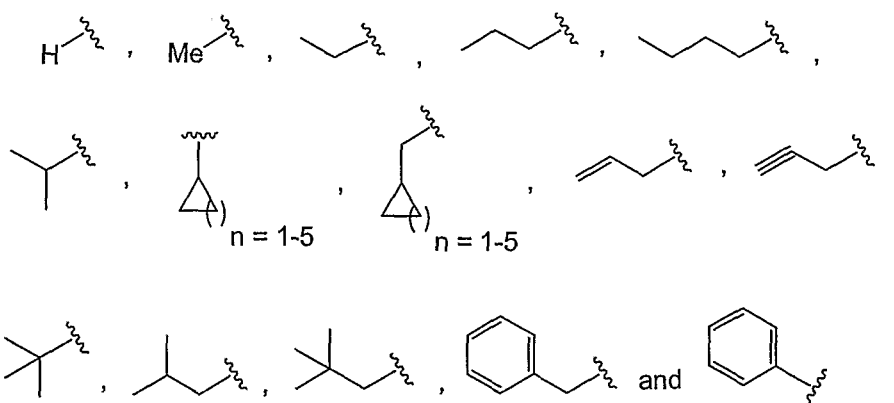


is selected from the group consisting of:

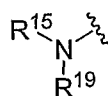
5


$$R^{16} = H, \text{ and}$$

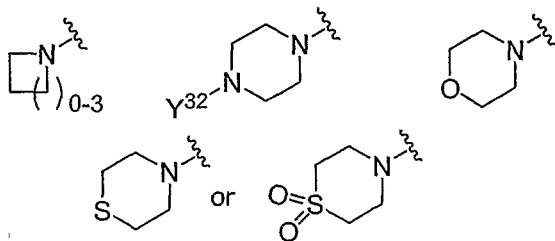
R¹⁵ and R¹⁹ can be the same or different, each being independently selected from the following:



or alternately, the moiety:

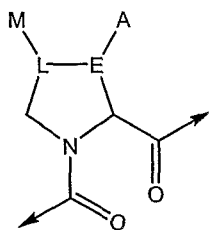


is represented by one of the following moieties,

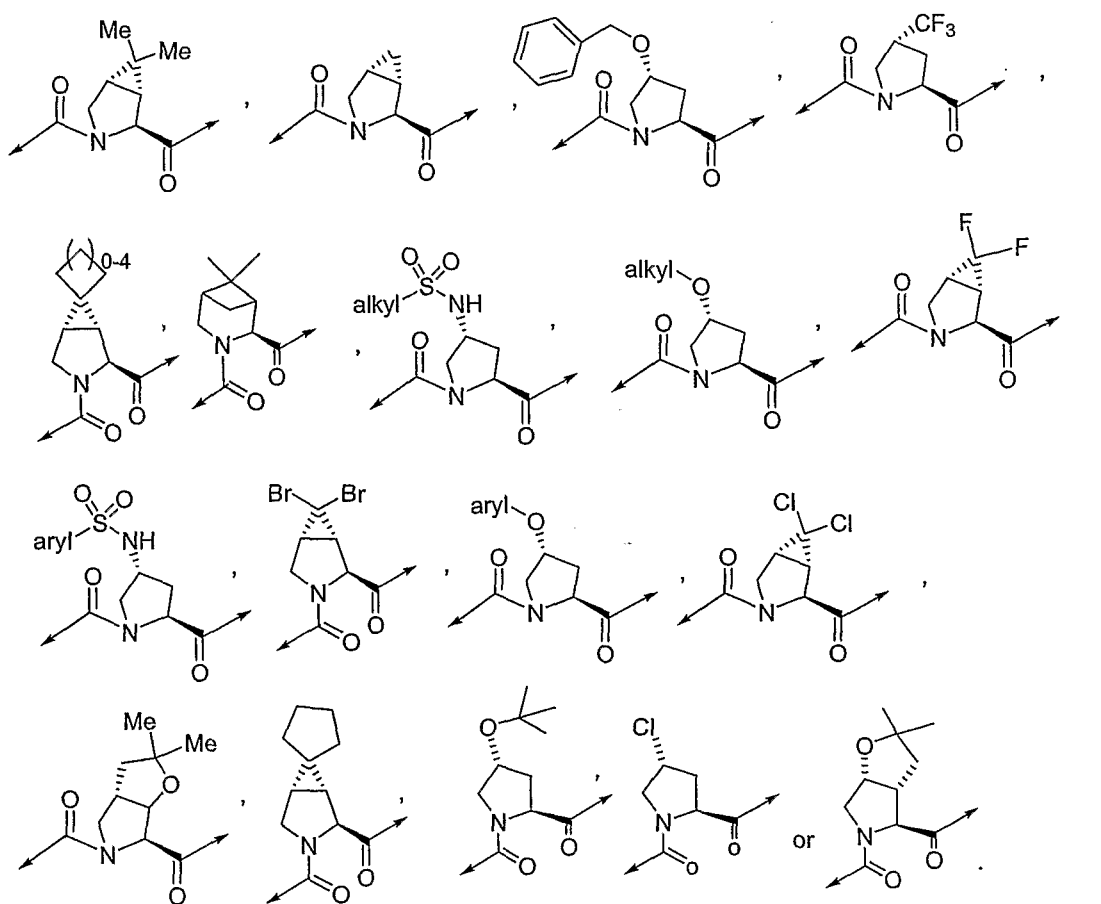


5

and the moiety:



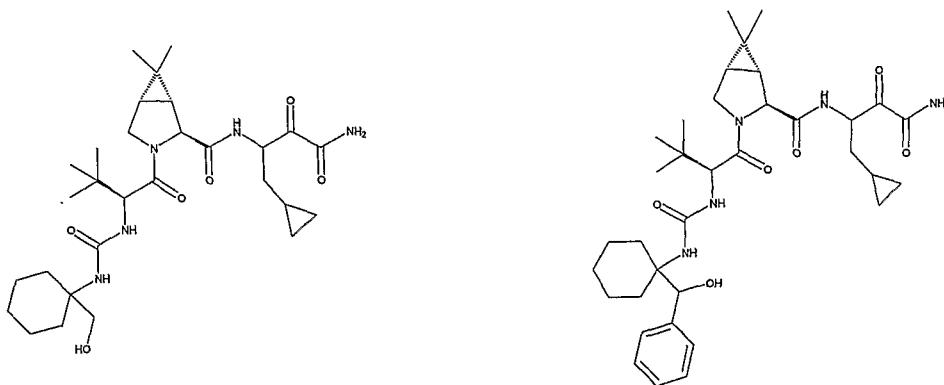
is:

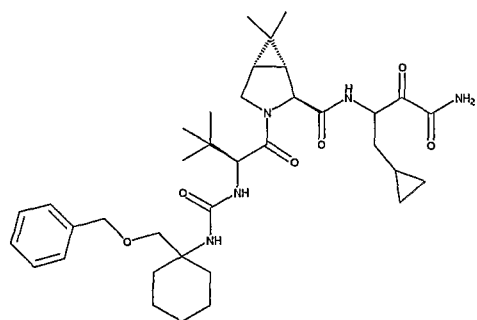
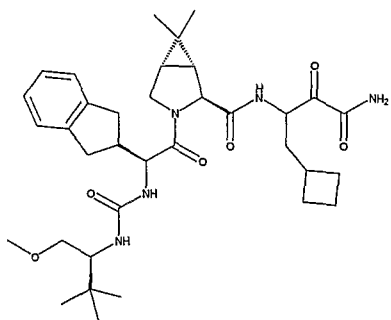
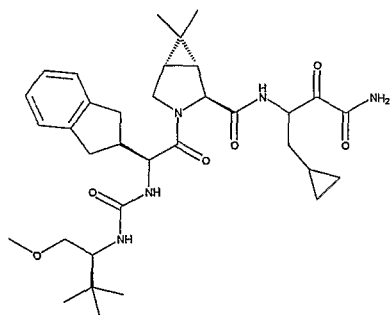
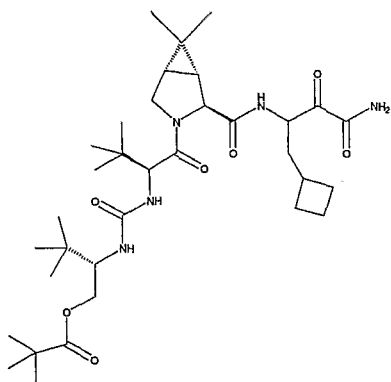
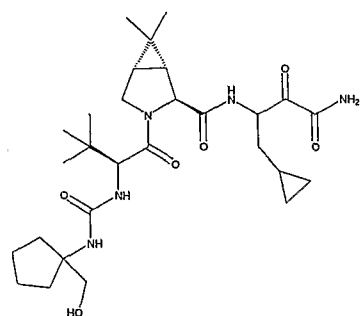
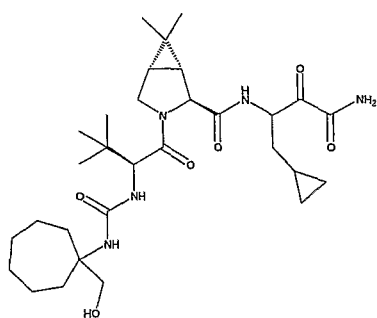
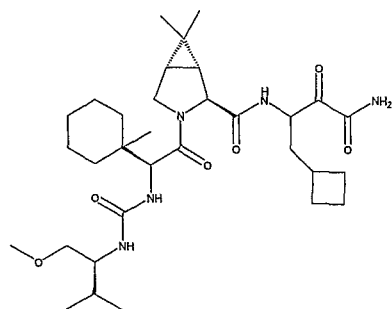
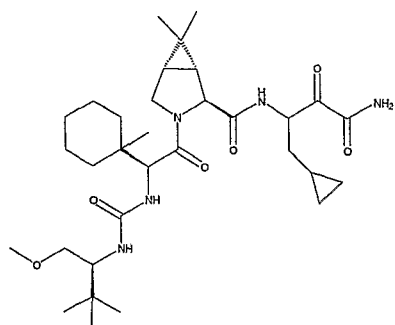


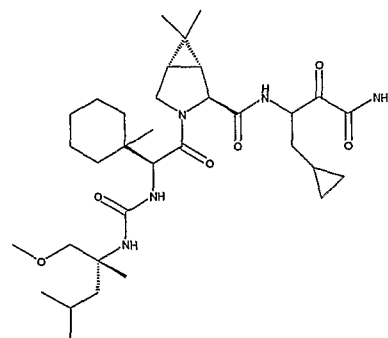
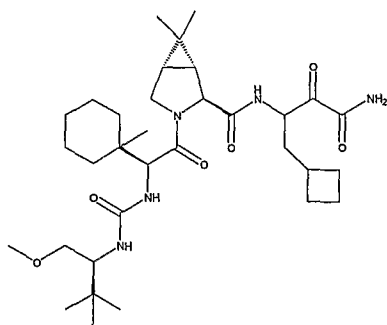
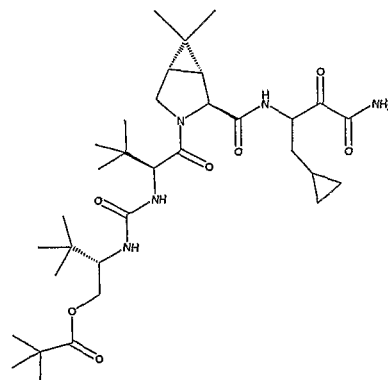
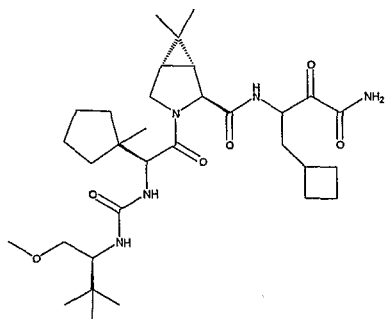
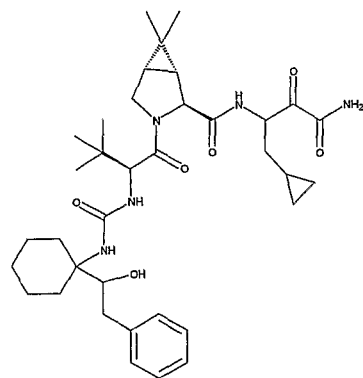
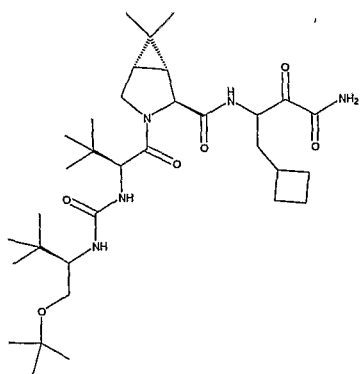
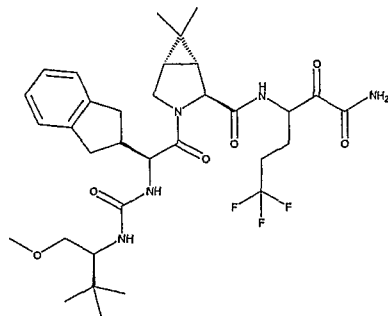
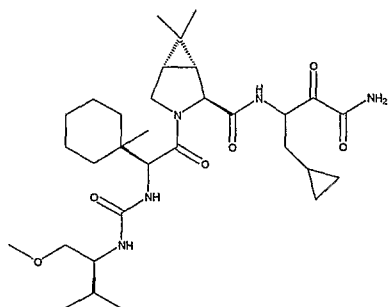
Yet another embodiment of the invention discloses compounds shown in **Table 1**, **Table 1A**, **Table 2** and **Table 3** later in this Description. Also shown in the **Tables** are the biological activities of several inventive compounds (as K_i^* values).

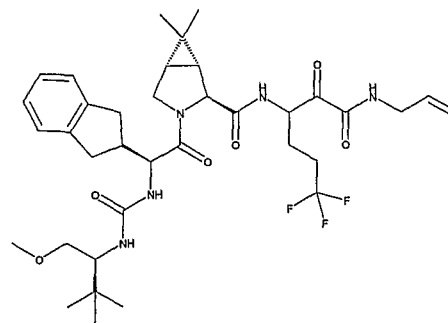
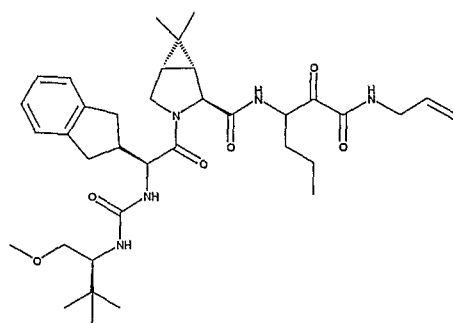
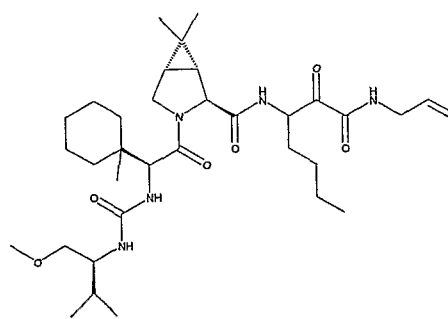
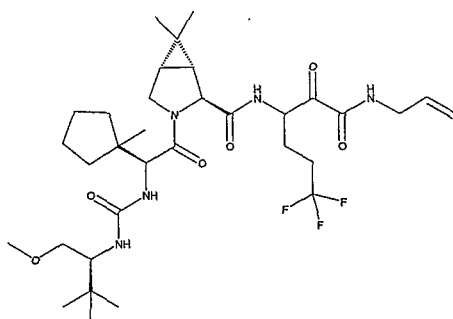
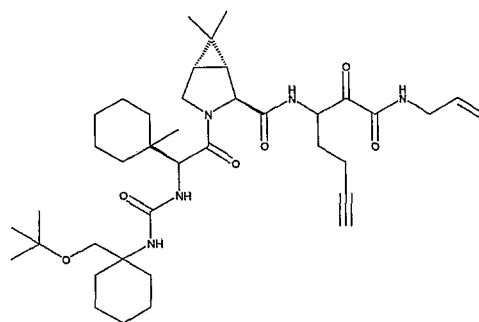
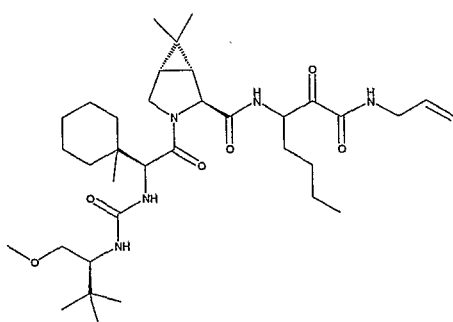
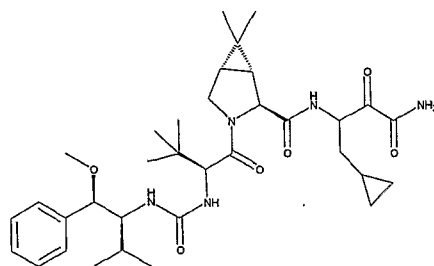
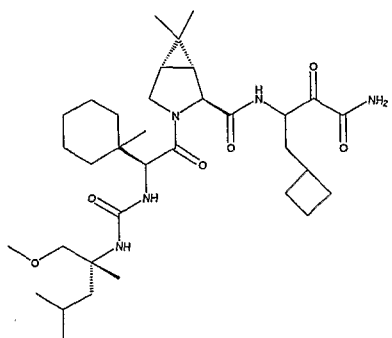
In an additional embodiment, this invention discloses the following compounds in **Table 4**:

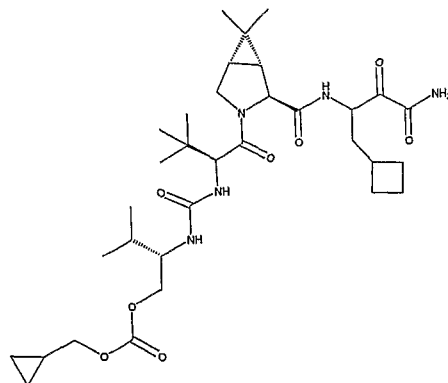
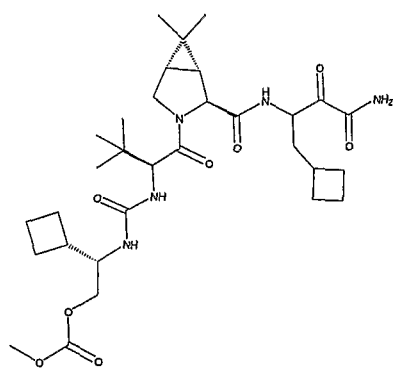
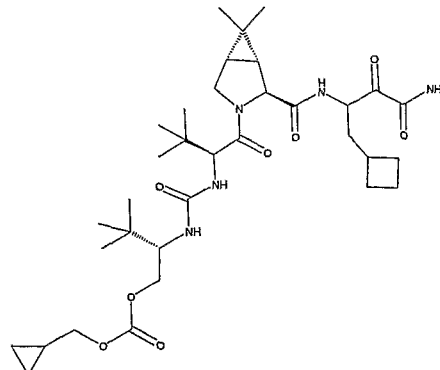
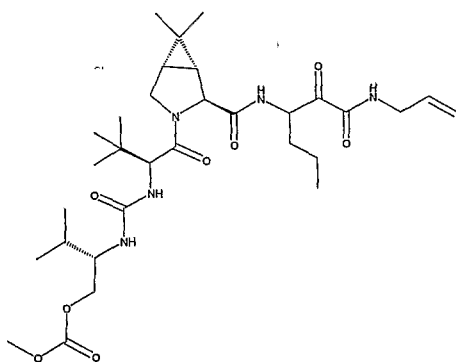
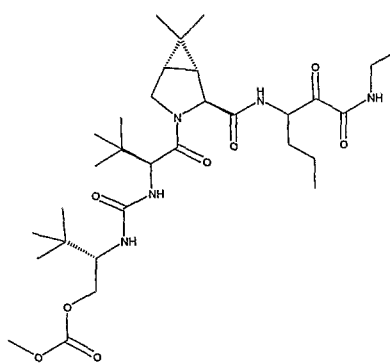
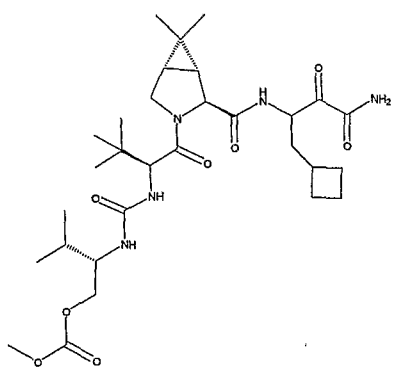
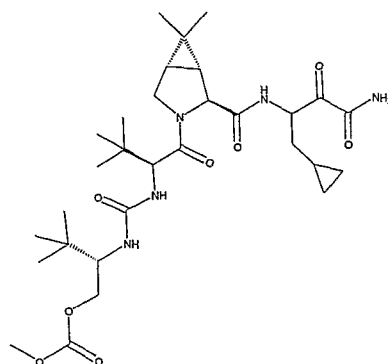
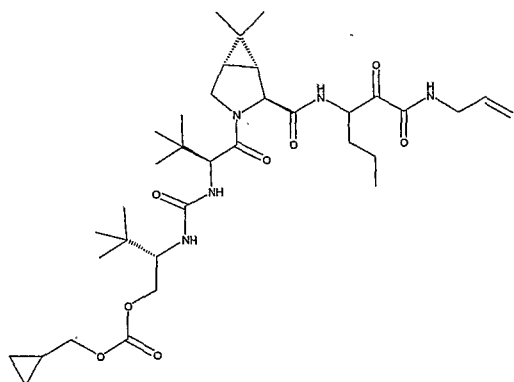
Table 4

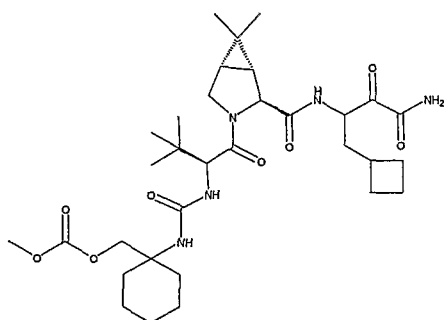
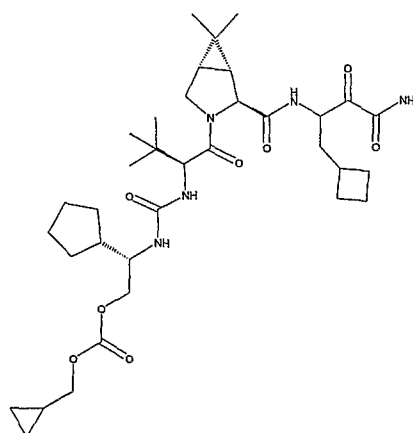
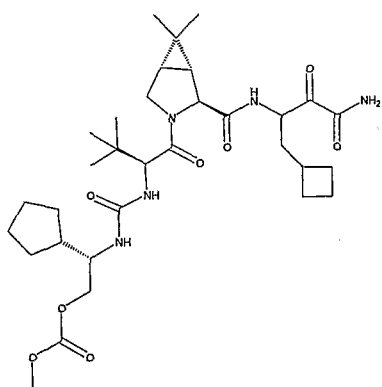
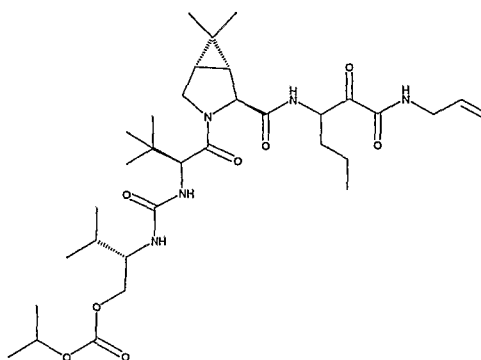
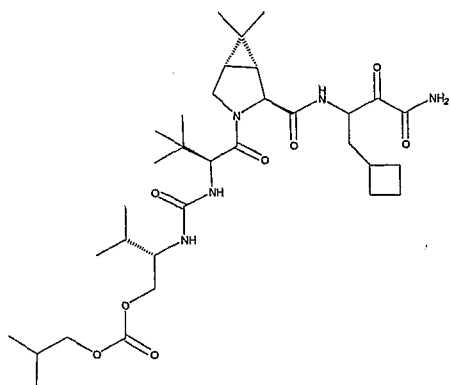
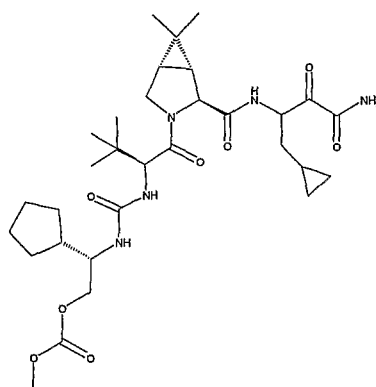
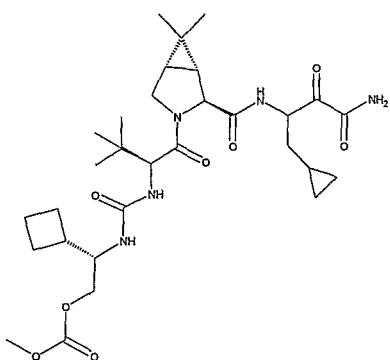


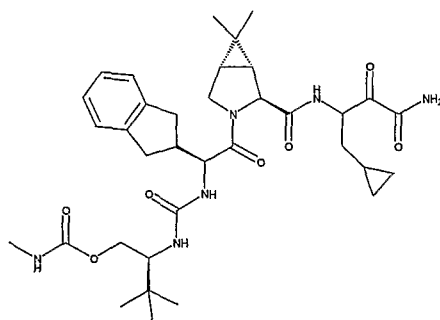
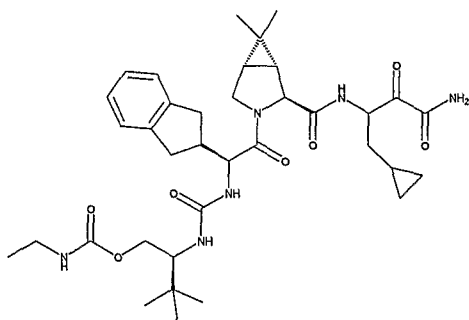
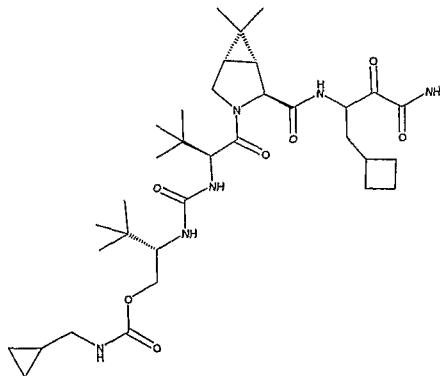
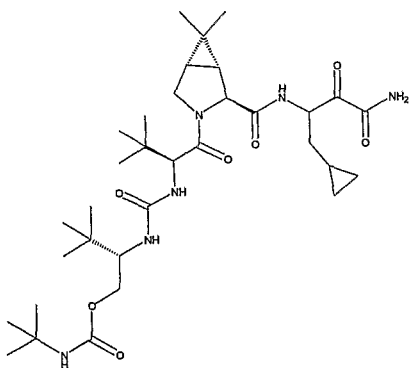
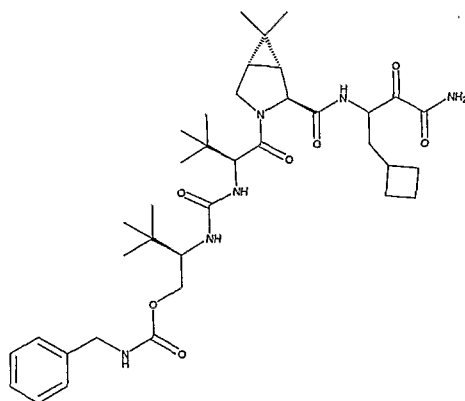
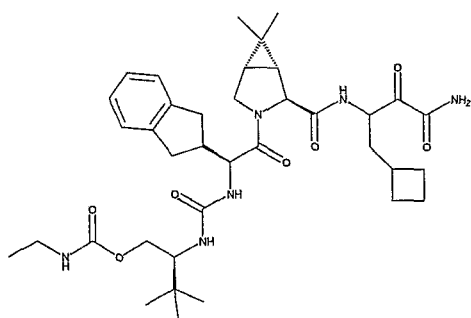
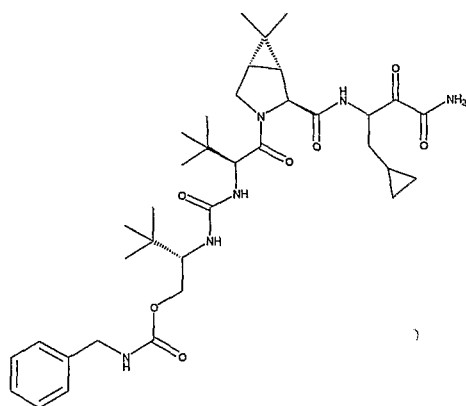
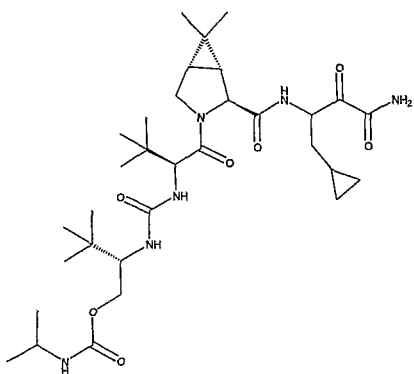


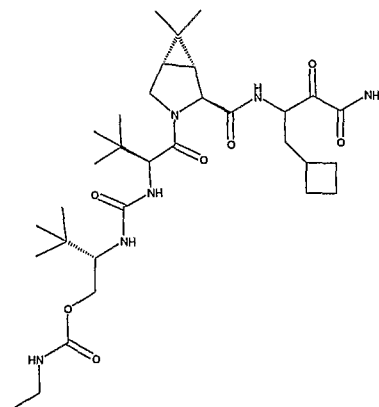
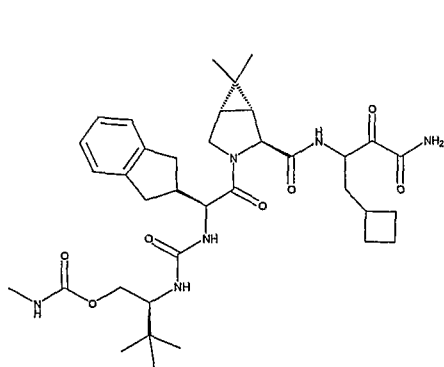
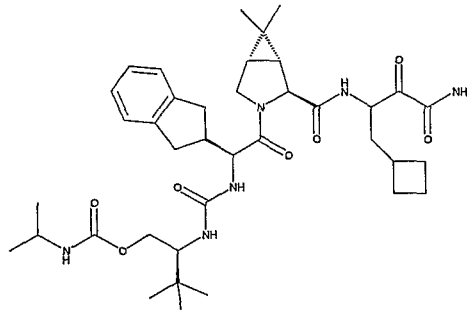
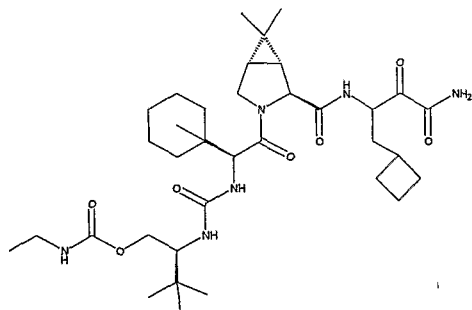
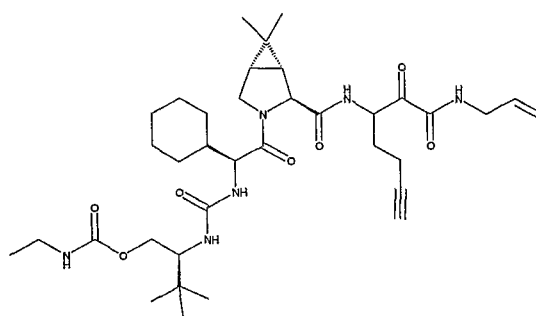
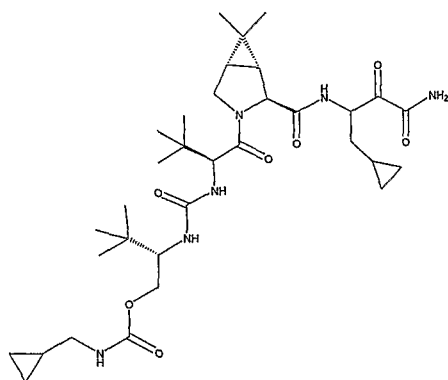
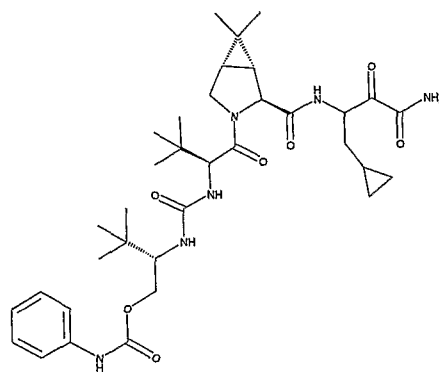
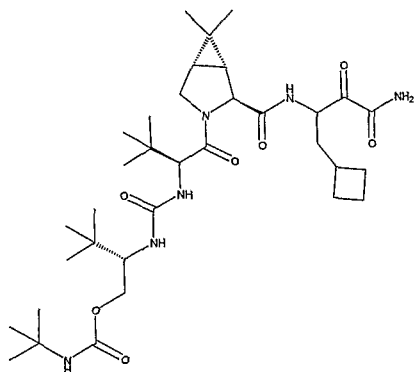


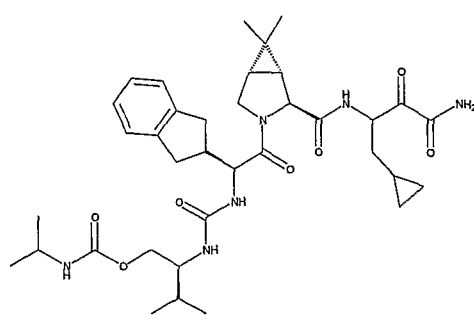
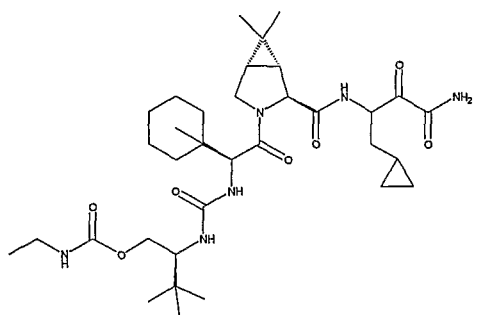
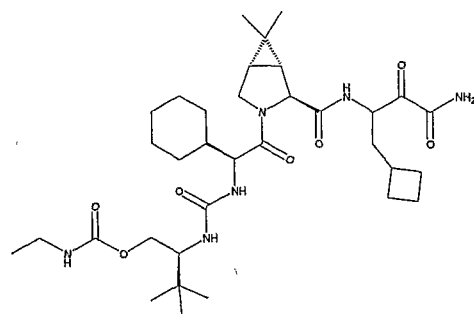
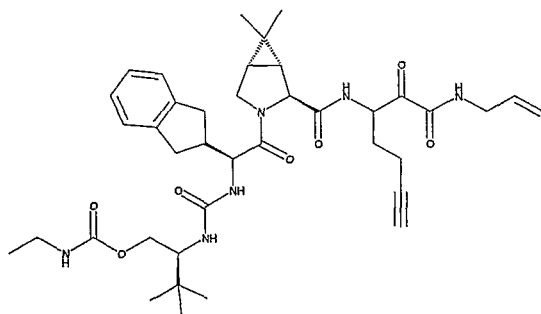
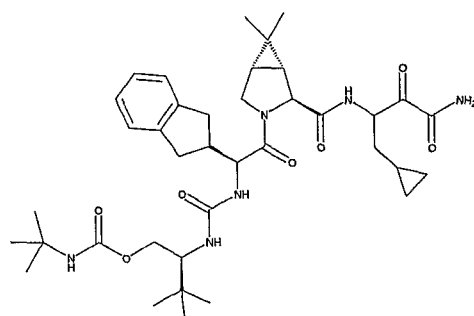
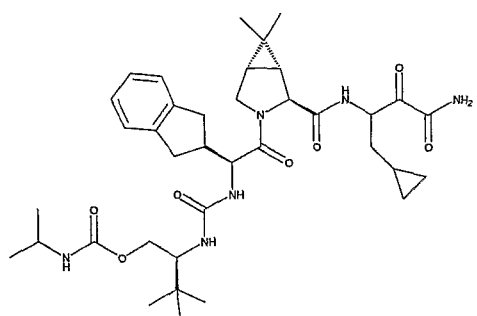
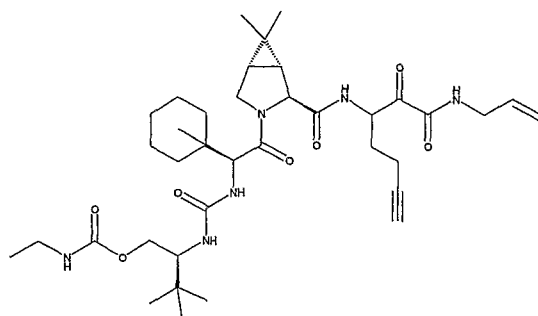
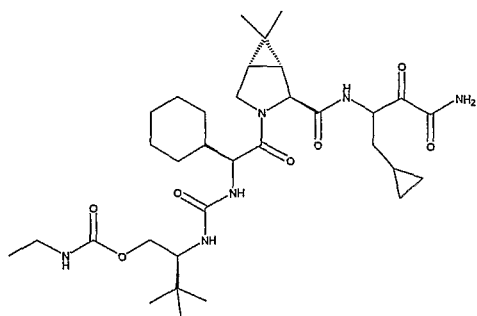


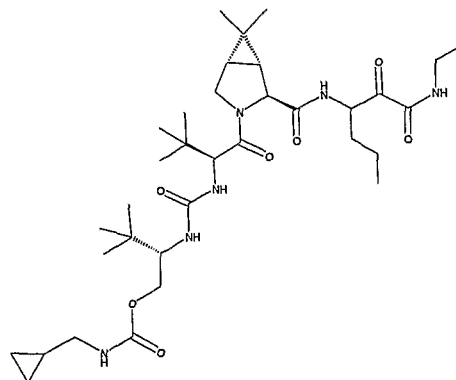
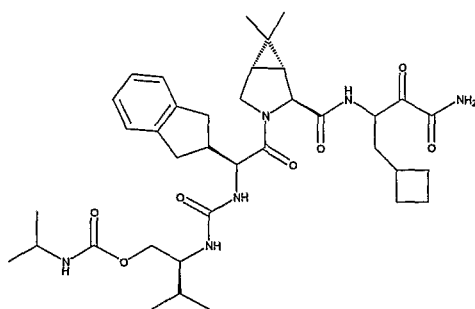
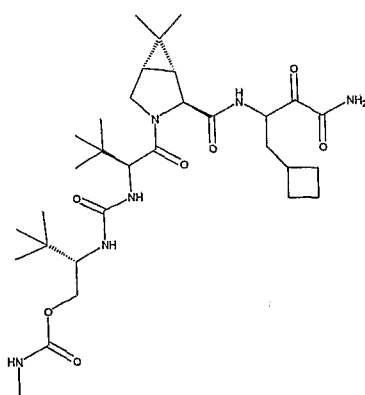
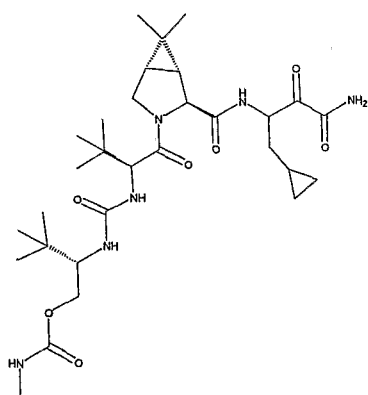
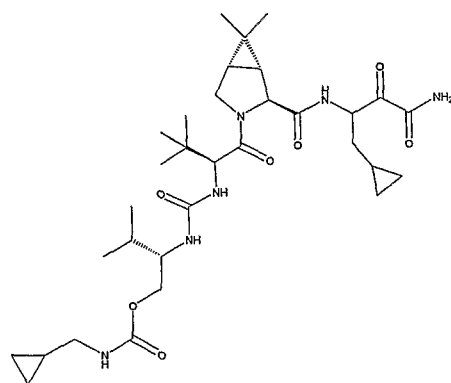
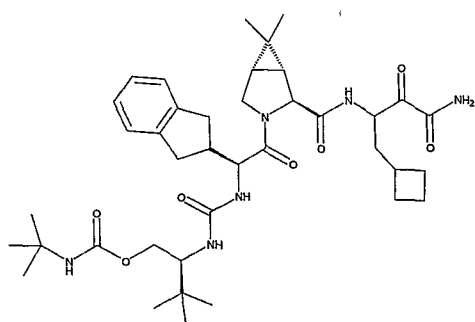
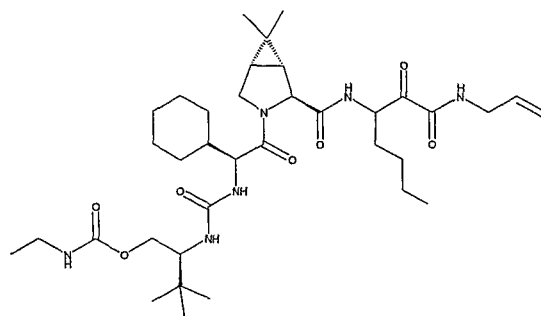
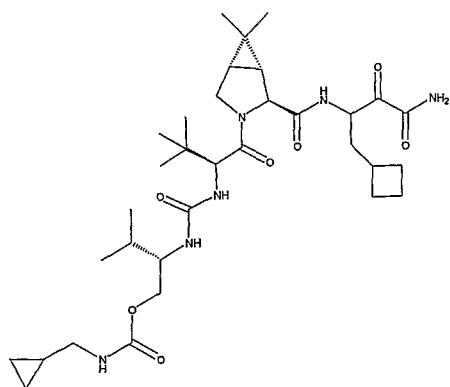


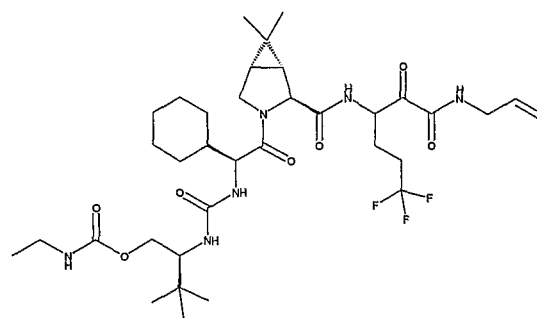
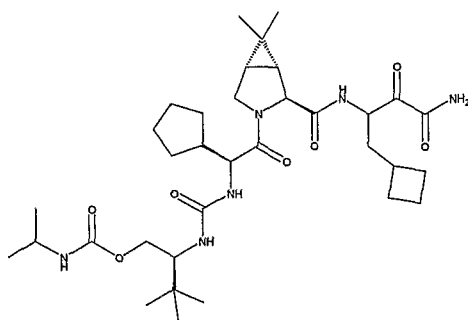
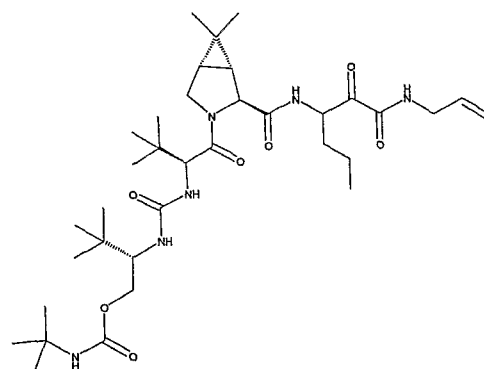
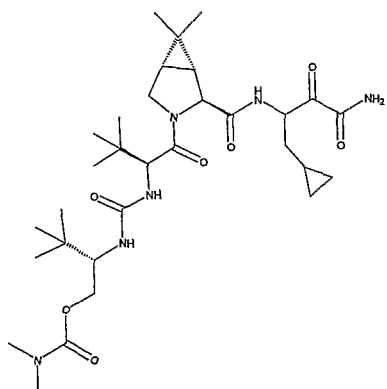
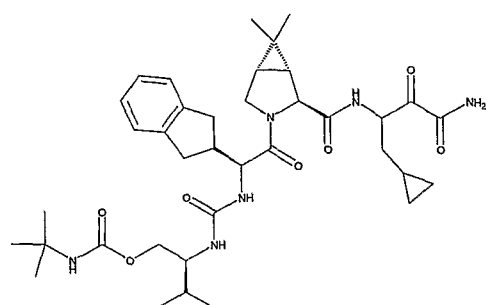
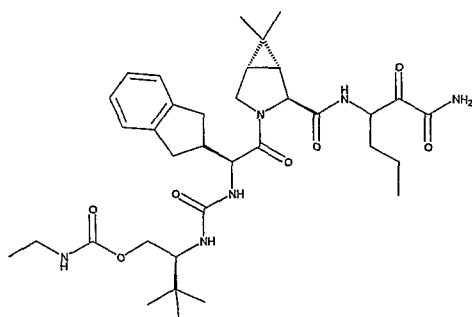
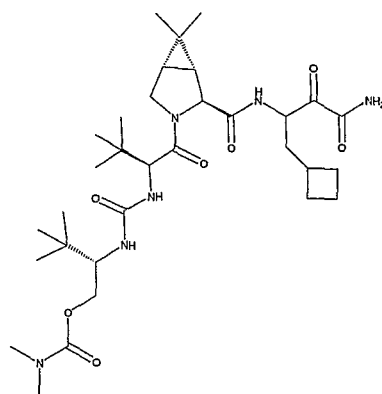
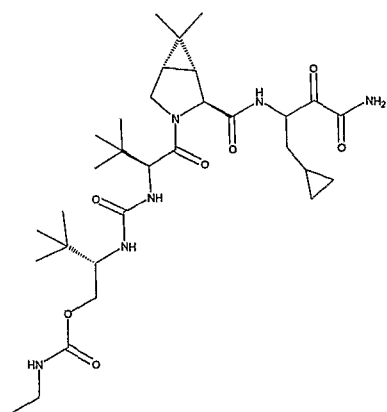


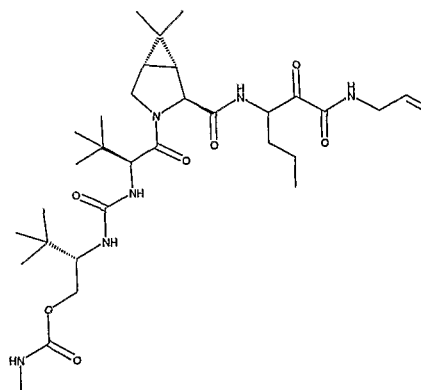
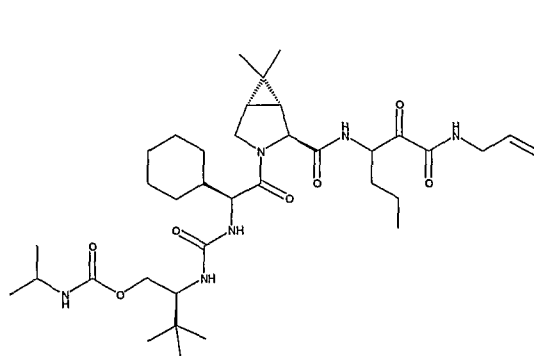
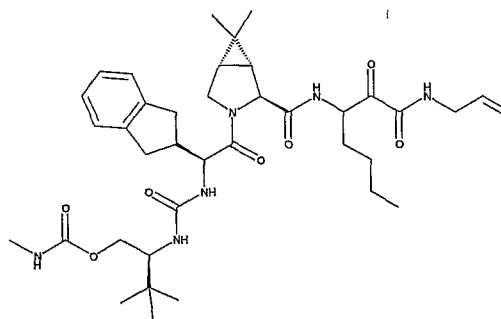
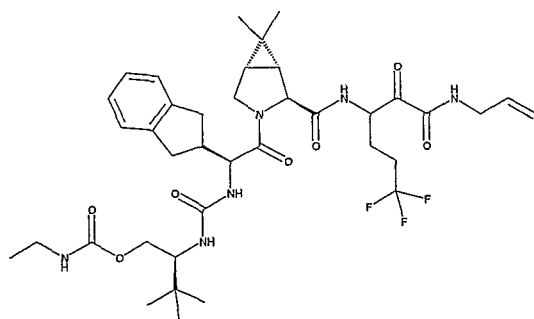
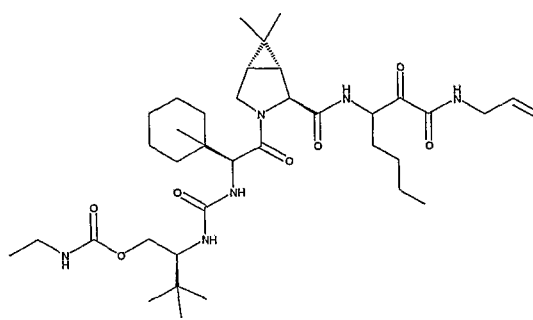
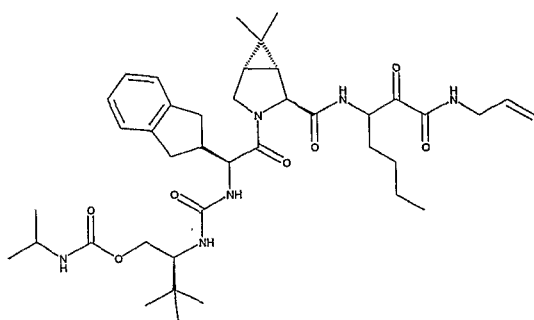
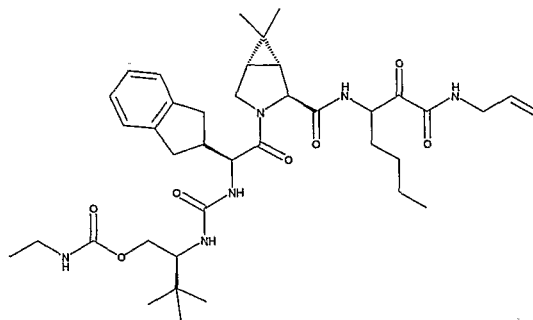
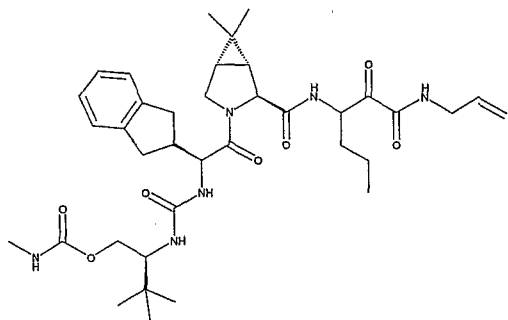


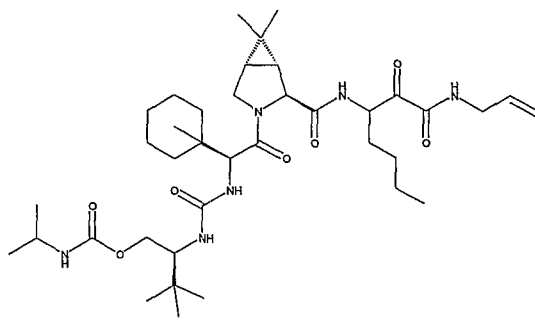
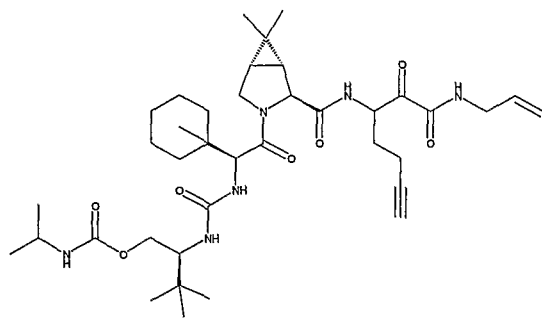
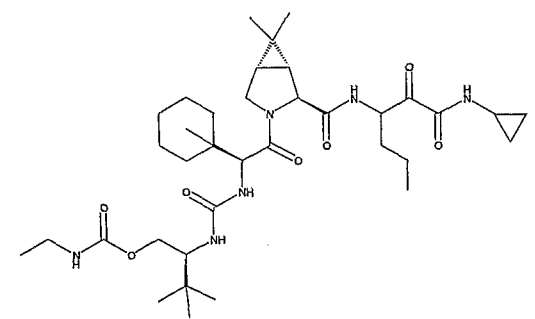
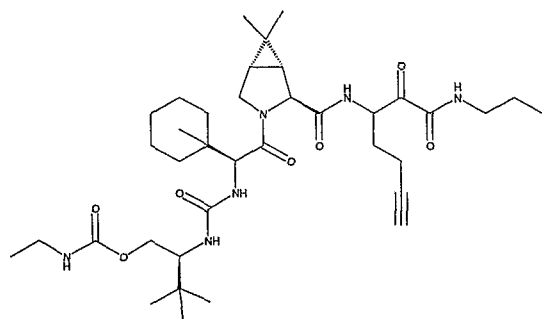
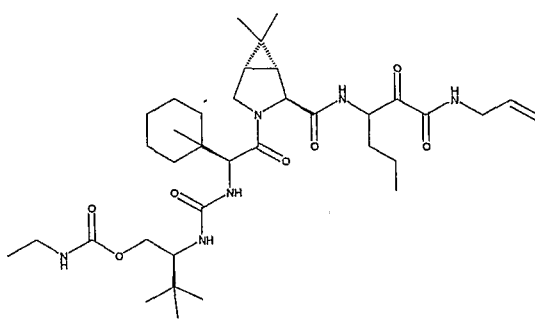
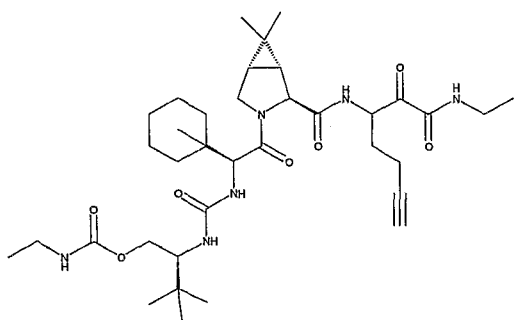
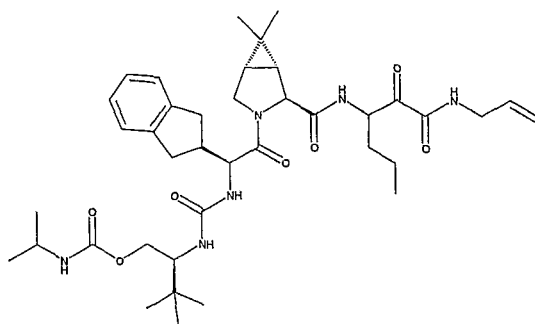
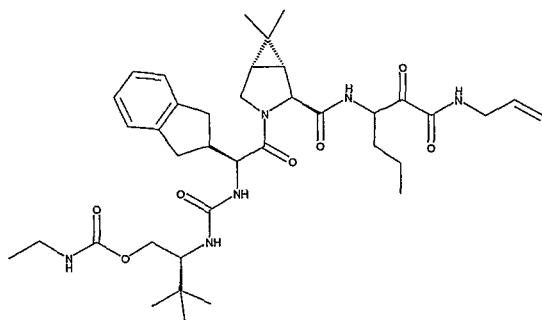


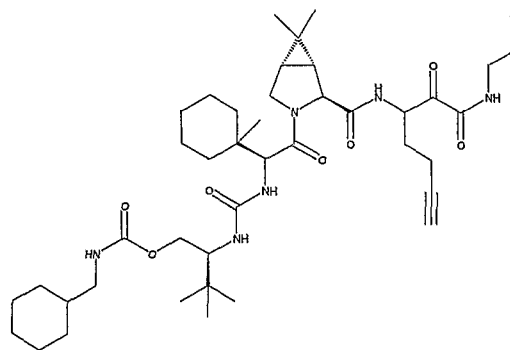
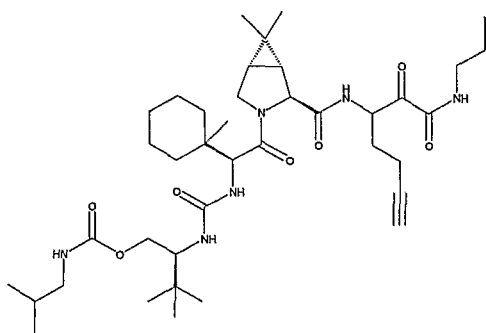
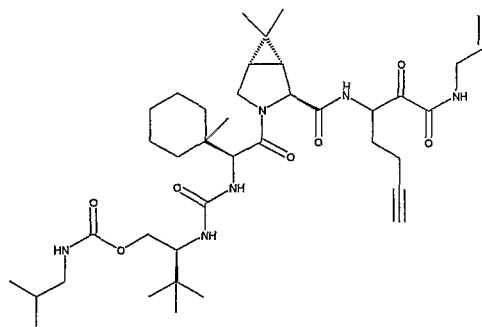
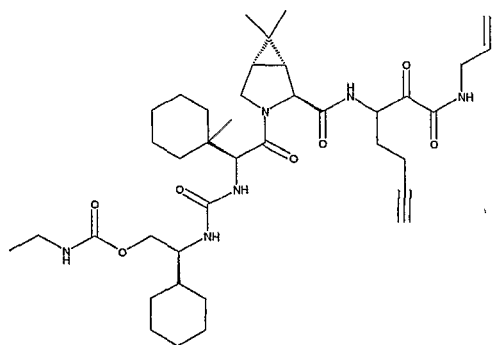
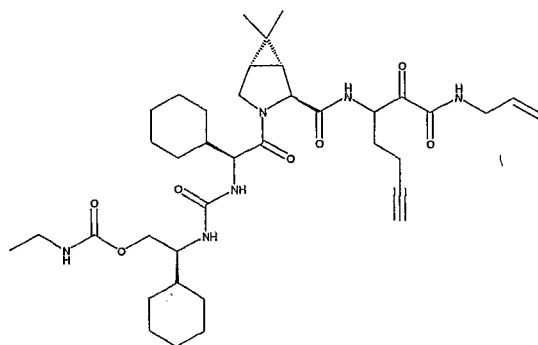
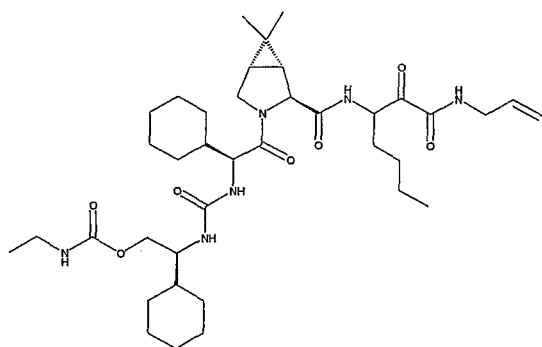
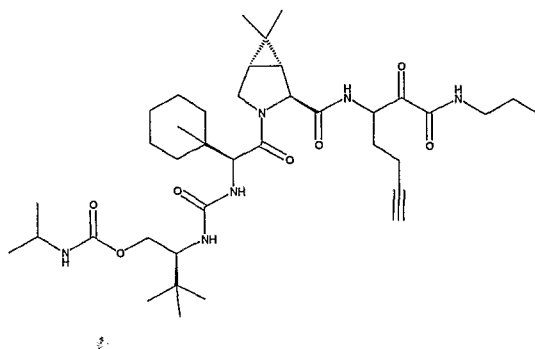
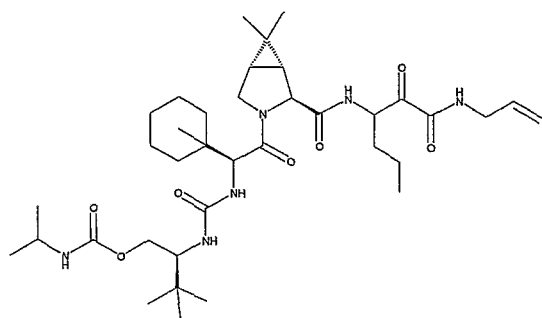


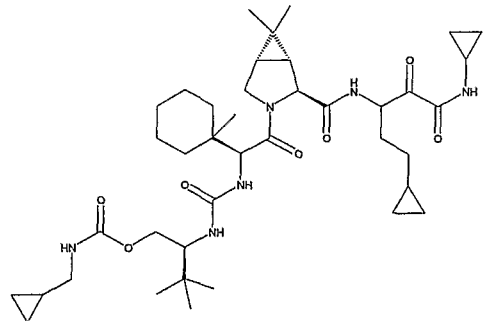
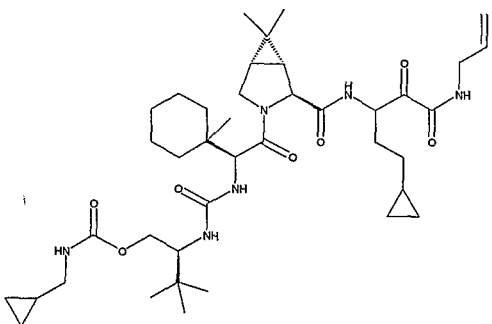
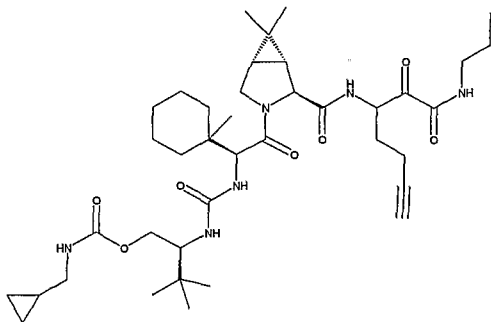
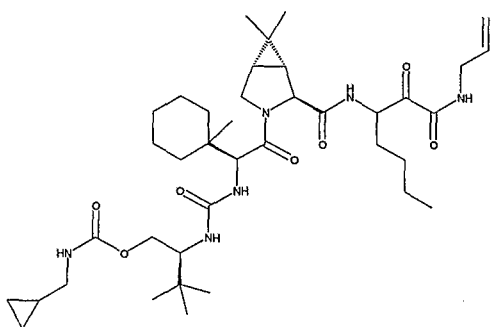
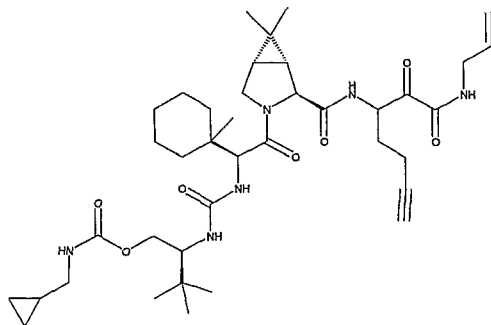
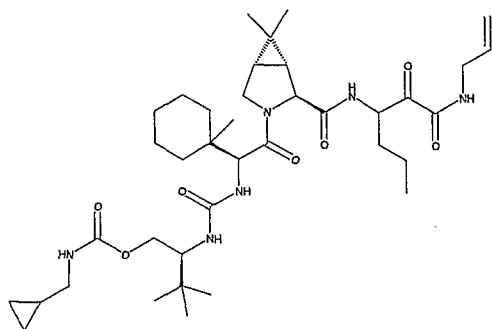






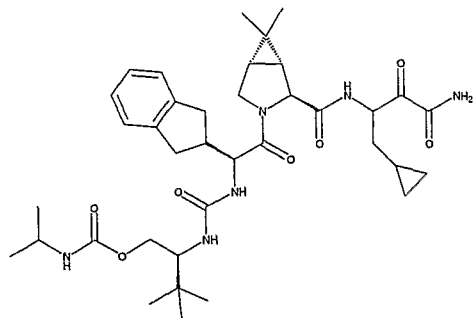
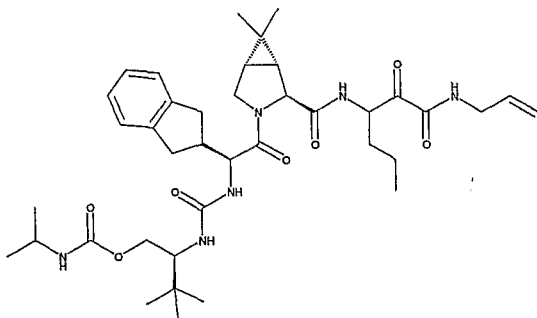
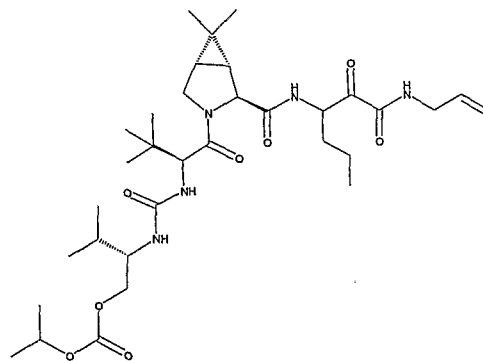
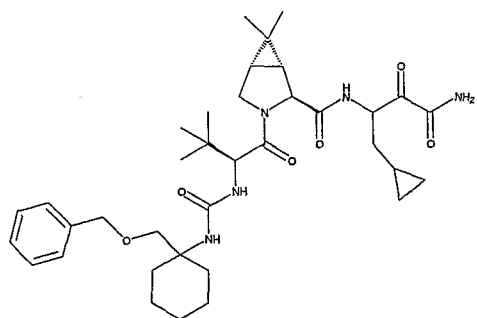
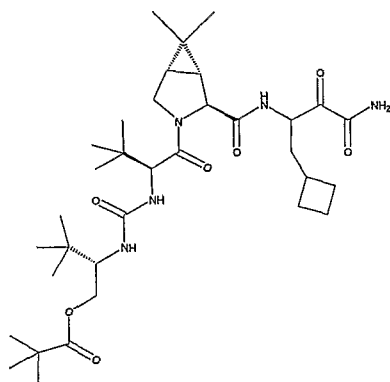
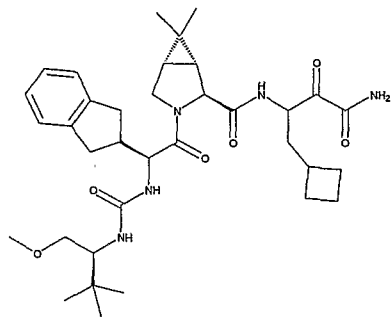
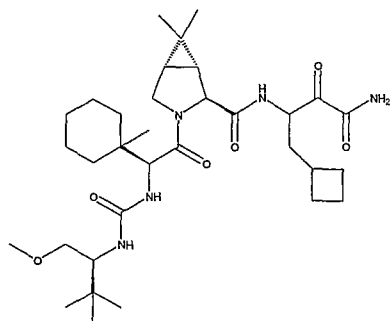
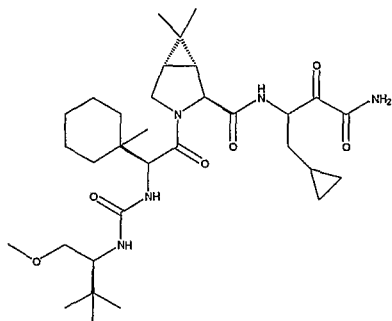


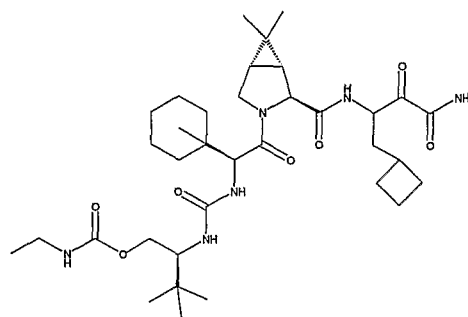
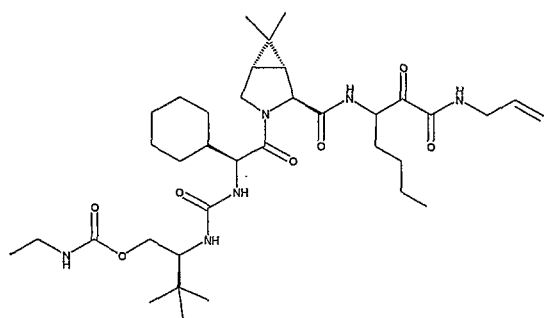
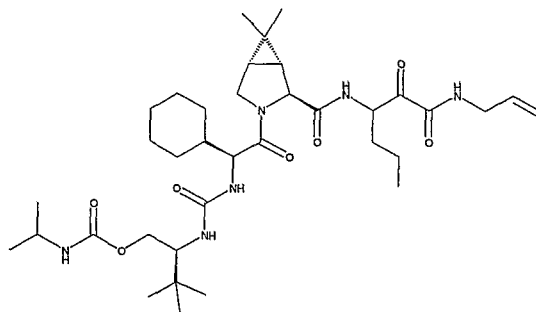
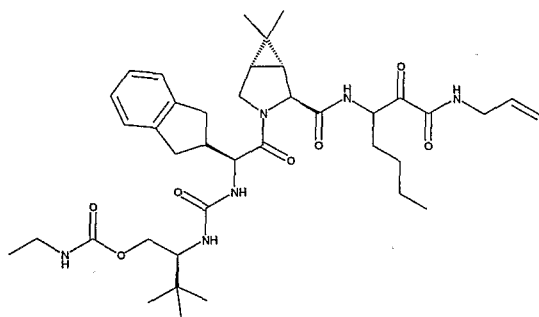
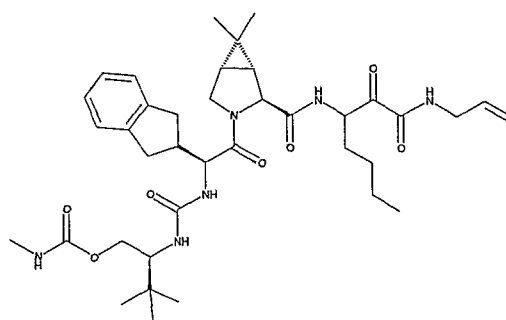
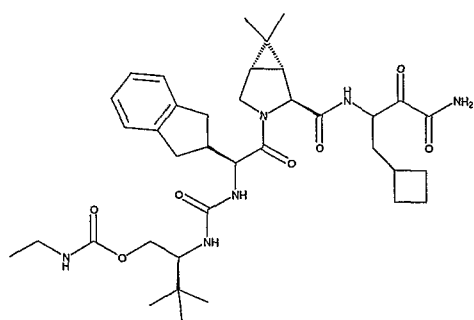
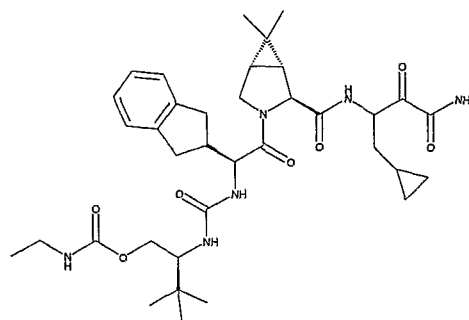
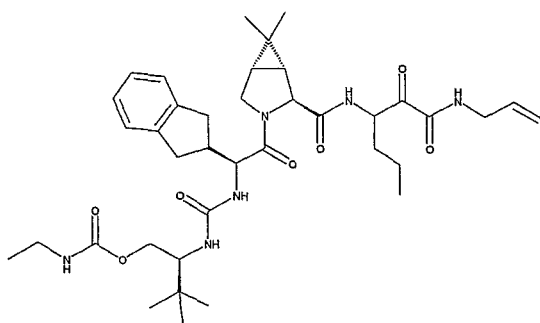


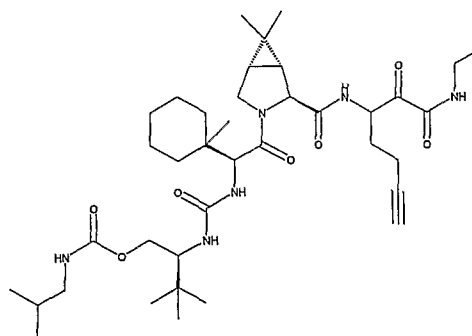
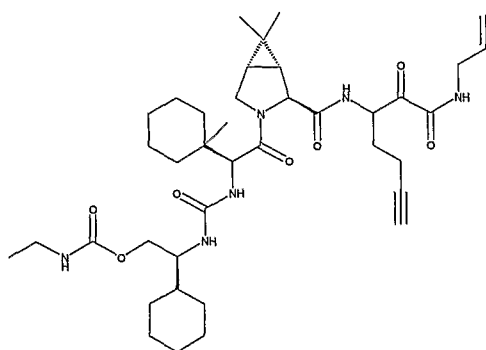
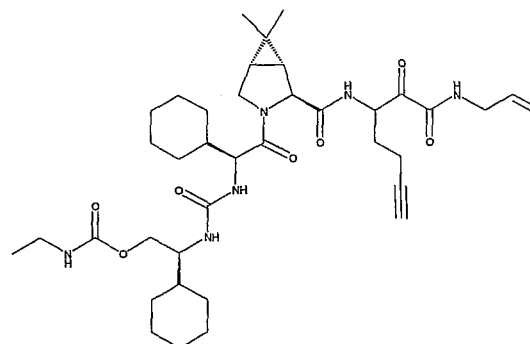
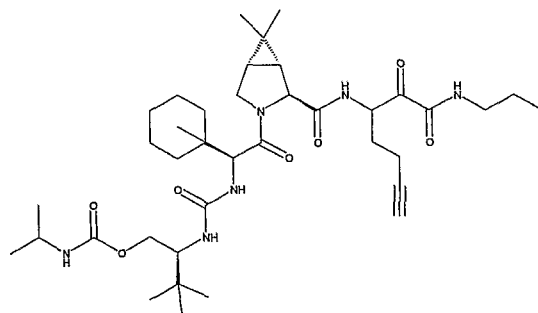
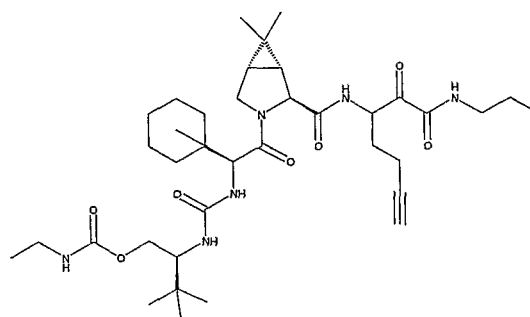
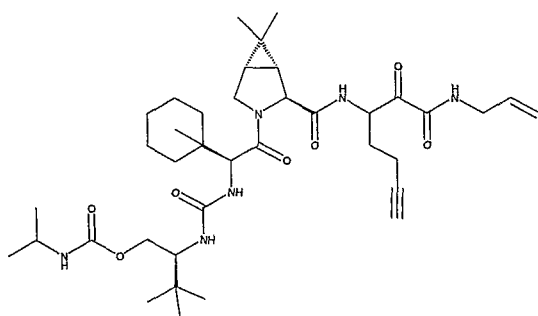
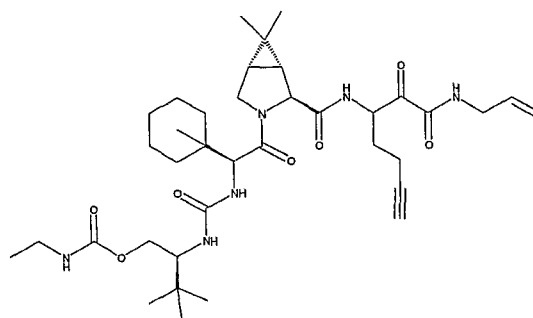
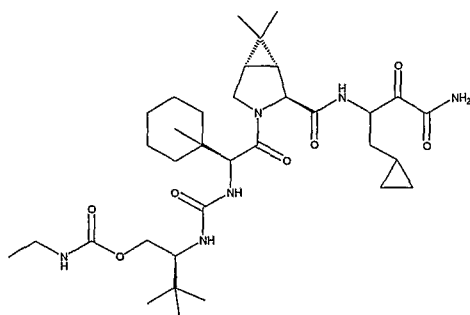


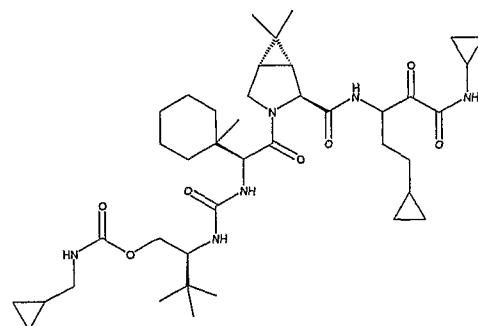
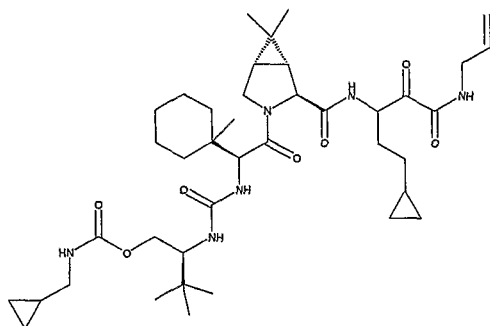
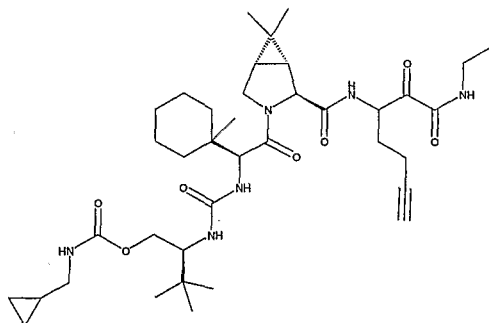
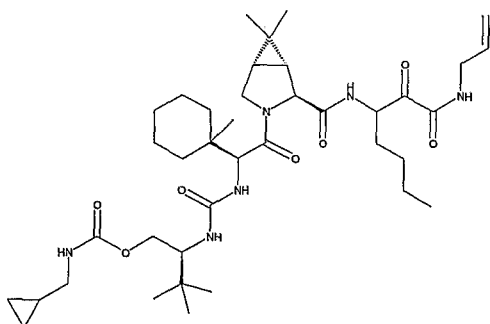
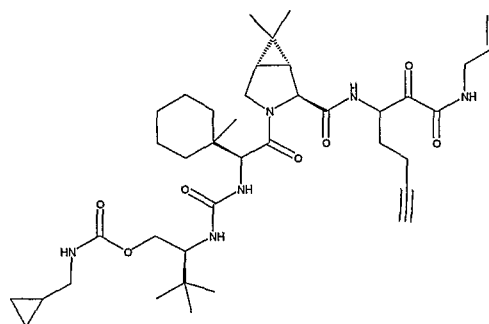
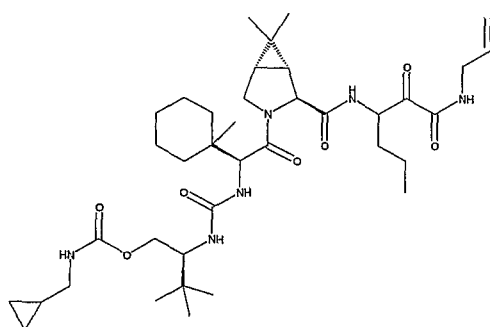
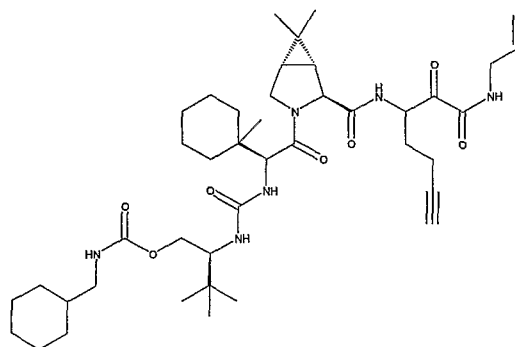
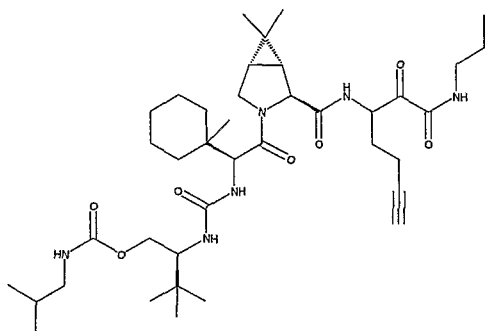
In an additional embodiment, the present invention discloses the following compounds in **Table 5**:

Table 5









As used above, and throughout this disclosure, the following terms, unless otherwise indicated, shall be understood to have the following meanings:

"Patient" includes both human and animals.

5 "Mammal" means humans and other mammalian animals.

"Alkyl" means an aliphatic hydrocarbon group which may be straight or branched and comprising about 1 to about 20 carbon atoms in the chain.

Preferred alkyl groups contain about 1 to about 12 carbon atoms in the chain.

10 More preferred alkyl groups contain about 1 to about 6 carbon atoms in the chain. Branched means that one or more lower alkyl groups such as methyl, ethyl or propyl, are attached to a linear alkyl chain. "Lower alkyl" means a group having about 1 to about 6 carbon atoms in the chain which may be straight or branched. The term "substituted alkyl" means that the alkyl group may be substituted by one or more substituents which may be the same or
15 different, each substituent being independently selected from the group consisting of halo, alkyl, aryl, cycloalkyl, cyano, hydroxy, alkoxy, alkylthio, amino, -NH(alkyl), -NH(cycloalkyl), -N(alkyl)₂, -N(alkyl)₂, carboxy and -C(O)O-alkyl. Non-limiting examples of suitable alkyl groups include methyl, ethyl, n-propyl, isopropyl
20 and t-butyl.

"Alkenyl" means an aliphatic hydrocarbon group containing at least one carbon-carbon double bond and which may be straight or branched and comprising about 2 to about 15 carbon atoms in the chain. Preferred alkenyl groups have about 2 to about 12 carbon atoms in the chain; and more
25 preferably about 2 to about 6 carbon atoms in the chain. Branched means that one or more lower alkyl groups such as methyl, ethyl or propyl, are attached to a linear alkenyl chain. "Lower alkenyl" means about 2 to about 6 carbon atoms in the chain which may be straight or branched. The term "substituted alkenyl" means that the alkenyl group may be substituted by one or more
30 substituents which may be the same or different, each substituent being independently selected from the group consisting of halo, alkyl, aryl, cycloalkyl, cyano, alkoxy and -S(alkyl). Non-limiting examples of suitable alkenyl groups include ethenyl, propenyl, n-butenyl, 3-methylbut-2-enyl, n-pentenyl, octenyl and decenyl.

"Alkynyl" means an aliphatic hydrocarbon group containing at least one carbon-carbon triple bond and which may be straight or branched and comprising about 2 to about 15 carbon atoms in the chain. Preferred alkynyl groups have about 2 to about 12 carbon atoms in the chain; and more preferably about 2 to about 4 carbon atoms in the chain. Branched means that one or more lower alkyl groups such as methyl, ethyl or propyl, are attached to a linear alkynyl chain. "Lower alkynyl" means about 2 to about 6 carbon atoms in the chain which may be straight or branched. Non-limiting examples of suitable alkynyl groups include ethynyl, propynyl, 2-butyne and 3-methylbutynyl. The term "substituted alkynyl" means that the alkynyl group may be substituted by one or more substituents which may be the same or different, each substituent being independently selected from the group consisting of alkyl, aryl and cycloalkyl.

"Aryl" means an aromatic monocyclic or multicyclic ring system comprising about 6 to about 14 carbon atoms, preferably about 6 to about 10 carbon atoms. The aryl group can be optionally substituted with one or more "ring system substituents" which may be the same or different, and are as defined herein. Non-limiting examples of suitable aryl groups include phenyl and naphthyl.

"Heteroaryl" means an aromatic monocyclic or multicyclic ring system comprising about 5 to about 14 ring atoms, preferably about 5 to about 10 ring atoms, in which one or more of the ring atoms is an element other than carbon, for example nitrogen, oxygen or sulfur, alone or in combination. Preferred heteroaryls contain about 5 to about 6 ring atoms. The "heteroaryl" can be optionally substituted by one or more "ring system substituents" which may be the same or different, and are as defined herein. The prefix aza, oxa or thia before the heteroaryl root name means that at least a nitrogen, oxygen or sulfur atom respectively, is present as a ring atom. A nitrogen atom of a heteroaryl can be optionally oxidized to the corresponding N-oxide. Non-limiting examples of suitable heteroaryls include pyridyl, pyrazinyl, furanyl, thienyl, pyrimidinyl, pyridone (including N-substituted pyridones), isoxazolyl, isothiazolyl, oxazolyl, thiazolyl, pyrazolyl, furazanyl, pyrrolyl, pyrazolyl, triazolyl, 1,2,4-thiadiazolyl, pyrazinyl, pyridazinyl, quinoxalyl, phthalazinyl, oxindolyl, imidazo[1,2-a]pyridinyl, imidazo[2,1-b]thiazolyl, benzofurazanyl,

indolyl, azaindolyl, benzimidazolyl, benzothienyl, quinolinyl, imidazolyl, thienopyridyl, quinazolinyl, thienopyrimidyl, pyrrolopyridyl, imidazopyridyl, isoquinolinyl, benzoazaindolyl, 1,2,4-triazinyl, benzothiazolyl and the like. The term "heteroaryl" also refers to partially saturated heteroaryl moieties such as, for example, tetrahydroisoquinolyl, tetrahydroquinolyl and the like.

"Aralkyl" or "arylalkyl" means an aryl-alkyl- group in which the aryl and alkyl are as previously described. Preferred aralkyls comprise a lower alkyl group. Non-limiting examples of suitable aralkyl groups include benzyl, 2-phenethyl and naphthalenylmethyl. The bond to the parent moiety is through the alkyl.

"Alkylaryl" means an alkyl-aryl- group in which the alkyl and aryl are as previously described. Preferred alkylaryls comprise a lower alkyl group. Non-limiting example of a suitable alkylaryl group is tolyl. The bond to the parent moiety is through the aryl.

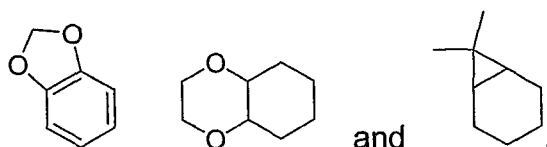
"Cycloalkyl" means a non-aromatic mono- or multicyclic ring system comprising about 3 to about 10 carbon atoms, preferably about 5 to about 10 carbon atoms. Preferred cycloalkyl rings contain about 5 to about 7 ring atoms. The cycloalkyl can be optionally substituted with one or more "ring system substituents" which may be the same or different, and are as defined above. Non-limiting examples of suitable monocyclic cycloalkyls include cyclopropyl, cyclopentyl, cyclohexyl, cycloheptyl and the like. Non-limiting examples of suitable multicyclic cycloalkyls include 1-decalinyl, norbornyl, adamantyl and the like, as well as partially saturated species such as, for example, indanyl, tetrahydronaphthyl and the like.

"Halogen" or "halo" means fluorine, chlorine, bromine, or iodine. Preferred are fluorine, chlorine and bromine.

"Ring system substituent" means a substituent attached to an aromatic or non-aromatic ring system which, for example, replaces an available hydrogen on the ring system. Ring system substituents may be the same or different, each being independently selected from the group consisting of alkyl, alkenyl, alkynyl, aryl, heteroaryl, aralkyl, alkylaryl, heteroaralkyl, heteroarylalkenyl, heteroarylalkynyl, alkylheteroaryl, hydroxy, hydroxyalkyl, alkoxy, aryloxy, aralkoxy, acyl, aroyl, halo, nitro, cyano, carboxy, alkoxycarbonyl, aryloxycarbonyl, aralkoxycarbonyl, alkylsulfonyl, arylsulfonyl,

heteroarylsulfonyl, alkylthio, arylthio, heteroarylthio, aralkylthio, heteroaralkylthio, cycloalkyl, heterocyclyl, $-C(=N-CN)-NH_2$, $-C(=NH)-NH_2$, $-C(=NH)-NH(alkyl)$, Y_1Y_2N- , $Y_1Y_2N-alkyl-$, $Y_1Y_2NC(O)-$, $Y_1Y_2NSO_2-$ and $-SO_2NY_1Y_2$, wherein Y_1 and Y_2 can be the same or different and are

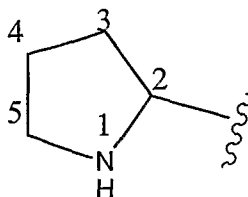
- 5 independently selected from the group consisting of hydrogen, alkyl, aryl, cycloalkyl, and aralkyl. "Ring system substituent" may also mean a single moiety which simultaneously replaces two available hydrogens on two adjacent carbon atoms (one H on each carbon) on a ring system. Examples of such moiety are methylene dioxy, ethylenedioxy, $-C(CH_3)_2-$ and the like which
- 10 form moieties such as, for example:



- "Heterocyclyl" means a non-aromatic saturated monocyclic or multicyclic ring system comprising about 3 to about 10 ring atoms, preferably about 5 to about 10 ring atoms, in which one or more of the atoms in the ring
- 15 system is an element other than carbon, for example nitrogen, oxygen or sulfur, alone or in combination. There are no adjacent oxygen and/or sulfur atoms present in the ring system. Preferred heterocyclyls contain about 5 to about 6 ring atoms. The prefix aza, oxa or thia before the heterocyclyl root name means that at least a nitrogen, oxygen or sulfur atom respectively is
- 20 present as a ring atom. Any $-NH$ in a heterocyclyl ring may exist protected such as, for example, as an $-N(Boc)$, $-N(CBz)$, $-N(Tos)$ group and the like; such protections are also considered part of this invention. The heterocyclyl can be optionally substituted by one or more "ring system substituents" which may be the same or different, and are as defined herein. The nitrogen or
- 25 sulfur atom of the heterocyclyl can be optionally oxidized to the corresponding N-oxide, S-oxide or S,S-dioxide. Non-limiting examples of suitable monocyclic heterocyclyl rings include piperidyl, pyrrolidinyl, piperazinyl, morpholinyl, thiomorpholinyl, thiazolidinyl, 1,4-dioxanyl, tetrahydrofuranyl, tetrahydrothiophenyl, lactam, lactone, and the like.

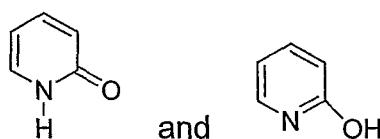
- 30 It should be noted that in hetero-atom containing ring systems of this invention, there are no hydroxyl groups on carbon atoms adjacent to a N, O or

S, as well as there are no N or S groups on carbon adjacent to another heteroatom. Thus, for example, in the ring:



there is no -OH attached directly to carbons marked 2 and 5.

- 5 It should also be noted that tautomeric forms such as, for example, the moieties:



are considered equivalent in certain embodiments of this invention.

- 10 "Alkynylalkyl" means an alkynyl-alkyl- group in which the alkynyl and alkyl are as previously described. Preferred alkynylalkyls contain a lower alkynyl and a lower alkyl group. The bond to the parent moiety is through the alkyl. Non-limiting examples of suitable alkynylalkyl groups include propargylmethyl.

- 15 "Heteroaralkyl" means a heteroaryl-alkyl- group in which the heteroaryl and alkyl are as previously described. Preferred heteroaralkyls contain a lower alkyl group. Non-limiting examples of suitable aralkyl groups include pyridylmethyl, and quinolin-3-ylmethyl. The bond to the parent moiety is through the alkyl.

- 20 "Hydroxyalkyl" means a HO-alkyl- group in which alkyl is as previously defined. Preferred hydroxyalkyls contain lower alkyl. Non-limiting examples of suitable hydroxyalkyl groups include hydroxymethyl and 2-hydroxyethyl.

- 25 "Acyl" means an H-C(O)-, alkyl-C(O)- or cycloalkyl-C(O)-, group in which the various groups are as previously described. The bond to the parent moiety is through the carbonyl. Preferred acyls contain a lower alkyl. Non-limiting examples of suitable acyl groups include formyl, acetyl and propanoyl.

"Aroyl" means an aryl-C(O)- group in which the aryl group is as previously described. The bond to the parent moiety is through the carbonyl. Non-limiting examples of suitable groups include benzoyl and 1-naphthoyl.

"Alkoxy" means an alkyl-O- group in which the alkyl group is as previously described. Non-limiting examples of suitable alkoxy groups include methoxy, ethoxy, n-propoxy, isopropoxy and n-butoxy. The bond to the parent moiety is through the ether oxygen.

5 "Aryloxy" means an aryl-O- group in which the aryl group is as previously described. Non-limiting examples of suitable aryloxy groups include phenoxy and naphthoxy. The bond to the parent moiety is through the ether oxygen.

10 "Aralkyloxy" means an aralkyl-O- group in which the aralkyl group is as previously described. Non-limiting examples of suitable aralkyloxy groups include benzyloxy and 1- or 2-naphthalenemethoxy. The bond to the parent moiety is through the ether oxygen.

"Alkylthio" means an alkyl-S- group in which the alkyl group is as previously described. Non-limiting examples of suitable alkylthio groups
15 include methylthio and ethylthio. The bond to the parent moiety is through the sulfur.

"Arylthio" means an aryl-S- group in which the aryl group is as previously described. Non-limiting examples of suitable arylthio groups include phenylthio and naphthylthio. The bond to the parent moiety is through
20 the sulfur.

"Aralkylthio" means an aralkyl-S- group in which the aralkyl group is as previously described. Non-limiting example of a suitable aralkylthio group is benzylthio. The bond to the parent moiety is through the sulfur.

"Alkoxycarbonyl" means an alkyl-O-CO- group. Non-limiting examples
25 of suitable alkoxycarbonyl groups include methoxycarbonyl and ethoxycarbonyl. The bond to the parent moiety is through the carbonyl.

"Aryloxycarbonyl" means an aryl-O-C(O)- group. Non-limiting examples of suitable aryloxycarbonyl groups include phenoxycarbonyl and naphthoxycarbonyl. The bond to the parent moiety is through the carbonyl.

30 "Aralkoxycarbonyl" means an aralkyl-O-C(O)- group. Non-limiting example of a suitable aralkoxycarbonyl group is benzyloxycarbonyl. The bond to the parent moiety is through the carbonyl.

"Alkylsulfonyl" means an alkyl-S(O₂)- group. Preferred groups are those in which the alkyl group is lower alkyl. The bond to the parent moiety is through the sulfonyl.

5 "Arylsulfonyl" means an aryl-S(O₂)- group. The bond to the parent moiety is through the sulfonyl.

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

15 The term "one or more" or "at least one", when indicating the number of substituents, compounds, combination agents and the like, refers to at least one, and up to the maximum number of chemically and physically permissible, substituents, compounds, combination agents and the like, that are present or added, depending on the context. Such techniques and knowledge are well
20 known within the skills of the concerned artisan.

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

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

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

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

When any variable (e.g., aryl, heterocycle, R^2 , etc.) occurs more than one time in any constituent or in Formula 1, its definition on each occurrence is independent of its definition at every other occurrence.

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

Prodrugs and solvates of the compounds of the invention are also contemplated herein. The term "prodrug", as employed herein, denotes a compound that is a drug precursor which, upon administration to a subject, undergoes chemical conversion by metabolic or chemical processes to yield a compound of Formula 1 or a salt and/or solvate thereof. A discussion of prodrugs is provided in T. Higuchi and V. Stella, *Pro-drugs as Novel Delivery Systems* (1987) 14 of the A.C.S. Symposium Series, and in *Bioreversible Carriers in Drug Design*, (1987) Edward B. Roche, ed., American Pharmaceutical Association and Pergamon Press, both of which are incorporated herein by reference thereto.

"Solvate" means a physical association of a compound of this invention with one or more solvent molecules. This physical association involves varying degrees of ionic and covalent bonding, including hydrogen bonding. In certain instances the solvate will be capable of isolation, for example when one or more solvent molecules are incorporated in the crystal lattice of the crystalline solid. "Solvate" encompasses both solution-phase and isolatable solvates. Non-limiting examples of suitable solvates include ethanolates, methanolates, and the like. "Hydrate" is a solvate wherein the solvent molecule is H_2O .

"Effective amount" or "therapeutically effective amount" is meant to describe an amount of compound or a composition of the present invention effective in inhibiting the CDK(s) and thus producing the desired therapeutic, ameliorative, inhibitory or preventative effect.

5 The compounds of Formula 1 can form salts which are also within the scope of this invention. Reference to a compound of Formula 1 herein is understood to include reference to salts thereof, unless otherwise indicated. The term "salt(s)", as employed herein, denotes acidic salts formed with inorganic and/or organic acids, as well as basic salts formed with inorganic
10 and/or organic bases. In addition, when a compound of Formula 1 contains both a basic moiety, such as, but not limited to a pyridine or imidazole, and an acidic moiety, such as, but not limited to a carboxylic acid, zwitterions ("inner salts") may be formed and are included within the term "salt(s)" as used herein. Pharmaceutically acceptable (i.e., non-toxic, physiologically
15 acceptable) salts are preferred, although other salts are also useful. Salts of the compounds of the Formula 1 may be formed, for example, by reacting a compound of Formula 1 with an amount of acid or base, such as an equivalent amount, in a medium such as one in which the salt precipitates or in an aqueous medium followed by lyophilization.

20 Exemplary acid addition salts include acetates, ascorbates, benzoates, benzenesulfonates, bisulfates, borates, butyrates, citrates, camphorates, camphorsulfonates, fumarates, hydrochlorides, hydrobromides, hydroiodides, lactates, maleates, methanesulfonates, naphthalenesulfonates, nitrates, oxalates, phosphates, propionates, salicylates, succinates, sulfates,
25 tartarates, thiocyanates, toluenesulfonates (also known as tosylates,) and the like. Additionally, acids which are generally considered suitable for the formation of pharmaceutically useful salts from basic pharmaceutical compounds are discussed, for example, by P. Stahl *et al*, Camille G. (eds.) *Handbook of Pharmaceutical Salts. Properties, Selection and Use*. (2002)
30 Zurich: Wiley-VCH; S. Berge *et al*, *Journal of Pharmaceutical Sciences* (1977) 66(1) 1-19; P. Gould, *International J. of Pharmaceutics* (1986) 33 201-217; Anderson *et al*, *The Practice of Medicinal Chemistry* (1996), Academic Press, New York; and in *The Orange Book* (Food & Drug Administration,

Washington, D.C. on their website). These disclosures are incorporated herein by reference thereto.

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

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

Pharmaceutically acceptable esters of the present compounds include the following groups: (1) carboxylic acid esters obtained by esterification of the hydroxy groups, in which the non-carbonyl moiety of the carboxylic acid portion of the ester grouping is selected from straight or branched chain alkyl (for example, acetyl, n-propyl, t-butyl, or n-butyl), alkoxyalkyl (for example, methoxymethyl), aralkyl (for example, benzyl), aryloxyalkyl (for example, phenoxymethyl), aryl (for example, phenyl optionally substituted with, for example, halogen, C₁₋₄alkyl, or C₁₋₄alkoxy or amino); (2) sulfonate esters, such as alkyl- or aralkylsulfonyl (for example, methanesulfonyl); (3) amino acid esters (for example, L-valyl or L-isoleucyl); (4) phosphonate esters and (5) mono-, di- or triphosphate esters. The phosphate esters may be further esterified by, for example, a C₁₋₂₀ alcohol or reactive derivative thereof, or by a 2,3-di (C₆₋₂₄)acyl glycerol.

Compounds of Formula 1, and salts, solvates, esters and prodrugs thereof, may exist in their tautomeric form (for example, as an amide or imino ether). All such tautomeric forms are contemplated herein as part of the present invention.

All stereoisomers (for example, geometric isomers, optical isomers, and the like) of the present compounds (including those of the salts, solvates and prodrugs of the compounds as well as the salts and solvates of the prodrugs), such as those which may exist due to asymmetric carbons on

5 various substituents, including enantiomeric forms (which may exist even in the absence of asymmetric carbons), rotameric forms, atropisomers, and diastereomeric forms, are contemplated within the scope of this invention, as are positional isomers (such as, for example, 4-pyridyl and 3-pyridyl).

Individual stereoisomers of the compounds of the invention may, for example,

10 be substantially free of other isomers, or may be admixed, for example, as racemates or with all other, or other selected, stereoisomers. The chiral centers of the present invention can have the S or R configuration as defined by the *IUPAC* 1974 Recommendations. The use of the terms "salt", "solvate" "prodrug" and the like, is intended to equally apply to the salt, solvate and

15 prodrug of enantiomers, stereoisomers, rotamers, tautomers, positional isomers, racemates or prodrugs of the inventive compounds.

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

20 It is to be understood that the utility of the compounds of Formula 1 for the therapeutic applications discussed herein is applicable to each compound by itself or to the combination or combinations of one or more compounds of Formula 1 as illustrated, for example, in the next immediate paragraph. The same understanding also applies to pharmaceutical composition(s)

25 comprising such compound or compounds and method(s) of treatment involving such compound or compounds.

The compounds according to the invention can have pharmacological properties; in particular, the compounds of Formula 1 can be inhibitors of HCV protease, each compound by itself or one or more compounds of Formula 1

30 can be combined with one or more compounds selected from within Formula 1. The compound(s) can be useful for treating diseases such as, for example, HCV, HIV, (AIDS, Acquired Immune Deficiency Syndrome), and related disorders, as well as for modulating the activity of hepatitis C virus (HCV)

protease, preventing HCV, or ameliorating one or more symptoms of hepatitis C.

The compounds of Formula 1 may be used for the manufacture of a medicament to treat disorders associated with the HCV protease, for example, the method comprising bringing into intimate contact a compound of Formula 1 and a pharmaceutically acceptable carrier.

In another embodiment, this invention provides pharmaceutical compositions comprising the inventive compound or compounds as an active ingredient. The pharmaceutical compositions generally additionally comprise at least one pharmaceutically acceptable carrier diluent, excipient or carrier (collectively referred to herein as carrier materials). Because of their HCV inhibitory activity, such pharmaceutical compositions possess utility in treating hepatitis C and related disorders.

In yet another embodiment, the present invention discloses methods for preparing pharmaceutical compositions comprising the inventive compounds as an active ingredient. In the pharmaceutical compositions and methods of the present invention, the active ingredients will typically be administered in admixture with suitable carrier materials suitably selected with respect to the intended form of administration, i.e. oral tablets, capsules (either solid-filled, semi-solid filled or liquid filled), powders for constitution, oral gels, elixirs, dispersible granules, syrups, suspensions, and the like, and consistent with conventional pharmaceutical practices. For example, for oral administration in the form of tablets or capsules, the active drug component may be combined with any oral non-toxic pharmaceutically acceptable inert carrier, such as lactose, starch, sucrose, cellulose, magnesium stearate, dicalcium phosphate, calcium sulfate, talc, mannitol, ethyl alcohol (liquid forms) and the like. Moreover, when desired or needed, suitable binders, lubricants, disintegrating agents and coloring agents may also be incorporated in the mixture. Powders and tablets may be comprised of from about 5 to about 95 percent inventive composition.

Suitable binders include starch, gelatin, natural sugars, corn sweeteners, natural and synthetic gums such as acacia, sodium alginate, carboxymethylcellulose, polyethylene glycol and waxes. Among the lubricants there may be mentioned for use in these dosage forms, boric acid, sodium

benzoate, sodium acetate, sodium chloride, and the like. Disintegrants include starch, methylcellulose, guar gum and the like.

Sweetening and flavoring agents and preservatives may also be included where appropriate. Some of the terms noted above, namely
5 disintegrants, diluents, lubricants, binders and the like, are discussed in more detail below.

Additionally, the compositions of the present invention may be formulated in sustained release form to provide the rate controlled release of any one or more of the components or active ingredients to optimize the
10 therapeutic effects, i.e. HCV inhibitory activity and the like. Suitable dosage forms for sustained release include layered tablets containing layers of varying disintegration rates or controlled release polymeric matrices impregnated with the active components and shaped in tablet form or capsules containing such impregnated or encapsulated porous polymeric
15 matrices.

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

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

For preparing suppositories, a low melting wax such as a mixture of
25 fatty acid glycerides such as cocoa butter is first melted, and the active ingredient is dispersed homogeneously therein by stirring or similar mixing. The molten homogeneous mixture is then poured into convenient sized molds, allowed to cool and thereby solidify.

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

The compounds of the invention may also be deliverable transdermally. The transdermal compositions may take the form of creams, lotions, aerosols

and/or emulsions and can be included in a transdermal patch of the matrix or reservoir type as are conventional in the art for this purpose.

The compounds of the invention may also be administered orally, intravenously, intranasally or subcutaneously.

5 The compounds of the invention may also comprise preparations which are in a unit dosage form. In such form, the preparation is subdivided into suitably sized unit doses containing appropriate quantities of the active components, e.g., an effective amount to achieve the desired purpose.

10 The quantity of the inventive active composition in a unit dose of preparation may be generally varied or adjusted from about 1.0 milligram to about 1,000 milligrams, preferably from about 1.0 to about 950 milligrams, more preferably from about 1.0 to about 500 milligrams, and typically from about 1 to about 250 milligrams, according to the particular application. The actual dosage employed may be varied depending upon the patient's age,
15 sex, weight and severity of the condition being treated. Such techniques are well known to those skilled in the art.

Generally, the human oral dosage form containing the active ingredients can be administered 1 or 2 times per day. The amount and frequency of the administration will be regulated according to the judgment of
20 the attending clinician. A generally recommended daily dosage regimen for oral administration may range from about 1.0 milligram to about 1,000 milligrams per day, in single or divided doses.

Some useful terms are described below:

25 Capsule - refers to a special container or enclosure made of methyl cellulose, polyvinyl alcohols, or denatured gelatins or starch for holding or containing compositions comprising the active ingredients. Hard shell capsules are typically made of blends of relatively high gel strength bone and pork skin gelatins. The capsule itself may contain small amounts of dyes, opaquing agents, plasticizers and preservatives.

30 Tablet- refers to a compressed or molded solid dosage form containing the active ingredients with suitable diluents. The tablet can be prepared by compression of mixtures or granulations obtained by wet granulation, dry granulation or by compaction.

Oral gel- refers to the active ingredients dispersed or solubilized in a hydrophilic semi-solid matrix.

Powder for constitution refers to powder blends containing the active ingredients and suitable diluents which can be suspended in water or juices.

5 Diluent - refers to substances that usually make up the major portion of the composition or dosage form. Suitable diluents include sugars such as lactose, sucrose, mannitol and sorbitol; starches derived from wheat, corn, rice and potato; and celluloses such as microcrystalline cellulose. The amount of diluent in the composition can range from about 10 to about 90% by weight
10 of the total composition, preferably from about 25 to about 75%, more preferably from about 30 to about 60% by weight, even more preferably from about 12 to about 60%.

Disintegrant - refers to materials added to the composition to help it break apart (disintegrate) and release the medicaments. Suitable
15 disintegrants include starches; "cold water soluble" modified starches such as sodium carboxymethyl starch; natural and synthetic gums such as locust bean, karaya, guar, tragacanth and agar; cellulose derivatives such as methylcellulose and sodium carboxymethylcellulose; microcrystalline celluloses and cross-linked microcrystalline celluloses such as sodium
20 croscarmellose; alginates such as alginic acid and sodium alginate; clays such as bentonites; and effervescent mixtures. The amount of disintegrant in the composition can range from about 2 to about 15% by weight of the composition, more preferably from about 4 to about 10% by weight.

Binder - refers to substances that bind or "glue" powders together and
25 make them cohesive by forming granules, thus serving as the "adhesive" in the formulation. Binders add cohesive strength already available in the diluent or bulking agent. Suitable binders include sugars such as sucrose; starches derived from wheat, corn rice and potato; natural gums such as acacia, gelatin and tragacanth; derivatives of seaweed such as alginic acid, sodium
30 alginate and ammonium calcium alginate; cellulosic materials such as methylcellulose and sodium carboxymethylcellulose and hydroxypropylmethylcellulose; polyvinylpyrrolidone; and inorganics such as magnesium aluminum silicate. The amount of binder in the composition can range from about 2 to about 20% by weight of the composition, more

preferably from about 3 to about 10% by weight, even more preferably from about 3 to about 6% by weight.

Lubricant - refers to a substance added to the dosage form to enable the tablet, granules, etc. after it has been compressed, to release from the mold or die by reducing friction or wear. Suitable lubricants include metallic stearates such as magnesium stearate, calcium stearate or potassium stearate; stearic acid; high melting point waxes; and water soluble lubricants such as sodium chloride, sodium benzoate, sodium acetate, sodium oleate, polyethylene glycols and d'l-leucine. Lubricants are usually added at the very last step before compression, since they must be present on the surfaces of the granules and in between them and the parts of the tablet press. The amount of lubricant in the composition can range from about 0.2 to about 5% by weight of the composition, preferably from about 0.5 to about 2%, more preferably from about 0.3 to about 1.5% by weight.

Glident - material that prevents caking and improve the flow characteristics of granulations, so that flow is smooth and uniform. Suitable glidents include silicon dioxide and talc. The amount of glident in the composition can range from about 0.1% to about 5% by weight of the total composition, preferably from about 0.5 to about 2% by weight.

Coloring agents - excipients that provide coloration to the composition or the dosage form. Such excipients can include food grade dyes and food grade dyes adsorbed onto a suitable adsorbent such as clay or aluminum oxide. The amount of the coloring agent can vary from about 0.1 to about 5% by weight of the composition, preferably from about 0.1 to about 1%.

Bioavailability - refers to the rate and extent to which the active drug ingredient or therapeutic moiety is absorbed into the systemic circulation from an administered dosage form as compared to a standard or control.

Conventional methods for preparing tablets are known. Such methods include dry methods such as direct compression and compression of granulation produced by compaction, or wet methods or other special procedures. Conventional methods for making other forms for administration such as, for example, capsules, suppositories and the like are also well known.

Another embodiment of the invention discloses the use of the inventive compounds or pharmaceutical compositions disclosed above for treatment of diseases such as, for example, hepatitis C and the like. The method comprises administering a therapeutically effective amount of the inventive compound or pharmaceutical composition to a patient having such a disease or diseases and in need of such a treatment.

In yet another embodiment, the compounds of the invention may be used for the treatment of HCV in humans in monotherapy mode or in a combination therapy (e.g., dual combination, triple combination etc.) mode such as, for example, in combination with antiviral and/or immunomodulatory agents. Examples of such antiviral and/or immunomodulatory agents include Ribavirin (from Schering-Plough Corporation, Madison, New Jersey) and LevovirinTM (from ICN Pharmaceuticals, Costa Mesa, California), VP 50406TM (from Viropharma, Incorporated, Exton, Pennsylvania), ISIS 14803TM (from ISIS Pharmaceuticals, Carlsbad, California), HeptazymeTM (from Ribozyme Pharmaceuticals, Boulder, Colorado), VX 497TM (from Vertex Pharmaceuticals, Cambridge, Massachusetts), ThymosinTM (from SciClone Pharmaceuticals, San Mateo, California), MaxamineTM (Maxim Pharmaceuticals, San Diego, California), mycophenolate mofetil (from Hoffman-LaRoche, Nutley, New Jersey), interferon (such as, for example, interferon-alpha, PEG-interferon alpha conjugates) and the like. "PEG-interferon alpha conjugates" are interferon alpha molecules covalently attached to a PEG molecule. Illustrative PEG-interferon alpha conjugates include interferon alpha-2a (RoferonTM, from Hoffman La-Roche, Nutley, New Jersey) in the form of pegylated interferon alpha-2a (e.g., as sold under the trade name PegasysTM), interferon alpha-2b (IntronTM, from Schering-Plough Corporation) in the form of pegylated interferon alpha-2b (e.g., as sold under the trade name PEG-IntronTM), interferon alpha-2c (Berofer AlphaTM, from Boehringer Ingelheim, Ingelheim, Germany) or consensus interferon as defined by determination of a consensus sequence of naturally occurring interferon alphas (InfergenTM, from Amgen, Thousand Oaks, California).

As stated earlier, the invention includes tautomers, rotamers, enantiomers and other stereoisomers of the inventive compounds also. Thus, as one skilled in the art appreciates, some of the inventive compounds may

exist in suitable isomeric forms. Such variations are contemplated to be within the scope of the invention.

Another embodiment of the invention discloses a method of making the compounds disclosed herein. The compounds may be prepared by several techniques known in the art. Illustrative procedures are outlined in the following reaction schemes. The illustrations should not be construed to limit the scope of the invention which is defined in the appended claims. Alternative mechanistic pathways and analogous structures will be apparent to those skilled in the art.

It is to be understood that while the following illustrative schemes describe the preparation of a few representative inventive compounds, suitable substitution of any of both the natural and unnatural amino acids will result in the formation of the desired compounds based on such substitution. Such variations are contemplated to be within the scope of the invention.

For the procedures described below, the following abbreviations are used:

Abbreviations

Abbreviations which are used in the descriptions of the schemes, preparations and the examples that follow are:

THF: Tetrahydrofuran

DMF: N,N-Dimethylformamide

EtOAc: Ethyl acetate

AcOH: Acetic acid

HOOBt: 3-Hydroxy-1,2,3-benzotriazin-4(3H)-one

EDCI: 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride

NMM: N-Methylmorpholine

ADDP: 1,1'-(Azodicarbonyl)dipiperidine

DEAD: Diethylazodicarboxylate

MeOH: Methanol

EtOH: Ethanol

Et₂O: Diethyl ether

DMSO: Dimethylsulfoxide

HOBt: N-Hydroxybenzotriazole

PyBrOP: Bromo-tris-pyrrolidinophosphonium hexafluorophosphate

DCM: Dichloromethane

DCC: 1,3-Dicyclohexylcarbodiimide

TEMPO: 2,2,6,6-Tetramethyl-1-piperidinyloxy

5 Phg: Phenylglycine

Chg: Cyclohexylglycine

Bn: Benzyl

Bzl: Benzyl

Et: Ethyl

10 Ph: Phenyl

iBoc: isobutoxycarbonyl

iPr: isopropyl

^tBu or Bu^t: tert-Butyl

Boc: tert-Butyloxycarbonyl

15 Cbz: Benzyloxycarbonyl

Cp: Cyclopentylidenyl

Ts: p-toluenesulfonyl

Me: Methyl

HATU: O-(7-azabenzotriazol-1-yl)-1,1,3,3-tetramethyluronium

20 hexafluorophosphate

DMAP: 4-N,N-Dimethylaminopyridine

BOP: Benzotriazol-1-yl-oxy-tris(dimethylamino)hexafluorophosphate

PCC: Pyridiniumchlorochromate

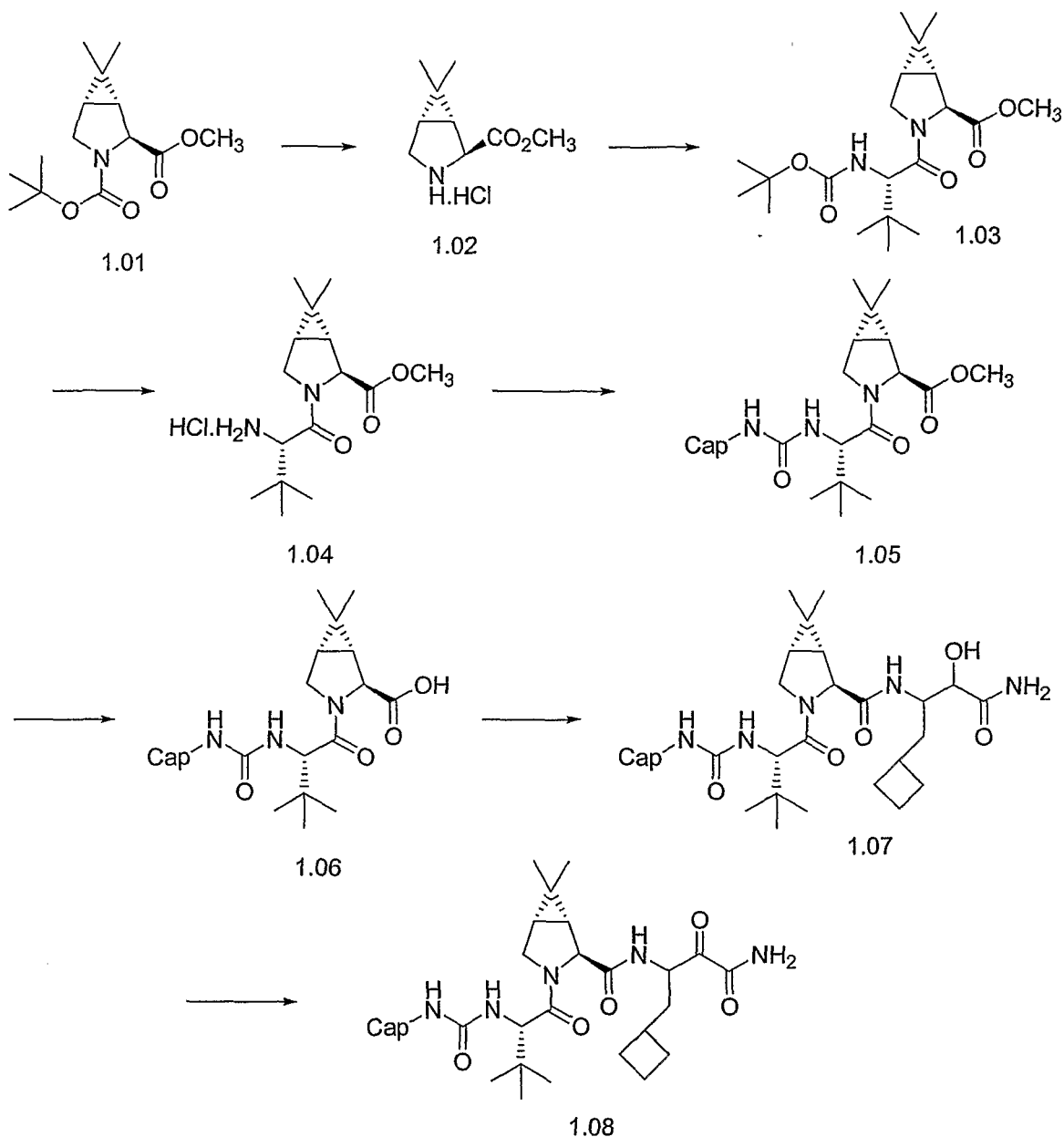
25 **General Schemes for Preparation of Target Compounds**

Compounds of the present invention were synthesized using the general schemes (Methods A-E) described below.

Method A:

30 Deprotection of the N-Boc functionality of 1.01 under acidic conditions provided the hydrochloride salt 1.02 which was subsequently coupled with N-Boc-tert-leucine under peptide coupling methodology to afford 1.03. N-Boc deprotection followed by treatment with appropriate isocyanate gave the urea 1.05. Hydrolysis of the methyl ester provided the acid 1.06. Peptide coupling

of the acid 1.06 with the appropriate P₁-P' primary amide moiety afforded the hydroxyl amide 1.07. Oxidation (Moffatt or related process - T.T.Tidwell, *Synthesis*, **1990**, 857; or Dess-Martin's - *J. Org. Chem.*, **1983**, 48, 4155) resulted in the target compound 1.08.

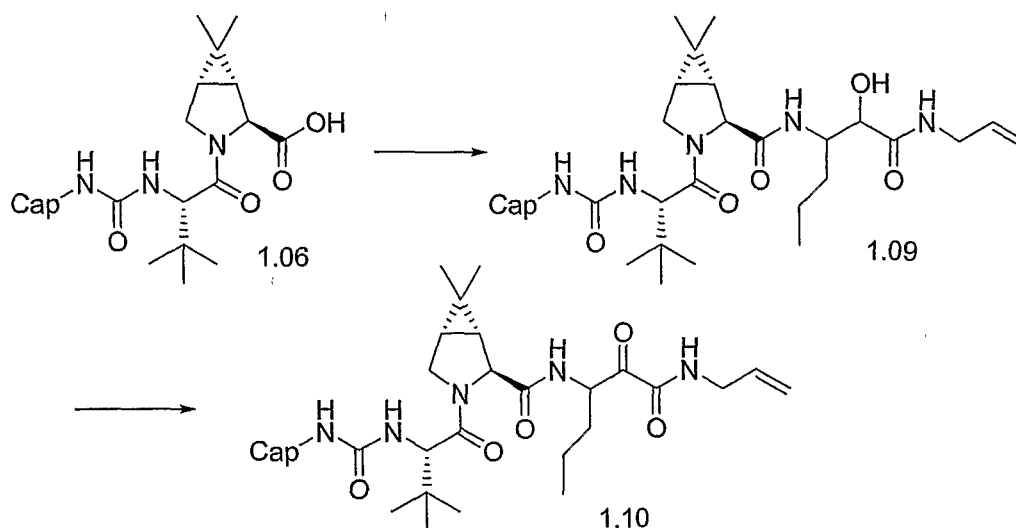


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Method B

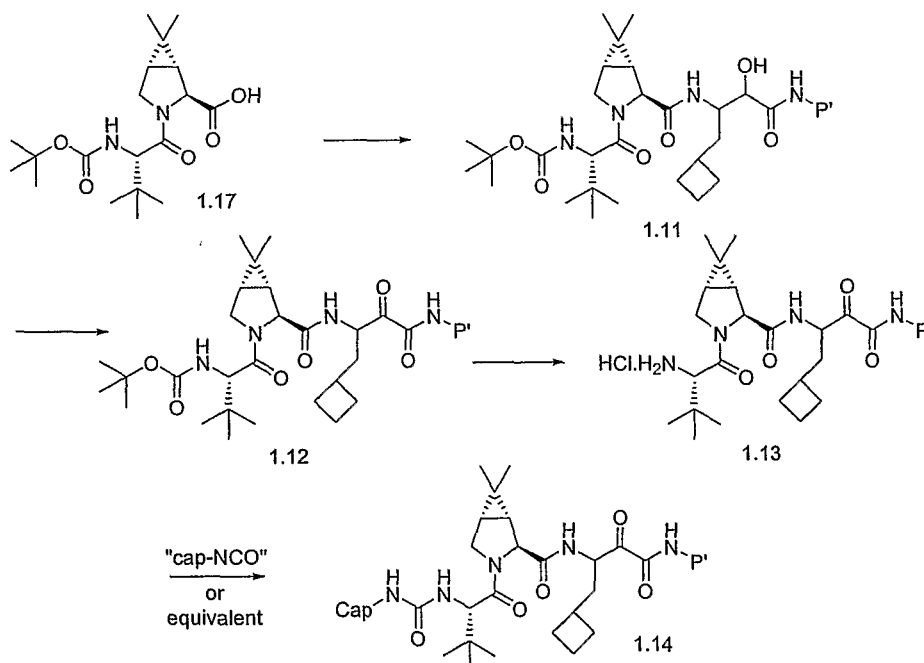
Peptide coupling of the acid 1.06 with the appropriate P₁-P' secondary amide moiety afforded the hydroxyl amide 1.09. Oxidation (Moffatt or Dess-Martin's) resulted in the target compound 1.10.

10



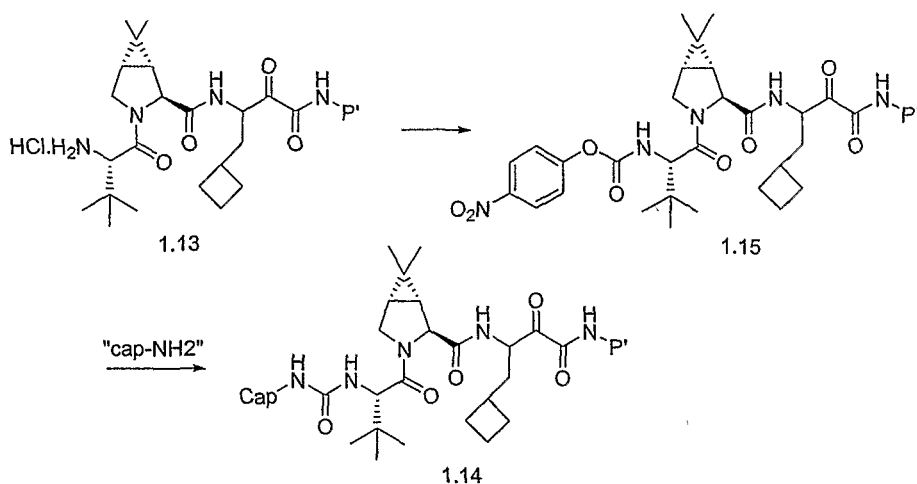
Method C

In another variation, peptide coupling of the N-Boc-P₂-P₃-acid 1.17 with the appropriate P₁-P' amide moiety afforded the hydroxyl amide 1.11. Oxidation (Moffatt or Dess-Martin's) resulted in the keto amide 1.12. Deprotection of the N-Boc functionality gave the hydrochloride salt 1.13. Treatment with a suitable isocyanate (or isocyanate equivalent) resulted in the target compound 1.14.



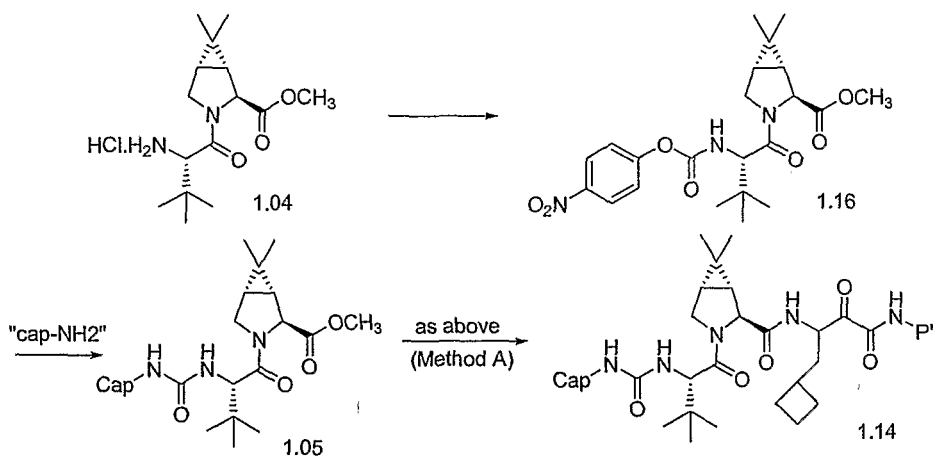
10 Method D

In yet another variation, the hydrochloride salt 1.13 was converted to the 4-nitrophenyl carbamate 1.15 by reaction with 4-nitrophenyl chloroformate. Subsequent treatment with an amine (or amine hydrochloride salt) of choice provided the target compound 1.14.



Method E

- In yet another variation, the dipeptide hydrochloride salt 1.03 was converted to the 4-nitrophenyl carbamate as described above. Treatment with an amine (or amine hydrochloride salt) of choice provided the urea derivative 1.05. Hydrolysis and further elaboration as described in Methods A/B provided the target compounds 1.14.

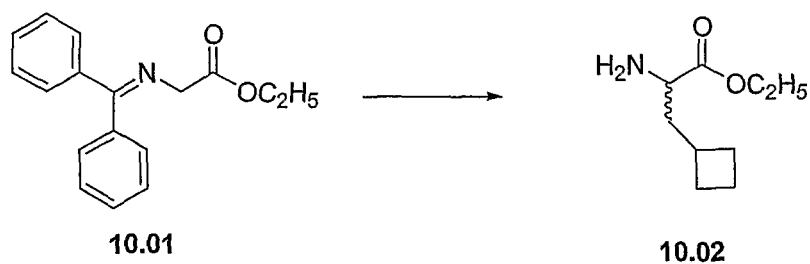


10 Preparation of Intermediates:

Preparation of P₁-P' moieties:

Preparation of Intermediates 10.11 and 10.12:

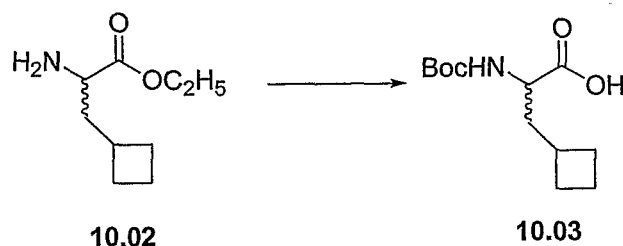
Step 1:



A stirred solution of ketimine **10.01** (50 g, 187.1 mmol) under N₂ in dry THF (400 mL) was cooled to -78 °C and treated with 1 M solution of K^tBuO (220 mL, 1.15 equiv.) in THF. The reaction mixture was warmed to 0 °C and stirred for 1 h and treated with bromomethyl cyclobutane (28 mL, 249 mmol).

- 5 The reaction mixture was stirred at room temperature for 48 h and concentrated *in vacuo*. The residue was dissolved in Et₂O (300 mL) and treated with aq. HCl (2 M, 300 mL). The resulting solution was stirred at room temperature for 5 h and extracted with Et₂O (1 L). The aqueous layer was made basic to pH ~12-14 with NaOH (50 % aq.) and extracted with CH₂Cl₂
10 (3x300 mL). The combined organic layers were dried (MgSO₄), filtered, and concentrated to give the pure amine (**10.02**, 18 g) as a colorless oil.

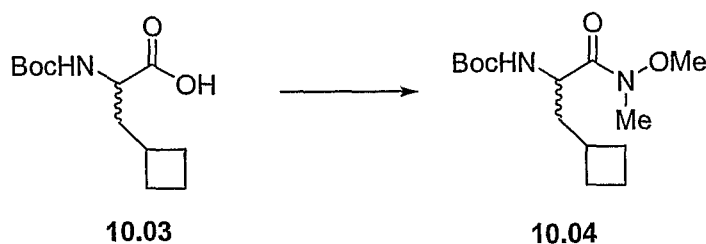
Step 2



- A solution of the amine **10.02** (18g, 105.2 mmol) at 0 °C in CH₂Cl₂ (350 mL) was treated with di-*tert*-butyldicarbonate (23 g, 105.4 mmol) and stirred at
15 rt. for 12 h. After the completion of the reaction (TLC), the reaction mixture was concentrated *in vacuo* and the residue was dissolved in THF/H₂O (200 ml, 1:1) and treated with LiOH•H₂O (6.5 g, 158.5 mmol) and stirred at room temperature for 3 h. The reaction mixture was concentrated and the basic
20 aqueous layer was extracted with Et₂O. The aqueous layer was acidified with conc. HCl to pH~1-2 and extracted with CH₂Cl₂. The combined organic layers were dried (MgSO₄), filtered, and concentrated *in vacuo* to yield **10.03** as a colorless viscous oil which was used for the next step without any further purification.

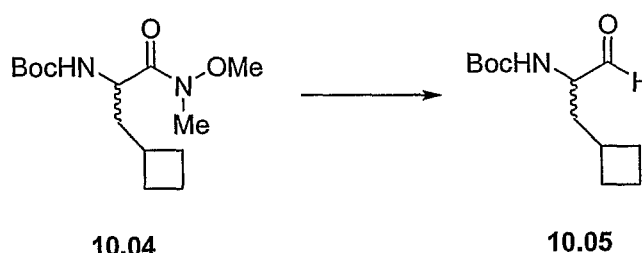
25

Step 3



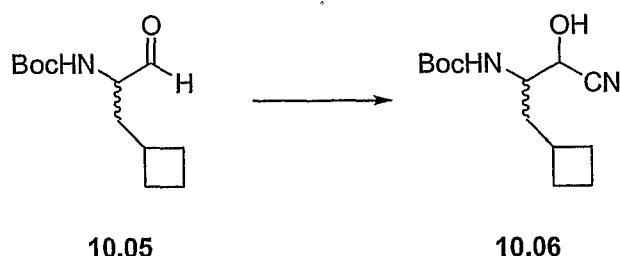
A solution of the acid **10.03** (15.0 g, 62 mmol) in CH_2Cl_2 (250 mL) was treated with BOP reagent (41.1 g, 93 mmol), N-methyl morpholine (27 mL), N,O-dimethyl hydroxylamine hydrochloride (9.07 g, 93 mmol) and stirred overnight at rt. The reaction mixture was diluted with 1 N aq. HCl (250 mL), and the layers were separated and the aqueous layer was extracted with CH_2Cl_2 (3x300 mL). The combined organic layers were dried (MgSO_4), filtered and concentrated *in vacuo* and purified by chromatography (SiO_2 , EtOAc/Hex 2:3) to yield the amide **10.04** (15.0 g) as a colorless solid.

Step 4



A solution of the amide **10.04** (15 g, 52.1 mmol) in dry THF (200 mL) was treated dropwise with a solution of LiAlH_4 (1M, 93 mL, 93 mmol) at 0 °C. The reaction mixture was stirred at room temperature for 1 h and carefully quenched at 0 °C with a solution of KHSO_4 (10% aq.) and stirred for 0.5 h. The reaction mixture was diluted with aq. HCl (1 M, 150 mL) and extracted with CH_2Cl_2 (3x200 mL). The combined organic layers were washed with aq. HCl (1 M), saturated NaHCO_3 , brine, and dried (MgSO_4). The mixture was filtered and concentrated *in vacuo* to yield **10.05** as a viscous colorless oil (14 g).

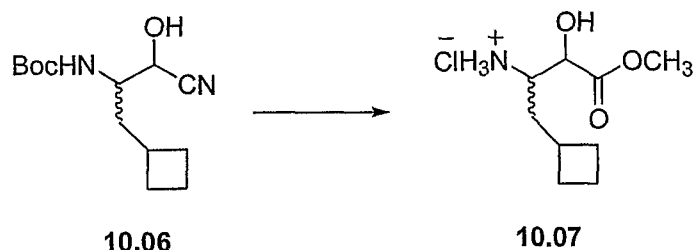
Step 5



A solution of the aldehyde **10.05** (14 g, 61.6 mmol) in CH_2Cl_2 (50 mL), was treated with Et_3N (10.73 mL, 74.4 mmol), and acetone cyanohydrin (10.86 g, 127.57 mmol) and stirred at room temperature for 24 hrs. The reaction mixture was concentrated *in vacuo* and diluted with aq. HCl (1 M, 200 mL) and extracted into CH_2Cl_2 (3x200 mL). The combined organic layer were

washed with H₂O, brine, dried (MgSO₄), filtered, concentrated *in vacuo* and purified by chromatography (SiO₂, EtOAc/Hex 1:4) to yield **10.06** (10.3 g) as a colorless liquid

Step 6

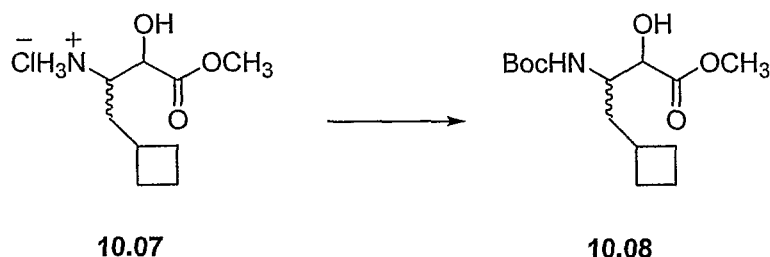


5

Methanol saturated with HCl*, prepared by bubbling HCl gas through CH₃OH (700 ml) at 0 °C, was treated with the cyanohydrin **10.06** and heated to reflux for 24 h. The reaction was concentrated *in vacuo* to yield **10.07**, which was used in the next step without purification.

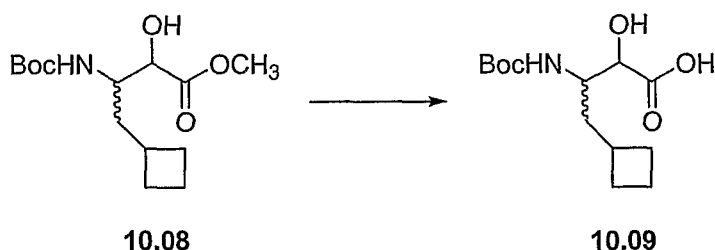
10 * Alternatively 6M HCl prepared by addition of AcCl to dry methanol can also be used.

Step 7



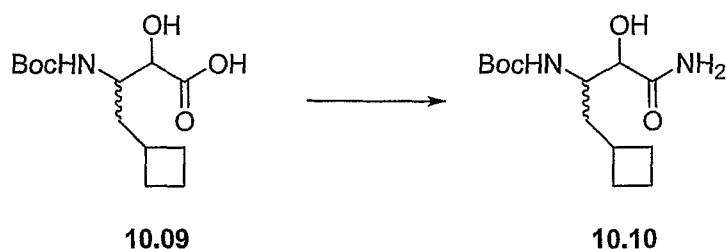
15 A solution of the amine hydrochloride **10.07** in CH₂Cl₂ (200 mL) was treated with Et₃N (45.0 mL, 315 mmol) and Boc₂O (45.7g, 209 mmol) at -78 °C. The reaction mixture was then stirred at room temperature overnight and diluted with HCl (2 M, 200 mL) and extracted into CH₂Cl₂. The combined organic layer were dried (MgSO₄) filtered, concentrated *in vacuo* and purified by chromatography (EtOAc/Hex 1:4) to yield hydroxy ester **10.08**.

20 Step 8.



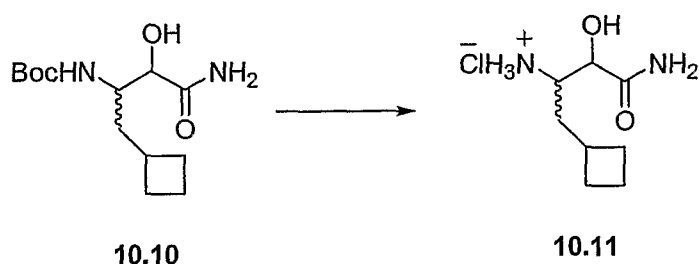
A solution of methyl ester **10.08** (3g, 10.5 mmol) in THF/H₂O (1:1) was treated with LiOH•H₂O (645 mg, 15.75 mmol) and stirred at rt. for 2 h. The reaction mixture was acidified with aq HCl (1 M, 15 mL) and concentrated *in vacuo*. The residue was dried in vacuum to afford **10.09** in quantitative yield.

5 Step 9



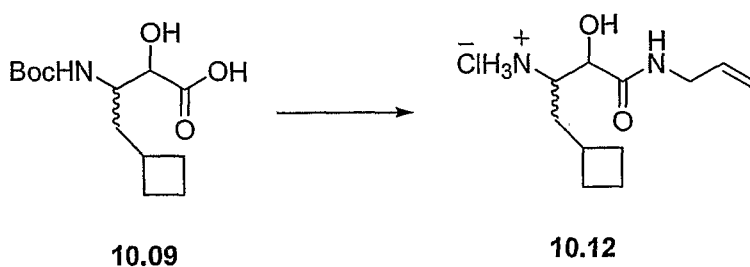
A solution of the acid **10.09** (from above) in CH₂Cl₂ (50 mL) and DMF (25 mL) was treated with NH₄Cl (2.94 g, 55.5 mmol), EDCI (3.15 g, 16.5 mmol), HOObt (2.69 g, 16.5 mmol), and NMM (4.4 g, 44 mmol). The reaction mixture was stirred at room temperature for 3 d. The solvents were removed under *vacuo* and the residue was diluted with aq. HCl (250 mL) and extracted with CH₂Cl₂. The combined organic layers were washed with aq. Sat'd. NaHCO₃, dried (MgSO₄) filtered concentrated in *vacuo* to obtain **10.10**, which was used as it was in the following steps. (Alternatively **10.10** can also be obtained directly by the reaction of **10.06** (4.5 g, 17.7 mmol) with aq. H₂O₂ (10 mL), LiOH•H₂O (820 mg, 20.8 mmol) at 0 °C in 50 mL of CH₃OH for 0.5 h.)

15 Step 10



A solution of **10.10** obtained in the previous step was dissolved in 4 N HCl in dioxane and stirred at rt. for 2 h. The reaction mixture was concentrated in *vacuo* to give the intermediate **10.11** as a solid, which was used without further purification.

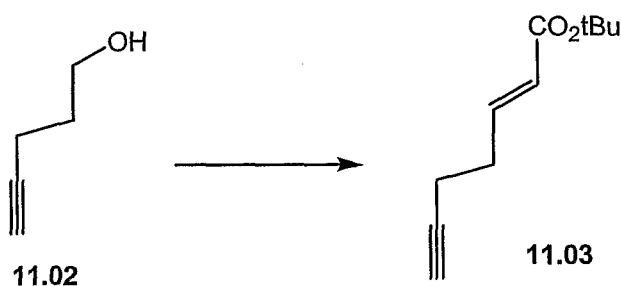
20 Step 11



The required intermediate **10.12** was obtained from compound **10.09** using essentially the procedures described above in Steps 9, 10 with appropriate reagents.

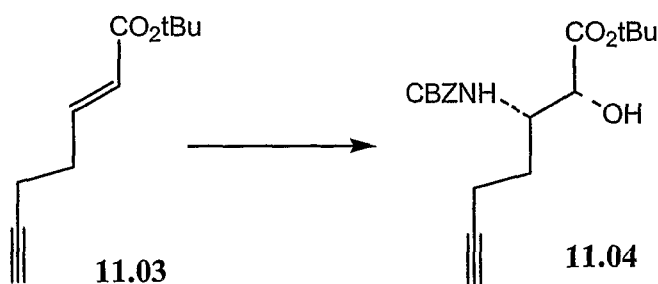
5 Preparation of Intermediate 11.01

Step 1



To a solution of 4-pentyn-1-ol, **11.02** (4.15g; Aldrich) was added Dess-Martin Periodinane (30.25g; Aldrich) and the resulting mixture was stirred for 45min. before the addition of (tert-Butoxycarbonylmethylene)triphenylphosphorane (26.75g; Aldrich). The resulting dark reaction was stirred overnight, diluted with EtOAc, washed with aq. sodium sulfite, sat. aq. NaHCO₃, water, brine and dried. The volatiles were removed under reduced pressure and the residue was purified by silica gel column chromatography using 1% EtOAc in hexanes as eluent to give the desired compound, **11.03** (3.92g). Some impure fractions were also obtained but set aside at this time.

Step 2

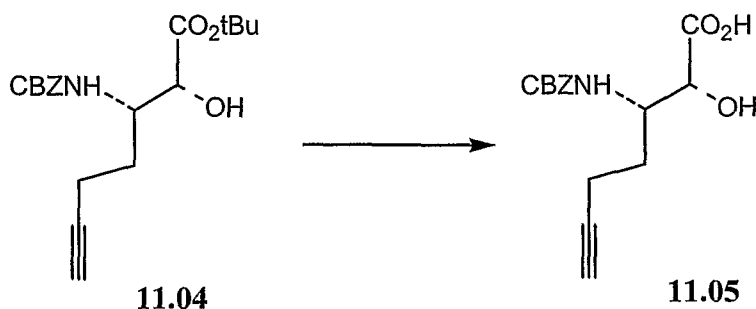


Using the alkene **11.03** (1.9g) in n-propanol (20ml; Aldrich)), benzyl carbamate (4.95g; Aldrich) in n-propanol (40ml), NaOH (1.29g) in water (79ml), tert-butyl hypochlorite (3.7ml), (DHQ)2PHAL (0.423g; Aldrich)) in n-

propanol (37.5ml), and potassium osmate:dehydrate (0.1544g; Aldrich) and the procedure set forth in Angew. Chem. Int. Ed. Engl (1998), 35, (23/24), pp. 2813-7.gave a crude product which was purified by silica gel column chromatography using EtOAc:Hexanes (1:5) to give the desired amino alcohol

5 **11.04** (1.37g, 37%) as a white solid.

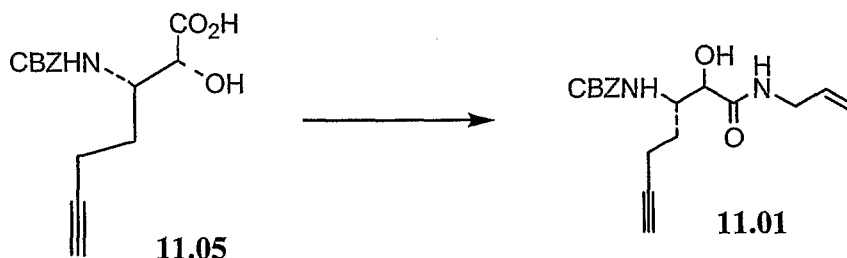
Step 3



To the ester **11.04** (0.700g) was added 4M HCl in dioxane (20ml; Aldrich) and the resulting mixture was allowed to stand at room temperature overnight. The

10 volatiles were removed under reduced pressure to give the acid **11.05** (0.621g) as a white solid.

Step 4



BOP reagent (3.65g; Sigma) followed by triethylamine (3.45ml) were added to

15 a dichloromethane (20ml) solution of the carboxylic acid **11.05** (2.00g) and allyl amine (0.616ml) at room temperature and the resulting mixture was stirred overnight. The reaction mixture was partitioned between EtOAc and 10% aq. HCl. The organic phase was separated, washed with sat. aq. sodium bicarbonate, water, dried (magnesium sulfate). The crude reaction product

20 was purified by silica gel column chromatography using (EtOAc:Hexanes; 70:30) as eluent to provide the desired amide **11.01** (1.73g) as a viscous yellow oil.

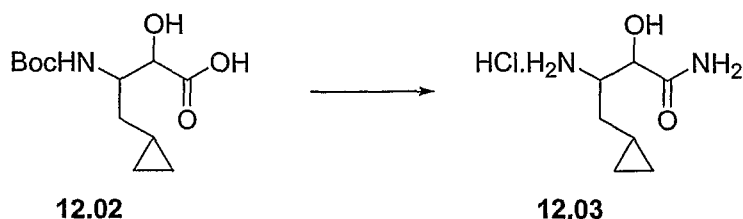
Preparation of Intermediates **12.03** and **12.04**

Step 1



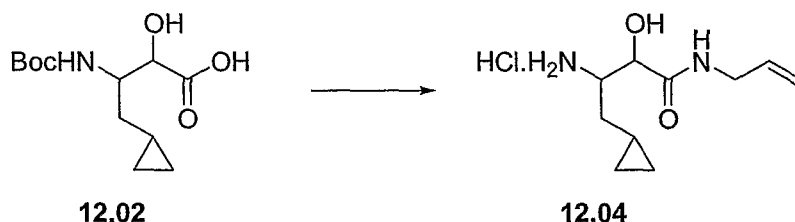
Compound **12.01** was converted to the required material **12.02** using essentially the procedures described for Intermediate **10.11**, Steps 3-8.

Step 2



Compound **12.02** was converted to the required intermediate **12.03** using essentially the procedures described for Intermediate **10.11**, Steps 9, 10..

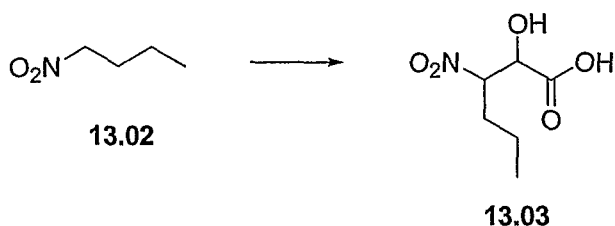
Step 3



Compound **12.02** was converted to the required intermediate **12.03** using essentially the procedures described for Intermediate **10.12**, Step 11.

Preparation of Intermediate **13.01**

Step 1

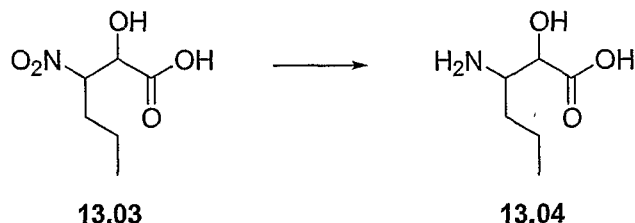


To a stirred solution of 1-nitrobutane, **13.02** (16.5 g, 0.16 mol) and glyoxylic acid in H₂O (28.1 g, 0.305 mol) and MeOH (122 mL) at 0°C-5°C, was added dropwise triethylamine (93 mL, 0.667 mol) over 2 hrs. The solution was warmed to room temperature, stirred overnight and concentrated to dryness to give an oil. The oil was then dissolved in H₂O and acidified to pH

≈ 1 with 10% HCl, followed by extraction with EtOAc. The combined organic

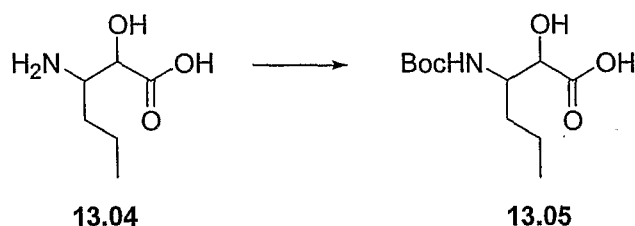
solution was washed with brine, dried over Na₂SO₄, filtered and concentrated to dryness to give the product **13.03** (28.1 g, 99% yield).

Step 2



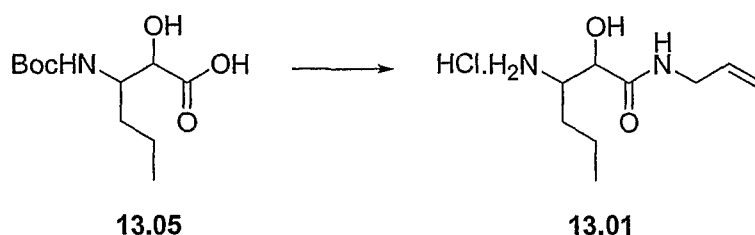
5 To a stirred solution of compound **13.03** (240 g, 1.35 mol) in acetic acid (1.25 L) was added 10% Pd/C (37 g). The resulting solution was hydrogenated at 59 psi for 3 hrs and then at 60 psi overnight. The acetic acid was then evaporated and azeotroped 3 times with toluene, then triturated with MeOH and ether. The solution was then filtered and azeotroped twice with
10 toluene to afford **13.04** as an off white solid (131 g, 0.891 mol, 66%).

Step 3



To a stirred solution of the amino acid **13.04** (2.0 g, 13.6 mmol) in dioxane (10 mL) and H₂O (5mL) at 0°C, was added 1N NaOH solution (4.3
15 mL, 14.0 mmol). The resulting solution was stirred for 10 minutes, followed by addition of di-*t*-butyldicarbonate (0.110 g, 14.0 mmol) and stirred at 0°C for 15 minutes. The solution was then warmed to room temperature, stirred for 45 minutes and kept at refrigerator overnight and concentrated to dryness to give a crude material. To the solution of this crude material in EtOAc (100 mL) and
20 ice, was added KHSO₄ (3.36 g) and H₂O (32 mL) and stirred for 4-6 minutes. The organic layer was then separated and the aqueous layer was extracted twice with EtOAc and the combined organic layer was washed with water, brine, dried over Na₂SO₄, filtered and concentrated to dryness to give the product **13.05** as a clear gum (3.0 g, 89% yield).

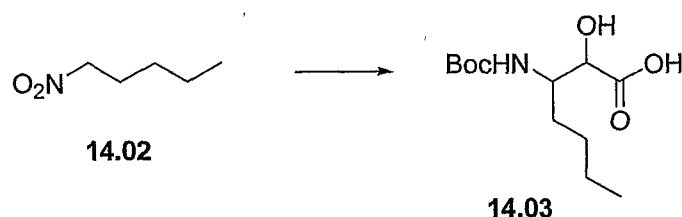
25 Step 4



Compound **13.05** was converted to the required intermediate **13.01** using essentially the procedures described for Intermediate **10.12**, Step 11.

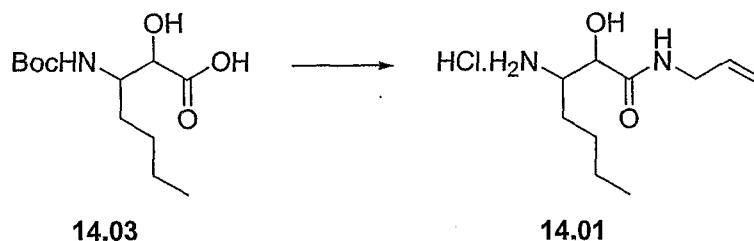
Preparation of Intermediate 14.01

5 Step 1



Compound **14.02** was converted to the required material **14.03** using essentially the procedures described for Intermediate **13.01**, Steps 1-3.

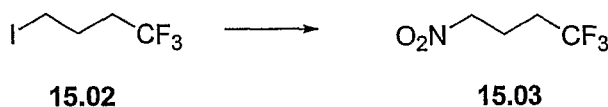
Step 2



Compound **14.03** was converted to the required intermediate **14.01** using essentially the procedures described for Intermediate **10.12**, Step 11.

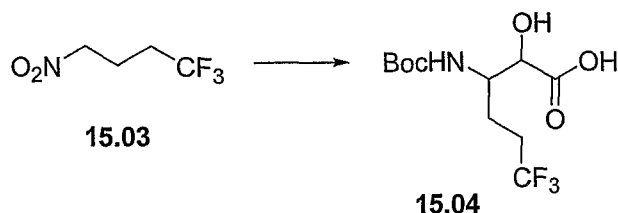
Preparation of Intermediate 15.01

Step 1

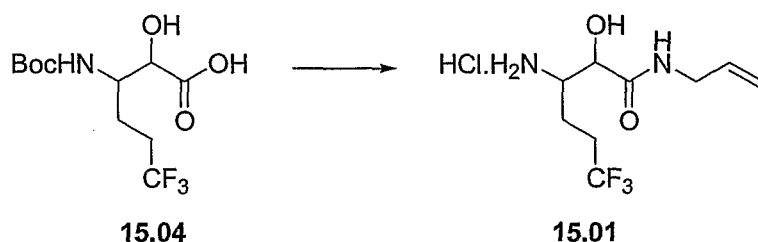


To a suspension of silver nitrite (9 g, 58.5 mmol) in diethyl ether (25 mL) at 0°C was added a solution of 4-iodo-1,1,1-trifluorobutane, **15.02** (10 g, 42.0 mmol) in diethyl ether (25 mL) slowly through an addition funnel (approx. 15 min). The resulting mixture was vigorously stirred at 0°C and warmed to rt.

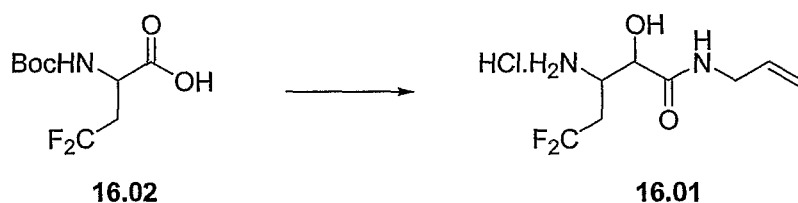
After 50 h, the solid material was filtered off through a celite pad. The resulting diethyl ether solution was concentrated *in vacuo* to give **15.03** as colorless oil, which was used without further purification.

Step 2

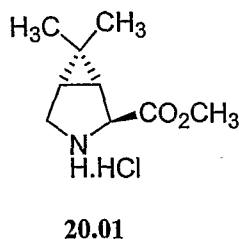
Compound **15.03** was converted to the required material **15.04** using essentially the procedures described for Intermediate **13.01**, Steps 1-3.

5 Step 3

Compound **15.04** was converted to the required intermediate **15.01** using essentially the procedures described for Intermediate **10.12**, Step 11.

Preparation of Intermediate 16.01

The acid **16.02** (Winkler, D.; Burger, K., *Synthesis*, **1996**, 1419) is processed as described above (preparation of Intermediate **10.12**) to give the expected intermediate **16.01**.

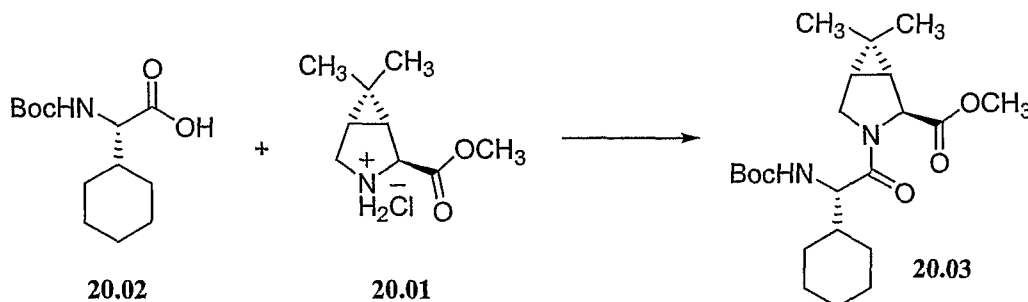
PREPARATION OF P₂ / P₃-P₂ MOIETIES15 Preparation of Intermediate 20.01

The amino ester **20.01** was prepared following the method of R. Zhang and J. S. Madalengoitia (*J. Org. Chem.* **1999**, 64, 330), with the exception that the Boc group was cleaved by the reaction of the Boc-protected amino acid with methanolic HCl (4M HCl in dioxane was also employed for the deprotection).

(Note: In a variation of the reported synthesis, the sulfonium ylide was replaced with the corresponding phosphonium ylide)

Preparation of Intermediate 20.04

Step 1

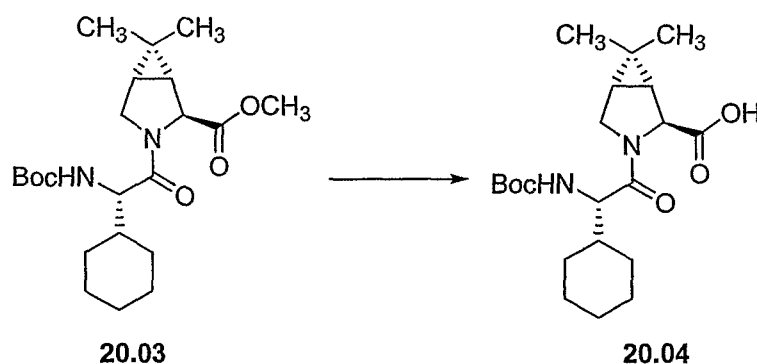


A solution of commercial amino acid Boc-Chg-OH, **20.02** (Senn chemicals, 6.64 g, 24.1 mmol) and amine hydrochloride **20.01** (4.5 g, 22 mmol) in CH_2Cl_2 (100 mL) at 0 °C was treated with BOP reagent and stirred at rt. for 15 h. The reaction mixture was concentrated *in vacuo*, then it was

10

diluted with aq. 1 M HCl and extracted into EtOAc (3x200 mL). The combined organic layers were washed with sat'd. NaHCO_3 (200 mL), dried (MgSO_4), filtered and concentrated *in vacuo*, and chromatographed (SiO_2 , EtOAc/Hex 3:7) to obtain **20.03** (6.0 g) as a colorless solid.

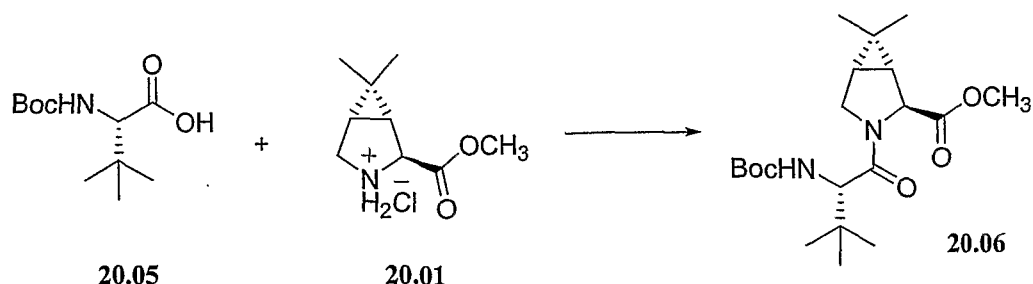
Step 2



A solution of methyl ester **20.03** (4.0 g, 9.79 mmol) in THF/ H_2O (1:1) was treated with $\text{LiOH}\cdot\text{H}_2\text{O}$ (401 mg, 9.79 mmol) and stirred at rt. for 3 h. The reaction mixture was acidified with aq. HCl and concentrated *in vacuo* to obtain the required intermediate, free acid **20.04**.

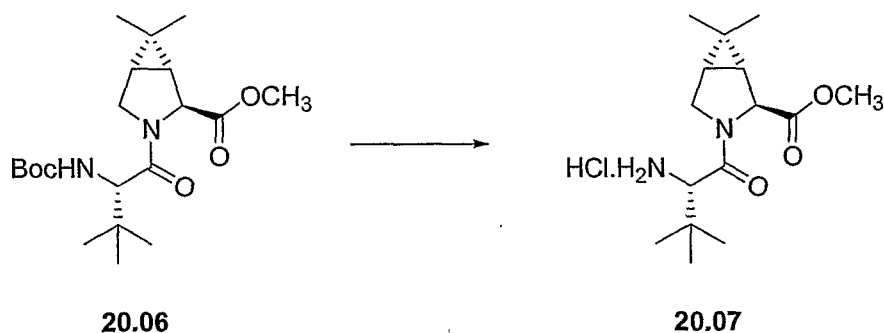
Preparation of Intermediate 20.08

Step 1



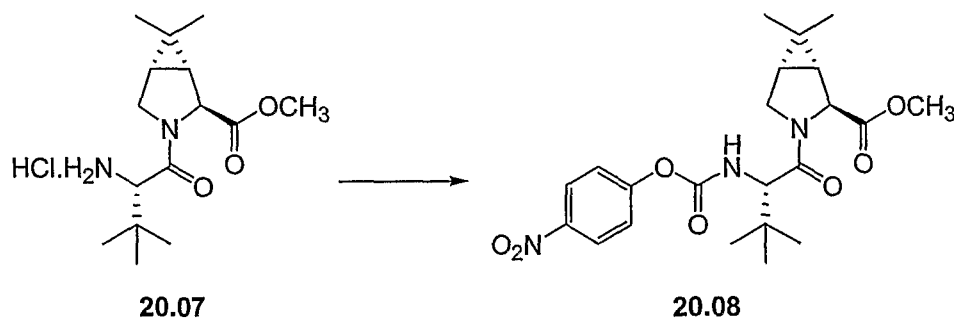
A solution of Boc-tert-Leu **20.05** (Fluka, 5.0 g 21.6 mmol) in dry $\text{CH}_2\text{Cl}_2/\text{DMF}$ (50 mL, 1:1) was cooled to 0 °C and treated with the amine salt **20.01** (5.3 g, 25.7 mmol), NMM (6.5 g, 64.8 mmol) and BOP reagent (11.6 g, 25.7 mmol). The reaction was stirred at rt. for 24h, diluted with aq. HCl (1 M) and extracted with CH_2Cl_2 . The combined organic layers were washed with HCl (aq, 1 M), sat'd. NaHCO_3 , brine, dried (MgSO_4), filtered and concentrated *in vacuo* and purified by chromatography (SiO_2 , Acetone/Hexane 1:5) to yield **20.06** as a colorless solid.

Step 2



A solution of methyl ester **20.06** (4.0 g, 10.46 mmol) was dissolved in 4M HCl in dioxane and stirred at rt. for 3 h. The reaction mixture was concentrated *in vacuo* to obtain the amine hydrochloride salt, **20.07** which was used without purification.

Step 3

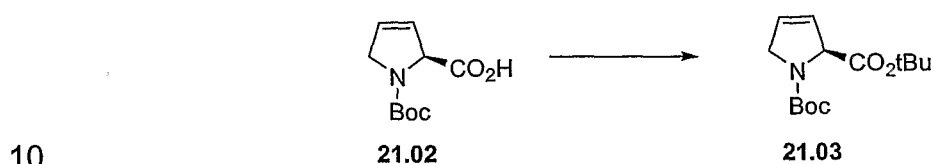


A solution of the amine salt **20.07** (840 mg, 2.64 mmol) in THF (14 mL)/acetonitrile (2 mL) was cooled to 0°C. 4-Nitrophenylchloroformate (800

mg, 3.96 mmol) was added followed by pyridine (0.64 mL, 7.92 mmol). The reaction was slowly warmed to room temperature over 3 hrs when TLC indicated reaction completion. Diethyl ether (50 mL) was added and the resulting precipitate was filtered off. The filtrate was washed with saturated ammonium chloride solution (1 x), brine (1 x), dried (Na_2SO_4) and concentrated. The residue was purified by flash chromatography using 20/80 EtOAc/hexanes which afforded 1.15 g of the required intermediate **20.08**.

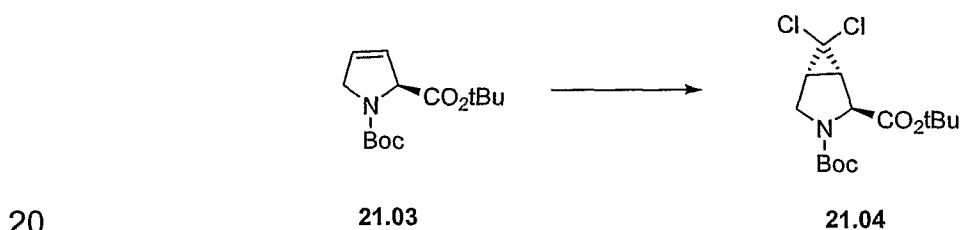
Preparation of Intermediate 21.01

Step 1



To a stirred solution of *N*-Boc-3,4-dehydroproline **21.02** (5.0 g, 23.5 mmol), di-*tert*-butyl dicarbonate (7.5 g, 34.4 mmol), and 4-*N,N*-dimethylaminopyridine (0.40 g, 3.33 mmol) in acetonitrile (100 mL) at room temperature was added triethylamine (5.0 mL, 35.6 mmol). The resulting solution was stirred at this temperature for 18 h before it was concentrated *in vacuo*. The dark brown residue was purified by flash column chromatography eluting with 10-25% EtOAc/hexane to give the product **21.03** as a pale yellow oil (5.29 g, 84%).

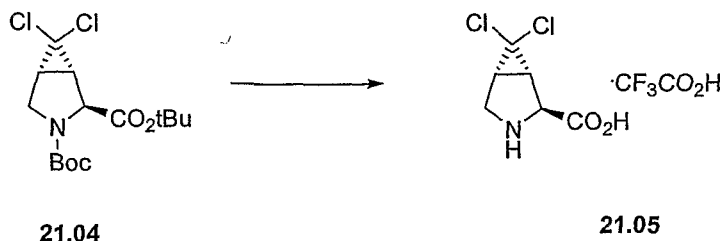
Step 2



To a stirred solution of the dehydroproline derivative **21.03** (10.1 g, 37.4 mmol), benzyltriethylammonium chloride (1.60 g, 7.02 mmol) in chloroform (120 mL) at room temperature was added 50% aqueous sodium hydroxide (120 g). After vigorously stirred at this temperature for 24 h, the dark mixture was diluted with CH_2Cl_2 (200 mL) and diethyl ether (600 mL). After the layers were separated, the aqueous solution was extracted with $\text{CH}_2\text{Cl}_2/\text{Et}_2\text{O}$ (1:2, 3x600 mL). The organic solution was dried (MgSO_4) and concentrated. The residue was purified by flash column chromatography

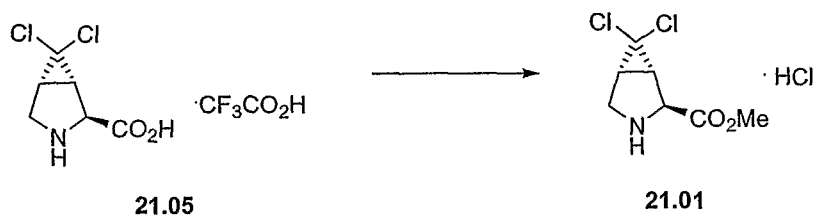
using 5-20% EtOAc/hexane to afford 9.34 g (71%) of **21.04** as an off-white solid.

Step 3



- 5 The solution of **21.04** (9.34 g, 26.5 mmol) in CH_2Cl_2 (25 mL) and $\text{CF}_3\text{CO}_2\text{H}$ (50 mL) was stirred at room temperature for 4.5 h before it was concentrated *in vacuo* to give a brown residue, **21.05** which was used in Step 4 without further purification.

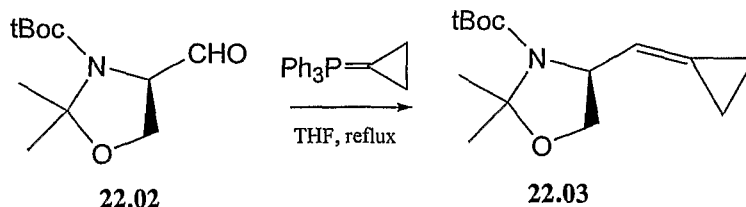
Step 4



- 10 Concentrated hydrochloric acid (4.5 mL) was added to a solution of the residue **21.05** from Step 3 in methanol (70 mL) and the resulting mixture was warmed to 65°C in an oil bath. After 18 h, the mixture was concentrated *in vacuo* to give a brown oil **21.01**, which was used further without purification.

15 Preparation of Intermediate **22.01**

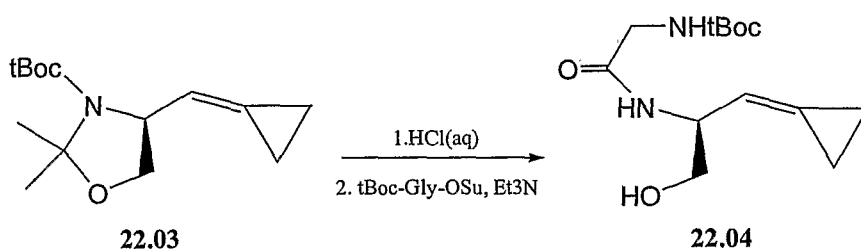
Step 1



- Potassium bis(trimethylsilyl)amide (158ml of a 0.5M solution in toluene; 79mmol) was added to a stirred suspension of
- 20 cyclopropyltriphenylphosphonium bromide (33.12g; 86.4mmol) in anhydrous tetrahydrofuran (130ml) and the resulting orange mixture was stirred under an atmosphere of nitrogen at room temperature for a period of 1h., before the addition of the aldehyde **22.02** (9.68g; 42.2mmol) in THF (8ml). The reaction

was then refluxed under an atmosphere of nitrogen for a period of 2h. After cooling, methanol, diethyl ether and Rochelles salt were added. The organic phase was separated, washed with brine, dried and concentrated under reduced pressure. The crude reaction product was purified by silica gel column chromatography using EtOAc-hexane (1:99) to EtOAc-hexane (5:95) to provide the alkene **22.03** (8.47g) as a yellow oil.

Step 2

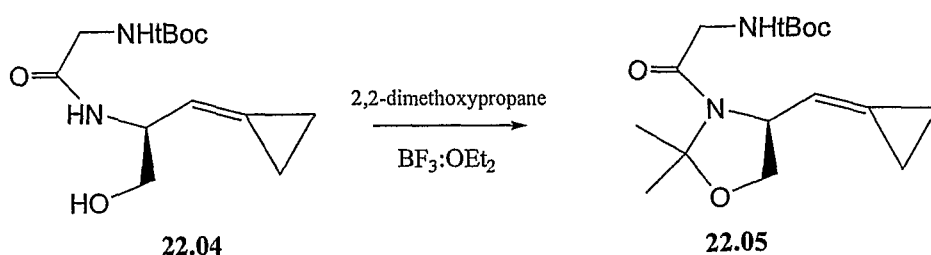


A solution of 1M HCl in MeOH/MeOAc was prepared by adding 14.2ml of acetyl chloride dropwise into cold methanol and diluting the resulting solution to 200ml at room temperature.

The carbamate **22.03** (9.49g; 37.5mmol) was dissolved in methanol (12ml) and added to 1M HCl in MeOH/MeOAc (150ml) while cooled in an ice bath. The resulting mixture was maintained at this temperature for 1h., then the ice bath was removed and stirring continued overnight at room temperature. The volatiles were removed under reduced pressure to yield a yellow oil which was used in the next step without purification.

The yellow oil was dissolved in a mixture of THF (30ml) and MeOH (20ml) and treated with triethylamine (15ml; 108mmol) until the solution was pH=9-10. After placing in an ice bath, the mixture was treated with N-Boc-Gly-OSu (11.22g; 41mmol). The ice bath was withdrawn and the reaction stirred at room temp. for 1h. The volatiles were removed under reduced pressure and the residue was purified by silica gel column chromatography using methanol (1-3%) in dichloromethane providing the desired amide **22.04** (9.09g).

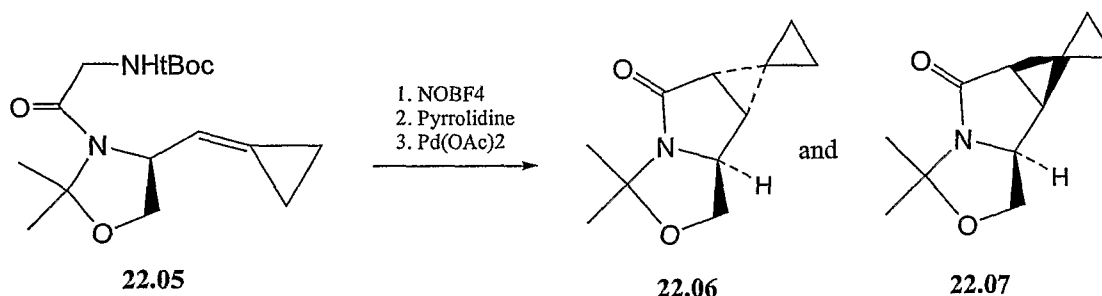
Step 3



The alcohol **22.04** (9.09g; 33.6mmol) was dissolved in acetone (118.5ml) and treated with 2,2-dimethoxypropane (37.4ml;304mmol) and $\text{BF}_3 \cdot \text{Et}_2\text{O}$ (0.32ml; 2.6mmol) and the resulting mixture was stirred at room temperature for a

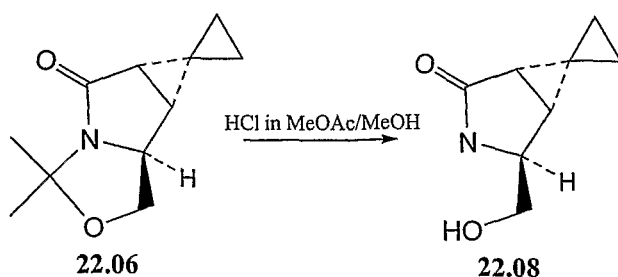
- 5 triethylamine and the volatiles were removed under reduced pressure. The residue was purified by silica gel column chromatography using 5-25% EtOAc in hexanes to provide the N,O-acetal **22.05** (8.85g).

Step 4



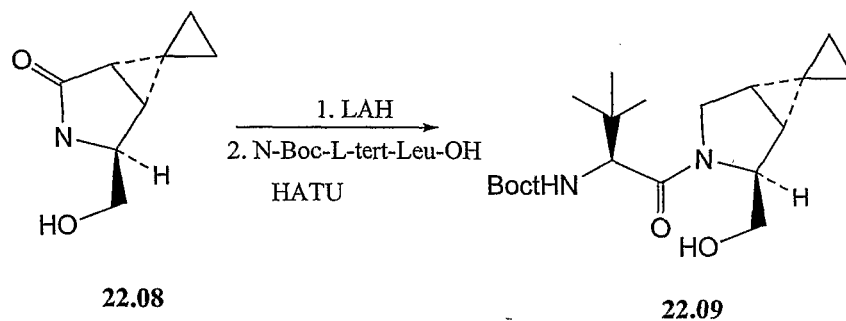
- 10 The carbamate **22.05** (8.81g; 28.4mmol) was dissolved in acetonitrile (45ml) and the solution was cooled to -40°C under an atmosphere of nitrogen. Pyridine (6.9ml; 85.3mmol) followed by nitrosium tetrafluoroborate (6.63g; 56.8mmol) were added and the resulting reaction mixture maintained below 0°C until TLC indicated that no starting material remained (approx. 2.25h.).
- 15 Pyrrolidine (20ml; 240mmol) was added and the cooling bath was withdrawn and stirring was continued at room temperature for 1h. and then the volatiles were removed under reduced pressure. The residue was quickly passed through a pad of silica gel to provide a yellow oil.
- The yellow oil was dissolved in anhydrous benzene (220ml) and palladium acetate (0.317g; 1.41mmol) was added before heating the resulting mixture to reflux, under an atmosphere of nitrogen for a period of 1.5h. After cooling, the volatiles were removed under reduced pressure and the dark residue was purified by silica gel column chromatography using EtOAc-hexane (1:4) to provide the i) the trans- pyrrolidinone **22.06** (1.94g) followed by ii) the cis- pyrrolidinone **22.07** (1.97g).
- 20
- 25

Step 5



Freshly prepared 1M HCl in MeOAc/MeOH (10ml; as described above) was added to the N,O-acetal **22.06** and stirred at room temperature for 1h. The solvent was removed under reduced pressure and the residue was purified by silica gel column chromatography using 0-4% MeOH in dichloromethane as eluent to provide the desired alcohol **22.08** (1.42g), a yellow oil.

Step 6

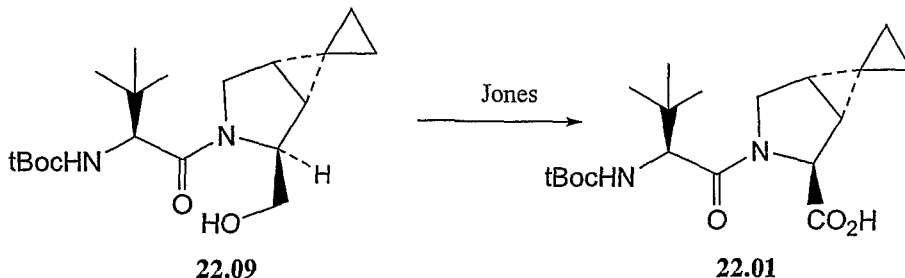


To a solution of the lactam **22.08** (1.29g; 8.44mmol) in anhydrous tetrahydrofuran (55ml) was added lithium aluminum hydride (2.40g; 63.2mmol) and the resulting mixture was refluxed for 8h. After cooling, water, followed by 15% aq. NaOH were added and the resulting mixture was filtered through celite and the solid was washed thoroughly with THF and MeOH. The solvent was removed under reduced pressure and the residue redissolved in dichloromethane, dried and concentrated under reduced pressure to provide the pyrrolidine, used without purification.

Hunigs base (4.5ml; 25.8mmol) was added to a mixture of N-Boc-L-tert-Leu-OH (1.76g; 7.6mmol), The crude pyrrolidine and HATU (2.89g; 7.6mmol) in anhydrous dichloromethane (50ml) at -60°C , under an atmosphere of nitrogen. The resulting reaction was allowed to come to room temperature slowly, overnight. EtOAc was added and the yellow solution was washed with dil. aq. HCl, sat. aq. sodium bicarbonate, water, brine. The organic layer was dried and concentrated under reduced pressure. The residue was purified by

silica gel column chromatography using EtOAc:hexanes (1:3) to give the desired amide **22.09** (2.00g).

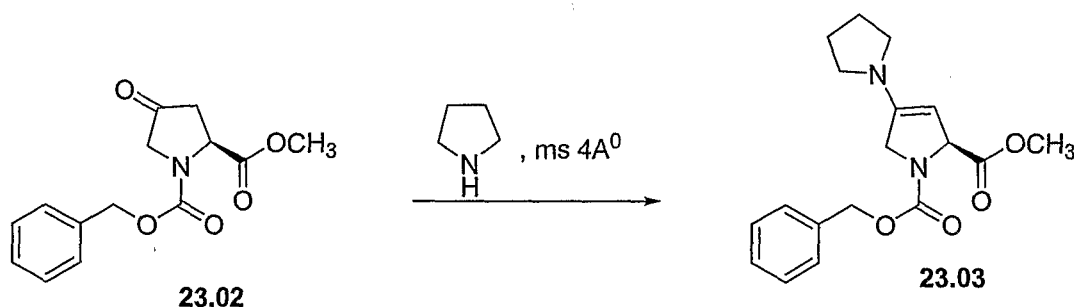
Step 7



- 5 The alcohol **22.09** (2.00g; 5.67mmol) was dissolved in acetone (116ml) and cooled in an ice bath for 10min. This solution was then added to a cooled Jones reagent (14.2ml; approx 2mmol/ml) and the resulting mixture was stirred at 5C for 0.5h and the cooling bath was removed. The reaction was stirred for a further 2h. at room temp., before adding to sodium sulfate
- 10 (28.54g), celite (15g) in EtOAc (100ml). Isopropanol (15ml) was added after 1min and then stirred for a further 10min. and filtered. The filtrate was concentrated under reduced pressure, providing a brown oil which was dissolved in EtOAc. This solution was washed with water, 3% aq. citric acid, brine, dried and concentrated to provide the desired carboxylic acid **22.01**
- 15 (1.64g) as a white solid.

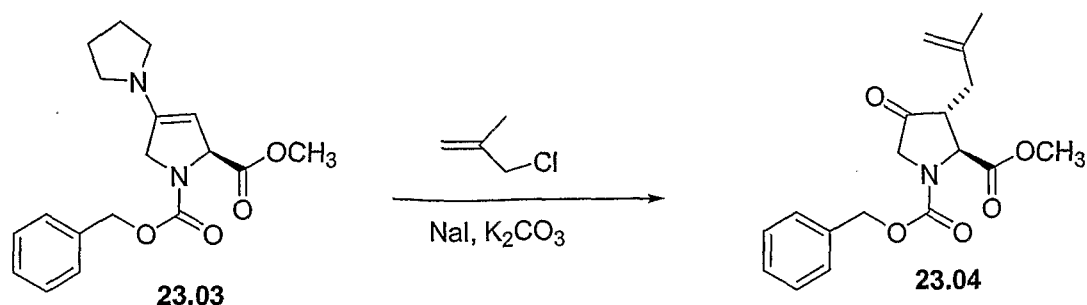
Preparation of Intermediate **23.01**

Step 1



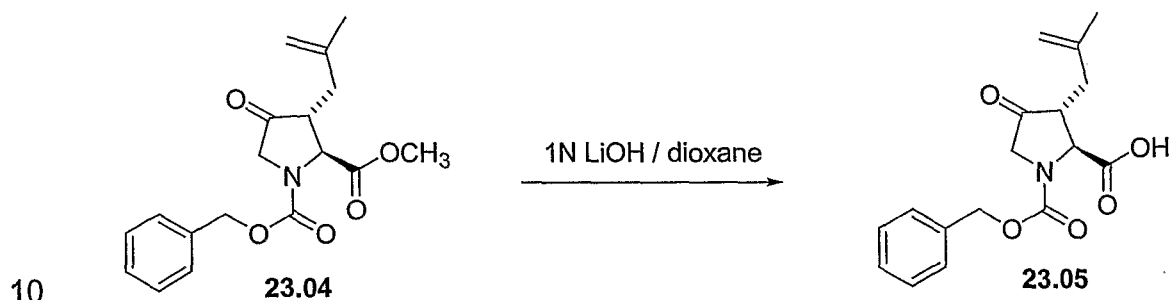
- 20 To the mixture of ester **23.02** (6.0g) and molecular sieve (5.2g) in anhydrous methylene chloride (35 mL) was added pyrrolidine (5.7 mL, 66.36 mmol). The resulting brown slurry was stirred at room temperature under N₂ for 24 h, filtered and washed with anhydrous CH₃CN. The combined filtrate was concentrated to yield the desired product, **23.03**.

Step 2



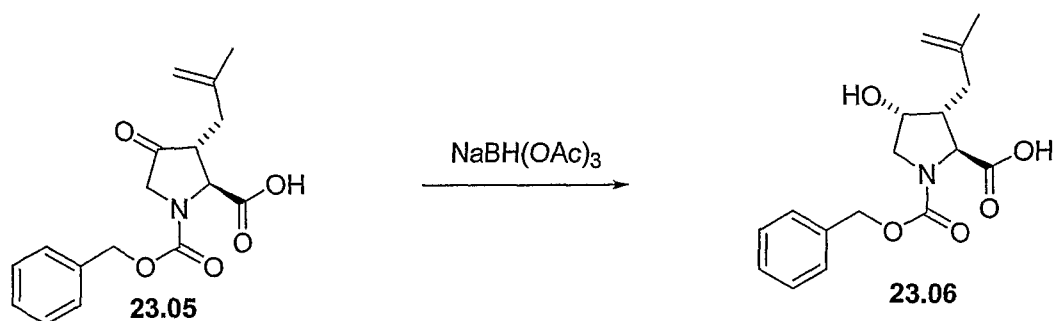
To a solution of the product **23.03** from proceeding step in CH₃CN (35 mL) was added anhydrous K₂CO₃, methallyl chloride (2.77g, 30.5 mmol), NaI (1.07g, 6.7 mmol). The resulting slurry was stirred at ambient temperature under N₂ for 24 h. 50 mL of ice-cold water was added followed by 2N KHSO₄ solution until pH was 1. EtOAc (100 mL) was added and the mixture was stirred for 0.75h. Combined organic layer was collected and washed with brine, dried over MgSO₄, and evaporated to yield the desired product, **23.04**.

Step 3



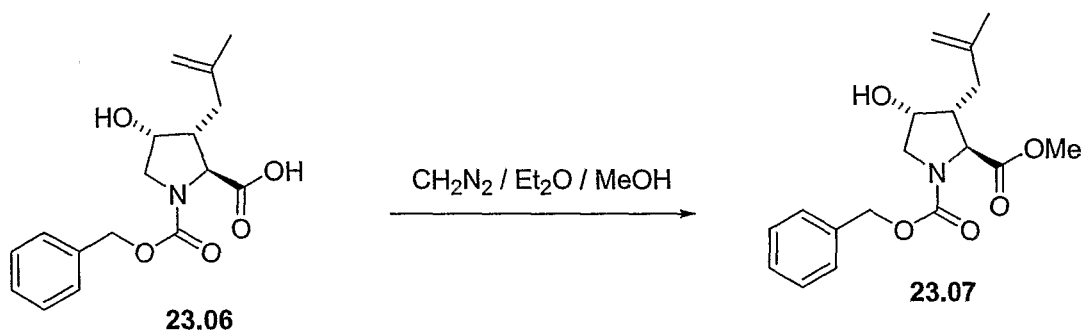
The product **23.04** from the preceding step (2.7 g, 8.16 mmol) was dissolved in dioxane (20 mL) and treated with freshly prepared 1N LiOH (9 mL). The reaction mixture was stirred at ambient temperature under N₂ for 20 h. The reaction mixture was taken in EtOAc and washed with H₂O. The combined aqueous phase was cooled to 0°C and acidified to pH 1.65 using 1N HCl. The turbid mixture was extracted with EtOAc (2 x 100 mL). Combined organic layer was washed with brine, dried over MgSO₄, and concentrated to give the desired acid, **23.05** (3.40 g).

Step 4



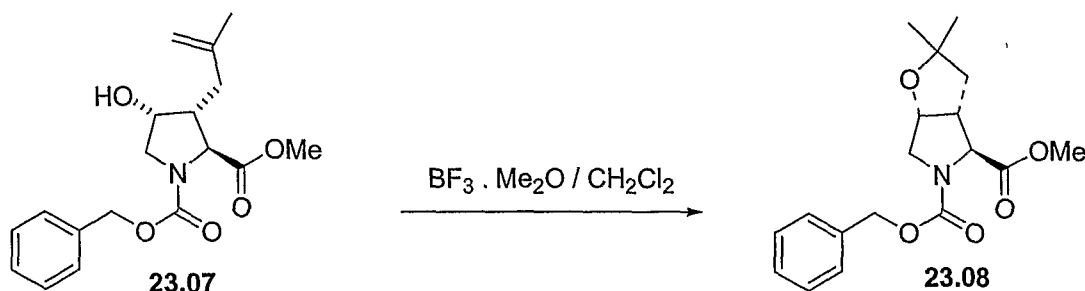
To a suspension of NaBH(OAc)_3 (3.93g, 18.5 mmol) in CH_2Cl_2 (55 mL) was added a solution of product **23.05** from preceding step in anhydrous CH_2Cl_2 (20 mL) and acetic acid (2 mL). The slurry was stirred at ambient temperature for 20 h. Ice cold water (100 mL) was added to the slurry and stirred for 1/2 hr. Organic layer was separated, filtered, dried and evaporated to yield the desired product, **23.06**.

Step 5



To a solution of the product **23.06** from preceding step (1.9g) in MeOH (40 mL) was treated with excess of CH_2N_2 / Et_2O solution and stirred for overnight. The reaction mixture was concentrated to dryness to yield a crude residue. The residue was chromatographed on silica gel, eluting with a gradient of EtOAc / hexane to afford 1.07 g of the pure desired product, **23.07**.

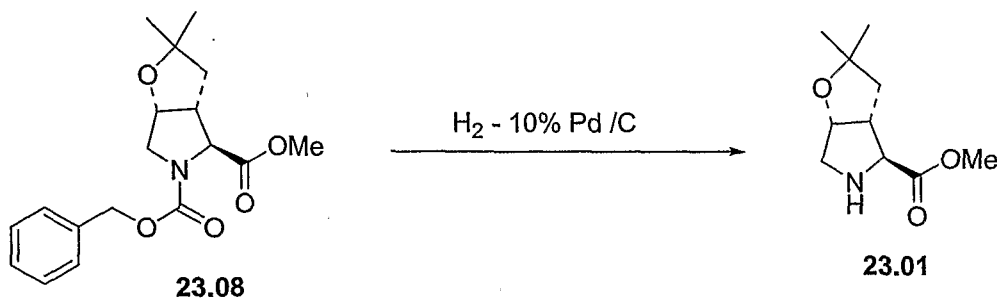
Step 6



To a solution of product **23.07** from preceding step (1.36 g) in anhydrous CH_2Cl_2 (40 mL) was treated with $\text{BF}_3 \cdot \text{Me}_2\text{O}$ (0.7 mL). The reaction mixture was stirred at ambient temperature for 20 h and quenched

with sat. NaHCO_3 (30 mL) and stirred for 1/2 hr. Organic layer was separated and combined organic layer was washed with brine, dried over MgSO_4 , concentrated to give crude residue. The residue was chromatographed on silica gel eluting with a gradient of EtOAc / hexane to afford 0.88 g of the desired compound, **23.08**.

Step 7

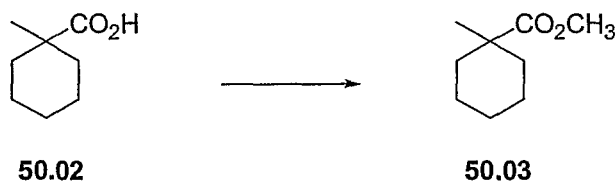


To a solution of the product **23.08** (0.92 g) from preceding step in MeOH (30 mL) was added 10 % Pd/C (0.16 g) at room temperature and hydrogenated at ambient temperature under 1 atm. Pressure. The reaction mixture was stirred for 4 h and concentrated to dryness to yield the desired compound, **23.01**.

PREPARATION OF P_3 MOIETIES

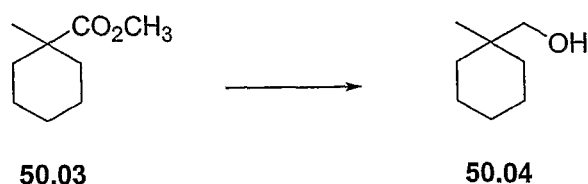
Preparation of Intermediate **50.01**

Step 1



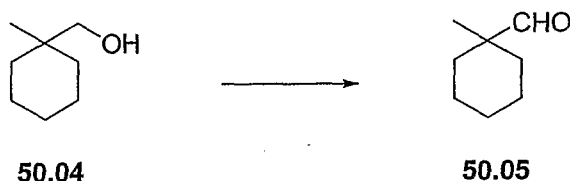
To a solution of **50.02** (15 g) in MeOH (150 mL) was added conc HCl (3-4 mL) and the mixture was refluxed for 16 h. The reaction mixture was cooled to room temperature and concentrated. The residue was taken in diethyl ether (250 mL) and washed with cold saturated sodium bicarbonate solution, and brine. The organic layer was dried (Na_2SO_4) and concentrated to afford the methyl ester **50.03** (12.98 g) which was carried forward without further purification.

Step 2



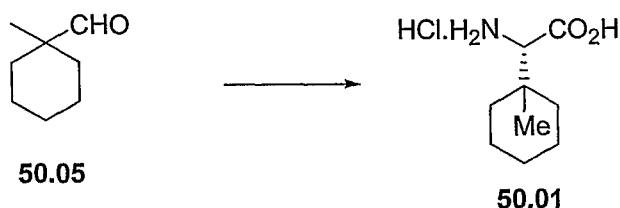
The methyl ester **50.03** from above was dissolved in methylene chloride (100 mL) and cooled to -78°C , under nitrogen atmosphere. DIBAL (1.0 M solution in methylene chloride, 200 mL) was added dropwise over 2 h period. The reaction mixture was warmed to room temperature over 16 h. The reaction mixture was cooled to 0°C and MeOH (5-8 mL) was added dropwise. A solution of aqueous 10% sodium potassium tartarate (200 mL) was slowly added with stirring. Diluted with methylene chloride (100 mL) and separated the organic layer (along with some white precipitate). The organic layer was washed with 1 N HCl (250 mL), brine (200 mL), dried (Na_2SO_4) and concentrated to provide the alcohol **50.04** (11.00 g) as a clear oil.

Step 3

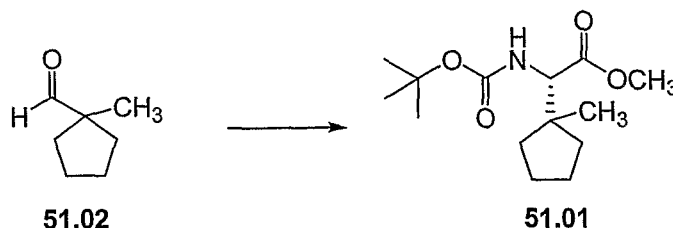


The alcohol **50.04** from above was dissolved in methylene chloride (400 mL) and cooled to 0°C under nitrogen atmosphere. PCC (22.2 g) was added in portions and the reaction mixture was slowly warmed to room temperature over 16 h. The reaction mixture was diluted with diethyl ether (500 mL) and filtered through a pad of celite. The filtrate was concentrated and the residue was taken in diethyl ether (500 mL). This was passed through a pad of silica gel and the filtrate was concentrated to provide the aldehyde **50.05** which was carried forward without further purification.

Step 4

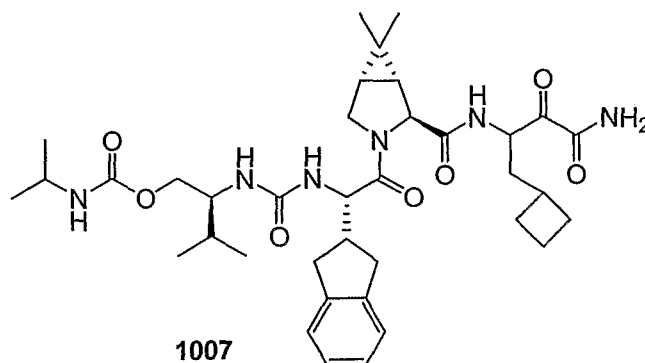
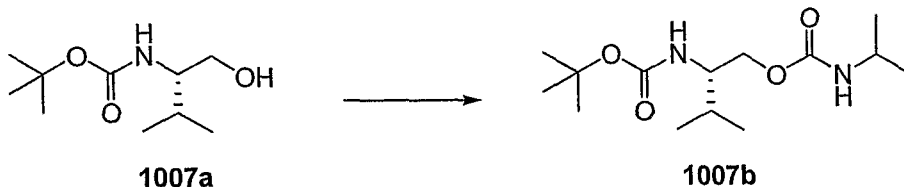


The aldehyde **50.05** from above was converted to the desired material **50.01** using essentially the method of Chakraborty *et. al* (Tetrahedron, **1995**, 51(33), 9179-90).

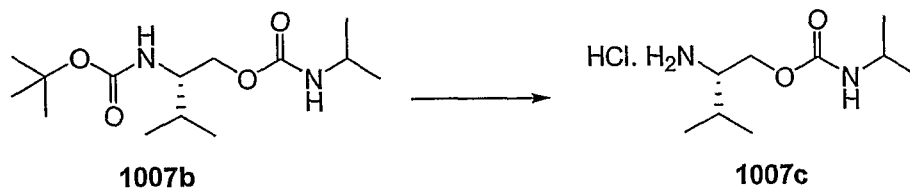
Preparation of Intermediate 51.01

The required intermediate **51.01** was obtained from the aldehyde **51.02** using the literature described procedure (T. K. Chakraborty et al.,

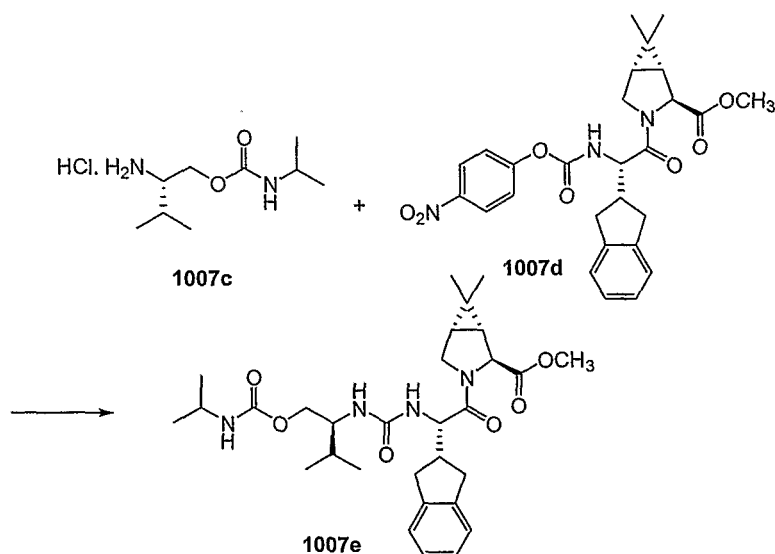
5 *Tetrahedron*, **1995**, 51 (33), 9179-90).

PREPARATION OF SPECIFIC EXAMPLESPreparation of Example 1007Step 1

Commercially available compound **1007a** (Aldrich Chemical Co., Milwaukee, Wisconsin, USA) was converted to **1007b** according to the literature procedure (M. E. Duggan, J. S. Imagire *Synthesis* **1989**, 131-2) in 90% yield. LC-MS: 289 (M+H).

Step 2

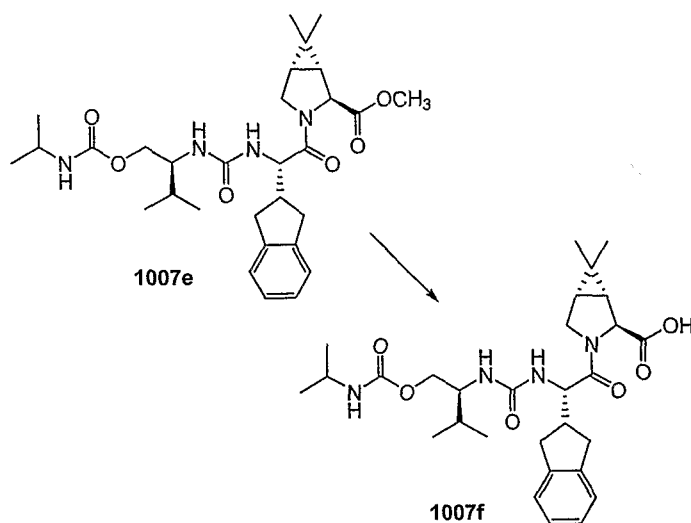
Deprotection of **1007b** using 4M HCl in dioxane at room temperature for 3 hrs provided **1007c** in quantitative yield. This material was used without further purification.

Step 3

Compound **1007d** was obtained from appropriate starting materials/reagents using the previously described procedures (See preparation of Intermediate **20.08**).

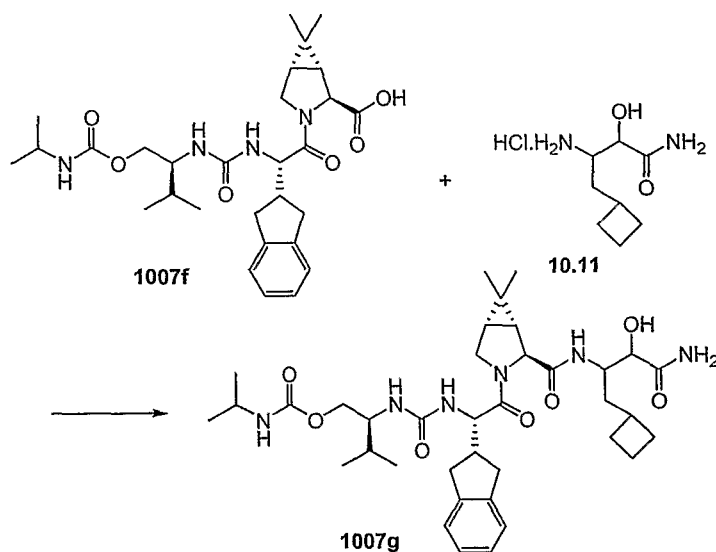
To a solution of **1007d** (200 mg, 0.394 mmol) in dichloromethane (10 mL) at 0°C, under nitrogen atmosphere, was added **1007c** (115 mg, 0.512 mmol) followed by DIPEA (0.22 mL, 1.182 mmol). The reaction was maintained at that temperature for 30 min and stored in the freezer (-20°C) for 48 hrs. The reaction mixture was quenched with saturated ammonium chloride solution and the product was extracted into dichloromethane (3 x). The combine organic layers was washed with brine (1 x), dried (Na₂SO₄), filtered and concentrated. The crude residue was purified by flash chromatography using 30/70 acetone/hexanes which provided the required compound **1007e** in 69% yield. LC-MS: 557 (M+H).

Step 4



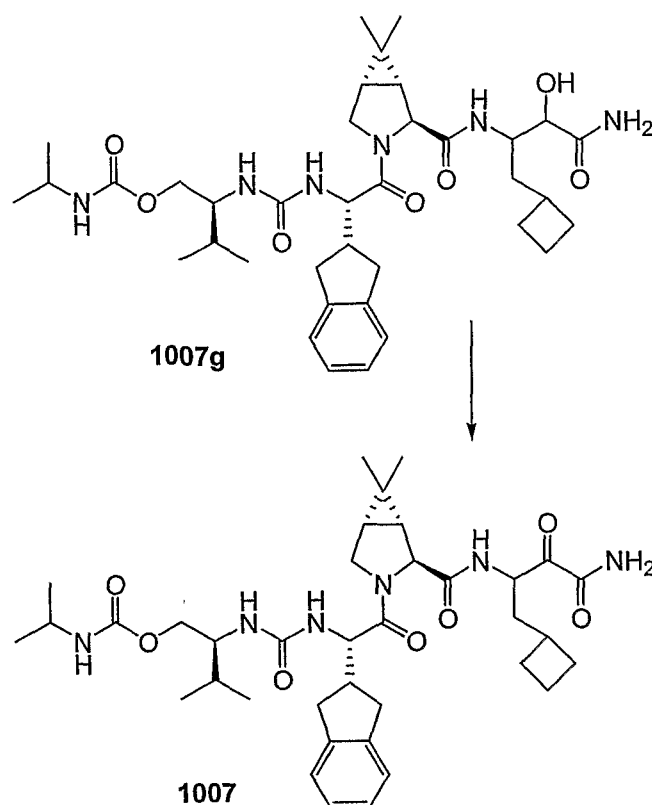
Hydrolysis of the methyl ester of **1007e** to provide the required acid **1007f** was carried out as described before (see preparation of Intermediate **20.04**, Step 2) with appropriate modifications.

5 Step 5



Coupling reaction of the acid **1007f** (0.125 mmol) with the amine salt **10.11** was carried out as described before (see preparation of Intermediate **20.08**, Step 1) with modifications (HATU instead of BOP, DIPEA instead of NMM; the reaction was carried out at 0°C for 15 min and warmed to 10°C over 24 hrs) and appropriate amounts of the reagents. The crude material obtained after workup, **1007g** was carried forward without purification. LC-MS: 697.2 (M+H).

Step 6



To a cold (0°C) solution of the material from above, **1007g** (0.125 mmol) in DMSO/toluene (3 mL each) was added EDCI (240 mg, 1.25 mmol) followed by dichloroacetic acid (0.052 mL, 0.625 mmol). After 15 min, the cold bath was removed and the reaction mixture was warmed to room temperature over 16 hr. The reaction mixture was diluted with EtOAc (20 mL) and washed with aqueous 1N NaHSO₄ (20 mL). The aqueous layer was separated and extracted with EtOAc (20 mL). The combined organic layers was washed with aqueous 1N NaHSO₄ (20 mL), saturated NaHCO₃ (20 mL), brine (20 mL), dried (Na₂SO₄), filtered and concentrated *in vacuo*. The crude residue was purified by flash column chromatography using 40/60 acetone/hexanes to provide the required target compound **1007** (57 mg, 0.082 mmol, 66% yield). LC-MS: 695.2 (M+H).

Preparation of Example 1044

CCNC(=O)OCC[C@H](C(C)(C)C)NC(=O)N[C@@H](C1=CC2=CC=CC=C2C1)C(=O)N[C@@H]3C[C@H](C4=CC5=CC=CC=C4C35)C[C@H](C(C)(C)C)N3C(=O)NC(=O)N[C@@H](CCCC)C(=O)NCC=C

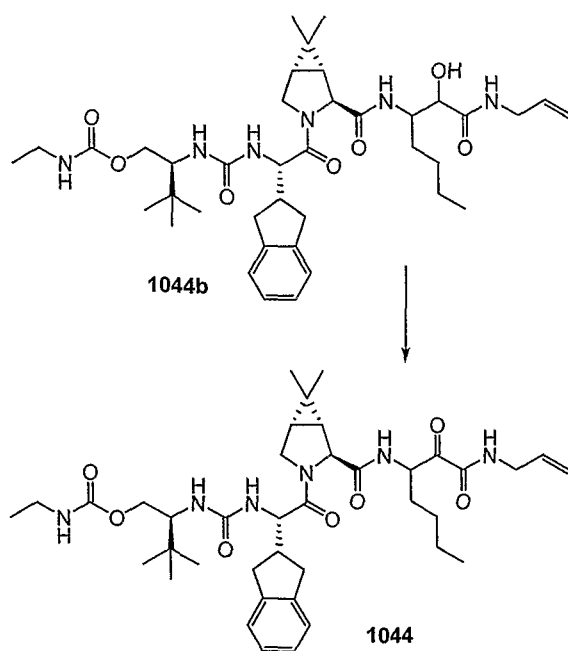
1044

Step 1

The reaction scheme shows the synthesis of compound 1044b.
 1044a is a complex molecule featuring a fluorenyl group, a dimethylamino group, a tert-butyl group, and a side chain with an ester and a hydroxyl group.
 14.01 is a molecule with a hydroxyl group, a dimethylamino group, and a side chain with an ester and a hydroxyl group.
 An arrow points from the reactants to the product, **1044b**, which is a complex molecule featuring a fluorenyl group, a dimethylamino group, a tert-butyl group, and a side chain with an ester and a hydroxyl group.

Coupling reaction of the acid **1044a**, obtained in a similar manner as described for **1007f** (see preparation of Example **1007**), with the amine salt **14.01** was carried out as described before (see preparation of Example **1007**, Step 5). The crude material obtained after workup, **1044b** was carried forward without purification. LC-MS: 725.2 (M+H).

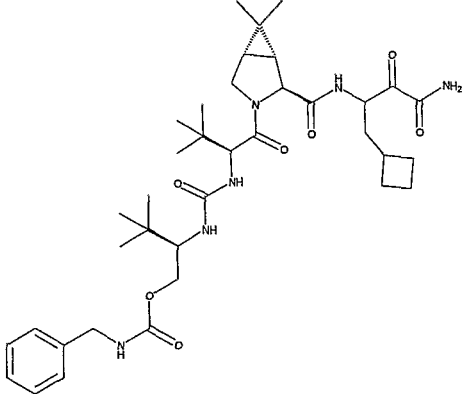
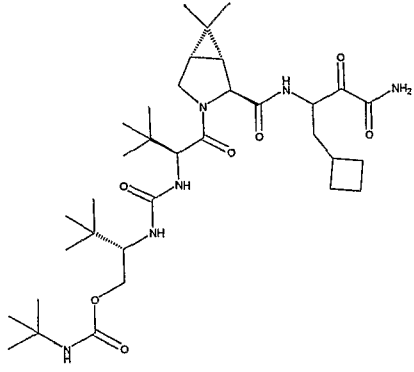
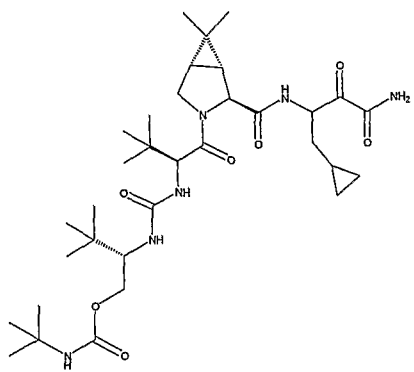
Step 2:

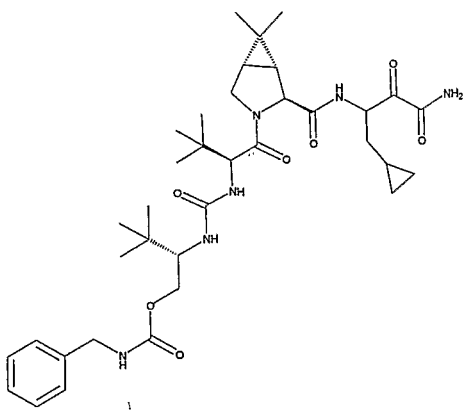
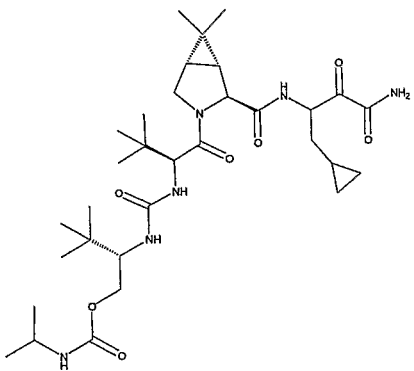
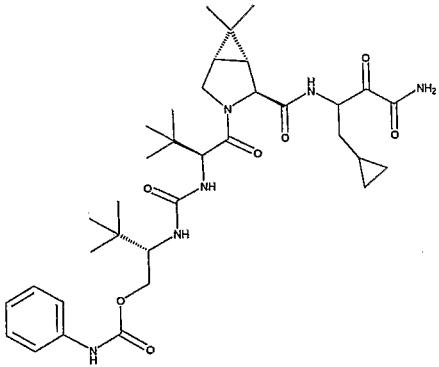
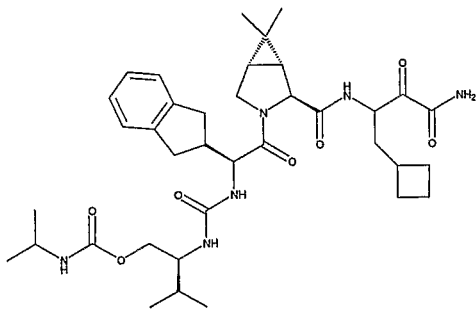


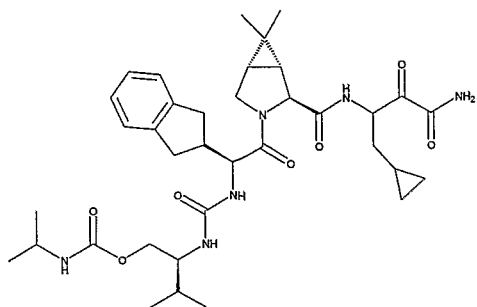
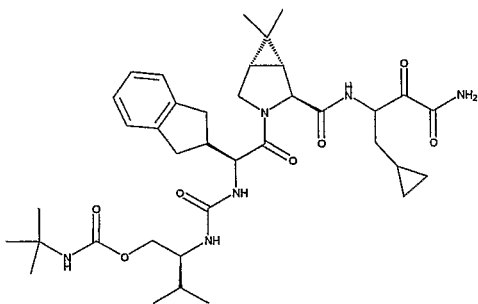
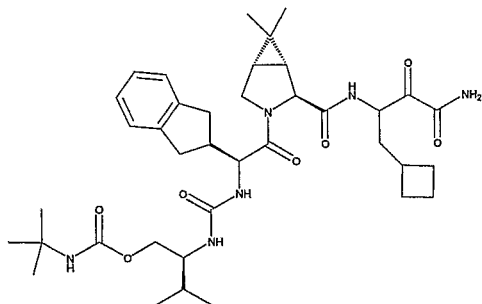
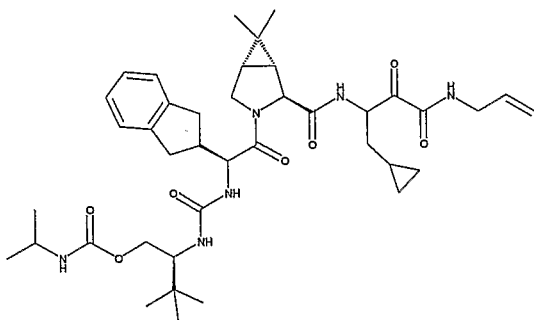
To a solution of the material from above, **1044b** (0.054 mmol) in dichloromethane (5 mL) was added Dess-Martin's periodinane (68 mg, 0.16 mmol). The reaction mixture was stirred at room temperature, under nitrogen atmosphere, for 4.5 hrs. The reaction mixture was diluted with dichloromethane (10 mL) and washed with aqueous 10% Na₂S₂O₃ (30 mL), saturated NaHCO₃ (30 mL), brine (30 mL), dried (Na₂SO₄), filtered and concentrated *in vacuo*. The crude residue was purified by flash column chromatography using 35/65 acetone/hexanes to provide the required target compound **1044** (23 mg, 0.032 mmol, 59% yield). LC-MS: 723.2 (M+H).

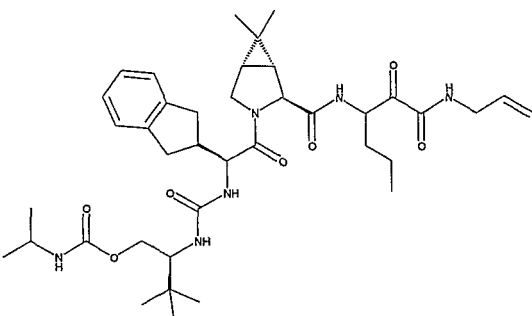
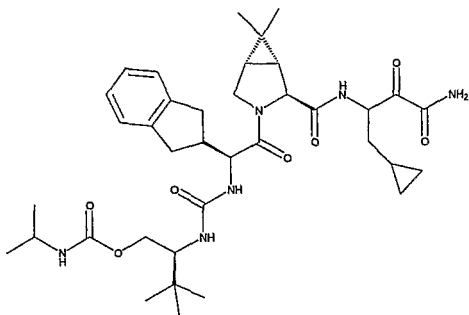
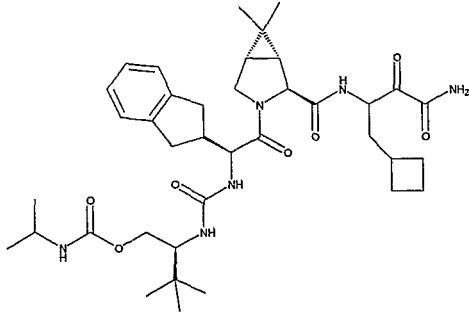
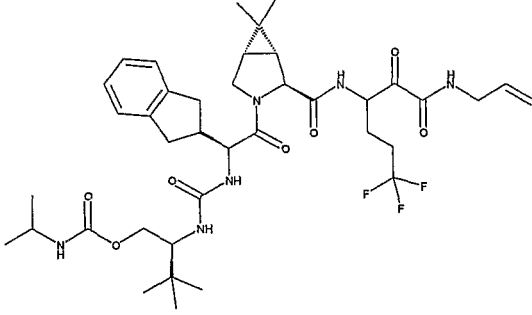
Compounds in the following **Table 1** and **Table 1A** were essentially prepared using the above-described procedures (Preparation of Examples **1007** and **1044**) with appropriate reagents and modifications as described in the General Schemes for Preparation of Target Compounds, Methods A-E.

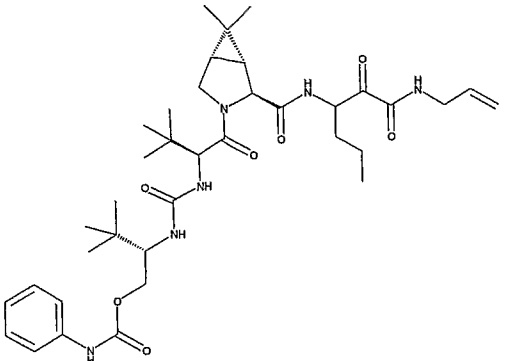
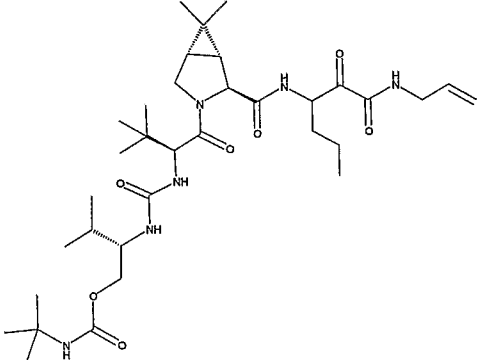
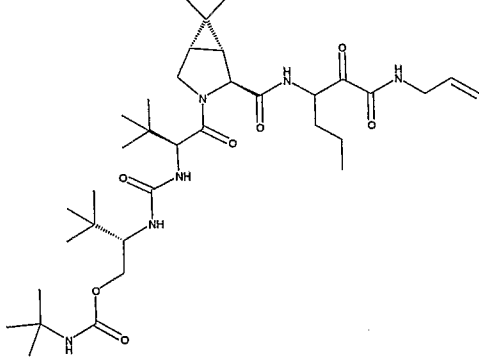
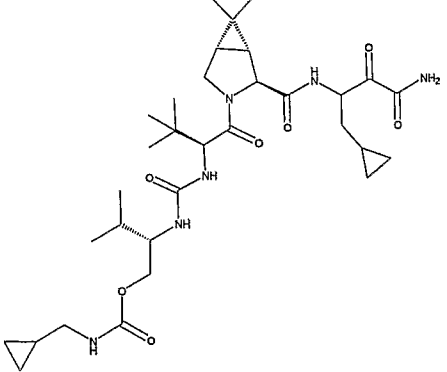
Table 1

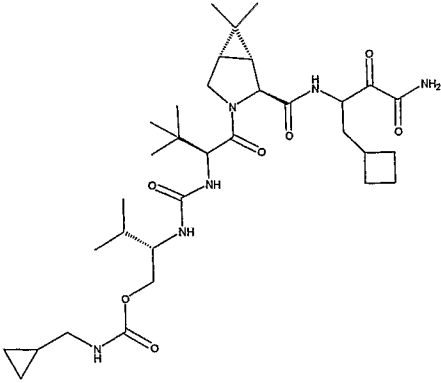
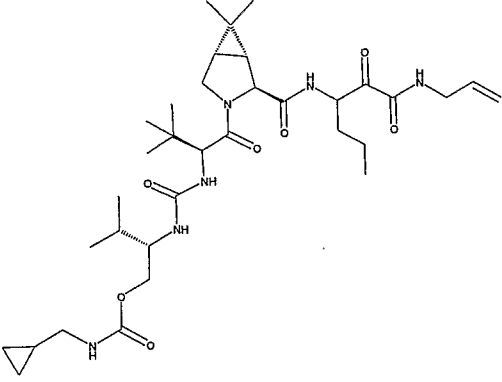
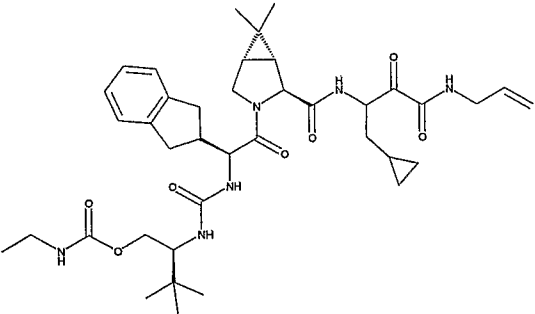
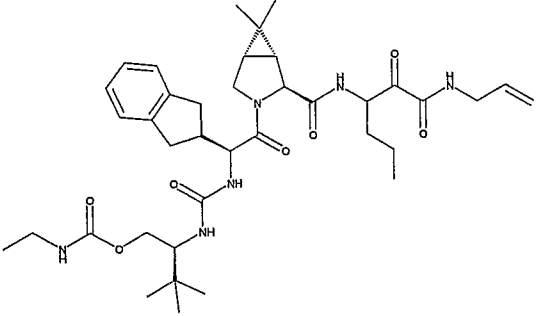
Example #	Structure	Ki* (nM)	Mol Weight
1001		A	696.885
1002		A	662.868
1003		A	648.841

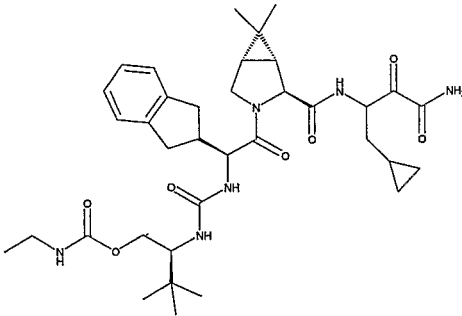
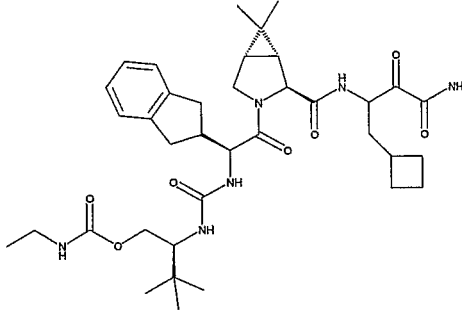
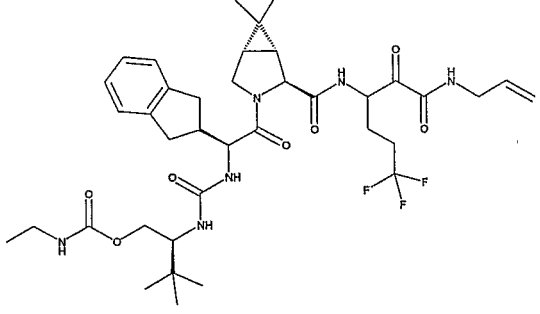
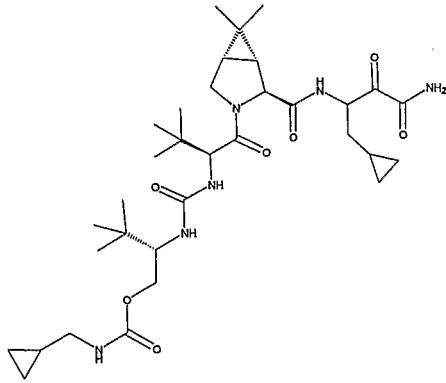
1004		A	682.859
1005		A	634.815
1006		A	668.832
1007		A	694.87

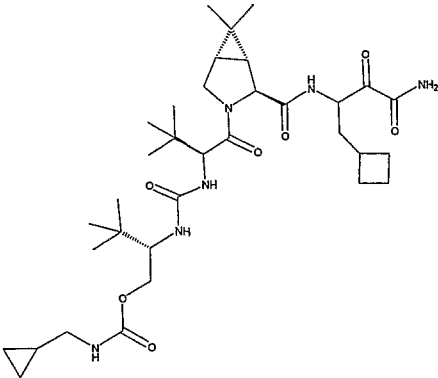
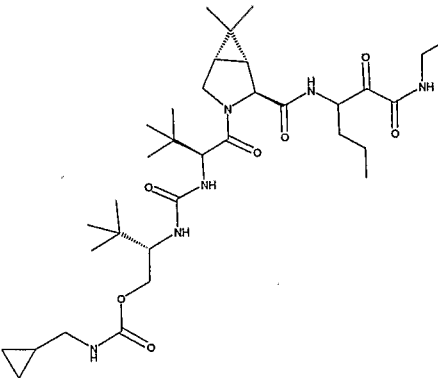
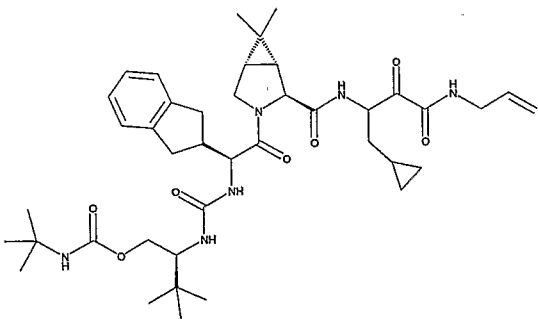
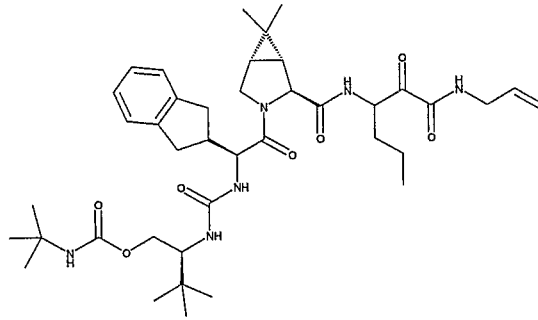
1008		A	680.843
1009		A	694.87
1010		A	708.896
1011		A	734.934

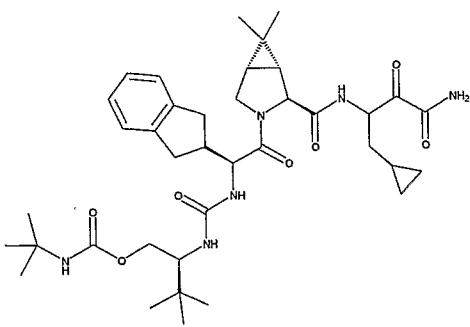
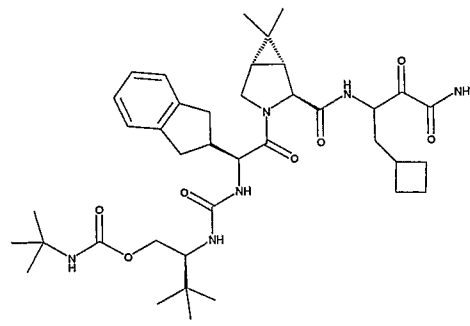
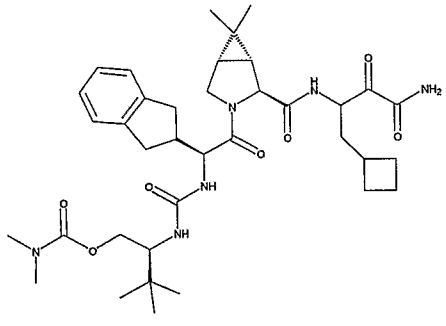
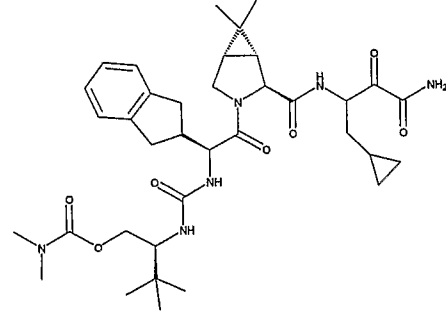
1012		A	722.923
1013		A	694.87
1014		A	708.896
1015		A	776.895

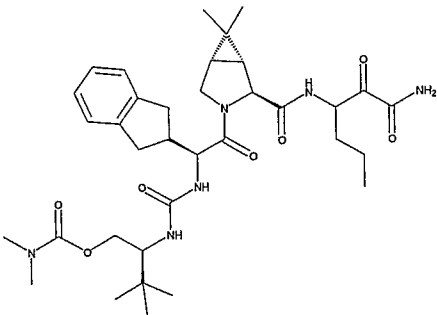
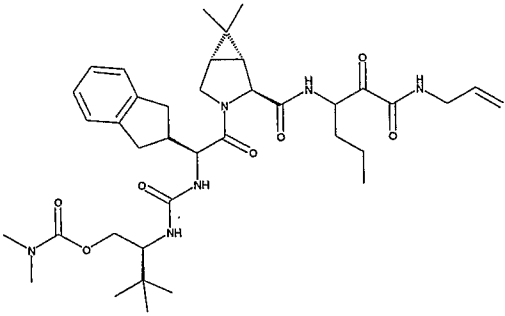
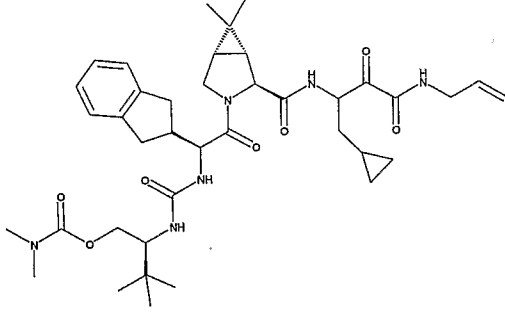
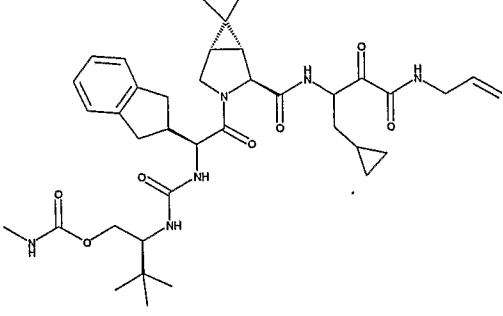
1016		A	696.885
1017		A	662.868
1018		A	676.895
1019		A	632.799

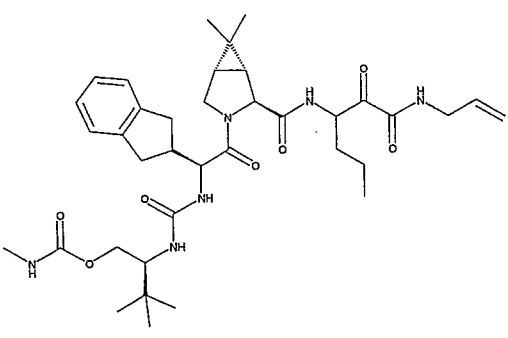
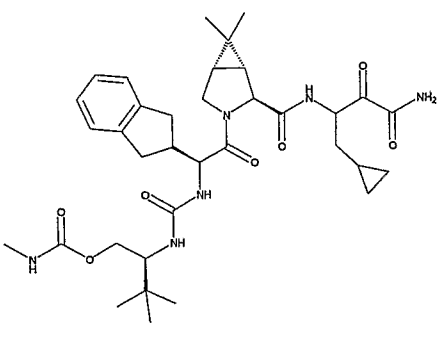
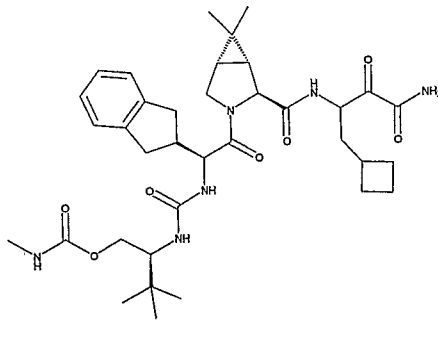
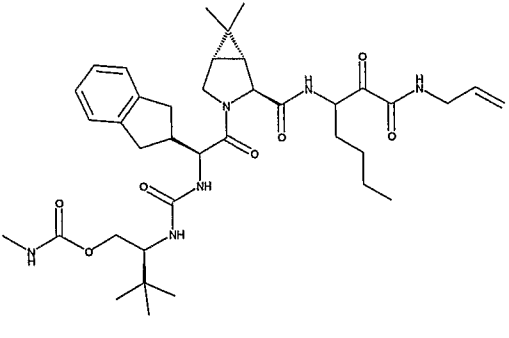
1020		A	646.826
1021		A	660.852
1022		A	720.907
1023		A	708.896

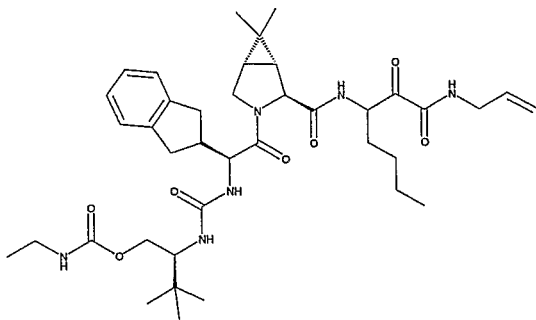
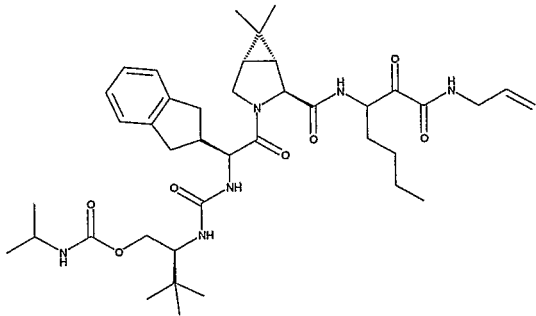
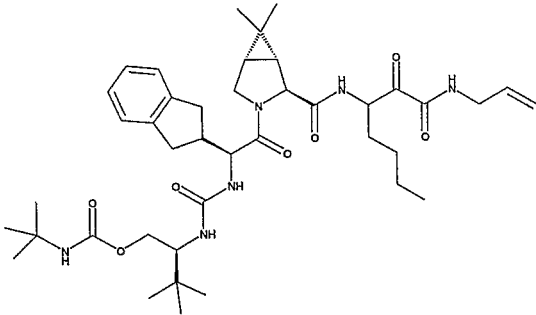
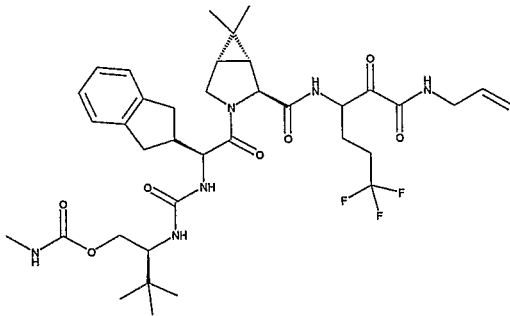
1024		A	680.843
1025		A	694.87
1026		A	762.868
1027		A	646.826

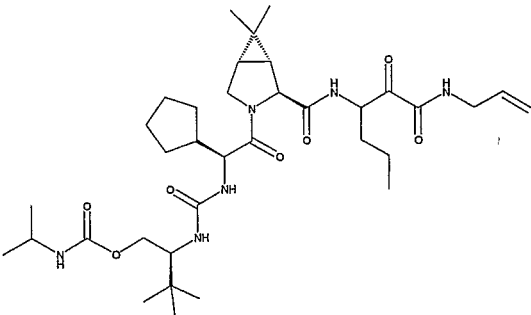
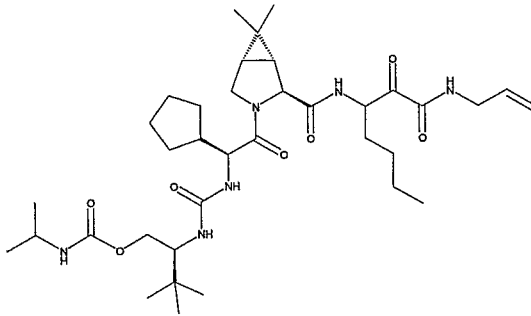
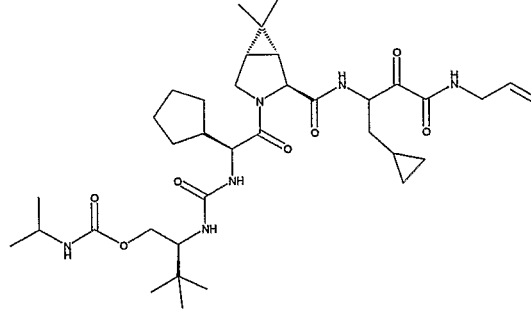
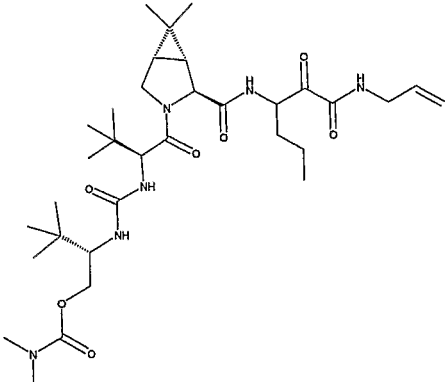
1028		A	660.852
1029		A	674.879
1030		A	748.961
1031		A	736.95

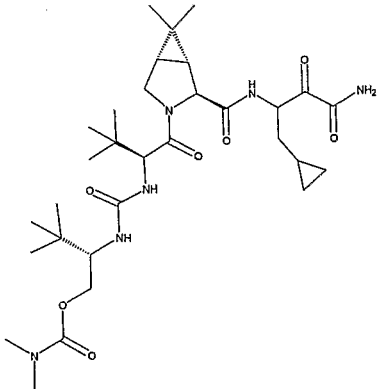
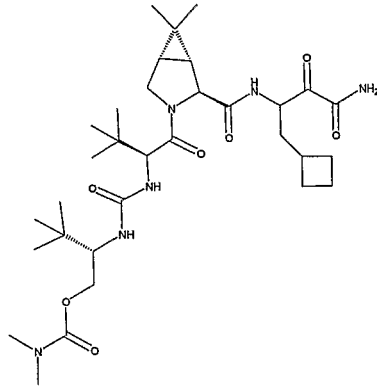
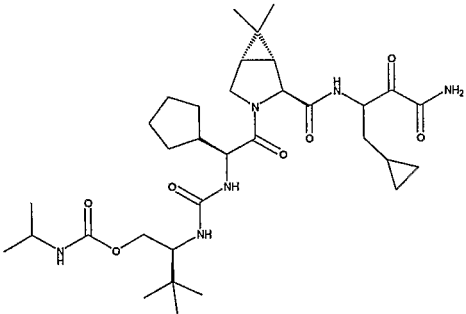
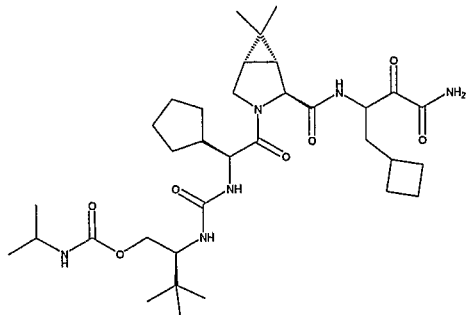
1032		A	708.896
1033		A	722.923
1034		A	694.87
1035		A	680.843

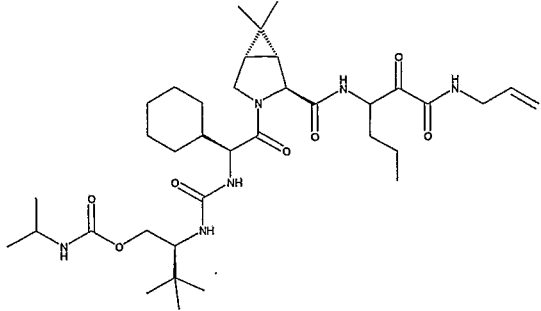
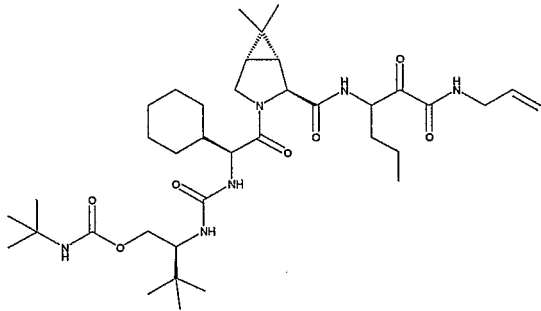
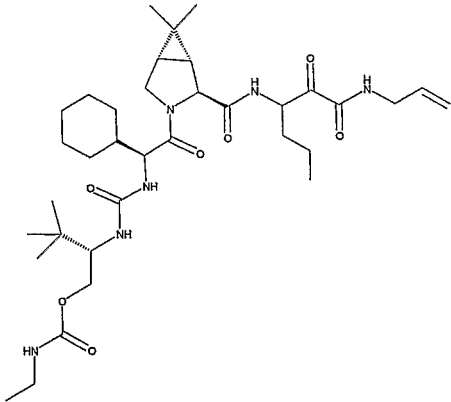
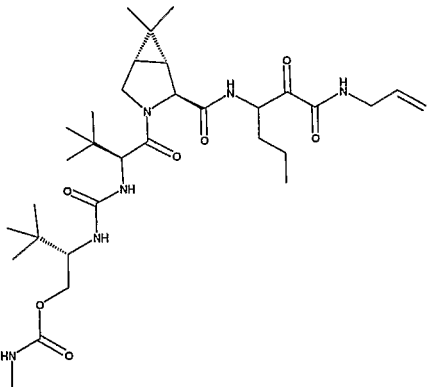
1036		A	668.832
1037		B	708.896
1038		B	720.907
1039		A	706.881

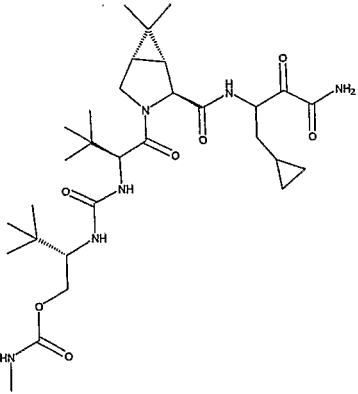
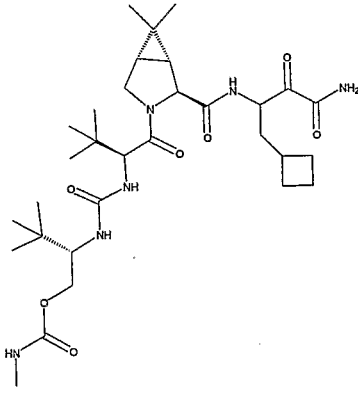
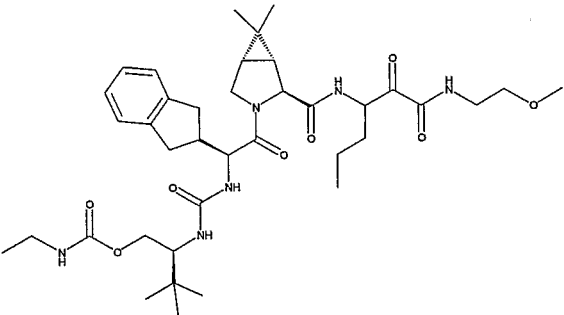
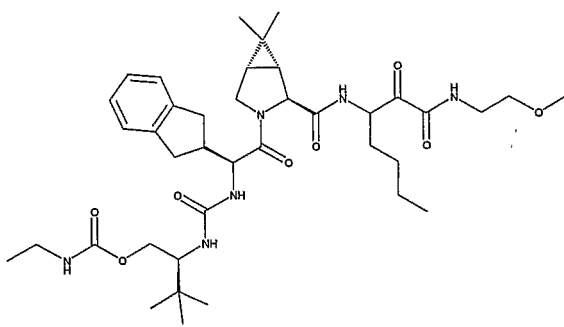
1040		A	694.87
1041		A	666.816
1042		A	680.843
1043		A	708.896

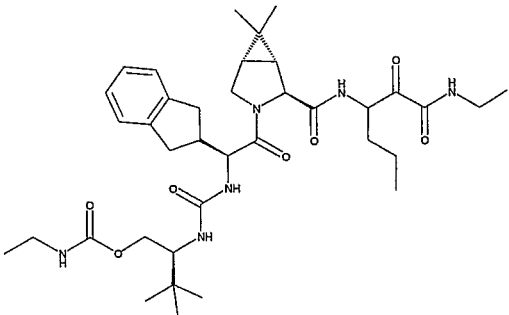
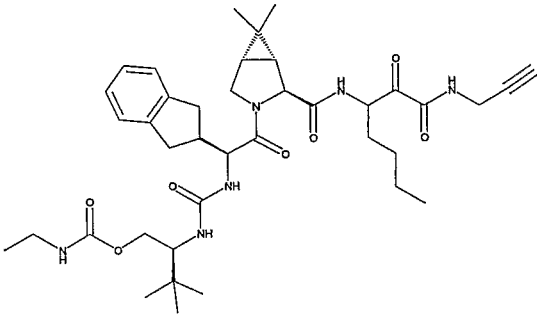
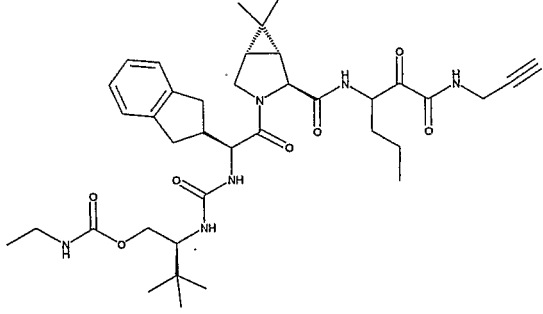
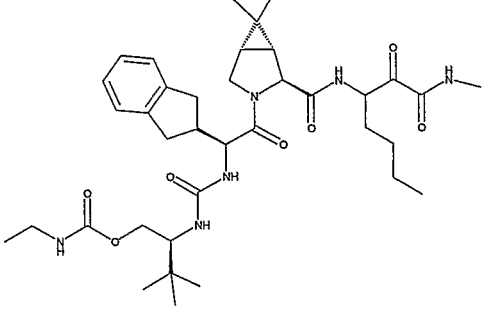
1044		A	722.923
1045		A	736.95
1046		A	750.977
1047		A	748.841

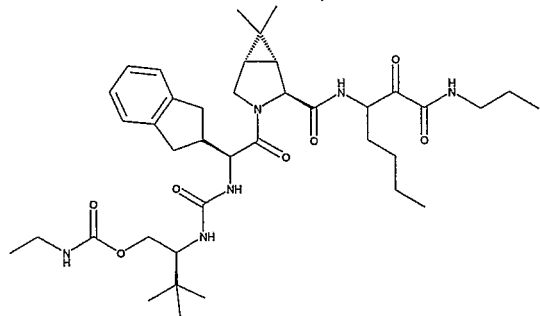
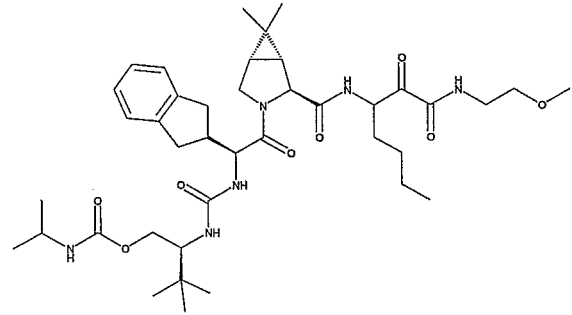
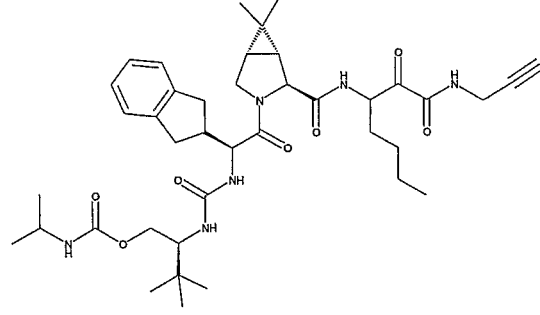
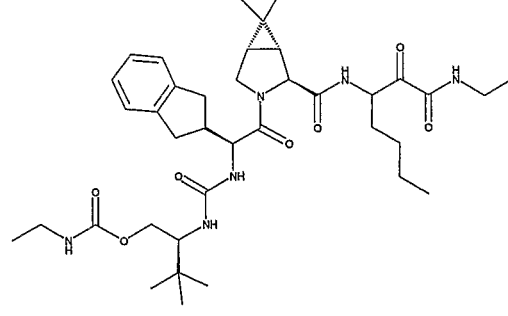
1048		A	674.879
1049		A	688.906
1050		B	686.89
1051		A	648.841

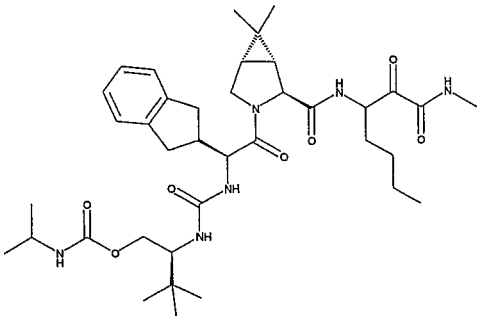
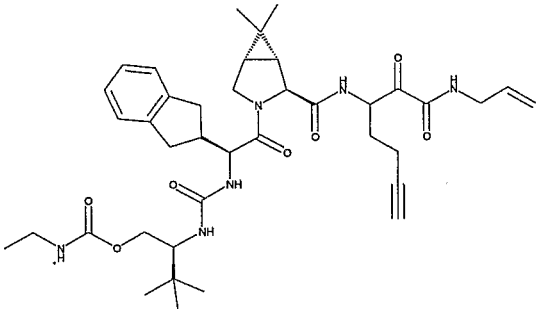
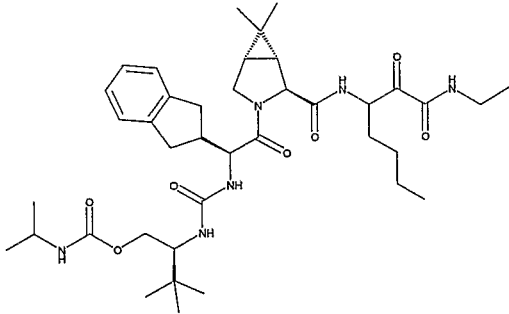
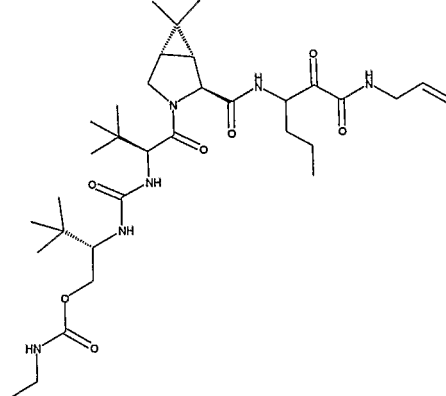
1052		A	620.788
1053		A	634.815
1054		A	646.826
1055		A	660.852

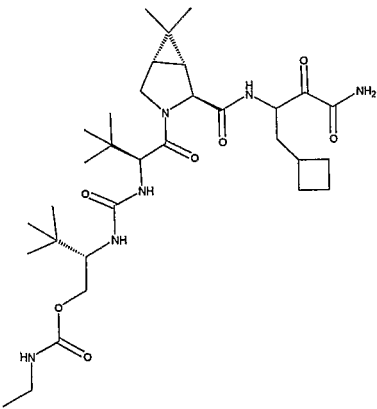
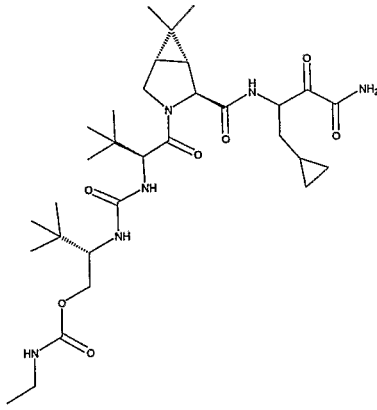
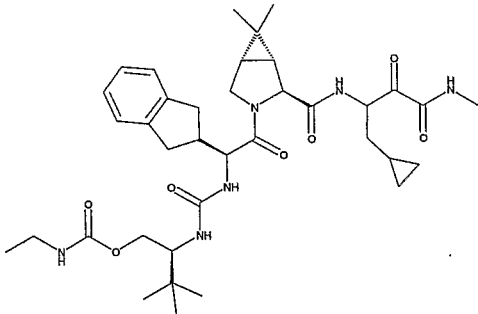
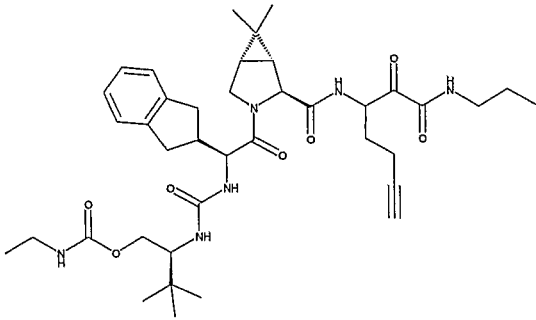
1056		A	688.906
1057		A	702.933
1058		A	674.879
1059		A	634.815

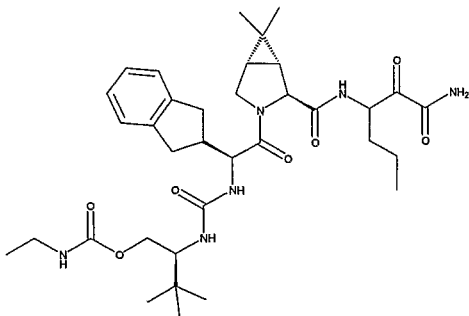
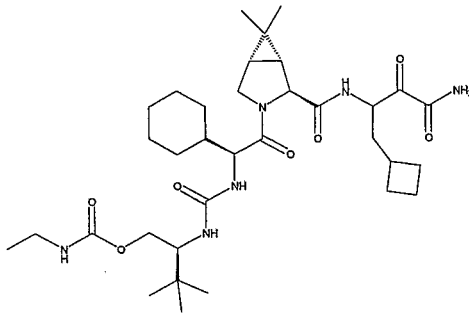
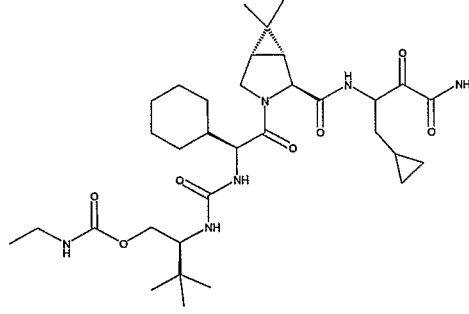
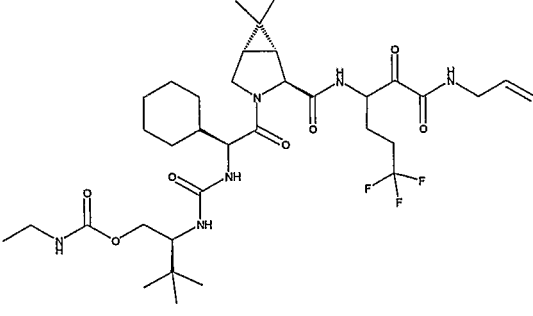
1060		A	606.761
1061		A	620.788
1062		B	726.912
1063		B	740.938

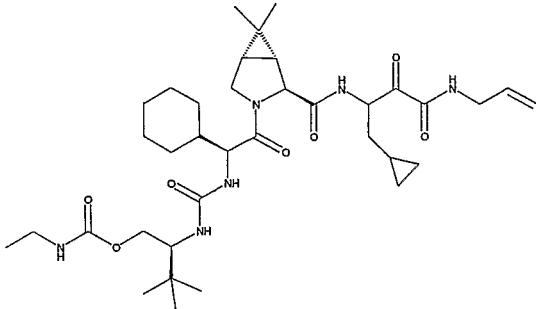
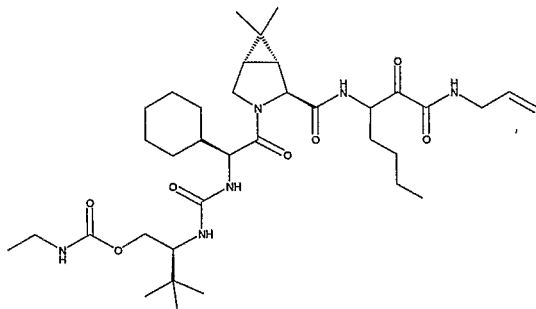
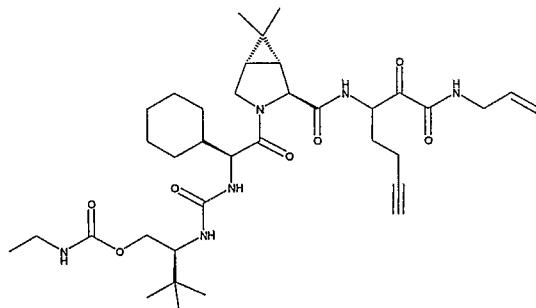
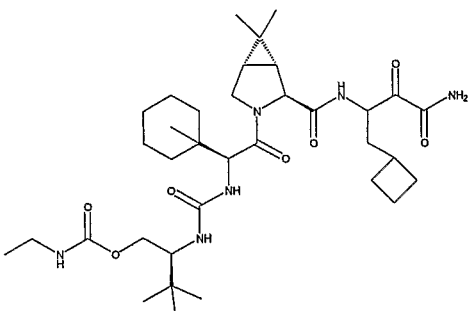
1064		B	696.885
1065		A	720.907
1066		A	706.881
1067		A	696.885

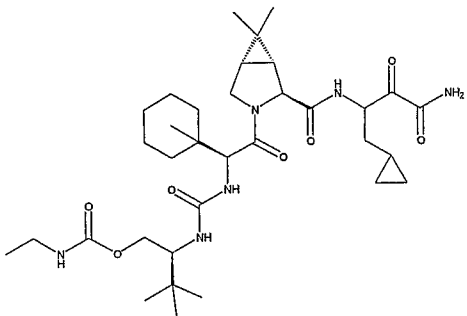
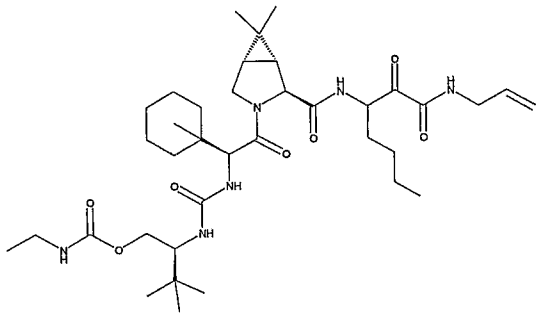
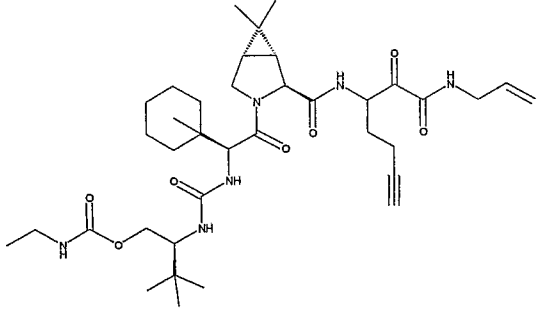
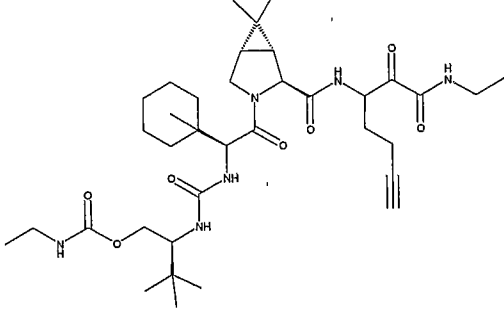
1068		B	724.939
1069		B	754.965
1070		A	734.934
1071		A	710.912

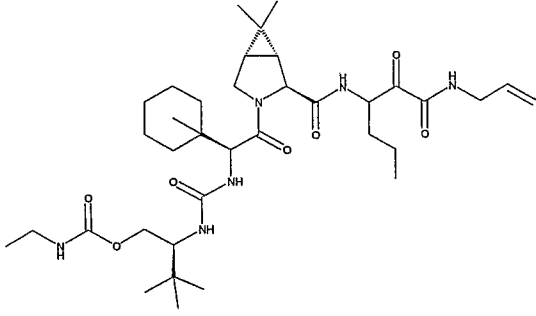
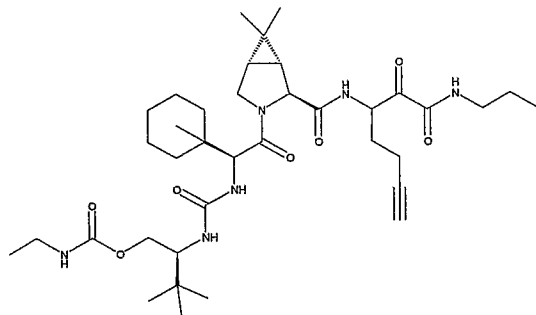
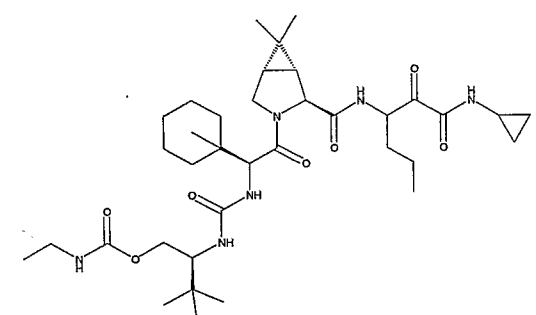
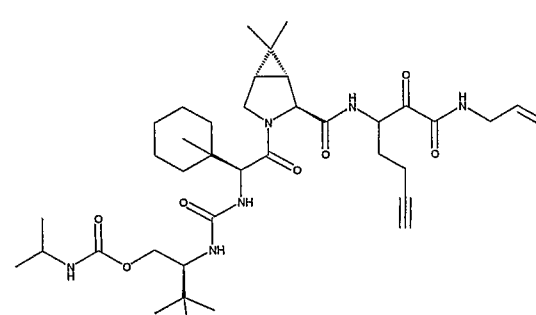
1072		A	710.912
1073		A	718.892
1074		B	724.939
1075		A	648.841

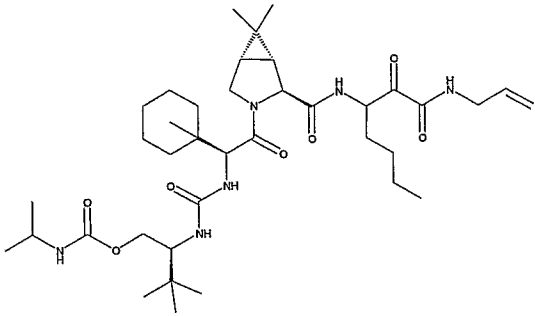
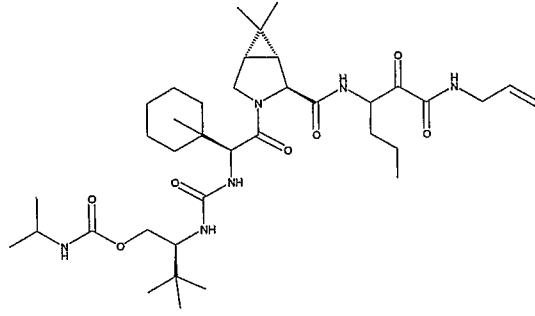
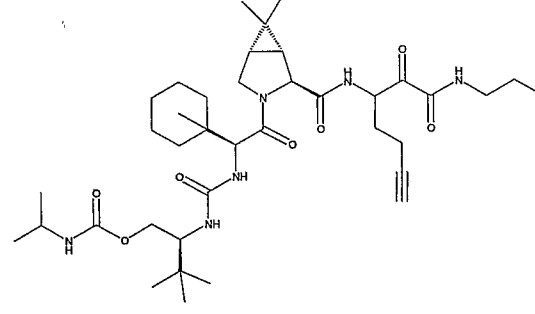
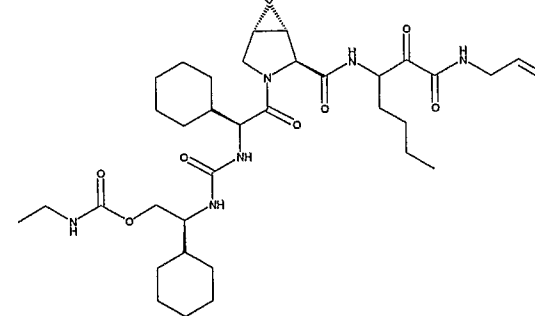
1076		A	634.815
1077		A	620.788
1078		B	694.87
1079		A	720.907

1080		A	668.832
1081		A	660.852
1082		A	646.826
1083		A	728.851

1084		A	686.89
1085		A	688.906
1086		A	684.874
1087		A	674.871

1088		A	660.844
1089		A	702.924
1090		A	698.892
1091		A	686.882

1092		A	688.898
1093		A	700.908
1094		A	688.898
1095		A	712.919

1096		A	716.951
1097		A	702.924
1098		A	714.935
1099		A	714.935

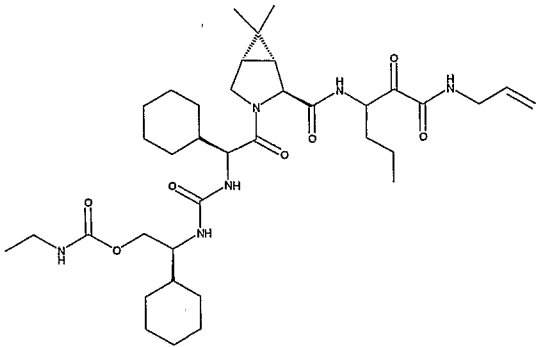
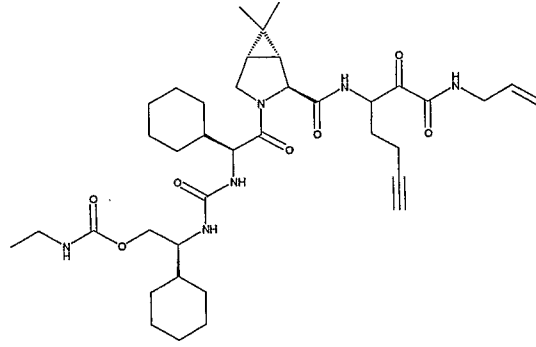
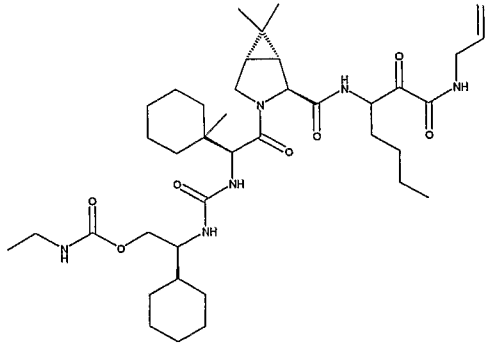
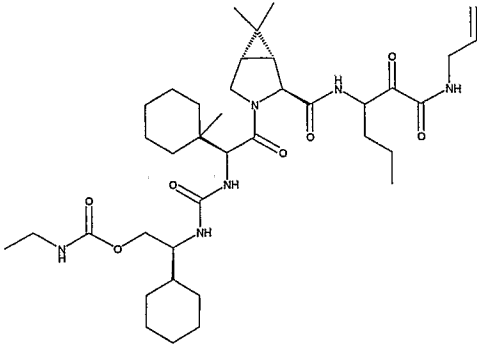
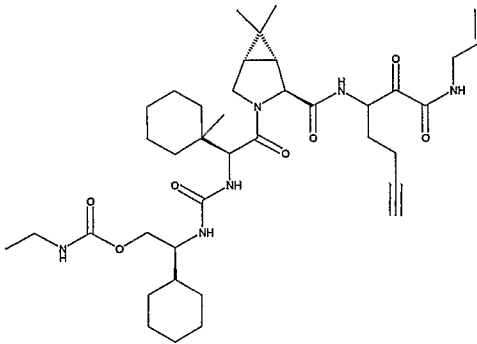
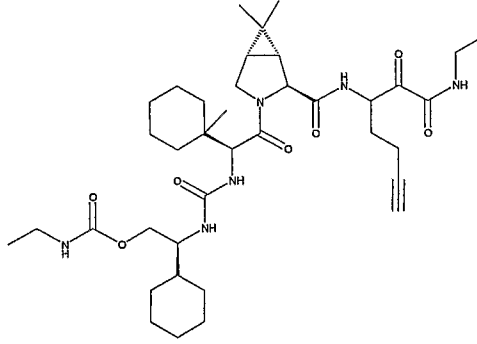
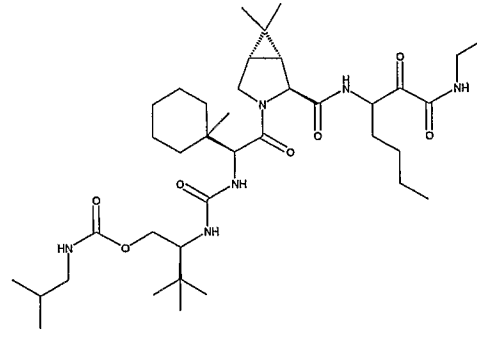
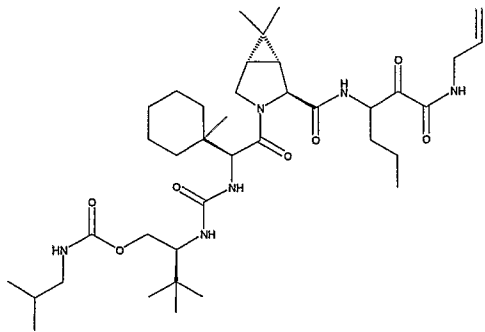
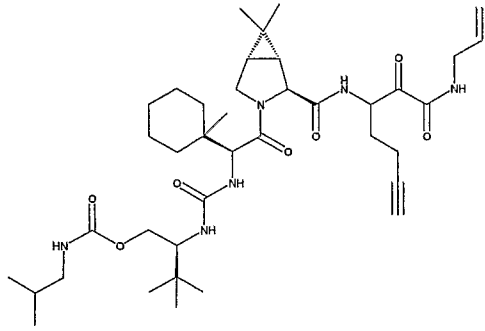
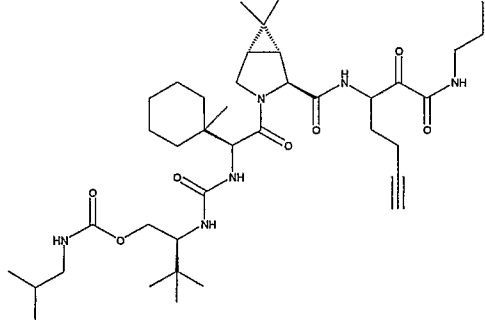
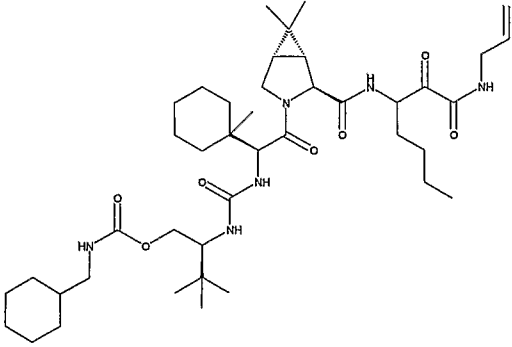
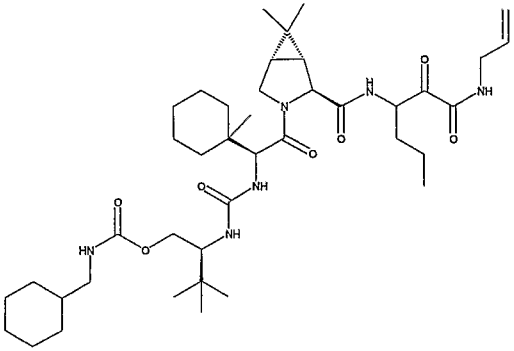
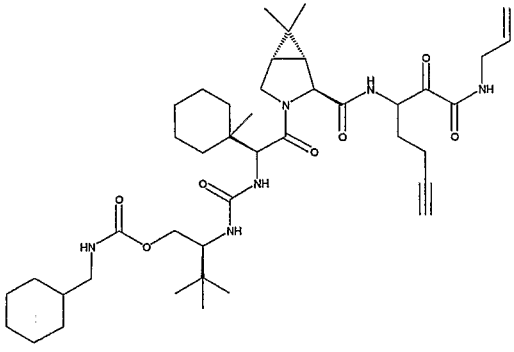
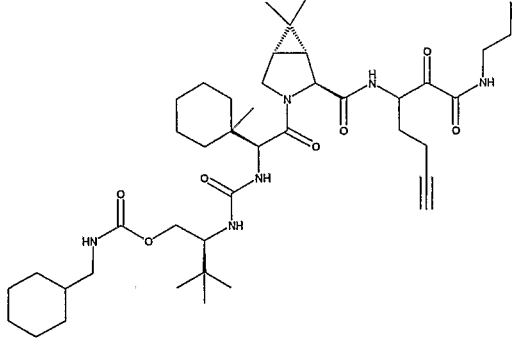
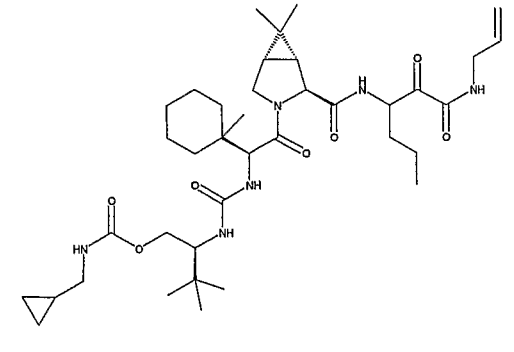
1100		A	700.908
1101		A	710.903

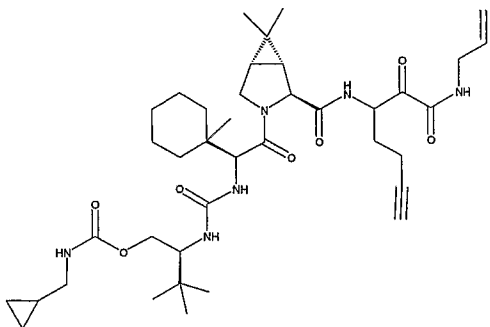
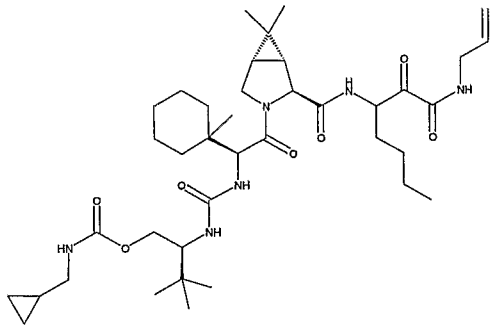
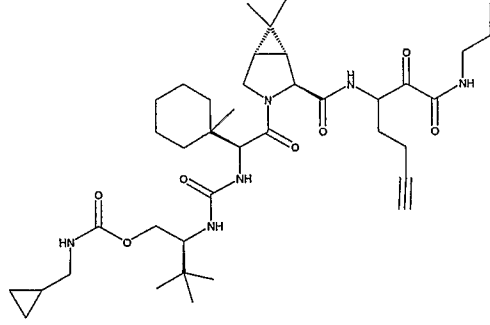
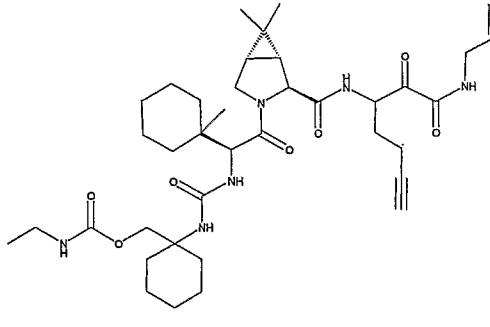
Table 1A

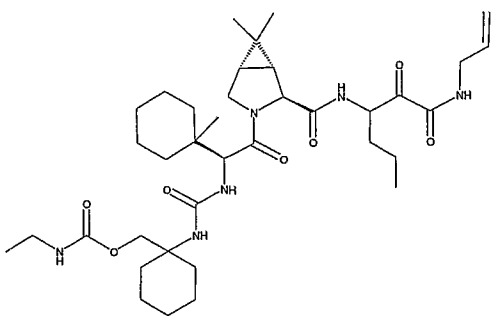
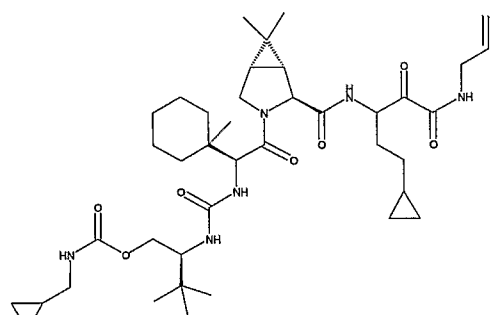
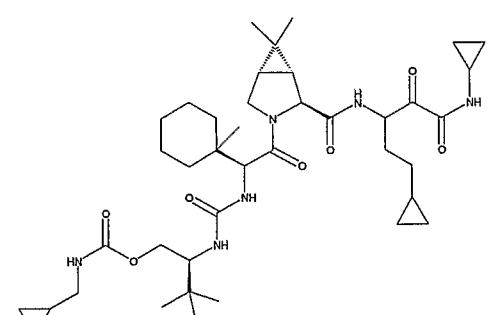
Example #	Structure	Ki* (nM)	LC-MS (M+H)
1102		A	729.2

1103		B	715.2
1104		A	725.2
1105		A	727.2
1106		A	731.2

1107		A	717.2
1108		A	727.2
1109		A	729.2
1110		B	772.2

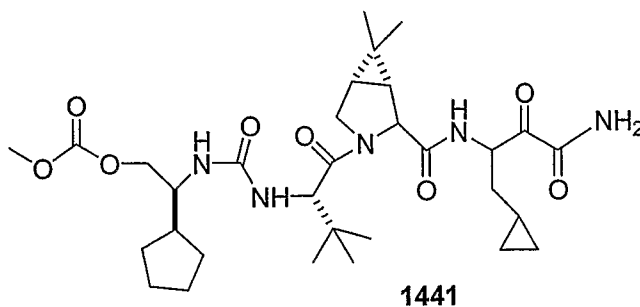
1111		B	757.2
1112		A	767.2
1113		B	769.4
1114		A	715.2

1115		A	724.939
1116		A	729.2
1117		A	727.2
1118		A	711.2

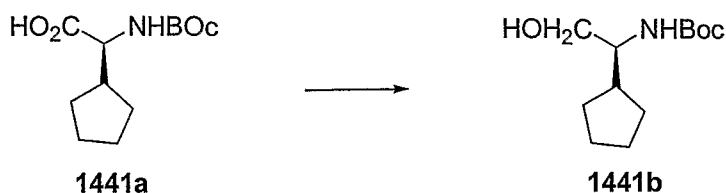
1119		B	701.2
1120		A	741.2
1121		A	741.4

Ki* range: A = <75 nM, B = 75-250 nM; C = > 250 nM

Preparation of Example 1441:

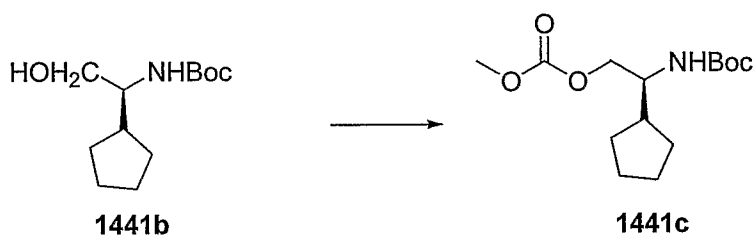


1441



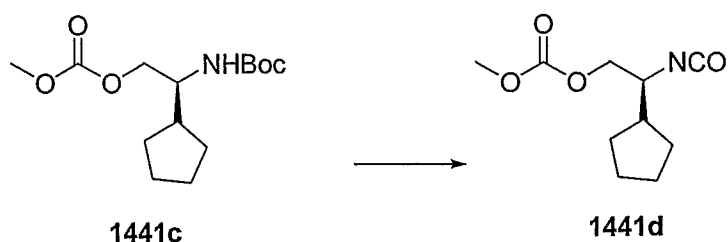
To a ice cooled solution of **1441a** (4.28 g, 10.08 mmol) in anhydrous ether (100 mL) was added LAH (1.53 g, 40.32 mmol) and the reaction mixture was allowed to warm to room temperature overnight. The reaction mixture was cooled to 0°C and EtOAc (3 mL) was added to it, followed by aqueous KHSO₄ (10 g in 25 mL of H₂O). The gummy residue was extracted with ether (300 mL) and the organic layer was washed with satd. NaHCO₃, followed by 10% aq. KH₂PO₄, brine, dried over MgSO₄, filtered and concentrated. The crude residue was purified by flash chromatography over SiO₂ using ethyl acetate/DCM (1:4) to yield **1441b** (2.14g, 92%).

Step2



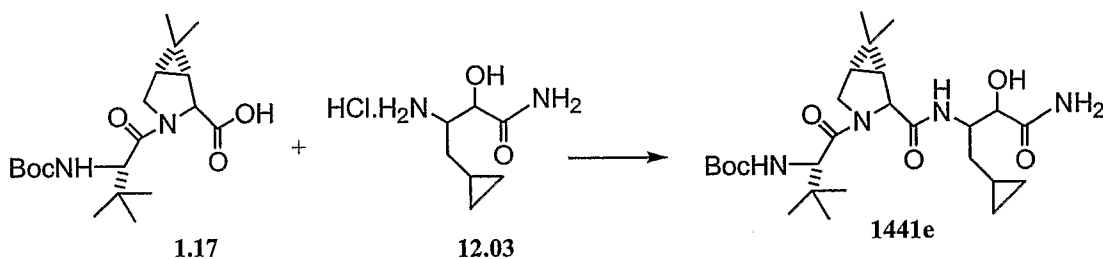
To a ice cooled solution of **1441b** (743 mg, 3.24 mmol) in anhydrous pyridine (10 mL) was added methyl chloroformate (1 mL, 13 mmol), followed by DMAP (1.6 g, 13 mmol) and the reaction mixture was allowed to warm to room temperature over 2 days. The reaction mixture was concentrated and EtOAc (100 mL) was added to it followed by 100 mL of ice-cold (5% KH₂PO₄containing 0.05 volumes of 1M H₃PO₄). The organic layer was washed with brine and dried over MgSO₄, filtered and concentrated. The crude was purified by flash chromatography over SiO₂ using ethyl acetate/DCM (1:4) to yield **1441c** (931 mg, 100% yield).

Step 3



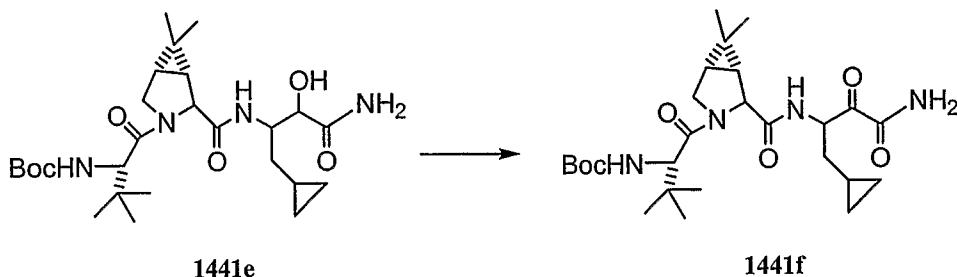
1441c was dissolved in 4M HCl in dioxane (10 mL) and concentrated after 30 min. Saturated NaHCO₃ (25 mL) was added to an ice-cold solution of the crude hydrochloride salt (194 mg, 1 mmol) in CH₂Cl₂ (25 mL). The reaction mixture was stirred vigorously for 10 min and COCl₂ (1.85 M solution in PhMe, 4 mL) was added to it and stirring was continued at room temperature for 1h. The organic layer was separated, dried over MgSO₄, filtered and concentrated to half the volume to yield **1441d** as a 0.05 M solution in CH₂Cl₂.

Step 4



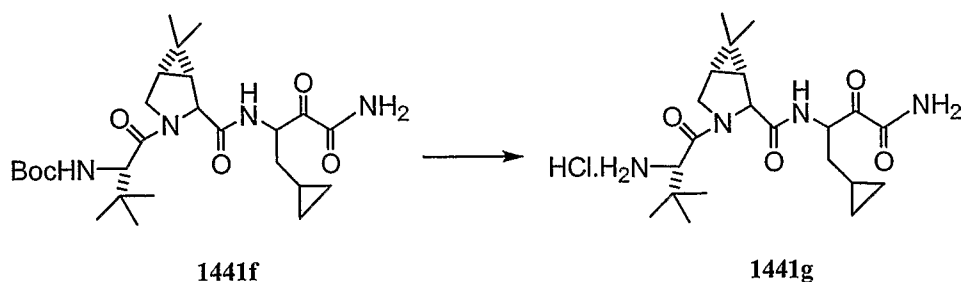
To a -20°C solution **1.17** (10.4 g, 28 mmol; obtained by the hydrolysis of **20.06** using the procedure described for Intermediate **20.04**, Step 2) in DCM (300 mL) was added HATU (1.05 equiv, 29.4 mmol, 11.2g), amine salt, Intermediate **12.03** (1.0 equiv, 28 mmol, 5.48 g). After 10 min at -20°C, DIPEA (3.6 equiv, 100 mmol, 17.4 mL) was added. Reaction was stirred at this temp for 16 hr. After 16 hr, the reaction was diluted with EtOAc and washed successively with NaHCO₃, citric acid (10% w/w) and brine. Organic layer was dried over MgSO₄, filtered and concentrated *in vacuo* to yield 14 g of the required intermediate **1441e**.

Step 5



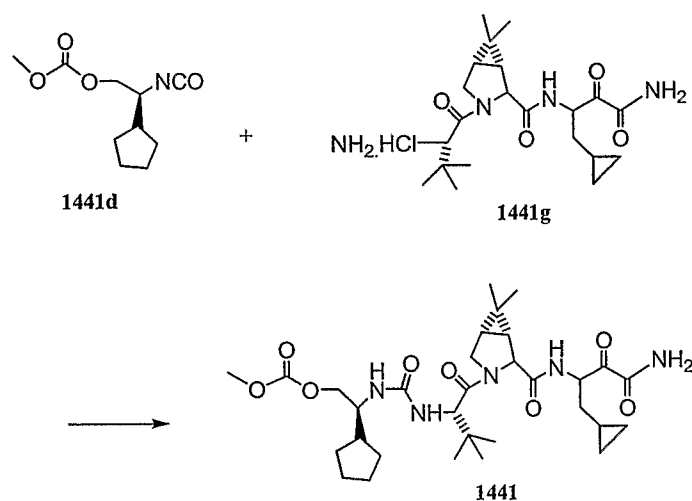
The hydroxyamide **1441e** was oxidized to the required ketoamide **1441f** in a manner described for Example **1007**, Step 6. LC-MS = 507 (M+H)⁺

Step 6



Deprotection of the t-Boc functionality of **1441f** to give the required material **1441g** was carried out as described for Example **1007**, Step 2.

Step 7



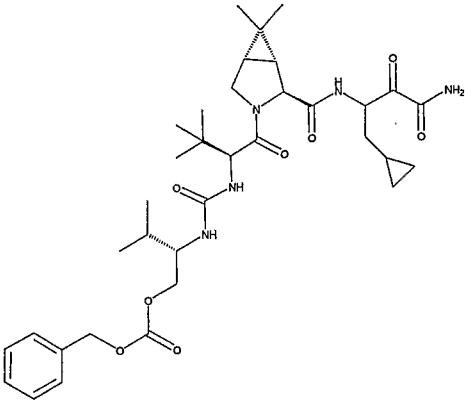
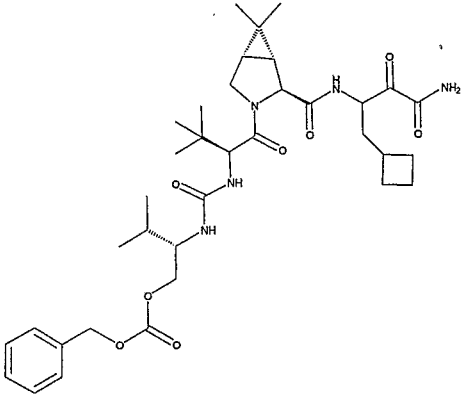
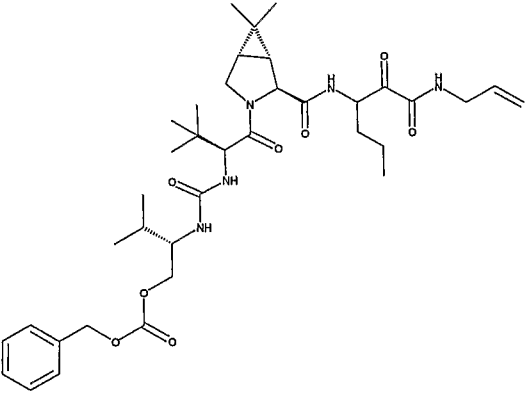
5

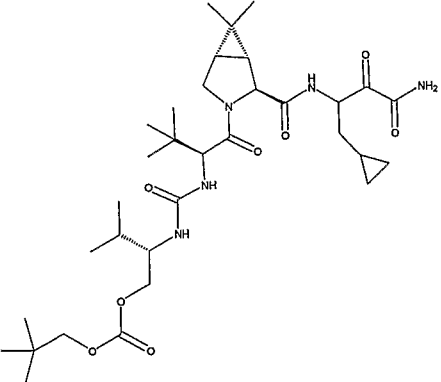
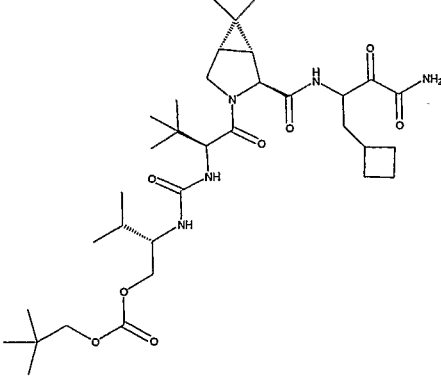
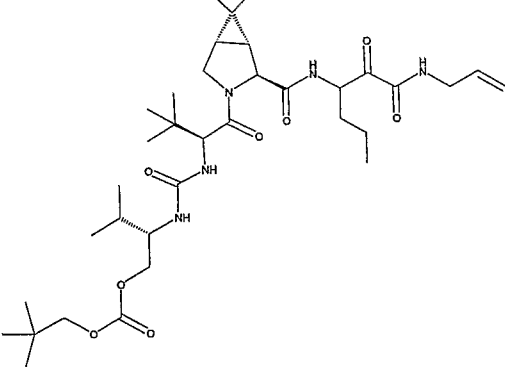
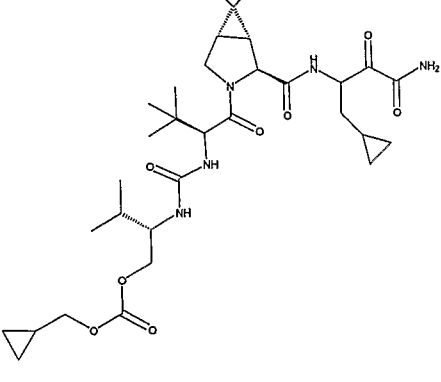
To a cooled solution (0 °C) of the amine hydrochloride **1441g** (20 mg, 0.045 mmol) in CH₂Cl₂ (2.0 mL) was added **1441d** (1.35 mL, 0.135 mmol), followed by DIPEA (63 μL, 0.4 mmol). The reaction mixture was stirred at room temperature for 1.2 h, diluted with ethyl acetate (20 mL), washed with 3% citric acid, brine, dried over MgSO₄, filtered, concentrated and purified over SiO₂ using EtOAc/DCM (1:9 to 9:1) to yield **1441** (23 mg). LCMS = 620.3 (M+H)⁺.

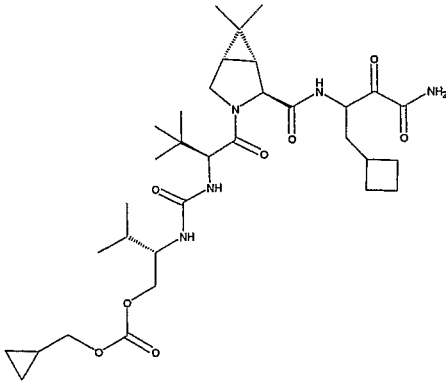
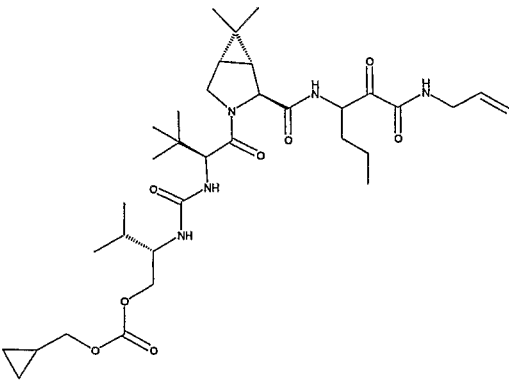
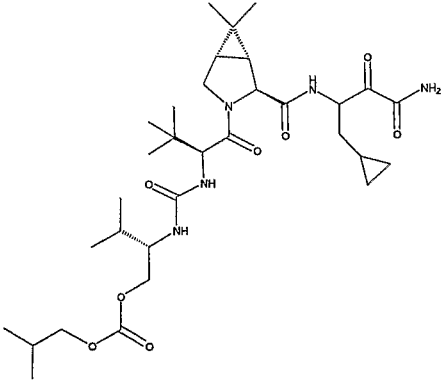
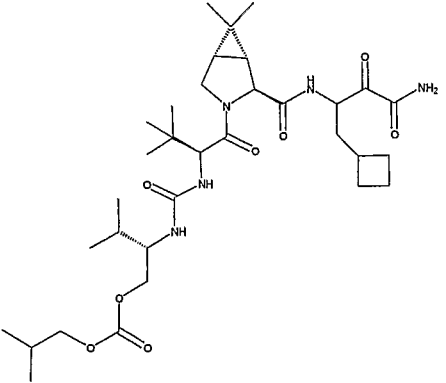
Compounds in the following table (**Table 2**) were essentially prepared using the above described procedures (Preparation of Example **1441**) with appropriate reagents and modifications as described in the General Schemes for Preparation of Target Compounds, Methods A-E.

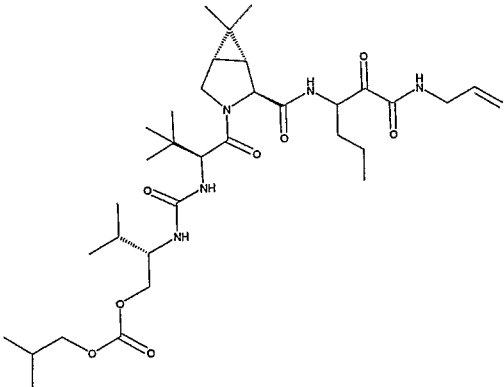
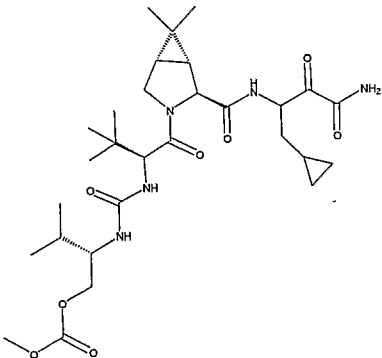
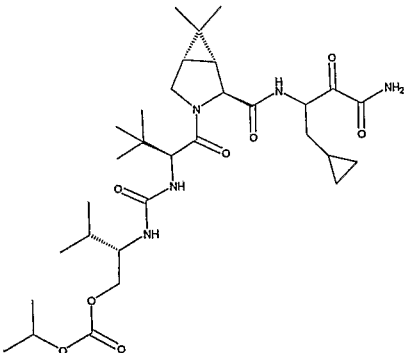
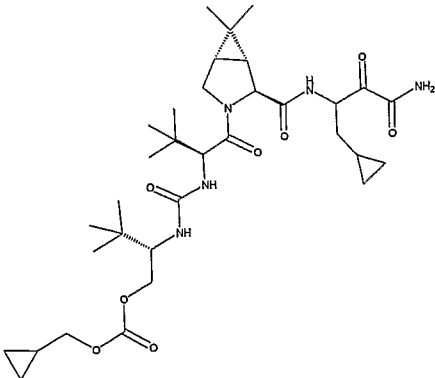
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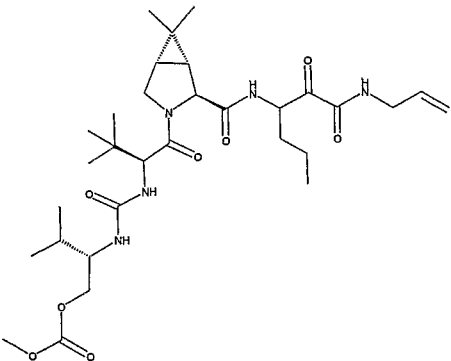
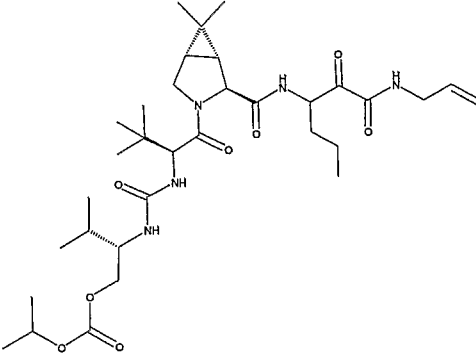
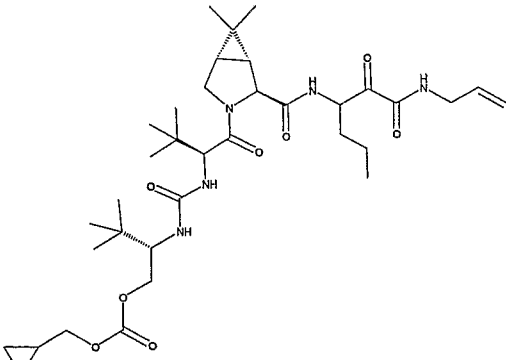
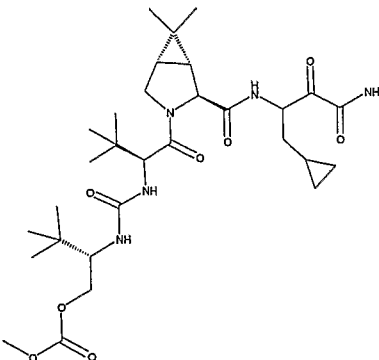
Table 2

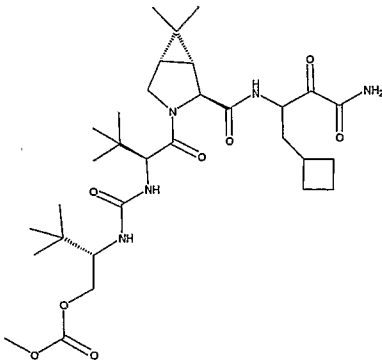
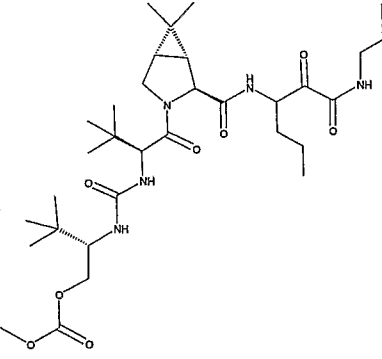
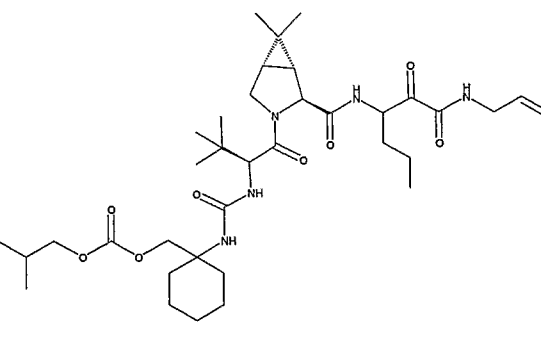
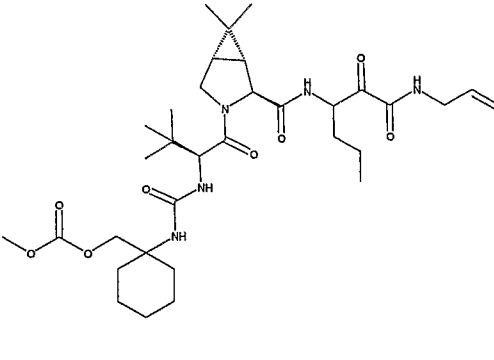
Example #	Structure	Ki* (nM)	Mol Weight
1401		A	669.817
1402		A	683.843
1403		B	697.87

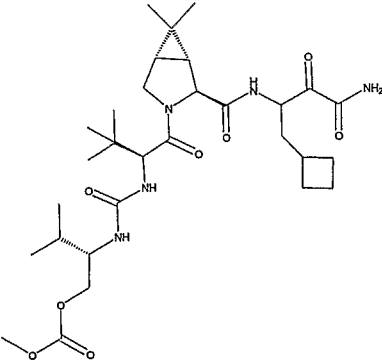
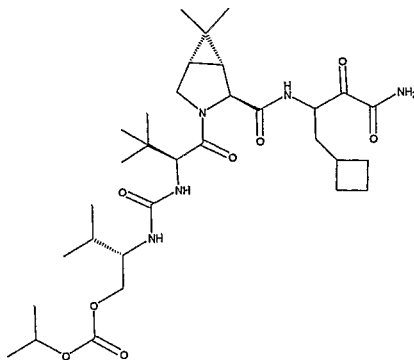
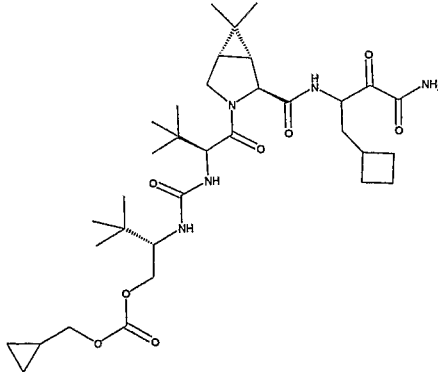
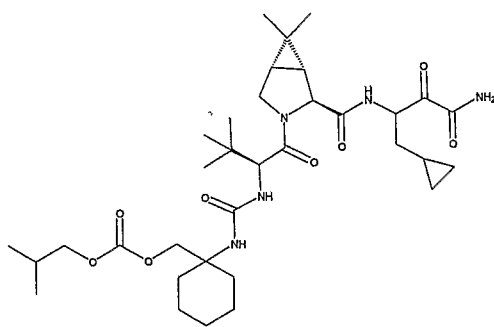
1404		A	649.826
1405		A	663.853
1406		B	677.88
1407		A	633.784

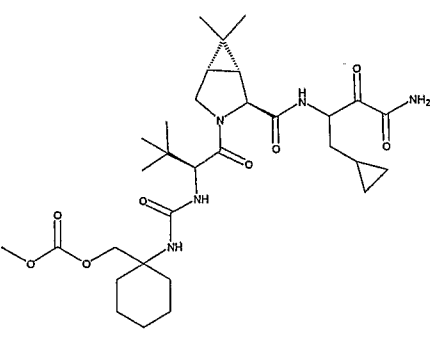
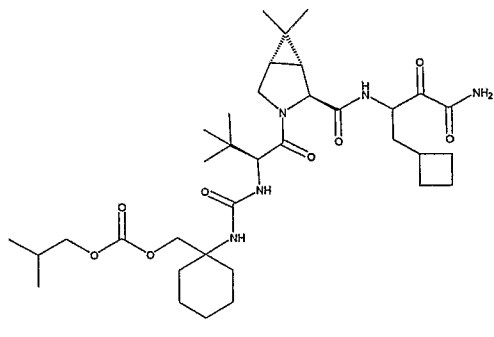
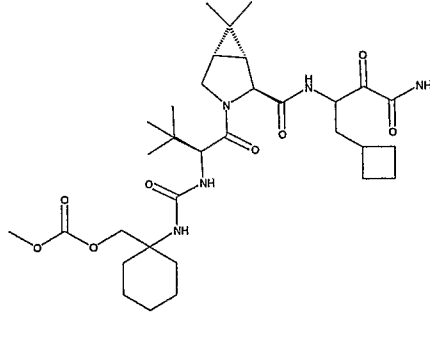
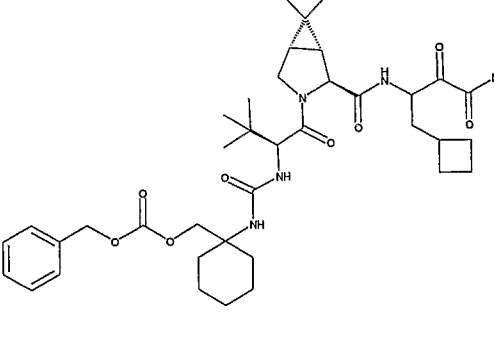
1408		A	647.81
1409		B	661.837
1410		A	635.799
1411		A	649.826

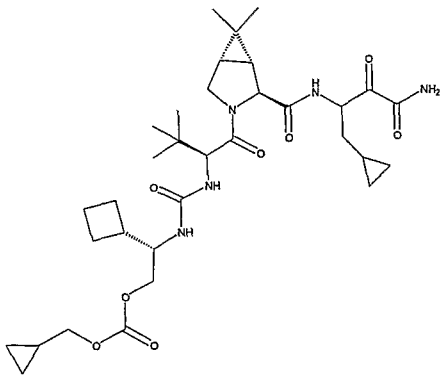
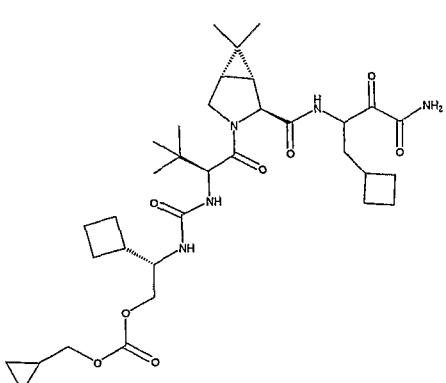
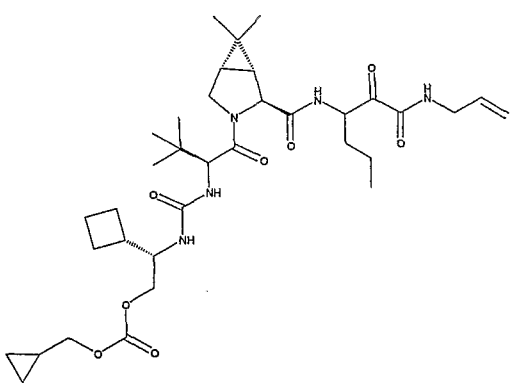
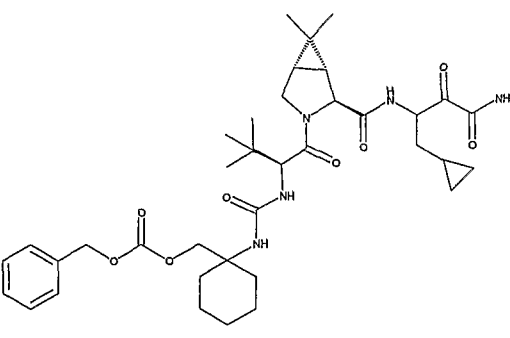
1412		A	663.853
1413		A	593.719
1414		A	621.773
1415		A	647.81

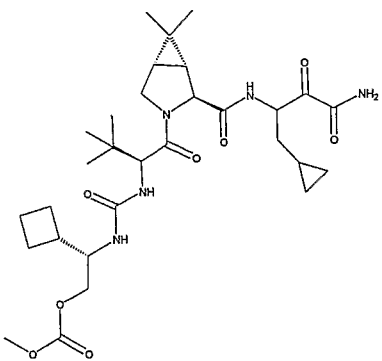
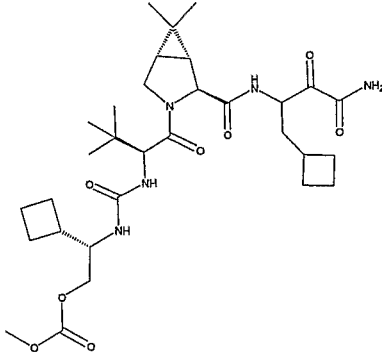
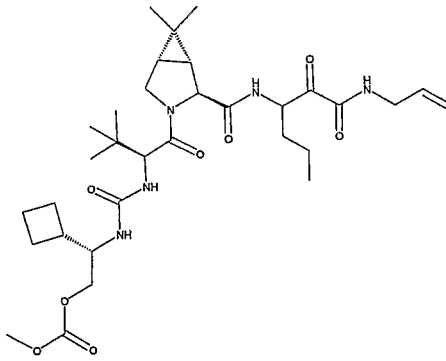
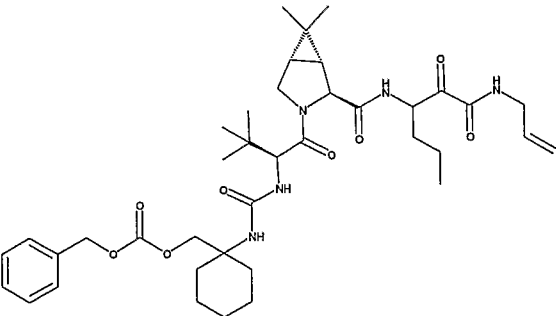
1416		A	621.773
1417		A	649.826
1418		A	675.864
1419		A	607.746

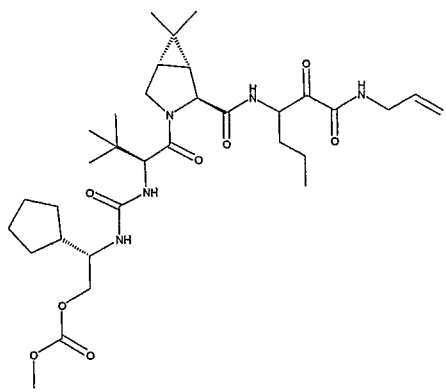
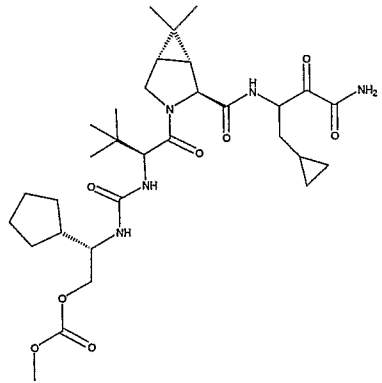
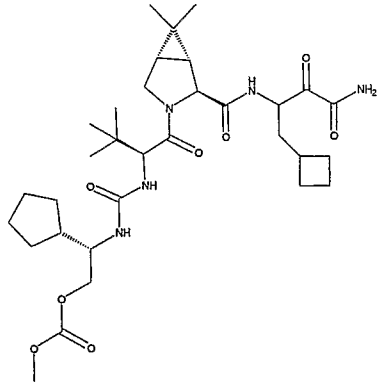
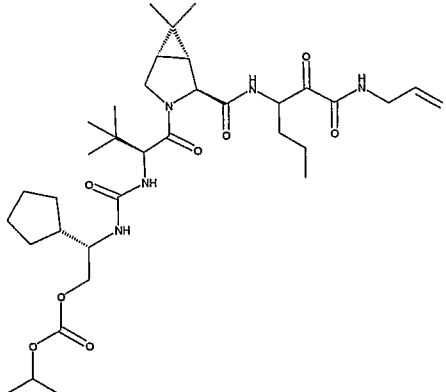
1420		A	621.773
1421		A	635.799
1422		C	689.891
1423		B	647.81

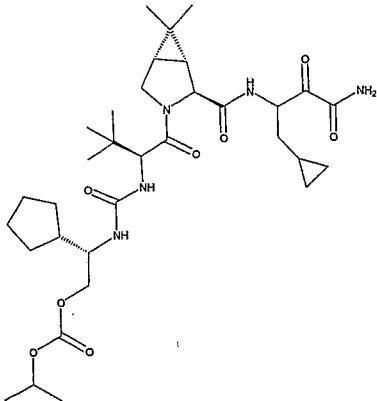
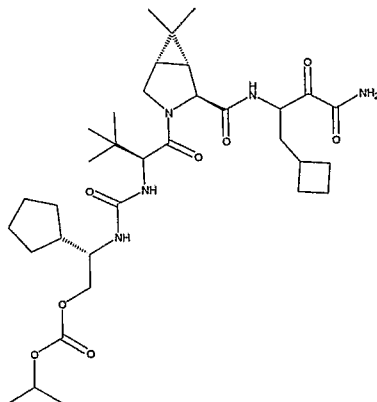
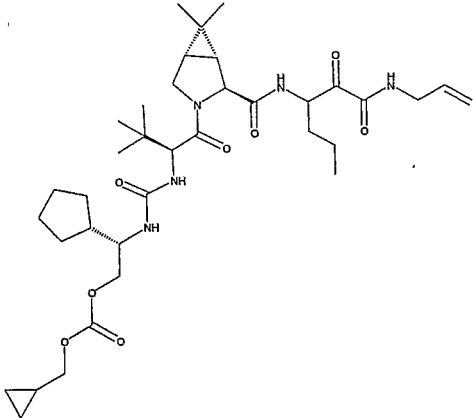
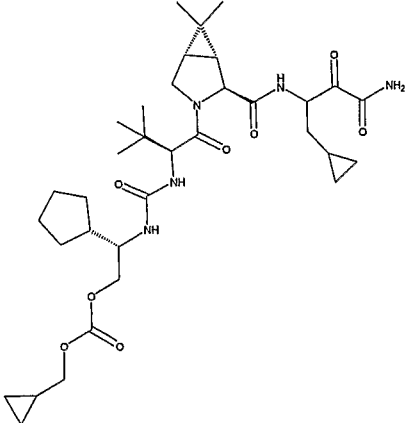
1424		A	607.746
1425		A	635.799
1426		A	661.837
1427		A	661.837

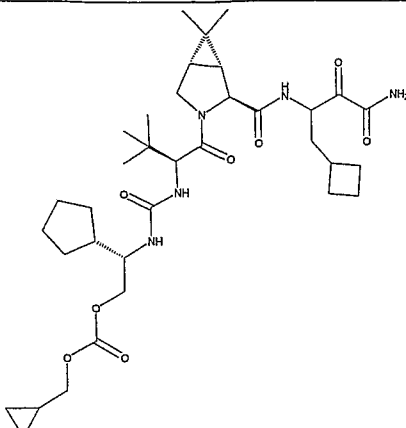
1428		A	619.757
1429		A	675.864
1430		A	633.784
1431		B	709.881

1432		A	645.795
1433		A	659.821
1434		B	673.848
1435		B	695.854

1436		A	605.73
1437		A	619.757
1438		B	633.784
1439		B	723.908

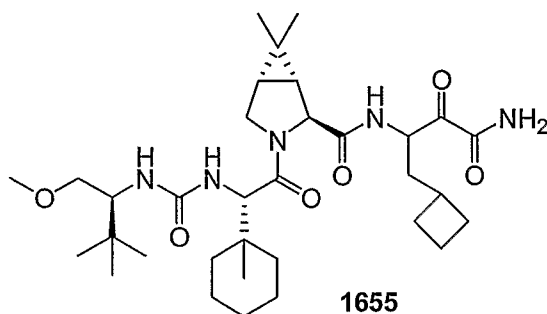
1440		B	647.81
1441		A	619.757
1442		A	633.784
1443		B	675.864

1444		A	647.81
1445		A	661.837
1446		B	687.875
1447		A	659.821

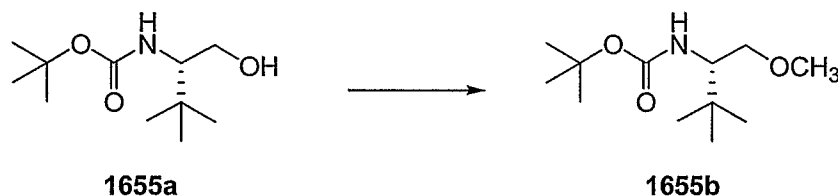
1448		A	673.848
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Ki* range A = <75 nM; B = 75-250 nM; C = >250 nM

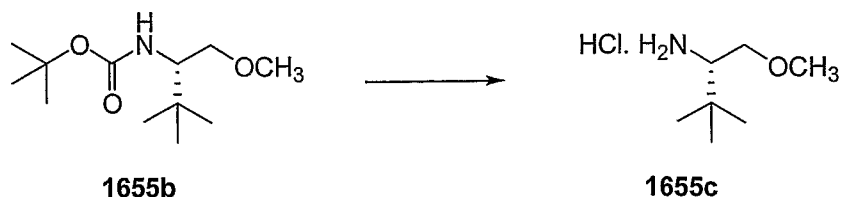
Preparation of Example 1655



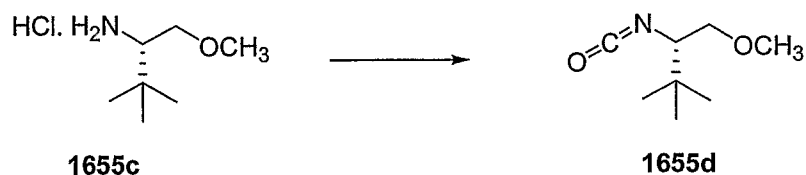
Step 1



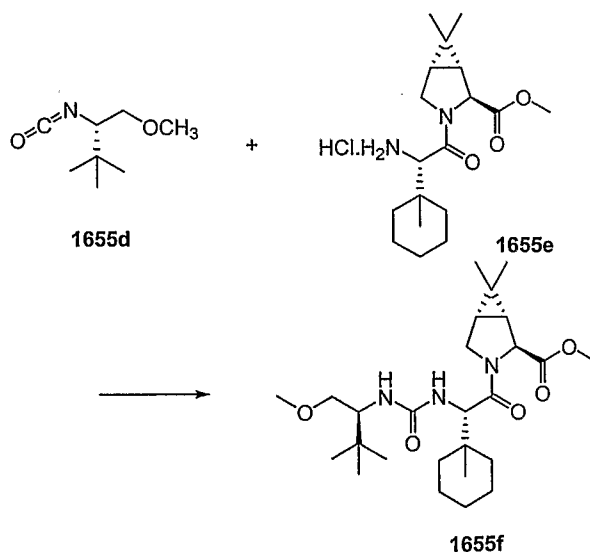
To a solution of commercially available compound **1655a** (Aldrich Chemical Co., Milwaukee, Wisconsin, USA, 950 mg, 4.38 mmol) in acetonitrile (40 mL) at room temperature was added methyl iodide (4.63 mL, 74.42 mmol). Silver (I) oxide (1.62 g, 7.01 mmol) was then added under nitrogen atmosphere and the reaction mixture was refluxed for approximately 16 hrs. (Note: The reaction flask was covered with aluminum foil). At this time, the reaction mixture was cooled to room temperature and filtered through a pad of celite. The filter cake was rinsed with ethyl acetate several times. The combined filtrate was concentrated and purified by flash column chromatography using 20/80 to 40/60 ethyl acetate/hexanes to afford 720 mg of the expected product, **1655b**.

Step 2

Conversion of **1655b** to compound **1655c** proceeded in quantitative yield using previously described procedure (Step 2, Example 1007).

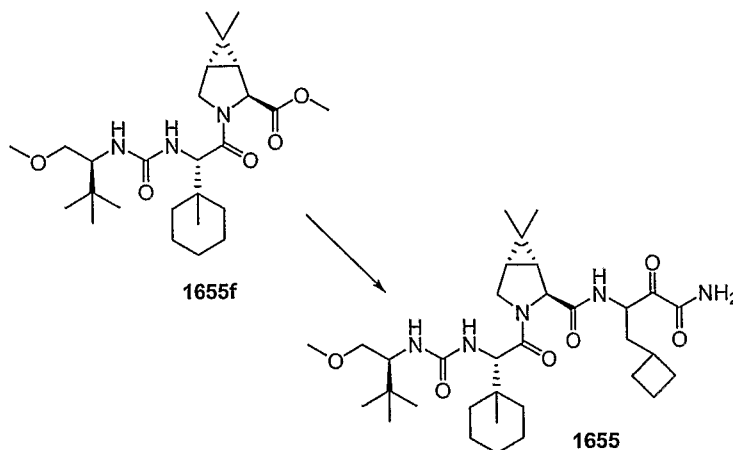
5 **Step 3**

To a solution of compound **1655c** (514 mg, 3.08 mmol) in dichloromethane (20 mL) was added saturated sodium bicarbonate solution (20 mL). This mixture was stirred vigorously and cooled to 0°C. Phosgene (20 wt% in toluene, 6.5 mL) was added dropwise. The reaction mixture was stirred vigorously for 4.5 hrs while maintaining the temperature at or below 5°C. At this time the reaction mixture was poured into a separatory funnel and the organic layer was separated. The organic layer was washed with saturated ammonium chloride solution (1 x), water (1 x), dried (Na₂SO₄) and concentrated. The residue, **1655d**, was diluted with dichloromethane (10 mL) and used further as a 0.308M solution.

Step 4

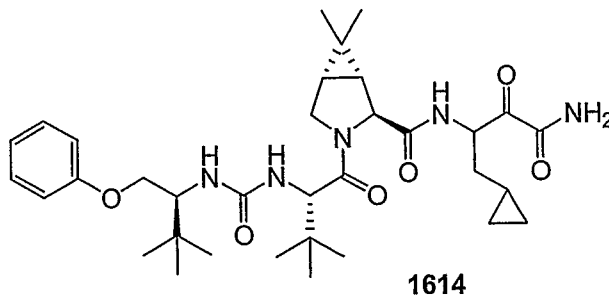
To a cold (0°C) solution of **1655e** (176 mg, 0.5 mmol; **1655e** was prepared as described for Intermediate **20.08**, Steps 1 and 2 using appropriate starting materials) in dichloromethane (4 mL) was added **1655d** (0.308 M solution, 4.87 mL, 1.5 mmol) followed by DIPEA (0.276 mL, 1.5 mmol). The reaction mixture was maintained at 10°C for 16 hrs. The reaction was quenched with saturated ammonium chloride solution and the aqueous layer was extracted with dichloromethane (3 x). The combined organic layer was washed with brine, dried (Na₂SO₄), filtered and concentrated *in vacuo*. The crude residue was purified by flash column chromatography using 20/80 acetone/hexanes to provide the required compound **1655f** (240 mg, 100% yield). LC-MS: 480.1 (M+H).

Step 5

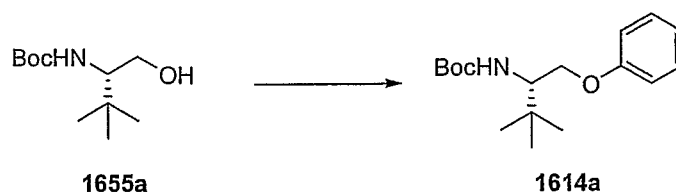


Compound **1655f** from above was converted to the required target compound **1655** using the intermediate **10.11** and procedures described above (Steps 4 - 6, Example **1007**). LC-MS of **1655** = 618.1 (M+H).

Preparation of Example 1614

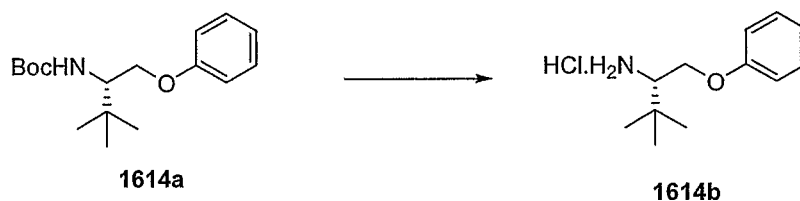


Step 1



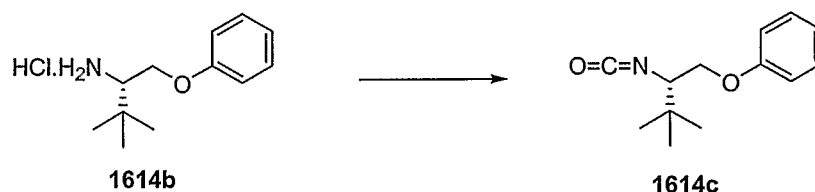
To a stirred solution of *N*-Boc-*tert*-leucinol **1655a** (2.0 g, 9.22 mmol), phenol (1.0 g, 10.6 mmol) and ADDP (3.8 g, 15.1 mmol) in CH₂Cl₂ (80 mL) at rt was bubbled argon gas for 15 min. Triphenylphosphine was then added in one portion. The resulting solution was stirred at RT for 18 h. The precipitates were filtered off and washed with diethyl ether (2 X 30 mL). The filtrate was concentrated *in vacuo*. The residue was purified by flash column chromatography eluting with 2-10% EtOAc/hexane to give the desired product **1614a** (0.33 g, 12%).

Step 2



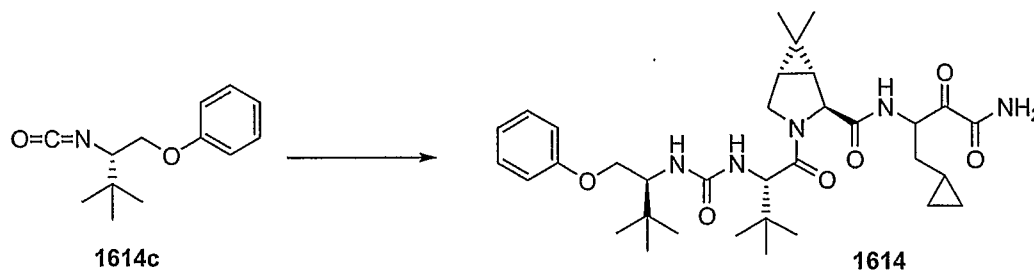
Compound **1614a** (0.32 g, 1.13 mmol) was dissolved in a 4 M hydrogen chloride solution in *p*-dioxane (20 mL) and stirred at RT for 3 h. It was concentrated *in vacuo* to give compound **1614b**, which was used without further purification.

Step 3



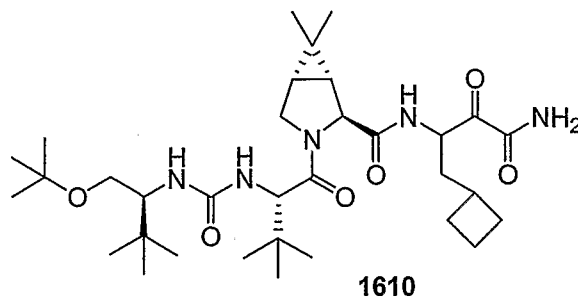
Compound **1614c** was prepared from **1614b** according to the procedures described for Example **1655**, Step 3.

Step 4



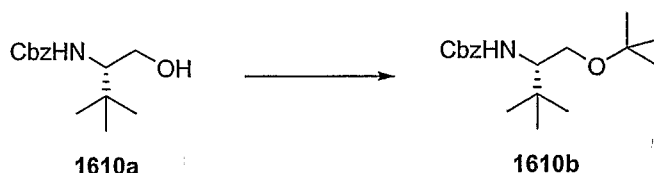
The isocyanate **1614c** was converted to the target compound **1614** as described in the General Schemes, Method C using the appropriate reagents and Intermediates.

Preparation of Example 1610



5

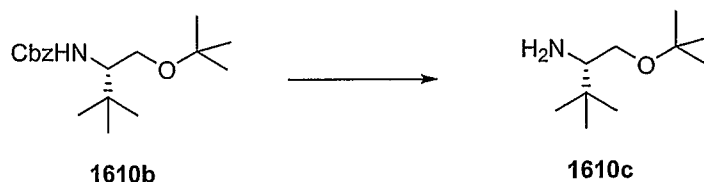
Step 1



To a stirred suspension of anhydrous magnesium sulfate in anhydrous CH_2Cl_2 (40 mL) at RT was added concentrated sulfuric acid (0.32 mL, 5.76 mmol). The mixture was vigorously stirred for 30 min before a solution of **1610a** (2.0 g, 7.90 mmol) in anhydrous CH_2Cl_2 (15 mL) was added. The mixture was then vigorously stirred at RT for 68 h. Saturated NaHCO_3 solution (50 mL) was added cautiously, along with CH_2Cl_2 (100 mL) and water (50 mL). Two phases were separated, and the aqueous layer was extracted with CH_2Cl_2 (2 X 100 mL). The combined organic solution was dried (MgSO_4), filtered and concentrated *in vacuo* to give **1610b**.

15

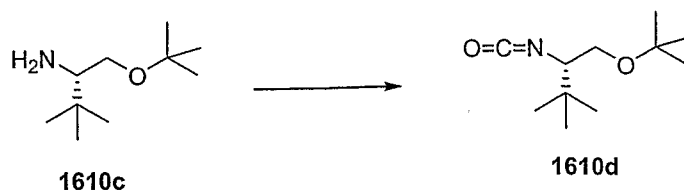
Step 2



A suspension of compound **1610b** and 10% Pd-C in absolute ethanol was vigorously stirred under a hydrogen atmosphere for 4 h. The catalyst was filtered off through a celite pad. The filtrate was concentrated *in vacuo* to afford **1610c** which was used without further purification.

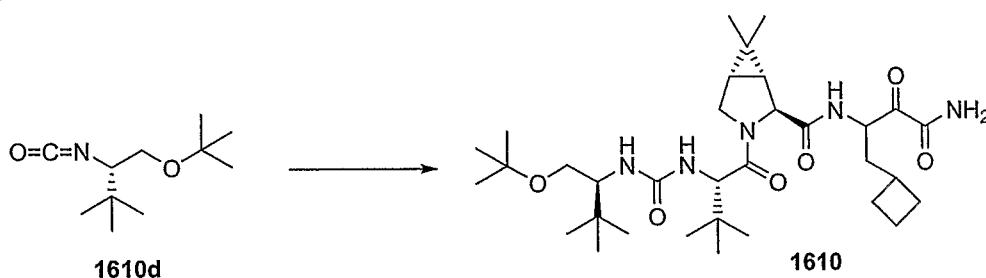
20

Step 3



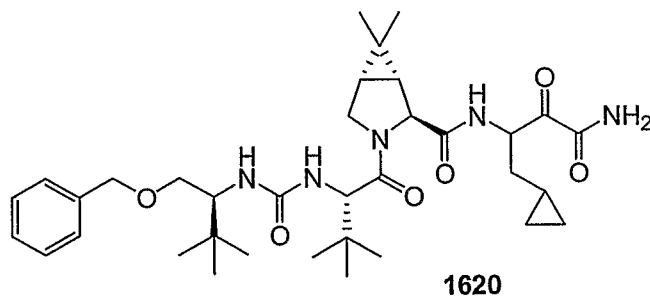
Compound **1610d** was prepared from **1610c** according to the procedures described for Example **1655**, Step 3.

Step 4

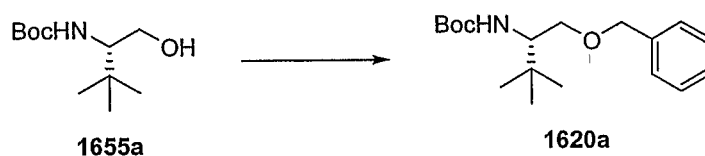


The isocyanate **1610d** was converted to the target compound **1610** as described in the General Schemes, Method C using the appropriate reagents and Intermediates.

Preparation of Example 1620

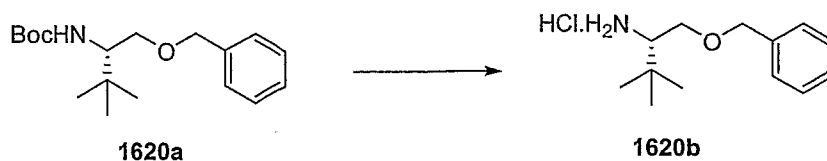


Step 1



A suspension of the alcohol **1655a** (3.46 g, 12.8 mmol), benzyl bromide (10 mL, 84.2 mmol) and silver (I) oxide (5.0 g, 21.6 mmol) in acetonitrile was stirred vigorously at 76 °C in an oil bath overnight (18 h). The solid material was filtered off and the solution was concentrated *in vacuo*. The product was purified by flash column chromatography eluting with 5-40% EtOAc/hexane to give the desired product **1620a** (0.78 g, 20%).

Step 2



Compound **16120b** was prepared from **1620a** according to the procedures described for Example **1614**, Step 2.

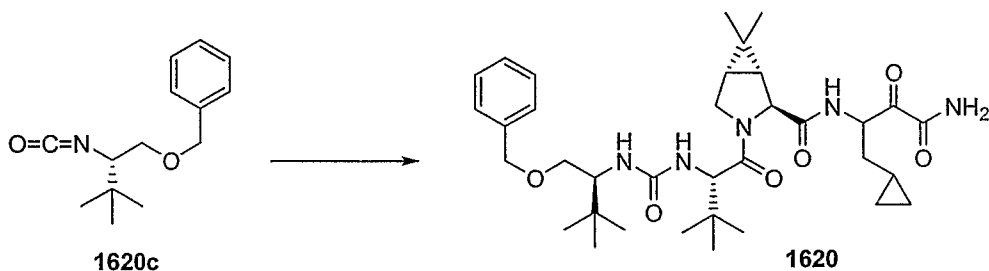
Step 3



5

Compound **1620c** was prepared from **1620b** according to the procedures described for Example **1655**, Step 3.

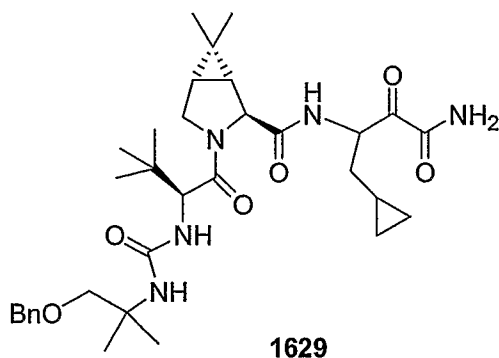
Step 4



10

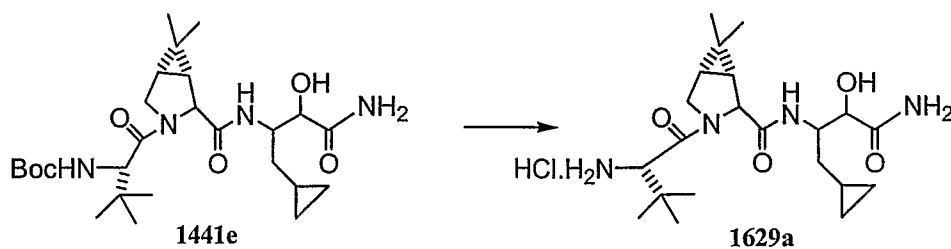
The isocyanate **1620c** was converted to the target compound **1620** as described in the General Schemes, Method C using the appropriate reagents and Intermediates.

Preparation of Example 1629



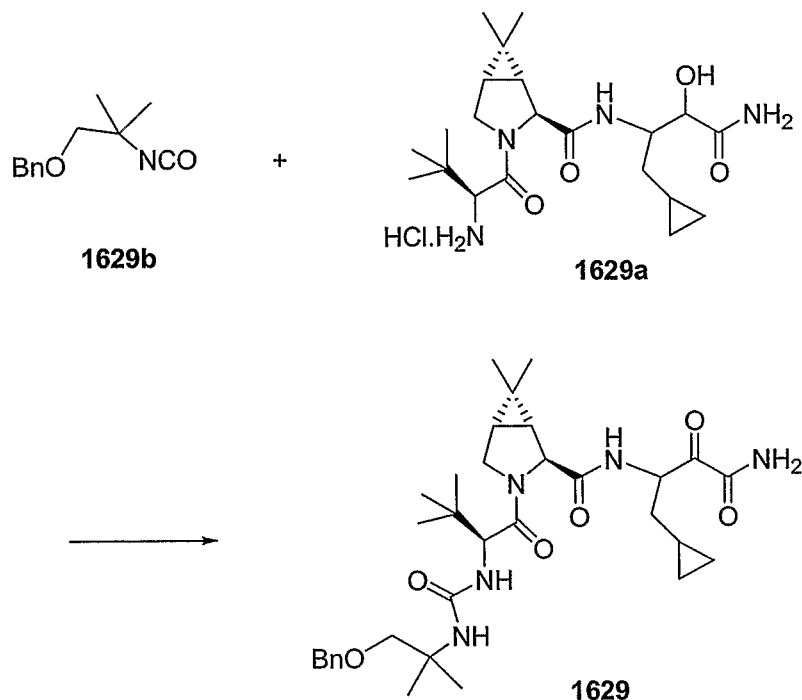
15

Step 1



To **1441e** (600 mg) was added 4M HCl in dioxane (25 mL). The reaction was stirred at room temperature for 30 min. and concentrated to yield a white solid, **1629a** (490 mg), which was carried forward without purification.

Step 2



5

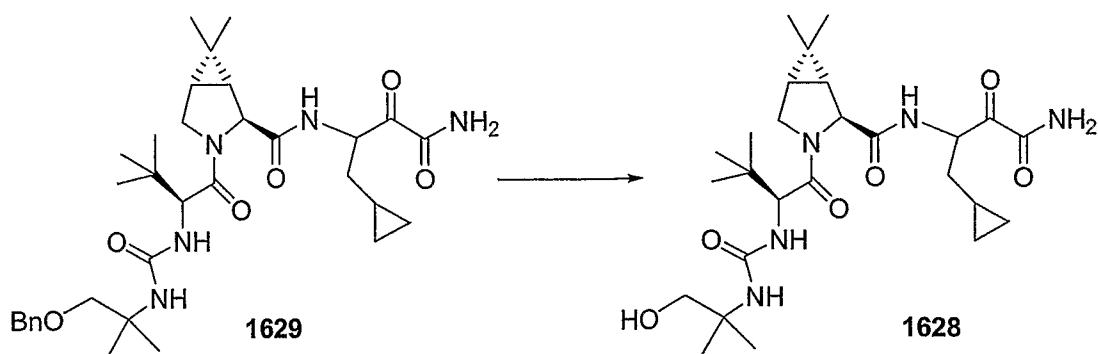
To a cooled (0 °C) solution of compound **1629a** (395 mg) in CH₂Cl₂ (25 mL) was added Et₃N (0.57 mL), followed by the isocyanate **1629b** (Robinson, Ralph P.; Marfat, Anthony. *Eur. Pat. Appl.* (1991), EP 436333 A2 19910710, 53 pp) in a manner described above (Example **1655**, Step 4). The crude hydroxyamide obtained was used without purification.

10

A solution of the crude hydroxyamide in toluene-DMSO (2.0 mL each) was cooled to 0 °C. To the reaction mixture was added EDCI·HCl (410.0 mg), followed by dichloroacetic acid (0.087 mL), after stirring for 2h at room temperature, it was diluted with EtOAc, washed with 1N HCl, satd. NaHCO₃, brine, dried over MgSO₄, filtered, concentrated to yield a white solid which was purified by chromatography over silica gel using acetone-hexane (40:60) to afford the title compound **1629** (280.0 mg) as a white solid: Mass spectrum for C₃₃H₄₉N₅O₆ (611.77); found FAB (M+H)⁺ = 612.5

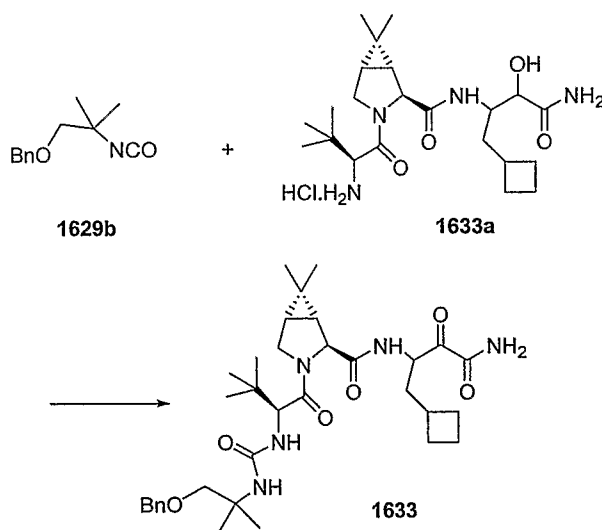
15

Preparation of Example 1628



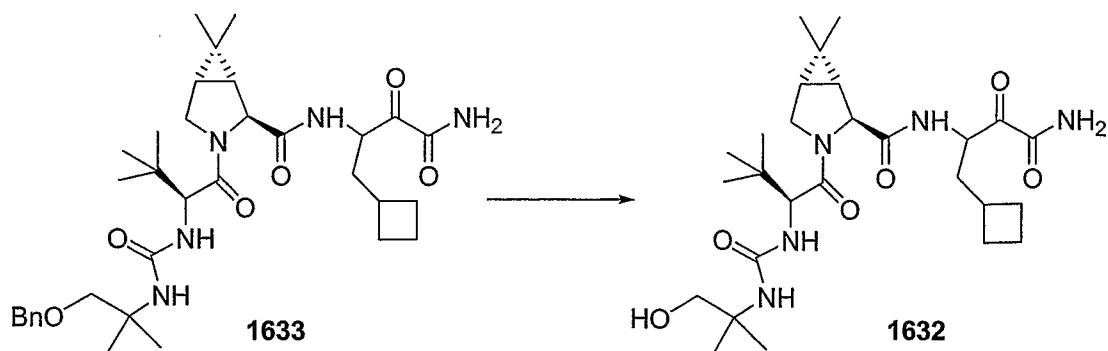
To a solution of compound **1629** (37.0 mg) in MeOH (2.0 mL) was added Pd-C (10 % w/v, 5.0 mg) and the reaction was stirred under hydrogen atmosphere for 1h, filtered through a pad of celite, concentrated and purified by chromatography over silica gel using acetone-hexane (4:6) to yield the required compound **1628** (22.0mg) as a white solid. Mass spectrum for C₂₆H₄₃N₅O₆ (521.65); found FAB (M+H)⁺ = 522.6.

Preparation of Example 1633



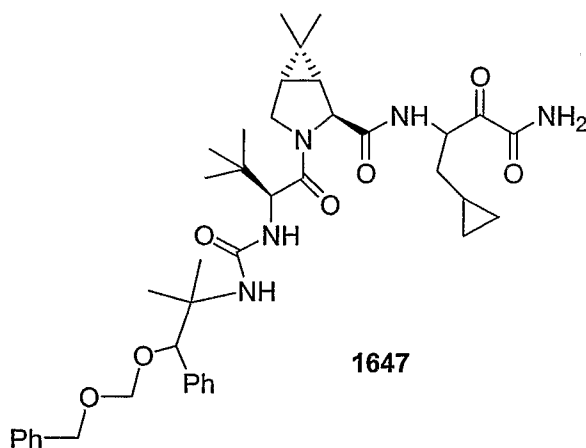
The required title compound **1633** was obtained from the isocyanate **1629b** and compound **1633a** (prepared from **1.17** and **10.11**) using procedures described for Example **1629**. Mass spectrum for C₃₄H₅₁N₅O₆ (625.80); found FAB (M+H)⁺ = 626.8.

Preparation of Example 1632

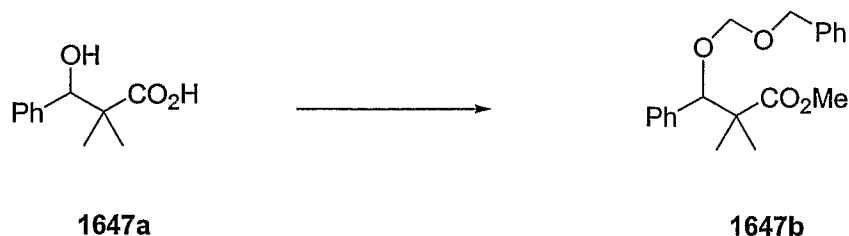


To a solution of compound **1633** (10.0 mg) in MeOH (2.0 mL) was added Pd-C (10 % w/v, 2.0 mg) and the reaction was stirred under hydrogen atmosphere for 1h, filtered through a pad of celite, concentrated and purified by chromatography over silica gel using acetone-hexane (4:6) to yield the title compound **1632** as a white solid (4.2 mg). Mass spectrum for C₂₇H₄₅N₅O₆ (535.68); found FAB (M+H)⁺ = 536.7.

Preparation of Example 1647



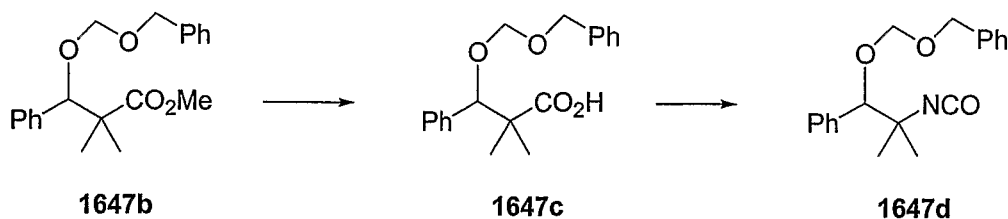
10 Step 1



To a stirred solution of the commercially available compound **1647a** (Aldrich Chemical Co., Milwaukee, Wisconsin, USA, 250.0 mg) in MeOH was added trimethylsilyl diazomethane (2.0 mL, 2M solution in PhMe). After 20 min the solvent was removed and the crude was redissolved in CH₂Cl₂ (2.0 mL) and Benzyloxymethyl chloride (1.5 equivalent) was added along with Et₃N (1.5 equivalent). The reaction mixture was stirred overnight, diluted with

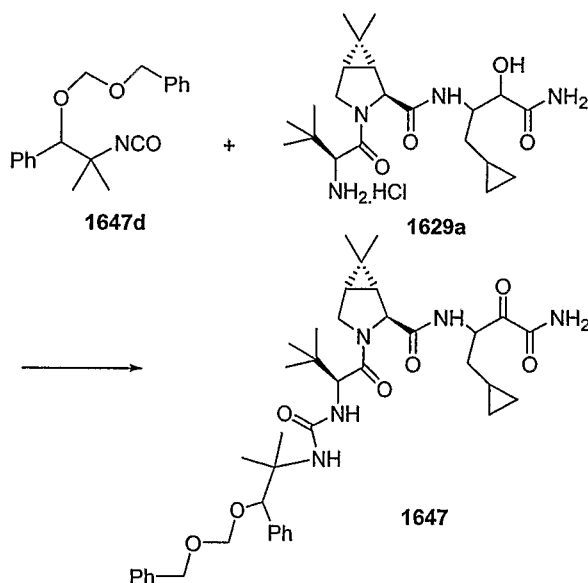
EtOAc, washed successively with 5 % $\text{Na}_2\text{S}_2\text{O}_3$, satd. NaHCO_3 , 1N HCl, brine, dried over MgSO_4 , filtered, concentrated to yield a white solid which was purified by chromatography over silica gel using EtOAc-hexane (1:3) to afford the compound **1647b** (413 mg) as a white solid: Mass spectrum for $\text{C}_{20}\text{H}_{24}\text{O}_4$ (328.40); found FAB $(\text{M}+\text{H})^+ = 329.4$.

Step 2



To a solution of 0.413 g of compound **1647b** in MeOH/ H_2O (5.0/0.5 mL) was added 0.735 g of KOH. The reaction mixture was refluxed overnight, cooled to room temperature and concentrated. The crude was redissolved in H_2O (10.0 mL) and acidified with 10 % aqueous HCl and extracted with CH_2Cl_2 , dried over MgSO_4 , filtered and concentrated to afford the corresponding carboxylic acid **1647c** (392 mg). The crude was directly used in the next step. To a solution of 123.2 mg of acid **1647c** in toluene (5.0 mL) was added DPPA (0.09 mL) and Et_3N (0.055 mL). The reaction mixture was heated at 110 °C for 40 min, cooled and washed with satd. NaHCO_3 , dried over MgSO_4 , filtered and concentrated to afford the isocyanate **1647d**. The crude obtained was used without purification.

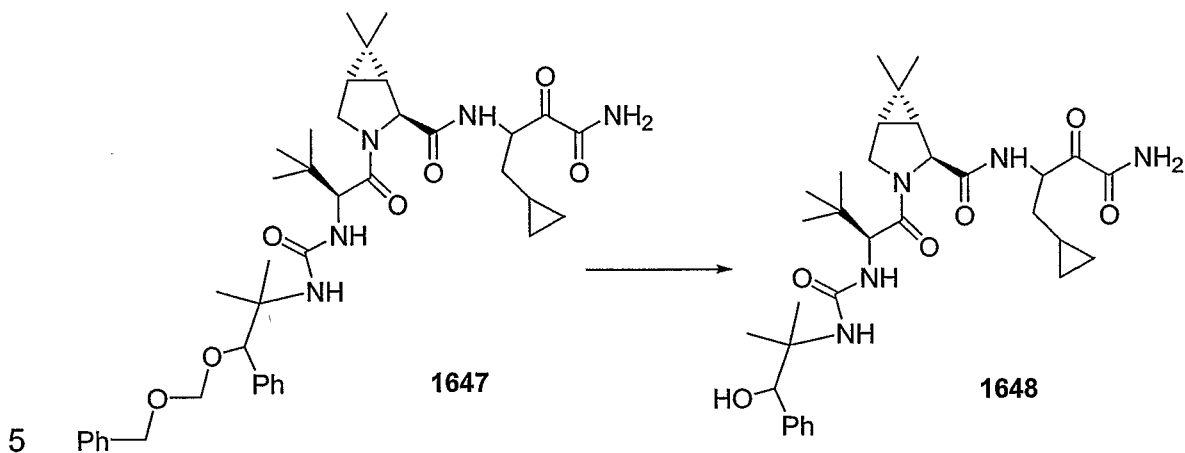
Step 3



The isocyanate **1647d** was treated with compound **1629a** (90.0 mg) in a manner described in Example **1629** to provide the title compound **1647**.

Mass spectrum for C₄₀H₅₅N₅O₇ (717.89); found FAB (M+H)⁺ = 718.8.

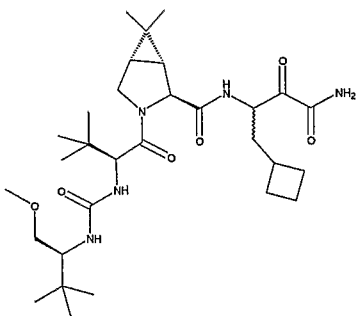
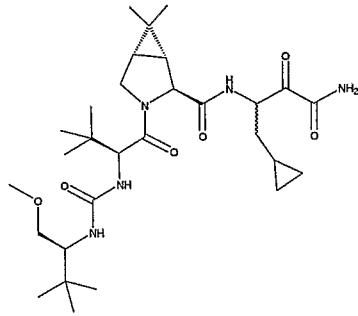
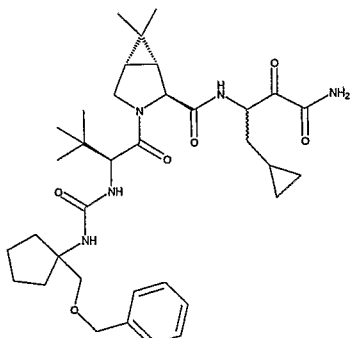
Preparation of Example 1648

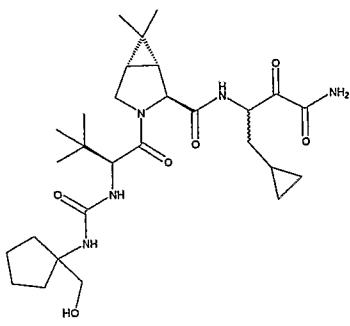
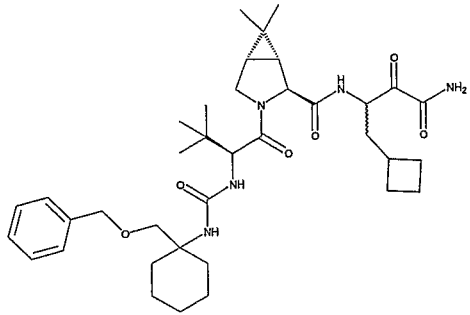
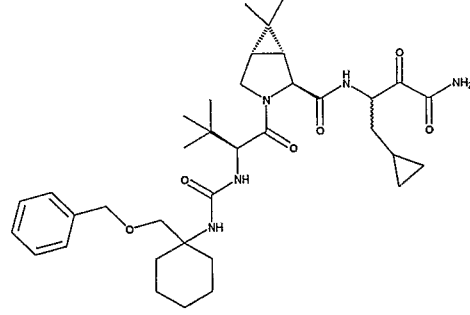
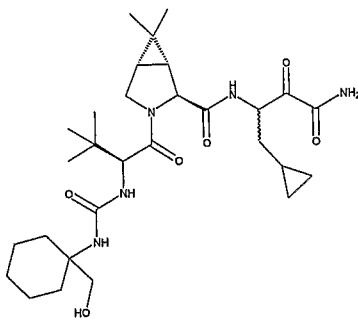


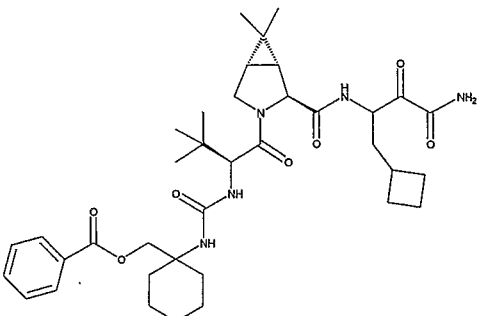
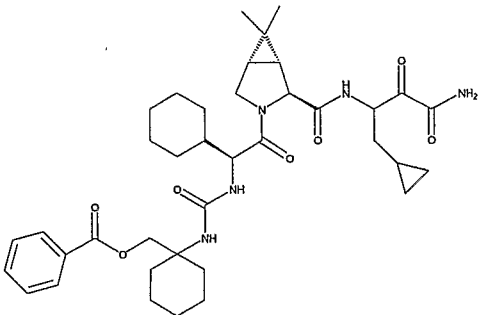
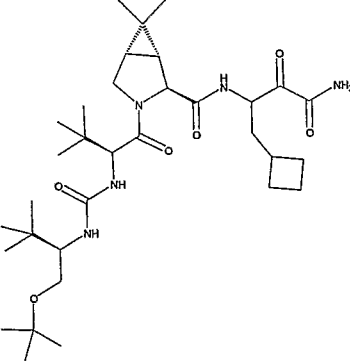
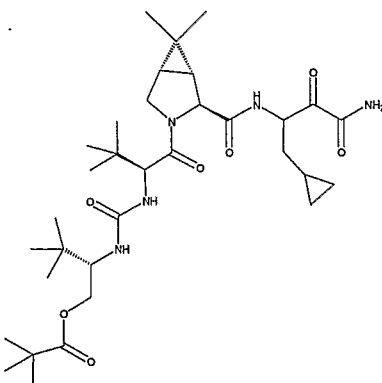
To a solution of compound **1647** in MeOH was added 6N HCl after 30 min, the MeOH was removed and the crude was redissolved in ethyl acetate and washed with satd. NaHCO₃. The crude was purified by chromatography over silica gel using acetone-hexane (40:60) to afford the title compound **1648** (25.0 mg) as a white solid: Mass spectrum for C₃₂H₄₇N₅O₆ (597.75); found FAB (M+H)⁺ = 598.7.

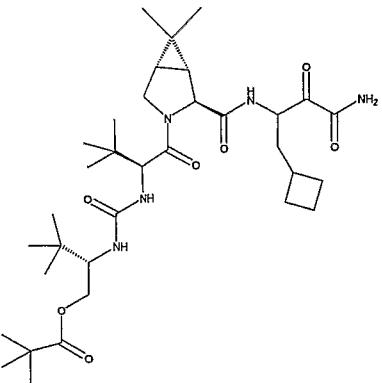
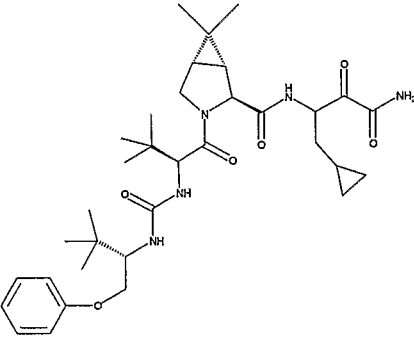
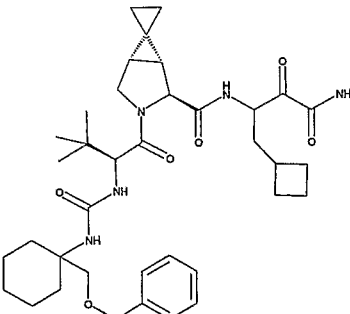
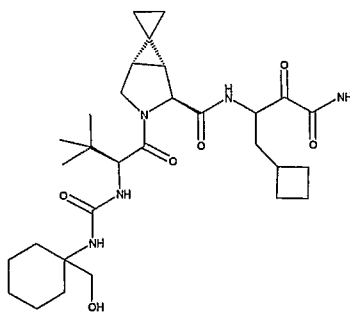
Compounds in the following table (**Table 3**) were essentially prepared using the above described procedures (Preparation of Examples **1610**, **1614**, **1620**, **1628**, **1629**, **1632**, **1633**, **1647**, **1648**, **1655**) with appropriate reagents and modifications as described in the General Schemes for Preparation of Target Compounds, Methods A-E.

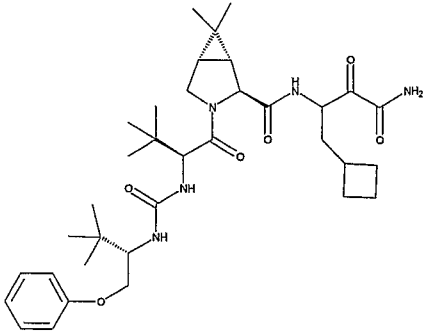
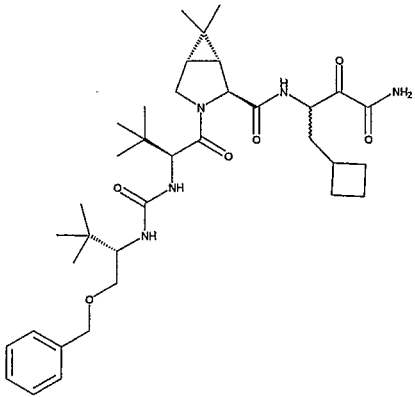
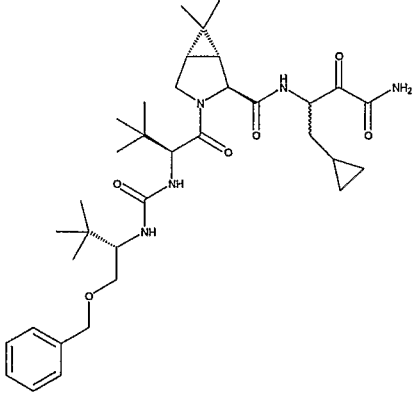
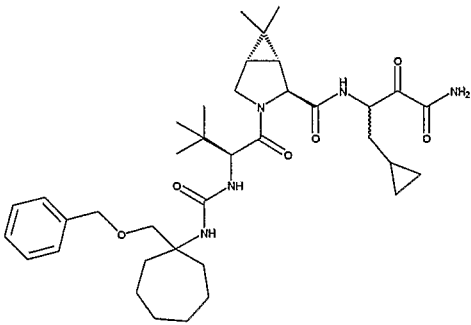
Table 3

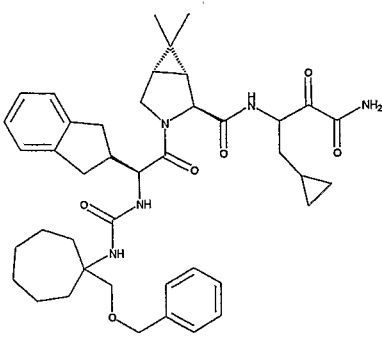
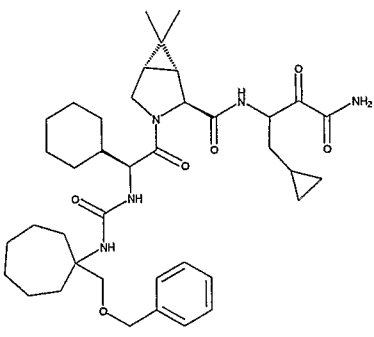
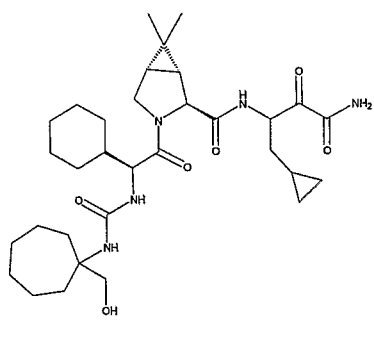
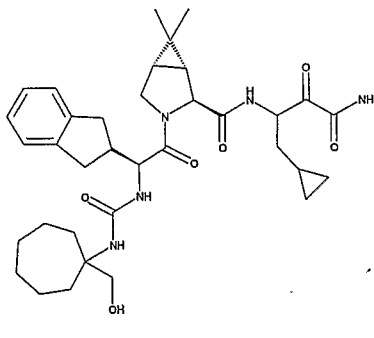
Example #	Structure	Ki* (nM)	Mol Weight
1601		B	577.763
1602		B	563.736
1603		A	637.818

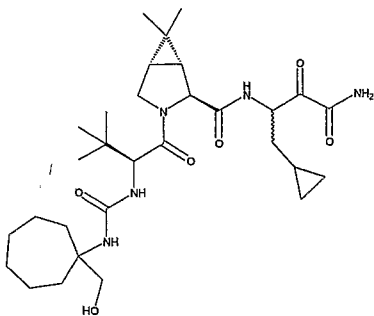
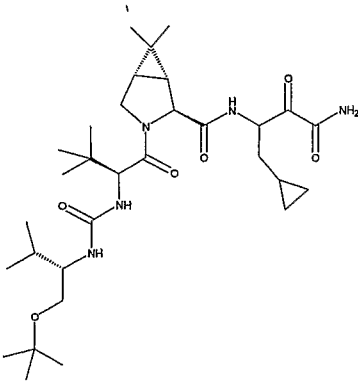
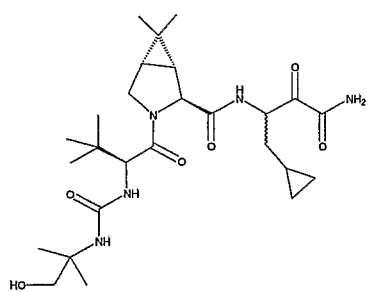
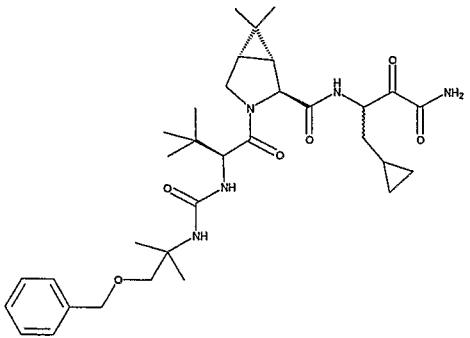
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1606		A	651.845
1607		A	561.72

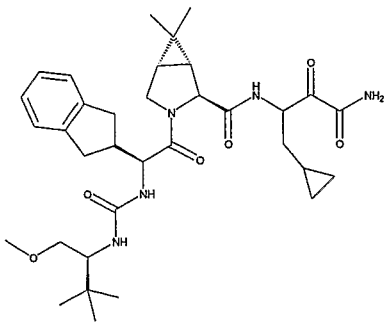
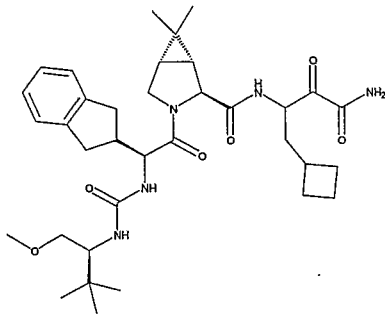
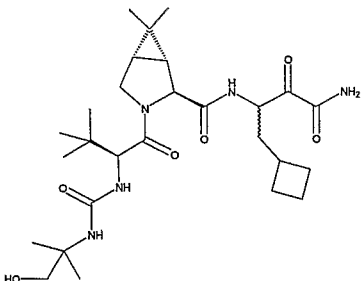
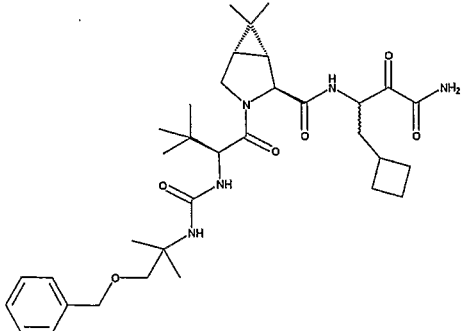
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1611		A	633.827

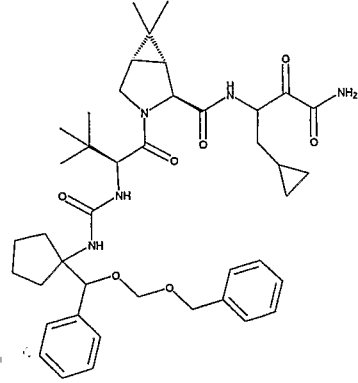
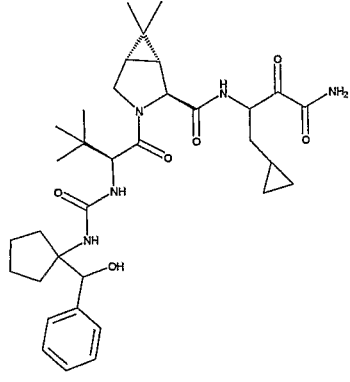
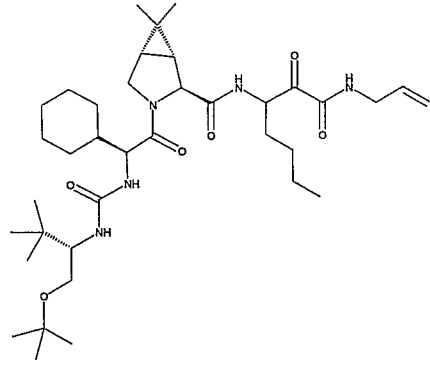
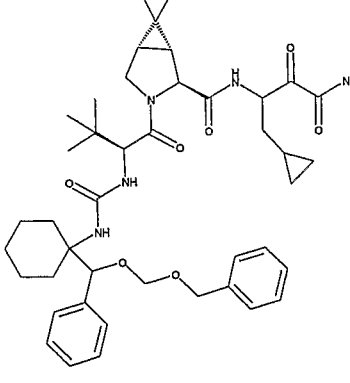
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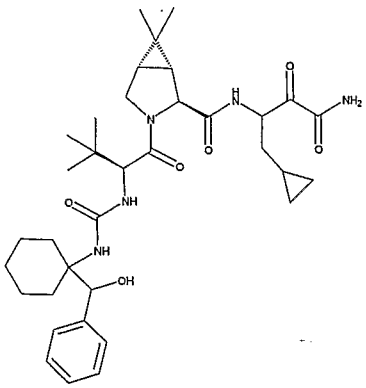
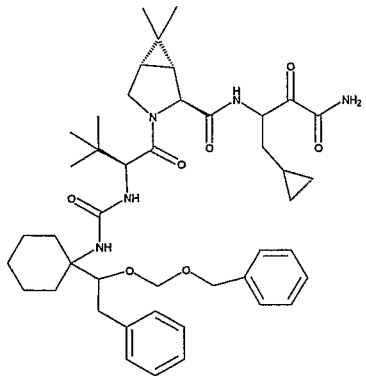
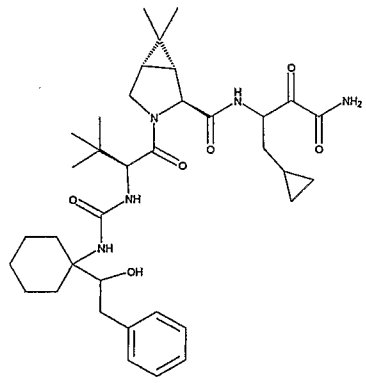
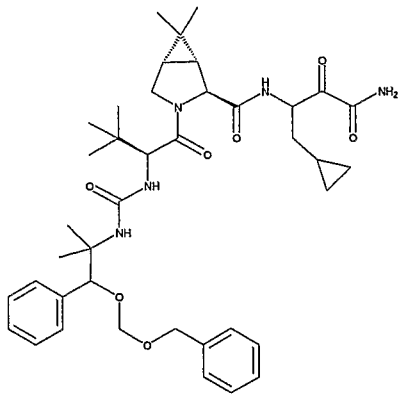
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1619		B	653.86
1620		B	639.834
1621		A	665.871

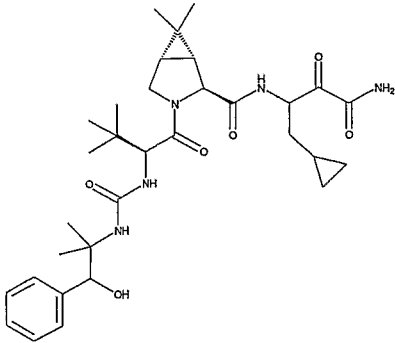
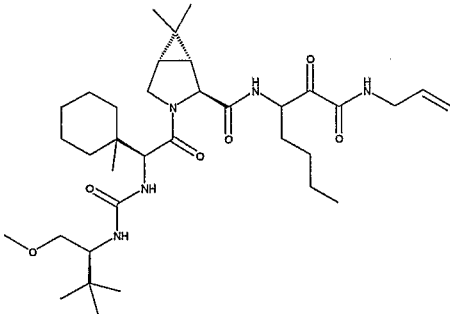
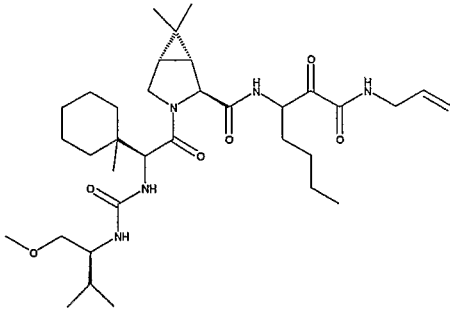
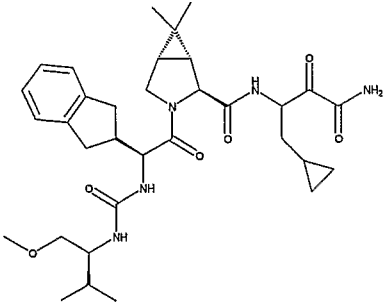
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1623		B	691.909
1624		A	601.785
1625		B	635.802

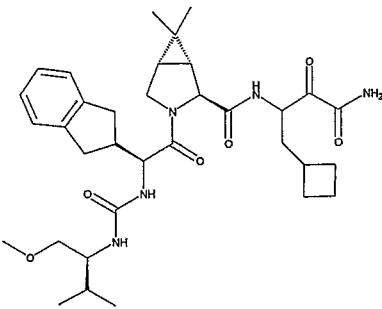
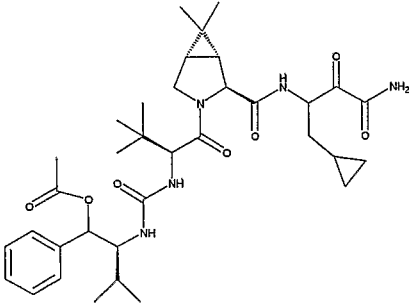
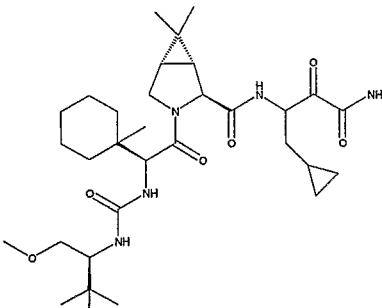
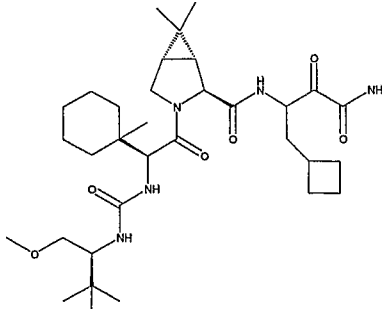
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1627		A	591.79
1628		A	521.656
1629		B	611.78

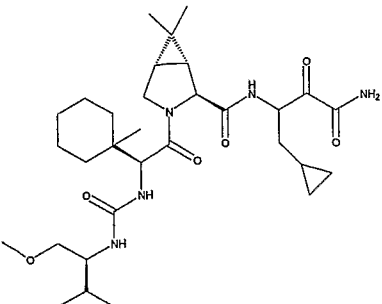
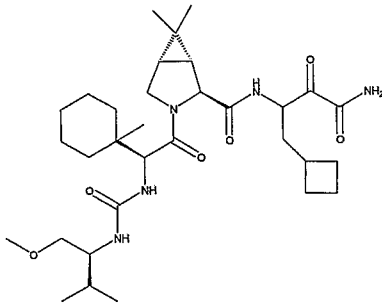
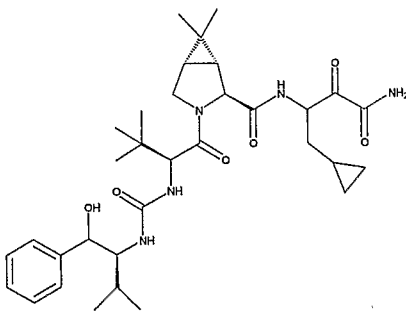
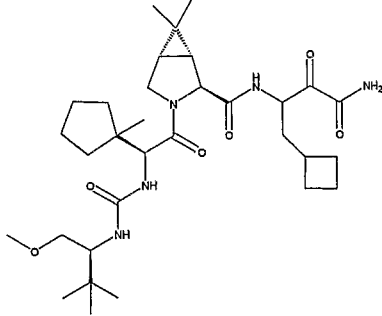
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1631		A	637.818
1632		A	535.682
1633		B	625.807

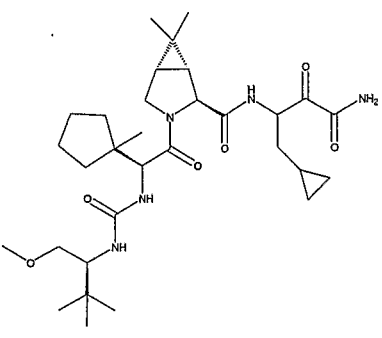
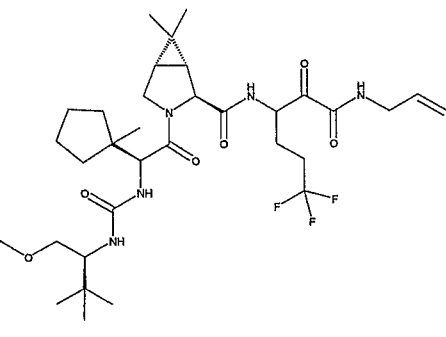
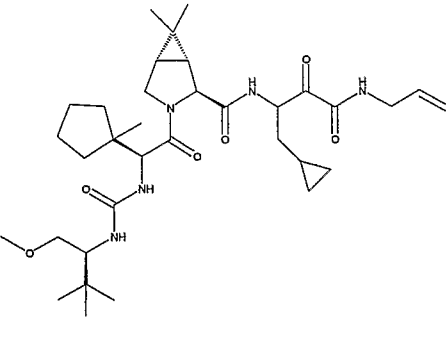
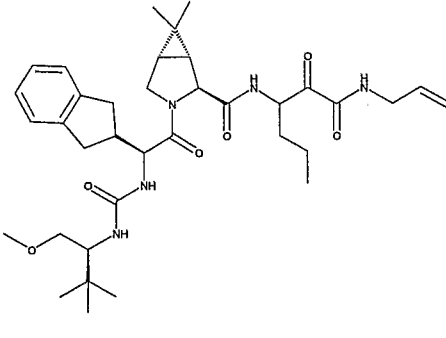
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1635		A	623.791
1636		B	673.935
1641		A	757.968

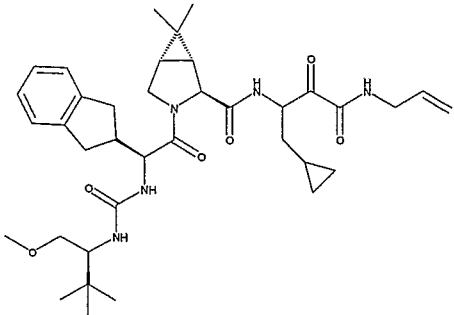
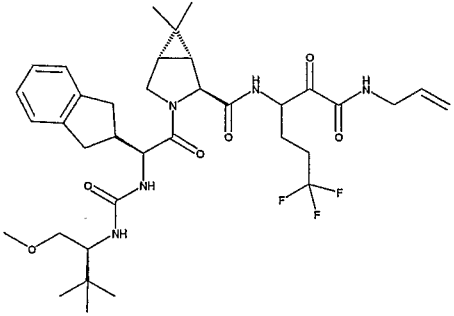
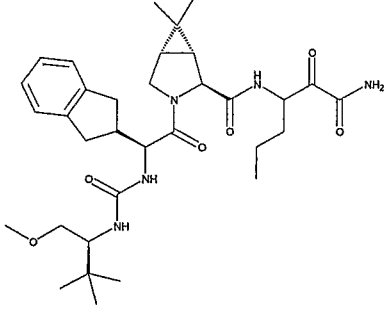
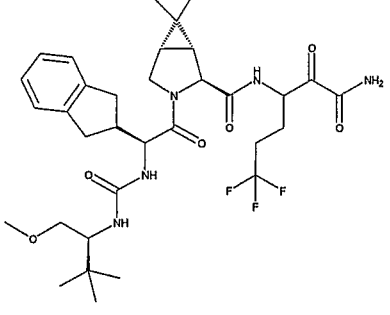
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1643		B	771.995
1644		A	651.845
1647		B	717.904

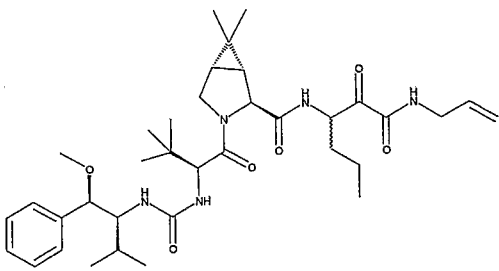
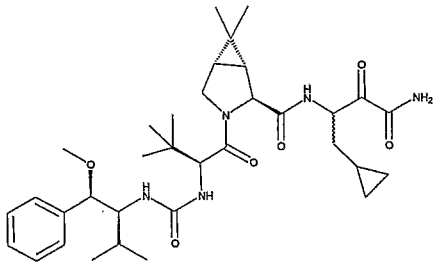
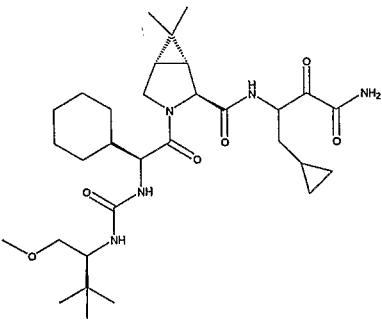
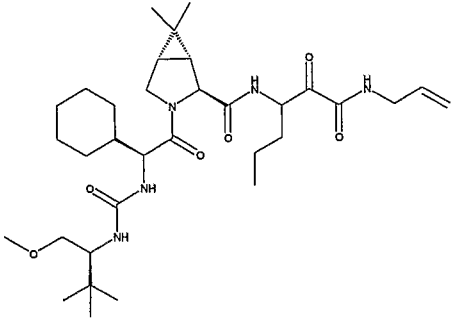
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1649		A	645.881
1650		B	631.854
1651		A	609.764

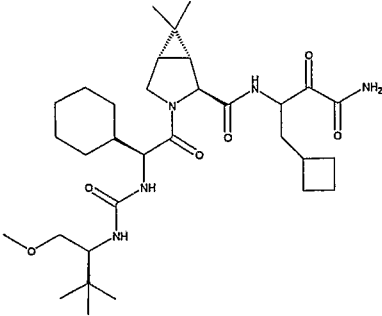
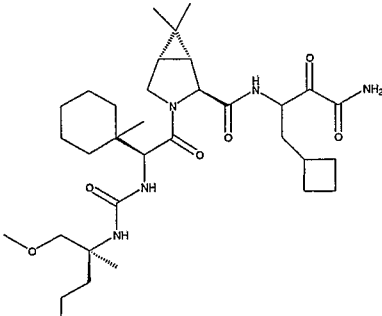
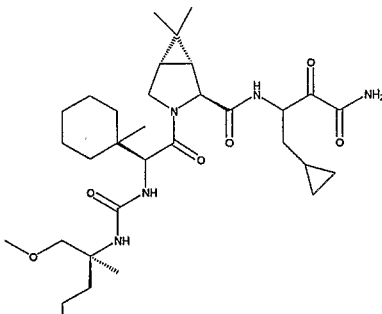
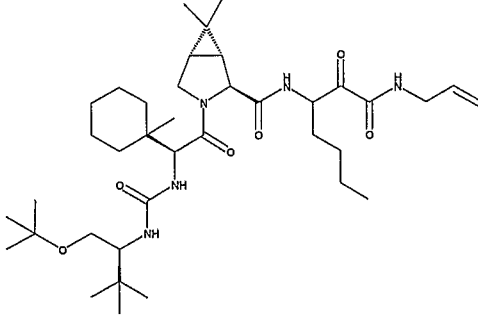
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1653		B	653.817
1654		A	603.801
1655		A	617.827

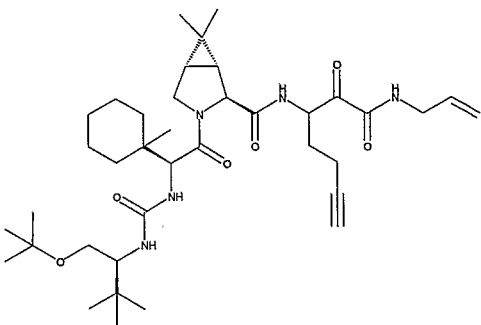
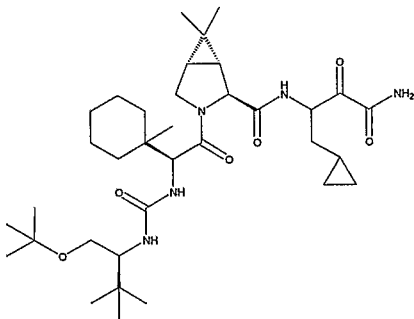
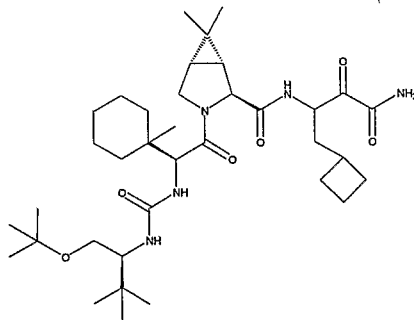
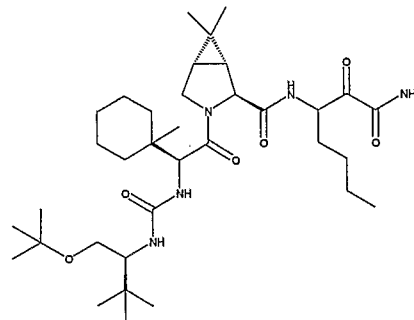
1656		A	589.774
1657		A	603.801
1658		B	611.78
1659		A	603.801

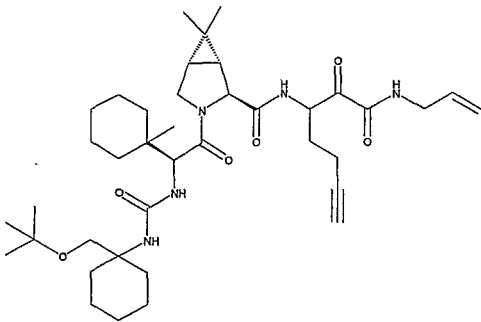
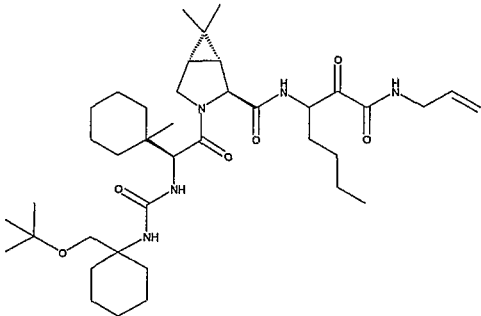
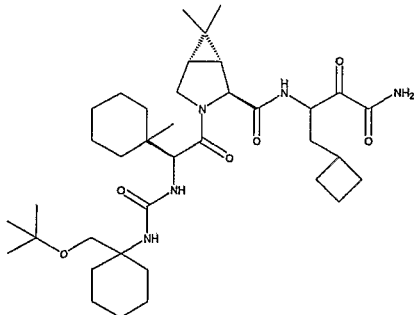
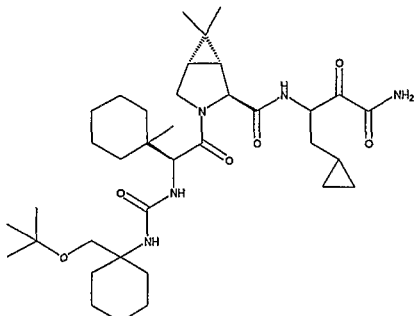
1660		A	589.774
1661		B	671.799
1662		B	629.838
1663		B	651.845

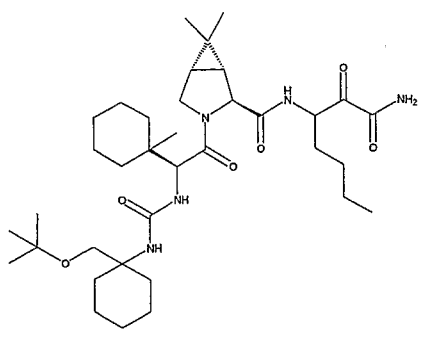
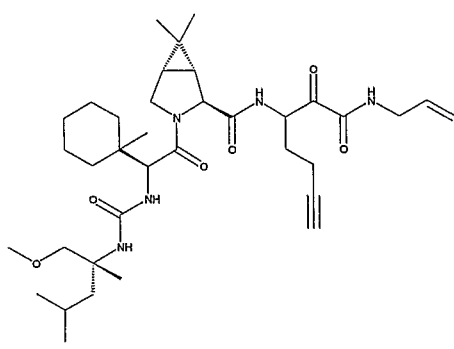
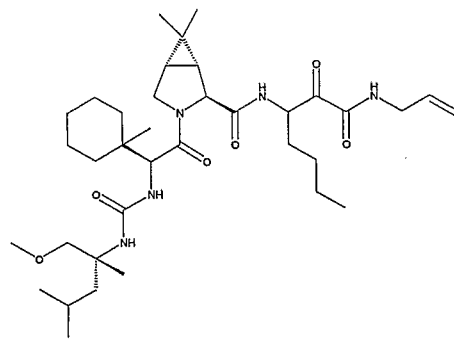
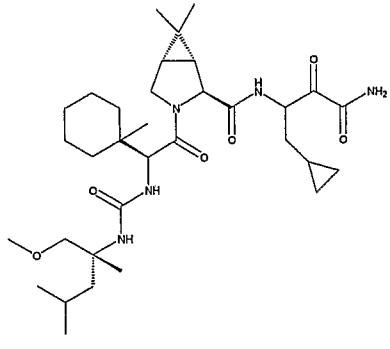
1664	 Chemical structure of compound 1664: A complex molecule featuring a central bicyclic amide core. The core is substituted with a 2-((tert-butoxy)methyl)propanamido group, a 2-allylamino-3-oxopropyl group, and a 2-((tert-butoxy)methyl)propanamido group. The structure also includes a cyclopropylmethyl group and a 2-allylamino-3-oxopropyl group.	B	663.856
1665	 Chemical structure of compound 1665: A complex molecule featuring a central bicyclic amide core. The core is substituted with a 2-((tert-butoxy)methyl)propanamido group, a 2-allylamino-3-oxopropyl group, and a 2-((tert-butoxy)methyl)propanamido group. The structure also includes a cyclopropylmethyl group and a 2-allylamino-3-oxopropyl group.	B	705.816
1666	 Chemical structure of compound 1666: A complex molecule featuring a central bicyclic amide core. The core is substituted with a 2-((tert-butoxy)methyl)propanamido group, a 2-allylamino-3-oxopropyl group, and a 2-((tert-butoxy)methyl)propanamido group. The structure also includes a cyclopropylmethyl group and a 2-allylamino-3-oxopropyl group.	A	611.78
1667	 Chemical structure of compound 1667: A complex molecule featuring a central bicyclic amide core. The core is substituted with a 2-((tert-butoxy)methyl)propanamido group, a 2-allylamino-3-oxopropyl group, and a 2-((tert-butoxy)methyl)propanamido group. The structure also includes a cyclopropylmethyl group and a 2-allylamino-3-oxopropyl group.	A	665.751

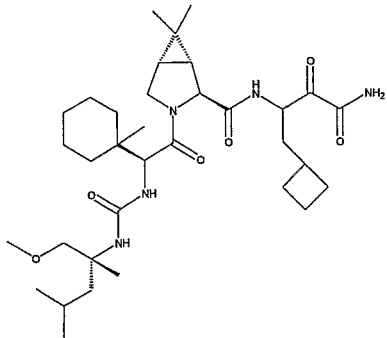
1668		B	653.86
1669		A	625.807
1670		A	589.774
1671		B	617.827

1672		A	603.801
1673		B	617.827
1674		B	603.801
1675		C	687.953

1676		B	683.921
1677		A	645.873
1678		B	659.899
1679		B	647.889

1680		A	695.932
1681		C	699.963
1682		B	671.910
1683		A	657.884

1684		B	659.899
1685		B	655.868
1686		C	659.899
1687		A	617.820

1688		A	631.846
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Ki* range A = <75 nM; B = 75-250 nM; C = >250 nM

The present invention relates to novel HCV protease inhibitors. This utility can be manifested in their ability to inhibit the HCV NS2/NS4a serine protease. A general procedure for such demonstration is illustrated by the following *in vitro* assay.

Assay for HCV Protease Inhibitory Activity:

Spectrophotometric Assay: Spectrophotometric assay for the HCV serine protease can be performed on the inventive compounds by following the procedure described by R. Zhang *et al*, *Analytical Biochemistry*, 270 (1999) 268-275, the disclosure of which is incorporated herein by reference. The assay based on the proteolysis of chromogenic ester substrates is suitable for the continuous monitoring of HCV NS3 protease activity. The substrates are derived from the P side of the NS5A-NS5B junction sequence (Ac-DTEDVVX(Nva), where X = A or P) whose C-terminal carboxyl groups are esterified with one of four different chromophoric alcohols (3- or 4-nitrophenol, 7-hydroxy-4-methyl-coumarin, or 4-phenylazophenol). Illustrated below are the synthesis, characterization and application of these novel spectrophotometric ester substrates to high throughput screening and detailed kinetic evaluation of HCV NS3 protease inhibitors.

Materials and Methods:

Materials: Chemical reagents for assay related buffers are obtained from Sigma Chemical Company (St. Louis, Missouri). Reagents for peptide synthesis were from Aldrich Chemicals, Novabiochem (San Diego, California), Applied Biosystems (Foster City, California) and Perseptive Biosystems (Framingham, Massachusetts). Peptides are synthesized manually or on an

automated ABI model 431A synthesizer (from Applied Biosystems). UV/VIS Spectrometer model LAMBDA 12 was from Perkin Elmer (Norwalk, Connecticut) and 96-well UV plates were obtained from Corning (Corning, New York). The prewarming block can be from USA Scientific (Ocala, Florida) and the 96-well plate vortexer is from Labline Instruments (Melrose Park, Illinois). A Spectramax Plus microtiter plate reader with monochromator is obtained from Molecular Devices (Sunnyvale, California).

Enzyme Preparation: Recombinant heterodimeric HCV NS3/NS4A protease (strain 1a) is prepared by using the procedures published previously (D. L.

Sali *et al*, *Biochemistry*, 37 (1998) 3392-3401). Protein concentrations are determined by the Biorad dye method using recombinant HCV protease standards previously quantified by amino acid analysis. Prior to assay initiation, the enzyme storage buffer (50 mM sodium phosphate pH 8.0, 300 mM NaCl, 10% glycerol, 0.05% lauryl maltoside and 10 mM DTT) is exchanged for the assay buffer (25 mM MOPS pH 6.5, 300 mM NaCl, 10% glycerol, 0.05% lauryl maltoside, 5 μ M EDTA and 5 μ M DTT) utilizing a Biorad Bio-Spin P-6 prepacked column.

Substrate Synthesis and Purification: The synthesis of the substrates is done as reported by R. Zhang *et al*, (*ibid.*) and is initiated by anchoring Fmoc-Nva-OH to 2-chlorotriyl chloride resin using a standard protocol (K. Barlos *et al*, *Int. J. Pept. Protein Res.*, 37 (1991), 513-520). The peptides are subsequently assembled, using Fmoc chemistry, either manually or on an automatic ABI model 431 peptide synthesizer. The N-acetylated and fully protected peptide fragments are cleaved from the resin either by 10% acetic acid (HOAc) and 10% trifluoroethanol (TFE) in dichloromethane (DCM) for 30 min, or by 2% trifluoroacetic acid (TFA) in DCM for 10 min. The combined filtrate and DCM wash is evaporated azeotropically (or repeatedly extracted by aqueous Na₂CO₃ solution) to remove the acid used in cleavage. The DCM phase is dried over Na₂SO₄ and evaporated.

The ester substrates are assembled using standard acid-alcohol coupling procedures (K. Holmber *et al*, *Acta Chem. Scand.*, B33 (1979) 410-412). Peptide fragments are dissolved in anhydrous pyridine (30-60 mg/ml) to which 10 molar equivalents of chromophore and a catalytic amount (0.1 eq.)

of para-toluenesulfonic acid (pTSA) were added. Dicyclohexylcarbodiimide (DCC, 3 eq.) is added to initiate the coupling reactions. Product formation is monitored by HPLC and can be found to be complete following 12-72 hour reaction at room temperature. Pyridine solvent is evaporated under vacuum and further removed by azeotropic evaporation with toluene. The peptide ester is deprotected with 95% TFA in DCM for two hours and extracted three times with anhydrous ethyl ether to remove excess chromophore. The deprotected substrate is purified by reversed phase HPLC on a C3 or C8 column with a 30% to 60% acetonitrile gradient (using six column volumes). The overall yield following HPLC purification can be approximately 20-30%. The molecular mass can be confirmed by electrospray ionization mass spectroscopy. The substrates are stored in dry powder form under desiccation.

Spectra of Substrates and Products: Spectra of substrates and the

corresponding chromophore products are obtained in the pH 6.5 assay buffer. Extinction coefficients are determined at the optimal off-peak wavelength in 1-cm cuvettes (340 nm for 3-Np and HMC, 370 nm for PAP and 400 nm for 4-Np) using multiple dilutions. The optimal off-peak wavelength is defined as that wavelength yielding the maximum fractional difference in absorbance between substrate and product (product OD - substrate OD)/substrate OD).

Protease Assay: HCV protease assays are performed at 30°C using a 200 µl reaction mix in a 96-well microtiter plate. Assay buffer conditions (25 mM MOPS pH 6.5, 300 mM NaCl, 10% glycerol, 0.05% lauryl maltoside, 5 µM EDTA and 5 µM DTT) are optimized for the NS3/NS4A heterodimer (D. L. Sali *et al, ibid.*). Typically, 150 µl mixtures of buffer, substrate and inhibitor are placed in wells (final concentration of DMSO $\leq$ 4 % v/v) and allowed to preincubate at 30 °C for approximately 3 minutes. Fifty µls of prewarmed protease (12 nM, 30°C) in assay buffer, is then used to initiate the reaction (final volume 200 µl). The plates are monitored over the length of the assay (60 minutes) for change in absorbance at the appropriate wavelength (340 nm for 3-Np and HMC, 370 nm for PAP, and 400 nm for 4-Np) using a Spectromax Plus microtiter plate reader equipped with a monochromator (acceptable results can be obtained with plate readers that utilize cutoff filters). Proteolytic cleavage of the ester linkage between the Nva and the

chromophore is monitored at the appropriate wavelength against a no enzyme blank as a control for non-enzymatic hydrolysis. The evaluation of substrate kinetic parameters is performed over a 30-fold substrate concentration range (~6-200 μM). Initial velocities are determined using linear regression and

5 kinetic constants are obtained by fitting the data to the Michaelis-Menten equation using non-linear regression analysis (Mac Curve Fit 1.1, K. Raner). Turnover numbers (k_{cat}) are calculated assuming the enzyme is fully active.

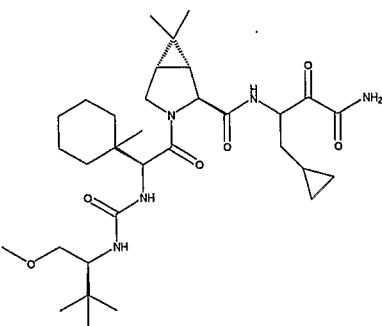
Evaluation of Inhibitors and Inactivators: The inhibition constants (K_i) for the competitive inhibitors Ac-D-(D-Gla)-L-I-(Cha)-C-OH (27), Ac-DTEDVVA(Nva)-

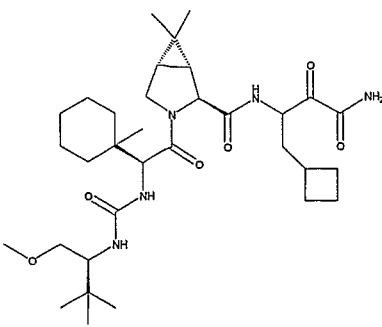
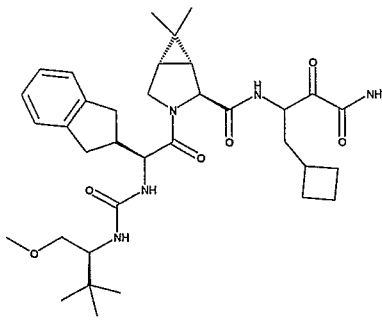
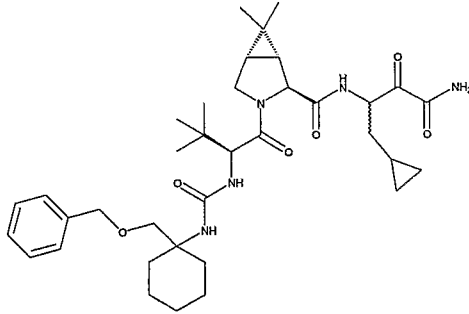
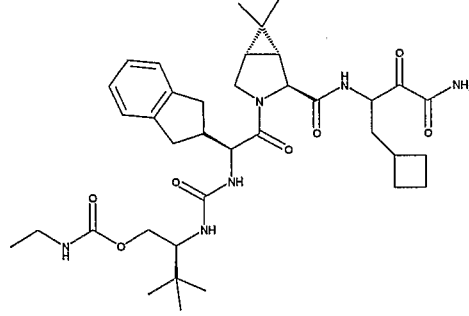
10 OH and Ac-DTEDVVP(Nva)-OH are determined experimentally at fixed concentrations of enzyme and substrate by plotting v_0/v_i vs. inhibitor concentration ($[I]_0$) according to the rearranged Michaelis-Menten equation for competitive inhibition kinetics: $v_0/v_i = 1 + [I]_0 / (K_i (1 + [S]_0 / K_m))$, where v_0 is the uninhibited initial velocity, v_i is the initial velocity in the presence of

15 inhibitor at any given inhibitor concentration ($[I]_0$) and $[S]_0$ is the substrate concentration used. The resulting data are fitted using linear regression and the resulting slope, $1/(K_i(1+[S]_0/K_m))$, is used to calculate the K_i value. The K_i^* values of some of the inventive compounds are shown in **Table 6** and **Table 6A** below:

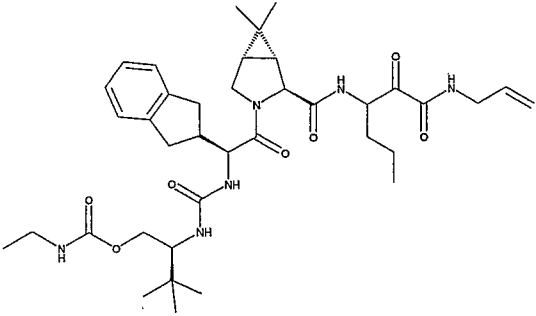
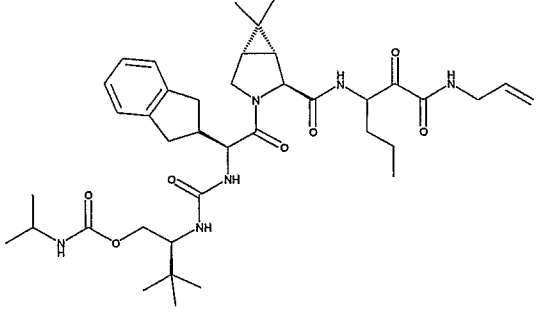
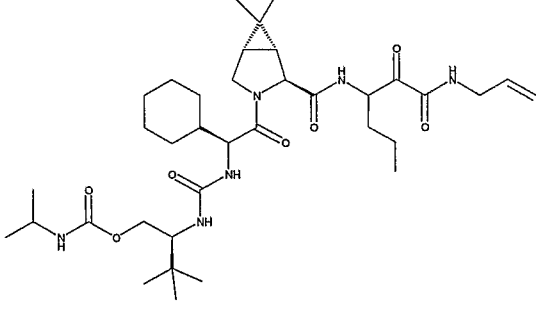
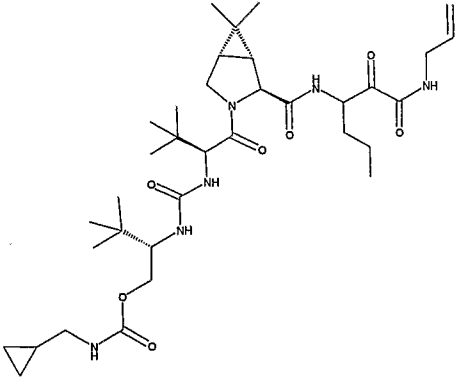
20

Table 6

Example #	Structure	K_i^* (nM)
1654		12

1655		24
1631		15
1606		16
1025		6.7

[illegible]

1023		33
1012		40
1056		30
1029		14

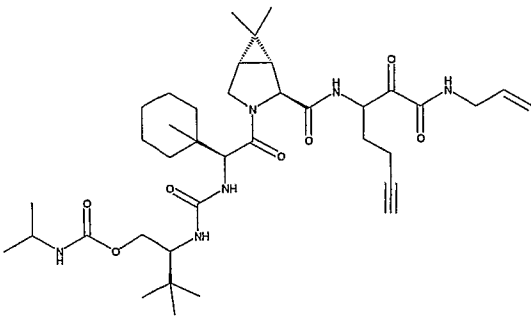
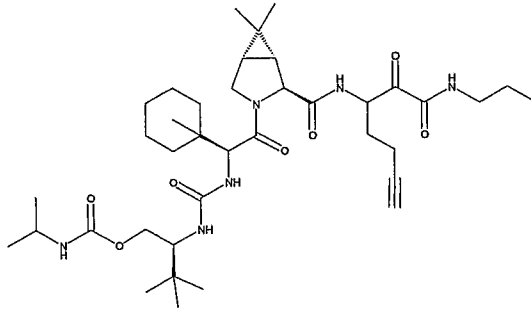
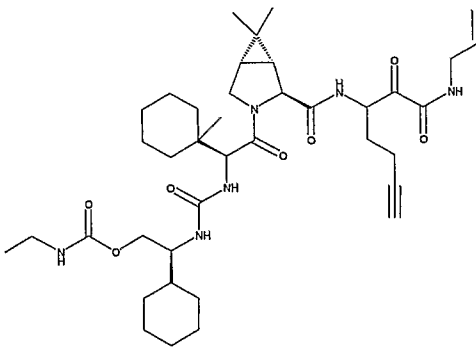
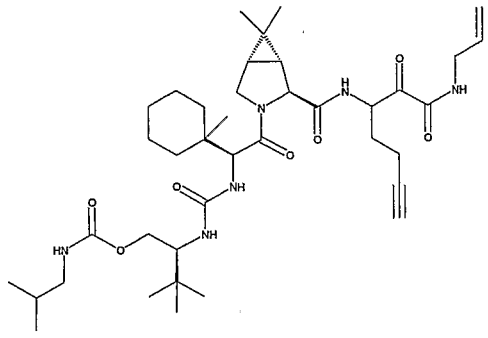
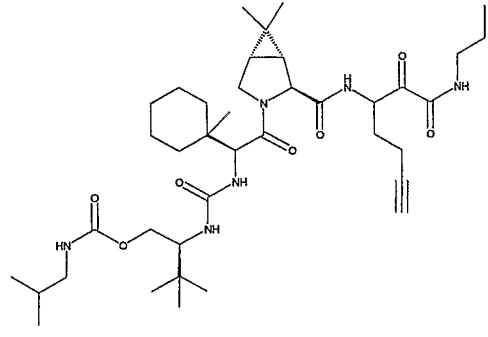
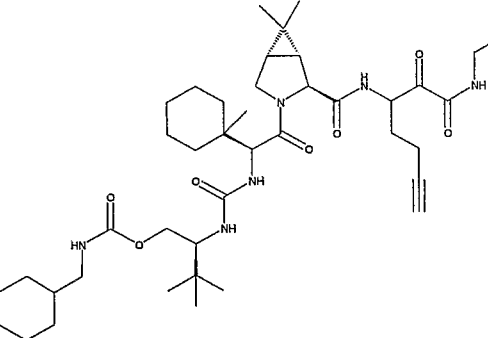
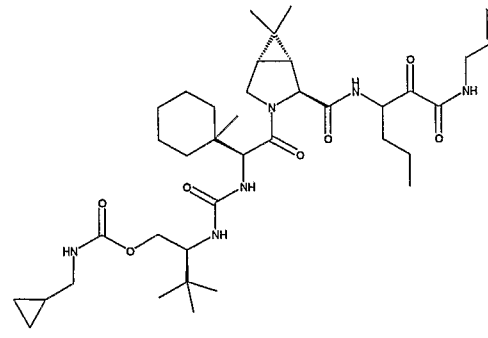
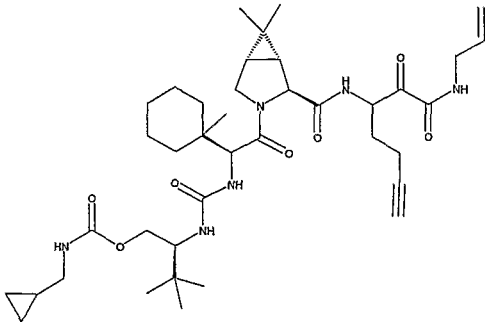
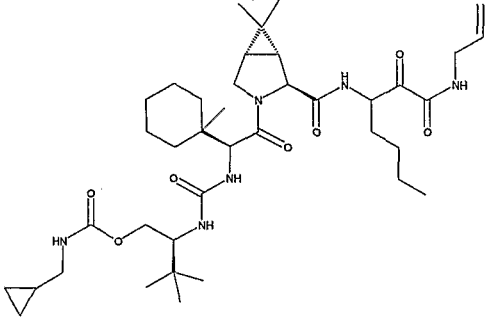
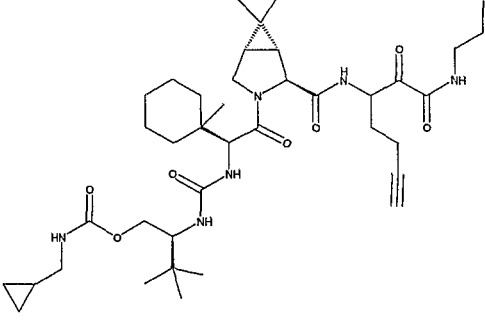
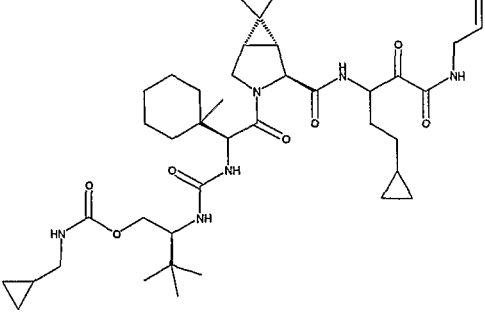
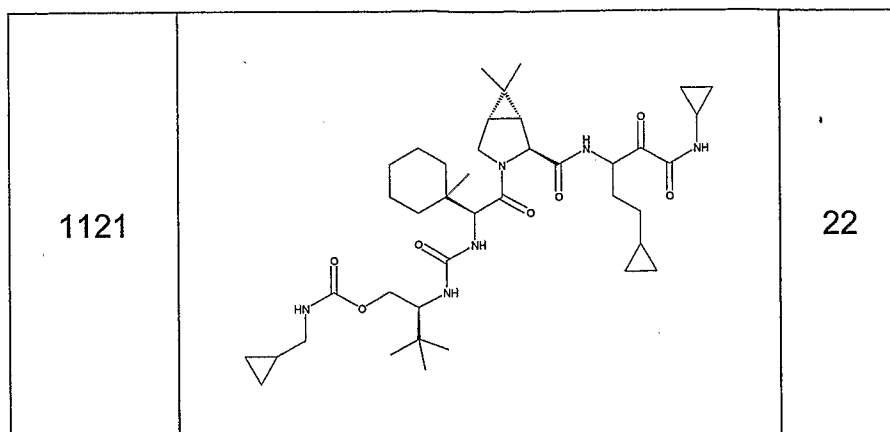
1095	 Chemical structure of compound 1095: A complex molecule featuring a central bicyclic amide core. It includes a cyclohexyl group, a tert-butyl group, a propargyl group, and a vinyl group. The structure is highly branched and contains multiple amide and ester linkages.	8
1098	 Chemical structure of compound 1098: A complex molecule featuring a central bicyclic amide core. It includes a cyclohexyl group, a tert-butyl group, a propargyl group, and an ethyl group. The structure is highly branched and contains multiple amide and ester linkages.	15

Table 6A

Example #	Structure	Ki* (nM)
1104	 Chemical structure of compound 1104: A complex molecule featuring a central bicyclic amide core. It includes a cyclohexyl group, a tert-butyl group, a propargyl group, and a vinyl group. The structure is highly branched and contains multiple amide and ester linkages.	13

1108		9
1109		27
1112		20
1114		32

1115		7.4
1116		34
1117		19
1120		30

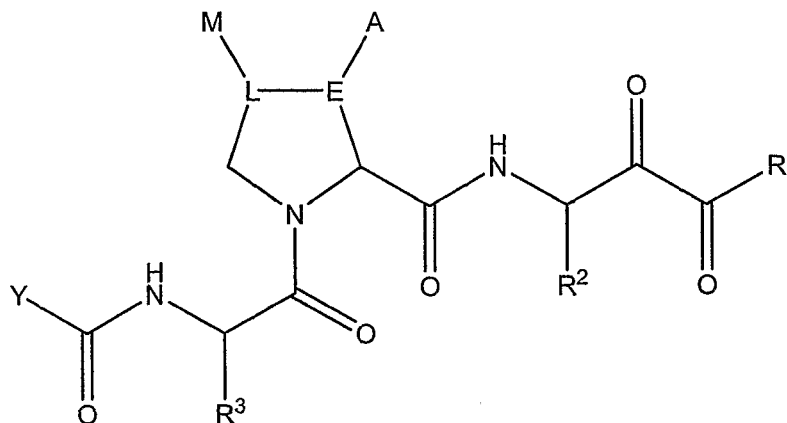


While the present invention has been described with in conjunction with the specific embodiments set forth above, many alternatives, modifications and other variations thereof will be apparent to those of ordinary skill in the art. All such alternatives, modifications and variations are intended to fall within the spirit and scope of the present invention.

Claims

What is claimed is:

1. A compound, or enantiomers, stereoisomers, rotamers, tautomers, or racemates of said compound, or a pharmaceutically acceptable salt, solvate or ester of said compound, said compound having the general structure shown in Formula I:

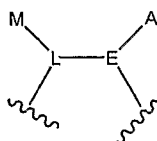


Formula I

wherein:

- 10 R^1 is H, OR^8 , NR^9R^{10} , or CHR^9R^{10} , wherein R^8 , R^9 and R^{10} can be the same or different, each being independently selected from the group consisting of H, alkyl-, alkenyl-, alkynyl-, aryl-, heteroalkyl-, heteroaryl-, cycloalkyl-, heterocyclyl-, arylalkyl-, and heteroarylalkyl;

- 15 A and M can be the same or different, each being independently selected from R, OR, NHR, NRR' , SR, SO_2R , and halo; or A and M are connected to each other such that the moiety:



- 20 shown above in Formula I forms either a three, four, six, seven or eight-membered cycloalkyl, a four to eight-membered heterocyclyl, a six to ten-membered aryl, or a five to ten-membered heteroaryl;

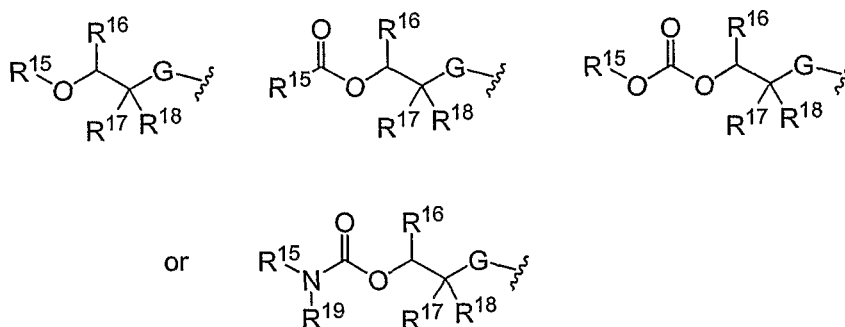
E is C(H) or C(R);

L is C(H), C(R), $CH_2C(R)$, or $C(R)CH_2$;

- 25 R, R' , R^2 , and R^3 can be the same or different, each being independently selected from the group consisting of H, alkyl-, alkenyl-, alkynyl-, cycloalkyl-, heteroalkyl-, heterocyclyl-, aryl-, heteroaryl-,

(cycloalkyl)alkyl-, (heterocyclyl)alkyl-, aryl-alkyl-, and heteroaryl-alkyl-; or alternately R and R' in NRR' are connected to each other such that NRR' forms a four to eight-membered heterocyclyl;

and Y is selected from the following moieties:



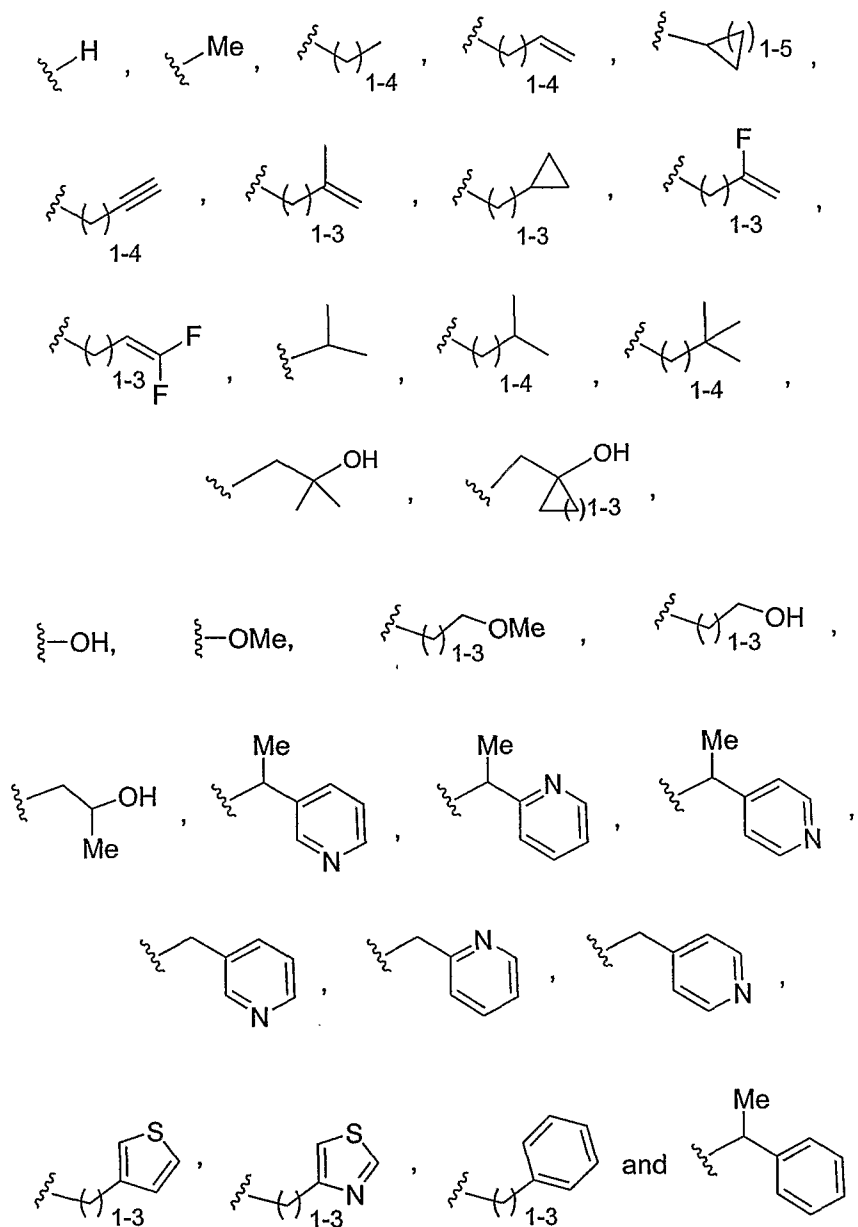
wherein G is NH or O; and R¹⁵, R¹⁶, R¹⁷, R¹⁸, and R¹⁹ can be the same or different, each being independently selected from the group consisting of H, alkyl, heteroalkyl, alkenyl, heteroalkenyl, alkynyl, heteroalkynyl, cycloalkyl, heterocyclyl, aryl, arylalkyl, heteroaryl, and heteroarylalkyl, or alternately, (i) either R¹⁵ and R¹⁶ are connected to each other to form a four to eight-membered cyclic structure, or R¹⁵ and R¹⁹ are connected to each other to form a four to eight-membered cyclic structure, and (ii) likewise, independently, R¹⁷ and R¹⁸ are connected to each other to form a three to eight-membered cycloalkyl or heterocyclyl;

wherein each of said alkyl, aryl, heteroaryl, cycloalkyl or heterocyclyl can be unsubstituted or optionally independently substituted with one or more moieties selected from the group consisting of: hydroxy, alkoxy, aryloxy, thio, alkylthio, arylthio, amino, amido, alkylamino, arylamino, alkylsulfonyl, arylsulfonyl, sulfonamido, alkylsulfonamido, arylsulfonamido, alkyl, aryl, heteroaryl, keto, carboxy, carbalkoxy, carboxamido, alkoxycarbonylamino, alkoxycarbonyloxy, alkylureido, arylureido, halo, cyano, and nitro.

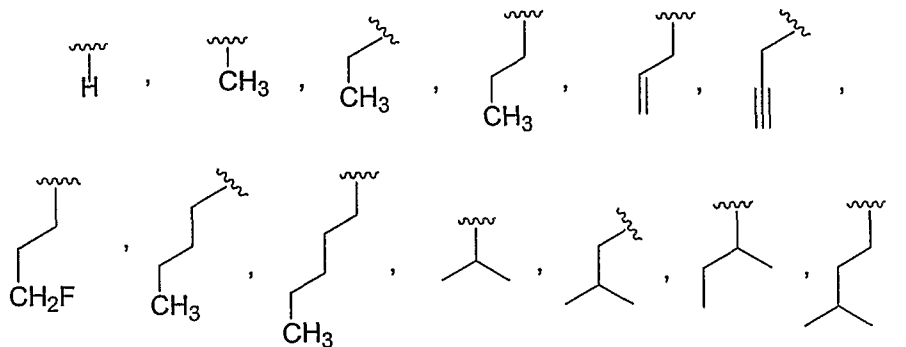
2. The compound of claim 1, wherein R¹ is NR⁹R¹⁰, and R⁹ is H, R¹⁰ is H, or R¹⁴ wherein R¹⁴ is H, alkyl, aryl, heteroalkyl, heteroaryl, cycloalkyl, alkyl-

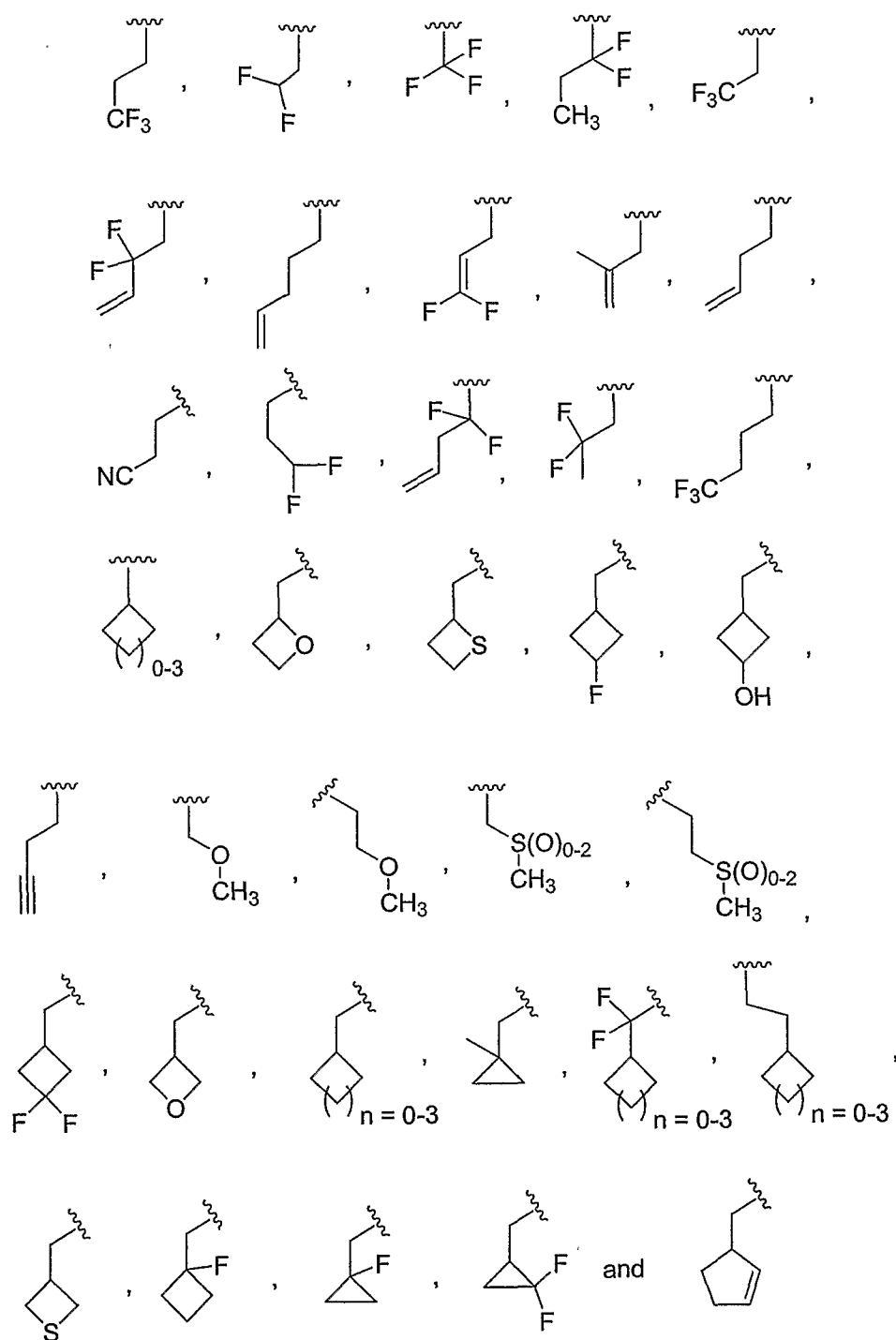
aryl, alkyl-heteroaryl, aryl-alkyl, alkenyl, alkynyl or heteroaryl-alkyl.

3. The compound of claim 2, wherein R¹⁴ is selected from the group consisting of:

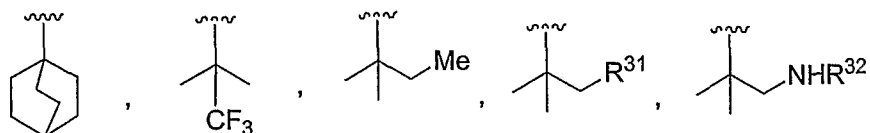
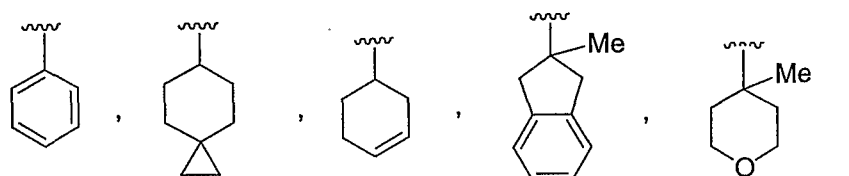
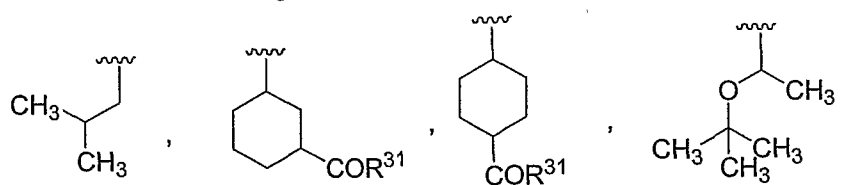
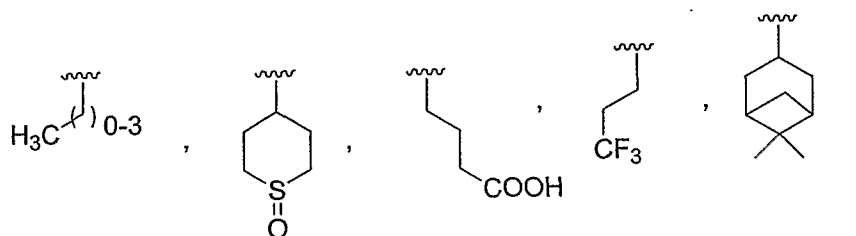
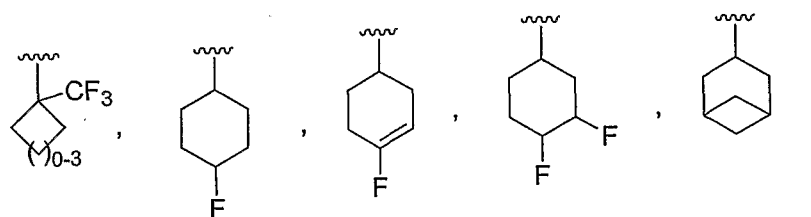
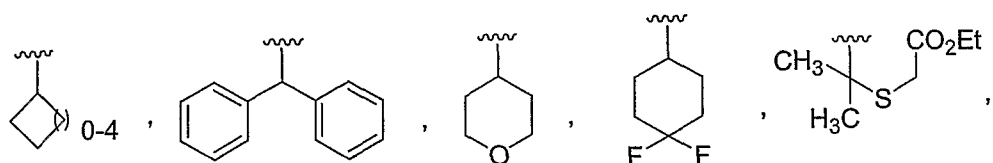
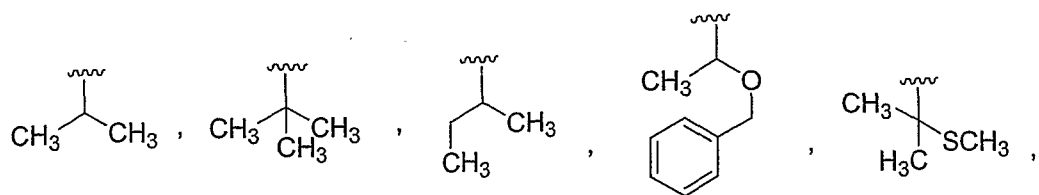


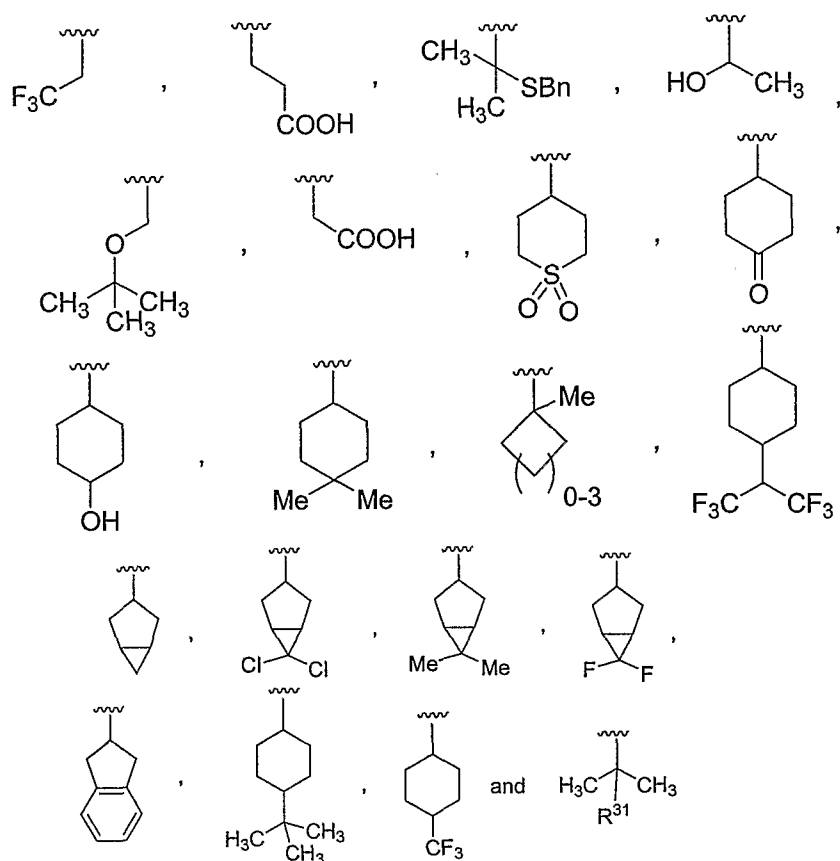
4. The compound of claim 1, wherein R² is selected from the group
5 consisting of the following moieties:





5. The compound of claim 1, wherein R^3 is selected from the group consisting of:

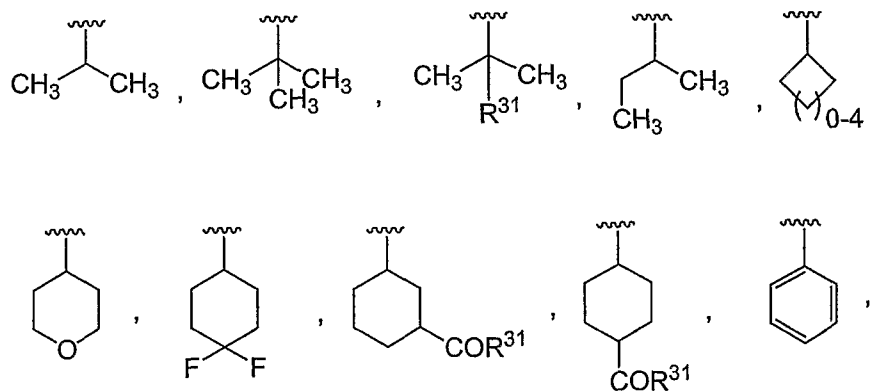


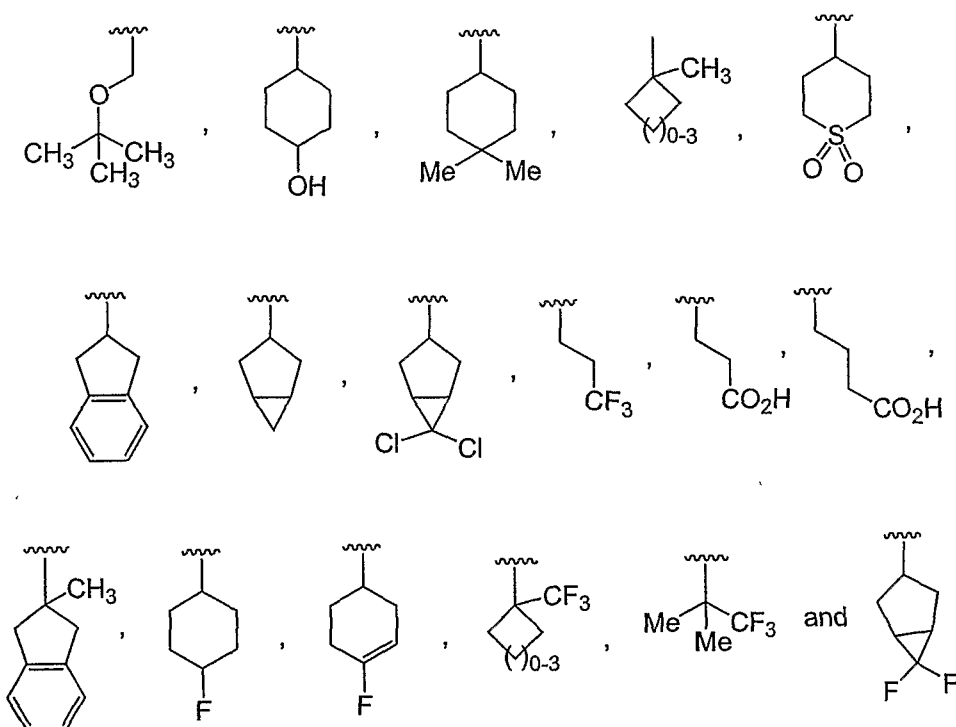


wherein R^{31} is OH or O-alkyl; and

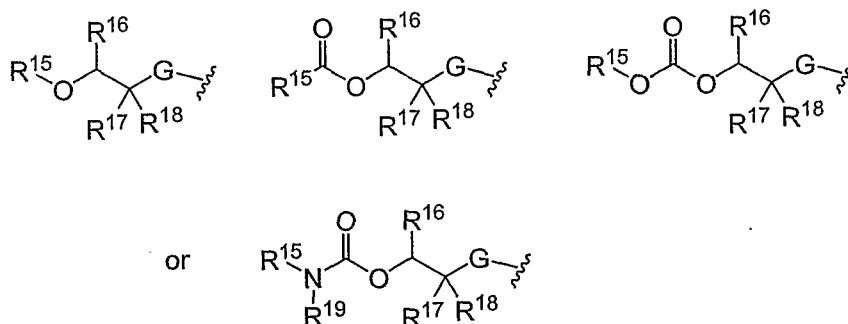
5 R^{32} is H, C(O)CH₃, C(O)OtBu or C(O)N(H)tBu.

6. The compound of claim 5, wherein R^3 is selected from the group consisting of the following moieties:





7. The compound of claim 1, wherein Y is selected from the following moieties:



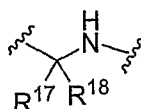
wherein G = NH or O; and

R^{15} , R^{16} , R^{17} , R^{18} , and R^{19} can be the same or different, each being independently selected from the group consisting of H, alkyl, heteroalkyl, alkenyl, heteroalkenyl, alkynyl, heteroalkynyl, cycloalkyl, heterocyclyl, aryl, and heteroaryl, or alternately, (i) either R^{15} and R^{16} are directly connected to form a four to eight-membered cyclic structure, or R^{15} and R^{19} are directly connected to form a four to eight-membered cyclic structure, and (ii) likewise, independently, R^{17} and R^{18} are directly connected to form a three to eight-membered cycloalkyl or heterocyclyl;

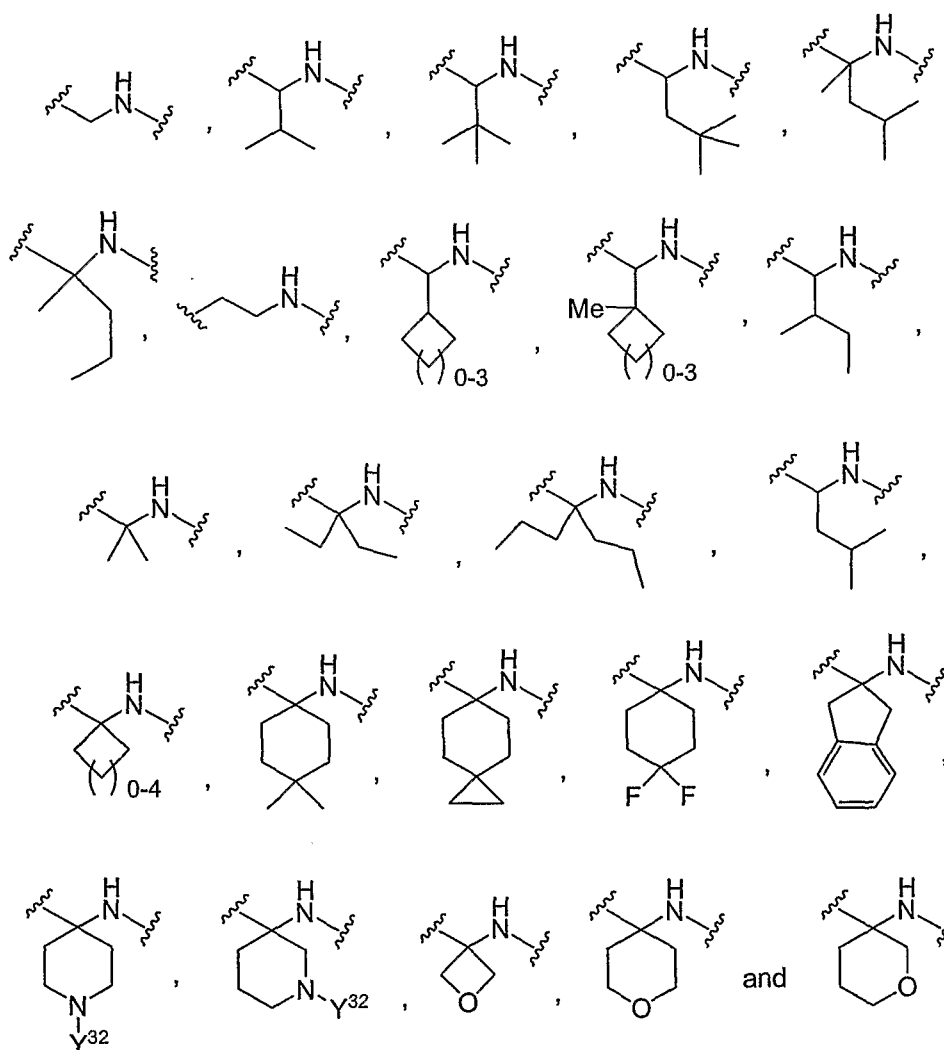
wherein each of said alkyl, aryl, heteroaryl, cycloalkyl or heterocyclyl can be unsubstituted or optionally independently substituted with one or more moieties selected from the group consisting of: hydroxy, alkoxy, aryloxy, thio,

alkylthio, arylthio, amino, amido, alkylamino, arylamino, alkylsulfonyl, arylsulfonyl, sulfonamido, alkylsulfonamido, arylsulfonamido, keto, carboxy, carbalkoxy, carboxamido, alkoxycarbonylamino, alkoxycarbonyloxy, alkylureido, arylureido, halo, cyano, and nitro.

- 5 8. The compound of claim 7, wherein G is NH.
9. The compound of claim 8, wherein

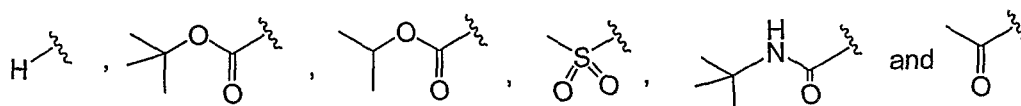


is selected from the group consisting of:



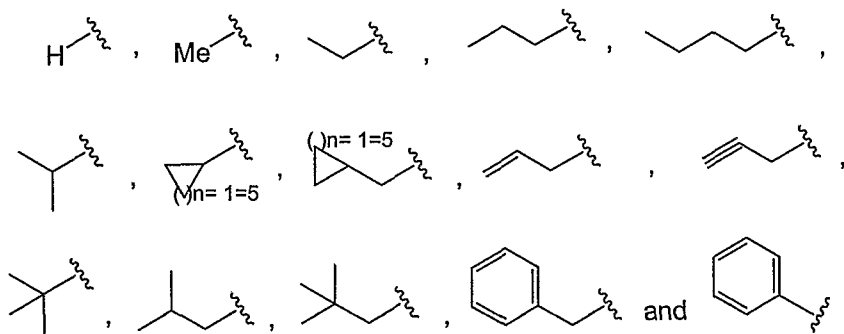
10

wherein Y³² is selected from the group consisting of:

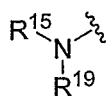


R¹⁶ is selected from H, methyl, phenyl, benzyl; and

R^{15} and R^{19} maybe the same or different, each being independently selected from the following:

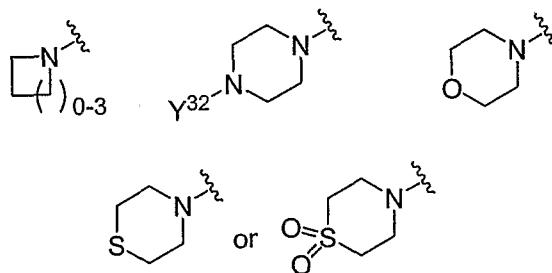


or alternately, the moiety:



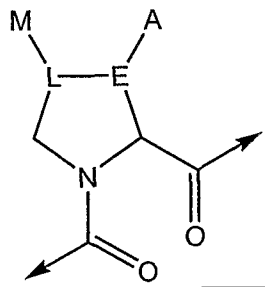
5

is selected from the following moieties:



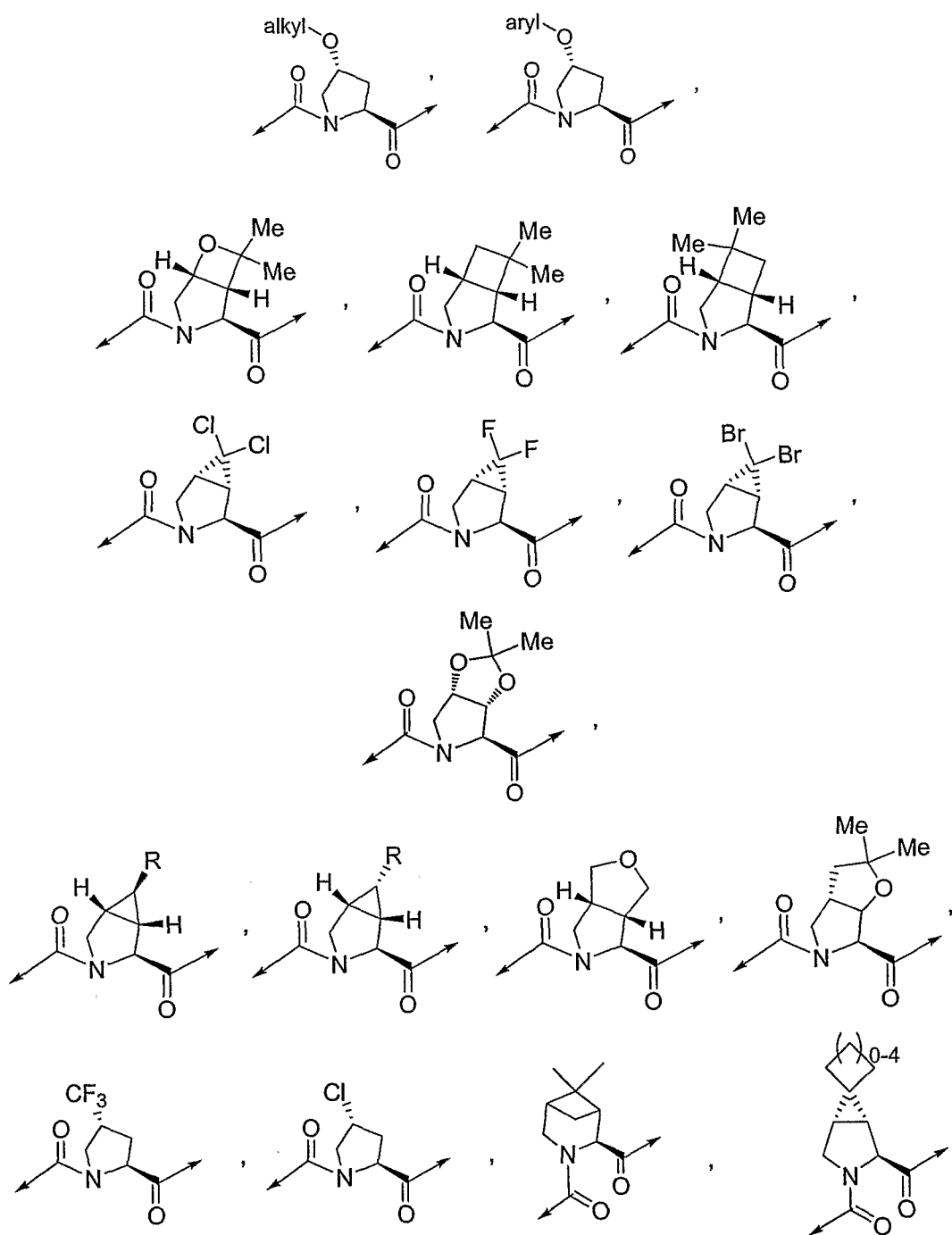
10. The compound of claim 9, wherein R^{16} is H.

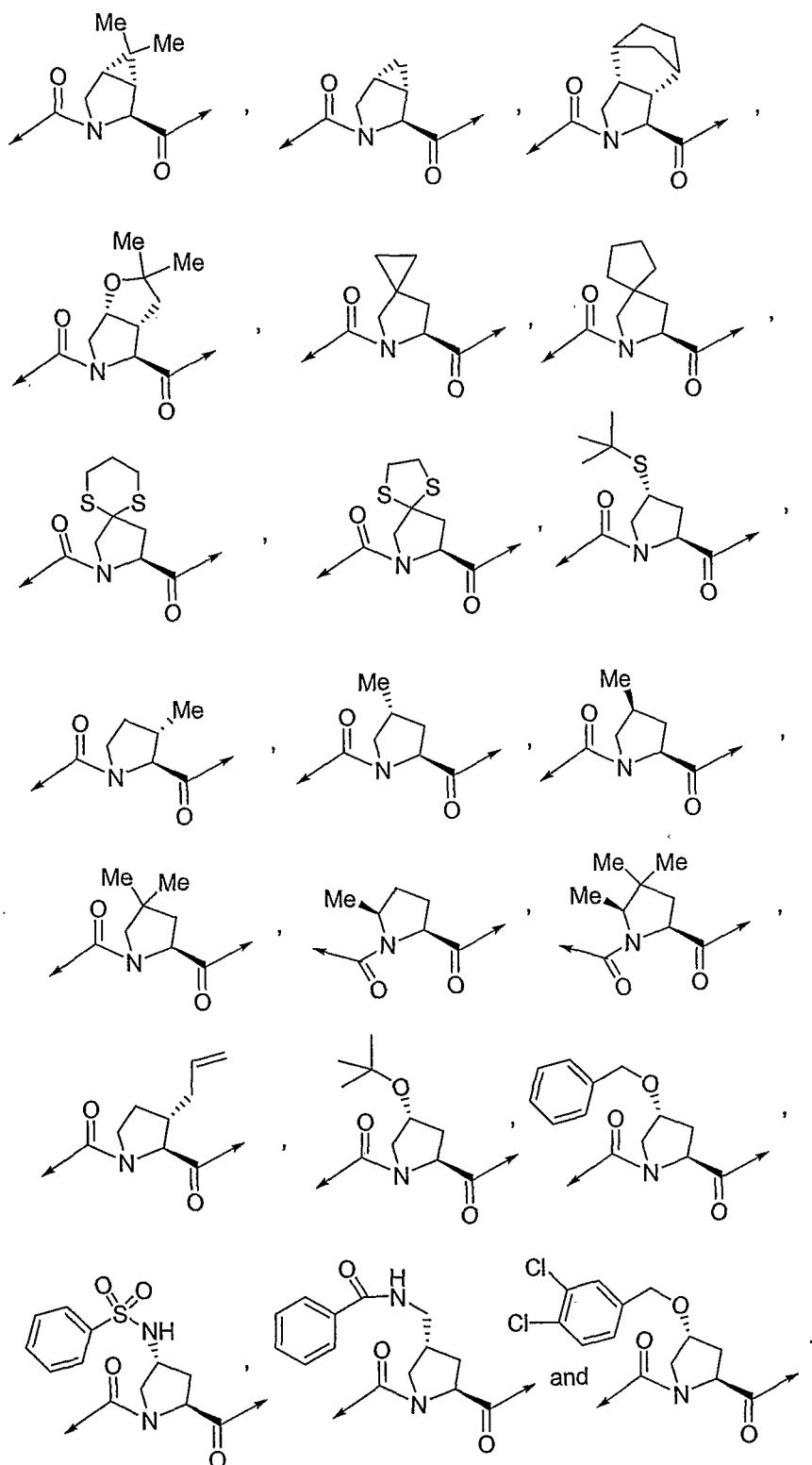
11. The compound of claim 1, wherein the moiety:



10

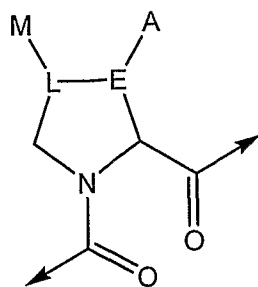
is selected from the following structures:



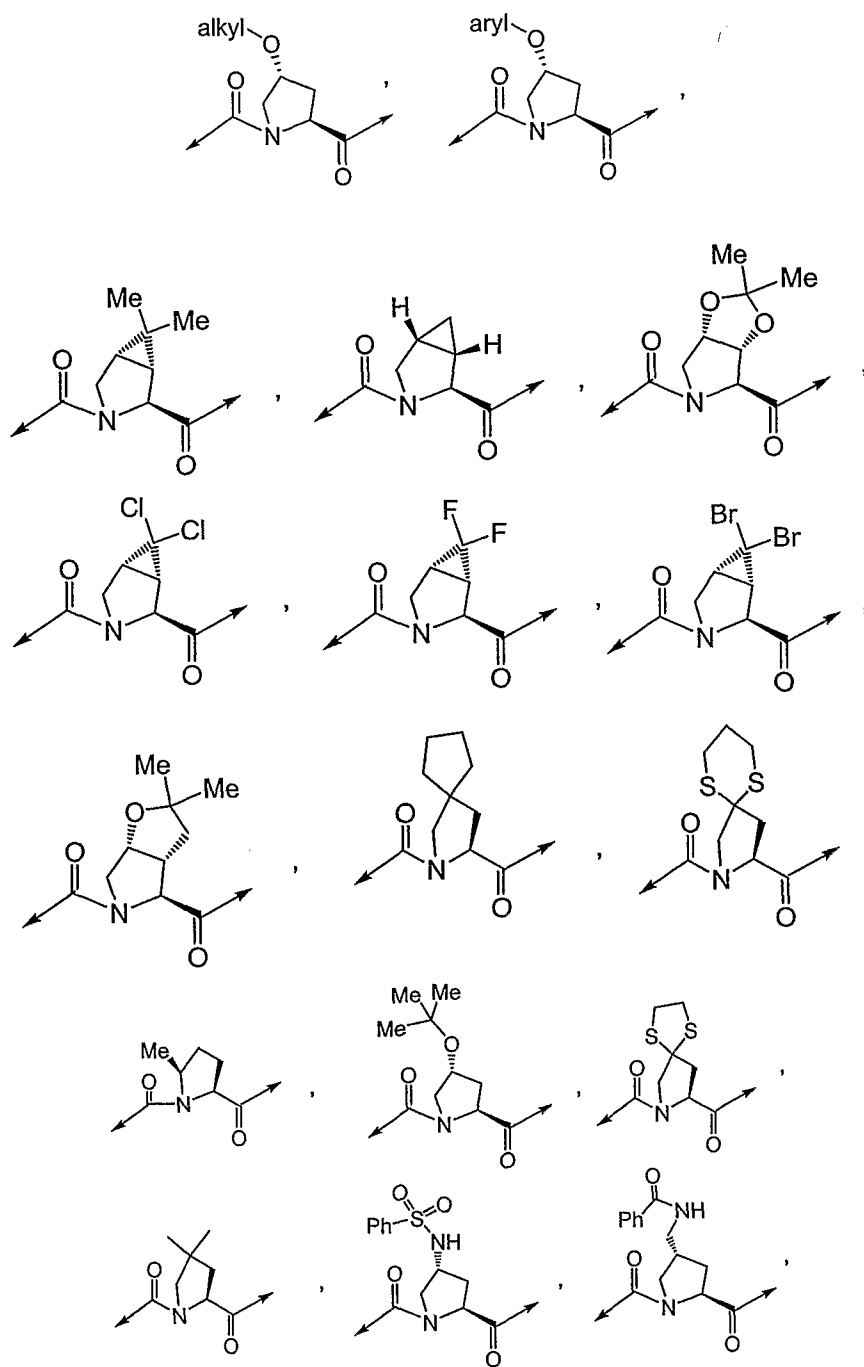


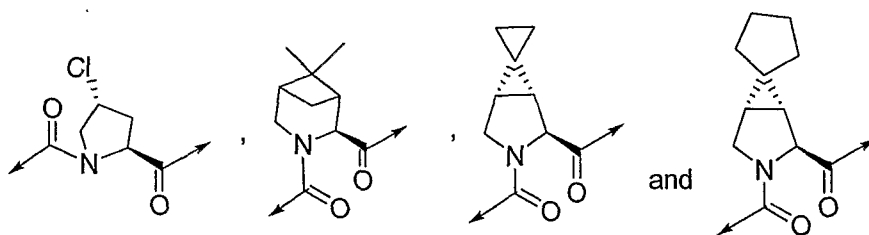
12. The compound of claim 11, wherein the moiety:

196

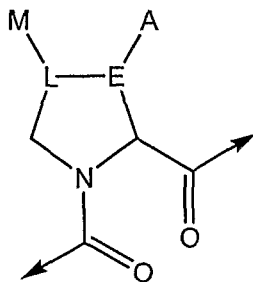


is selected from the following structures:

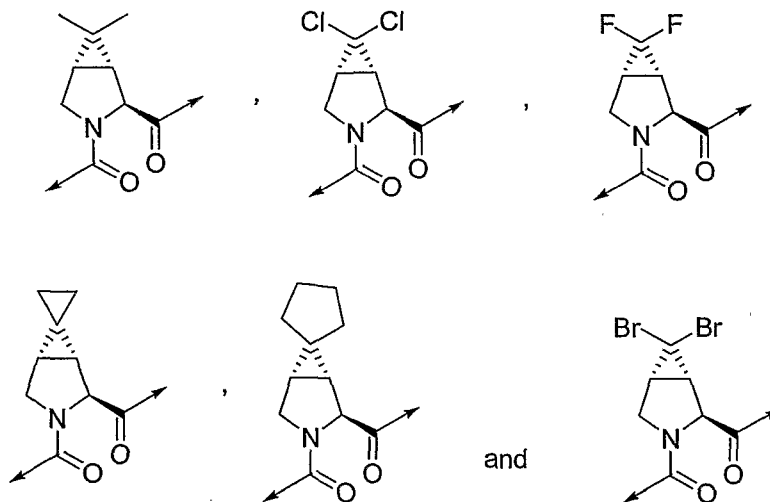




13. The compound of claim 12, wherein the moiety:

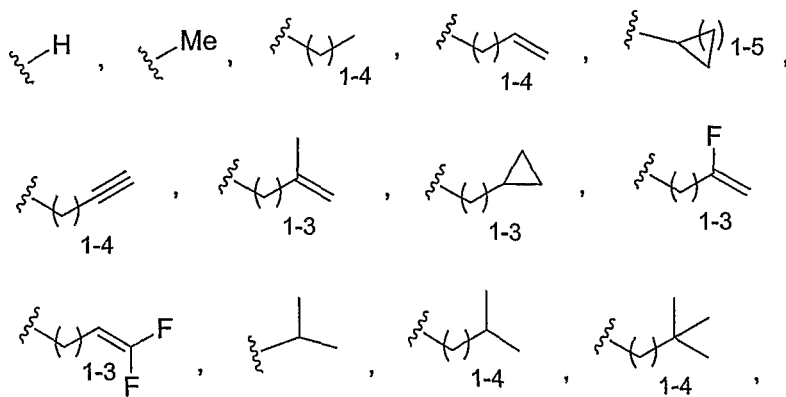


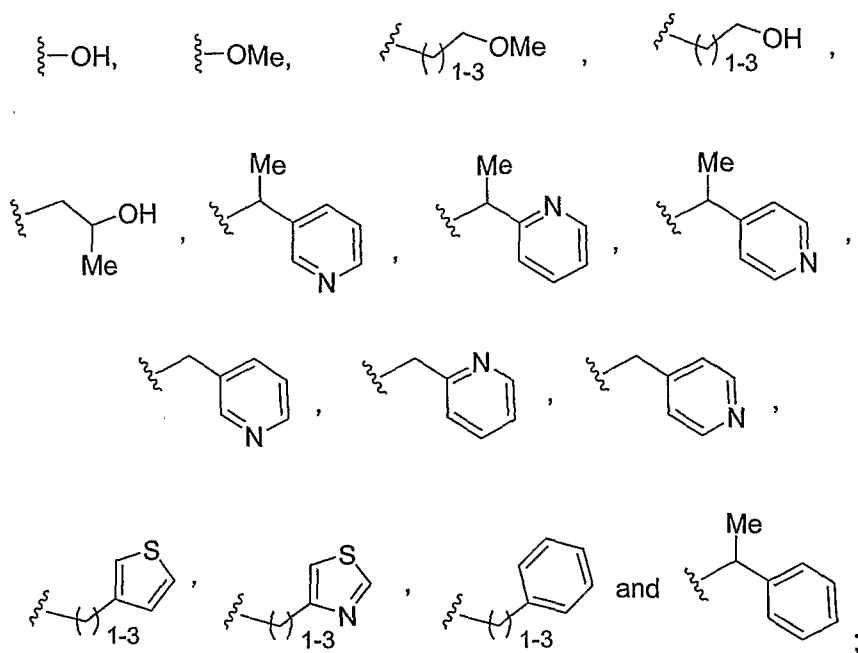
is selected from the following structures:



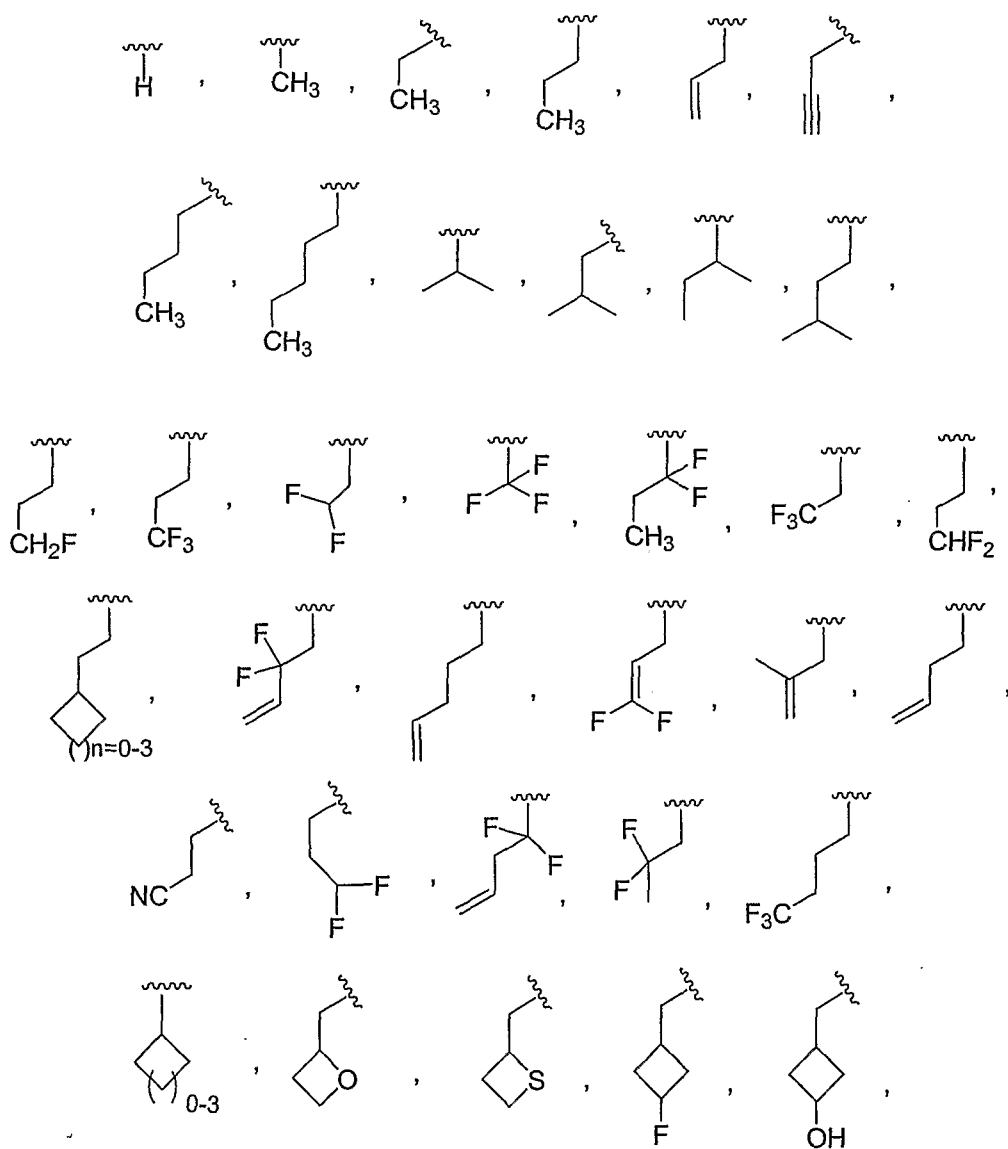
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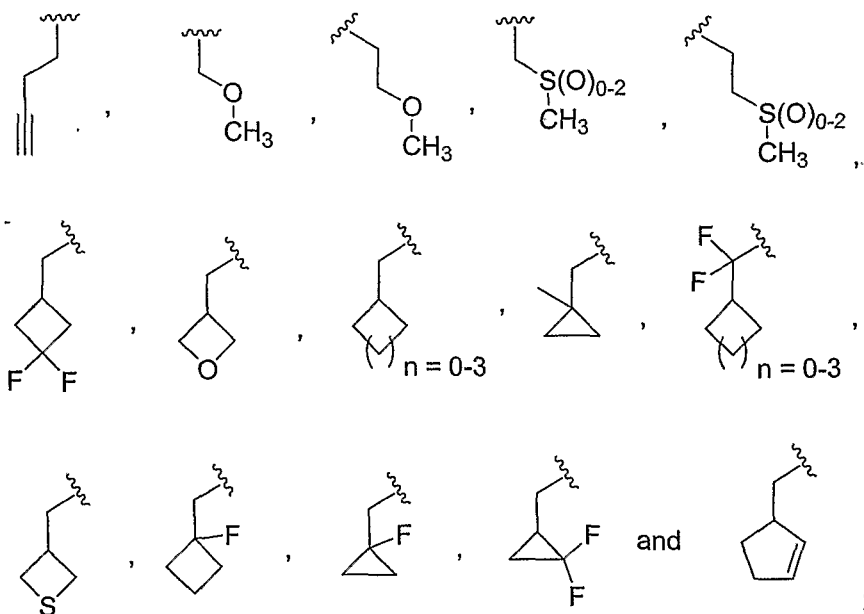
14. The compound of claim 1, wherein R^{14} is selected from the group consisting of:



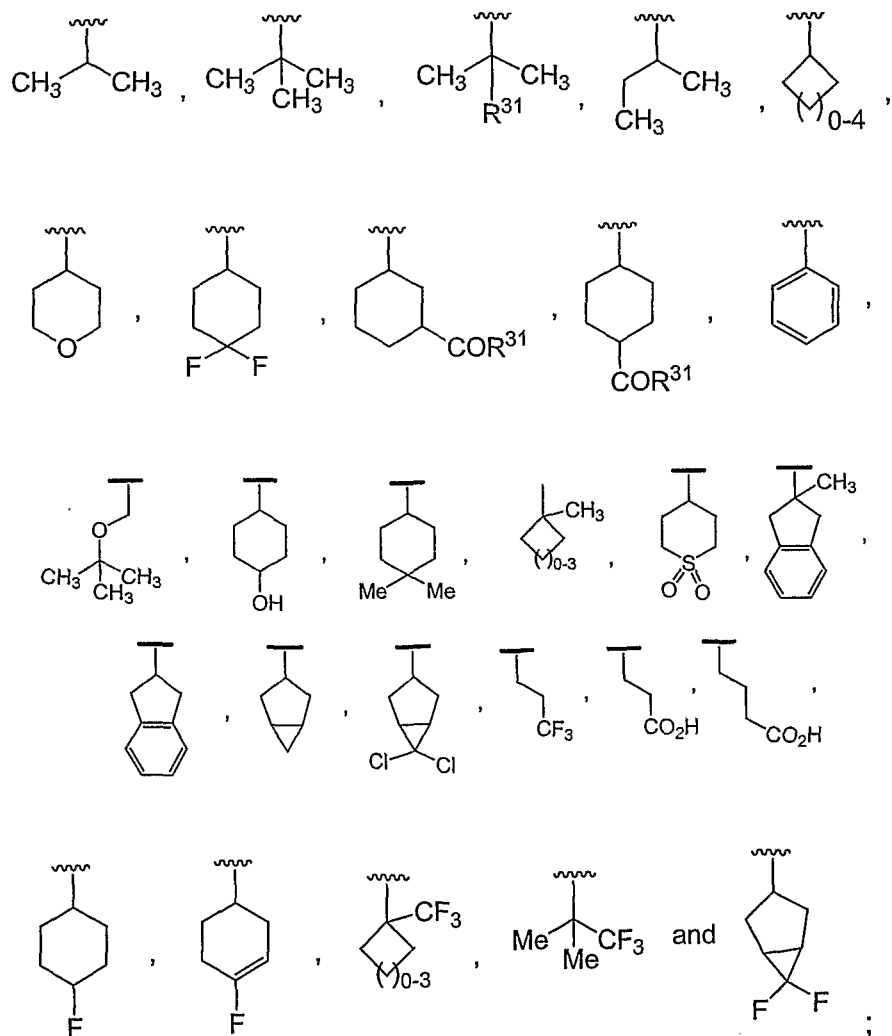


R² is selected from the group consisting of the following moieties:



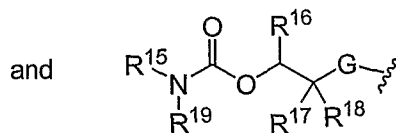
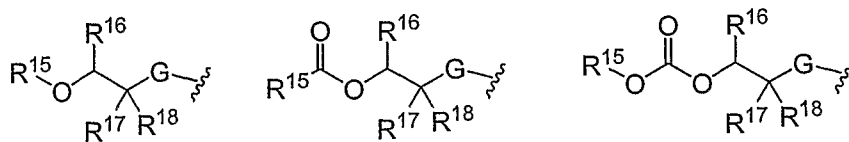


R³ is selected from the group consisting of the following moieties:

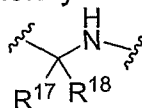


Y is selected from the group consisting of:

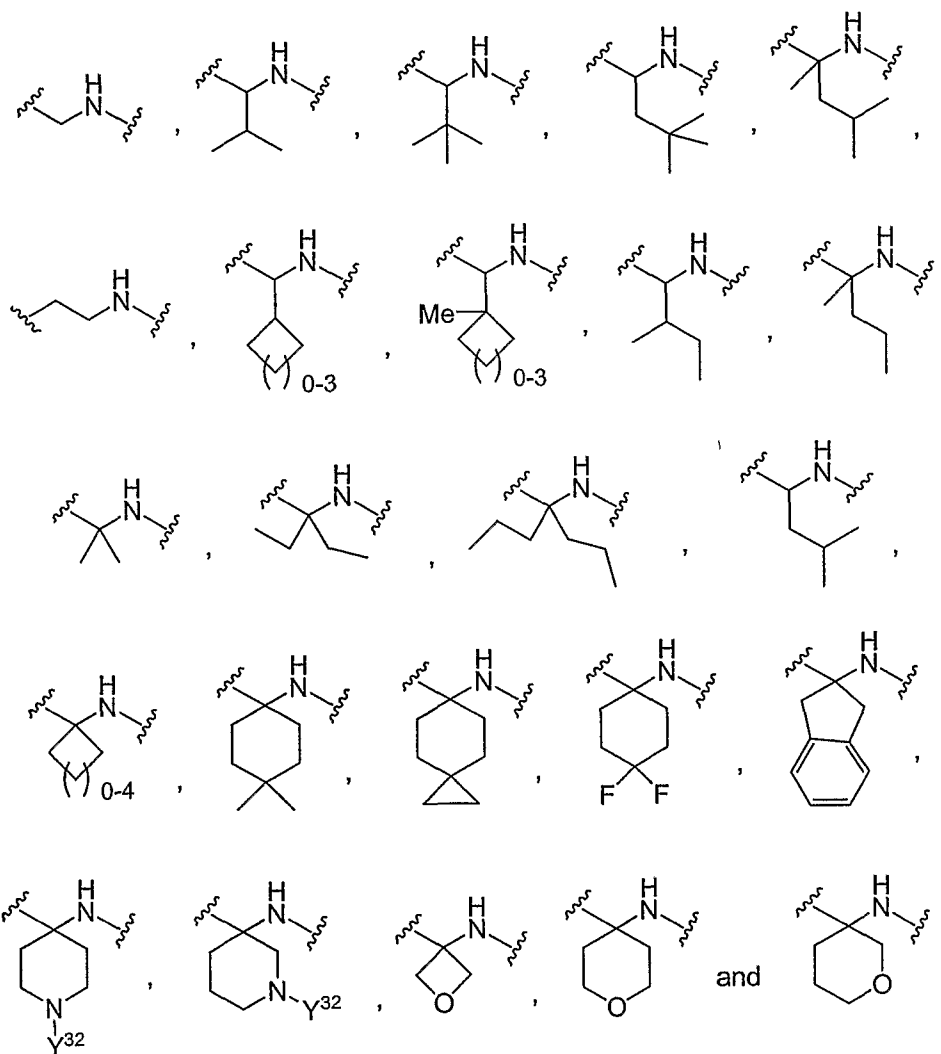
200



wherein G = NH; and the moiety:



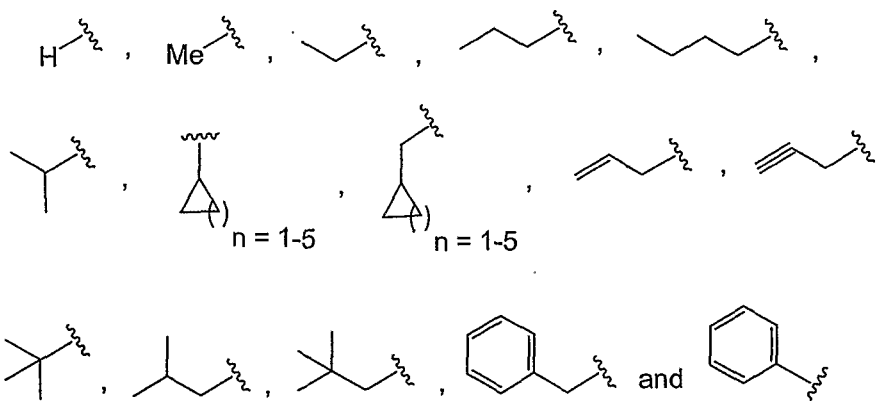
is selected from the group consisting of:



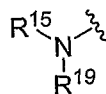
5

$R^{16} = H$; and

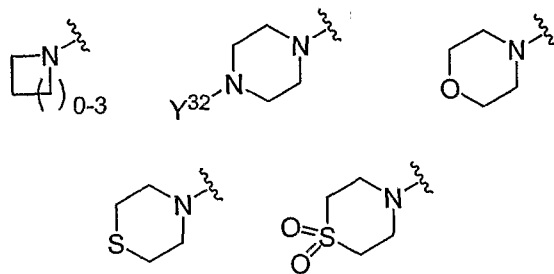
R^{15} and R^{19} maybe the same or different, and is selected from one of the following:



or alternately, the moiety:

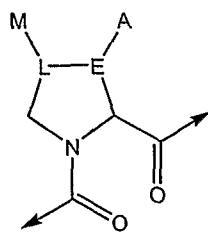


is represented by one of the following moieties,

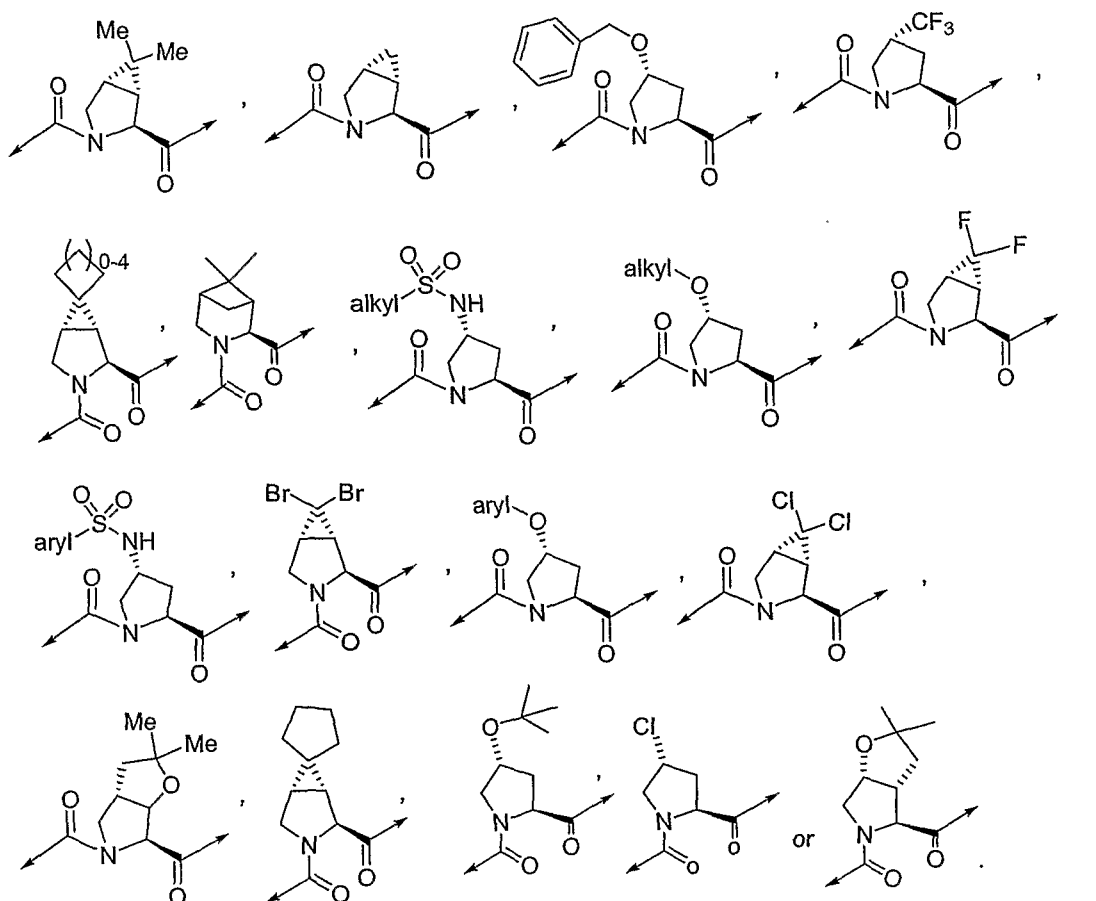


5

and the moiety:



is:



15. A pharmaceutical composition comprising as an active ingredient at least one compound of claim 1.

16. The pharmaceutical composition of claim 15 for use in treating disorders associated with HCV.

17. The pharmaceutical composition of claim 16 additionally comprising at least one pharmaceutically acceptable carrier.

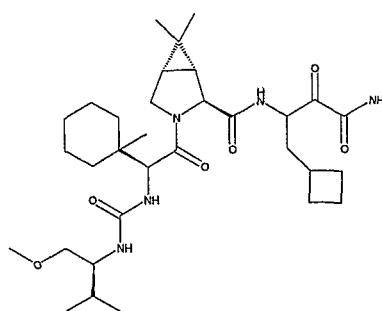
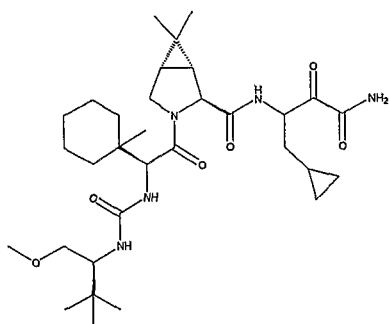
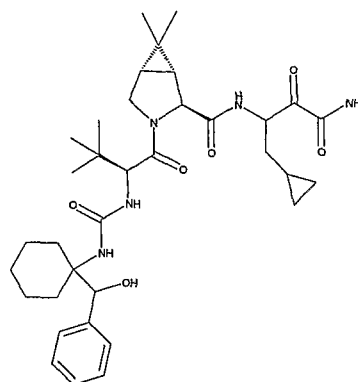
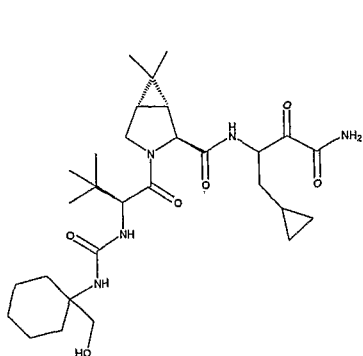
18. The pharmaceutical composition of claim 17, additionally containing at least one antiviral agent.

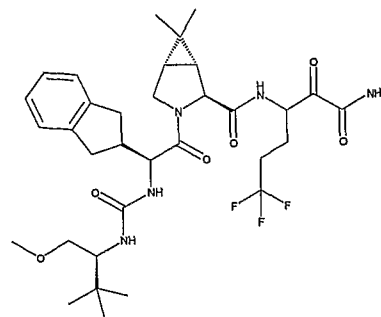
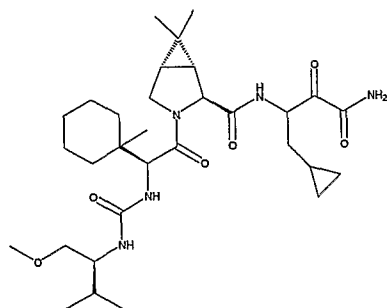
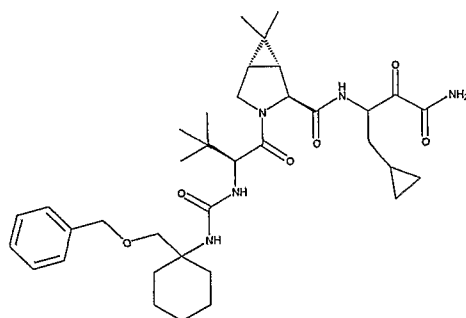
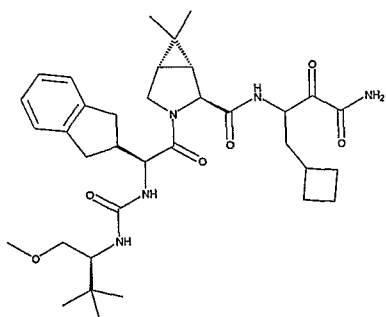
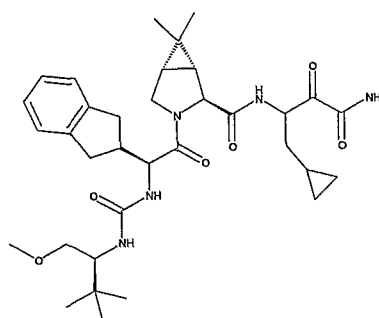
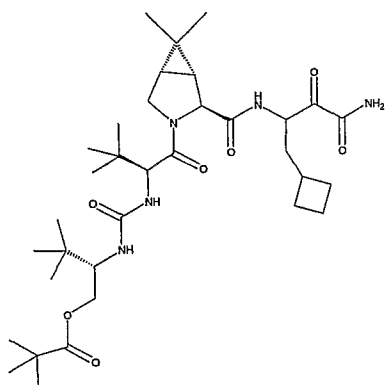
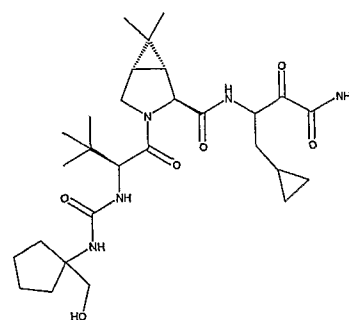
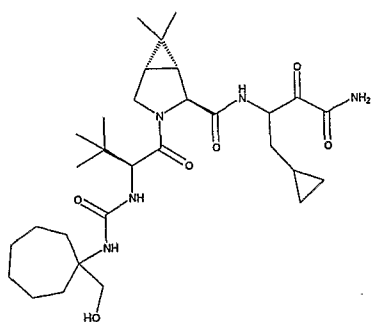
19. The pharmaceutical composition of claim 18, still additionally containing at least one interferon.

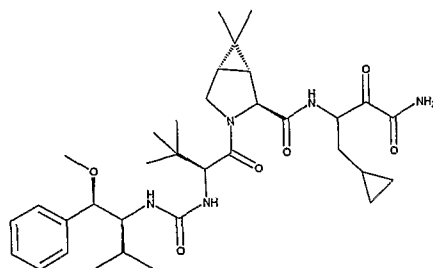
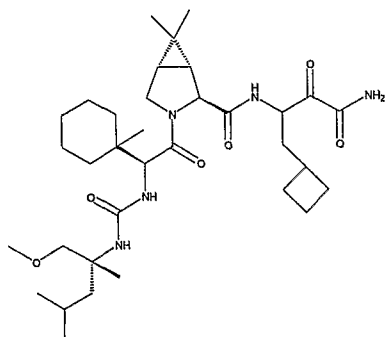
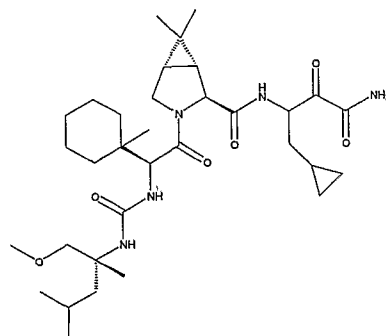
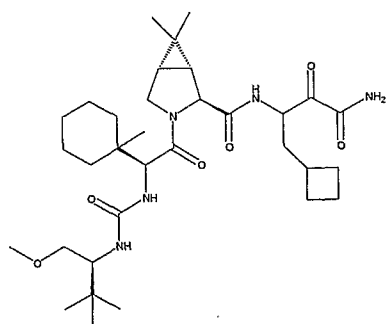
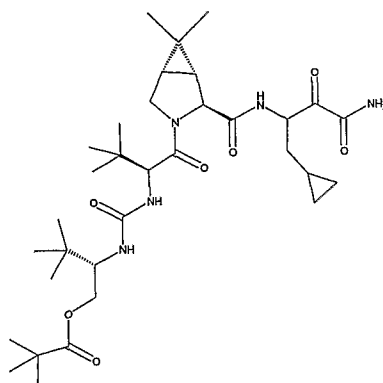
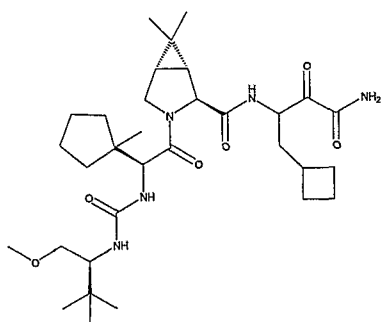
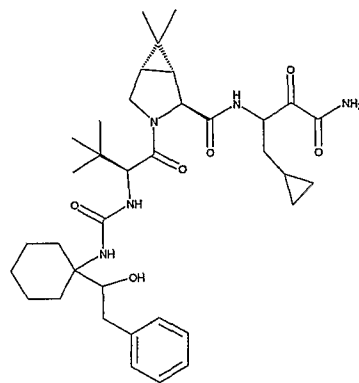
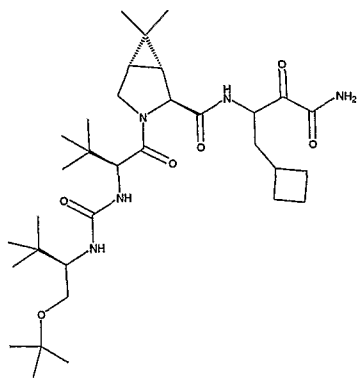
20. The pharmaceutical composition of claim 19, wherein said at least one antiviral agent is ribavirin and said at least one interferon is α -interferon or pegylated interferon.

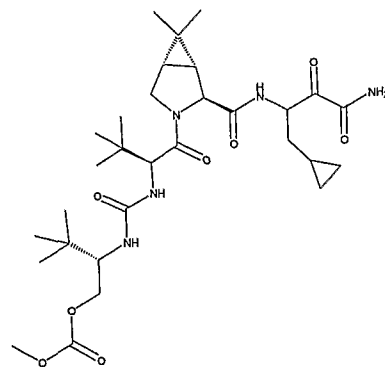
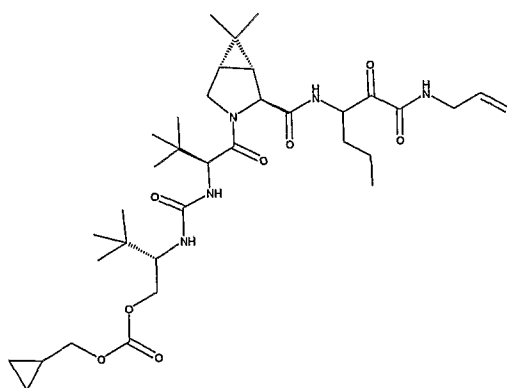
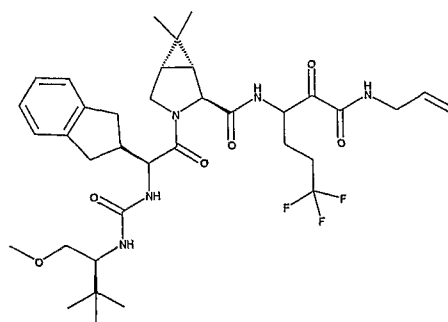
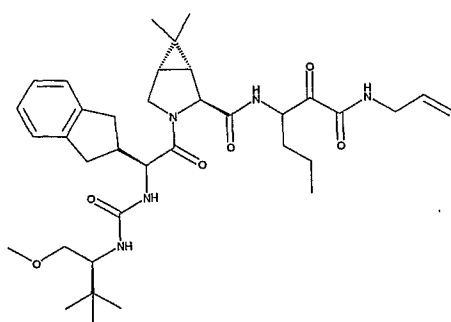
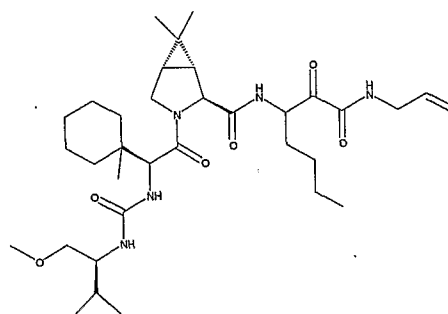
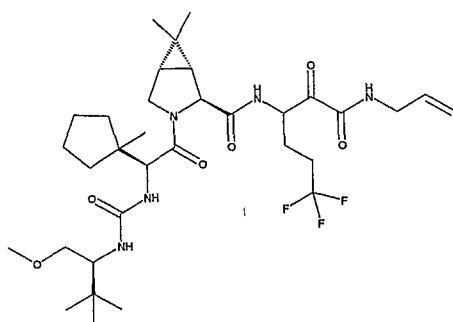
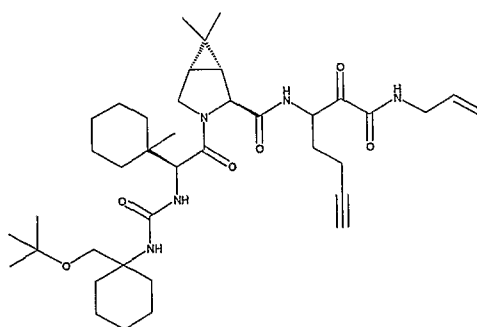
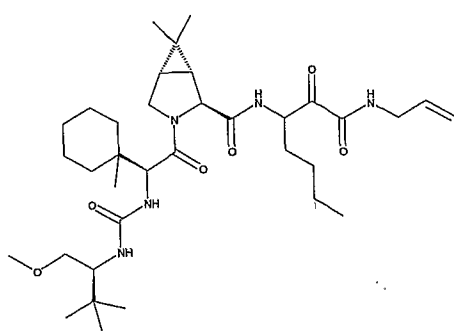
21. A method of treating disorders associated with the HCV, said method comprising administering to a patient in need of such treatment a pharmaceutical composition which comprises therapeutically effective amounts of at least one compound of claim 1.

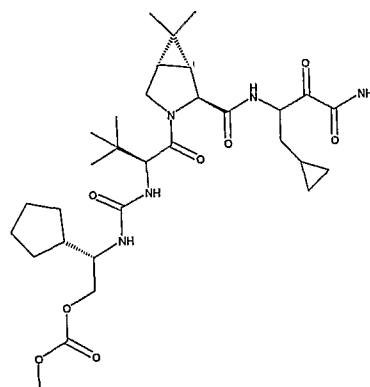
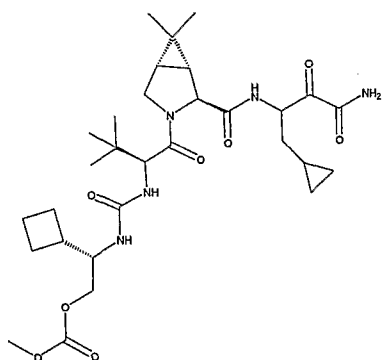
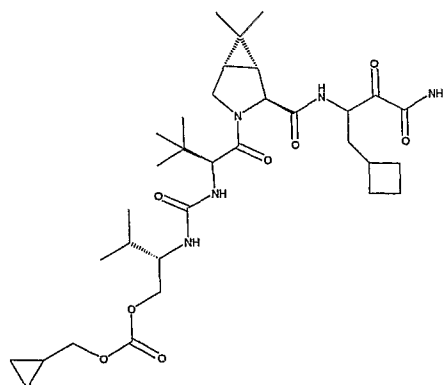
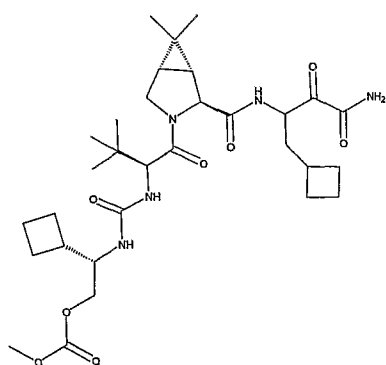
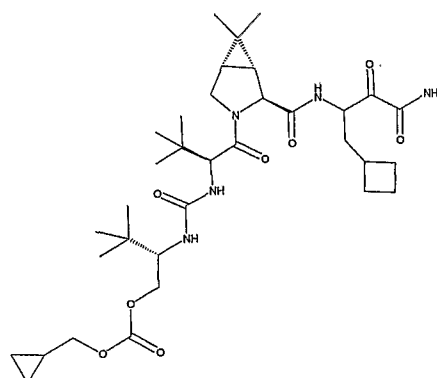
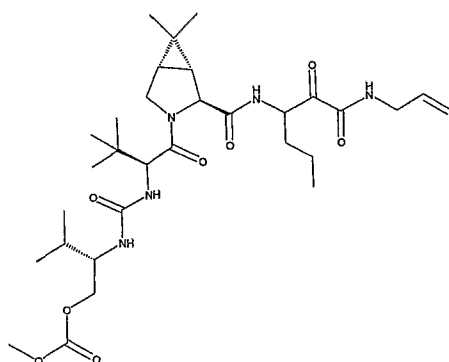
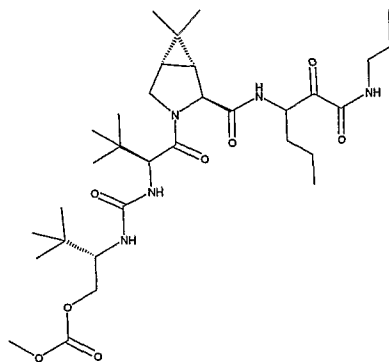
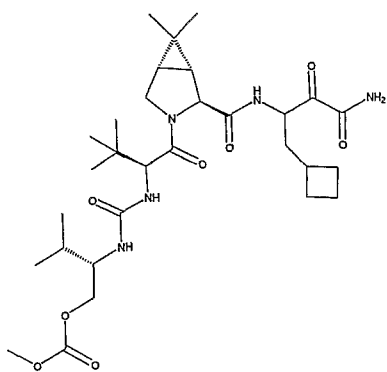
22. The method of claim 21, wherein said administration is oral or subcutaneous.
23. The use of a compound of claim 1 for the manufacture of a medicament to treat disorders associated with the HCV.
- 5 24. A method of preparing a pharmaceutical composition for treating the disorders associated with the HCV, said method comprising bringing into intimate physical contact at least one compound of claim 1 and at least one pharmaceutically acceptable carrier.
25. A compound exhibiting HCV protease inhibitory activity, or enantiomers, stereoisomers, rotamers, tautomers, diastereomers, or racemates of said compound, or a pharmaceutically acceptable salt, solvate or ester of said compound, said compound being selected from the compounds of structures listed below:
- 10

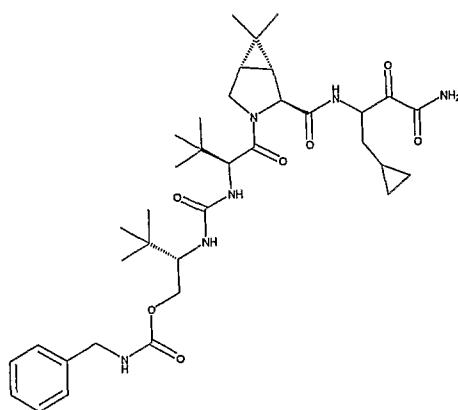
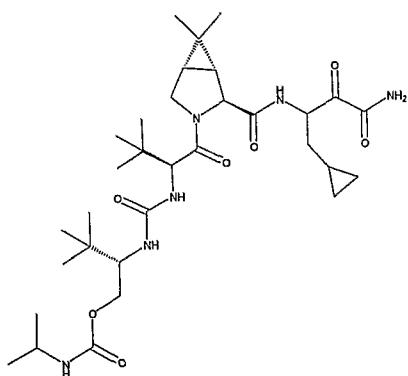
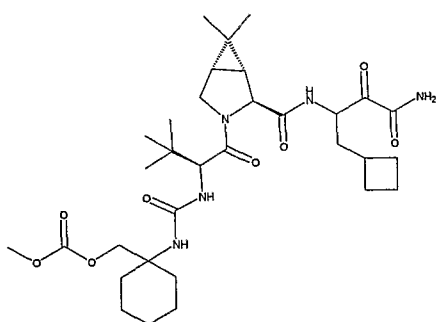
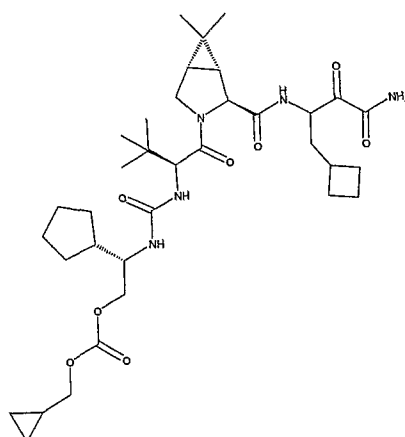
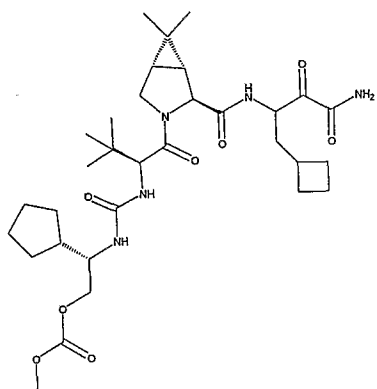
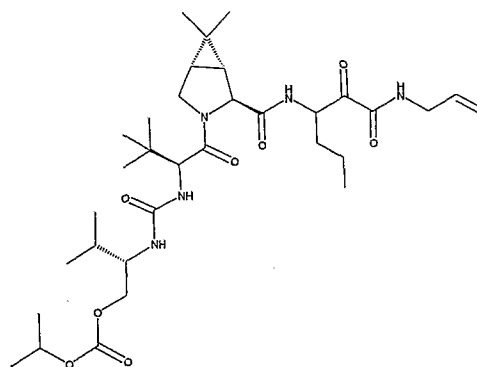
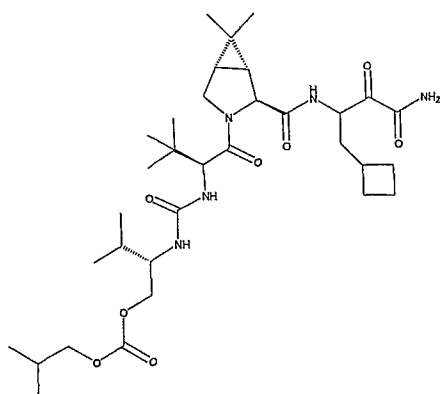


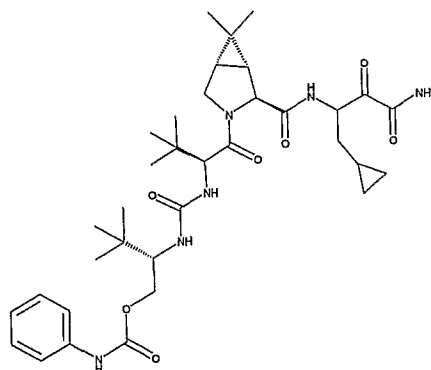
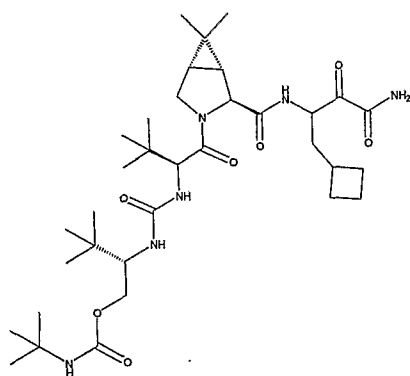
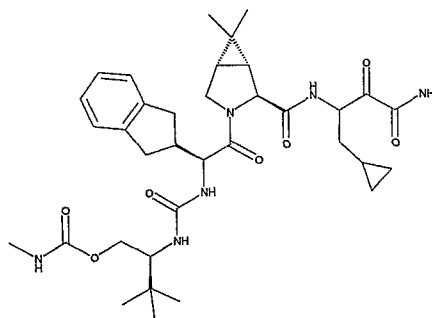
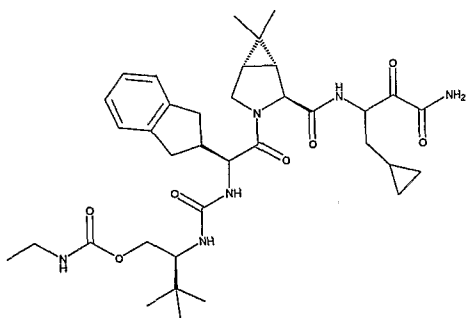
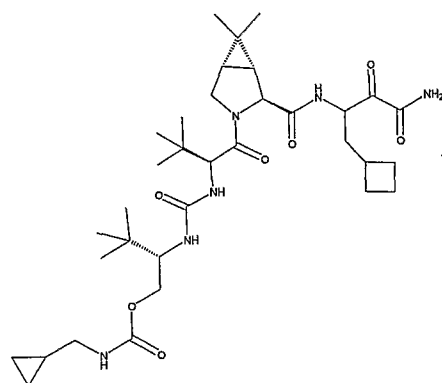
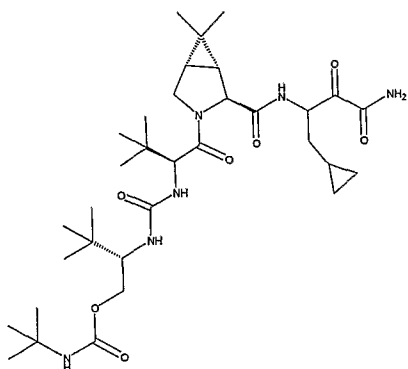
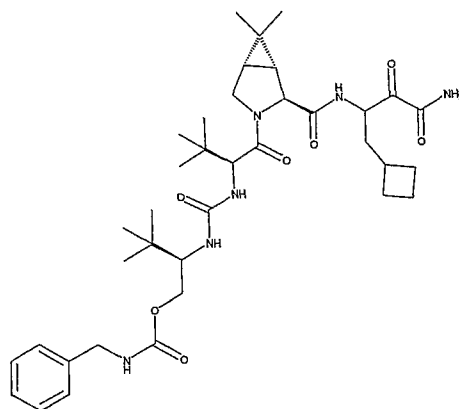
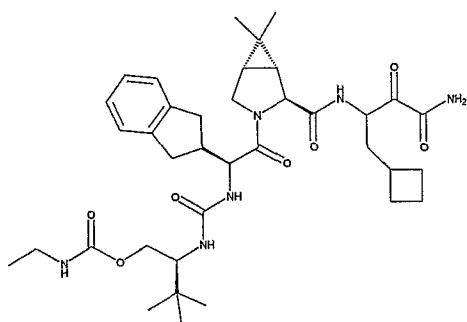


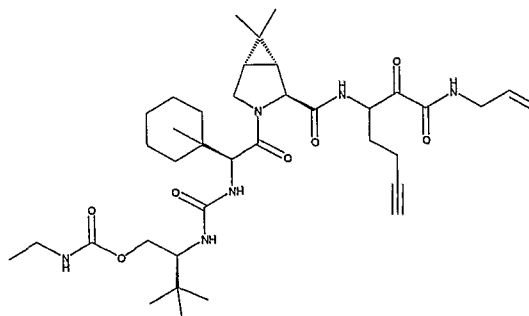
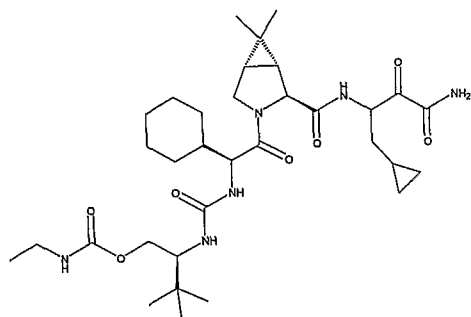
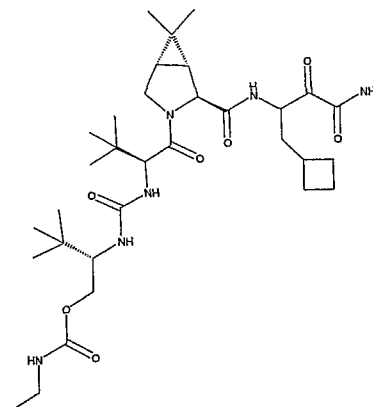
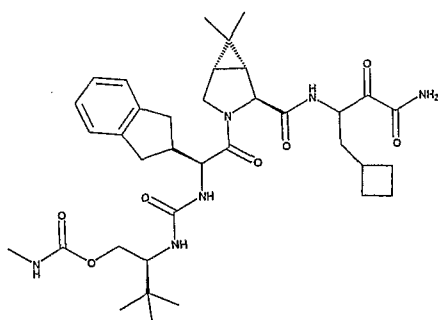
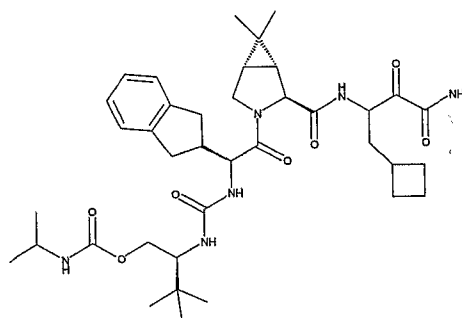
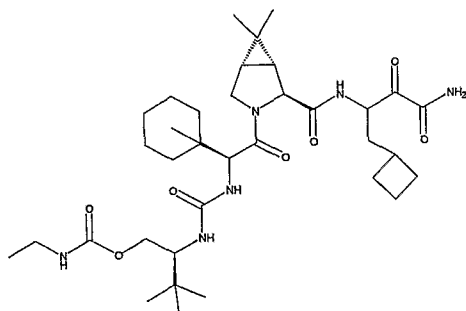
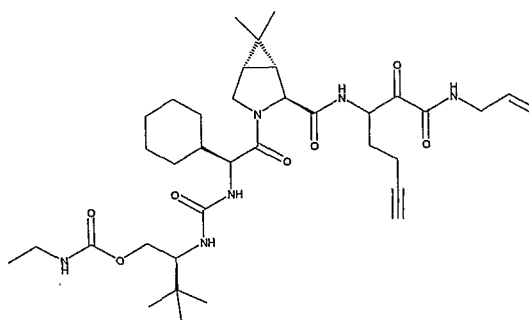
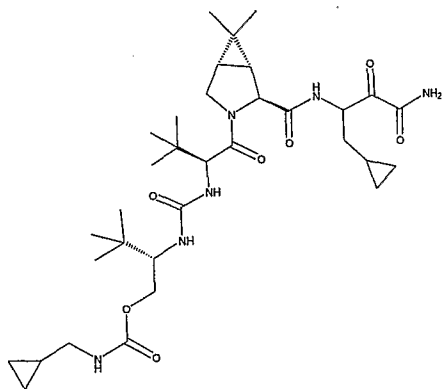


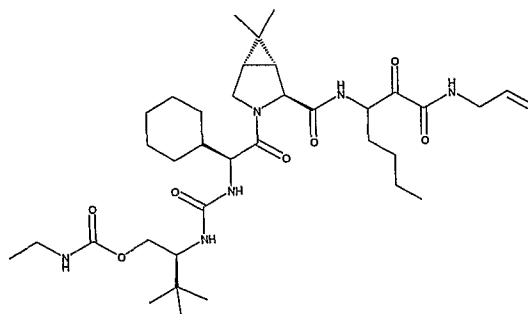
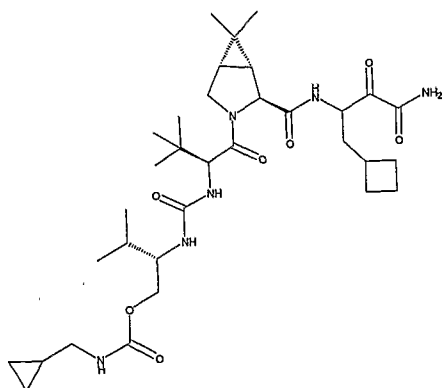
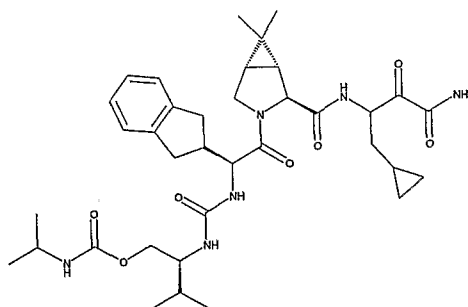
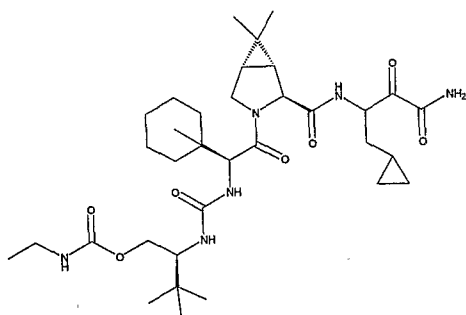
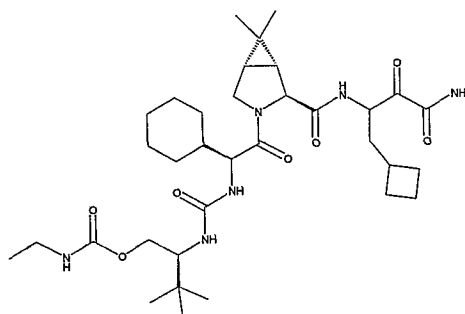
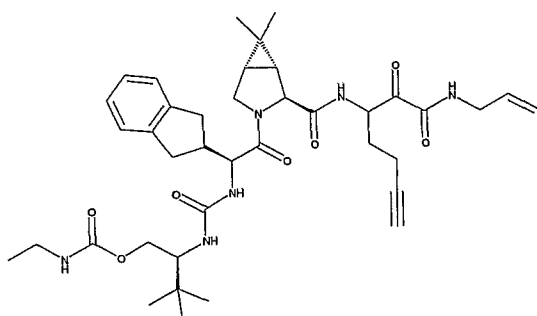
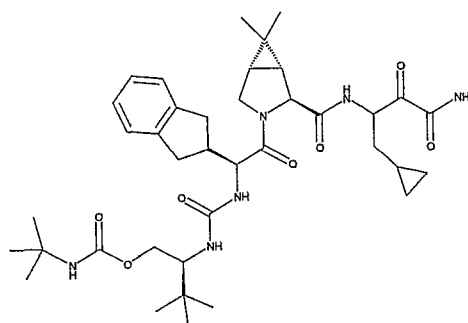
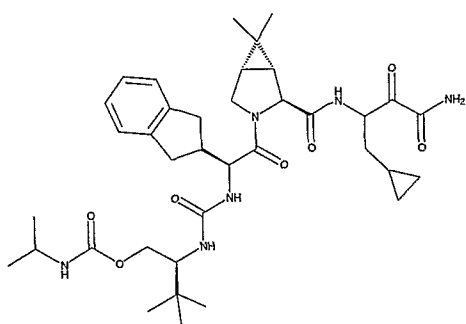


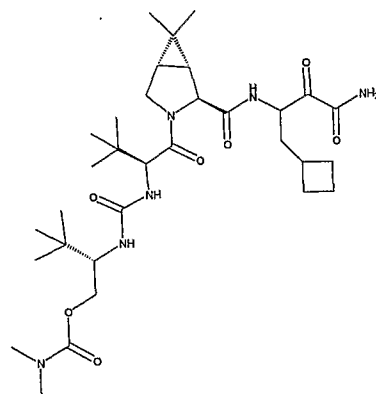
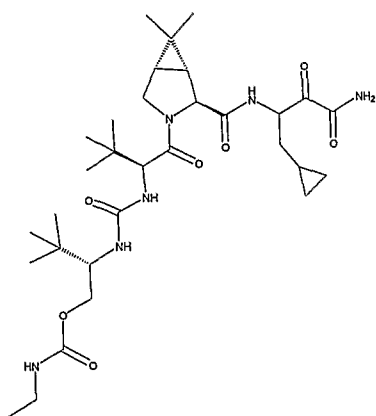
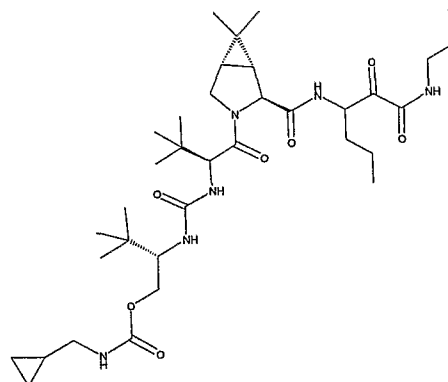
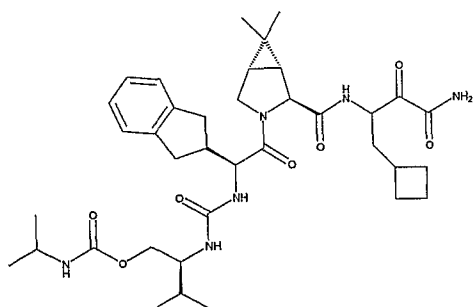
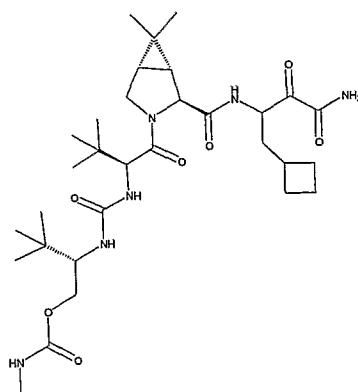
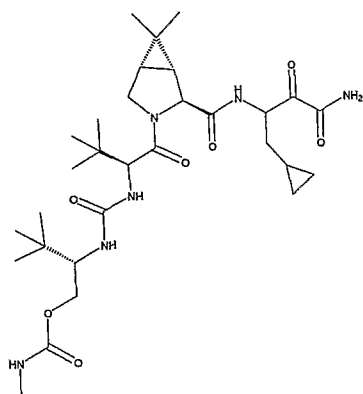
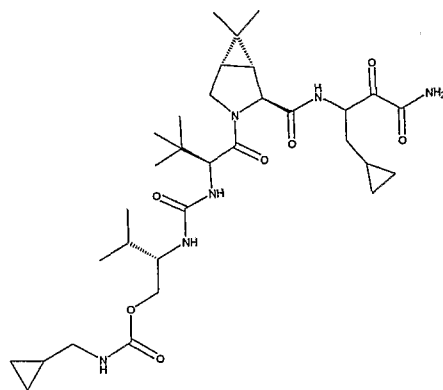
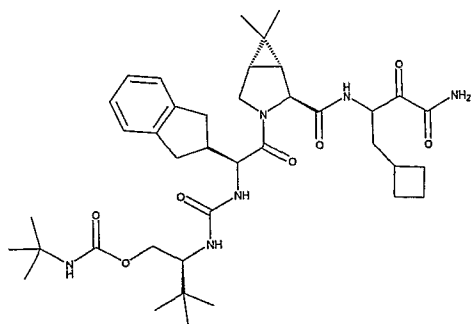


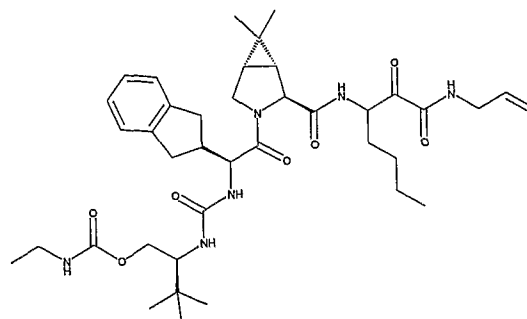
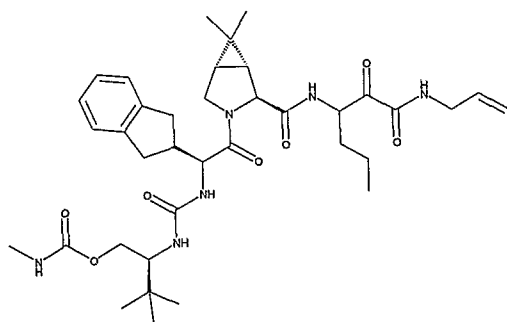
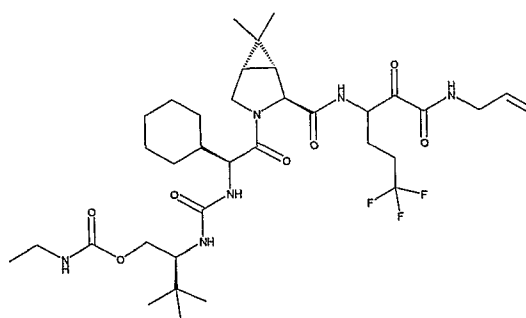
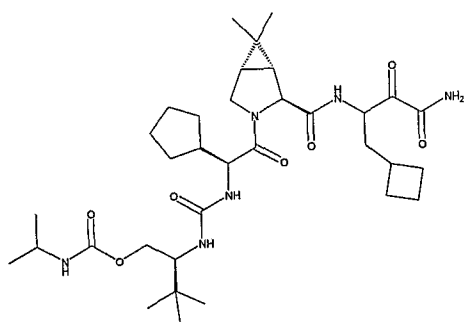
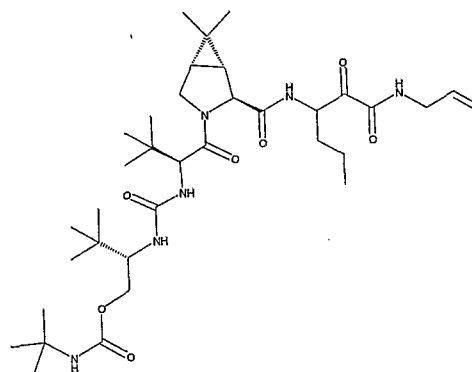
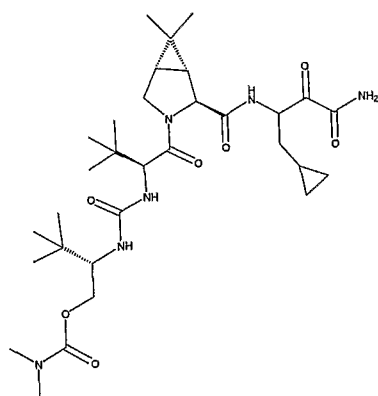
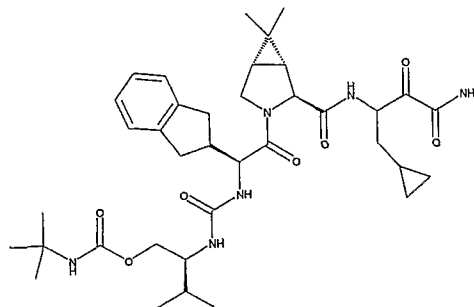
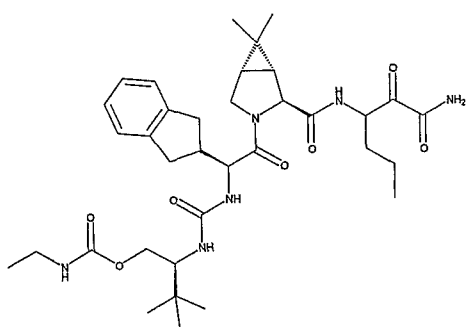


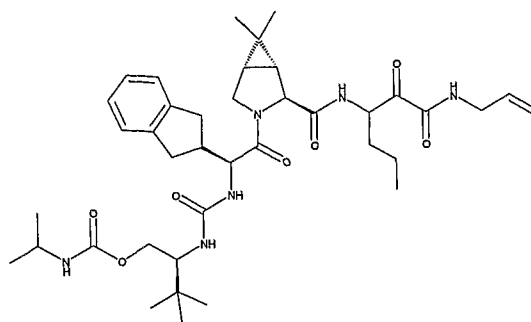
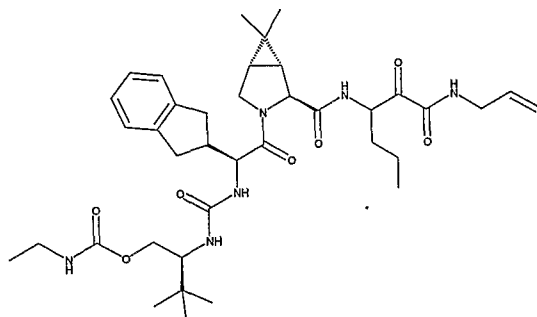
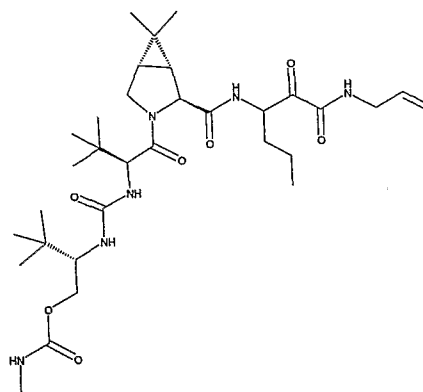
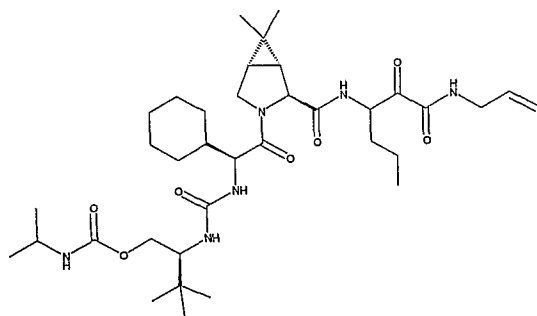
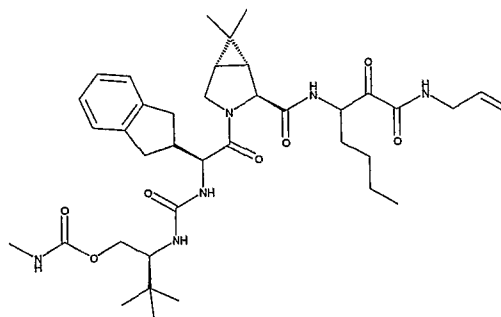
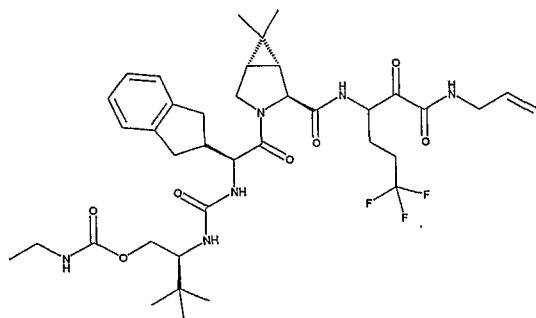
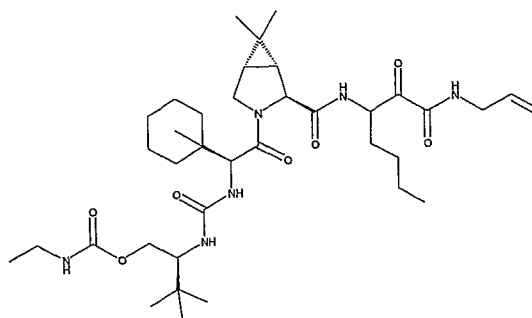
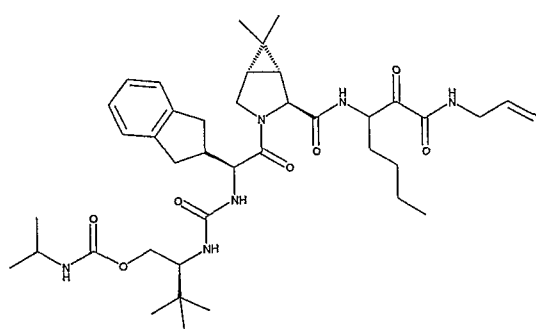


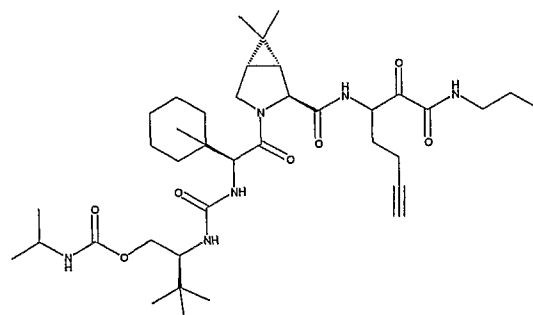
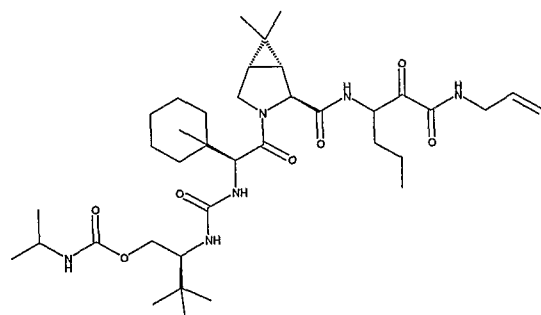
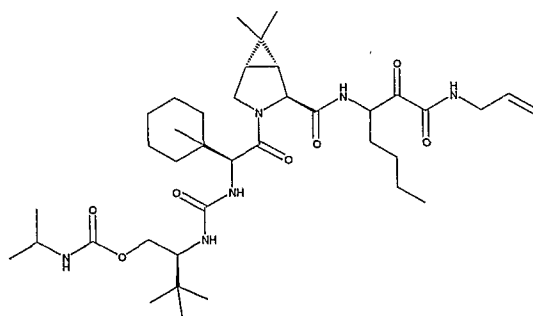
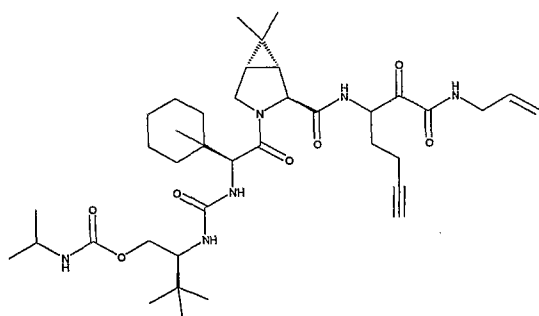
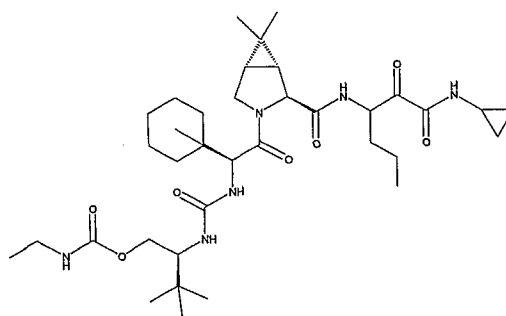
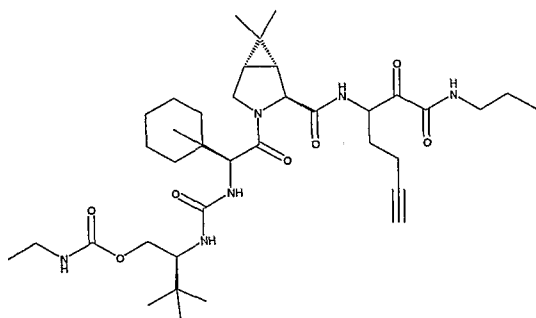
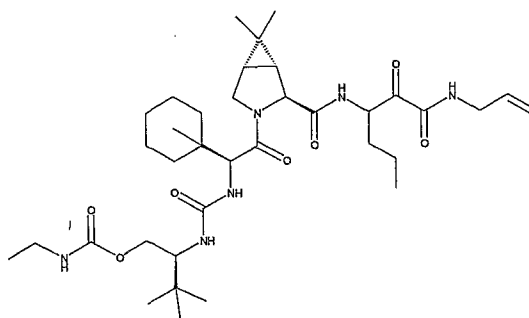
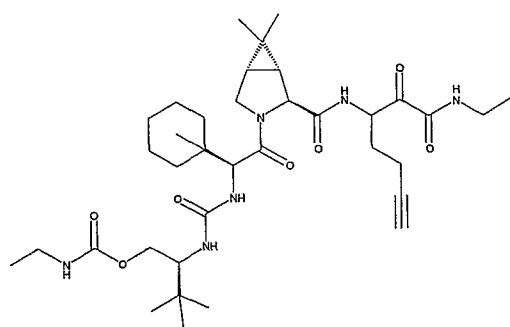


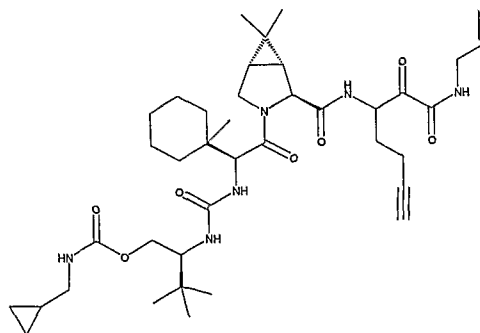
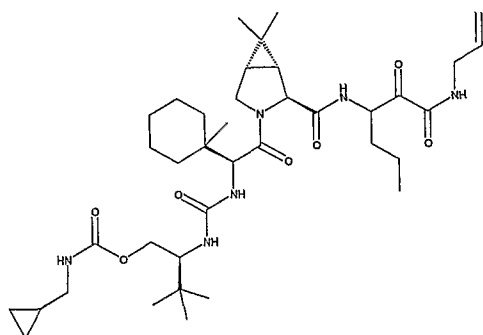
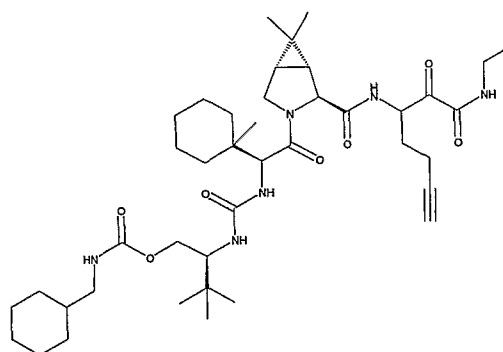
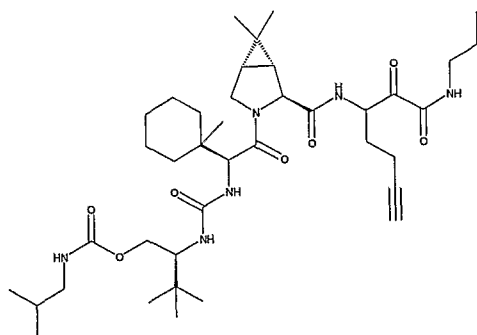
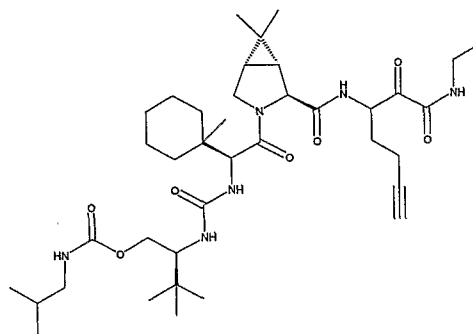
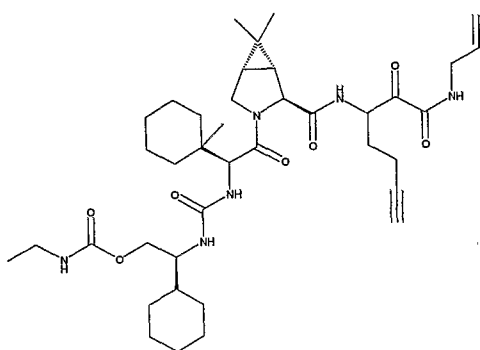
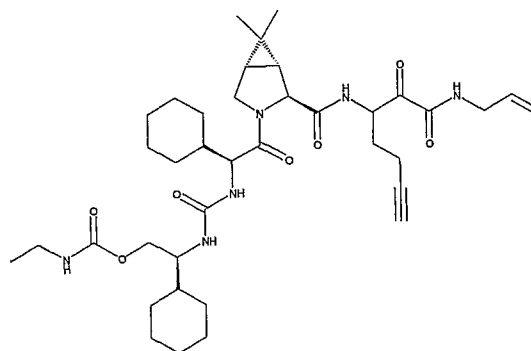
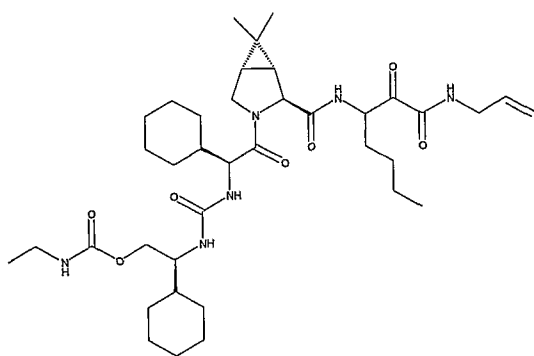


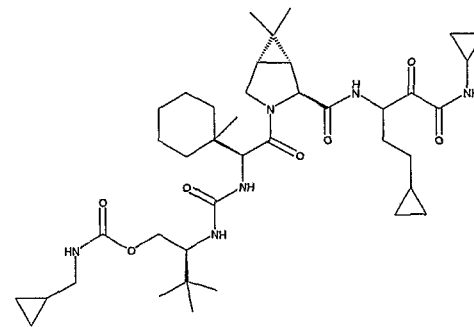
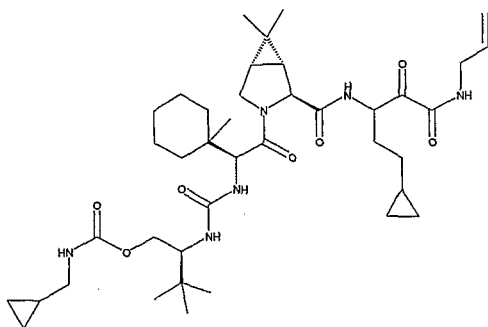
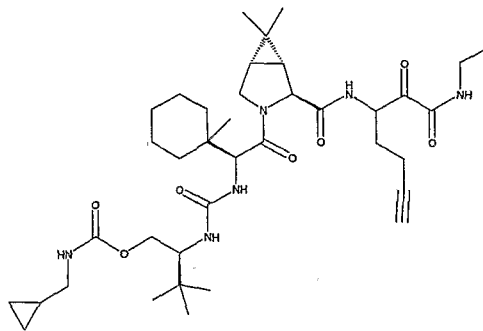
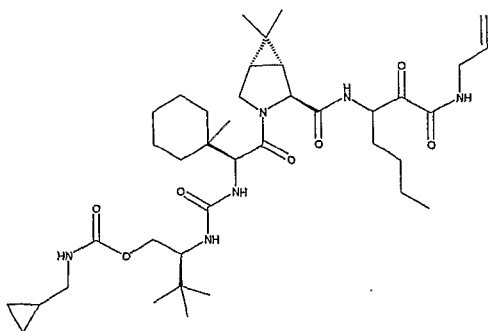












26. A pharmaceutical composition for treating disorders associated with the HCV, said composition comprising therapeutically effective amount of one or more compounds in claim 25 and a pharmaceutically acceptable carrier.

27. The pharmaceutical composition of claim 26, additionally containing at least one antiviral agent.

28. The pharmaceutical composition of claim 27, additionally containing at least one interferon or PEG-interferon alpha conjugate.

29. The pharmaceutical composition of claim 28, wherein said at least one antiviral agent is ribavirin and said at least one interferon is α -interferon or pegylated interferon.

30. A method of treatment of a hepatitis C virus associated disorder, comprising administering an effective amount of one or more compounds of claim 25.

31. A method of modulating the activity of hepatitis C virus (HCV) protease, comprising contacting HCV protease with one or more compounds of claim 25.

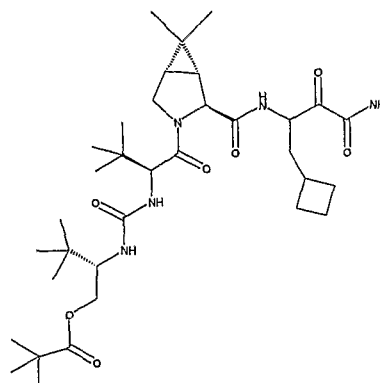
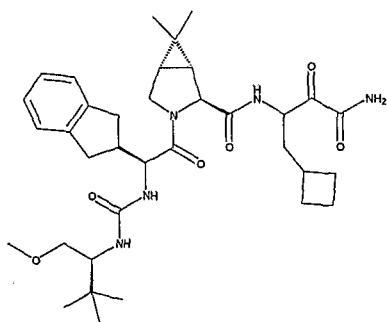
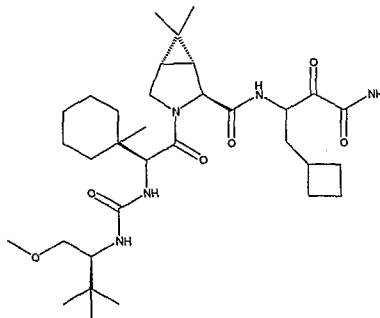
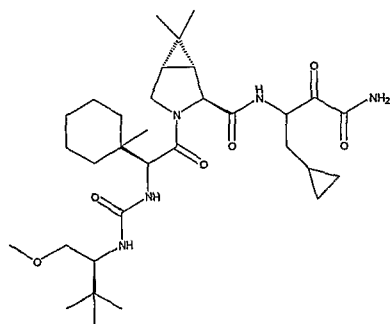
32. A method of treating, preventing, or ameliorating one or more symptoms of hepatitis C, comprising administering a therapeutically effective amount of one or more compounds of claim 25.

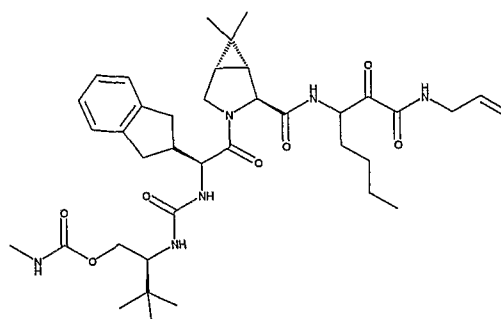
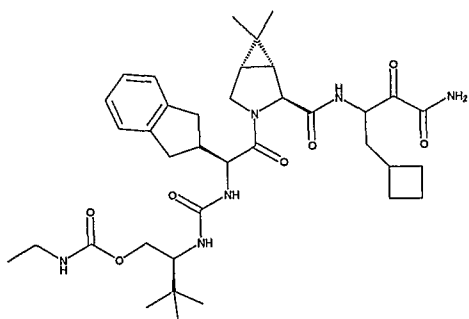
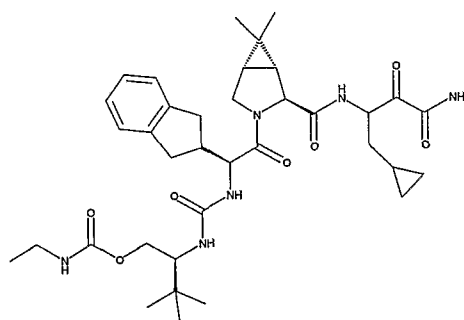
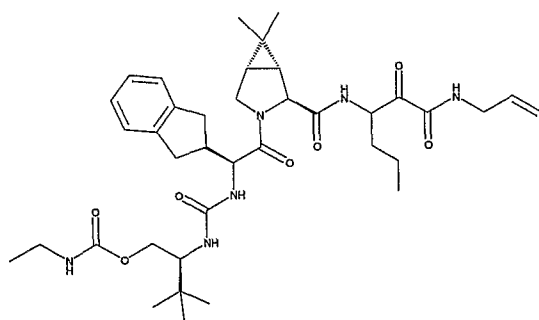
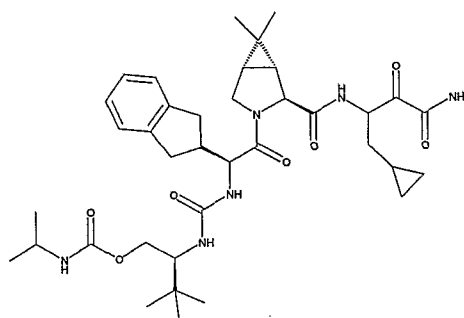
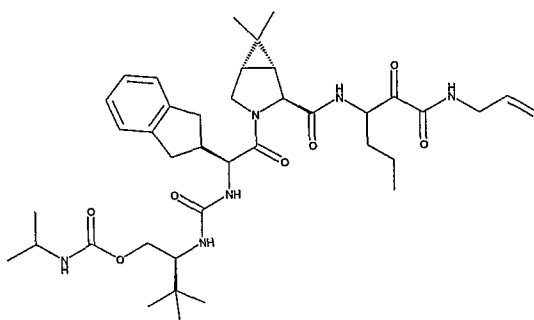
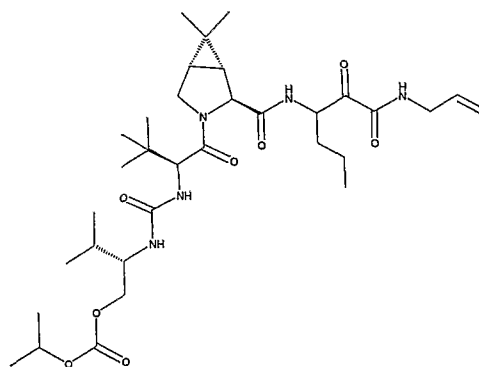
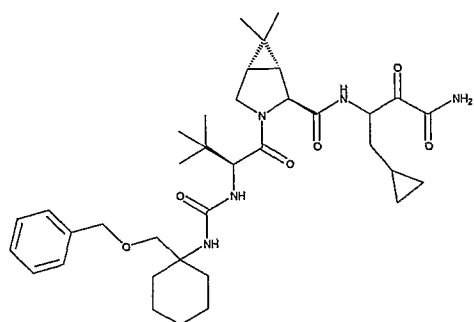
33. The method of claim 32, wherein the HCV protease is the NS3/NS4a protease.

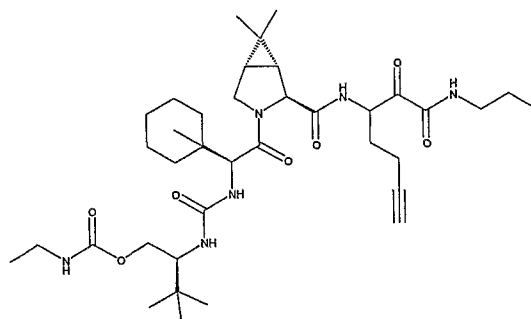
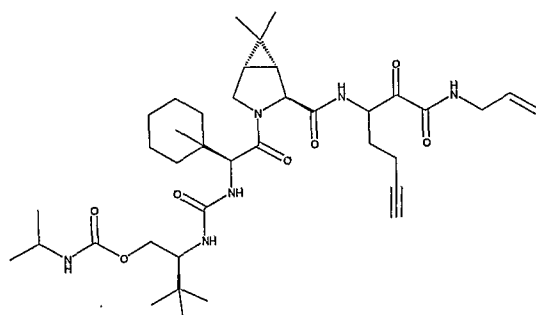
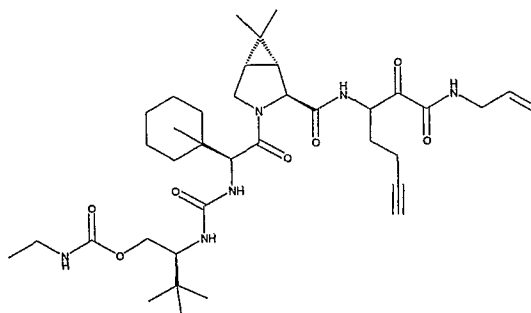
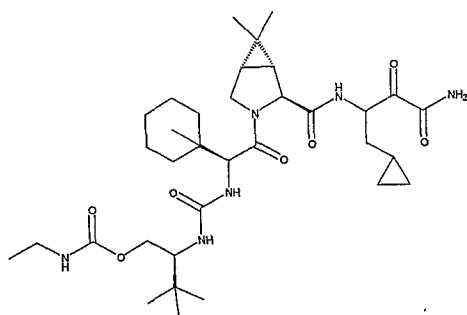
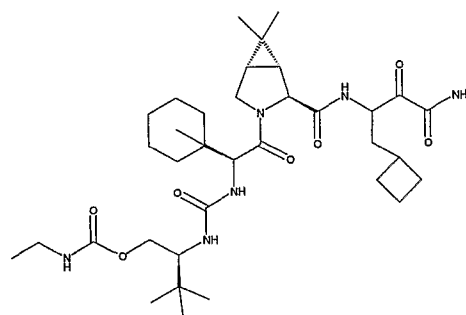
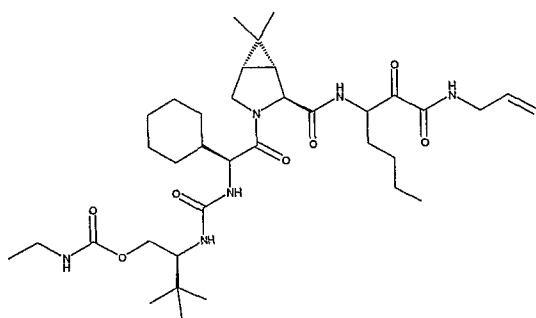
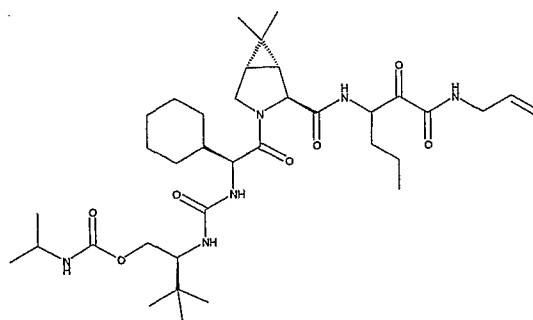
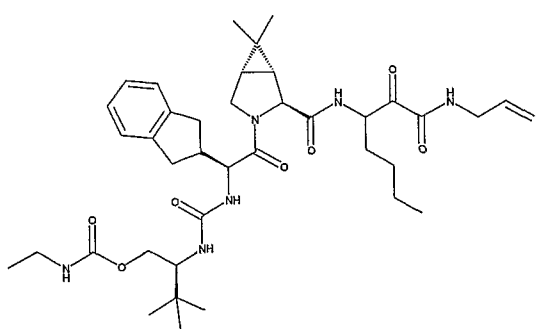
34. The method of claim 33, wherein the compound or compounds inhibit HCV NS3/NS4a protease.

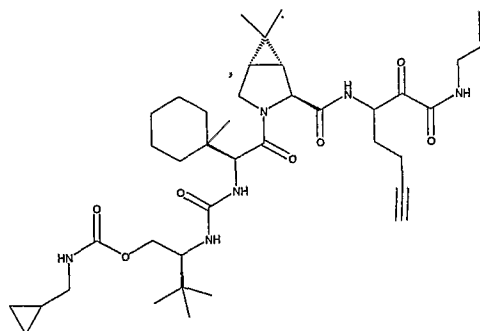
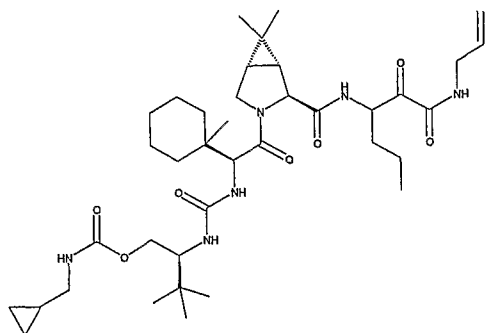
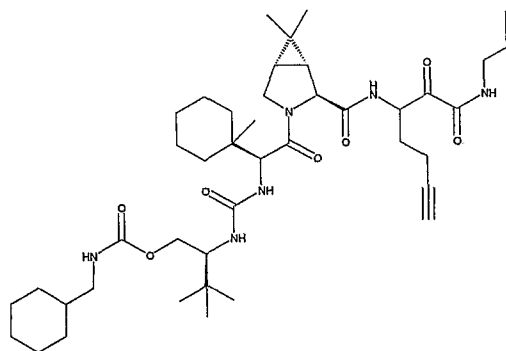
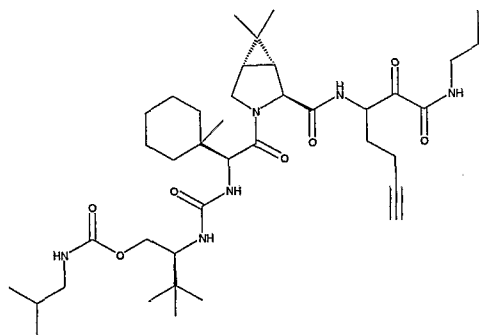
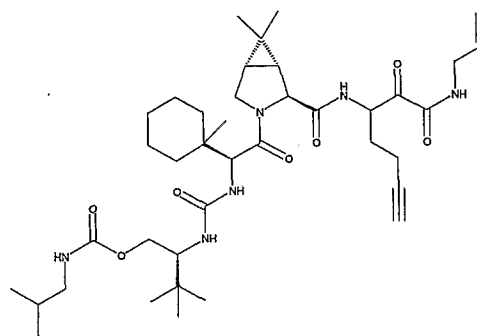
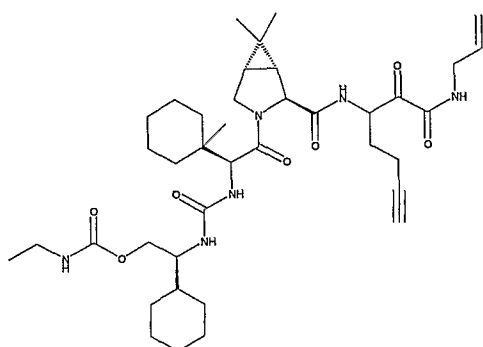
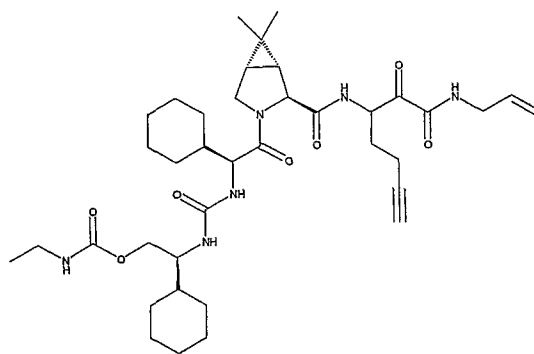
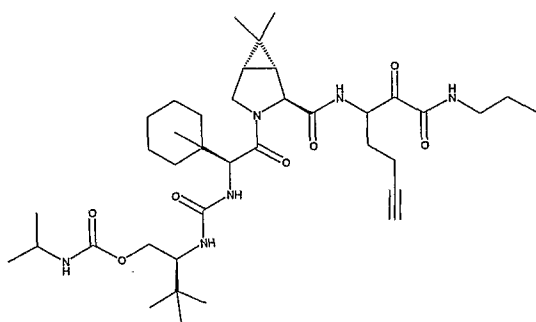
35. A method of modulating the processing of hepatitis C virus (HCV) polypeptide, comprising contacting a composition containing the HCV polypeptide under conditions in which said polypeptide is processed with one or more compounds of claim 25.

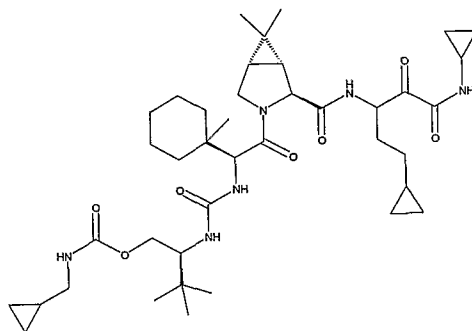
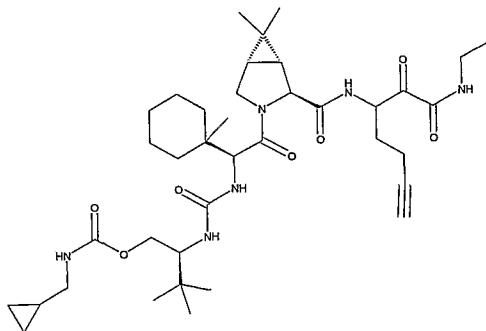
36. A method of treating disorders associated with the HCV, said method comprising administering to a patient in need of such treatment, a pharmaceutical composition which comprises therapeutically effective amounts of at least one compound, or enantiomers, stereoisomers, rotamers, tautomers, diastereomers or racemates of said compound, or a pharmaceutically acceptable salt, solvate or ester of said compound, said compound being selected from the following:











37. A compound of claim 1 in purified form.