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(54) Titre : N-(DIHYDROXYALKYL)-ETHYNYLALANINEAMIDES A GROUPE PIPERIDINYL TERMINAL, POUR LE TRAITEMENT DE L'HYPERTENSION

(54) Title: PIPERIDINYL-TERMINATED N-(DIHYDROXY ALKYL)-ETHYNYL-ALANINE AMIDES FOR TREATMENT OF HYPERTENSION

(57) Abrégé/Abstract:
Compounds characterized generally as piperidinyl-terminated alkylamino ethynyl alanine amino diol derivatives are useful as renin inhibitors for the treatment of hypertension. Compounds of particular interest are those of formula (I), wherein A is selected from CO and SO_2; wherein X is selected from oxygen atom and methylene; wherein B is selected from a piperidinyl group, an isoindolyl group and an azabicyclononyl group; wherein R_1 is selected from hydrido, methyl, ethyl, isopropyl and n-propyl; wherein R_2 is phenylmethyl; wherein each of R_3 and R_5 is hydrido; wherein R_4 is selected from (II), wherein V is selected from hydrido and methyl; wherein R_6 is cyclohexylmethyl; wherein R_7 is selected from isobutyl, cyclopropyl and cyclopropylmethyl; wherein q is a number selected from zero through three, inclusive; and wherein n is a number selected from zero through three, inclusive; or a pharmaceutically-acceptable salt thereof.

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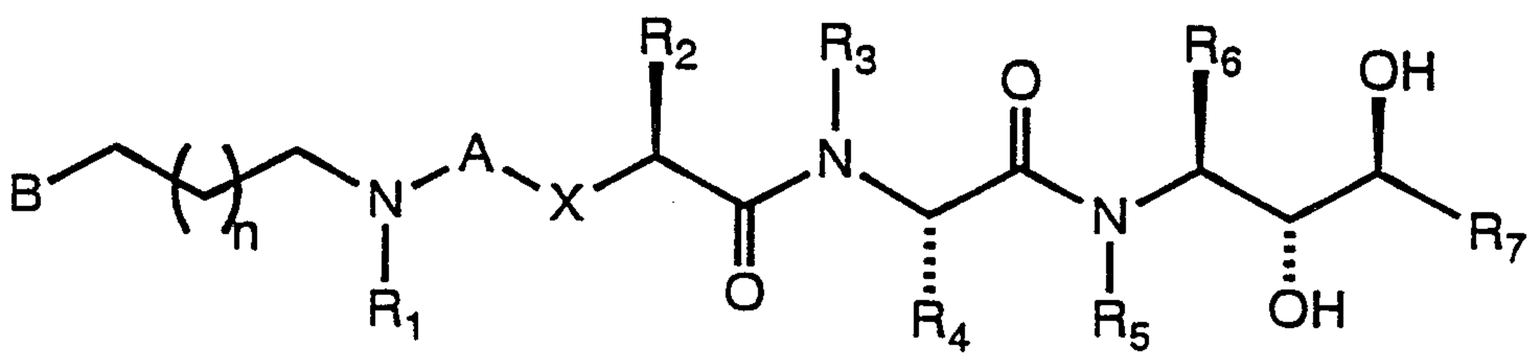

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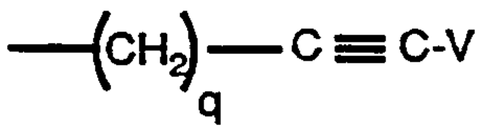

(II)

(57) Abstract

Compounds characterized generally as piperidinyl-terminated alkylamino ethynyl alanine amino diol derivatives are useful as renin inhibitors for the treatment of hypertension. Compounds of particular interest are those of formula (I), wherein A is selected from CO and SO_2; wherein X is selected from oxygen atom and methylene; wherein B is selected from a piperidinyl group, an isoindolyl group and an azabicyclononyl group; wherein R_1 is selected from hydrido, methyl, ethyl, isopropyl and n-propyl; wherein R_2 is phenylmethyl; wherein each of R_3 and R_5 is hydrido; wherein R_4 is selected from (II), wherein V is selected from hydrido and methyl; wherein R_6 is cyclohexylmethyl; wherein R_7 is selected from isobutyl, cyclopropyl and cyclopropylmethyl; wherein q is a number selected from zero through three, inclusive; and wherein n is a number selected from zero through three, inclusive; or a pharmaceutically-acceptable salt thereof.

PIPERIDINYL-TERMINATED N-(DIHYDROXY ALKYL)-ETHYNYL-ALANINE AMIDES FOR TREATMENT OF HYPERTENSION

FIELD OF THE INVENTION

Renin-inhibiting compounds are known for control of hypertension. Of particular interest herein are compounds useful as renin inhibiting agents.

BACKGROUND OF THE INVENTION

Renin is a proteolytic enzyme produced and secreted into the bloodstream by the juxtaglomerular cells of the kidney. In the bloodstream, renin cleaves a peptide bond in the serum protein angiotensinogen to produce a decapeptide known as angiotensin I. A second enzyme known as angiotensin converting enzyme, cleaves angiotensin I to produce the octapeptide known as angiotensin II. Angiotensin II is a potent pressor agent responsible for vasoconstriction and elevation of cardiovascular pressure. Attempts have been made to control hypertension by blocking the action of renin or by blocking the formation of angiotensin II in the body with inhibitors of angiotensin I converting enzyme.

Classes of compounds published as inhibitors of the action of renin on angiotensinogen include renin antibodies, pepstatin and its analogs, phospholipids, angiotensinogen analogs, pro-renin related analogs and peptide aldehydes.

A peptide isolated from actinomyces has been reported as an inhibitor of aspartyl proteases such as pepsin, cathepsin D and renin [Umezawa et al, in J. Antibiot. (Tokyo), 23, 259-262 (1970)]. This peptide, known as pepstatin, was found to reduce blood pressure in vivo after the injection of hog renin into nephrectomized

rats [Gross et al, Science, 175, 656 (1971)]. Pepstatin has the disadvantages of low solubility and of inhibiting acid proteases in addition to renin. Modified pepstatins have been synthesized in an attempt to increase the specificity for human renin over other physiologically important enzymes. While some degree of specificity has been achieved, this approach has led to rather high molecular weight hepta- and octapeptides [Boger et al, Nature, 303, 81 (1983)]. High molecular weight peptides are generally considered undesirable as drugs because gastrointestinal absorption is impaired and plasma stability is compromised.

Short peptide aldehydes have been reported as renin inhibitors [Kokubu et al, Biochim. Biophys. Res. Commun., 118, 929 (1984); Castro et al, FEBS Lett., 167, 273 (1984)]. Such compounds have a reactive C-terminal aldehyde group and would likely be unstable in vivo.

Other peptidyl compounds have been described as renin inhibitors. EP Appl. #128,762, published 18 December 1984, describes dipeptide and tripeptide glyco-containing compounds as renin inhibitors [also see Hanson et al, Biochm. Biophys. Res. Comm., 132, 155-161 (1985), 146, 959-963 (1987)]. EP Appl. #181,110, published 14 May 1986, describes dipeptide histidine derivatives as renin inhibitors. EP Appl. #186,977 published 9 July 1986 describes renin-inhibiting compounds containing an alkynyl moiety, specifically a propargyl glycine moiety, attached to the main chain between the N-terminus and the C-terminus, such as N-[4(S)-[(N)-[bis(1-naphthylmethyl)acetyl]-DL-propargylglycylamino]-3(S)-hydroxy-6-methylheptanoyl]-L-isoleucinol. EP Appl. #189,203, published 30 July 1986, describes peptidyl-aminodiols as renin inhibitors. EP Appl. #200,406, published 10 December 1986, describes alkylnaphthylmethylpropionyl-histidyl aminohydroxy alkanoates as renin inhibitors. EP Appl. #216,539,

published 1 April 1987, describes alkylnaphthylmethylpropionyl aminoacyl aminoalkanoate compounds as renin inhibitors orally administered for treatment of renin-associated hypertension. EP Appl. #229,667, published 22 July 1987, describes acyl α-aminoacyl aminodiol compounds having a piperazinylcarbonyl or an alkylaminoalkylcarbonyl terminal group at the N-amino acid terminus, such as 2(S)-{[(1-piperazinyl)carbonyl]-oxy]-3-phenylpropionyl}-Phe-His amide of 2(S)-amino-1-cyclohexyl-3(R), 4(S)-dihydroxy-6-methylheptane. PCT Application No. WO 87/04349, published 30 July 1987, describes aminocarbonyl aminoacyl hydroxyether derivatives having an alkylamino-containing terminal substituent and which are described as having renin-inhibiting activity for use in treating hypertension. EP Appl. #300,189 published 25 January 1989 describes amino acid monohydric derivatives having an alkylamino-alkylamino N-terminus and a β-alanine-histidine or sarcosyl-histidine attached to the main chain between the N-terminus and the C-terminus, which derivatives are mentioned as useful in treating hypertension. U.S. Patent No. 4,902,706 which issued 13 February 1990 describes a series of histidineamide-containing amino alkylaminocarbonyl-H-terminal aminodiol derivatives for use as renin inhibitors. U.S. Patent No. 5,032,577 which issued 16 July 1991 describes a series of histidineamide-aminodiol-containing renin inhibitors.

Heterocyclic-terminated aminodiol compounds have been described as renin inhibitors. For example, EP #410,260 published 30 January 1991 describes a series of heterocyclic-terminated peptidyl aminodiol renin inhibitor compounds having utility as antihypertensive agents, wherein specific compounds are described having various terminal heterocyclic groups such as morpholino, pyridinyl, piperazinyl, imidazolyl, pyrazolyl and indolyl groups, including the compound (2R)-2-benzyl-3-[2-(4-methylpiperazin-1-ylethyl)methylaminocarbonyl]propionyl-

L-(4-thiazolyl)Ala amide of (2S,3R,4S)-2-amino-1-cyclohexyl-3,4-dihydroxy-6-methylheptane. EP #456,185 published 13 November 1991 describes a series of heterocyclic-terminated sulfonamide-containing peptidyl aminodiol renin inhibitor compounds having utility as antihypertensive agents, wherein specific compounds are described having various terminal heterocyclic groups such as piperazinyl, oxo-substituted piperazinyl and morpholino groups.

The EP-A 0 438 233, EP-A 0 417 698, EP-A 0 332 008, EP-A 0 452 587, EP-A 0 416 373 disclose several aminodiol derivatives being useful as renin-inhibiting compounds.

WO-A 8 805 050 describes peptidylaminodiols having several alkyl and heterocyclic substituents. These compounds have renin-inhibiting activity and may be used as HIV-protease inhibitors.

The EP-A 0 349 922 discloses renin-inhibiting aminoalkyl-aminocarbonylaminodiolaminoacid derivatives as anti-hypertensive agents which may structurally vary at different positions by alkyl, alkylcarbonyl, phenyl, heterocyclic groups and in general alkynyl attached to an amino function or between an amino and a hydroxyl group. However, no specific compounds bearing such an alkynyl group are mentioned.

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DESCRIPTION OF THE INVENTION

Piperidinyl-terminated alkylamine ethynyl alanine amino diol compounds, having utility as renin inhibitors for treatment of hypertension in a subject, constitute a family of compounds of general Formula I:

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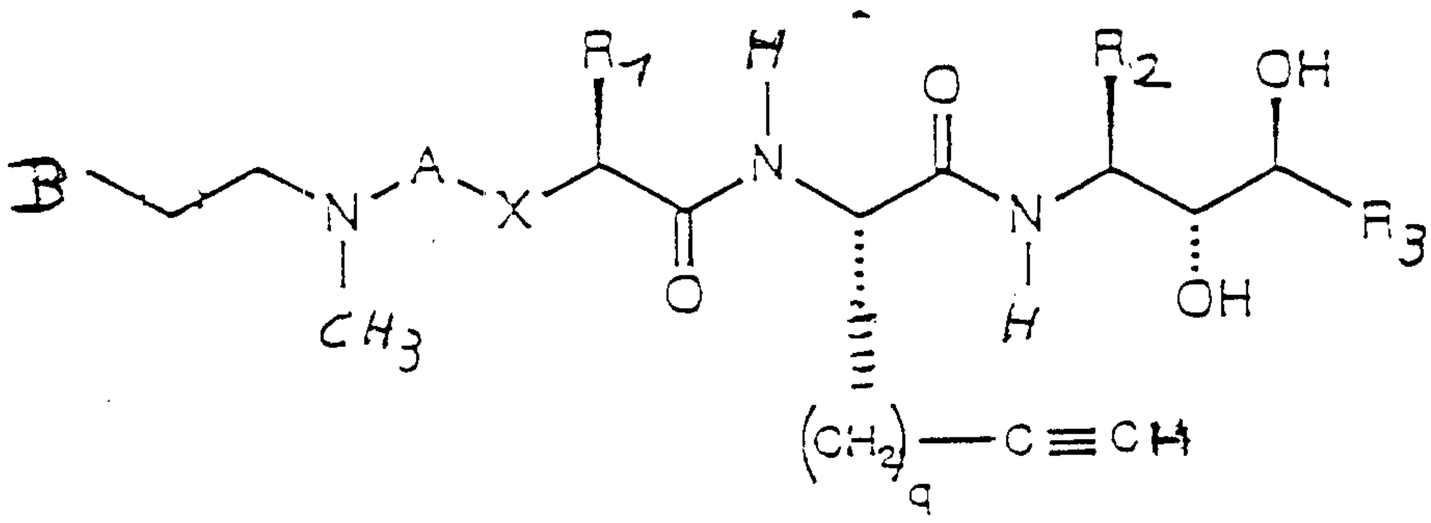

(I)

wherein A is selected from CO and SO_2; wherein X is methylene; wherein B is a heterocyclic ring system of four to ten ring members with one ring member being a nitrogen atom, wherein said ring system may be monocyclic or bicyclic and may be fully saturated or partially saturated and may be fused to a benzene or cyclohexane ring, wherein the point of attachment of B to the backbone of the structure of Formula I may be through a bond to any substitutable position on said heterocyclic ring system of B and wherein any substitutable position of B may be optionally substituted with one or more radicals selected from C_1-C_{20}-alkyl, C_1-C_{10}-alkoxy, C_2-C_{20}-alkenyl, C_2-C_{10}-alkynyl, halo, trifluoromethyl, oxo, cyano and phenyl, and wherein the said heterocyclic ring nitrogen atom may be combined with oxygen to form an N-oxide; wherein R_1 is phenylmethyl; wherein R_2 is cyclohexylmethyl; wherein R_3 is selected from hydrido, C_1-C_{20}-alkyl, C_3-C_{10}-cycloalkyl, C_3-C_{10}-cycloalkyl-C_1-C_{20}-alkyl, C_1-C_{20}-hydroxyalkyl and C_2-C_{20}-alkenyl; wherein q is a number selected from one or two; or a pharmaceutically-acceptable salt thereof.

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A preferred family of compounds consists of compounds of formula I,

wherein B is a heterocyclic ring system selected from piperidinyl, 4-oxopiperidinyl, azacycloheptanyl, azacyclooctanyl, azocyclononanyl, azetidinyl, 3,3-difluoropiperidinyl, 4,4-difluoropiperidinyl, delta-3-piperidinyl, 1,2,3,4-tetrahydroisoquinolinyl, N-methylpiperidinyl, pyrrolidinyl, isoindolyl, perhydroisoindolyl, 2-azabicyclo[2.2.1]heptanyl, normethyltropanyl, 2-azabicyclo[2.2.2]octanyl, benzomorphanyl, 3-azabicyclo[3.2.2]nonanyl,

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perhydrobenzomorphanyl, 2,6-methylpiperidinyl, 2-methyl-6-benzylpiperidinyl and methyl delta-4-6-benzylpipecolyl, and wherein any of said heterocyclic ring systems may be fused to a benzene or cyclohexane ring, wherein the point of attachment of B may be through a bond to any substitutable position on said heterocyclic ring system and where any substitutable position of B may be optionally substituted with one or more radicals selected from alkyl, alkoxy, alkenyl, alkynyl, halo, trifluoromethyl, oxo, cyano and phenyl, and wherein the nitrogen atom ring member of B may be combined with oxygen to form an N-oxide

An even more preferred family of compounds consists of compounds of Formula I wherein B is a

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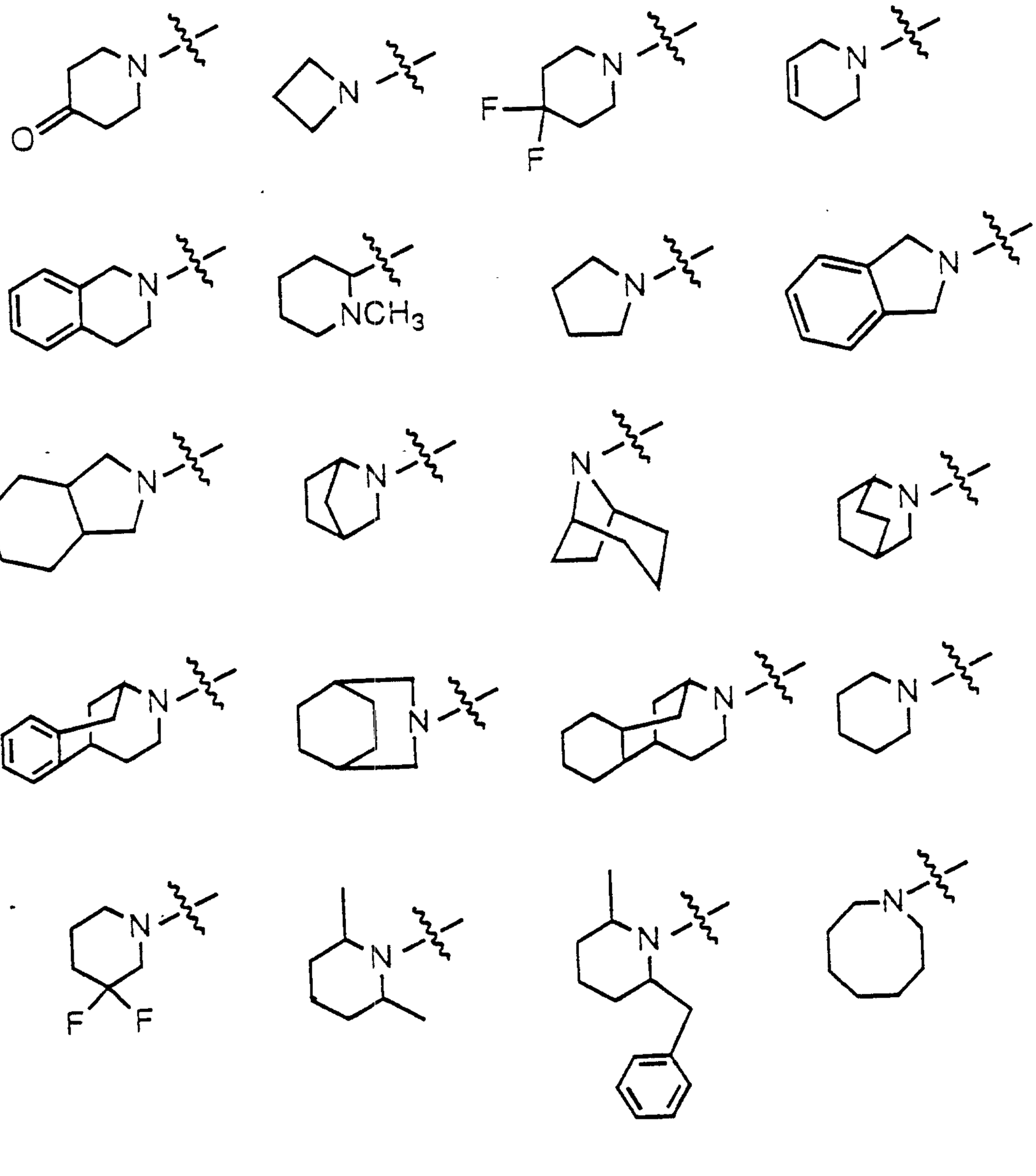
heterocyclic ring system selected from the group consisting of:



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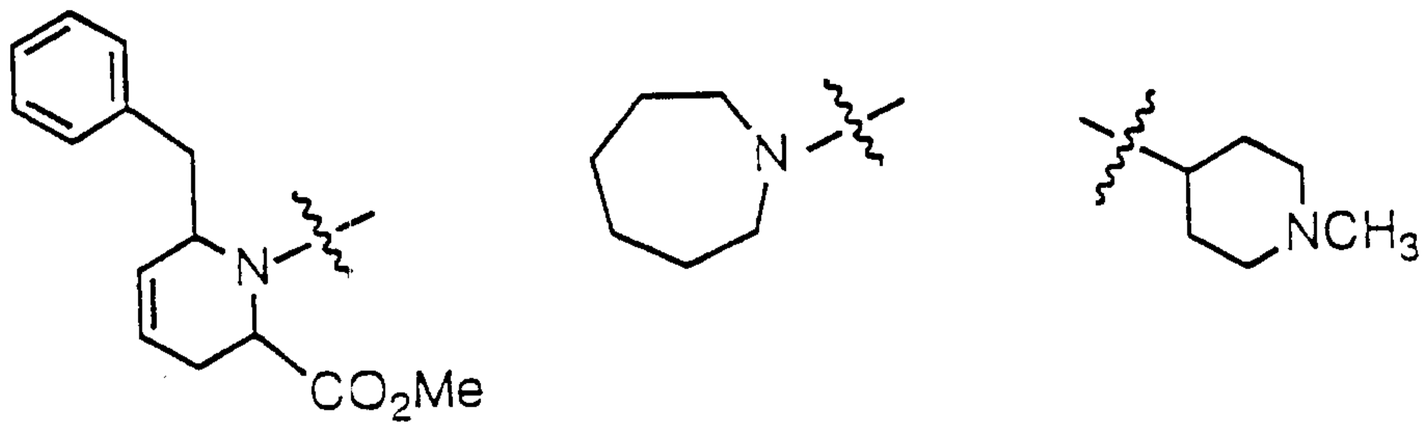

wherein said B group is attached to the backbone of the structure of Formula I through the bond on each B group bisected by the wavy line, and wherein any substitutable position may be optionally substituted with one or more radicals selected from alkyl, alkoxy, alkenyl, alkynyl, halo, trifluoromethyl, oxo, cyano and phenyl, and wherein the nitrogen atom ring member of B may be combined with oxygen to form an N-oxide;

wherein R_3 is selected from isobutyl, cyclopropyl and cyclopropylmethyl; or a pharmaceutically-acceptable salt thereof.

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The term "hydrido" denotes a single hydrogen atom (H). This hydrido group may be attached, for example, to an oxygen atom to form a hydroxyl group; or, as another example, one hydrido group may be attached to a carbon atom to form a $\rangle CH-$ group; or, as another example, two hydrido groups may be attached to a carbon atom to form a $-CH_2-$ group. Where the term "alkyl" is used, either alone or within other terms such as "haloalkyl" and "hydroxyalkyl", the term "alkyl" embraces linear or branched radicals having one to about twenty carbon atoms or, preferably, one to about twelve carbon atoms. More preferred alkyl radicals are "lower alkyl" radicals having one to about ten carbon atoms. Most preferred are lower alkyl radicals having one to about six carbon atoms. The term "cycloalkyl" embraces cyclic radicals having three to about ten ring carbon atoms, preferably three to about six carbon atoms, such as cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl. The term "alkenyl" embraces linear or branched radicals having two to about twenty carbon atoms, preferably three to about ten carbon atoms, and containing at least one carbon-carbon double bond, which carbon-carbon double bond may have either cis or trans geometry within the alkenyl moiety. The term "alkynyl" embraces linear or branched radicals having two to about twenty carbon atoms, preferably two to about ten carbon atoms, and containing at least one carbon-carbon triple bond. The term "alkoxy" embraces linear or branched oxy-containing radicals having alkyl portions of one to about ten carbon atoms, such as methoxy group. The "alkoxy" radical may be further substituted with one or more halo atoms, such as fluoro, chloro or bromo, to provide haloalkoxy groups. The term "sulfonyl", whether used alone or linked to

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other terms, denotes the divalent radical SO_2. The term "acyl" whether used alone, or within a term such as acyloxy, denotes a radical provided by the residue after removal of hydroxyl from an organic acid, examples of such radical being acetyl and benzoyl. "Lower alkanoyl" is an example of a more prefered sub-class of acyl. The term "alkenylalkyl" denotes a radical having a double-bond unsaturation site between two carbons, and which radical may consist of only two carbons or may be further substituted with alkyl groups which may optionally contain additional double-bond unsaturation. A group embraced by the term "heterocyclic ring system" may be attached to the backbone of Formula I as a substituent through a carbon atom of the hetero ring system, or may be attached through a carbon atom of a moiety substituted on a hetero ring-member carbon atom. Also, such hetero-containing group may be attached through a ring nitrogen atom. For any of the foregoing defined radicals, preferred radicals are those containing from one to about fifteen carbon atoms.

Specific examples of alkyl groups are methyl, ethyl, n-propyl, isopropyl, n-butyl, sec-butyl, isobutyl, tert-butyl, n-pentyl, isopentyl, methylbutyl, dimethylbutyl and neopentyl. Typical alkenyl and alkynyl groups may have one unsaturated bond, such as an allyl group, or may have a plurality of unsaturated bonds, with such plurality of bonds either adjacent, such as allene-type structures, or in conjugation, or separated by several saturated carbons.

Also included in the family of compounds of Formula I are isomeric forms, including diastereoisomers, and the pharmaceutically-acceptable salts thereof. The term "pharmaceutically-acceptable salts" embraces salts commonly used to form alkali metal salts and to form addition salts of free acids or free bases. The nature

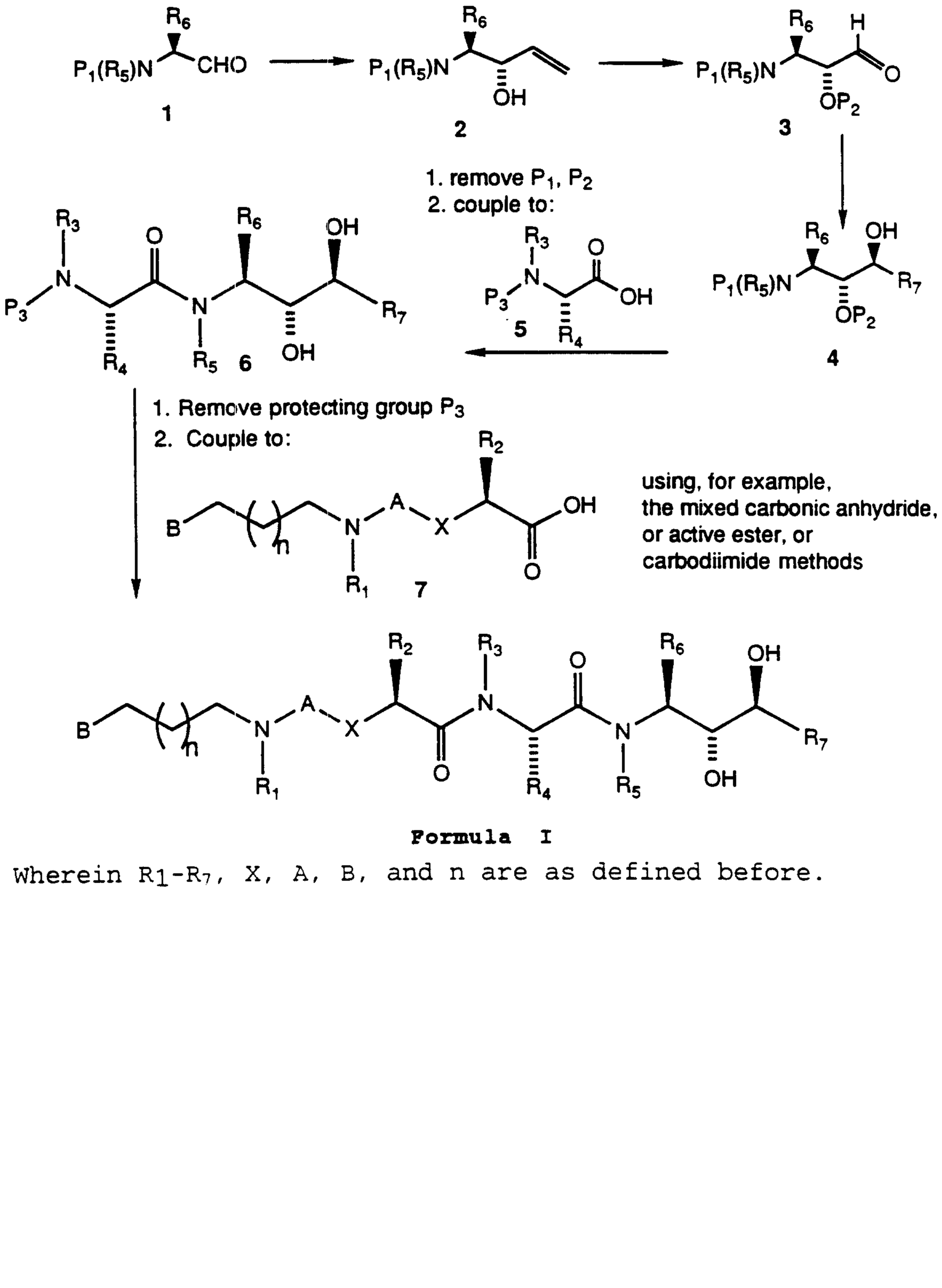
of the salt is not critical, provided that it is pharmaceutically-acceptable. Suitable pharmaceutically-acceptable acid addition salts of compounds of Formula I may be prepared from an inorganic acid or from an organic acid. Examples of such inorganic acids are hydrochloric, hydrobromic, hydroiodic, nitric, carbonic, sulfuric and phosphoric acid. Appropriate organic acids may be selected from aliphatic, cycloaliphatic, aromatic, araliphatic, heterocyclic, carboxylic and sulfonic classes of organic acids, example of which are formic, acetic, propionic, succinic, glycolic, gluconic, lactic, malic, tartaric, citric, ascorbic, glucuronic, maleic, fumaric, pyruvic, aspartic, glutamic, benzoic, anthranilic, p-hydroxybenzoic, salicyclic, phenylacetic, mandelic, embonic (pamoic), methansulfonic, ethane-sulfonic, 2-hydroxyethanesulfonic, pantothenic, benzenesulfonic, toluenesulfonic, sulfanilic, mesylic, cyclohexylaminosulfonic, stearic, algenic, β-hydroxybutyric, malonic, galactaric and galacturonic acid. Suitable pharmaceutically-acceptable base addition salts of compounds of Formula I include metallic salts made from aluminium, calcium, lithium, magnesium, potassium, sodium and zinc or organic salts made from N,N'-dibenzylethylenediamine, chloroprocaine, choline, diethanolamine, ethylenediamine, meglumine (N-methylglucamine) and procaine. Also included within the phrase "pharmaceutically-acceptable salts" are "quaternary" salts or salts of "onium" cations, such as ammonium, morpholinium and piperazinium cations, as well as any substituted derivatives of these cations where the salt is formed on the nitrogen atom lone pair of electrons. All of these salts may be prepared by conventional means from the corresponding compound of Formula I by reacting, for example, the appropriate acid or base with the compound of Formula I.

Compounds of Formula I would be useful to treat various circulatory-related disorders. As used herein,

the term "circulatory-related" disorder is intended to embrace cardiovascular disorders and disorders of the circulatory system, as well as disorders related to the circulatory system such as ophthalmic disorders including glaucoma. In particular, compounds of Formula I would be useful to inhibit enzymatic conversion of angiotensinogen to angiotensin I. When administered orally, a compound of Formula I would be expected to inhibit plasma renin activity and, consequently, lower blood pressure in a patient such as a mammalian subject (e.g., a human subject). Thus, compounds of Formula I would be therapeutically useful in methods for treating hypertension by administering to a hypertensive subject a therapeutically-effective amount of a compound of Formula I. The phrase "hypertensive subject" means, in this context, a subject suffering from or afflicted with the effects of hypertension or susceptible to a hypertensive condition if not treated to prevent or control such hypertension. Other examples of circulatory-related disorders which could be treated by compounds of the invention include congestive heart failure, renal failure and glaucoma.

Description of the Synthetic Methods for the Preparation of the Renin Inhibitors of the Invention

Synthetic Scheme 1



Formula I

Wherein R_1-R_7, X, A, B, and n are as defined before.

Synthetic Scheme 1

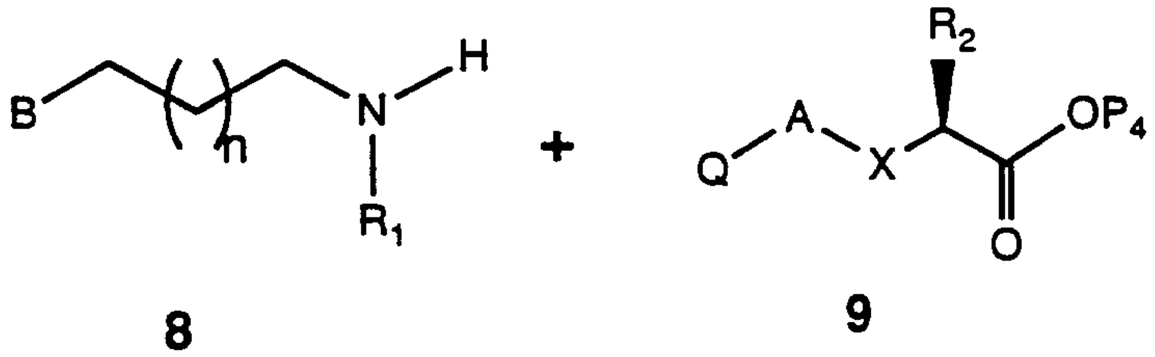
(Preparation of Compounds of Formula I)

A suitably protected amino aldehyde **1** is treated with a Grignard reagent or other organometallic reagent, preferably vinylmagnesium bromide, to obtain the vinyl carbinol **2**. This material, suitably protected, is oxidized, preferably with ozone, followed by dimethyl sulfide or zinc treatment, to give intermediate **3**. The preceeding process is exemplified in Hanson, et al., J. Org. Chem. 50, 5399 (1985). This aldehyde is reacted with an organometallic reagent such as isobutylmagnesium chloride to give intermediate **4**. Other suitable organometallic reagents include ethylmagnesium bromide, vinylmagnesium bromide, cyclopropylmagnesium bromide, and allylmagnesium bromide, but the choices are not limited to these reagents. After the formation of **4**, further transformation of the added side chain is permitted, before going on the next depicted step. For example, the compound **4** derived from the addition of allylmagnesium bromide may be cyclopropanated via diazomethane and rhodium acetate, to give a cyclopropylmethyl side chain. Compound **4** is deprotected then coupled, using standard amide/peptide coupling methodology to protected triple bond-containing (ethynyl) amino acid derivatives **5** to give compound **6**. These standard coupling procedures such as the carbodiimide, active ester (N-hydroxysuccinimide), and mixed carbonic anhydride methods are shown in Benoiton, et al. J. Org. Chem. 48, 2939 (1983) and Bodansky, et al."Peptide Synthesis", Wiley (1976). Ethynyl-containing amino acid derivatives may be prepared by using procedures such as found in Schollkopf,

Tetrahedron 39, 2085 (1983). Intermediate **6** is then deprotected, then coupled to intermediate **7** using the standard amide/peptide coupling methodology, to give compounds of Formula I. Suitable protecting groups may be selected from among those reviewed by R. Geiger in "The Peptides", Academic Press, N.Y. vol. 2 (1979). For Pexample, P_1 and P_3 may be Boc or Cbz; P_2 may be a typical oxygen protective group such as acetyl or t-butyldimethylsilyl.

Synthetic Scheme 2

Preparation of **7**:



Wherein R_1, R_2, X, A, B and n are as defined before.

Synthetic Scheme 2

(Preparation of Compounds of Formula I)

Intermediate **7** may be prepared according to the schematic of Synthetic Scheme 2. Intermediate **7** is prepared by coupling the heterocyclicalkylamine **8** to mono-protected carboxylic acid **9**. Carboxylic acid or sulfonic acid **9** is a mono-activated moiety by virtue of a suitable leaving group Q which may be chloride, bromide, fluoride, N-hydroxysuccinimido, p-toluenesulfonyloxy or isobutyloxycarbonyloxy, but is not limited to these groups. After coupling, protecting group P_4 is removed (if P_4 is a benzyl group, hydrogenolysis over palladium-on-carbon (Pd-C) is performed) to give intermediate amino acid **7**.

Abbreviations used:

P_1 is an N-protecting group; P_2 is H or an oxygen protecting group; P_3 is an N-protecting group; P_4 is an oxygen protecting group such as benzyl or methyl; Q is a leaving group; Boc is t-butyloxycarbonyl; Cbz is carbobenzoxy.

The following Steps constitute specific exemplification of methods to prepare starting materials and intermediates embraced by the foregoing generic synthetic scheme. Those skilled in the art will readily understand that known variations of the conditions and processes of the following preparative procedures can be used to prepare the compounds of the Steps. All temperatures expressed are in degrees Centigrade.

Step 1

(2R,3S)-N-[(tert-Butyloxy)carbonyl]-3-amino-2-acetoxy-4-phenylbutanal

Ozone/oxygen was bubbled at -70°C into a solution of (3S,4S)-N-[(tert-Butyloxy)carbonyl]-4-amino-3-acetoxy-5-phenylpentene (2.55g, 8.0 mmol) [prepared by the method of Hanson et al., J. Org. Chem., 50, 5399 (1985)] in 100mL of methylene chloride until a deep blue color persisted. Oxygen was introduced until the blue color completely faded, then 3.0 mL of Me_2S was added and the solution was allowed to warm to 0-5° C and stand overnight. The solvent was removed at 0°C under vacuum yielding the title compound as a thick yellow oil which was used without further purification.

Step 2

(2S,3R,4S)-N-[(tert-Butyloxy)carbonyl]-2-amino-1-phenyl-3,4-dihydroxy-6-methylheptane

The title compound of Step 1 was dissolved under nitrogen in 100mL of dry THF and cooled to -70° C. To this solution was added 13mL (26mmol) of a 2.0M solution of isobutylmagnesium chloride in ether and the stirred mixture was allowed to warm to room temperature and stir for 2 hrs. After decomposition with $MeOH/H_2O$

the mixture was diluted with ether, washed with saturated NH_4Cl solution twice and dried with magnesium sulfate and the solvents evaporated under vacuum. The residue was allowed to stand overnight in 80% MeOH-H_2O containing excess ammonium hydroxide. The MeOH was stripped off and the mixture was extracted with ether. These extracts were combined, washed with water, dilute $KHSO_4$, then dried and evaporated to give 2.36g of a yellow glass which crystallized from 50mL of pentane on standing overnight. The yellow-white powder obtained was recrystallized from ether-hexane and furnished the title compound (0.41g) as white, hairy needles, mp 134-136° C, Rf (ether): single spot, 0.6. By chromatography of the mother liquors and crystallization of the appropriate fractions, an additional 0.22g of product, mp 138-139° C, was obtained.

Anal: Calcd. for $C_{19}H_{31}NO_4$: C, 67.62; H, 9.26; N, 4.15. Found: C, 67.51; H, 9.43; N, 4.24.

Step 3

(2S,3R,4S)-N-[(tert-Butyloxy)carbonyl]-2-amino-1-cyclohexyl-3,4-dihydroxy-6-methylheptane

The title compound of Step 2 (0.27g) was reduced in MeOH with 60 psi H_2 at 60° in 3 hrs using 5% Rh/C catalyst. After filtering, the solvent was stripped off and the white crystals were recrystallized from CH_2Cl_2-hexane to furnish tiny needles of the title compound (0.19g, mp126-128°C); further recrystallization gave mp128.5-129.5°C. Rf (ether): single spot, 0.8.

Anal: Calcd. for $C_{19}H_{37}NO_4$: C, 66.43; H, 10.86, N, 4.08. Found: C, 66.43; H, 11.01; N, 4.03.

Step 4

(2S,3R,4S) 2-amino-1-cyclohexyl-3,4-dihydroxy-6-methylheptane

The title compound of Step 3 (10g) was dissolved 6.9N HCl in dioxane (300mL). The mixture was stirred for 30 minutes at room temperature. The solvent was removed in vacuo and to the residue was added 5% aqueous sodium hydroxide (30mL) until a pH of 14 was obtained. This mixture was extracted with ether and the ether extract was washed with water and brine, then the solvent was evaporated to give the title compound (7.3g, 100% yield). 300 MHz ^{1}H NMR: consistent with proposed structure.

Anal. calcd for $C_{14}H_{29}NO_2$: C, 69.07; H, 12.01; N, 5.78. Found: C, 69.19; H, 12.34; N, 5.78.

Step 5

L-Boc-*C*-propargylglycine

L-*C*-Propargylglycine (10g) [prepared by the method of Schwyzer et al., Helv. Chim. Acta, 59, 2181 (1976)] was suspended in tetrahydrofuran (30mL). Water (30mL), potassium carbonate (36.7g), and di-*tert*-butyl-dicarbonate (21.9g) were added. Additional water was added to produce a solution which was stirred for 12 hours at room temperature. The organic solvent was then evaporated and the aqueous solution was washed with ether, then acidified to pH 3 with 1N aqueous citric acid. The solution was extracted with methylene chloride and the solvent evaporated to give the title compound (18.9g, 97% yield), used without further purification.

Step 6

Boc L-C-propargylglycine amide of (2S,3R,4S) 2-amino-1-cyclohexyl-3,4-dihydroxy-6-methylheptane

Boc L-C-propargylglycine (1.2g) was dissolved in methylene chloride (5 mL) and N-methyl piperidine (0.57g) was added. The mixture was cooled to zero degrees centigrade and isobutyl chloroformate (0.78g) was added. The mixture was stirred for 10 minutes whereupon the title compound of Step 4 (1.4g) in methylene chloride (5 mL) was added and this mixture stirred for 15 minutes at 0°C and 4°C for 12 hours. The reaction mixture was washed successively with 1N citric acid, saturated sodium hydrogen carbonate, water and brine. The organic layer was dried over magnesium sulfate and evaporated to dryness. The residue was chromatographed on silica gel to give the title compound as a colorless oil. 300 MHz ^{1}H NMR: consistent with proposed structure.

Step 7

L-C-propargylglycine amide of (2S,3R,4S) 2-amino-1-cyclohexyl-3,4-dihydroxy-6-methylheptane

The title compound of Step 6 (0.76g) was dissolved in a mixture of trifluoroacetic acid (4.9 mL) and methylene chloride (4.9 mL), and stirred for 30 minutes at room temperature. The solvent was then evaporated and the residue taken up in ethyl acetate. The organic layer was washed with saturated sodium hydrogen carbonate, water and brine, then dried over magnesium sulfate and evaporated to give the title amine. 300 MHz ^{1}H NMR: consistent with proposed structure.

Step 8

2R-(Phenylmethyl)butanedioic acid, 1-(phenylmethyl) ester, dicyclohexylammonium salt

To a slurry of 4-(4-methoxybenzyl)itaconate [prepared by the method of Talley in US Patent # 4,939,288] (50g) in toluene (250mL) was added 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU, 30.4g) in one portion. Then a solution of benzyl bromide (34.2g) in toluene (50mL) was added dropwise over 0.5 hour. The reaction was stirred for 0.5 hour at room temperature and then poured into a separatory funnel. The mixture was washed with 3N HCl, aqueous sodium bicarbonate, brine and dried over magnesium sulfate. The solvent was evaporated to give a clear mobile liquid (68g). Chromatography on silica gel, eluting with from 100% hexane to 25% ethyl acetate gave pure 1-(benzyl)-4-(4-methoxybenzyl) itaconate (55g, 81% yield). A large Fisher-Parter bottle was charged with this itaconate (41g), triethylamine (36g), palladium acetate (380mg), tri-o-tolylphosphine (1.04g) and iodobenzene (24.7g). The bottle was sealed and flushed with nitrogen and placed in an oil bath and heated for 70 minutes. The residue was chromatographed on silica gel, eluting with 100% hexanes until the less polar impurities were removed. Eluting with 10% ethyl acetate in hexane gave the pure phenyl itaconate. This compound (23.8g) was mixed with toluene (200mL) and the resulting solution treated with trifluoroacetic acid (30mL). The solution was stirred at room temperature for 1.5 hour and then evaporated. The residue was taken up in ether (150mL) and treated with dicyclohexylamine (10.4g) and stirred at 0° whereupon the salt precipitated. This was isolated by filtration and washed with hexane and dried to give pure 1-benzyl 2-benzylidene succinoate

dicyclohexylammonium salt (21.24g, 78% yield). This benzylidene compound (20g) was place in a Fisher-Porter bottle and also added were degassed methanol (200mL) and rhodium (R,R) DiPAMP (600mg) catalyst. The bottle was sealed and flushed with nitrogen then hydrogen. The reaction was hydrogenated at 40 psig for 15 hours at room temperature. The contents were then poured into a round bottom flask (500mL) and the solvent evaporated to give a dark solid. The residue was taken up in boiling *iso*octane and allowed to stand, with some title compound crystallizing (7.34g). The non-dissolved residue was taken up in boiling dimethoxyethane. This solution was allowed to cool for 12 hours, whereupon crystals of the title compound formed (6.05g). Combining the two crops gave 13.39g, 66% yield, mp 122-125°. 300 MHz ^{1}H NMR: consistent with proposed structure.

Step 9

<u>2R-(Phenylmethyl)butanedioic acid, 1-(phenylmethyl) ester</u>

The title compound of Step 8 (9.3g) was suspended in a mixture of water (84mL) and methanol (8.5mL). Solid sodium bisulfate (6.12) was added and the mixture stirred for 5 minutes. The mixture was extracted with methylene chloride and the combined extracts were dried over magnesium sulfate and evaporated to dryness. The residue was chromatographed on silica gel, eluting with methanol-chloroform-acetic acid (5:95:0.5), to give the pure title compound (4.3g, 74% yield).

Step 10

N-Benzyl-N-methyl-2-chloroethylamine Hydrochloride

The procedure of Hall, et al.[Organic Syntheses Coll. Vol. 4, 1963, 333-335] was used. To thionyl chloride (22.92 mL, 03.14 mol) at 0°C was added dropwise N-benzyl-N-methyl ethanolamine (50g, 0.303 mol). The creamy, off-white material was stirred for 1 hour at 0°C and then 1 hour at room temperature. Anhydrous ethanol (129 mL) was added to the material. The solution was refluxed for 20 minutes and then was concentrated to an off-white solid. The solid was triturated with Et_2O to give the title compound as a white solid (62.51g, 94% yield, mp 136-138°C).

Step 11

2-(N-Benzyl-N-methylamino)-1-(N-piperidinyl)ethane

A solution of piperdine (1.16g, 13.6 mmol), the title compound of Step 10 (3.0g, 13.6 mmol) and $NaHCO_3$ (3.94 g, 46.9 mmol) in EtOH (24 mL) was refluxed overnight in a modification of the procedure of Bach, et al. [J. Am. Chem. Soc. 79, 2221-2225 (1957)]. After filtration, the filtrate was concentrated to a yellow murky oil. The oil was dissolved into a 1.0M KOH solution (10 mL) and was extracted with EtOAc (3x5 mL). The organic layer was washed with a 5% NaHCO3, solution (5mL), H_2O (5mL), and brine (5mL) and then was dried over $MgSO_4$. The filtrate was concentrated and purified by medium pressure column chromatography on silica gel [eluting NH_4OH-EtOH-$CHCl_3$ (1:5:94)] to give 1.85g (58% yield) of the title compound as an oil. The proton spectral data were consistent with the proposed structure.

Step 12

2-(N-Methylamino)-1-(N-piperidinyl)ethane

A solution of the title compound of Step 11 (1.85g, 7.96mmol) and 20% $Pd(OH)_2$ on carbon in EtOH (50mL) was placed under a hydrogen atmosphere (60 psi) at room temperature for 17 hours. The mixture was filtered and concentrated to give the title compound as a clear, yellow liquid (1.02g, 90% crude yield). The proton spectral data were consistent with the proposed structure.

Step 13

Phenylmethyl aR-[2-[methyl[2-(1-piperidinyl)ethyl]amino]-2-oxoethyl]benzenepropanoate

To a mixture of the title compound of Step 9 (1.00g, 3.35 mmol), pyridine (0.127mL, 3.35mmol), N,N'-di-succinimidyl carbonate (0.86g, 3.35mmol), dimethylaminopyridine (24mg) in dimethylformamide (10mL) that had been stirred at room temperature for 3 hours, was added 2-(N-methylamino)-1-piperidinylethane (0.57g, 4.02mmol) in dimethylformamide (4mL); the solution was then stirred overnight. The reaction mixture was diluted with CH_2Cl_2 (12 mL) and then was washed with 5% aqueous K_2CO_3 solution (2x5 mL), H_2O (10 mL), and brine (10 mL). The organic layer was dried over $MgSO_4$. The filtrate was concentrated and the residue purified by medium pressure column chromatography (silica gel, eluting with 5% MeOH in CH_2Cl_2) to give 1.12g (84% yield) of pure title compound as a clear, yellow oil. The proton NMR spectral data were consistent with the proposed structure.

Step 14

αR-[2-[methyl[2-(1-piperidinyl)ethyl]amino]-2-oxoethyl]benzenepropanoic acid

A mixture of the title compound of Step 13 (5.5g, 13mmol) and 4% Pd-C in EtOH at room temperature was placed under a hydrogen atmosphere (5 psi). The reaction was monitored by thin layer chromatography [NH_4OH-EtOH-$CHCl_3$ (1:5:94)]. After 4 hours the reaction mixture was filtered and concentrated to give the title compound (4g) as a yellow oil. The proton NMR spectral data was consistent for the proposed structure.

Step 15

2-[2-(N-Benzyl-N-methylamino)ethyl]-1,3-dihydroisoindole

A solution of 1,3-dihydroisoindole [Bornstein, J.; Shield, J.E.; Boisselle, A.P. *Organic Synthesis*, Collective Vol 5; John Wiley & Son, Inc; New York, *1973*, 406-408] (2.30g, 19.3mmol), $NaHCO_3$ (5.59g, 66.6mmol), and N-(2-chloroethyl)-N-methylbenzenemethanamine hydrochloride (4.25g, 19.3mmol) in anhydrous EtOH was refluxed overnight under an atmosphere of N_2. The black, opaque mixture was filtered and the solids were washed with EtOH. The filtrate was concentrated to give a black slurry. The slurry was dissolved into a 1.0N KOH solution (25mL) and was extracted with EtOAc (3x10mL). The combined organic layers were washed with a 5% $NaHCO_3$ solution (10mL), H_2O (10mL), and brine (10mL) and then dried over $MgSO_4$. The filtrate was concentrated in vacuo and purified by medium pressure column chromatography [silica gel, NH_4OH:EtOH:$CHCl_3$ (1:4:95)] to give the

title compound as a black oil (2.22g). The proton NMR spectrum was consistent with the proposed structure.

Step 16

2-[2-(Methylamino)ethyl]-1,3-dihydroisoindole

A mixture of the title compound of Step 15 (2.00g, 7.51mmol) and 20% $Pd(OH)_2/C$ in MeOH (50mL) was placed under a hydrogen atmosphere (60 psi) at room temperature for 37 hours. The filtrate was concentrated to give the title compound as a clear, yellow oil (1.34g). The proton NMR spectral data showed that the desired product was contaminated with a small amount of unreacted starting material (5%).

Step 17

Phenylmethyl αR-[2-[[2-(1,3-dihydro-2H-isoindol-2-yl)ethyl]methylamino]-2-oxoethyl]benzenepropanoate

To a solution of the title compound of Step 9 (0.38g, 1.3mmol) and pyridine (0.10g, 1.3mmol) in anhydrous dimethylformamide (2mL) was added N,N'-disuccinimidyl carbonate (DSC) (0.34g, 1.3mmol) and dimethylaminopyridine (DMAP, 9mg). After 3 hours, the title compound of Step 16 (1.3mmol) was added and the solution was stirred overnight at room temperature. The opaque, brown solution was concentrated in vacuo to give a black oil. The oil was dissolved in EtOAc (25mL) and washed with a 5% K_2CO_3 solution (2x7mL), H_2O (7mL), and brine (10ml). The organic layer was dried over $MgSO_4$. The filtrate was concentrated and purified by medium pressure column chromatography (silica gel, 2.5% EtOH in CH_2Cl_2) to give the title compound as a pale,

yellow oil (0.44g). The proton NMR spectral data were consistent with the proposed structure.

Step 18

αR-[2-[[2-(1,3-dihydro-2H-isoindol-2-yl)ethyl]methylamino]-2-oxoethyl]benzenepropanoic acid

A mixture of the title compound of Step 17 (0.44g, 0.96mmol) and 4% Pd/C (132mg) in ethanol (10ml) was stirred overnight at room temperature under a hydrogen atmosphere from a balloon. The mixture was filtered through a celite bed and concentrated to give the title compound as a green foam (0.40g). The proton NMR spectrum was consistent with the proposed structure.

Step 19

2-(N-Benzyl-N-methylamino)-1-(N-3-azabicyclo[3.2.2]-nonanyl)ethane

The procedure of Step 11 was used, substituting 3-azabicyclo[3.2.2]nonane for piperidine to give the title compound. The proton spectral data were consistent with the proposed structure.

Step 20

2-(N-Methylamino)-1-(N-3-azabicyclo[3.2.2]nonanyl)ethane

The procedure of Step 12 was used, substituting the title compound of Step 19 for the title compound of Step 11 to give the title compound. The proton spectral data were consistent with the proposed structure.

Step 21

Phenylmethyl αR-[2-[methyl[2-(N-3-azabicyclo[3.2.2]-nonanyl)ethyl]amino]-2-oxoethyl]benzenepropanoate

The procedure of Step 13 was used substituting the title compound of Step 20 for 2-(N-methylamino)-1-piperidinylethane. The proton NMR spectral data were consistent with the proposed structure.

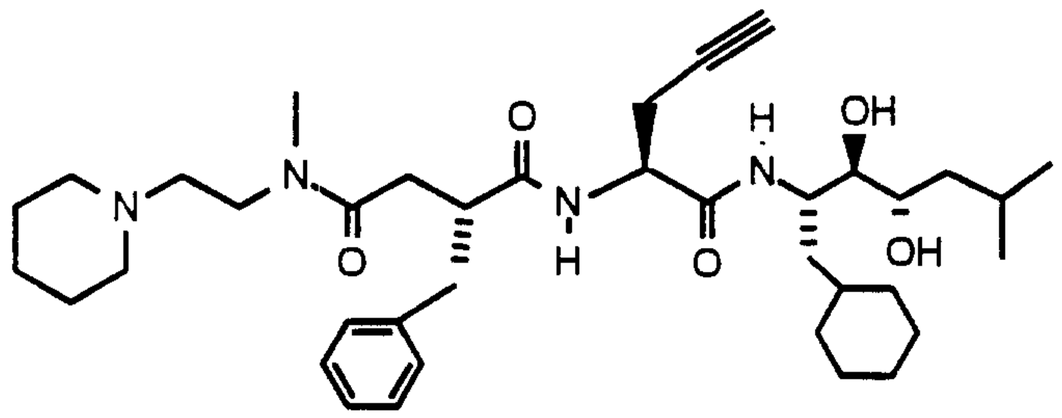
Step 22

αR-[2-[methyl[2-(N-3-azabicyclo[3.2.2]nonanyl)-ethyl]amino]-2-oxoethyl]benzenepropanoic acid

The procedure of Step 14 was used, substituting the title compound of Step 21 for the title compound of Step 13 to give the title compound. The proton NMR spectral data was consistent for the proposed structure.

The following working Examples are provided to illustrate synthesis of Compounds 1-29 of the present invention and are not intended to limit the scope thereof. Those skilled in the art will readily understand that known variations of the conditions and processes of the following preparative procedures can be used to prepare the compounds of the Examples. All temperatures expressed are in degrees Centigrade.

Example 1

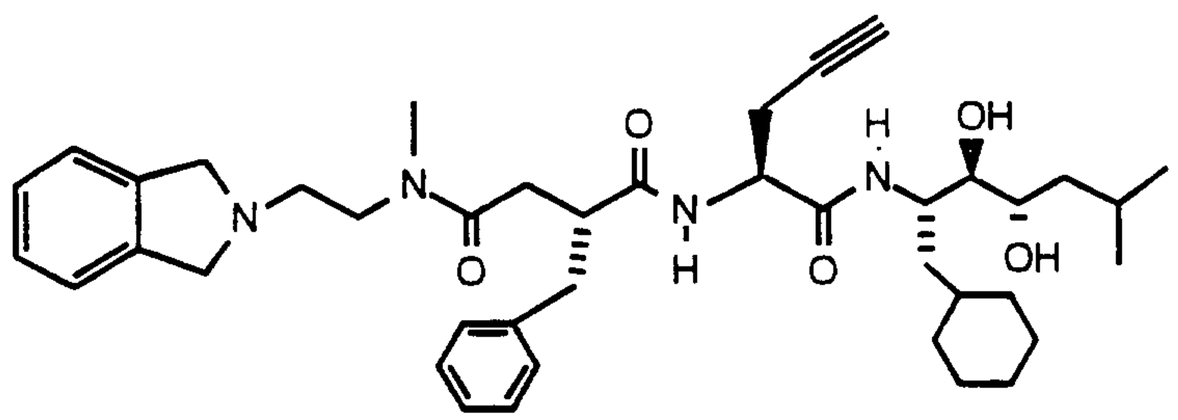


N^1-[1R*-[[[1S,1R*-(cyclohexylmethyl)-2S*,3R*-dihydroxy-5-methylhexyl]amino]carbonyl]-3-butynyl]-N^4-methyl-2S*-(phenylmethyl)-N^4-[2-(1-piperidinyl)ethyl]butanediamide

The title acid of Step 14 (150mg) was covered with dry dimethylformamide (1mL) and stirred at room temperature for 10 minutes, whereupon a white solid precipitated. To this was added solid N,N'-disuccinimidyl carbonate (104mg), followed by pyridine (35mL). A solution slowly formed. After a few minutes, a solution of dimethylaminopyridine (7mg) in dimethylformamide (0.2mL) was added. A solution resulted within minutes. Four hours later, the title amine of Step 7 (139mg) was added as a solid. The mixture was stirred for 2 days at room temperature. The solvent was then evaporated and the residue taken up in ethyl acetate, washing this layer four times with 5% aqueous potassium carbonate. The organic layer was dried and evaporated to a pale yellow foam. This foam was chromatographed on silica gel, eluting with 10% methanol in methylene chloride containing 1% ammonium hydroxide, to give the pure title compound as a white powder (169mg, 63% yield). ^1H NMR: consistent with proposed structure.

Anal. calcd for $C_{38}H_{60}N_4O_5$ + 0.5 water: C, 68.95; H, 9.29; N, 8.46. Found: C, 69.19; H, 9.19; N, 8.29.

Example 2

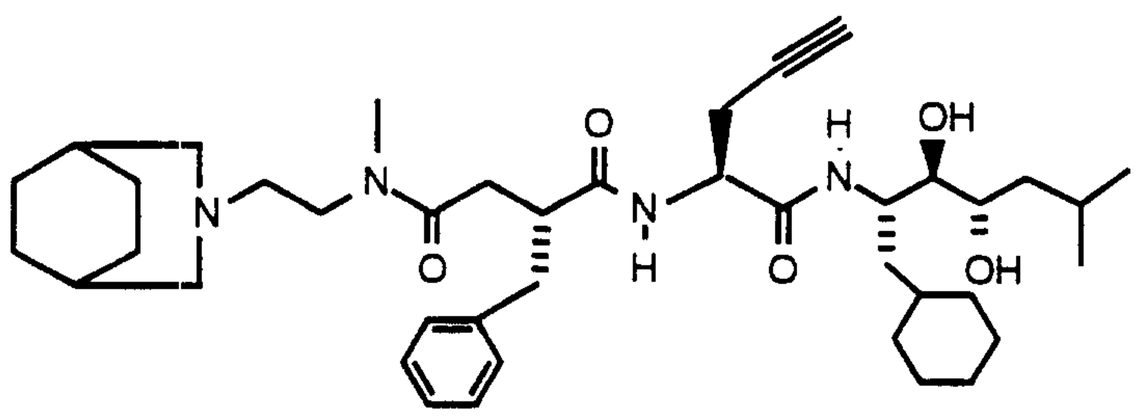


N^1-[1R*-[[[1S,1R*-(cyclohexylmethyl)-2S*,3R*-dihydroxy-5-methylhexyl]amino]carbonyl]-3-butynyl]-N^4-[2-(1,3-dihydro-2H-isoindol-2-yl)ethyl]-N^4-methyl-2S*-(phenylmethyl)butanediamide

To a mixture of the title acid of Step 18 (158mg) and dry dimethylformamide (1mL), stirred at room temperature for 10 minutes, was added solid N,N'-disuccinimidyl carbonate (110mg), followed by pyridine (35mL). After a few minutes, a solution of dimethylaminopyridine (10mg) in dimethylformamide (0.2mL) was added. Four hours later, the title amine of Step 7 (139mg) was added as a solid. The mixture was stirred for 2 days at room temperature. The solvent was then evaporated and the residue taken up in ethyl acetate, washing this organic layer four times with 5% aqueous potassium carbonate. The organic layer was dried and evaporated to a pale yellow foam. This foam was chromatographed on silica gel, eluting with 7% methanol in methylene chloride containing 1% ammonium hydroxide, to give the pure title compound as a yellow foam (99mg, 34% yield). ^{1}H NMR: consistent with proposed structure.

Anal. calcd for $C_{41}H_{58}N_4O_5$ + 1 water: C, 69.85; H, 8.58; N, 7.95. Found: C, 69.83; H, 8.57; N, 7.83.

Example 3



N^1-[1R*-[[[1S,1R*-(cyclohexylmethyl)-2S*,3R*-dihydroxy-5-methylhexyl]amino]carbonyl]-3-butynyl]-N^4-methyl-2S*-(phenylmethyl)-N^4-[2-(N-3-azabicyclo[3.2.2]nonanyl)ethyl]butanediamide

The title acid of Step 22 (167mg) was dissolved in dimethylformamide (2mL) at room temperature and to this was added N,N'-disuccinimidyl carbonate (114mg), followed by pyridine (35mg) and dimethylaminopyridine (6mg). This solution was stirred for 3 hours, whereupon the title compound of Step 7 (152mg) was added in one portion. The mixture was stirred at room temperature for 12h, then the solvent was evaporated. The residue was taken up in ethyl acetate and this organic solution was successively washed with 5% aqueous potassium carbonate, water and brine. The solvent was evaporated and the residue partitioned between 0.5M aqueous citric acid and ethyl acetate. The ethyl acetate layer was washed with 1N potassium hydroxide and the organic layer dried, filtered and evaporated to give the title compound (103mg). ^{1}H NMR: consistent with proposed structure. Anal. calcd for $C_{41}H_{64}N_4O_5$ + 1 water: C, 69.26; H, 9.36; N, 7.88. Found: C, 68.83; H, 9.34; N, 7.67.

Compounds #4-31, as shown in Table I below, may be synthesized by reference to the foregoing specific and general procedures for preparing compounds of Formula I.

TABLE I

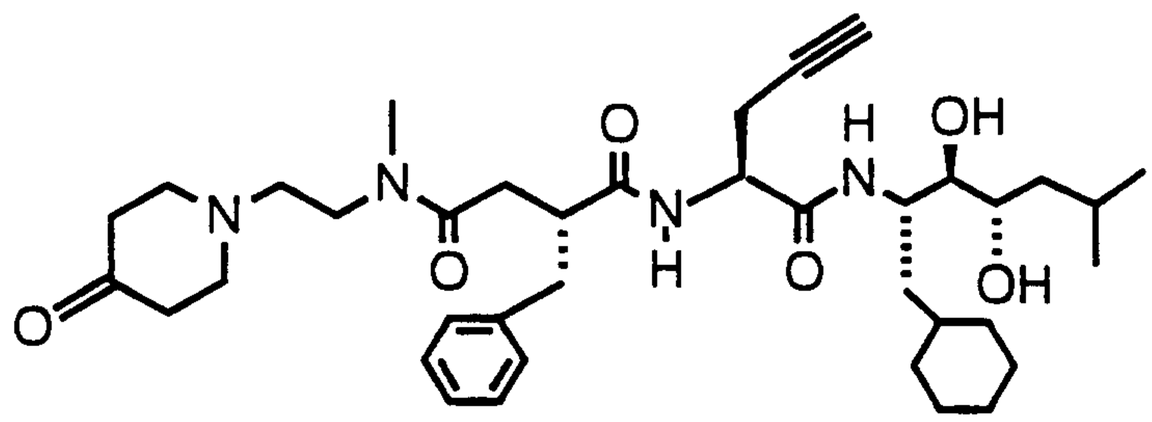
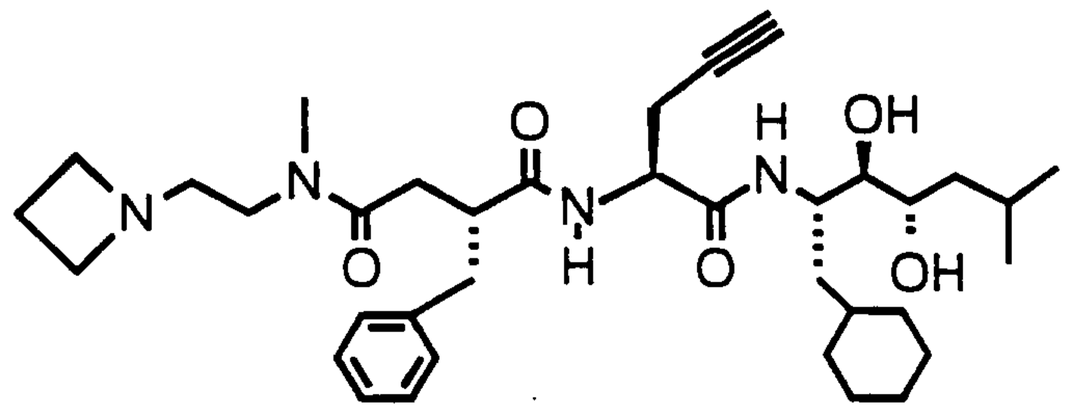
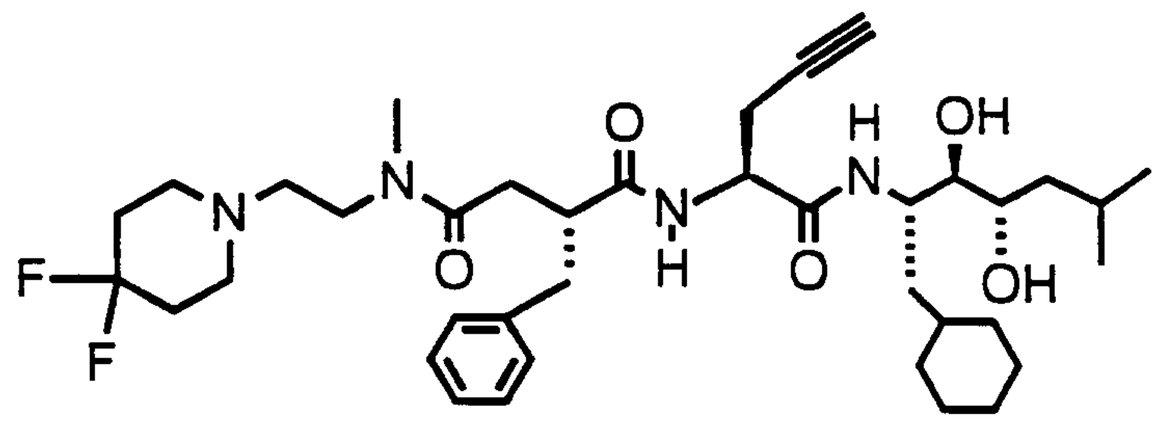
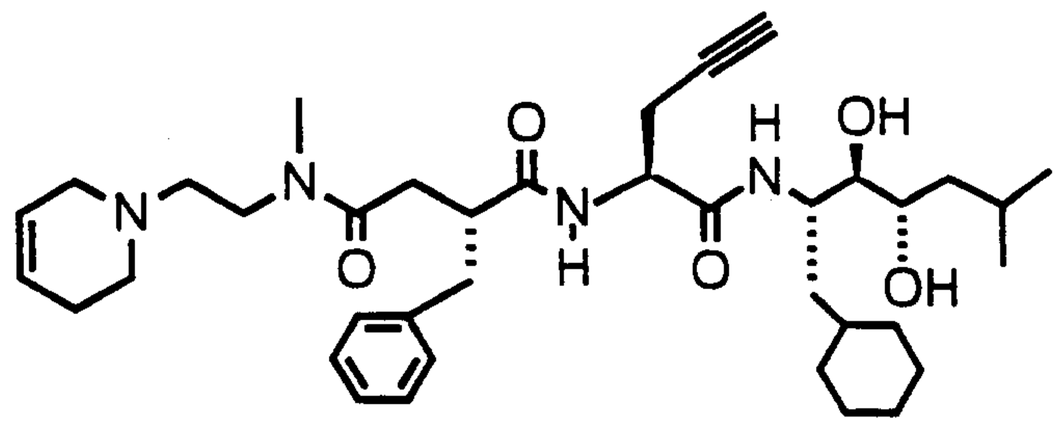
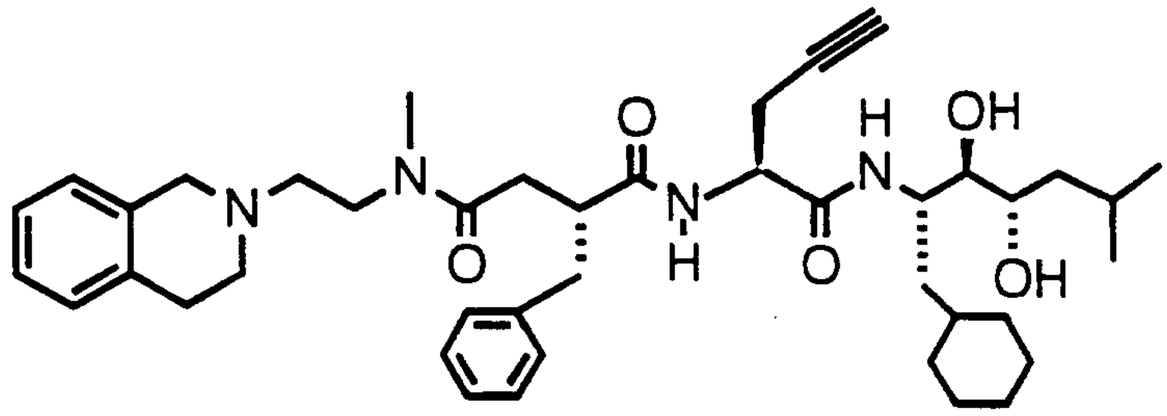
Example Compound No.	Structure
4	
5	
6	
7	
8	

TABLE I

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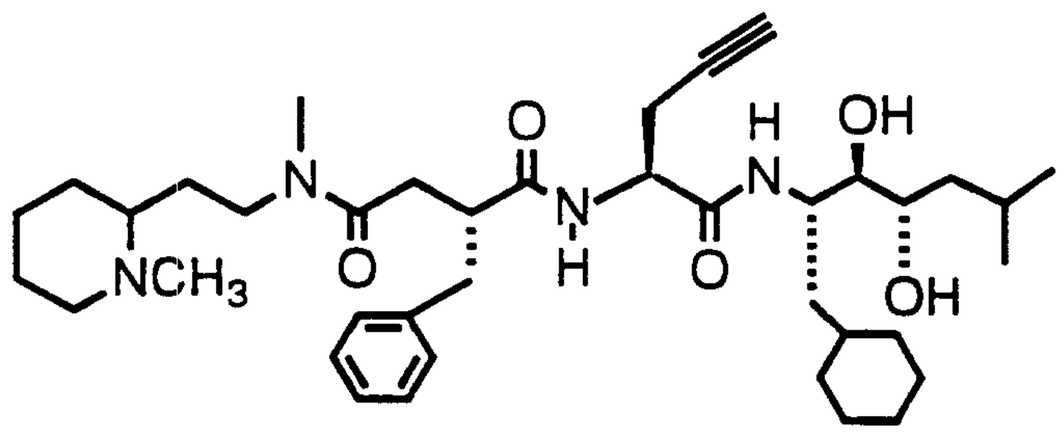
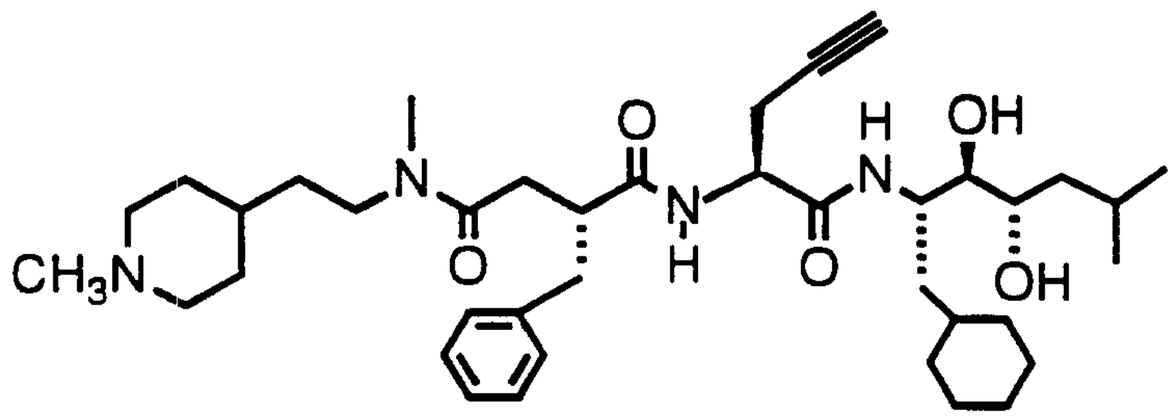
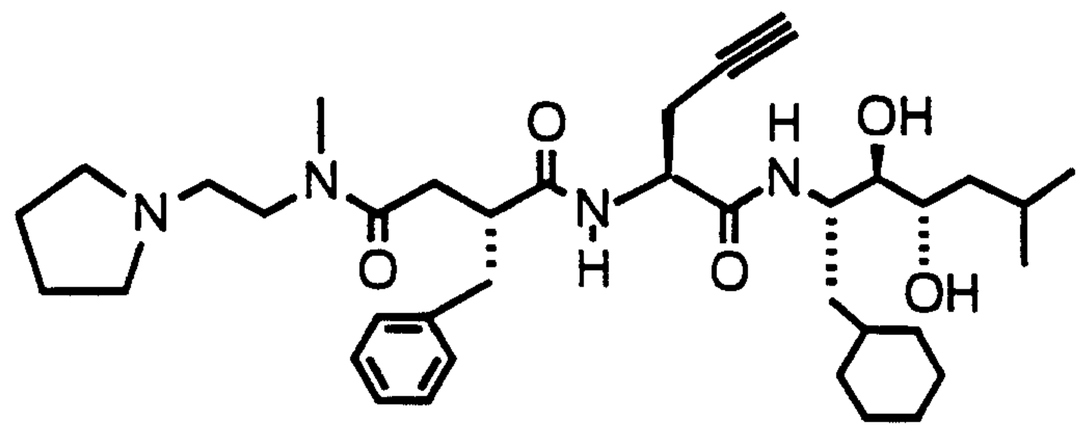
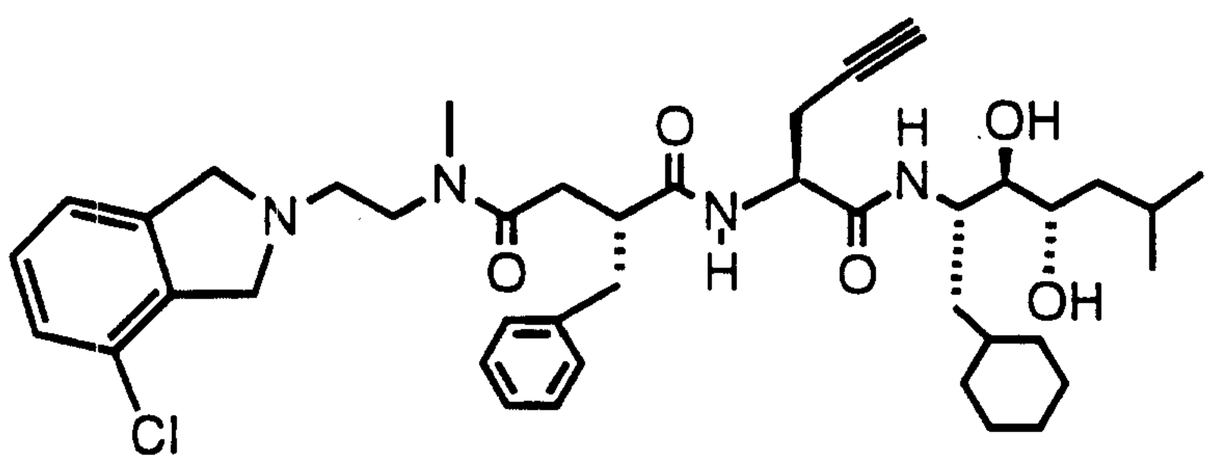
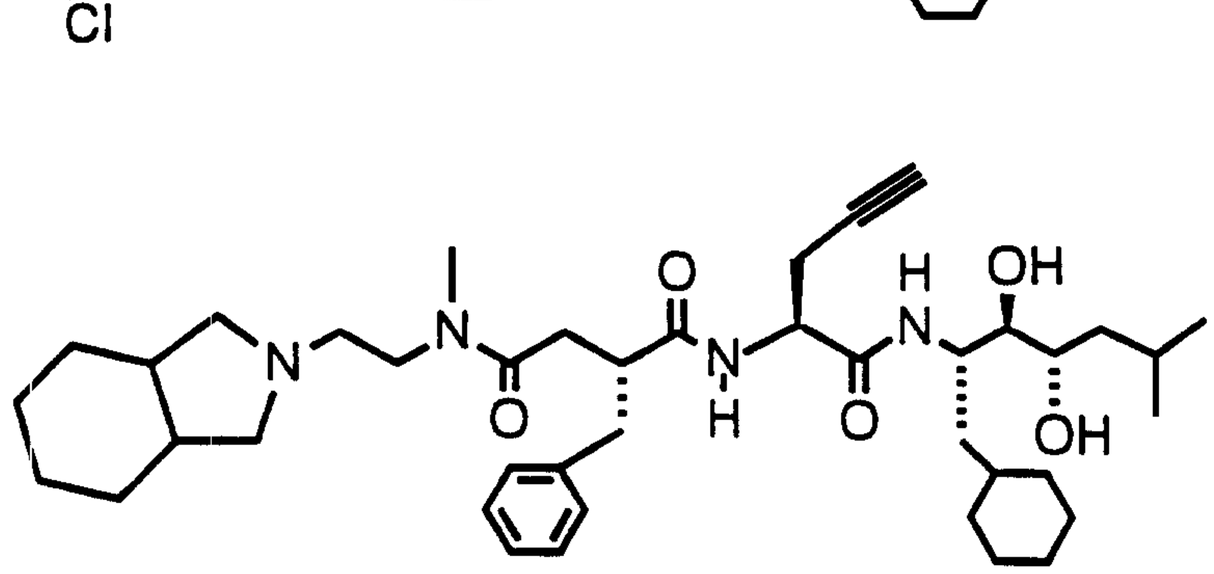
9	
10	
11	
12	
13	

TABLE I

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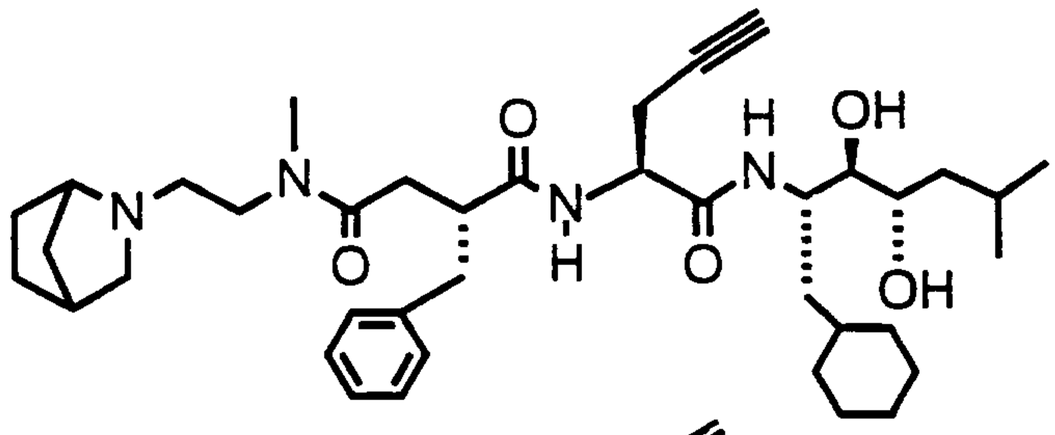
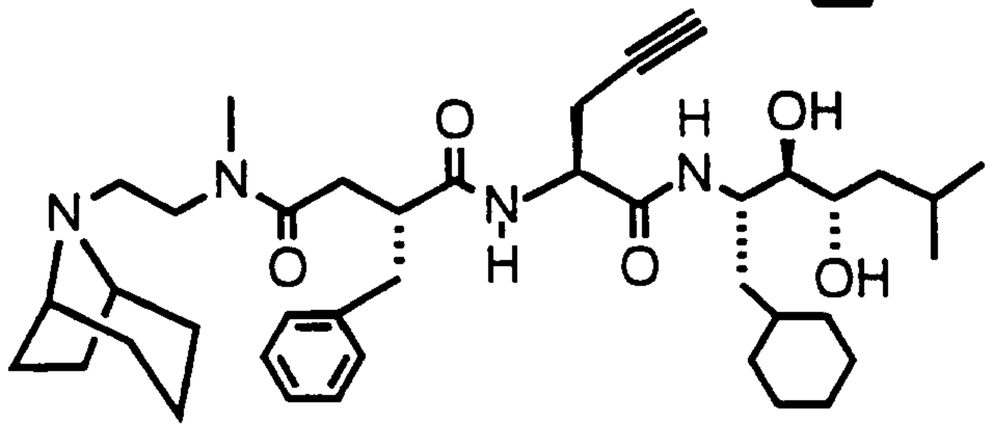
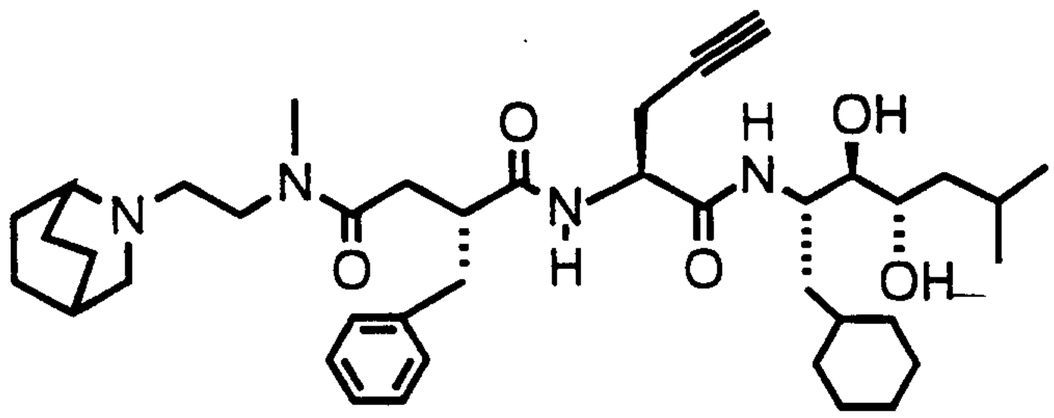
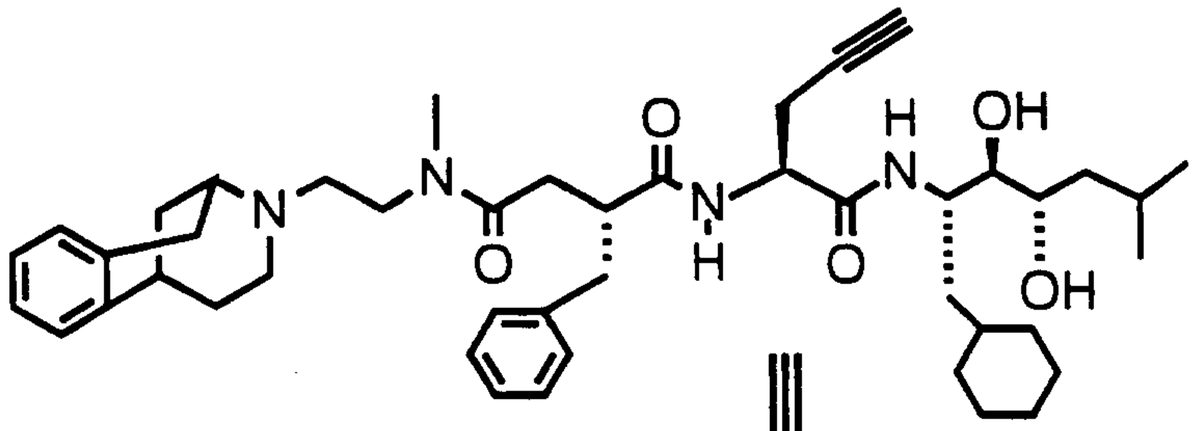
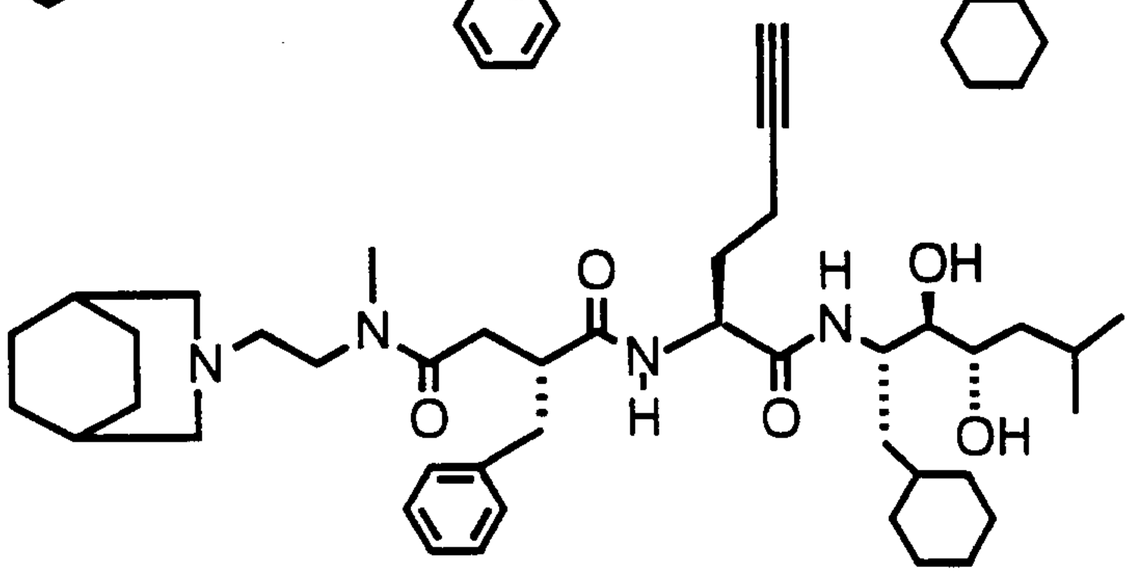
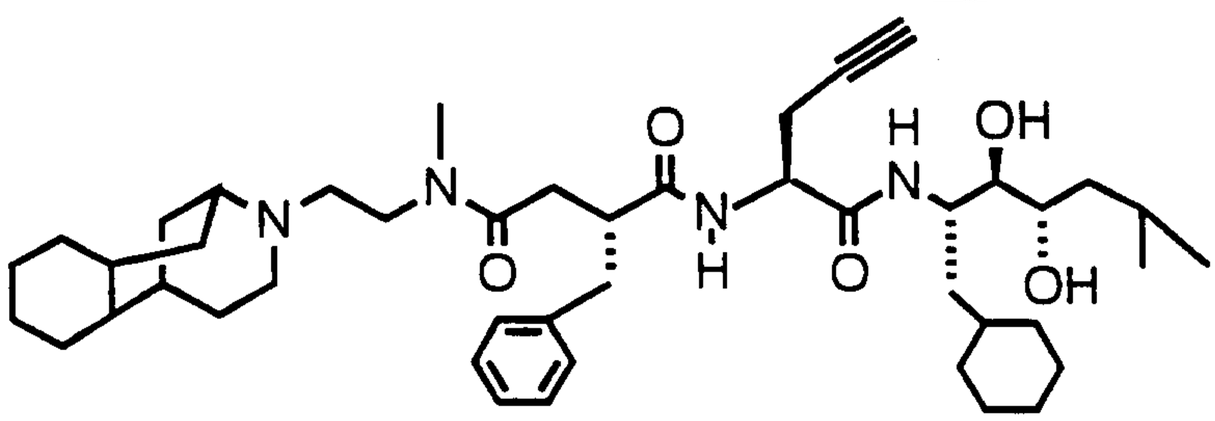
14	
15	
16	
17	
18	
19	

TABLE I

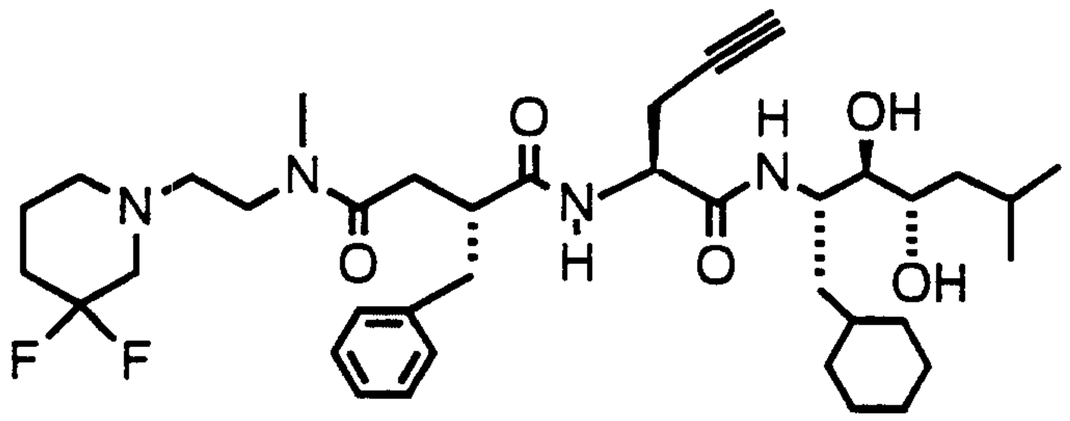
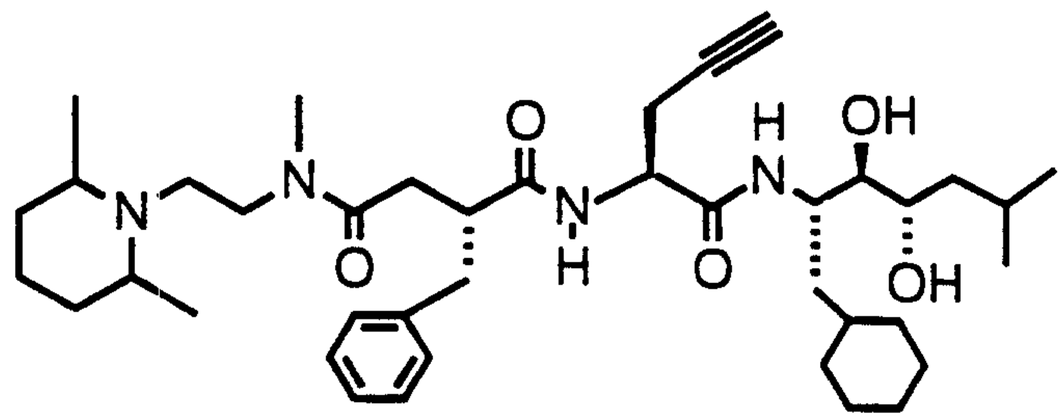
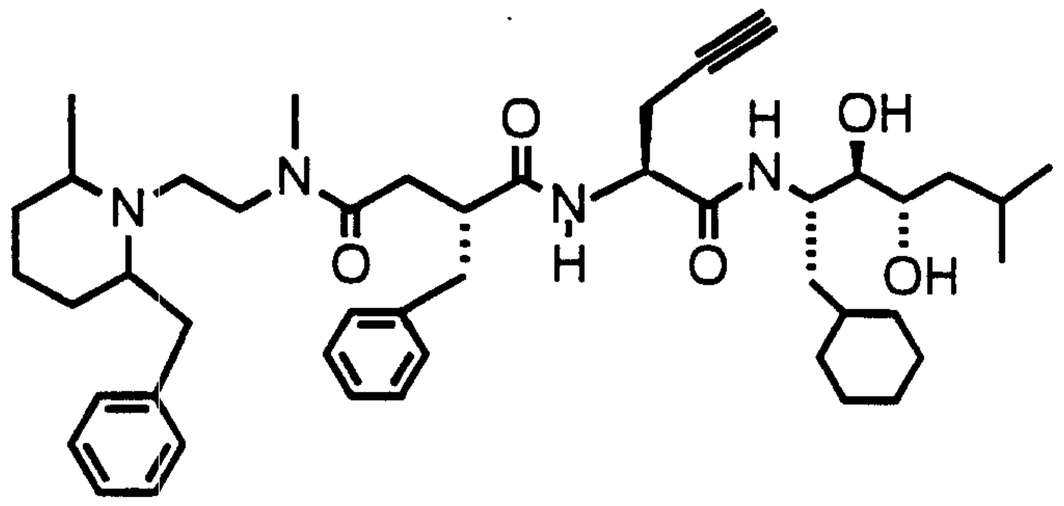
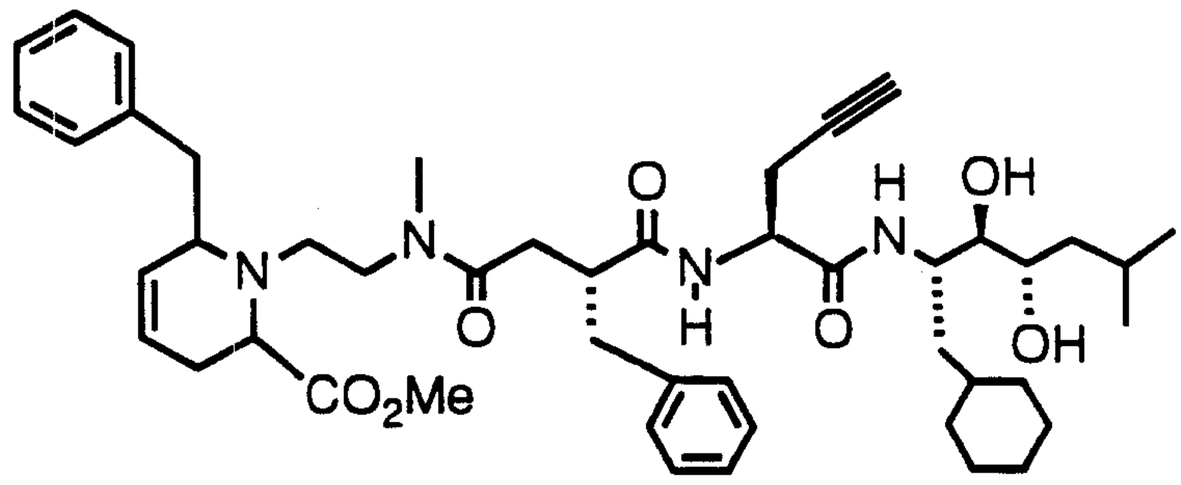
Example Compound No.	Structure
20	
21	
22	
23	
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TABLE I

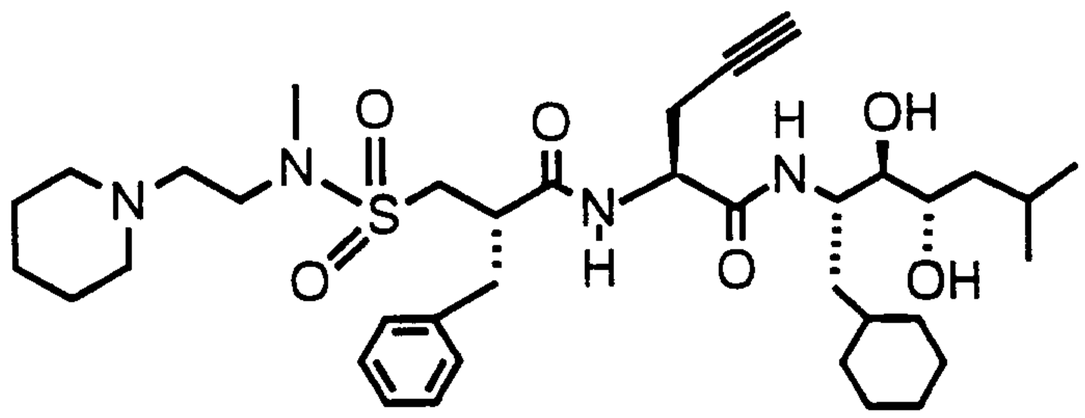
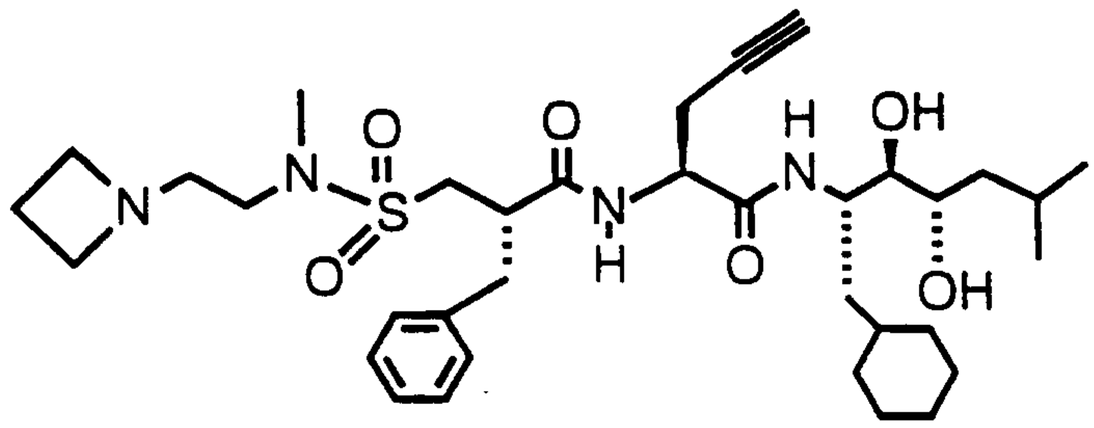
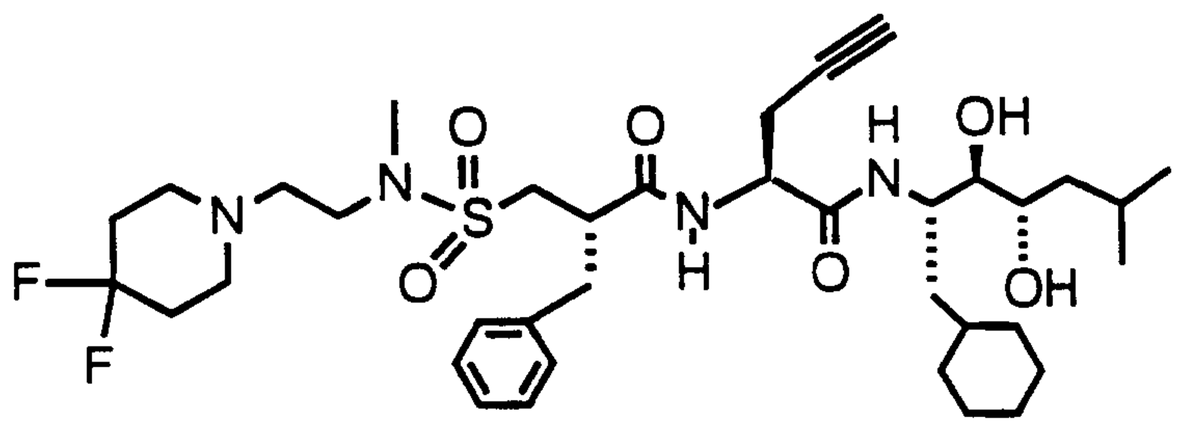
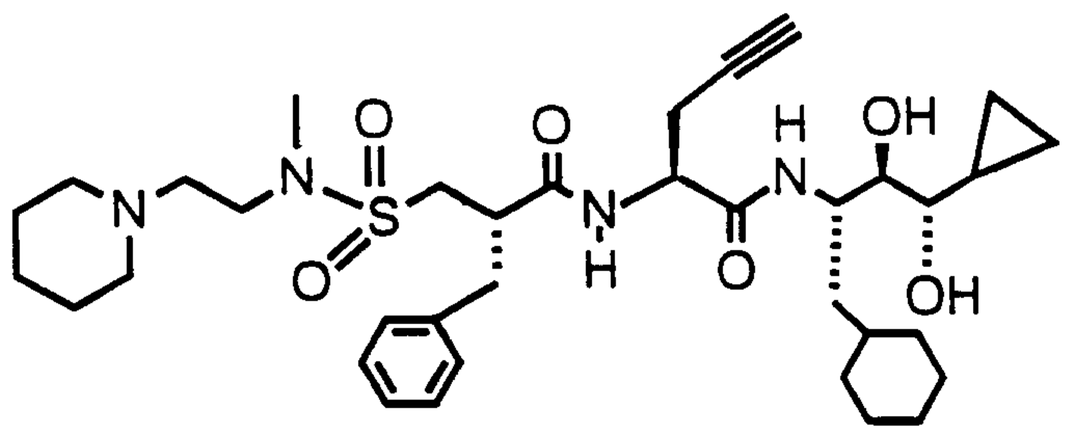
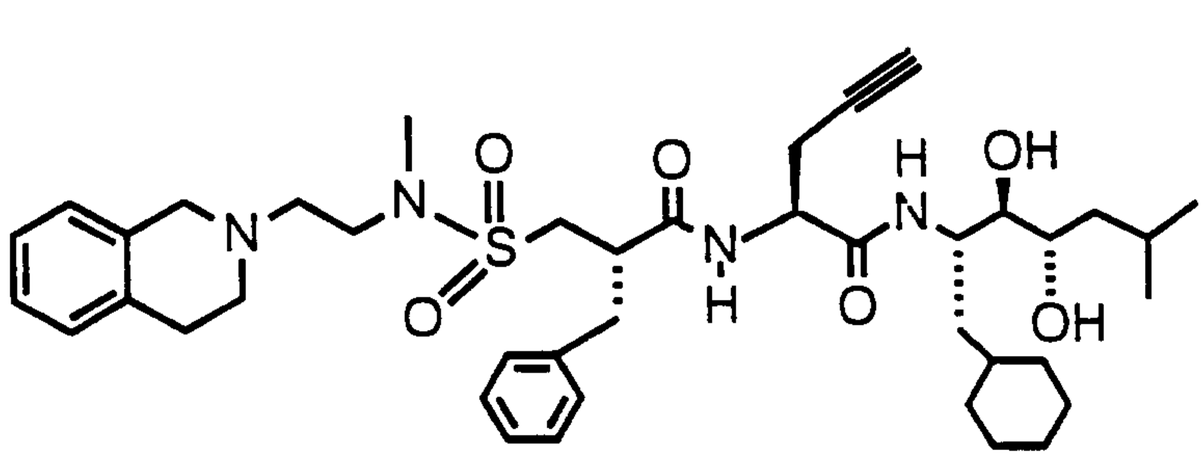
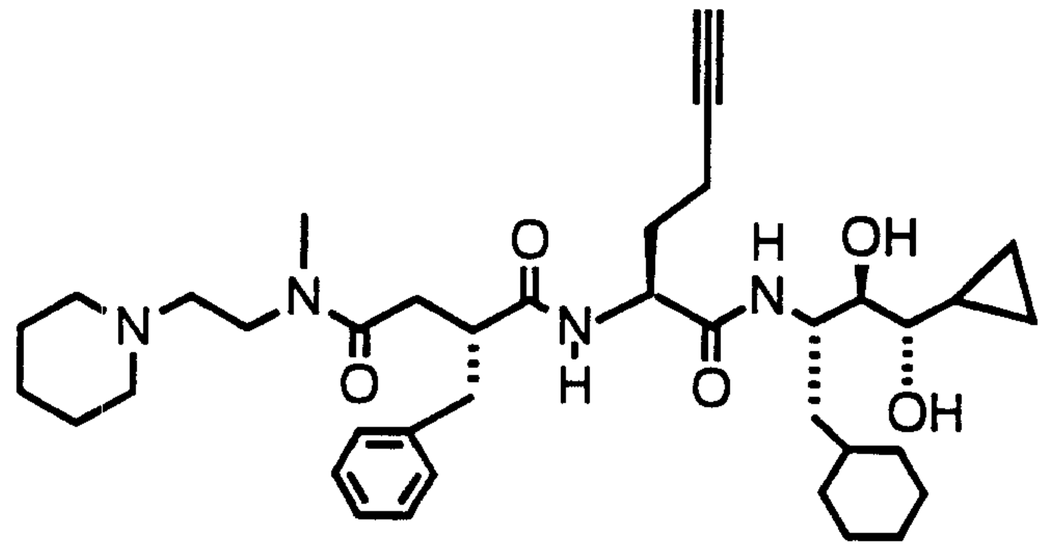
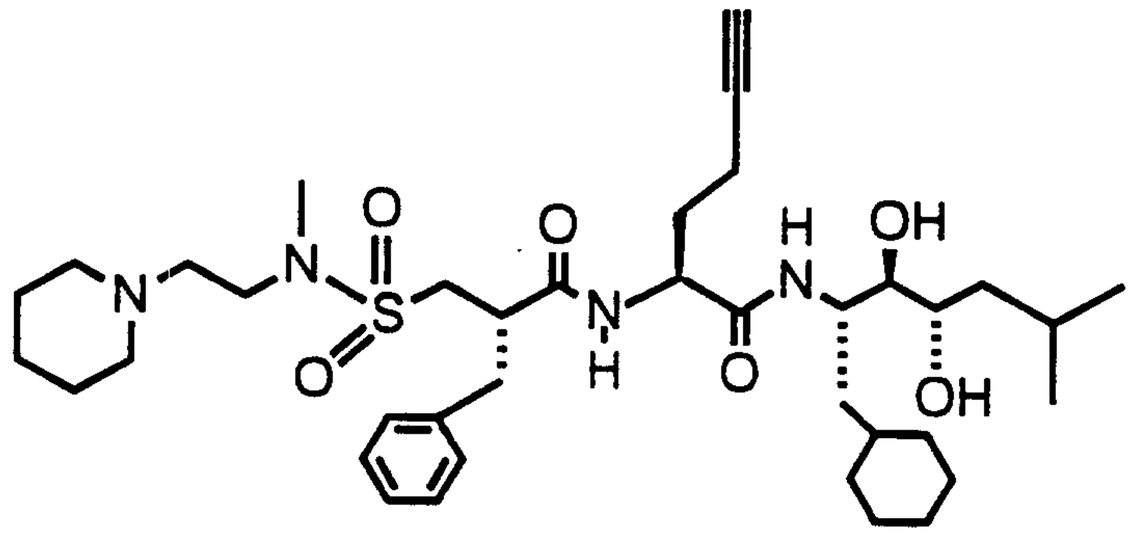
Example Compound No.	Structure
25	
26	
27	
28	
29	

TABLE I

Example Compound No.	Structure
30	
31	

BIOLOGICAL EVALUATION

Human Renin Inhibition in vitro

Compounds of Formula I were evaluated as inhibitors of human renin in an in vitro assay, as follows: This human renin inhibition test has been previously described in detail [Papaioannou et al., Clinical and Experimental Hypertension, A7(9), 1243-1257 (1985)]. Human renin was obtained from the National Institute for Biological Standards, London. An incubation mixture was prepared containing the following components: in a total volume of 0.25mL: 100 mM Tris-acetate buffer at pH 7.4, 25 x 10^{-6} Goldblatt units of renin, 0.05mL of plasma from human volunteers taking oral contraceptives, 6.0 mM Na-EDTA, 2.4 mM phenylmethyl sulfonyl fluoride, 1.5 mM 8-hydroxyquinoline, 0.4 mg/mL bovine serum albumin (BSA), and 0.024 mg/mL neomycin sulfate. This mixture was incubated for two hours at 37°C in the presence or absence of renin inhibitors. The produced angiotensin I was determined by radioimmunoassay (New England Nuclear kit). Test compounds to be assayed were dissolved in DMSO and diluted with 100mM Tris-acetate buffer at pH 7.4 containing 0.5% BSA to the appropriate concentration. The final concentration of organic solvent in the reaction mixture was less than 1%. Control incubations at 37°C were used to correct for effects of organic solvent on renin activity. The in vitro enzymatic conversion of angiotensinogen to angiotensin I was inhibited by test compounds of the invention as indicated in Table II, below:

Table II

Human Renin in vitro Inhibition Data

Compound Example #	IC_{50} Human Renin (nM)
Example 1	0.83
Example 2	0.56
Example 3	1.2

Also embraced within this invention is a class of pharmaceutical compositions comprising one or more compounds of Formula I in association with one or more non-toxic, pharmaceutically acceptable carriers and/or diluents and/or adjuvants (collectively referred to herein as "carrier" materials) and, if desired, other active ingredients. The compounds of the present invention may be administered by any suitable route, preferably in the form of a pharmaceutical composition adapted to such a route, and in a dose effective for the treatment intended. Therapeutically effective doses of the compounds of the present invention required to prevent or arrest the progress of the medical condition are readily ascertained by one of ordinary skill in the art. The compounds and composition may, for example, be administered intravascularly, intraperitoneally, subcutaneously, intramuscularly or topically.

For oral administration, the pharmaceutical composition may be in the form of, for example, a tablet, capsule, suspension or liquid. The pharmaceutical composition is preferably made in the form of a dosage unit containing a particular amount of the active ingredient. Examples of such dosage units are tablets or capsules. These may with advantage contain an amount of active ingredient from about 1 to 250 mg, preferably from about 25 to 150 mg. A suitable daily dose for a mammal may vary widely depending on the condition of the patient and other factors. However, a dose of from about 0.1 to 3000 mg/kg body weight, particularly from about 1 to 100 mg/kg body weight, may be appropriate.

The active ingredient may also be administered by injection as a composition wherein, for example, saline, dextrose or water may be used as a suitable carrier. A suitable daily dose is from about 0.1 to 100 mg/kg body weight injected per day in multiple doses depending on the disease being treated. A preferred daily dose would be from

about 1 to 30 mg/kg body weight. Compounds indicated for prophylactic therapy will preferably be administered in a daily dose generally in a range from about 0.1 mg to about 100 mg per kilogram of body weight per day. A more preferred dosage will be a range from about 1 mg to about 100 mg per kilogram of body weight. Most preferred is a dosage in a range from about 1 to about 50 mg per kilogram of body weight per day. A suitable dose can be administered, in multiple sub-doses per day. These sub-doses may be administered in unit dosage forms. Typically, a dose or sub-dose may contain from about 1 mg to about 400 mg of active compound per unit dosage form. A more preferred dosage will contain from about 2 mg to about 200 mg of active compound per unit dosage form. Most preferred is a dosage form containing from about 3 mg to about 100 mg of active compound per unit dose.

The dosage regimen for treating a disease condition with the compounds and/or compositions of this invention is selected in accordance with a variety of factors, including the type, age, weight, sex and medical condition of the patient, the severity of the disease, the route of administration, and the particular compound employed, and thus may vary widely.

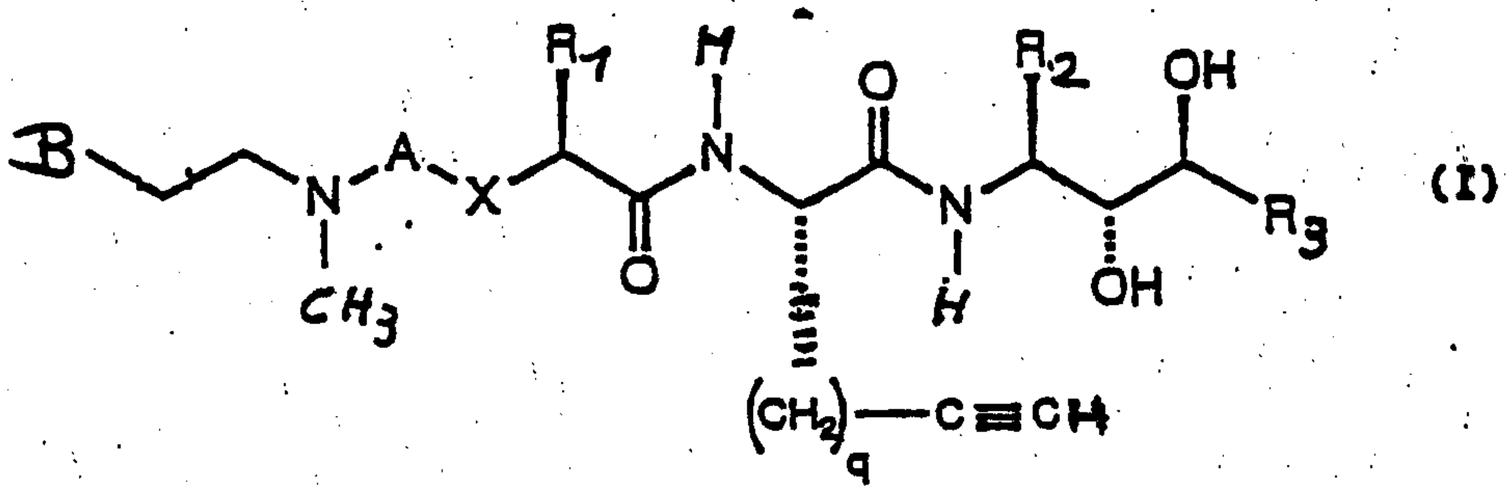
For therapeutic purposes, the compounds of this invention are ordinarily combined with one or more adjuvants appropriate to the indicated route of administration. If administered per os, the compounds may be admixed with lactose, sucrose, starch powder, cellulose esters of alkanoic acids, cellulose alkyl esters, talc, stearic acid, magnesium stearate, magnesium oxide, sodium and calcium salts of phosphoric and sulfuric acids, gelatin, acacia gum, sodium alginate, polyvinylpyrrolidone, and/or polyvinyl alcohol, and then tableted or encapsulated for convenient administration. Such capsules or tablets may contain a controlled-release formulation as may be provided in a

dispersion of active compound in hydroxypropylmethyl cellulose. Formulations for parenteral administration may be in the form of aqueous or non-aqueous isotonic sterile injection solutions or suspensions. These solutions and suspensions may be prepared from sterile powders or granules having one or more of the carriers or diluents mentioned for use in the formulations for oral administration. The compounds may be dissolved in water, polyethylene glycol, propylene glycol, ethanol, corn oil, cottonseed oil, peanut oil, sesame oil, benzyl alcohol, sodium chloride, and/or various buffers. Other adjuvants and modes of administration are well and widely known in the pharmaceutical art.

Although this invention has been described with respect to specific embodiments, the details of these embodiments are not to be construed as limitations.

What Is Claimed Is:

1. A compound of Formula I:



(I)

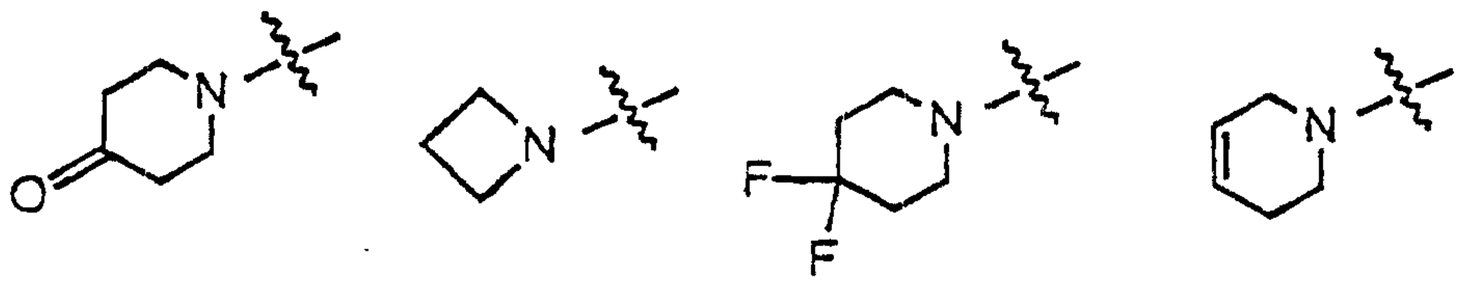
wherein A is selected from CO and SO_2; wherein X is methylene; wherein B is a heterocyclic ring system of four to ten ring members with one ring member being a nitrogen atom, wherein said ring system may be monocyclic or bicyclic and may be fully saturated or partially saturated and may be fused to a benzene or cyclohexane ring, wherein the point of attachment of B to the backbone of the structure of Formula I is through a bond to the nitrogen atom on said heterocyclic ring system of B and wherein any substitutable position of B may be optionally substituted with one or more radicals selected from C_1-C_{20}-alkyl, C_1-C_{10}-alkoxy, C_2-C_{20}-alkenyl, C_2-C_{10}-alkynyl, halo, trifluoromethyl, oxo, cyano and phenyl, and wherein the said heterocyclic ring nitrogen atom may be combined with oxygen to form an N-oxide; wherein R_1 is phenylmethyl; wherein R_2 is cyclohexylmethyl; wherein R_3 is selected from hydrido, C_1-C_{20}-alkyl, C_3-C_{10}-cycloalkyl, C_3-C_{10}-cycloalkyl-C_1-C_{20}-alkyl, C_1-C_{20}-hydroxyalkyl and C_2-C_{20}-alkenyl; wherein q is a number selected from one or two; or a pharmaceutically-acceptable salt thereof.

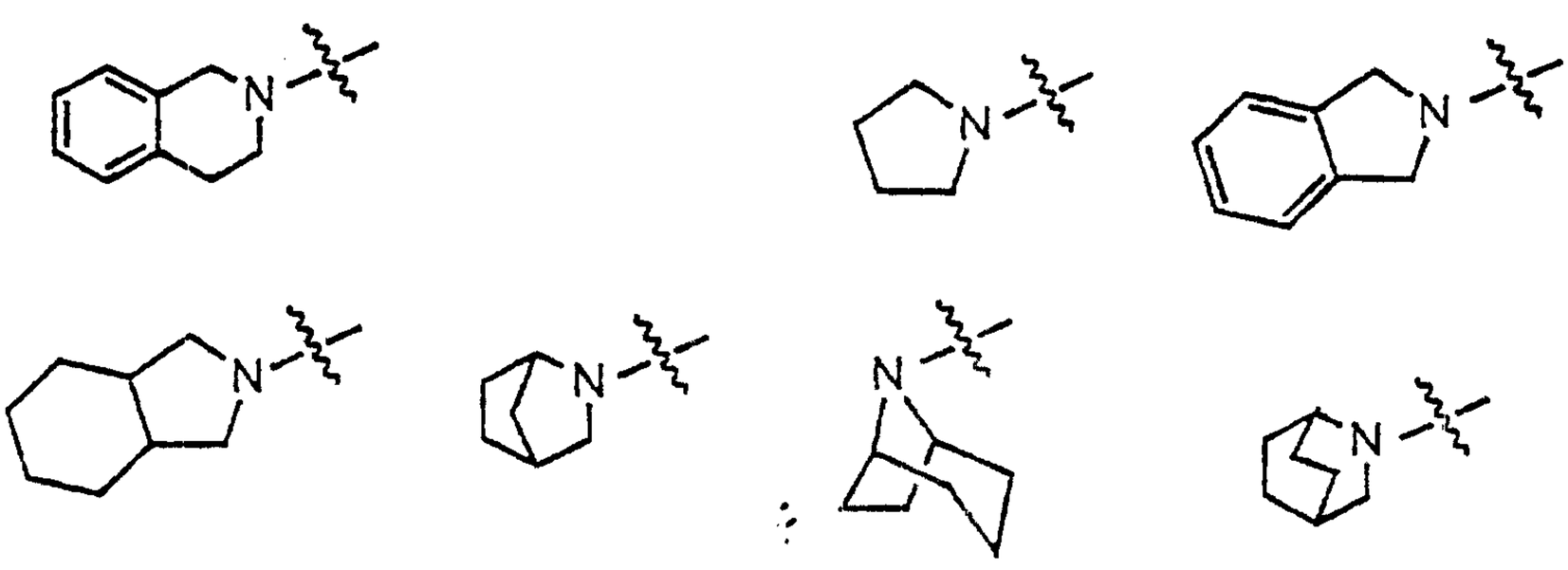
2. Compound of Claim 1

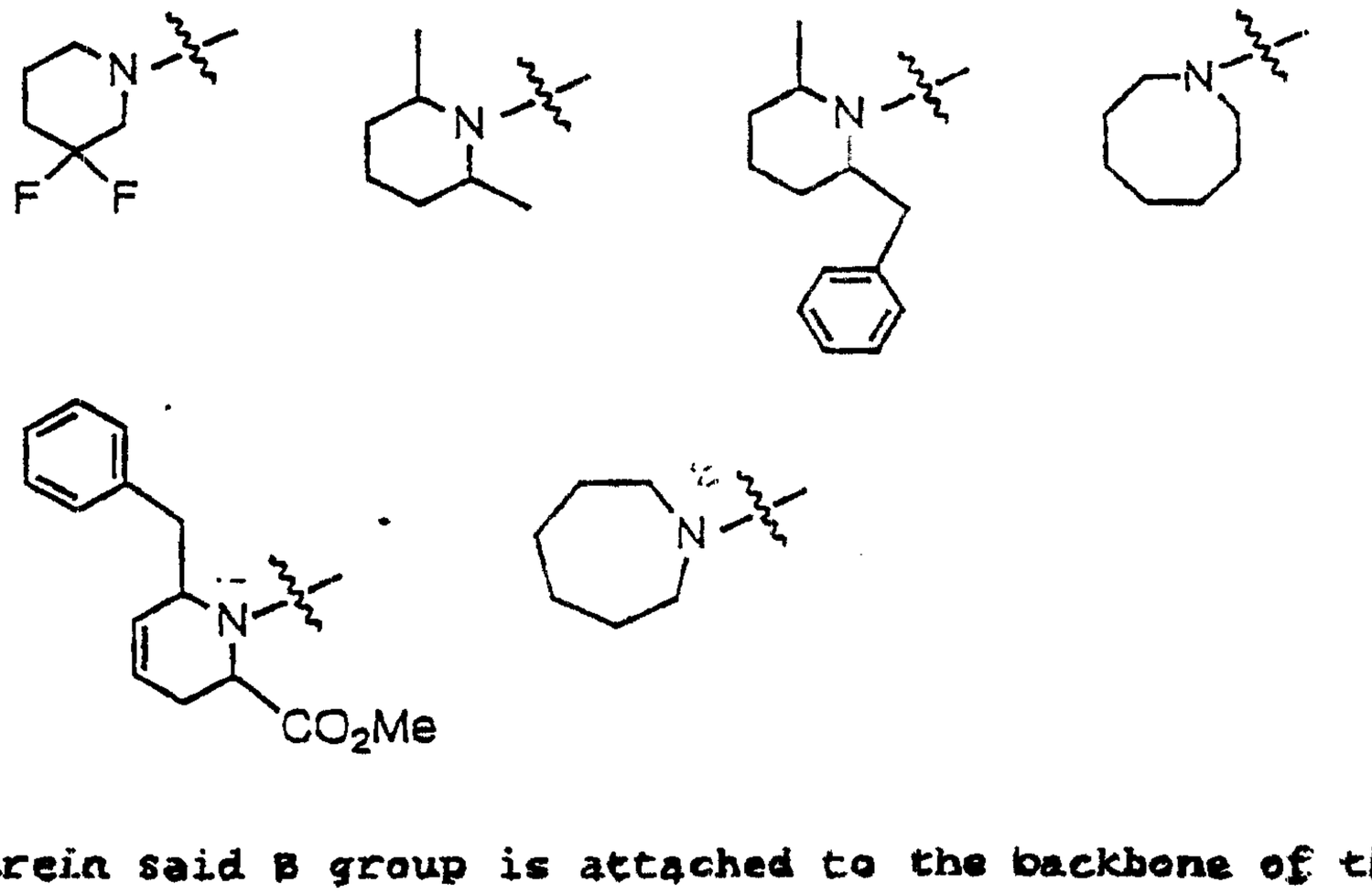
wherein B is a heterocyclic ring system selected from piperidinyl, 4-oxopiperidinyl, azacycloheptanyl, azacyclooctanyl, azocyclononanyl, azetidinyl, 3,3-difluoropiperidinyl, 4,4-difluoropiperidinyl, delta-3-piperidinyl, 1,2,3,4-tetrahydroisoquinolinyl, N-methylpiperidinyl, pyrrolidinyl, isoindolyl, perhydroisoindolyl, 2-azabicyclo[2.2.1]heptanyl, normethyltropanyl, 2-azabicyclo[2.2.2]octanyl, benzomorphanyl, 3-azabicyclo[3.2.2]nonanyl, perhydrobenzomorphanyl, 2,6-methylpiperidinyl, 2-methyl-6-benzylpiperidinyl and methyl delta-4-6-benzylpipecolyl, and wherein any of said heterocyclic ring systems may be fused to a benzene or cyclohexane ring, wherein

any substitutable position of B may be optionally substituted with one or more radicals selected from C_1-C_{20}-alkyl, C_1-C_{10}-alkoxy, C_2-C_{20}-alkenyl, C_2-C_{10}-alkynyl, halo, trifluoromethyl, oxo, cyano and phenyl, and wherein the nitrogen atom ring member of B may be combined with oxygen to form an N-oxide; or a pharmaceutically-acceptable salt thereof.

3. Compound of Claim 2 wherein B is a heterocyclic ring system selected from the group consisting of;







wherein said B group is attached to the backbone of the structure of Formula I through the bond on each B group bisected by the wavy line, and wherein any

substitutable position may be optionally substituted with one or more radicals selected from C_1-C_{20}-alkyl, C_1-C_{10}-alkoxy, C_2-C_{20}-alkenyl, C_2-C_{10}-alkynyl, halo, trifluoromethyl, oxo, cyano and phenyl, and wherein the nitrogen atom ring member of B may be combined with oxygen to form an N-oxide;

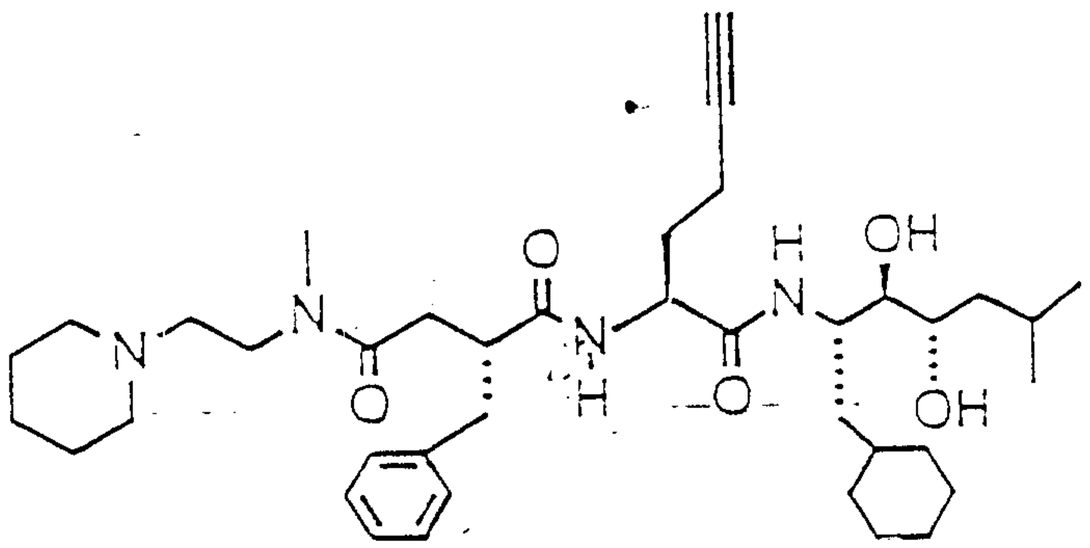
wherein R_3 is selected from isobutyl, cyclopropyl and cyclopropylmethyl; or a pharmaceutically-acceptable salt thereof.

4. Compound of Claim 3 which is N^1-[1R*-[[[1S,1R*-(cyclohexylmethyl)-2S*,3R*-dihydroxy-5-methylhexyl]amino]carbonyl]-3-butynyl]-N^4-methyl-2S*-(phenylmethyl)-N^4-[2-(1-piperidinyl)ethyl]butanediamide or a pharmaceutically-acceptable salt thereof.

5. Compound of Claim 3 which is N^1-[1R*-[[[1S,1R*-(cyclohexylmethyl)-2S*,3R*-dihydroxy-5-methylhexyl]amino]carbonyl]-3-butynyl]-N^4-[2-(1,3-dihydro-2H-isoindol-2-y1)ethyl]-N^4-methyl-2S*-(phenylmethyl)butanediamide or a pharmaceutically-acceptable salt thereof.

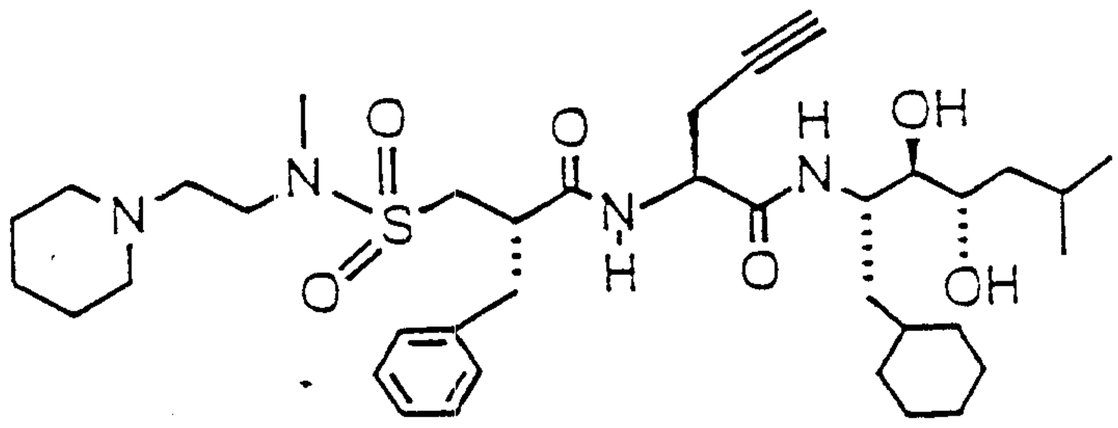
6. Compound of Claim 3 which is N^1-[1R*-(((1S,1R*-(cyclohexylmethyl)-2S*,3R*-dihydoxy-5-methylhexyl)amino)carbonyl)-3-butynyl)-N^4-methyl-2S*-(phenylmethyl)-N^4-(2-(N-3-azabicyclo(3.2.2)nonanyl)-ethyl) butanediamide or a pharmaceutically-acceptable salt thereof.

7. Compound of Claim 3 which is



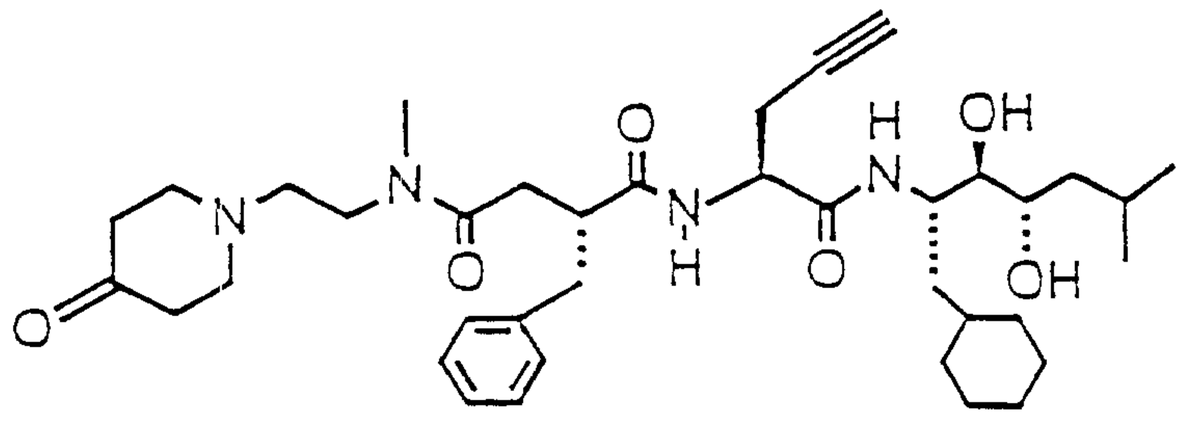
or a pharmaceutically-acceptable salt thereof.

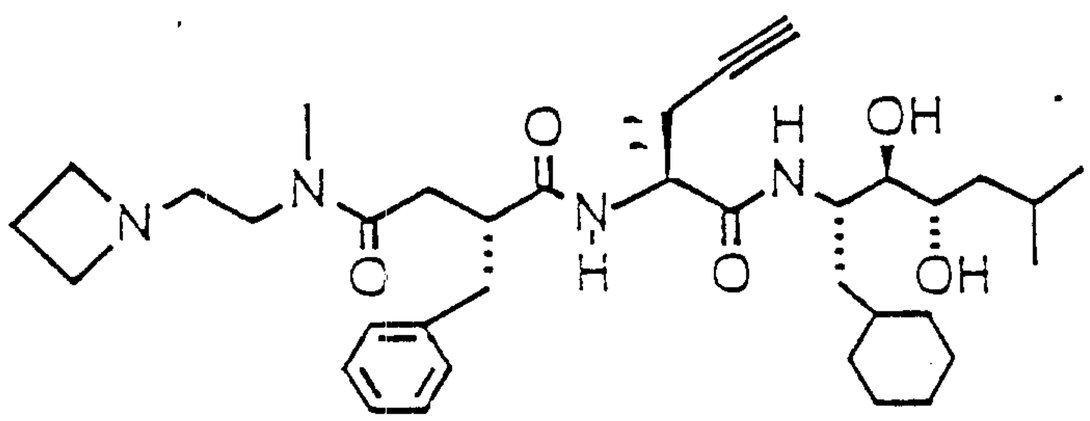
8. Compound of claim 3 which is

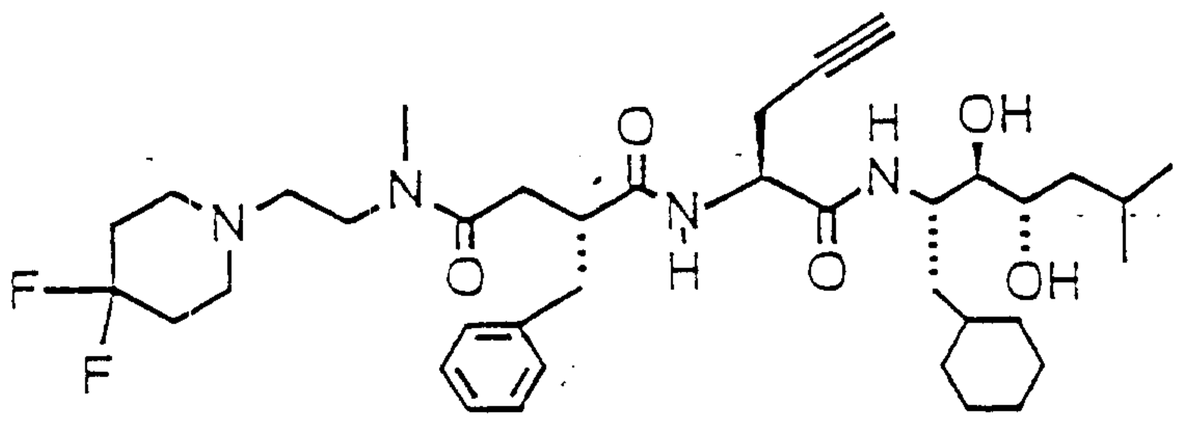


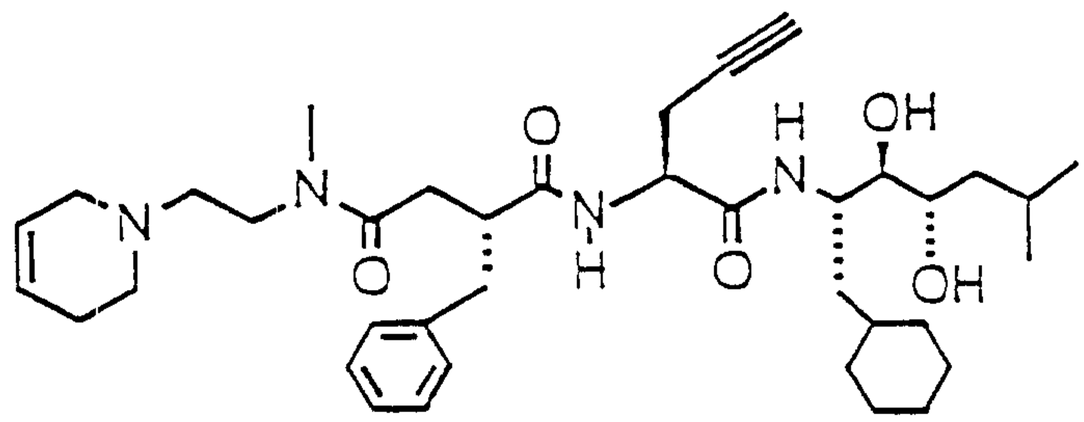
or a phramaceutically-acceptable salt thereof.

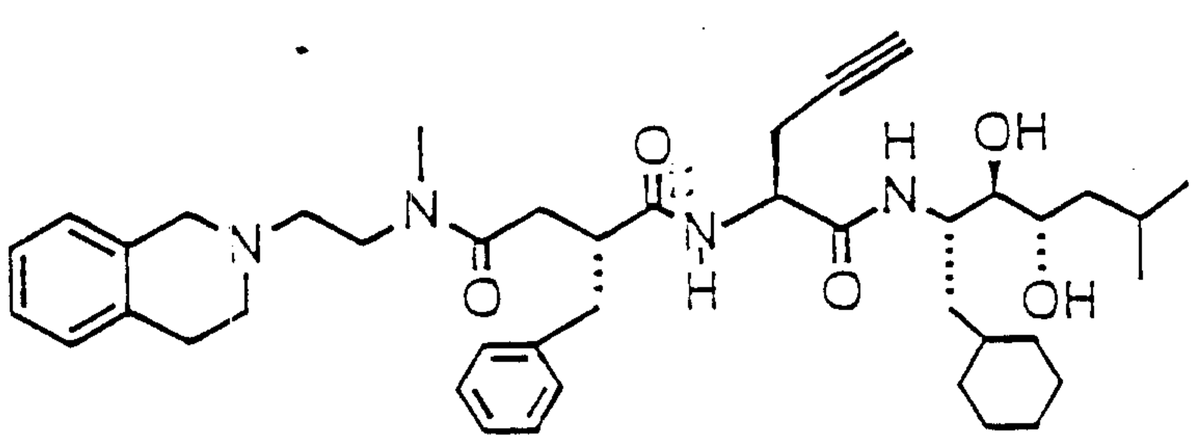
9. Compound of Claim 3 selected from compounds, their tautomers, and the pharmaceutically-acceptable salts thereof, of the group consisting of











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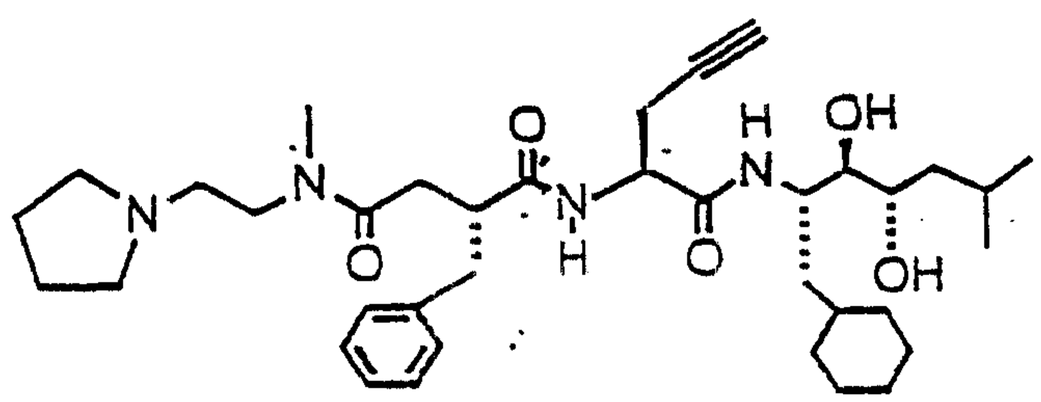

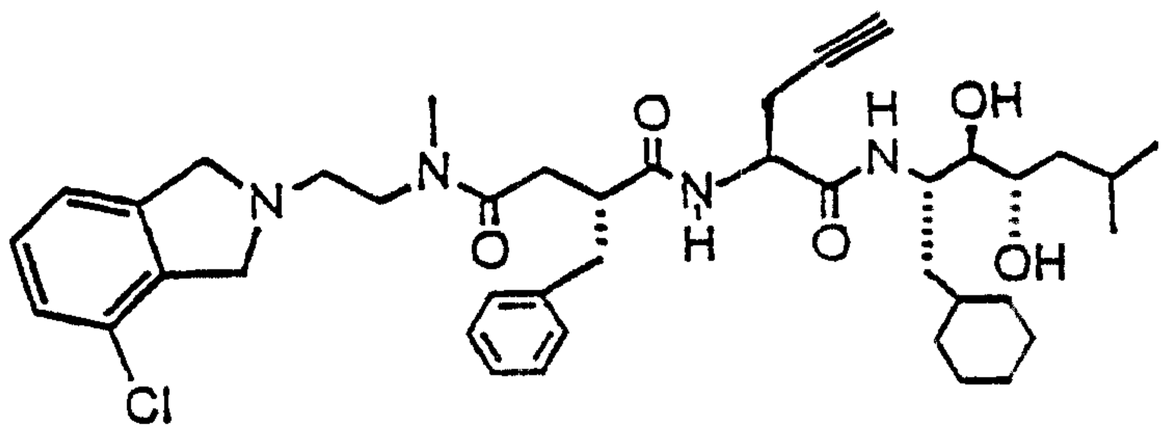

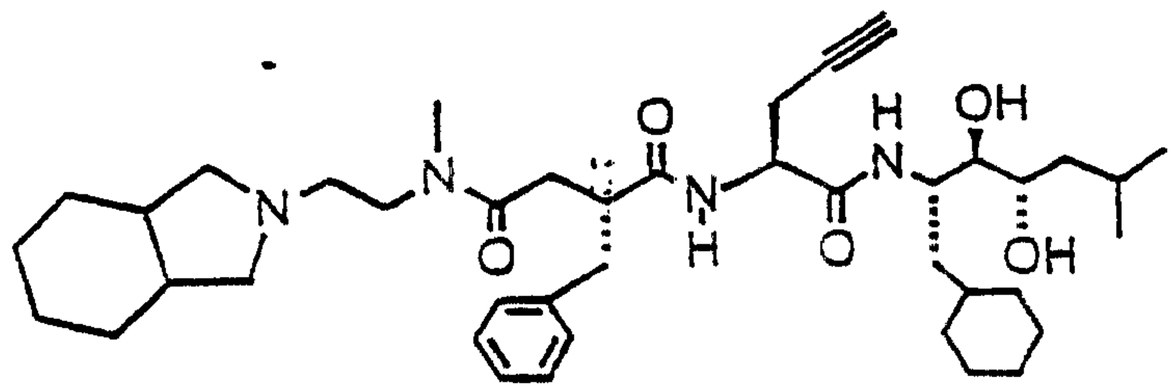

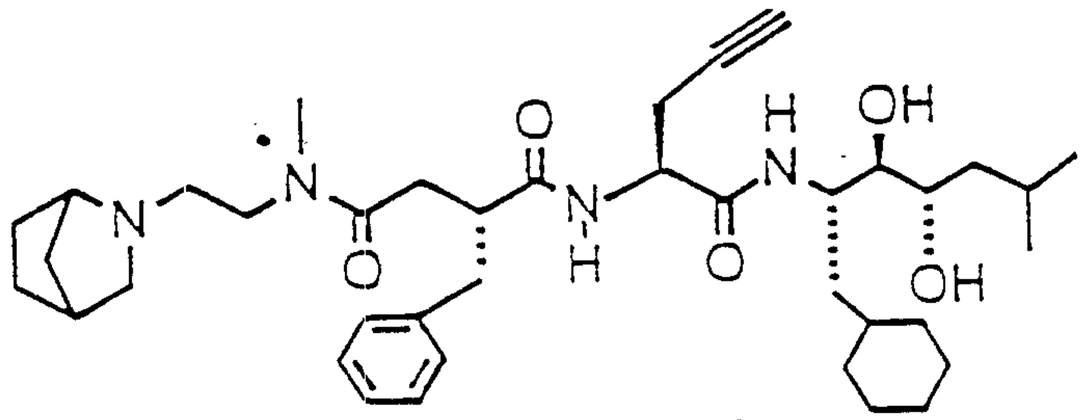

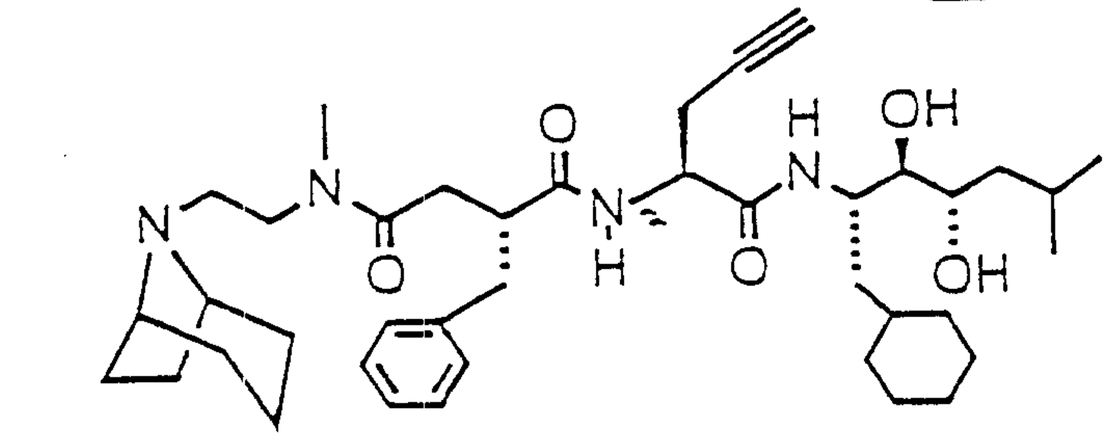

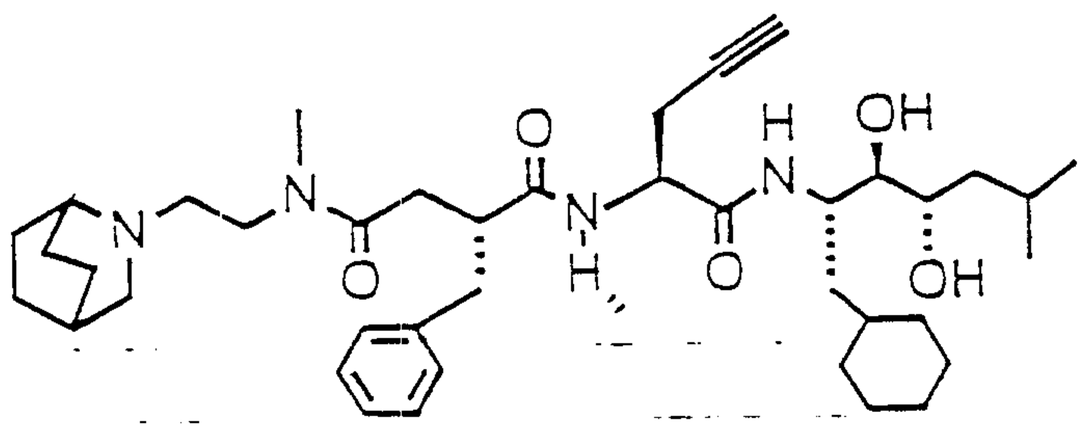

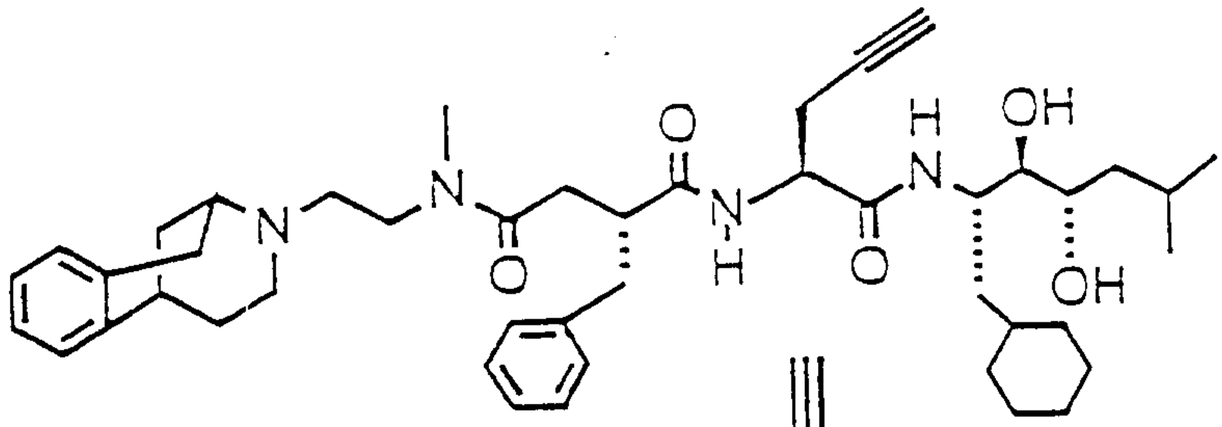

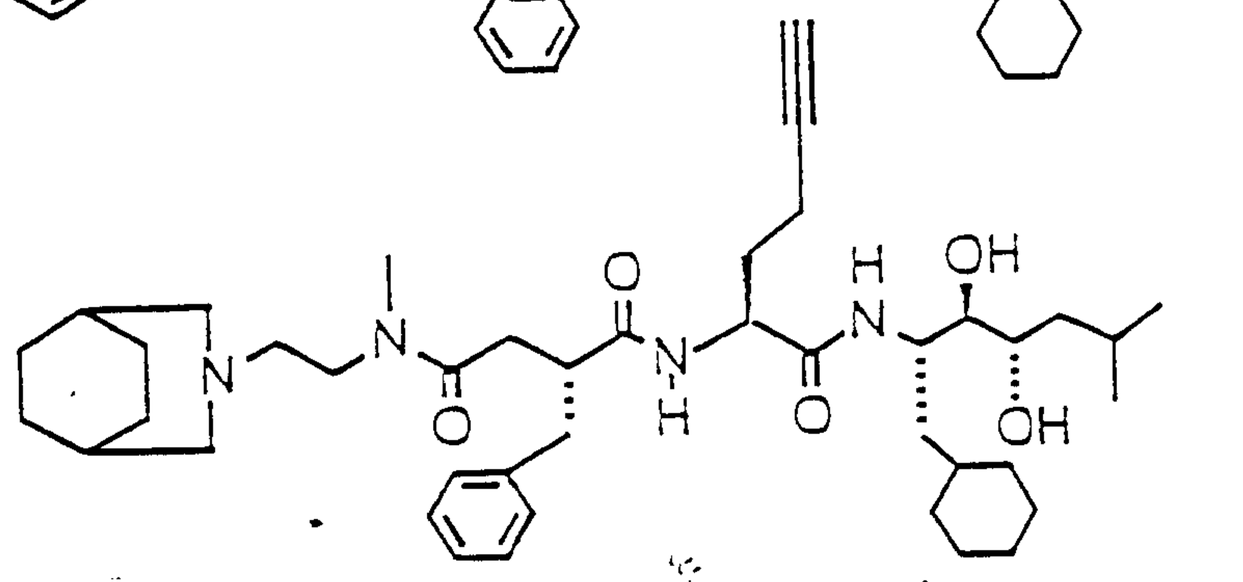

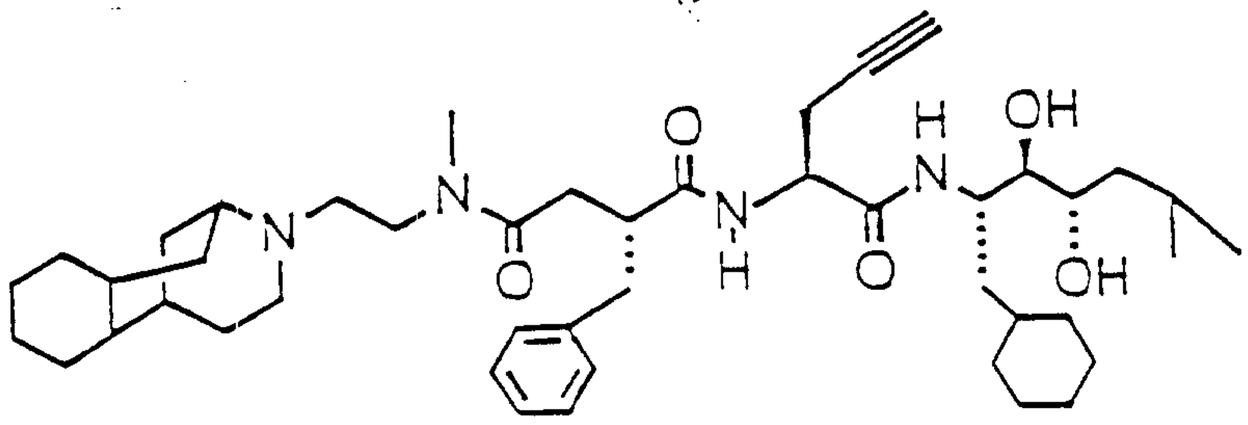

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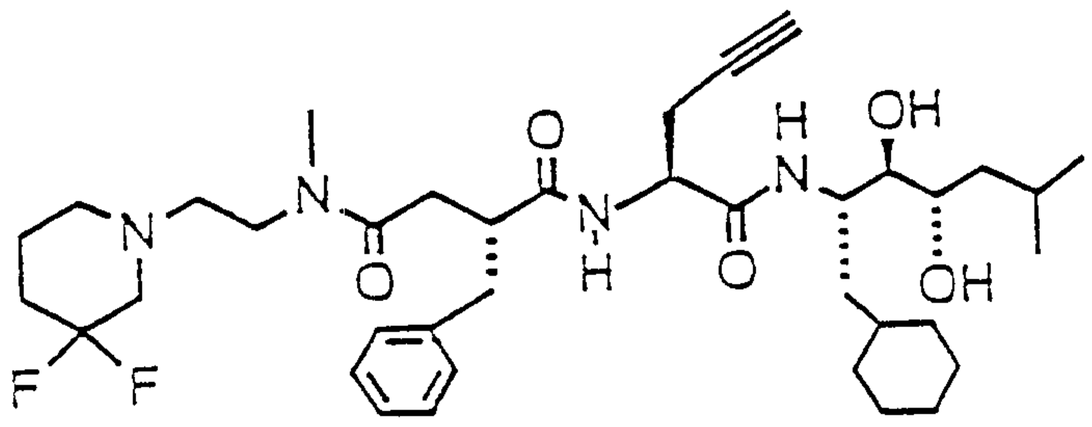

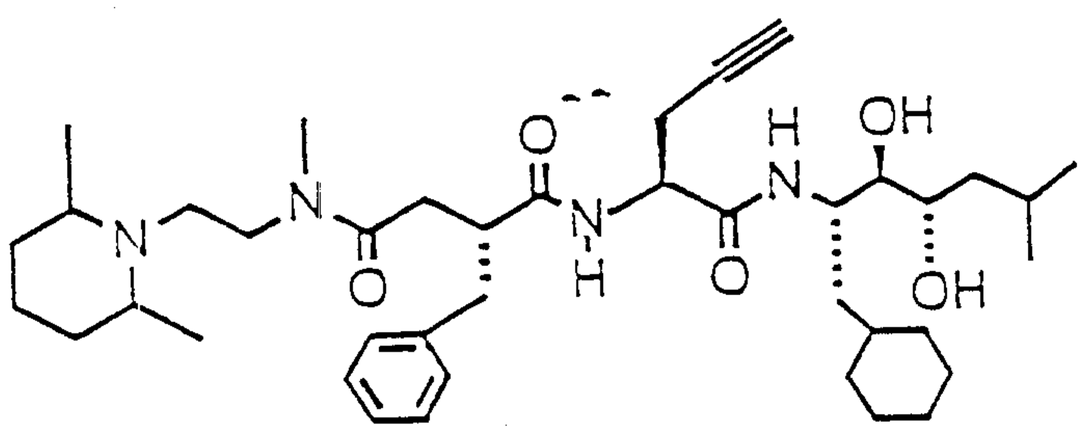

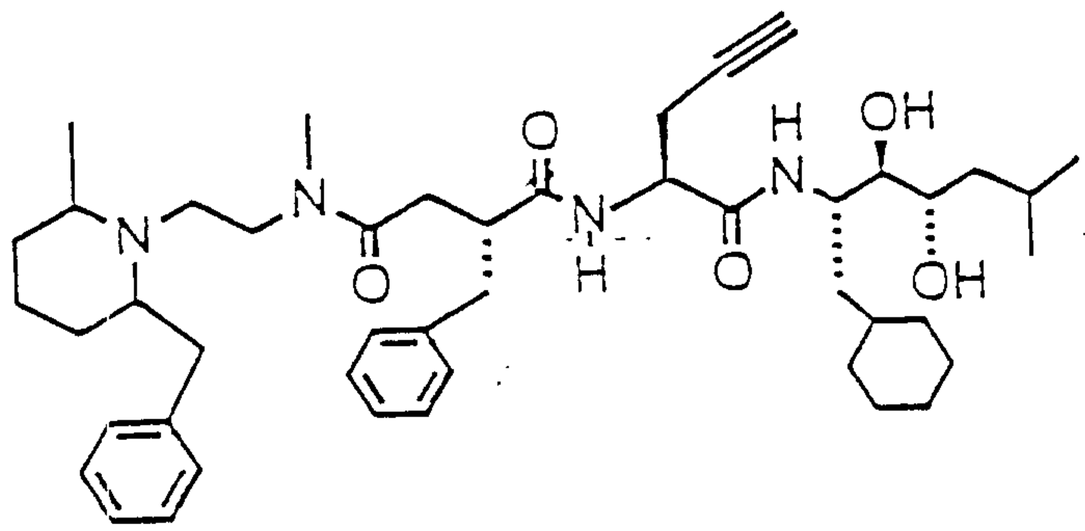

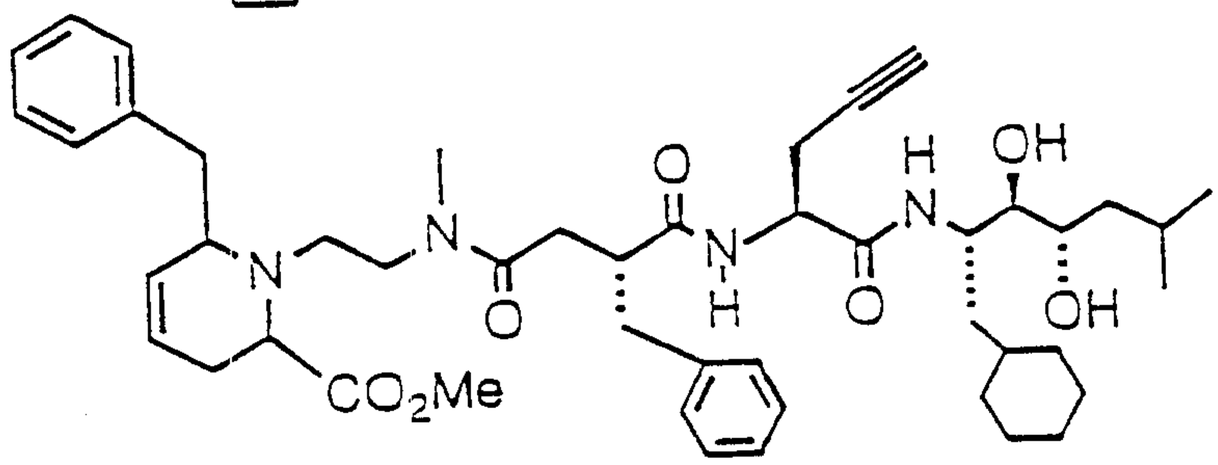

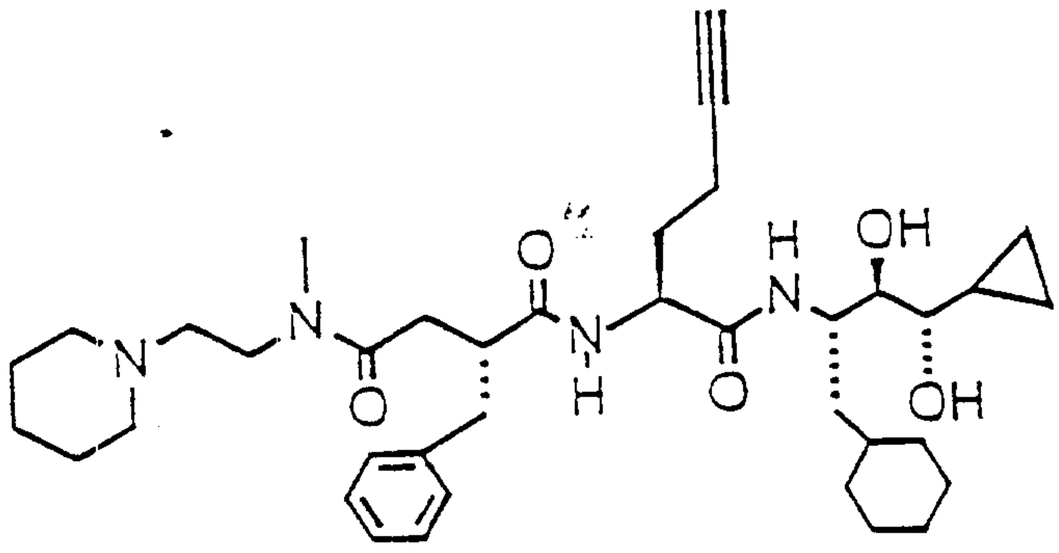

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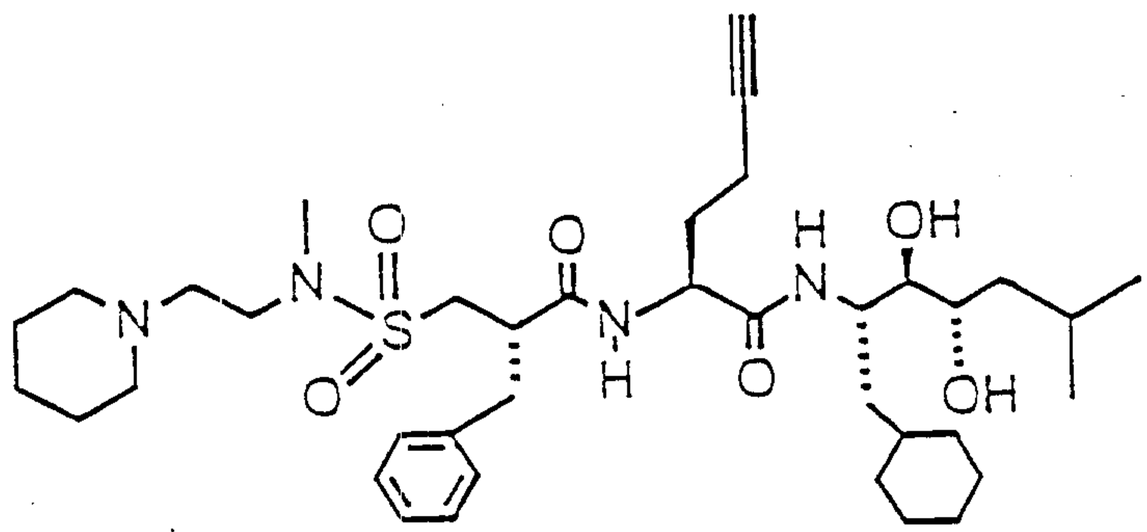

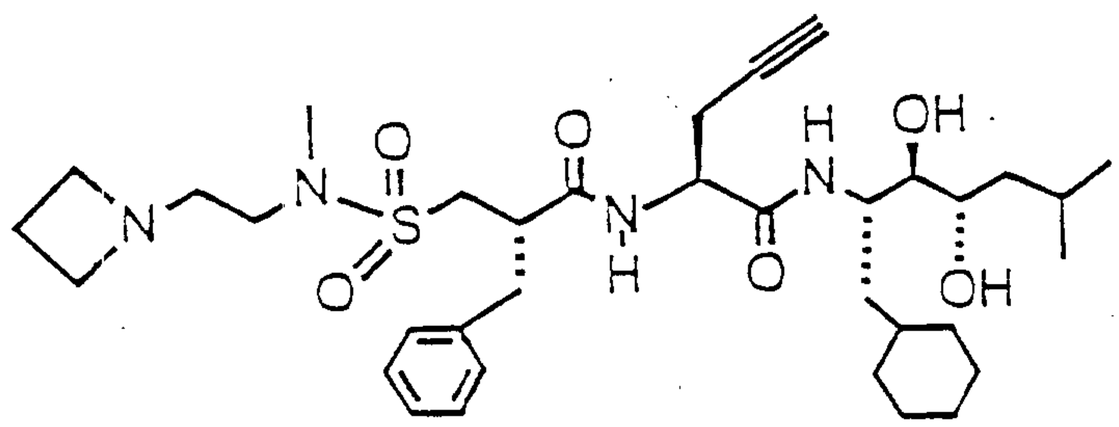

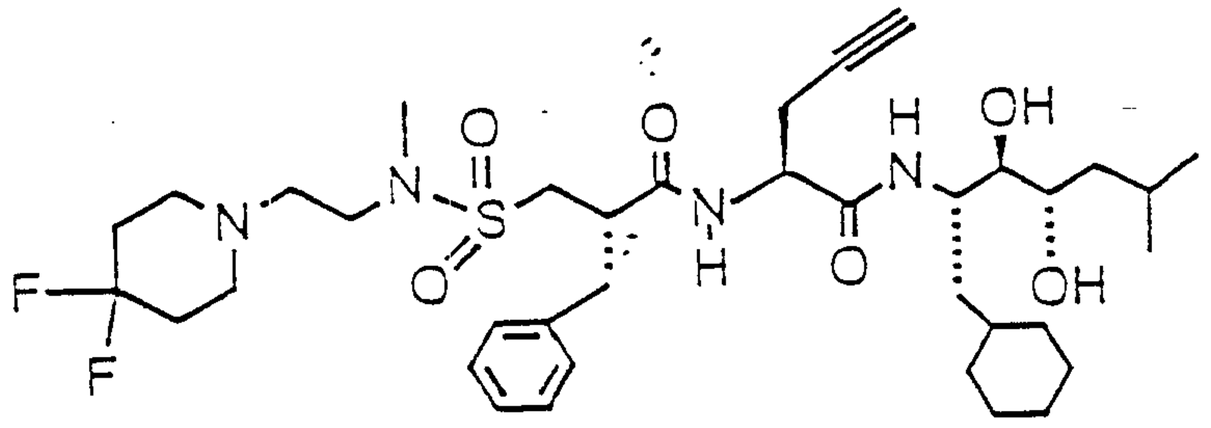

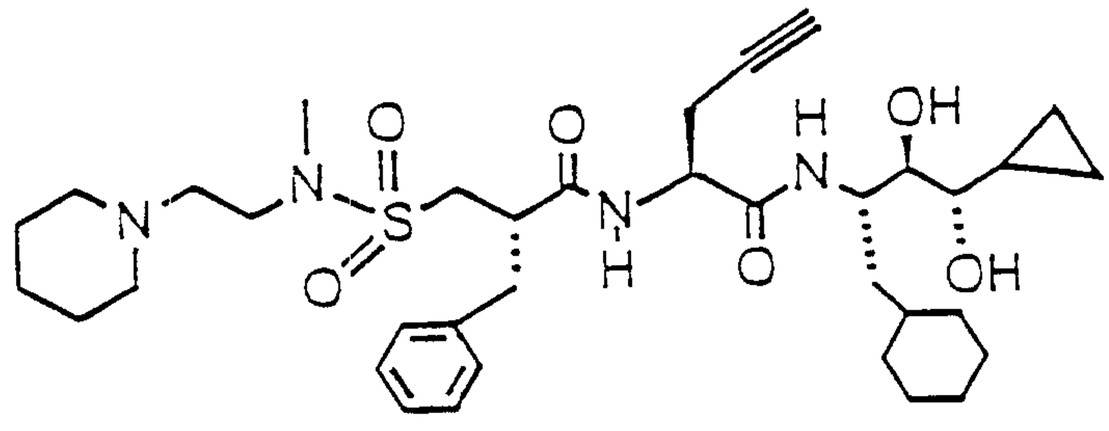

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10. A pharmaceutical composition comprising a therapeutically-effective amount of a renin-inhibiting compound and a pharmaceutically-acceptable carrier or diluent, said renin-inhibiting compound selected from a family of compounds according to any of Claims 1-9.

11. Use of a compound according to any of Claims 1-9 for preparing a medicament for treating a circulatory-related disorder.

12. Use according to Claim 11 wherein said circulatory-related disorder is a cardiovascular disorder.

13. Use according to Claim 12 wherein said cardiovascular disorder is hypertension.

14. Use according to Claim 12 wherein said cardiovascular disorder is congestive heart failure.

15. Use according to Claim 11 wherein said circulatory-related disorder is glaucoma.

16. Use according to Claim 11 wherein said circulatory-related disorder is renal failure.

AMENDED SHEET