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(74) Agents: LEW, Belinda et al.; Wilmer Cutler Pickering
Hale and Dorr LLP, 1875 Pennsylvania Avenue, NW,
Washington, DC 20006 (US).

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(71) Applicant (*for all designated States except US*): NITROMED, INC. [US/US]; 125 Spring Street, Lexington, MA 02421-7801 (US).

(72) Inventors; and

(75) Inventors/Applicants (*for US only*): GARVEY, David, S. [US/US]; 10 Grand Hill Drive, Dover, MA 02030 (US). CAI, Xiong [US/US]; 26 Concord Avenue, Belmont, MA 02478 (US). FANG, Xinqin [US/US]; 77 Bow Street, Lexington, MA 02420 (US). RANATUNGE, Ramani, R. [US/US]; 11 Bates Road, Lexington, MA 02421 (US). WEY, Shiow-Jyi [CN/US]; 10 Charnstaffe Lane, Unit 302, Billerica, MA 01821 (US). ZHAI, Hai-Xiao [US/US]; 283 South Road, Bedford, MA 01730 (US).

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(54) Title: NITRIC OXIDE ENHANCING ANGIOTENSIN II ANTAGONIST COMPOUNDS, COMPOSITIONS AND METHODS OF USE

(57) Abstract: The invention describes compositions and kits comprising at least one nitric oxide enhancing angiotensin II antagonist compound, or pharmaceutically acceptable salts thereof, and novel compositions comprising at least one nitric oxide enhancing angiotensin II antagonist compound, and, optionally, at least one nitric oxide enhancing compound and/or at least one therapeutic agent. The invention also provides methods for (a) treating cardiovascular diseases; (b) treating renovascular diseases; (c) treating diabetes; (d) treating diseases resulting from oxidative stress; (e) treating endothelial dysfunctions; (f) treating diseases caused by endothelial dysfunctions; (g) treating cirrhosis; (h) treating pre-eclampsia; (j) treating osteoporosis; (k) treating nephropathy; (l) treating peripheral vascular diseases; (m) treating portal hypertension (o) treating central nervous system disorders; (p) treating metabolic syndrome; and (q) treating hyperlipidemia. The nitric oxide enhancing angiotensin II antagonist compounds comprise at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound through one or more sites such as carbon, oxygen and/or nitrogen via a bond or moiety that cannot be hydrolyzed.

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NITRIC OXIDE ENHANCING ANGIOTENSIN II ANTAGONIST COMPOUNDS, COMPOSITIONS AND METHODS OF USE

RELATED APPLICATIONS

5 This application claims priority under 35 USC § 119 to U.S. Application No. 60/706,005 filed August 8, 2005; U.S. Application No. 60/706,419 filed August 9, 2005; and to U.S. Application No. 60/748,579 filed December 9, 2005.

FIELD OF THE INVENTION

10 The invention describes compositions and kits comprising at least one nitric oxide enhancing angiotensin II antagonist compound, or pharmaceutically acceptable salts thereof, and novel compositions comprising at least one nitric oxide enhancing angiotensin II antagonist compound, and, optionally, at least one nitric oxide enhancing compound and/or at least one therapeutic agent. The invention also provides methods for (a) treating cardiovascular diseases; (b) treating renovascular diseases; (c) treating diabetes; (d) treating
15 diseases resulting from oxidative stress; (e) treating endothelial dysfunctions; (f) treating diseases caused by endothelial dysfunctions; (g) treating cirrhosis; (h) treating pre-eclampsia; (j) treating osteoporosis; (k) treating nephropathy; (l) treating peripheral vascular diseases; (m) treating portal hypertension (o) treating central nervous system disorders; (p) treating metabolic syndrome; and (q) treating hyperlipidemia. The nitric oxide enhancing angiotensin
20 II antagonist compounds comprise at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound through one or more sites such as carbon, oxygen and/or nitrogen via a bond or moiety that cannot be hydrolyzed.

BACKGROUND OF THE INVENTION

25 The decline in cardiovascular morbidity and mortality in the United States over the past three decades has been the result of significant advances in research on cardiovascular disease mechanisms and therapeutic strategies. The incidence and prevalence of myocardial infarction and death from myocardial infarction, as well as that from cerebrovascular accident, have decreased significantly over this period largely owing to advances in prevention, early diagnosis, and treatment of these very common diseases.

30 The compounds administered for the treatment of diuresis, cardiovascular diseases, and diseases resulting from oxidative and/or endothelial dysfunctions often result in toxic, chronic and/or debilitating side effects. Cardiovascular compounds such as ACE inhibitors, beta-adrenergic blockers, antithrombotic and vasodilator compounds or anti-hyperlipidemic

compounds, show, for example, respiratory toxicity resulting in asthma and/or bronchitis. Hence there is a need in the art for compounds that have improved efficacy, lower toxicity and that can be used at low dosages. The invention is directed to these, as well as other, important ends.

SUMMARY OF THE INVENTION

The invention provides novel nitric oxide enhancing angiotensin II antagonist compounds, and pharmaceutically acceptable salts thereof, comprising at least one nitric oxide enhancing group selected from an -ONO group, an -SNO group, an -NNO group, an -ONO₂ group, an -SNO₂ group, an -NNO₂ group, an -(N₂O₂-)•M₁⁺ group, a heterocyclic nitric oxide donor group and a nitroxide group; where the nitric oxide enhancing group is directly or indirectly linked to the angiotensin II antagonist compound through one or more sites such as carbon, oxygen, nitrogen and/or sulfur via a bond or moiety that cannot be hydrolyzed. In one embodiment, the heterocyclic nitric oxide donors are furoxans, sydnonimines, oxatriazole-5-ones and/or oxatriazole-5-imines. The nitric oxide enhancing angiotensin II antagonist compounds are not pro-drugs of the parent angiotensin II antagonist compound. The invention also provides compositions comprising the novel compounds described herein in a pharmaceutically acceptable carrier.

The invention is also based on the discovery that administering at least one angiotensin II antagonist compound comprising at least one nitric oxide enhancing group selected from an -ONO group, an -SNO group, an -NNO group, an -ONO₂ group, an -SNO₂ group, an -NNO₂ group, an -(N₂O₂-)•M₁⁺ group, a heterocyclic nitric oxide donor group and a nitroxide group; where the nitric oxide enhancing group is linked to the angiotensin II antagonist compound through one or more sites such as carbon, oxygen, nitrogen and/or sulfur via a bond or moiety that cannot be hydrolyzed, or a pharmaceutically acceptable salt thereof, and, optionally, at least one nitric oxide enhancing compound improves the properties of the angiotensin II antagonist compound. Nitric oxide enhancing compounds include, for example, S-nitrosothiols, nitrites, nitrates, N-oxo-N-nitrosamines, furoxans, sydnonimines, SPM 3672, SPM 4757, SPM 5185, SPM 5186 and analogues thereof, substrates of the various isozymes of nitric oxide synthase, and nitroxides. Thus, another embodiment of the invention provides compositions comprising at least one nitric oxide enhancing angiotensin II antagonist compound and at least one nitric oxide enhancing compound. The invention also provides for such compositions in a pharmaceutically acceptable carrier.

The invention provides compositions comprising at least one nitric oxide enhancing angiotensin II antagonist compound, and, optionally, at least one nitric oxide enhancing compound and/or at least one therapeutic agent, including, but not limited to, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs), phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, steroids, and combinations of two or more thereof. In one embodiment the at least one therapeutic agent is selected from the group consisting of an aldosterone antagonist, an angiotensin II antagonist, an angiotensin-converting enzyme (ACE) inhibitors, a β -adrenergic antagonist, a digitalis, a diuretic, and a hydralazine compound. The invention also provides for such compositions in a pharmaceutically acceptable carrier.

Another embodiment of the invention provides compositions comprising an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and at least one therapeutic agent selected from the group consisting of an aldosterone antagonist, an angiotensin II antagonist, an angiotensin-converting enzyme (ACE) inhibitor, a β -adrenergic antagonist, a diuretic and a hydralazine compound. The invention also provides for such compositions in a pharmaceutically acceptable carrier.

The invention provides methods for (a) treating cardiovascular diseases; (b) treating renovascular diseases; (c) treating diabetes; (d) treating diseases resulting from oxidative stress; (e) treating endothelial dysfunctions; (f) treating diseases caused by endothelial dysfunctions; (g) treating cirrhosis; (h) treating pre-eclampsia; (j) treating osteoporosis; (k) treating nephropathy; (l) treating peripheral vascular diseases; (m) treating portal hypertension; (o) treating central nervous system disorders; (p) treating metabolic syndrome; and (q) treating hyperlipidemia in a patient in need thereof comprising administering to the patient an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and, optionally, at least one therapeutic agent, such as, for example, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic

compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs),
5 phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, steroids, and combinations of two or more thereof. The methods can optionally further comprise the administration of at least one nitric oxide enhancing compound. In this embodiment of the invention, the methods can involve (i) administering the nitric oxide
10 enhancing angiotensin II antagonist compounds, (ii) administering the nitric oxide enhancing angiotensin II antagonist compounds, and nitric oxide enhancing compounds, (iii) administering the nitric oxide enhancing angiotensin II antagonist compounds and therapeutic agents, or (iv) administering the nitric oxide enhancing angiotensin II antagonist compounds, nitric oxide enhancing compounds, and therapeutic agents. In one embodiment the at least
15 one therapeutic agent is selected from the group consisting of an aldosterone antagonist, an angiotensin II antagonist, an angiotensin-converting enzyme (ACE) inhibitor, a β -adrenergic antagonist, a diuretic, and a hydralazine compound. The nitric oxide enhancing angiotensin II antagonist compounds, nitric oxide enhancing compounds, and/or therapeutic agents can be administered separately or as components of the same composition in one or more
20 pharmaceutically acceptable carriers.

Another embodiment of the invention provides kits comprising at least one nitric oxide enhancing angiotensin II antagonist compound, and, optionally, at least one nitric oxide enhancing compound. The kit can further comprise at least one therapeutic agent, such as, for example, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II
25 antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs),
30 phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, steroids, and combinations of two or more thereof. The nitric oxide enhancing angiotensin II antagonist compound, the nitric oxide enhancing compound and/or therapeutic

agent, can be separate components in the kit or can be in the form of a composition in one or more pharmaceutically acceptable carriers.

These and other aspects of the invention are described in detail herein.

DETAILED DESCRIPTION OF THE INVENTION

5 As used throughout the disclosure, the following terms, unless otherwise indicated, shall be understood to have the following meanings.

"Cardiovascular disease or disorder" refers to any cardiovascular disease or disorder known in the art, including, but not limited to, heart failure, restenosis, hypertension (e.g. pulmonary hypertension, labile hypertension, idiopathic hypertension, low-renin
10 hypertension, salt-sensitive hypertension, low-renin, salt-sensitive hypertension, thromboembolic pulmonary hypertension; pregnancy-induced hypertension; renovascular hypertension; hypertension-dependent end-stage renal disease, hypertension associated with cardiovascular surgical procedures, hypertension with left ventricular hypertrophy, and the like), diastolic dysfunction, coronary artery disease, myocardial infarctions, cerebral
15 infarctions, atherosclerosis, atherogenesis, cerebrovascular disease, angina, (including chronic, stable, unstable and variant (Prinzmetal) angina pectoris), aneurysm, ischemic heart disease, cerebral ischemia, myocardial ischemia, thrombosis, platelet aggregation, platelet adhesion, smooth muscle cell proliferation, vascular or non-vascular complications associated with the use of medical devices, wounds associated with the use of medical devices, vascular
20 or non-vascular wall damage, peripheral vascular disease, neointimal hyperplasia following percutaneous transluminal coronary angiograph, vascular grafting, coronary artery bypass surgery, thromboembolic events, post-angioplasty restenosis, coronary plaque inflammation, hypercholesterolemia, embolism, stroke, shock, arrhythmia, atrial fibrillation or atrial flutter, thrombotic occlusion and reclusion cerebrovascular incidents, left ventricular dysfunction and
25 hypertrophy, and the like.

"Heart failure" includes, but is not limited to congestive heart failure, compensated heart failure, decompensated heart failure, and the like.

"Thromboembolic events" include, but are not limited to, ischemic stroke, transient ischemic stroke, myocardial infarction, angina pectoris, thrombosis (for example, restenosis,
30 arterial thrombosis, coronary thrombosis, heart valve thrombosis, coronary stenosis, stent thrombosis, graft thrombosis, and first and subsequent thrombotic stroke, and the like), thromboembolism (for example, pulmonary thromboembolism, cerebral thromboembolism, and the like), thrombophlebitis, thrombocytopenia, bleeding disorders, thrombotic occlusion

and reocclusion and acute vascular events. Patients who are at risk of developing thromboembolic events, may include those with a familial history of, or genetically predisposed to, thromboembolic disorders, who have had ischemic stroke, transient ischemic stroke, myocardial infarction, and those with unstable angina pectoris or chronic stable angina pectoris and patients with altered prostacyclin/thromboxane A₂ homeostasis or higher than normal thromboxane A₂ levels leading to increase risk for thromboembolism, including patients with diabetes and rheumatoid arthritis.

“Diseases resulting from oxidative stress” refers to any disease that involves the generation of free radicals or radical compounds, such as, for example, atherogenesis, atheromatosis, arteriosclerosis, atherosclerosis, vascular hypertrophy associated with hypertension, hyperlipoproteinaemia, normal vascular degeneration through aging, parathyroidal reactive hyperplasia, renal disease (e.g., acute or chronic), neoplastic diseases, inflammatory diseases, neurological and acute bronchopulmonary disease, tumorigenesis, ischemia-reperfusion syndrome, arthritis, sepsis, cognitive dysfunction, endotoxic shock, endotoxin-induced organ failure, and the like.

“Renovascular diseases” refers to any disease or dysfunction of the renal system including, but not limited to, renal failure (e.g., acute or chronic), renal insufficiency, nephrotic edema, acute glomerulonephritis, oliguric renal failure, renal deterioration associated with severe hypertension, unilateral perichymal renal disease, polycystic kidney disease, chronic pyelonephritis, renal diseases associated with renal insufficiency, complications associated with dialysis or renal transplantation, renovascular hypertension, nephropathy, glomerulonephritis, scleroderma, glomerular sclerosis, and the like.

“Endothelial dysfunction” refers to the impaired ability in any physiological processes carried out by the endothelium, in particular, production of nitric oxide regardless of cause. It may be evaluated by, such as, for example, invasive techniques, such as, for example, coronary artery reactivity to acetylcholine or methacholine, and the like, or by noninvasive techniques, such as, for example, blood flow measurements, brachial artery flow dilation using cuff occlusion of the arm above or below the elbow, brachial artery ultrasonography, imaging techniques, measurement of circulating biomarkers, such as, asymmetric dimethylarginine (ADMA), and the like. For the latter measurement the endothelial-dependent flow-mediated dilation will be lower in patients diagnosed with an endothelial dysfunction.

“Methods for treating endothelial dysfunction” include, but are not limited to,

treatment prior to the onset/diagnosis of a disease that is caused by or could result from endothelial dysfunction, such as, for example, atherosclerosis, hypertension, diabetes, heart failure, and the like.

“Methods for treating diseases caused by endothelial dysfunction” include, but are not limited to, the treatment of any disease resulting from the dysfunction of the endothelium, such as, for example, arteriosclerosis, heart failure, hypertension, cardiovascular diseases, cerebrovascular diseases, renovascular diseases, mesenteric vascular diseases, pulmonary vascular diseases, ocular vascular diseases, peripheral vascular diseases, peripheral ischemic diseases, and the like.

“Central nervous system disorders” include, but are not limited to, any disorder that is responsive to the positive modulation of the AMPA receptor, such as, for example, neurodegenerative disorders, cognitive or memory dysfunctions, memory and learning disorders, attention disorders, Alzheimer’s disease, depression, schizophrenia, memory loss, dementia, senile dementia, learning deficit, attention deficit, cognitive deficit, psychotic disorders, intellectual impairment disorders, autism, disorders resulting from neurotoxic agents, alcohol intoxication or substance abuse, and the like.

“Metabolic syndrome” also known as “insulin-resistance syndrome” or “syndrome X” refers to a condition characterized by an increased amount of adipose tissue inside the abdominal cavity, insulin resistance with increased risk of developing senile diabetes, i.e. diabetes type II, high levels of blood fats and high blood pressure.

“Therapeutic agent” includes any therapeutic agent that can be used to treat or prevent the diseases described herein. “Therapeutic agents” include, for example, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs), phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, and the like. Therapeutic agent includes the pharmaceutically acceptable salts thereof, pro-drugs, and pharmaceutical derivatives thereof including, but not limited to, the corresponding nitrosated and/or nitrosylated and/or heterocyclic nitric oxide donor derivatives

and/or nitroxide derivative. Although nitric oxide enhancing compounds have therapeutic activity, the term "therapeutic agent" does not include the nitric oxide enhancing compounds described herein, since nitric oxide enhancing compounds are separately defined.

"Prodrug" refers to a compound that is made more active *in vivo*.

5 "Antioxidant" refers to and includes any compound that can react and quench a free radical.

"Angiotensin converting enzyme (ACE) inhibitor" refers to compounds that inhibit an enzyme which catalyzes the conversion of angiotensin I to angiotensin II. ACE inhibitors include, but are not limited to, amino acids and derivatives thereof, peptides, including di- and tri-peptides, and antibodies to ACE which intervene in the renin-angiotensin system by inhibiting the activity of ACE thereby reducing or eliminating the formation of the pressor substance angiotensin II.

10 "Angiotensin II antagonists" refers to compounds which interfere with the function, synthesis or catabolism of angiotensin II. Angiotensin II antagonists include peptide compounds and non-peptide compounds, including, but not limited to, angiotensin II antagonists, angiotensin II receptor antagonists, agents that activate the catabolism of angiotensin II, and agents that prevent the synthesis of angiotensin I from angiotensin II. The renin-angiotensin system is involved in the regulation of hemodynamics and water and electrolyte balance. Factors that lower blood volume, renal perfusion pressure, or the concentration of sodium in plasma tend to activate the system, while factors that increase these parameters tend to suppress its function.

15 "Anti-hyperlipidemic compounds" refers to any compound or agent that has the effect of beneficially modifying serum cholesterol levels such as, for example, lowering serum low density lipoprotein (LDL) cholesterol levels, or inhibiting oxidation of LDL cholesterol, whereas high density lipoprotein (HDL) serum cholesterol levels may be lowered, remain the same, or be increased. Preferably, the anti-hyperlipidemic compound brings the serum levels of LDL cholesterol and HDL cholesterol (and, more preferably, triglyceride levels) to normal or nearly normal levels.

20 "Diuretic compound" refers to and includes any compound or agent that increases the amount of urine excreted by a patient.

30 "Neutral endopeptidase inhibitors" refers to and includes compounds that are antagonists of the renin angiotensin aldosterone system including compounds that are dual inhibitors of neutral endopeptidases and angiotensin converting (ACE) enzymes.

"Renin inhibitors" refers to compounds which interfere with the activity of renin.

"Phosphodiesterase inhibitor" or "PDE inhibitor" refers to any compound that inhibits the enzyme phosphodiesterase. The term refers to selective or non-selective inhibitors of cyclic guanosine 3',5'-monophosphate phosphodiesterases (cGMP-PDE) and cyclic adenosine 3',5'-monophosphate phosphodiesterases (cAMP-PDE).

"Platelet reducing agents" refers to compounds that prevent the formation of a blood thrombus via any number of potential mechanisms. Platelet reducing agents include, but are not limited to, fibrinolytic agents, anti-coagulant agents and any inhibitors of platelet function. Inhibitors of platelet function include agents that impair the ability of mature platelets to perform their normal physiological roles (i.e., their normal function, such as, for example, adhesion to cellular and non-cellular entities, aggregation, release of factors such as growth factors) and the like.

"Proton pump inhibitor" refers to any compound that reversibly or irreversibly blocks gastric acid secretion by inhibiting the H^+/K^+ -ATP ase enzyme system at the secretory surface of the gastric parietal cell.

"NSAID" refers to a nonsteroidal anti-inflammatory compound or a nonsteroidal anti-inflammatory drug. NSAIDs inhibit cyclooxygenase, the enzyme responsible for the biosyntheses of the prostaglandins and certain autocoid inhibitors, including inhibitors of the various isozymes of cyclooxygenase (including but not limited to cyclooxygenase-1 and -2), and as inhibitors of both cyclooxygenase and lipoxygenase.

"Cyclooxygenase-2 (COX-2) selective inhibitor" refers to a compound that selectively inhibits the cyclooxygenase-2 enzyme over the cyclooxygenase-1 enzyme. In one embodiment, the compound has a cyclooxygenase-2 IC_{50} of less than about 2 μM and a cyclooxygenase-1 IC_{50} of greater than about 5 μM , in the human whole blood COX-2 assay (as described in Brideau et al., *Inflamm Res.*, 45: 68-74 (1996)) and also has a selectivity ratio of cyclooxygenase-2 inhibition over cyclooxygenase-1 inhibition of at least 10, and preferably of at least 40. In another embodiment, the compound has a cyclooxygenase-1 IC_{50} of greater than about 1 μM , and preferably of greater than 20 μM . The compound can also inhibit the enzyme, lipoxygenase. Such selectivity may indicate an ability to reduce the incidence of common NSAID-induced side effects.

"Patient" refers to animals, preferably mammals, most preferably humans, and includes males and females, and children and adults.

"Topical" refers to the delivery of a compound by application to the body surface and

includes, but is not limited to, transdermal delivery and transmucosal delivery.

"Transdermal" refers to the delivery of a compound by passage through the skin and into the blood stream.

"Transmucosal" refers to delivery of a compound by passage of the compound through the mucosal tissue and into the blood stream.

"Parenteral" refers to delivery of a compound by subcutaneous, intravenous, intramuscular, intracardiac, intradermal, intraperitoneal, intrathecal or intrasternal injection and also includes infusion techniques.

"Penetration enhancement" or "permeation enhancement" refers to an increase in the permeability of the skin or mucosal tissue to a selected pharmacologically active compound such that the rate at which the compound permeates through the skin or mucosal tissue is increased.

"Carriers" or "vehicles" refers to carrier materials suitable for compound administration and include any such material known in the art such as, for example, any liquid, gel, solvent, liquid diluent, solubilizer, or the like, which is non-toxic and which does not interact with any components of the composition in a deleterious manner.

"Sustained release" refers to the release of an active compound and/or composition such that the blood levels of the active compound are maintained within a desirable therapeutic range over a period of time. The sustained release formulation can be prepared using any conventional method known to one skilled in the art to obtain the desired release characteristics.

"Nitric oxide enhancing" refers to compounds and functional groups which, under physiological conditions can increase endogenous nitric oxide. Nitric oxide enhancing compounds include, but are not limited to, nitric oxide releasing compounds, nitric oxide donating compounds, nitric oxide donors, radical scavenging compounds and/or reactive oxygen species scavenger compounds. In one embodiment the radical scavenging compound contains a nitroxide group.

"Nitroxide group" refers to compounds that have the ability to mimic superoxide dimutase and catalase and act as radical scavengers, or react with superoxide or other reactive oxygen species via a stable aminoxyl radical i.e. N-oxide.

"Nitric oxide adduct" or "NO adduct" refers to compounds and functional groups which, under physiological conditions, can donate, release and/or directly or indirectly transfer any of the three redox forms of nitrogen monoxide (NO^+ , NO^- , $\text{NO}\bullet$), such that the

biological activity of the nitrogen monoxide species is expressed at the intended site of action. "Nitric oxide releasing" or "nitric oxide donating" refers to methods of donating, releasing and/or directly or indirectly transferring any of the three redox forms of nitrogen monoxide (NO^+ , NO^- , $\text{NO}\bullet$), such that the biological activity of the nitrogen monoxide species is expressed at the intended site of action.

"Nitric oxide donor" or "NO donor" refers to compounds that donate, release and/or directly or indirectly transfer a nitrogen monoxide species, and/or stimulate the endogenous production of nitric oxide or endothelium-derived relaxing factor (EDRF) *in vivo* and/or elevate endogenous levels of nitric oxide or EDRF *in vivo* and/or are oxidized to produce nitric oxide and/or are substrates for nitric oxide synthase and/or cytochrome P450. "NO donor" also includes compounds that are precursors of L-arginine, inhibitors of the enzyme arginase and nitric oxide mediators.

"Heterocyclic nitric oxide donor" refers to a trisubstituted 5-membered ring comprising two or three nitrogen atoms and at least one oxygen atom. The heterocyclic nitric oxide donor is capable of donating and/or releasing a nitrogen monoxide species upon decomposition of the heterocyclic ring. Exemplary heterocyclic nitric oxide donors include oxatriazol-5-ones, oxatriazol-5-imines, sydnonimines, furoxans, and the like.

"Alkyl" refers to a lower alkyl group, a substituted lower alkyl group, a haloalkyl group, a hydroxyalkyl group, an alkenyl group, a substituted alkenyl group, an alkynyl group, a bridged cycloalkyl group, a cycloalkyl group or a heterocyclic ring, as defined herein. An alkyl group may also comprise one or more radical species, such as, for example a cycloalkylalkyl group or a heterocyclicalkyl group.

"Lower alkyl" refers to branched or straight chain acyclic alkyl group comprising one to about ten carbon atoms (preferably one to about eight carbon atoms, more preferably one to about six carbon atoms). Exemplary lower alkyl groups include methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, sec-butyl, t-butyl, pentyl, neopentyl, iso-amyl, hexyl, octyl, and the like.

"Substituted lower alkyl" refers to a lower alkyl group, as defined herein, wherein one or more of the hydrogen atoms have been replaced with one or more R^{100} groups, wherein each R^{100} is independently a hydroxy, an ester, an amidyl, an oxo, a carboxyl, a carboxamido, a halo, a cyano, a nitrate, a nitrite, a thionitrate, a thionitrite or an amino group, as defined herein.

"Haloalkyl" refers to a lower alkyl group, an alkenyl group, an alkynyl group, a bridged cycloalkyl group, a cycloalkyl group or a heterocyclic ring, as defined herein, to which is appended one or more halogens, as defined herein. Exemplary haloalkyl groups include trifluoromethyl, chloromethyl, 2-bromobutyl, 1-bromo-2-chloro-pentyl, and the like.

5 "Alkenyl" refers to a branched or straight chain C₂-C₁₀ hydrocarbon (preferably a C₂-C₈ hydrocarbon, more preferably a C₂-C₆ hydrocarbon) that can comprise one or more carbon-carbon double bonds. Exemplary alkenyl groups include propylenyl, buten-1-yl, isobutenyl, penten-1-yl, 2,2-methylbuten-1-yl, 3-methylbuten-1-yl, hexan-1-yl, hepten-1-yl, octen-1-yl, and the like.

10 "Lower alkenyl" refers to a branched or straight chain C₂-C₄ hydrocarbon that can comprise one or two carbon-carbon double bonds.

"Substituted alkenyl" refers to a branched or straight chain C₂-C₁₀ hydrocarbon (preferably a C₂-C₈ hydrocarbon, more preferably a C₂-C₆ hydrocarbon) which can comprise one or more carbon-carbon double bonds, wherein one or more of the hydrogen atoms have
15 been replaced with one or more R¹⁰⁰ groups, wherein each R¹⁰⁰ is independently a hydroxy, an oxo, a carboxyl, a carboxamido, a halo, a cyano or an amino group, as defined herein.

"Alkynyl" refers to an unsaturated acyclic C₂-C₁₀ hydrocarbon (preferably a C₂-C₈ hydrocarbon, more preferably a C₂-C₆ hydrocarbon) that can comprise one or more carbon-carbon triple bonds. Exemplary alkynyl groups include ethynyl, propynyl, butyn-1-yl, butyn-
20 2-yl, pentyl-1-yl, pentyl-2-yl, 3-methylbutyn-1-yl, hexyl-1-yl, hexyl-2-yl, hexyl-3-yl, 3,3-dimethyl-butyn-1-yl, and the like.

"Bridged cycloalkyl" refers to two or more cycloalkyl groups, heterocyclic groups, or a combination thereof fused via adjacent or non-adjacent atoms. Bridged cycloalkyl groups can be unsubstituted or substituted with one, two or three substituents independently selected
25 from alkyl, alkoxy, amino, alkylamino, dialkylamino, hydroxy, halo, carboxyl, alkylcarboxylic acid, aryl, amidyl, ester, alkylcarboxylic ester, carboxamido, alkylcarboxamido, oxo and nitro. Exemplary bridged cycloalkyl groups include adamantyl, decahydronaphthyl, quinuclidyl, 2,6-dioxabicyclo(3.3.0)octane, 7-oxabicyclo(2.2.1)heptyl, 8-azabicyclo(3,2,1)oct-2-enyl and the like.

30 "Cycloalkyl" refers to a saturated or unsaturated cyclic hydrocarbon comprising from about 3 to about 10 carbon atoms. Cycloalkyl groups can be unsubstituted or substituted with one, two or three substituents independently selected from alkyl, alkoxy, amino, alkylamino, dialkylamino, arylamino, diarylamino, alkylarylamino, aryl, amidyl, ester, hydroxy, halo,

carboxyl, alkylcarboxylic acid, alkylcarboxylic ester, carboxamido, alkylcarboxamido, oxo, alkylsulfinyl, and nitro. Exemplary cycloalkyl groups include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cyclohexenyl, cyclohepta-1,3-dienyl, and the like.

"Heterocyclic ring or group" refers to a saturated or unsaturated cyclic hydrocarbon group having about 2 to about 10 carbon atoms (preferably about 4 to about 6 carbon atoms) where 1 to about 4 carbon atoms are replaced by one or more nitrogen, oxygen and/or sulfur atoms. Sulfur may be in the thio, sulfinyl or sulfonyl oxidation state. The heterocyclic ring or group can be fused to an aromatic hydrocarbon group. Heterocyclic groups can be unsubstituted or substituted with one, two or three substituents independently selected from alkyl, alkoxy, amino, alkylthio, aryloxy, arylthio, arylalkyl, hydroxy, oxo, thial, halo, carboxyl, carboxylic ester, alkylcarboxylic acid, alkylcarboxylic ester, aryl, arylcarboxylic acid, arylcarboxylic ester, amidyl, ester, alkylcarbonyl, arylcarbonyl, alkylsulfinyl, carboxamido, alkylcarboxamido, arylcarboxamido, sulfonic acid, sulfonic ester, sulfonamide nitrate and nitro. Exemplary heterocyclic groups include pyrrolyl, furyl, thienyl, 3-pyrrolyl, 4,5,6-trihydro-2H-pyranyl, pyridinyl, 1,4-dihydropyridinyl, pyrazolyl, triazolyl, pyrimidinyl, pyridazinyl, oxazolyl, thiazolyl, imidazolyl, indolyl, thiophenyl, furanyl, tetrahydrofuranyl, tetrazolyl, pyrrolinyl, pyrrolindinyl, oxazolindinyl 1,3-dioxolanyl, imidazolynyl, imidazolindinyl, pyrazolynyl, pyrazolidinyl, isoxazolyl, isothiazolyl, 1,2,3-oxadiazolyl, 1,2,3-triazolyl, 1,3,4-thiadiazolyl, 2H-pyranyl, 4H-pyranyl, piperidinyl, 1,4-dioxanyl, morpholynyl, 1,4-dithianyl, thiomorpholynyl, pyrazinyl, piperazinyl, 1,3,5-triazinyl, 1,3,5-trithianyl, benzo(b)thiophenyl, benzimidazolyl, benzothiazolynyl, quinolynyl, 2,6-dioxabicyclo(3.3.0)octane, and the like.

"Heterocyclic compounds" refer to mono- and polycyclic compounds comprising at least one aryl or heterocyclic ring.

"Aryl" refers to a monocyclic, bicyclic, carbocyclic or heterocyclic ring system comprising one or two aromatic rings. Exemplary aryl groups include phenyl, pyridyl, naphthyl, quinoyl, tetrahydronaphthyl, furanyl, indanyl, indenyl, indoyle, and the like. Aryl groups (including bicyclic aryl groups) can be unsubstituted or substituted with one, two or three substituents independently selected from alkyl, alkoxy, alkylthio, amino, alkylamino, dialkylamino, arylamino, diarylamino, alkylarylamino, halo, cyano, alkylsulfinyl, hydroxy, carboxyl, carboxylic ester, alkylcarboxylic acid, alkylcarboxylic ester, aryl, arylcarboxylic acid, arylcarboxylic ester, alkylcarbonyl, arylcarbonyl, amidyl, ester, carboxamido, alkylcarboxamido, carbomyl, sulfonic acid, sulfonic ester, sulfonamido and nitro. Exemplary

substituted aryl groups include tetrafluorophenyl, pentafluorophenyl, sulfonamide, alkylsulfonyl, arylsulfonyl, and the like.

“Cycloalkenyl” refers to an unsaturated cyclic C₂-C₁₀ hydrocarbon (preferably a C₂-C₈ hydrocarbon, more preferably a C₂-C₆ hydrocarbon) which can comprise one or more carbon-carbon double bonds.

“Alkylaryl” refers to an alkyl group, as defined herein, to which is appended an aryl group, as defined herein. Exemplary alkylaryl groups include benzyl, phenylethyl, hydroxybenzyl, fluorobenzyl, fluorophenylethyl, and the like.

“Arylalkyl” refers to an aryl radical, as defined herein, attached to an alkyl radical, as defined herein. Exemplary arylalkyl groups include benzyl, phenylethyl, 4-hydroxybenzyl, 3-fluorobenzyl, 2-fluorophenylethyl, and the like.

“Arylalkenyl” refers to an aryl radical, as defined herein, attached to an alkenyl radical, as defined herein. Exemplary arylalkenyl groups include styryl, propenylphenyl, and the like.

“Cycloalkylalkyl” refers to a cycloalkyl radical, as defined herein, attached to an alkyl radical, as defined herein.

“Cycloalkylalkoxy” refers to a cycloalkyl radical, as defined herein, attached to an alkoxy radical, as defined herein.

“Cycloalkylalkylthio” refers to a cycloalkyl radical, as defined herein, attached to an alkylthio radical, as defined herein.

“Heterocyclicalkyl” refers to a heterocyclic ring radical, as defined herein, attached to an alkyl radical, as defined herein.

“Arylheterocyclic ring” refers to a bi- or tricyclic ring comprised of an aryl ring, as defined herein, appended via two adjacent carbon atoms of the aryl ring to a heterocyclic ring, as defined herein. Exemplary arylheterocyclic rings include dihydroindole, 1,2,3,4-tetrahydroquinoline, and the like.

“Alkylheterocyclic ring” refers to a heterocyclic ring radical, as defined herein, attached to an alkyl radical, as defined herein. Exemplary alkylheterocyclic rings include 2-pyridylmethyl, 1-methylpiperidin-2-one-3-methyl, and the like.

"Alkoxy" refers to $R_{50}O-$, wherein R_{50} is an alkyl group, as defined herein (preferably a lower alkyl group or a haloalkyl group, as defined herein). Exemplary alkoxy groups include methoxy, ethoxy, t-butoxy, cyclopentyloxy, trifluoromethoxy, and the like.

"Aryloxy" refers to $R_{55}O-$, wherein R_{55} is an aryl group, as defined herein. Exemplary arylkoxy groups include naphthyloxy, quinolyloxy, isoquinolizinyloxy, and the like.

"Alkylthio" refers to $R_{50}S-$, wherein R_{50} is an alkyl group, as defined herein.

"Lower alkylthio" refers to a lower alkyl group, as defined herein, appended to a thio group, as defined herein.

"Arylalkoxy" or "alkoxyaryl" refers to an alkoxy group, as defined herein, to which is appended an aryl group, as defined herein. Exemplary arylalkoxy groups include benzyloxy, phenylethoxy, chlorophenylethoxy, and the like.

"Arylalkylthio" refers to an alkylthio group, as defined herein, to which is appended an aryl group, as defined herein. Exemplary arylalkylthio groups include benzylthio, phenylethylthio, chlorophenylethylthio, and the like.

"Arylalkylthioalkyl" refers to an arylalkylthio group, as defined herein, to which is appended an alkyl group, as defined herein. Exemplary arylalkylthioalkyl groups include benzylthiomethyl, phenylethylthiomethyl, chlorophenylethylthioethyl, and the like.

"Alkylthioalkyl" refers to an alkylthio group, as defined herein, to which is appended an alkyl group, as defined herein. Exemplary alkylthioalkyl groups include allylthiomethyl, ethylthiomethyl, trifluoroethylthiomethyl, and the like.

"Alkoxyalkyl" refers to an alkoxy group, as defined herein, appended to an alkyl group, as defined herein. Exemplary alkoxyalkyl groups include methoxymethyl, methoxyethyl, isopropoxymethyl, and the like.

"Alkoxyhaloalkyl" refers to an alkoxy group, as defined herein, appended to a haloalkyl group, as defined herein. Exemplary alkoxyhaloalkyl groups include 4-methoxy-2-chlorobutyl and the like.

"Cycloalkoxy" refers to $R_{54}O-$, wherein R_{54} is a cycloalkyl group or a bridged cycloalkyl group, as defined herein. Exemplary cycloalkoxy groups include cyclopropyloxy, cyclopentyloxy, cyclohexyloxy, and the like.

"Cycloalkylthio" refers to $R_{54}S-$, wherein R_{54} is a cycloalkyl group or a bridged cycloalkyl group, as defined herein. Exemplary cycloalkylthio groups include cyclopropylthio, cyclopentylthio, cyclohexylthio, and the like.

"Haloalkoxy" refers to an alkoxy group, as defined herein, in which one or more of the

hydrogen atoms on the alkoxy group are substituted with halogens, as defined herein.
Exemplary haloalkoxy groups include 1,1,1-trichloroethoxy, 2-bromobutoxy, and the like.

"Hydroxy" refers to -OH.

"Oxy" refers to -O-

5 "Oxo" refers to =O.

"Oxylate" refers to $-O^- R_{77}^+$ wherein R_{77} is an organic or inorganic cation.

"Thiol" refers to -SH.

"Thio" refers to -S-.

10 "Oxime" refers to $=N-OR_{81}$ wherein R_{81} is a hydrogen, an alkyl group, an aryl group, an alkylsulfonyl group, an arylsulfonyl group, a carboxylic ester, an alkylcarbonyl group, an arylcarbonyl group, a carboxamido group, an alkoxyalkyl group or an alkoxyaryl group.

"Hydrazone" refers to $=N-N(R_{81})(R'_{81})$ wherein R'_{81} is independently selected from R_{81} , and R_{81} is as defined herein.

"Hydrazino" refers to $H_2N-N(H)-$.

15 "Organic cation" refers to a positively charged organic ion. Exemplary organic cations include alkyl substituted ammonium cations, and the like.

"Inorganic cation" refers to a positively charged metal ion. Exemplary inorganic cations include Group I metal cations such as for example, sodium, potassium, magnesium, calcium, and the like.

20 "Hydroxyalkyl" refers to a hydroxy group, as defined herein, appended to an alkyl group, as defined herein.

"Nitrate" refers to $-O-NO_2$ i.e. oxidized nitrogen.

"Nitrite" refers to $-O-NO$ i.e. oxidized nitrogen.

"Thionitrate" refers to $-S-NO_2$.

25 "Thionitrite" and "nitrosothiol" refer to $-S-NO$.

"Nitro" refers to the group $-NO_2$ and "nitrosated" refers to compounds that have been substituted therewith.

"Nitroso" refers to the group $-NO$ and "nitrosylated" refers to compounds that have been substituted therewith.

30 "Nitrile" and "cyano" refer to $-CN$.

"Halogen" or "halo" refers to iodine (I), bromine (Br), chlorine (Cl), and/or fluorine (F).

"Imine" refers to $-C(=N-R_{51})-$ wherein R_{51} is a hydrogen atom, an alkyl group, an aryl

group or an arylheterocyclic ring, as defined herein

"Amine" refers to any organic compound that contains at least one basic nitrogen atom.

5 "Amino" refers to -NH_2 , an alkylamino group, a dialkylamino group, an arylamino group, a diarylamino group, an alkylarylamino group or a heterocyclic ring, as defined herein.

"Alkylamino" refers to $\text{R}_{50}\text{NH-}$, wherein R_{50} is an alkyl group, as defined herein. Exemplary alkylamino groups include methylamino, ethylamino, butylamino, cyclohexylamino, and the like.

"Arylamino" refers to $\text{R}_{55}\text{NH-}$, wherein R_{55} is an aryl group, as defined herein.

10 "Dialkylamino" refers to $\text{R}_{52}\text{R}_{53}\text{N-}$, wherein R_{52} and R_{53} are each independently an alkyl group, as defined herein. Exemplary dialkylamino groups include dimethylamino, diethylamino, methyl propargylamino, and the like.

"Diarylamino" refers to $\text{R}_{55}\text{R}_{60}\text{N-}$, wherein R_{55} and R_{60} are each independently an aryl group, as defined herein.

15 "Alkylarylamino" or "arylalkylamino" refers to $\text{R}_{52}\text{R}_{55}\text{N-}$, wherein R_{52} is an alkyl group, as defined herein, and R_{55} is an aryl group, as defined herein.

"Alkylarylalkylamino" refers to $\text{R}_{52}\text{R}_{79}\text{N-}$, wherein R_{52} is an alkyl group, as defined herein, and R_{79} is an arylalkyl group, as defined herein.

20 "Alkylcycloalkylamino" refers to $\text{R}_{52}\text{R}_{80}\text{N-}$, wherein R_{52} is an alkyl group, as defined herein, and R_{80} is a cycloalkyl group, as defined herein.

"Aminoalkyl" refers to an amino group, an alkylamino group, a dialkylamino group, an arylamino group, a diarylamino group, an alkylarylamino group or a heterocyclic ring, as defined herein, to which is appended an alkyl group, as defined herein. Exemplary aminoalkyl groups include dimethylaminopropyl, diphenylaminocyclopentyl, methylaminomethyl, and the like.

"Aminoaryl" refers to an aryl group to which is appended an alkylamino group, an arylamino group or an arylalkylamino group. Exemplary aminoaryl groups include anilino, N-methylanilino, N-benzylanilino, and the like.

"Sulfinyl" refers to -S(O)- .

30 "Methanthial" refers to -C(S)- .

"Thial" refers to $=\text{S}$.

"Sulfonyl" refers to $\text{-S(O)}_2\text{-}$.

"Sulfonic acid" refers to $\text{-S(O)}_2\text{OR}_{76}$, wherein R_{76} is a hydrogen, an organic cation or

an inorganic cation, as defined herein.

"Alkylsulfonic acid" refers to a sulfonic acid group, as defined herein, appended to an alkyl group, as defined herein.

5 "Arylsulfonic acid" refers to a sulfonic acid group, as defined herein, appended to an aryl group, as defined herein.

"Sulfonic ester" refers to $-S(O)_2OR_{58}$, wherein R_{58} is an alkyl group, an aryl group, or an aryl heterocyclic ring, as defined herein.

10 "Sulfonamido" refers to $-S(O)_2-N(R_{51})(R_{57})$, wherein R_{51} and R_{57} are each independently a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein, or R_{51} and R_{57} when taken together are a heterocyclic ring, a cycloalkyl group or a bridged cycloalkyl group, as defined herein.

"Alkylsulfonamido" refers to a sulfonamido group, as defined herein, appended to an alkyl group, as defined herein.

15 "Arylsulfonamido" refers to a sulfonamido group, as defined herein, appended to an aryl group, as defined herein.

"Alkylthio" refers to $R_{50}S-$, wherein R_{50} is an alkyl group, as defined herein (preferably a lower alkyl group, as defined herein).

"Arylthio" refers to $R_{55}S-$, wherein R_{55} is an aryl group, as defined herein.

20 "Arylalkylthio" refers to an aryl group, as defined herein, appended to an alkylthio group, as defined herein.

"Alkylsulfinyl" refers to $R_{50}-S(O)-$, wherein R_{50} is an alkyl group, as defined herein.

"Alkylsulfonyl" refers to $R_{50}-S(O)_2-$, wherein R_{50} is an alkyl group, as defined herein.

"Alkylsulfonyloxy" refers to $R_{50}-S(O)_2-O-$, wherein R_{50} is an alkyl group, as defined herein.

25 "Arylsulfinyl" refers to $R_{55}-S(O)-$, wherein R_{55} is an aryl group, as defined herein.

"Arylsulfonyl" refers to $R_{55}-S(O)_2-$, wherein R_{55} is an aryl group, as defined herein.

"Arylsulfonyloxy" refers to $R_{55}-S(O)_2-O-$, wherein R_{55} is an aryl group, as defined herein.

30 "Amidyl" refers to $R_{51}C(O)N(R_{57})-$ wherein R_{51} and R_{57} are each independently a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein.

"Ester" refers to $R_{51}C(O)R_{82}$ wherein R_{51} is a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein and R_{82} is oxygen or sulfur.

"Carbamoyl" refers to $-O-C(O)N(R_{51})(R_{57})$, wherein R_{51} and R_{57} are each

independently a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein, or R_{51} and R_{57} taken together are a heterocyclic ring, a cycloalkyl group or a bridged cycloalkyl group, as defined herein.

"Carboxyl" refers to $-C(O)OR_{76}$, wherein R_{76} is a hydrogen, an organic cation or an inorganic cation, as defined herein.

"Carbonyl" refers to $-C(O)-$.

"Alkylcarbonyl" refers to $R_{52}-C(O)-$, wherein R_{52} is an alkyl group, as defined herein.

"Arylcarbonyl" refers to $R_{55}-C(O)-$, wherein R_{55} is an aryl group, as defined herein.

"Arylalkylcarbonyl" refers to $R_{55}-R_{52}-C(O)-$, wherein R_{55} is an aryl group, as defined herein, and R_{52} is an alkyl group, as defined herein.

"Alkylarylcarbonyl" refers to $R_{52}-R_{55}-C(O)-$, wherein R_{55} is an aryl group, as defined herein, and R_{52} is an alkyl group, as defined herein.

"Heterocyclicalkylcarbonyl" refer to $R_{78}C(O)-$ wherein R_{78} is a heterocyclicalkyl group, as defined herein.

"Carboxylic ester" refers to $-C(O)OR_{58}$, wherein R_{58} is an alkyl group, an aryl group or an aryl heterocyclic ring, as defined herein.

"Alkylcarboxylic acid" and "alkylcarboxyl" refer to an alkyl group, as defined herein, appended to a carboxyl group, as defined herein.

"Alkylcarboxylic ester" refers to an alkyl group, as defined herein, appended to a carboxylic ester group, as defined herein.

"Alkyl ester" refers to an alkyl group, as defined herein, appended to an ester group, as defined herein.

"Arylcarboxylic acid" refers to an aryl group, as defined herein, appended to a carboxyl group, as defined herein.

"Arylcarboxylic ester" and "arylcarboxyl" refer to an aryl group, as defined herein, appended to a carboxylic ester group, as defined herein.

"Aryl ester" refers to an aryl group, as defined herein, appended to an ester group, as defined herein.

"Carboxamido" refers to $-C(O)N(R_{51})(R_{57})$, wherein R_{51} and R_{57} are each independently a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein, or R_{51} and R_{57} when taken together are a heterocyclic ring, a cycloalkyl group or a bridged cycloalkyl group, as defined herein.

"Alkylcarboxamido" refers to an alkyl group, as defined herein, appended to a

carboxamido group, as defined herein.

"Arylcarboxamido" refers to an aryl group, as defined herein, appended to a carboxamido group, as defined herein.

"Urea" refers to $-N(R_{59})-C(O)N(R_{51})(R_{57})$ wherein R_{51} , R_{57} , and R_{59} are each independently a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein, or R_{51} and R_{57} taken together are a heterocyclic ring, a cycloalkyl group or a bridged cycloalkyl group, as defined herein.

"Phosphoryl" refers to $-P(R_{70})(R_{71})(R_{72})$, wherein R_{70} is a lone pair of electrons, thial or oxo, and R_{71} and R_{72} are each independently a covalent bond, a hydrogen, a lower alkyl, an alkoxy, an alkylamino, a hydroxy, an oxy or an aryl, as defined herein.

"Phosphoric acid" refers to $-P(O)(OR_{51})OH$ wherein R_{51} is a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein.

"Phosphinic acid" refers to $-P(O)(R_{51})OH$ wherein R_{51} is a hydrogen atom, an alkyl group, an aryl group or an arylheterocyclic ring, as defined herein.

"Silyl" refers to $-Si(R_{73})(R_{74})(R_{75})$, wherein R_{73} , R_{74} and R_{75} are each independently a covalent bond, a lower alkyl, an alkoxy, an aryl or an arylalkoxy, as defined herein.

The compounds and compositions of the invention are angiotensin II antagonists, include, but are not limited to, angiotensin, abitesartan, candesartan, candesartan cilexetil, elisartan, embusartan, enoltasartan, eprosartan, fonsartan, forasartan, glycylosartan, irbesartan, losartan, olmesartan, milfasartan, medoxomil, ripisartan, pomisartan, prazosartan, saprisartan, saralasin, sarmesin, tasosartan, telmisartan, valsartan, zolasartan, 3-(2'(tetrazole-5-yl)-1,1'-biphen-4-yl)methyl-5,7-dimethyl-2-ethyl-3H-imidazo(4,5-b)pyridine, antibodies to angiotensin II, A-81282, A-81988, BAY 106734, BIBR-363, BIBS-39, BIBS-222, BMS-180560, BMS-184698, BMS-346567, CGP-38560A, CGP-42112A, CGP-48369, CGP-49870, CGP-63170, CI-996, CP-148130, CL-329167, CV-11194, DA-2079, DE-3489, DMP-811, DuP-167, DuP-532, DuP-753, E-1477, E-4177, E-4188, EMD-66397, EMD-666R4, EMD-73495, EMD-66684, EXP-063, EXP-929, EXP-3174, EXP-6155, EXP-6803, EXP-7711, EXP-9270, EXP-9954, FK-739, FRI 153332, GA-0050, GA-0056, HN-65021, HOE-720, HR-720, ICI-D6888, ICI-D7155, ICI-D8731, KRI-1177, KT3-671, KT-3579, KW-3433, L-158809, L-158978, , L-159282, L-159689, L-159874, L-161177, L-162154, L-162234, L-162441, L-163007, L-163017, LF-70156, LRB-057, LRB-081, LRB-087, LY-235656, LY-266099, LY-285434, LY-301875, LY-302289, LY-315995, ME-3221, MK-954, PD-123177, PD-123319, PD-126055, PD-

150304, RG-13647, RWJ-38970, RWJ-46458, S-8307, S-8308, SC-51757, SC-54629, SC-52458, SC-52459, SK 1080, SL-910102, SR-47436, TAK-536, UP-2696, U-96849, U-97018, UK-77778, UP-275-22, WAY-126227, WK-1260, WK-1360, WK-1492, WY 126227, YH-1498, YM-358, YM-31472, X-6803, XH-148, XR-510, ZD-6888, ZD-7155, ZD-8731, ZD 8131, the compounds of ACS registry numbers 133240-46-7, 135070-05-2, 139958-16-0, 145160-84-5, 147403-03-0, 153806-29-2, 439904-54-8P, 439904-55-9P, 439904-56-0P, 439904-57-1P, 439904-58-2P, 155918-60-8P, 155918-61-9P, 272438-16-1P, 272446-75-0P, 223926-77-0P, 169281-89-4, 165113-17-7P, 165113-18-8P, 165113-19-9P, 165113-20-2P, 165113-13-3P, 165113-14-4P, 165113-15-5P, 165113-16-6P, 165113-21-3P, 165113-22-4P, 165113-23-5P, 165113-24-6P, 165113-25-7P, 165113-26-8P, 165113-27-9P, 165113-28-0P, 165113-29-1P, 165113-30-4P, 165113-31-5P, 165113-32-6P, 165113-33-7P, 165113-34-8P, 165113-35-9P, 165113-36-0P, 165113-37-1P, 165113-38-2P, 165113-39-3P, 165113-40-6P, 165113-41-7P, 165113-42-8P, 165113-43-9P, 165113-44-0P, 165113-45-1P, 165113-46-2P, 165113-47-3P, 165113-48-4P, 165113-49-5P, 165113-50-8P, 165113-51-9P, 165113-52-0P, 165113-53-1P, 165113-54-2P, 165113-55-3P, 165113-56-4P, 165113-57-5P, 165113-58-6P, 165113-59-7P, 165113-60-0P, 165113-61-1P, 165113-62-2P, 165113-63-3P, 165113-64-4P, 165113-65-5P, 165113-66-6P, 165113-67-7P, 165113-68-8P, 165113-69-9P, 165113-70-2P, 165113-71-3P, 165113-72-4P, 165113-73-5P, 165113-74-6P, 114798-27-5, 114798-28-6, 114798-29-7, 124749-82-2, 114798-28-6, 124749-84-4, 124750-88-5, 124750-91-0, 124750-93-2, 161946-65-2P, 161947-47-3P, 161947-48-4P, 161947-51-9P, 161947-52-0P, 161947-55-3P, 161947-56-4P, 161947-60-0P, 161947-61-1P, 161947-68-8P, 161947-69-9P, 161947-70-2P, 161947-71-3P, 161947-72-4P, 161947-74-6P, 161947-75-7P, 161947-81-5P, 161947-82-6P, 161947-83-7P, 161947-84-8P, 161947-85-9P, 161947-86-0P, 161947-87-1P, 161947-88-2P, 161947-89-3P, 161947-90-6P, 161947-91-7P, 161947-92-8P, 161947-93-9P, 161947-94-0P, 161947-95-1P, 161947-96-2P, 161947-97-3P, 161947-98-4P, 161947-99-5P, 161948-00-1P, 161948-01-2P, 161948-02-3P, 168686-32-6P, 167301-42-0P, 166813-82-7P, 166961-56-4P, 166961-58-6P, 158872-96-9P, 158872-97-0P, 158807-14-8P, 158807-15-9P, 158807-16-0P, 158807-17-1P, 158807-18-2P, 158807-19-3P, 158807-20-6P, 155884-08-5P, 154749-99-2, 167371-59-7P, 244126-99-6P, 177848-35-0P, 141309-82-2P, and the like.

The contemplated angiotensin II antagonists are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition),

McGraw-Hill, (1996); Merck Index on CD-ROM, 13th Edition; STN Express, file phar and file registry, the disclosures of each of which are incorporated by reference herein in their entirety.

In one embodiment, the angiotensin II antagonist compounds of the invention
 5 comprise at least one nitric oxide enhancing group selected from the group consisting of an -
 ONO group, an
 -SNO group, an -NNO group, an -ONO₂ group, an -SNO₂ group, an -NNO₂ group, an
 -(N₂O₂-)•M₁⁺ group, a heterocyclic group (e.g., furoxan, sydnonimine, oxatriazole-5-one,
 oxatriazole-5-imine) and a nitroxide group; wherein the nitric oxide (NO) enhancing group is
 10 directly or indirectly linked to the angiotensin II antagonist compound through one or more
 sites such as carbon, oxygen, nitrogen and/or sulfur by a bond or moiety that cannot be
 hydrolyzed. The nitric oxide enhancing angiotensin II antagonist compounds may be
 represented by Formula (A):
 (angiotensin II antagonist compound)-(nonhydrolyzable bond)-(linking group)_{aa}-(NO
 15 enhancing group)

(A)

wherein:

the angiotensin II antagonist compound can be any known in the art. In one
 embodiment, the angiotensin II antagonist compound is angiotensin, abitesartan, candesartan,
 20 candesartan cilexetil, elisartan, embusartan, enoltasartan, eprosartan, fonsartan, forasartan,
 glycylosartan, irbesartan, losartan, olmesartan, milfasartan, medoxomil, ripisartan,
 pomisartan, prazosartan, saprisartan, saralasin, sarmesin, tasosartan, telmisartan, valsartan,
 zolasartan, BMS 180560, CL 329167, GA 0056, KW 3433, MK 996 or YM 358;

the nitric oxide enhancing group is selected from the group consisting of an -ONO
 25 group, an -SNO group, an -NNO group, an -ONO₂ group, an -SNO₂ group, an -NNO₂ group,
 an
 -(N₂O₂-)•M₁⁺ group, a heterocyclic group (e.g., furoxan, sydnonimine, oxatriazole-5-one,
 oxatriazole-5-imine) and a nitroxide group;

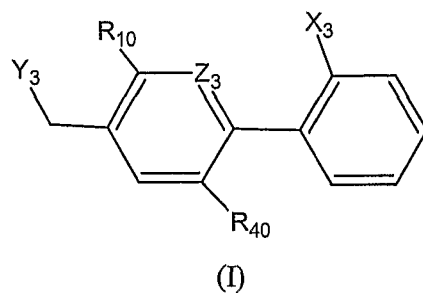
aa is 0 or 1;

30 when aa is 0, the nitric oxide enhancing group is directly linked to the angiotensin II
 antagonist compound via a bond that cannot be hydrolyzed;

when aa is 1, the linking group can be any known in the art;

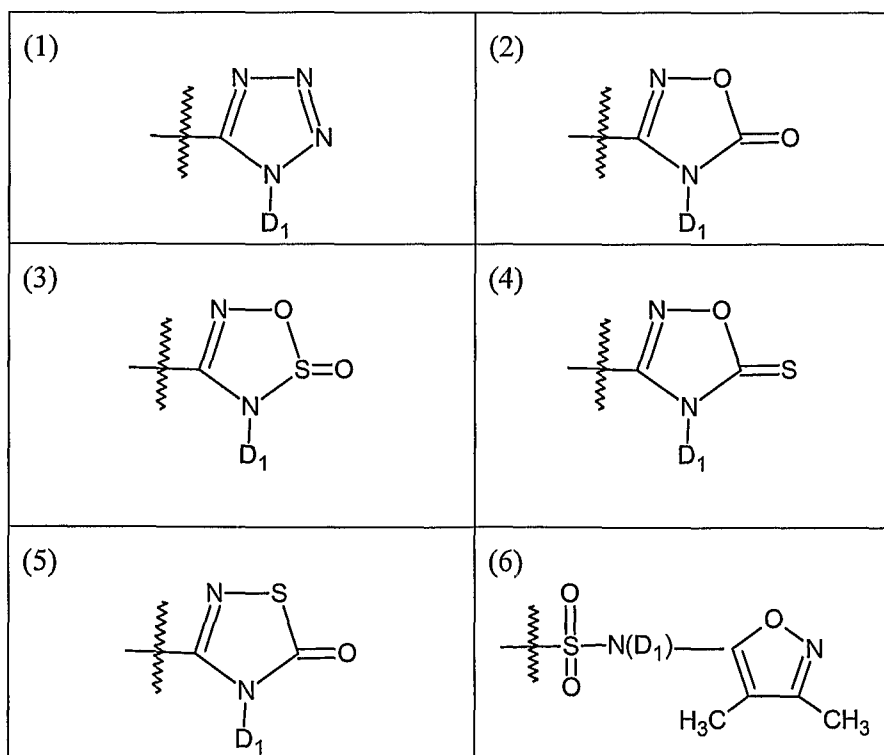
the linking group may optionally comprise one or more hydrolyzable bonds; however, the hydrolyzable bond cannot be directly adjacent the angiotensin II antagonist compound. In other words, at least one atom or moiety in the linking group directly adjacent to the angiotensin II antagonist compound must form a non-hydrolyzable bond with the angiotensin

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (I) and pharmaceutically acceptable salts thereof:



wherein:

X_3 is:



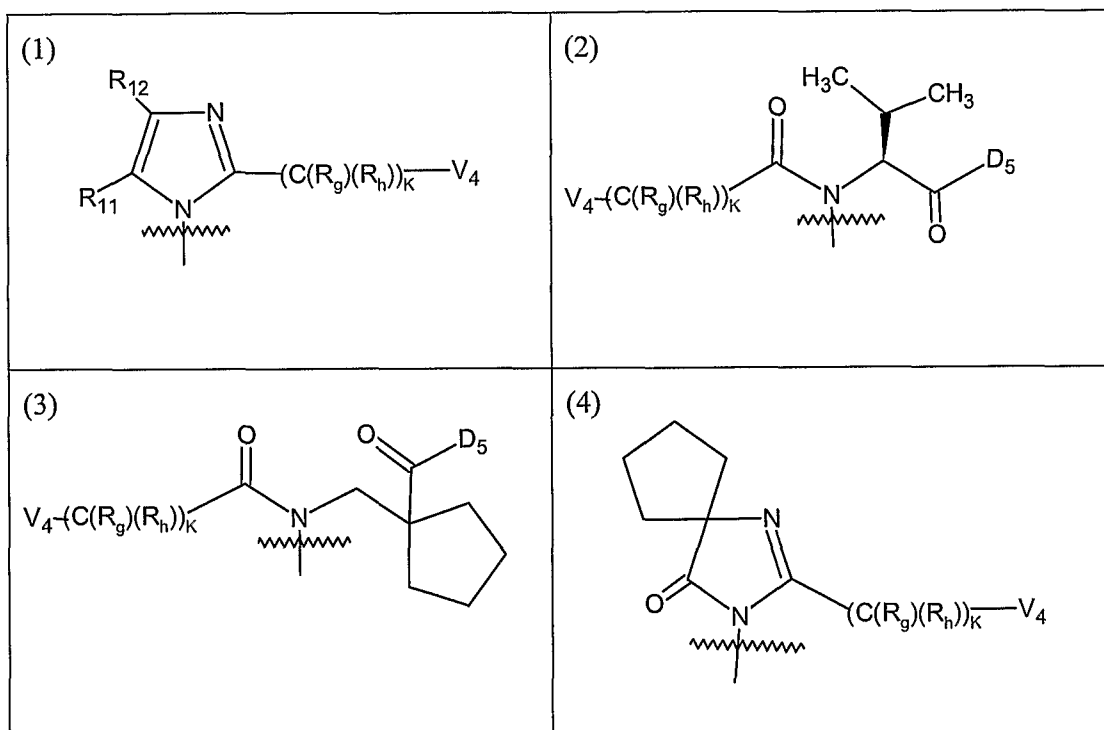
(7) $-N(D_1)-S(O)_2-K$;

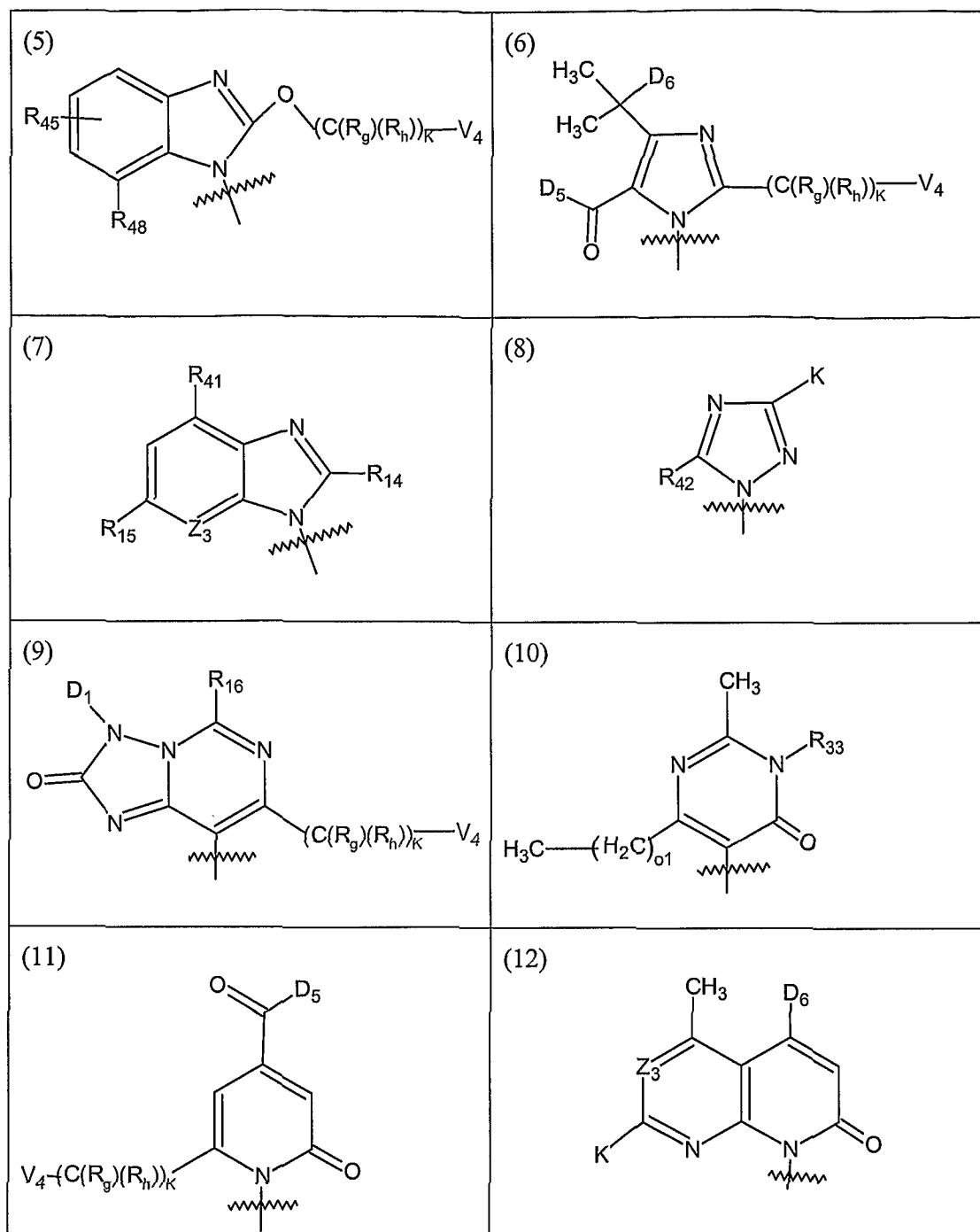
- (8) $-N(D_1)-C(O)-N(D_1)-K$;
 (9) $-C(O)-D_5$;
 (10) $-C(O)-CH_2-NH(D_1)$;
 (11) $-S(O)_2-N(D_1)-C(O)-K$;
 (12) $-S(O)_2-N(D_1)-C(O)-ND_1-K$;
 (13) $-S(O)_2-N(D_1)-D_6$;
 (14) $-S(O)_2-N(D_1)-S(O)_2-K$;
 (15) $-N(D_1)-S(O)_2-N(D_1)-C(O)-K$; or
 (16) $-S(O)_2-N(D_1)-C(O)-U_3-K$;

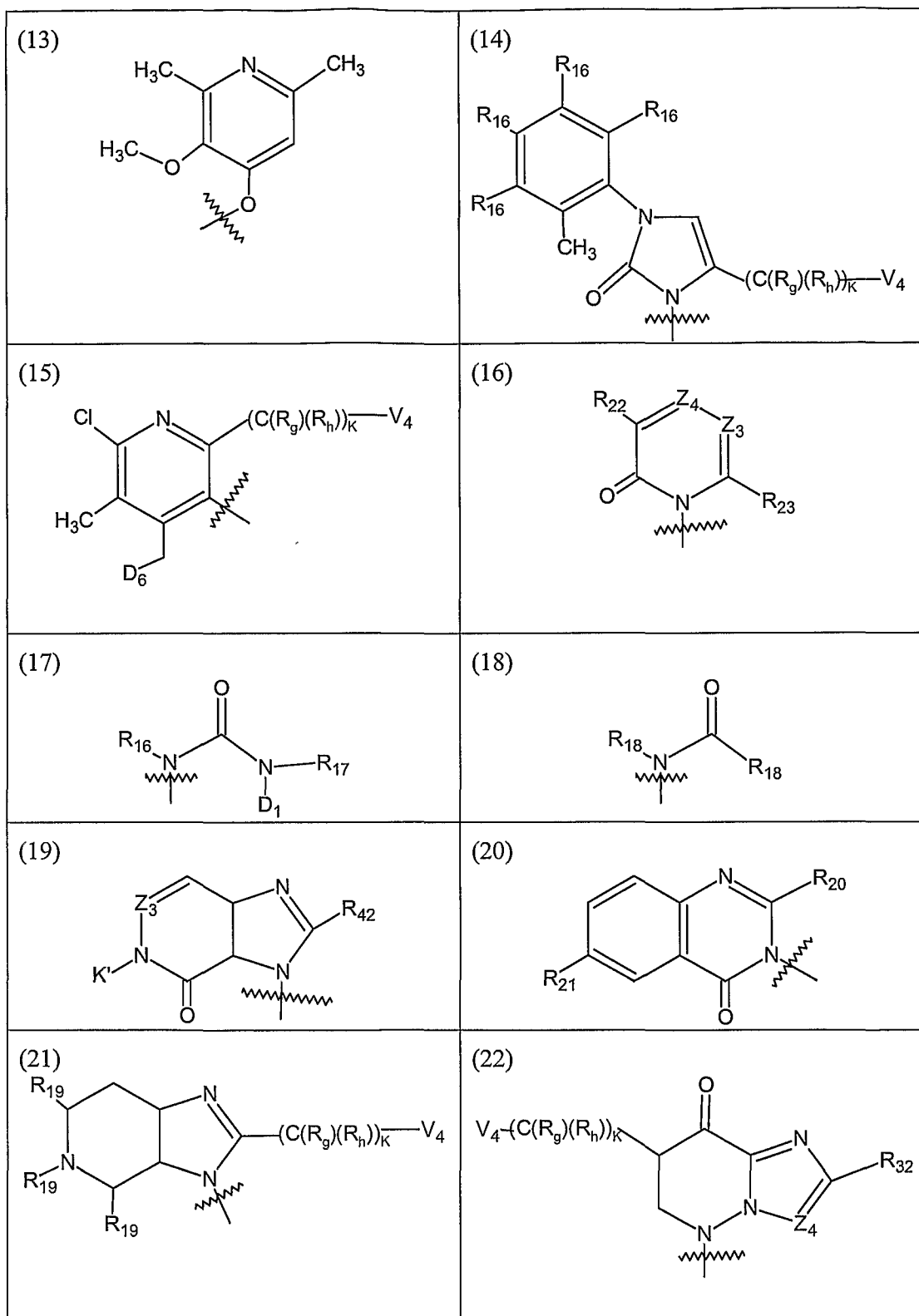
Z_3 is $-CH$ or a nitrogen atom;

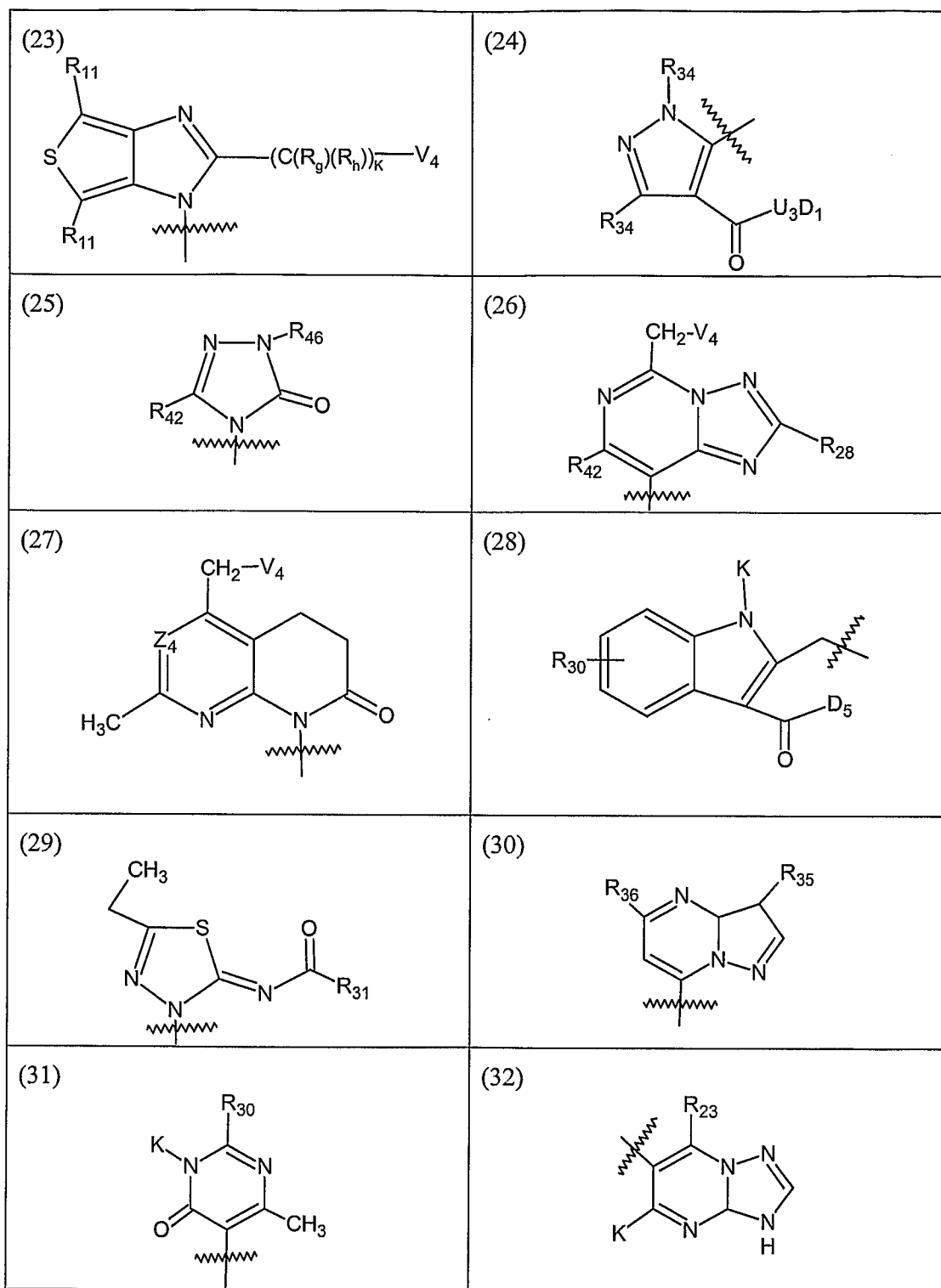
R_{10} is a fluorine or a hydrogen atom;

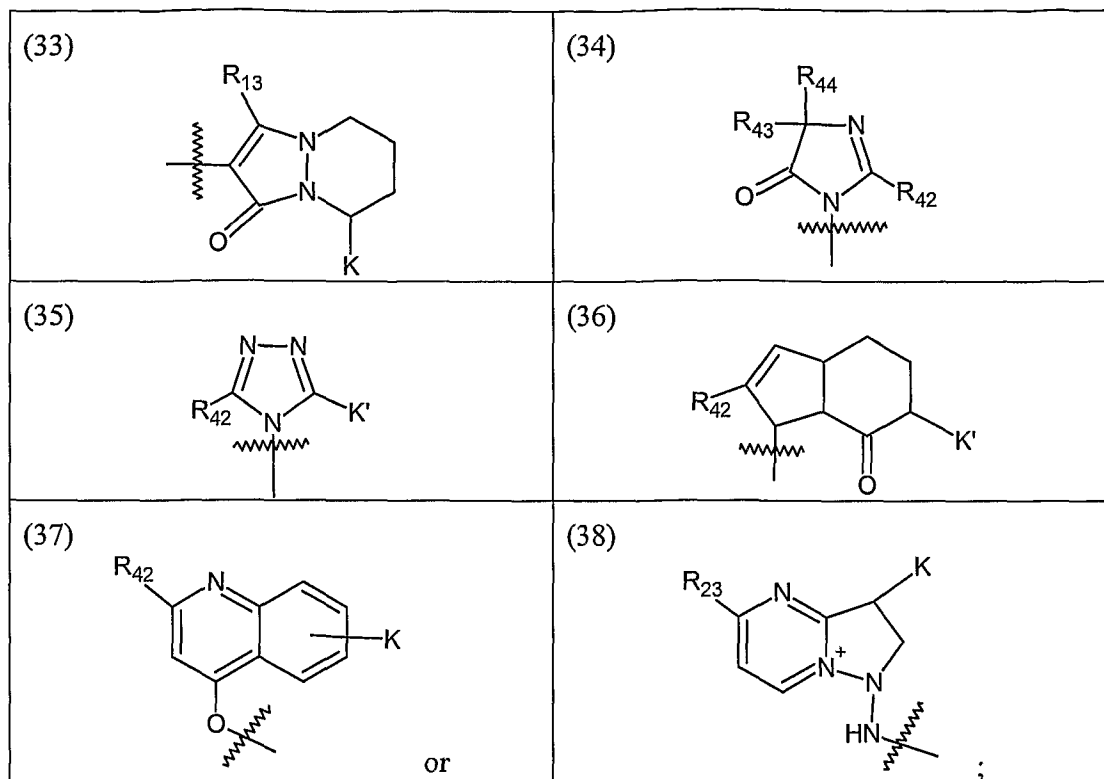
Y_3 is:











Z_4 is C- R_{29} , a nitrogen or $-C-K$;

R_{11} is:

- (1) $-CH_2-D_6$;
- (2) $-C(O)-D_5$;
- (3) $-C(O)-O-CH(CH_3)-O-C(O)-OR_{13}$; or
- (4) $-CH_2-N(D_1)-C(O)-OR_{13}$;

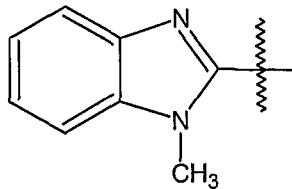
R_{12} is a chlorine, $-SCH_3$ or a haloalkyl;

R_{13} is a lower alkyl or K;

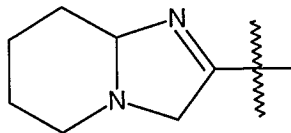
R_{14} is a lower alkyl, a cycloalkyl or $-(C(R_g)R_h))_k-V_4$;

R_{15} is:

- (1) hydrogen;
- (2) a lower alkyl;
- (3)



(4)

(5) $-\text{C}(\text{O})-\text{D}_6$; or

(6) K;

5 R_{16} is a hydrogen, a lower alkyl, an alkoxy, $-\text{D}_6$, a cyano, $-\text{C}(\text{O})-\text{D}_5$, $\text{NH}(\text{D}_1)$, K or an alkylcarbonyl;

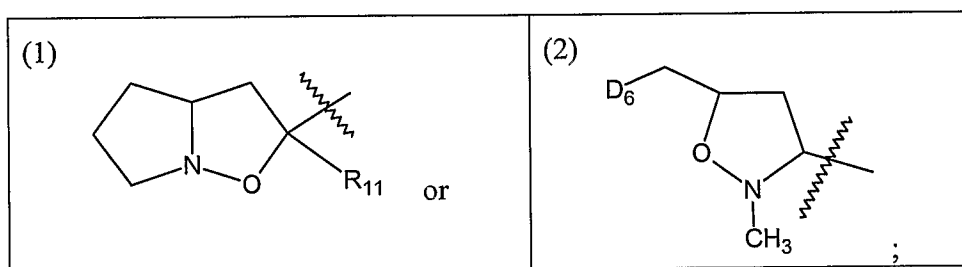
R_{17} is an aryl or a cycloalkyl;

R_{18} at each occurrence is independently selected from a lower alkyl, an alkoxyalkyl, an alkylcarboxylic acid, an hydroxyalkyl, an arylalkoxy, an arylalkyl, an aryl or K;

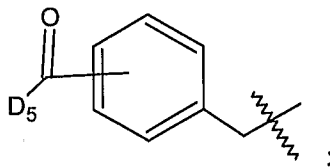
10 R_{19} is a hydrogen or $-\text{C}(\text{O})-\text{D}_5$;

R_{20} is a hydrogen, a lower alkyl, an alkylaryl or K;

R_{21} is:



15 R_{22} is a hydrogen, $-\text{C}(\text{O})-\text{D}_5$, K or



R_{23} is a lower alkyl or an alkoxyalkyl;

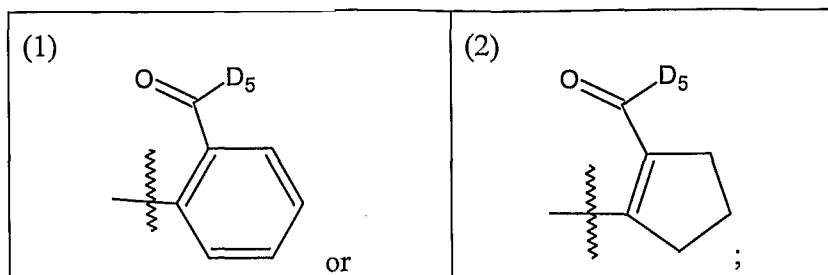
R_{27} is a lower alkyl, an aryl an arylalkyl or $-(\text{CH}_2)_k-\text{C}(\text{O})\text{D}_5$;

R_{28} is $-\text{D}_6$, $-\text{S}(\text{O})_2-\text{N}(\text{D}_1)\text{H}$, $-\text{N}(\text{D}_1)\text{H}$, $-\text{C}(\text{O})-\text{D}_5$ or CH_2-D_6 ;

20 R_{29} is a hydrogen, a lower alkyl or $-\text{C}(\text{O})-\text{D}_5$;

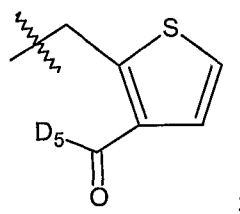
R_{30} is a lower alkyl or a haloalkyl;

R_{31} is:



R_{32} is a hydrogen, an alkyl, an aryl or $-(C(R_g)R_h))_k-V_4$;

R_{33} is $-(CH_2)_2-D_6$ or



5 R_{34} is a hydrogen, a lower alkyl, a lower haloalkyl, an aryl, an arylalkyl or $-(C(R_g)R_h))_k-V_4$;

R_{35} is a hydrogen or a lower alkyl;

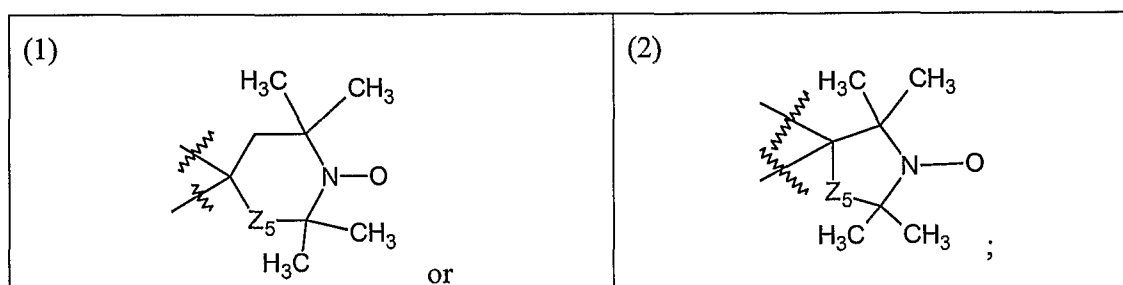
R_{36} is an alkoxy, $-D_6$ an amino group or $-N(R_{13})(R_{13})$;

R_{40} is a hydrogen, a lower alkyl, an alkoxyalkyl or $-(C(R_g)R_h))_k-V_4$;

10 R_{41} is a hydrogen or a lower alkyl;

R_{42} is a lower alkyl or $-(C(R_g)R_h))_k-V_4$;

R_{43} and R_{44} taken together are:



15 R_{45} is a hydrogen or K;

R_{46} is an alkyl group, an aryl group or K;

R_{48} is $-C(O)-D_5$, $-OK$, $-C(O)-K$ or $C(=N-OR_{81})$;

R_{81} is a hydrogen, an alkyl group, an aryl group, an alkylsulfonyl group, an arylsulfonyl group, a carboxylic ester, an alkylcarbonyl group, an arylcarbonyl group, a

carboxamido group, an alkoxyalkyl group or an alkoxyaryl group;

R_g and R_h are each independently a hydrogen, a lower alkyl group, $-\text{CH}_2-\text{U}_3-\text{V}_5$ or V_4 ;
or R_g and R_h taken together with the carbon atom to which they are attached are an
oxo group or an aryl group;

Z_5 is $-\text{CH}_2$ or oxygen;

o_1 is an integer from 0 to 3;

k is an integer from 1 to 6;

D_1 is a hydrogen or K;

D_5 is $-\text{U}_3\text{D}_1$ or K' ;

D_6 is $-\text{OD}_1$ or K' ;

K is $-(\text{W}_3)_a-\text{E}_b-(\text{C}(\text{R}_e)(\text{R}_f))_{p1}-\text{E}_c-(\text{C}(\text{R}_e)(\text{R}_f))_x-(\text{W}_3)_d-(\text{C}(\text{R}_e)(\text{R}_f))_y-(\text{W}_3)_i-\text{E}_j-(\text{W}_3)_g-$
 $(\text{C}(\text{R}_e)(\text{R}_f))_z-\text{V}_4$;

K' is $-\text{G}-\text{E}_c-(\text{C}(\text{R}_e)(\text{R}_f))_x-\text{W}_d-(\text{C}(\text{R}_e)(\text{R}_f))_y-\text{W}_i-\text{E}_j-\text{W}_g-(\text{C}(\text{R}_e)(\text{R}_f))_z-\text{V}_4$;

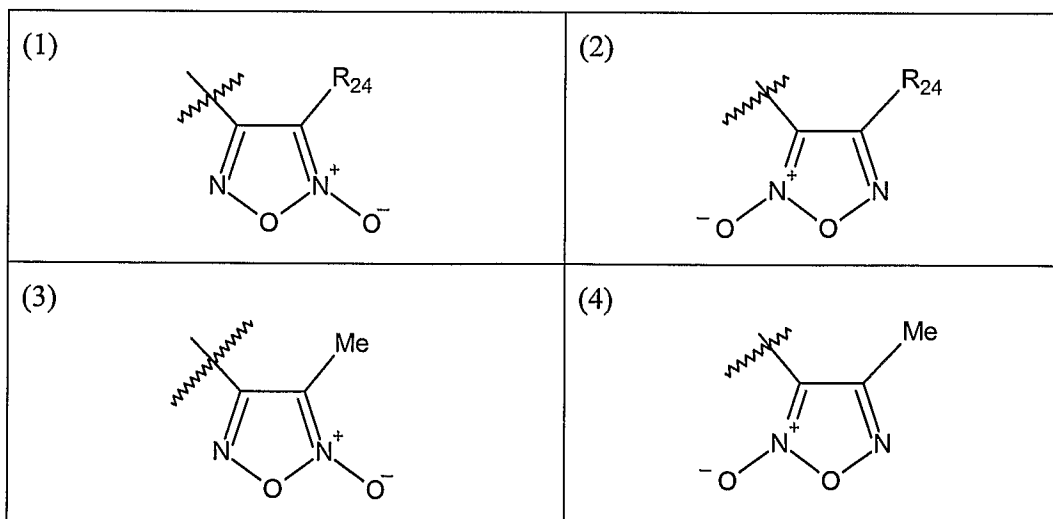
a, b, c, d, g, i and j are each independently an integer from 0 to 3;

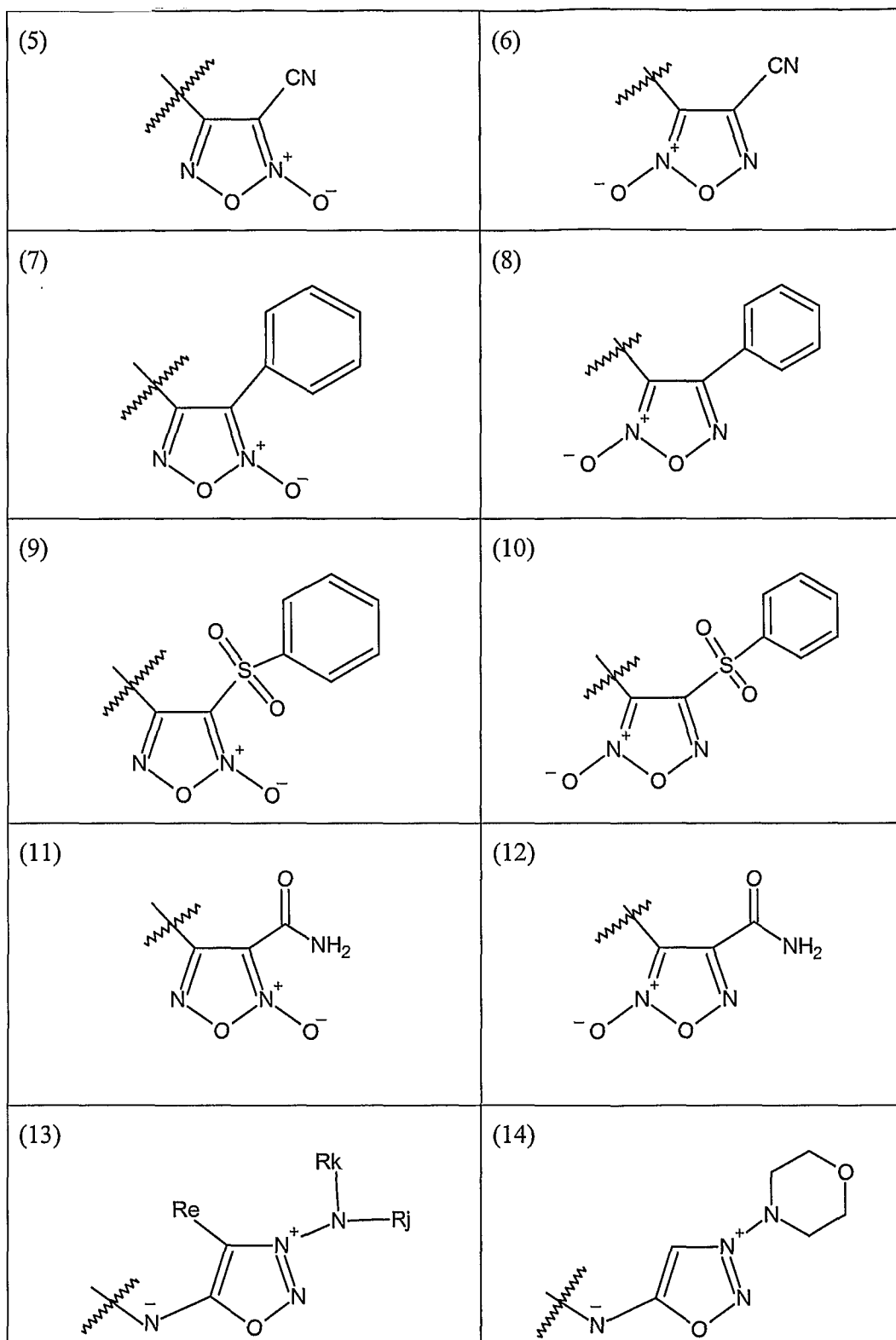
p_1, x, y and z are each independently an integer from 0 to 10;

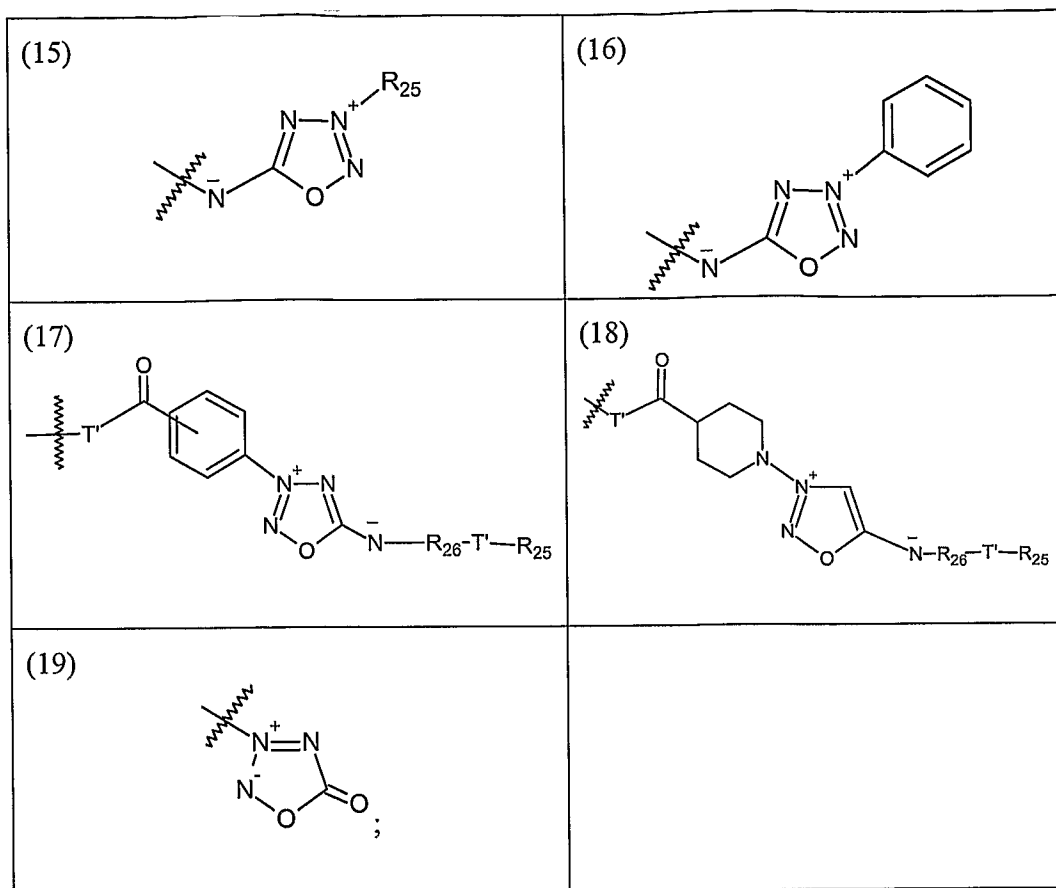
G is a heterocyclic ring or T_3 ;

V_4 is $\text{V}_3, \text{R}_e, -\text{U}_3-\text{V}_5$ or V_6 ;

V_3 is:







R_{24} is $-C_6H_4R_{37}$, $-CN$, $-S(O)_2-C_6H_4R_{37}$, $-C(O)-N(R_a)(R_i)$, $-NO_2$, $-C(O)-OR_{25}$ or $-S(O)_2-R_{25}$;

R_{25} is an aryl group, a lower alkyl group, a haloalkyl group, a hydroxyalkyl group or an arylalkyl group;

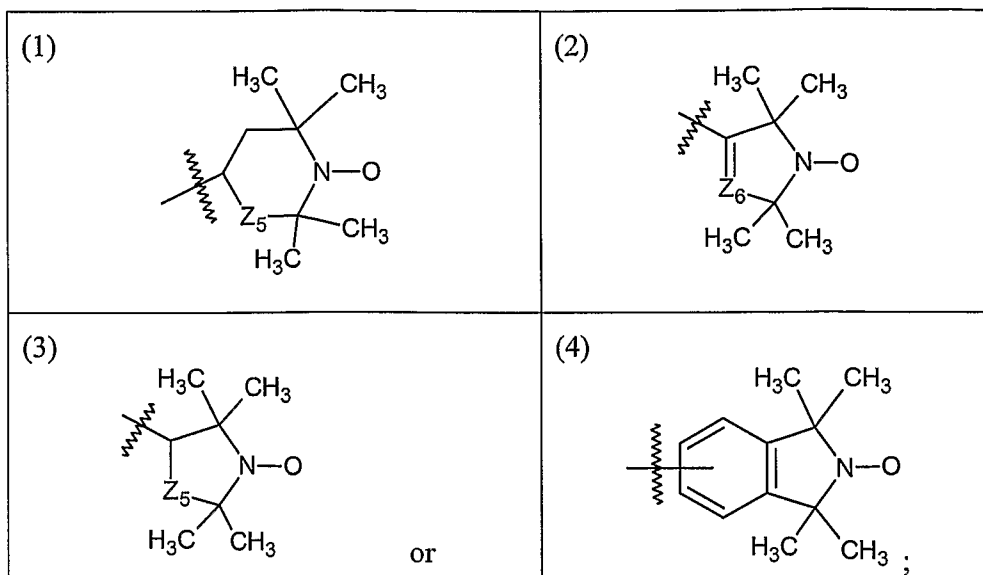
R_{26} is $-C(O)-$ or $-S(O)_2-$;

R_{37} is a hydrogen, $-CN$, $-S(O)_2-R_{25}$, $-C(O)-N(R_a)(R_i)$, $-NO_2$ or $-C(O)-OR_{25}$;

T' is oxygen, sulfur or NR_6 ;

R_6 is a hydrogen, a lower alkyl group, or an aryl group;

V₆ is:



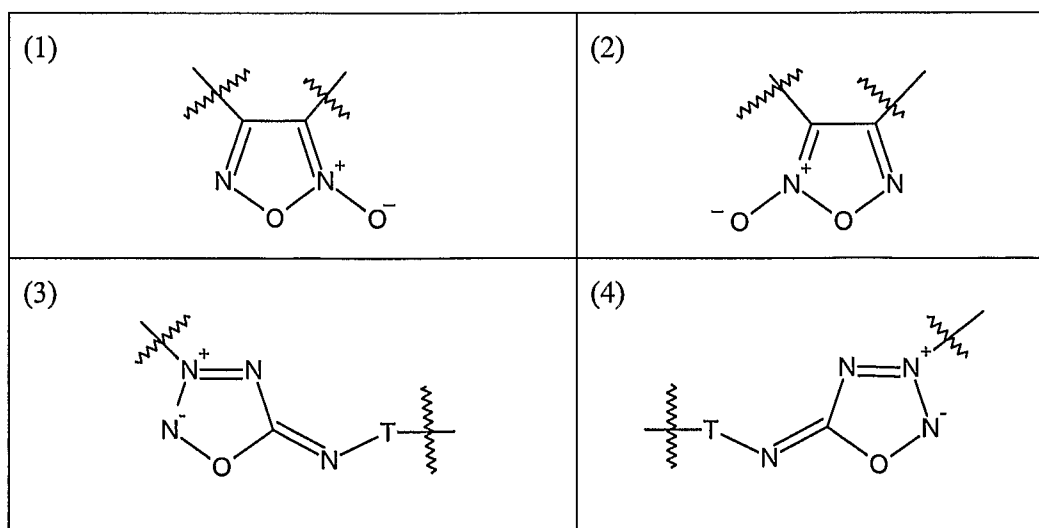
Z₅ is -CH₂ or oxygen;

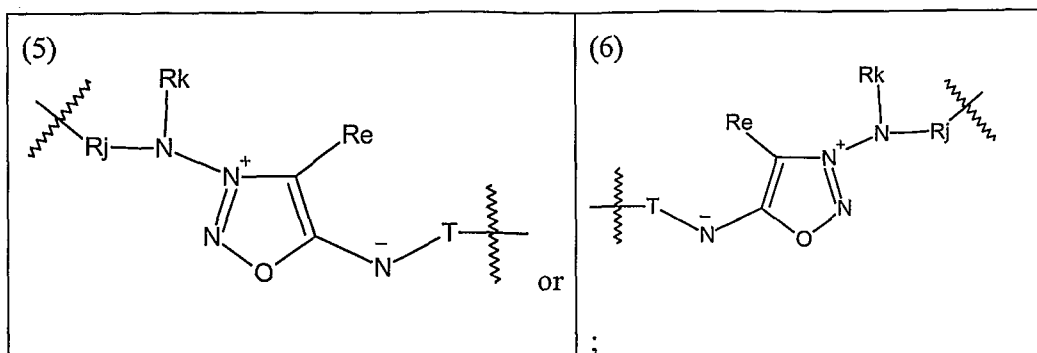
Z₆ is -CH or nitrogen;

W₃ at each occurrence is independently -C(O)-, -C(S)-, -T₃-, -(C(R_e)(R_f))_h-, -N(R_a)R_i, an alkyl group, an aryl group, a heterocyclic ring, an arylheterocyclic ring, -(CH₂CH₂O)_{q1}- or a heterocyclic nitric oxide donor;

E at each occurrence is independently -T₃-, an alkyl group, an aryl group, -(C(R_e)(R_f))_h-, a heterocyclic ring, an arylheterocyclic ring, -(CH₂CH₂O)_{q1}- or Y₄;

Y₄ is:





T is a $-S(O)_o-$; a carbonyl or a covalent bond;

o is an integer from 0 to 2;

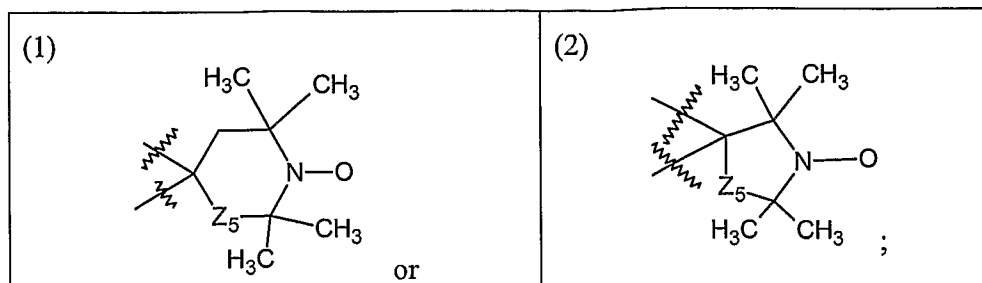
R_j and R_k are independently selected from an alkyl group, an aryl group, or R_j and R_k taken together with the nitrogen atom to which they are attached are a heterocyclic ring;

T_3 at each occurrence is independently a covalent bond, a carbonyl, an oxygen, $-S(O)_o-$ or $-N(R_a)R_i$;

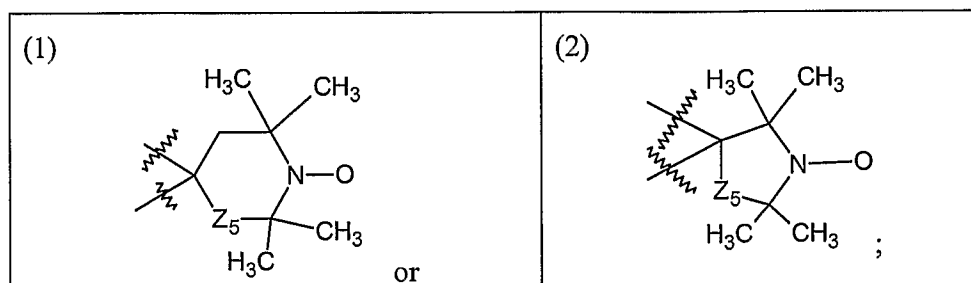
h is an integer from 1 to 10;

q_1 is an integer from 1 to 5;

R_e and R_f are each independently a hydrogen, an alkyl, a cycloalkoxy, a halogen, a hydroxy, an hydroxyalkyl, an alkoxyalkyl, an arylheterocyclic ring, an alkylaryl, an alkylcycloalkyl, an alkylheterocyclic ring, a cycloalkylalkyl, a cycloalkylthio, an arylalkylthio, an arylalkylthioalkyl, an alkylthioalkyl, a cycloalkenyl, an heterocyclicalkyl, an alkoxy, a haloalkoxy, an amino, an alkylamino, a dialkylamino, an arylamino, a diarylamino, an alkylaryl amino, an alkoxyhaloalkyl, a sulfonic acid, a sulfonic ester, an alkylsulfonic acid, an arylsulfonic acid, an arylalkoxy, an alkylthio, an arylthio, a cyano, an aminoalkyl, an aminoaryl, an aryl, an arylalkyl, an alkylaryl, a carboxamido, an alkylcarboxamido, an arylcarboxamido, an amidyl, a carboxyl, a carbamoyl, an alkylcarboxylic acid, an arylcarboxylic acid, an alkylcarbonyl, an arylcarbonyl, an ester, a carboxylic ester, an alkylcarboxylic ester, an arylcarboxylic ester, a sulfonamido, an alkylsulfonamido, an arylsulfonamido, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfonyl, arylsulphonyloxy, a sulfonic ester, an alkyl ester, an aryl ester, a urea, a phosphoryl, a nitro, $-U_3-V_5$, V_6 , $-(C(R_o)(R_p))_{k1}-U_3-V_5$, $-(C(R_o)(R_p))_{k1}-U_3-V_3$, $-(C(R_o)(R_p))_{k1}-U_3-V_6$, $-(C(R_o)(R_p))_{k1}-U_3-C(O)-V_6$, or R_e and R_f taken together with the carbons to which they are attached form a carbonyl, a methanthial, a heterocyclic ring, a cycloalkyl group, an aryl group, an oxime, an imine, a hydrazone, a bridged cycloalkyl group,



R_o and R_p are each independently a hydrogen, an alkyl, a cycloalkoxy, a halogen, a hydroxy, an hydroxyalkyl, an alkoxyalkyl, an arylheterocyclic ring, an alkylaryl, an
 5 alkylcycloalkyl, an alkylheterocyclic ring, a cycloalkylalkyl, a cycloalkylthio, an arylalklythio, an arylalklythioalkyl, an alkylthioalkyl a cycloalkenyl, an heterocyclicalkyl, an alkoxy, a haloalkoxy, an amino, an alkylamino, a dialkylamino, an arylamino, a diarylamino, an alkylaryl amino, an alkoxyhaloalkyl, a sulfonic acid, a sulfonic ester, an alkylsulfonic acid, an arylsulfonic acid, an arylalkoxy, an alkylthio, an arylthio, a cyano an aminoalkyl, an
 10 aminoaryl, an aryl, an arylalkyl, an alkylaryl, a carboxamido, an alkylcarboxamido, an arylcarboxamido, an amidyl, a carboxyl, a carbamoyl, an alkylcarboxylic acid, an arylcarboxylic acid, an alkylcarbonyl, an arylcarbonyl, an ester, a carboxylic ester, an alkylcarboxylic ester, an arylcarboxylic ester, a sulfonamido, an alkylsulfonamido, an arylsulfonamido, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfonyl, arylsulphonyloxy, a
 15 sulfonic ester, an alkyl ester, an aryl ester, a urea, a phosphoryl, a nitro, $-U_3-V_5$, V_6 , or R_o and R_p taken together with the carbons to which they are attached form a carbonyl, a methanthial, a heterocyclic ring, a cycloalkyl group, an aryl group, an oxime, an imine, a hydrazone a bridged cycloalkyl group,



U_3 is an oxygen, sulfur or $-N(R_a)R_i$;

V_5 is $-\text{NO}$ or $-\text{NO}_2$ (i.e. an oxidized nitrogen);

k_1 is an integer from 1 to 3;

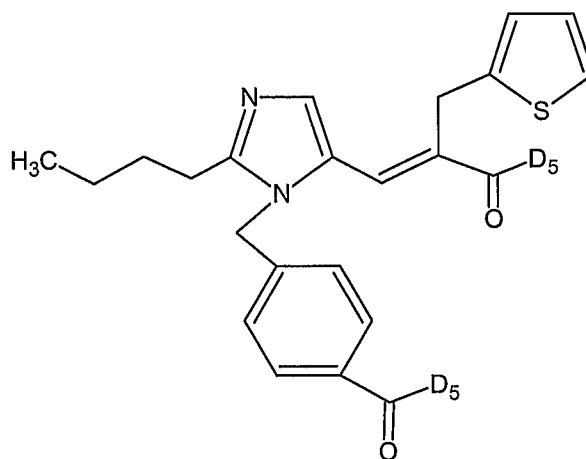
R_a is a lone pair of electrons, a hydrogen or an alkyl group;

R_i is a hydrogen, an alkyl, an aryl, an alkylcarboxylic acid, an arylcarboxylic acid, an alkylcarboxylic ester, an arylcarboxylic ester, an alkylcarboxamido, an arylcarboxamido, an alkylaryl, an alkylsulfinyl, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfinyl, an arylsulfonyl, an arylsulphonyloxy, a sulfonamido, a carboxamido, a carboxylic ester, an aminoalkyl, an aminoaryl, $-\text{CH}_2-\text{C}-(\text{U}_3-\text{V}_5)(\text{R}_e)(\text{R}_f)$, a bond to an adjacent atom creating a double bond to that atom or $-(\text{N}_2\text{O}_2-)\cdot\text{M}_1^+$, wherein M_1^+ is an organic or inorganic cation; and

with the proviso that the compound of Formula (I) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (I) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

In cases where multiple designations of variables which reside in sequence are chosen as a "covalent bond" or the integer chosen is 0, the intent is to denote a single covalent bond connecting one radical to another. For example, E_0 would denote a covalent bond, while E_2 denotes $(\text{E}-\text{E})$ and $(\text{C}(\text{R}_4)(\text{R}_4))_2$ denotes $-\text{C}(\text{R}_4)(\text{R}_4)-\text{C}(\text{R}_4)(\text{R}_4)-$.

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (II) and pharmaceutically acceptable salts thereof:



(II)

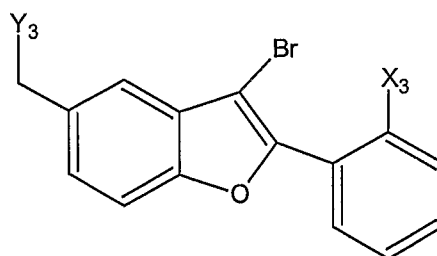
wherein:

D_5 is as defined herein; and

with the proviso that the compound of Formula (II) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (II)

through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (III) and pharmaceutically acceptable salts thereof:



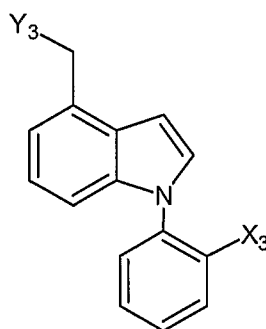
(III)

wherein:

X₃ and Y₃ are as defined herein; and

with the proviso that the compound of Formula (III) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (III) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (IV) and pharmaceutically acceptable salts thereof:



(IV)

wherein:

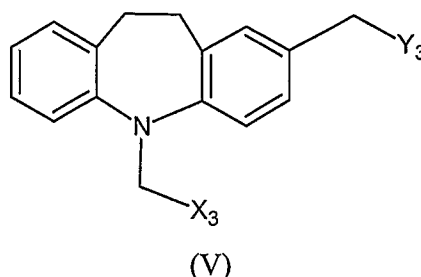
X₃ and Y₃ are as defined herein; and

with the proviso that the compound of Formula (IV) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (IV)

through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (V) and pharmaceutically acceptable salts thereof:

5



wherein:

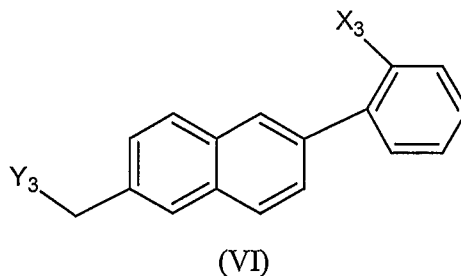
X₃ and Y₃ are as defined herein; and

10

with the proviso that the compound of Formula (V) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (V) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (VI) and pharmaceutically acceptable salts thereof:

15



wherein:

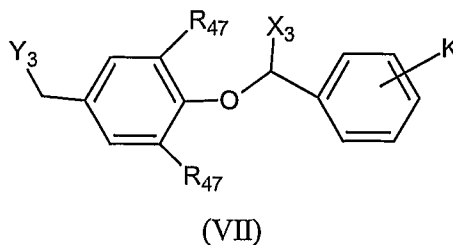
20

X₃ and Y₃ are as defined herein; and

with the proviso that the compound of Formula (VI) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (VI) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

25

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (VII) and pharmaceutically acceptable salts thereof:



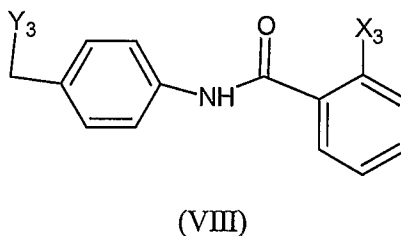
wherein:

R_{47} is a lower alkyl or $-(C(R_g)R_h))_k-V_4$;

X_3 , Y_3 , R_g , R_h , V_4 , K and k are as defined herein; and

with the proviso that the compound of Formula (VII) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (VII) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

In another embodiment, the invention provides nitric oxide enhancing angiotensin II antagonist compounds of Formula (VIII) and pharmaceutically acceptable salts thereof:



wherein:

X_3 and Y_3 are as defined herein; and

with the proviso that the compound of Formula (VIII) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (VIII) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed.

In other embodiments of the invention the compound of Formula (I) is a nitric oxide enhancing abitesartan, a nitric oxide enhancing candesartan, a nitric oxide enhancing elisartan, a nitric oxide enhancing embusartan, a nitric oxide enhancing enoltasartan, a nitric oxide enhancing fonsartan, a nitric oxide enhancing forasartan, a nitric oxide enhancing glycylosartan, a nitric oxide enhancing irbesartan, a nitric oxide enhancing losartan, a nitric oxide enhancing olmesartan, a nitric oxide enhancing milfasartan, a nitric oxide enhancing pomisartan, a nitric oxide enhancing ripisartan, a nitric oxide enhancing tasosartan, a nitric

oxide enhancing telmisartan, a nitric oxide enhancing valsartan, a nitric oxide enhancing CL-329167, a nitric oxide enhancing MK 996, a nitric oxide enhancing SR-47436, a nitric oxide enhancing YM 358, or a nitric oxide enhancing any of the following compounds of ACS registry number 124750-92-1, 133240-46-7, 135070-05-2, 139958-16-0, 145160-84-5, 147403-03-0, 153806-29-2, 439904-54-8P, 439904-55-9P, 439904-56-0P, 439904-57-1P, 439904-58-2P, 155918-60-8P, 155918-61-9P, 272438-16-1P, 272446-75-0P, 223926-77-0P, 169281-89-4, 439904-65-1P, 165113-01-9P, 165113-02-0P, 165113-03-1P, 165113-03-2P, 165113-05-3P, 165113-06-4P, 165113-07-5P, 165113-08-6P, 165113-09-7P, 165113-10-0P, 165113-11-1P, 165113-12-2P, 165113-17-7P, 165113-18-8P, 165113-19-9P, 165113-20-2P, 165113-13-3P, 165113-14-4P, 165113-15-5P, 165113-16-6P, 165113-21-3P, 165113-22-4P, 165113-23-5P, 165113-24-6P, 165113-25-7P, 165113-26-8P, 165113-27-9P, 165113-28-0P, 165113-29-1P, 165113-30-4P, 165113-31-5P, 165113-32-6P, 165113-33-7P, 165113-34-8P, 165113-35-9P, 165113-36-0P, 165113-37-1P, 165113-38-2P, 165113-39-3P, 165113-40-6P, 165113-41-7P, 165113-42-8P, 165113-43-9P, 165113-44-0P, 165113-45-1P, 165113-46-2P, 165113-47-3P, 165113-48-4P, 165113-49-5P, 165113-50-8P, 165113-51-9P, 165113-52-0P, 165113-53-1P, 165113-54-2P, 165113-55-3P, 165113-56-4P, 165113-57-5P, 165113-58-6P, 165113-59-7P, 165113-60-0P, 165113-61-1P, 165113-62-2P, 165113-63-3P, 165113-64-4P, 165113-65-5P, 165113-66-6P, 165113-67-7P, 165113-68-8P, 165113-69-9P, 165113-70-2P, 165113-71-3P, 165113-72-4P, 165113-73-5P, 165113-74-6P, 114798-27-5, 114798-28-6, 114798-29-7, 124749-82-2, 114798-28-6, 124749-84-4, 124750-88-5, 124750-91-0, 124750-93-2, 161946-65-2P, 161947-47-3P, 161947-48-4P, 161947-51-9P, 161947-52-0P, 161947-55-3P, 161947-56-4P, 161947-60-0P, 161947-61-1P, 161947-68-8P, 161947-69-9P, 161947-70-2P, 161947-71-3P, 161947-72-4P, 161947-74-6P, 161947-75-7P, 161947-81-5P, 161947-82-6P, 161947-83-7P, 161947-84-8P, 161947-85-9P, 161947-86-0P, 161947-87-1P, 161947-88-2P, 161947-89-3P, 161947-90-6P, 161947-91-7P, 161947-92-8P, 161947-93-9P, 161947-94-0P, 161947-95-1P, 161947-96-2P, 161947-97-3P, 161947-98-4P, 161947-99-5P, 161948-00-1P, 161948-01-2P, 161948-02-3P, 168686-32-6P, 167301-42-0P, 166813-82-7P, 166961-56-4P, 166961-58-6P, 158872-96-9P, 158872-97-0P, 158807-14-8P, 158807-15-9P, 158807-16-0P, 158807-17-1P, 158807-18-2P, 158807-19-3P, 158807-20-6P, 155884-08-5P, 154749-99-2, 167371-59-7P, 244126-99-6P, 177848-35-0P and 141309-82-2P; the compound of Formula (II) is a nitric oxide enhancing eprosartan; the compound of Formula (III) is a nitric oxide enhancing saprisartan or a nitric oxide enhancing zolasartan; the compound of Formula (IV) is a nitric oxide enhancing BMS 180560; the compound of Formula (V) is a nitric oxide

enhancing KW 3433; the compound of Formula (VI) is a nitric oxide enhancing GA 0056; and the compound of Formula (VII) is a nitric oxide enhancing L 158,809.

In another embodiment, the nitric oxide enhancing angiotensin II antagonist compounds of Formula (I) is:

- 5 L-valine, N-[5-(nitrooxy)-1-oxopentyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- L-valine, N-[6-(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- L-valine, N-[3-[(nitrooxy)methyl]benzoyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- L-valine, N-[4,5-bis(nitrooxy)-1-oxopentyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- 10 L-valine, N-[5,6-bis(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- pentanamide, N-[(1S)-1-[(dimethylamino)carbonyl]-2-methylpropyl]-5-(nitrooxy)-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- 15 pentanamide, N-[3-(nitrooxy)propyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- pentanamide, N-[(1S)-1-[[bis[2-(nitrooxy)ethyl]amino]carbonyl]-2-methylpropyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- pentanamide, N-[(1S)-2-methyl-1-[[methyl[2-(nitrooxy)ethyl]amino]carbonyl]propyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- 20 pentanamide, N-[(1S)-2-methyl-1-[[4-[(nitrooxy)methyl]-1-piperidinyl]carbonyl]propyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;
- 1-piperidinyloxy, 4-[[[4'-(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]amino]carbonyl]-2,2,6,6-tetramethyl-;
- 25 1H-pyrrol-1-yloxy, 3-[[[4'-(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]amino]carbonyl]-2,5-dihydro-2,2,5,5-tetramethyl-;
- benzamide, N-[[4'-(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]-3-[(nitrooxy)methyl]-;
- 1H-benzimidazole-7-methanol, 2-ethoxy-1-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-, nitrate (ester); and pharmaceutically acceptable salts thereof.
- 30

Compounds of the invention that have one or more asymmetric carbon atoms may exist as the optically pure enantiomers, pure diastereomers, mixtures of enantiomers, mixtures of diastereomers, racemic mixtures of enantiomers, diastereomeric racemates or mixtures of

diastereomeric racemates. It is to be understood that the invention anticipates and includes within its scope all such isomers and mixtures thereof.

Another embodiment of the invention provides the nitric oxide enhancing metabolites of the angiotensin II antagonists. These metabolites, include but are not limited to, degradation products, hydrolysis products, gluconoride adducts and the like, of the nitric oxide enhancing angiotensin II antagonist compounds and pharmaceutically acceptable salts thereof, of the angiotensin II antagonist compounds.

Another embodiment of the invention provides processes for making the novel compounds of the invention and to the intermediates useful in such processes. The reactions are performed in solvents appropriate to the reagents and materials used are suitable for the transformations being effected. It is understood by one skilled in the art of organic synthesis that the functionality present in the molecule must be consistent with the chemical transformation proposed. This will, on occasion, necessitate judgment by the routineer as to the order of synthetic steps, protecting groups required, and deprotection conditions. Substituents on the starting materials may be incompatible with some of the reaction conditions required in some of the methods described, but alternative methods and substituents compatible with the reaction conditions will be readily apparent to one skilled in the art. The use of sulfur and oxygen protecting groups is well known for protecting thiol and alcohol groups against undesirable reactions during a synthetic procedure and many such protecting groups are known and described by, for example, Greene and Wuts, *Protective Groups in Organic Synthesis*, Third Edition, John Wiley & Sons, New York (1999).

The chemical reactions described herein are generally disclosed in terms of their broadest application to the preparation of the compounds of this invention. Occasionally, the reactions may not be applicable as described to each compound included within the disclosed scope. The compounds for which this occurs will be readily recognized by one skilled in the art. In all such cases, either the reactions can be successfully performed by conventional modifications known to one skilled in the art, e.g., by appropriate protection of interfering groups, by changing to alternative conventional reagents, by routine modification of reaction conditions, and the like, or other reactions disclosed herein or otherwise conventional, will be applicable to the preparation of the corresponding compounds of this invention. In all preparative methods, all starting materials are known or readily prepared from known starting materials.

The angiotensin II antagonist compounds are either commercially available or can be

prepared according to the methods described are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, 13th Edition; and on STN Express, file phar and file registry.

5 The parent angiotensin II antagonist compounds are substituted to contain a nitric oxide enhancing group linked to the angiotensin II antagonist compound through one or more sites such as carbon and/or nitrogen using conventional methods known to one skilled in the art. Known methods for linking the nitric oxide enhancing group to compounds are described in WO 99/64417, WO 94/01422; EP 0 574 726 A1, EP 0 683 159 A1; and in *J. Med. Chem.*,
10 47: 2688-2693 (2004); *J. Med. Chem.*, 47: 1840-1846 (2004); *J. Med. Chem.*, 46: 3762-3765 (2003); *J. Med. Chem.*, 46: 747-754 (2003); *Chem Rev.*, 102: 1091-1134 (2002); *J. Med. Chem.*, 42: 1941-1950 (1999); *J. Med. Chem.*, 41: 5393-5401 (1998); *J. Med. Chem.*, 38: 4944-4949 (1995); *Arzneim. Forsch. Drug Res.*, 47 (II): 847-854 (1997); the disclosures of each of which are incorporated by reference herein in their entirety. The methods of linking
15 the nitric oxide enhancing group to compounds described in these references can be applied by one skilled in the art to produce any of the angiotensin II antagonist compounds comprising a heterocyclic nitric oxide donor group described herein.

 Known methods of linking the nitroxide group to compounds are described in U.S. Patent Nos. 6,448,267, 6,455,542, 6,759,430, and in WO 2004/050084, WO 03/088961, the
20 disclosures of each of which are incorporated by reference herein in their entirety.

 Nitric oxide enhancing angiotensin II antagonist compounds comprising at least one -ONO group, -SNO group, -NNO group, -ONO₂ group, -SNO₂ group, -NNO₂ group and/or -(N₂O₂-)•M₁⁺ group can be synthesized using conventional methods known to one skilled in the art. Known methods for attaching a -ONO group, -SNO group, -NNO group, -ONO₂
25 group, -SNO₂ group, -NNO₂ group and/or -(N₂O₂-)•M₁⁺ group to compounds are described in U.S. Patent Nos. 5,380,758, 5,859,053, 5,703,073 and 6,297,260; and in WO 94/03421, WO 94/04484, WO 94/12463, WO 95/09831, WO 95/19952, WO 95/30641, WO 97/27749, WO 98/09948, WO 98/19672, WO 98/21193, WO 00/51988, WO 00/61604, WO 00/72838, WO 01/00563, WO 01/04082, WO 01/10814, WO 01/12584, WO 01/45703, WO 00/61541, WO
30 00/61537, WO 02/11707, WO 02/30866 and in Oae et al, *Org. Prep. Proc. Int.*, 15(3):165-198 (1983), the disclosures of each of which are incorporated by reference herein in their entirety. The methods of for attaching a -ONO group, -SNO group, -NNO group, -ONO₂ group, -SNO₂ group, -NNO₂ group and/or -(N₂O₂-)•M₁⁺ group to compounds described in

these references can be applied by one skilled in the art to produce any of the nitric oxide enhancing angiotensin II antagonist compounds described herein.

Compounds contemplated for use in the invention, e.g., nitric oxide enhancing angiotensin II antagonist compounds comprising at least one nitric oxide enhancing group, linked to the angiotensin II antagonist compound through one or more sites such as carbon, oxygen, nitrogen and/or sulfur via a bond or moiety that cannot be hydrolyzed, are, optionally, used in combination with nitric oxide enhancing compounds that release nitric oxide, increase endogeneous levels of nitric oxide or otherwise directly or indirectly deliver or transfer a biologically active form of nitrogen monoxide to a site of its intended activity, such as on a cell membrane *in vivo*.

Nitrogen monoxide can exist in three forms: NO⁻ (nitroxyl), NO[•] (nitric oxide) and NO⁺ (nitrosonium). NO[•] is a highly reactive short-lived species that is potentially toxic to cells. This is critical because the pharmacological efficacy of NO depends upon the form in which it is delivered. In contrast to the nitric oxide radical (NO[•]), nitrosonium (NO⁺) does not react with O₂ or O₂⁻ species, and functionalities capable of transferring and/or releasing NO⁺ and NO⁻ are also resistant to decomposition in the presence of many redox metals. Consequently, administration of charged NO equivalents (positive and/or negative) does not result in the generation of toxic by-products or the elimination of the active NO group.

The term "nitric oxide" encompasses uncharged nitric oxide (NO[•]) and charged nitrogen monoxide species, preferably charged nitrogen monoxide species, such as nitrosonium ion (NO⁺) and nitroxyl ion (NO⁻). The reactive form of nitric oxide can be provided by gaseous nitric oxide. The nitrogen monoxide releasing, delivering or transferring compounds have the structure F-NO, wherein F is a nitrogen monoxide releasing, delivering or transferring group, and include any and all such compounds which provide nitrogen monoxide to its intended site of action in a form active for its intended purpose.

The term "NO adducts" encompasses any nitrogen monoxide releasing, delivering or transferring compounds, including, for example, S-nitrosothiols, nitrites, nitrates, S-nitrothiols, sydnonimines, 2-hydroxy-2-nitrosohydrazines, (NONOates), (E)-alkyl-2-((E)-hydroxyimino)-5-nitro-3-hexeneamide (FK-409), (E)-alkyl-2-((E)-hydroxyimino)-5-nitro-3-hexeneamines, N-((2Z, 3E)-4-ethyl-2-(hydroxyimino)-6-methyl-5-nitro-3-heptenyl)-3-pyridinecarboxamide (FR 146801), N-nitrosoamines, N-hydroxyl nitrosamines, nitrosimines, diazetine dioxides, oxatriazole 5-imines, oximes, hydroxylamines, N-hydroxyguanidines, hydroxyureas, benzofuroxanes, furoxans as well as substrates for the endogenous enzymes

which synthesize nitric oxide.

Suitable NONOates include, but are not limited to, (Z)-1-(N-methyl-N-(6-(N-methylammoniohexyl)amino))diazene-1,2-diolate ("MAHMA/NO"), (Z)-1-(N-(3-ammoniopropyl)-N-(n-propyl)amino)diazene-1,2-diolate ("PAPA/NO"), (Z)-1-(N-(3-aminopropyl)-N-(4-(3-aminopropylammonio)butyl)amino) diazene-1,2-diolate (spermine NONOate or "SPER/NO") and sodium(Z)-1-(N,N-diethylamino)diazene-1,2-diolate (diethylamine NONOate or "DEA/NO") and derivatives thereof. NONOates are also described in U.S. Patent Nos. 6,232,336, 5,910,316 and 5,650,447, the disclosures of which are incorporated herein by reference in their entirety. The "NO adducts" can be mono-nitrosylated, poly-nitrosylated, mono-nitrosated and/or poly-nitrosated at a variety of naturally susceptible or artificially provided binding sites for biologically active forms of nitrogen monoxide.

Suitable furoxanes include, but are not limited to, CAS 1609, C93-4759, C92-4678, S35b, CHF 2206, CHF 2363, and the like.

Suitable sydnonimines include, but are not limited to, molsidomine (N-ethoxycarbonyl-3-morpholinosydnonimine), SIN-1 (3-morpholinosydnonimine) CAS 936 (3-(cis-2,6-dimethylpiperidino)-N-(4-methoxybenzoyl)-sydnonimine, pirsidomine), C87-3754 (3-(cis-2,6-dimethylpiperidino)sydnonimine, linsidomine, C4144 (3-(3,3-dimethyl-1,4-thiazane-4-yl)sydnonimine hydrochloride), C89-4095 (3-(3,3-dimethyl-1,1-dioxo-1,4-thiazane-4-yl)sydnonimine hydrochloride, and the like.

Suitable oximes, include, but are not limited to, NOR-1, NOR-3, NOR-4, and the like.

One group of NO adducts is the S-nitrosothiols, which are compounds that include at least one -S-NO group. These compounds include S-nitroso-polypeptides (the term "polypeptide" includes proteins and polyamino acids that do not possess an ascertained biological function, and derivatives thereof); S-nitrosylated amino acids (including natural and synthetic amino acids and their stereoisomers and racemic mixtures and derivatives thereof); S-nitrosylated sugars; S-nitrosylated, modified and unmodified, oligonucleotides (preferably of at least 5, and more preferably 5-200 nucleotides); straight or branched, saturated or unsaturated, aliphatic or aromatic, substituted or unsubstituted S-nitrosylated hydrocarbons; and S-nitroso heterocyclic compounds. S-nitrosothiols and methods for preparing them are described in U.S. Patent Nos. 5,380,758 and 5,703,073; WO 97/27749; WO 98/19672; and Oae et al, *Org. Prep. Proc. Int.*, 15(3):165-198 (1983), the disclosures of each of which are incorporated by reference herein in their entirety.

Another embodiment of the invention is S-nitroso amino acids where the nitroso group is linked to a sulfur group of a sulfur-containing amino acid or derivative thereof. Such compounds include, for example, S-nitroso-N-acetylcysteine, S-nitroso-captopril, S-nitroso-N-acetylpenicillamine, S-nitroso-homocysteine, S-nitroso-cysteine, S-nitroso-glutathione, S-nitroso-cysteinyl-glycine, and the like.

Suitable S-nitrosylated proteins include thiol-containing proteins (where the NO group is attached to one or more sulfur groups on an amino acid or amino acid derivative thereof) from various functional classes including enzymes, such as tissue-type plasminogen activator (TPA) and cathepsin B; transport proteins, such as lipoproteins; heme proteins, such as hemoglobin and serum albumin; and biologically protective proteins, such as immunoglobulins, antibodies and cytokines. Such nitrosylated proteins are described in WO 93/09806, the disclosure of which is incorporated by reference herein in its entirety. Examples include polynitrosylated albumin where one or more thiol or other nucleophilic centers in the protein are modified.

Other examples of suitable S-nitrosothiols include:

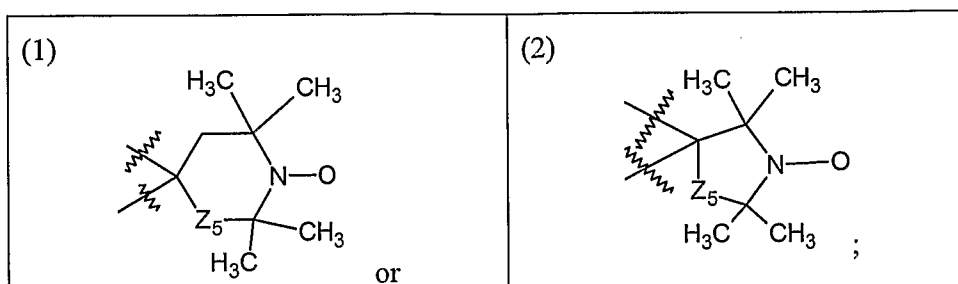
- (i) $\text{HS}(\text{C}(\text{R}_e)(\text{R}_f))_m\text{SNO}$;
- (ii) $\text{ONS}(\text{C}(\text{R}_e)(\text{R}_f))_m\text{R}_e$; or
- (iii) $\text{H}_2\text{N}-\text{CH}(\text{CO}_2\text{H})-(\text{CH}_2)_m-\text{C}(\text{O})\text{NH}-\text{CH}(\text{CH}_2\text{SNO})-\text{C}(\text{O})\text{NH}-\text{CH}_2-\text{CO}_2\text{H}$;

wherein m is an integer from 2 to 20;

R_e and R_f are each independently a hydrogen, an alkyl, a cycloalkoxy, a halogen, a hydroxy, an hydroxyalkyl, an alkoxyalkyl, an arylheterocyclic ring, an alkylaryl, an alkylcycloalkyl, an alkylheterocyclic ring, a cycloalkylalkyl, a cycloalkylthio, an arylalkylthio, an arylalkylthioalkyl, an alkylthioalkyl, a cycloalkenyl, an heterocyclicalkyl, an alkoxy, a haloalkoxy, an amino, an alkylamino, a dialkylamino, an arylamino, a diarylamino, an alkylaryl amino, an alkoxyhaloalkyl, a sulfonic acid, a sulfonic ester, an alkylsulfonic acid, an arylsulfonic acid, an arylalkoxy, an alkylthio, an arylthio, a cyano, an aminoalkyl, an aminoaryl, an aryl, an arylalkyl, an alkylaryl, a carboxamido, an alkylcarboxamido, an arylcarboxamido, an amidyl, a carboxyl, a carbamoyl, an alkylcarboxylic acid, an arylcarboxylic acid, an alkylcarbonyl, an arylcarbonyl, an ester, a carboxylic ester, an alkylcarboxylic ester, an arylcarboxylic ester, a sulfonamido, an alkylsulfonamido, an arylsulfonamido, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfonyl, arylsulphonyloxy, a sulfonic ester, an alkyl ester, an aryl ester, a urea, a phosphoryl, a nitro, $-\text{U}_3-\text{V}_5$, V_6 , $-(\text{C}(\text{R}_o)(\text{R}_p))_{k1}-\text{U}_3-\text{V}_5$, $-(\text{C}(\text{R}_o)(\text{R}_p))_{k1}-\text{U}_3-\text{V}_6$, $-(\text{C}(\text{R}_o)(\text{R}_p))_{k1}-\text{U}_3-\text{C}(\text{O})-\text{V}_6$, or R_e and R_f taken

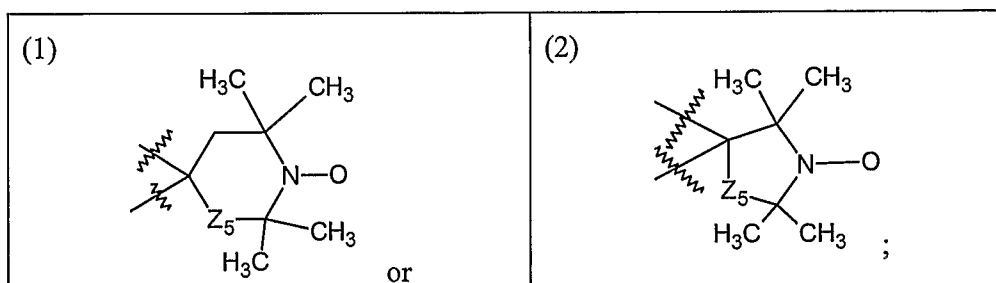
together with the carbons to which they are attached form a carbonyl, a methanthial, a heterocyclic ring, a cycloalkyl group, an aryl group, an oxime, a hydrazone, a bridged cycloalkyl group,

5



R_o and R_p are each independently a hydrogen, an alkyl, a cycloalkoxy, a halogen, a hydroxy, an hydroxyalkyl, an alkoxyalkyl, an arylheterocyclic ring, an alkylaryl, an alkylcycloalkyl, an alkylheterocyclic ring, a cycloalkylalkyl, a cycloalkylthio, an arylalkylthio, an arylalkylthioalkyl, an alkylthioalkyl a cycloalkenyl, an heterocyclicalkyl, an alkoxy, a haloalkoxy, an amino, an alkylamino, a dialkylamino, an arylamino, a diarylamino, an alkylaryl amino, an alkoxyhaloalkyl, a sulfonic acid, a sulfonic ester, an alkylsulfonic acid, an arylsulfonic acid, an arylalkoxy, an alkylthio, an arylthio, a cyano, an aminoalkyl, an aminoaryl, an aryl, an arylalkyl, an alkylaryl, a carboxamido, an alkylcarboxamido, an arylcarboxamido, an amidyl, a carboxyl, a carbamoyl, an alkylcarboxylic acid, an arylcarboxylic acid, an alkylcarbonyl, an arylcarbonyl, an ester, a carboxylic ester, an alkylcarboxylic ester, an arylcarboxylic ester, a sulfonamido, an alkylsulfonamido, an arylsulfonamido, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfonyl, arylsulphonyloxy, a sulfonic ester, an alkyl ester, an aryl ester, a urea, a phosphoryl, a nitro, $-U_3-V_5$, V_6 , or R_o and R_p taken together with the carbons to which they are attached form a carbonyl, a methanthial, a heterocyclic ring, a cycloalkyl group, an aryl group, an oxime, an imine, a hydrazone, a bridged cycloalkyl group,

20



k_1 is an integer form 1 to 3;

U_3 is an oxygen, sulfur- or $-N(R_a)R_i$;

V_5 is $-NO$ or $-NO_2$ (i.e. an oxidized nitrogen);

5 R_a is a lone pair of electrons, a hydrogen or an alkyl group;

R_i is a hydrogen, an alkyl, an aryl, an alkylcarboxylic acid, an arylcarboxylic acid, an alkylcarboxylic ester, an arylcarboxylic ester, an alkylcarboxamido, an arylcarboxamido, an alkylaryl, an alkylsulfinyl, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfinyl, an arylsulfonyl, arylsulphonyloxy, a sulfonamido, a carboxamido, a carboxylic ester, an aminoalkyl, an aminoaryl, $-CH_2-C(U_3-V_5)(R_e)(R_f)$, a bond to an adjacent atom creating a double bond to that atom or $-(N_2O_2)^- \cdot M_1^+$, wherein M_1^+ is an organic or inorganic cation.

In cases where R_e and R_f are independently a heterocyclic ring or taken together R_e and R_f are a heterocyclic ring, then R_i can be a substituent on any disubstituted nitrogen contained within the radical wherein R_i is as defined herein.

15 Nitrosothiols can be prepared by various methods of synthesis. In general, the thiol precursor is prepared first, then converted to the S-nitrosothiol derivative by nitrosation of the thiol group with $NaNO_2$ under acidic conditions (pH is about 2.5) which yields the S-nitroso derivative. Acids which can be used for this purpose include aqueous sulfuric, acetic and hydrochloric acids. The thiol precursor can also be nitrosylated by reaction with an organic nitrite such as tert-butyl nitrite, or a nitrosonium salt such as nitrosonium tetrafluoroborate in an inert solvent.

Another group of NO adducts for use in the invention, where the NO adduct is a compound that donates, transfers or releases nitric oxide, include compounds comprising at least one ON-O- or ON-N- group. The compounds that include at least one ON-O- or ON-N- group are preferably ON-O- or ON-N-polypeptides (the term "polypeptide" includes proteins and polyamino acids that do not possess an ascertained biological function, and derivatives thereof); ON-O- or ON-N-amino acids (including natural and synthetic amino acids and their stereoisomers and racemic mixtures); ON-O- or ON-N-sugars; ON-O- or -ON-N- modified or unmodified oligonucleotides (comprising at least 5 nucleotides, preferably 5-200 nucleotides); ON-O- or ON-N- straight or branched, saturated or unsaturated, aliphatic or aromatic, substituted or unsubstituted hydrocarbons; and ON-O-, ON-N- or ON-C-heterocyclic compounds. Examples of compounds comprising at least one ON-O- or ON-N-group include butyl nitrite, isobutyl nitrite, *tert*-butyl nitrite, amyl nitrite, isoamyl nitrite, N-

nitrosamines, N-nitrosamides, N-nitrosourea, N-nitrosoguanidines, N-nitrosocarbamates, N-acyl-N-nitroso compounds (such as, N-methyl-N-nitrosourea); N-hydroxy-N-nitrosamines, cupferron, alanosine, dopastin, 1,3-disubstituted nitrosiminobenzimidazoles, 1,3,4-thiadiazole-2-nitrosimines, benzothiazole-2(3H)-nitrosimines, thiazole-2-nitrosimines, oligonitroso
 5 sydnonimines, 3-alkyl-N-nitroso-sydnonimines, 2H-1,3,4-thiadiazine nitrosimines.

Another group of NO adducts for use in the invention include nitrates that donate, transfer or release nitric oxide, such as compounds comprising at least one O₂N-O-, O₂N-N- or O₂N-S- group. Among these compounds are O₂N-O-, O₂N-N- or O₂N-S- polypeptides (the
 10 term "polypeptide" includes proteins and also polyamino acids that do not possess an ascertained biological function, and derivatives thereof); O₂N-O-, O₂N-N- or O₂N-S- amino acids (including natural and synthetic amino acids and their stereoisomers and racemic mixtures); O₂N-O-, O₂N-N- or O₂N-S- sugars; O₂N-O-, O₂N-N- or O₂N-S- modified and unmodified oligonucleotides (comprising at least 5 nucleotides, preferably 5-200
 15 nucleotides); O₂N-O-, O₂N-N- or O₂N-S- straight or branched, saturated or unsaturated, aliphatic or aromatic, substituted or unsubstituted hydrocarbons; and O₂N-O-, O₂N-N- or O₂N-S- heterocyclic compounds. Examples of compounds comprising at least one O₂N-O-, O₂N-N- or O₂N-S- group include isosorbide dinitrate, isosorbide mononitrate, clonitrate, erythrityl tetranitrate, mannitol hexanitrate, nitroglycerin, pentaerythritoltetranitrate, pentrinitrol, propatylnitrate and organic nitrates with a sulfhydryl-containing amino acid such
 20 as, for example SPM 3672, SPM 4757, SPM 5185, SPM 5186 and those disclosed in U. S. Patent Nos. 5,284,872, 5,428,061, 5,661,129, 5,807,847 and 5,883,122 and in WO 97/46521, WO 00/54756 and in WO 03/013432, the disclosures of each of which are incorporated by reference herein in their entirety.

Another group of NO adducts are N-oxo-N-nitrosoamines that donate, transfer or
 25 release nitric oxide and are represented by the formula: R^{1''}R^{2''}N-N(O-M⁺)-NO, where R^{1''} and R^{2''} are each independently a polypeptide, an amino acid, a sugar, a modified or unmodified oligonucleotide, a straight or branched, saturated or unsaturated, aliphatic or aromatic, substituted or unsubstituted hydrocarbon, or a heterocyclic group, and where M₁⁺ is an organic or inorganic cation, such, as for example, an alkyl substituted ammonium cation or a
 30 Group I metal cation.

The invention is also directed to compounds that stimulate endogenous NO or elevate levels of endogenous endothelium-derived relaxing factor (EDRF) *in vivo* or are oxidized to produce nitric oxide and/or are substrates for nitric oxide synthase and/or cytochrome P450.

Such compounds include, for example, L-arginine, L-homoarginine, and N-hydroxy-L-arginine, N-hydroxy-L-homoarginine, N-hydroxydebrisoquine, N-hydroxypentamidine including their nitrosated and/or nitrosylated analogs (e.g., nitrosated L-arginine, nitrosylated L-arginine, nitrosated N-hydroxy-L-arginine, nitrosylated N-hydroxy-L-arginine, nitrosated and nitrosylated L-homoarginine), N-hydroxyguanidine compounds, amidoxime, ketoximes, aldoxime compounds, that can be oxidized in vivo to produce nitric oxide. Compounds that may be substrates for a cytochrome P450, include, for example, imino(benzylamino)methylhydroxyl amine, imino(((4-methylphenyl)methyl)amino)methylhydroxylamine, imino(((4-methoxyphenyl)methyl)amino)methylhydroxylamine, imino(((4-(trifluoromethyl)phenyl)methyl)amino)methylhydroxylamine, imino(((4-nitrophenyl)methyl)amino)methylhydroxylamine, (butylamino)iminomethylhydroxylamine, imino(propylamino)methylhydroxylamine, imino(pentylamino)methylhydroxylamine, imino(propylamino)methylhydroxylamine, imino((methylethyl)amino)methylhydroxylamine, (cyclopropylamino)iminomethylhydroxylamine, imino-2-1,2,3,4-tetrahydroisoquinolyl methylhydroxylamine, imino(1-methyl(2-1,2,3,4-tetrahydroisoquinolyl))methylhydroxylamine, (1,3-dimethyl(2-1,2,3,4-tetrahydroisoquinolyl))iminomethylhydroxylamine, (((4-chlorophenyl)methyl)amino)iminomethylhydroxylamine, ((4-chlorophenyl)amino)iminomethylhydroxylamine, (4-chlorophenyl)(hydroxyimino)methylamine, and 1-(4-chlorophenyl)-1-(hydroxyimino)ethane, and the like, precursors of L-arginine and/or physiologically acceptable salts thereof, including, for example, citrulline, ornithine, glutamine, lysine, polypeptides comprising at least one of these amino acids, inhibitors of the enzyme arginase (e.g., N-hydroxy-L-arginine and 2(S)-amino-6-boronoheptanoic acid), nitric oxide mediators and/or physiologically acceptable salts thereof, including, for example, pyruvate, pyruvate precursors, α -keto acids having four or more carbon atoms, precursors of α -keto acids having four or more carbon atoms (as disclosed in WO 03/017996, the disclosure of which is incorporated herein in its entirety), and the substrates for nitric oxide synthase, cytokines, adenosin, bradykinin, calreticulin, bisacodyl, and phenolphthalein. EDRF is a vascular relaxing factor secreted by the endothelium, and has been identified as nitric oxide (NO) or a closely related derivative thereof (Palmer et al, *Nature*, 327:524-526 (1987); Ignarro et al, *Proc. Natl. Acad. Sci. USA*, 84:9265-9269 (1987)).

The invention is also directed to nitric oxide enhancing compounds that can increase endogenous nitric oxide. Such compounds, include for example, nitroxide containing compounds, include, but are not limited to, substituted 2,2,6,6-tetramethyl-1-piperidinyloxy

compounds, substituted 2,2,5,5-tetramethyl-3-pyrroline-1-oxyl compounds, substituted 2,2,5,5-tetramethyl-1-pyrrolidinyloxy compounds, substituted 1,1,3,3-tetramethylisoindolin-2-yloxy compounds, substituted 2,2,4,4-tetramethyl-1-oxazolidinyl-3-oxyl compounds, substituted 3-imidazolin-1-yloxy, 2,2,5,5-tetramethyl-3-imidazolin-1-yloxy compounds, OT-551, 4-hydroxy-2,2,6,6-tetramethyl-1-piperidinyloxy (tempol), and the like. Suitable substituents, include, but are not limited to, aminomethyl, benzoyl, 2-bromoacetamido, 2-(2-(2-bromoacetamido)ethoxy)ethylcarbamoyl, carbamoyl, carboxy, cyano, 5-(dimethylamino)-1-naphthalenesulfonamido, ethoxyfluorophosphinyloxy, ethyl, 5-fluoro-2, 4-dinitroanilino, hydroxy, 2-iodoacetamido, isothiocyanato, isothiocyanatomethyl, methyl, maleimido, maleimidoethyl, 2-(2-maleimidoethoxy)ethylcarbamoyl, maleimidomethyl, maleimido, oxo, phosphonooxy, and the like.

The invention is also based on the discovery that compounds and compositions of the invention may be used in conjunction with other therapeutic agents for co-therapies, partially or completely, in place of other therapeutic agents, such as, for example, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs), phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, steroids, and combinations of two or more thereof. The therapeutic agent may optionally be nitrosated and/or nitrosylated and/or contain at least one heterocyclic nitric oxide donor group and/or at least one nitroxide group.

Suitable aldosterone antagonists include, but are not limited to, canrenone, potassium canrenoate, drospirenone, spironolactone, eplerenone (INSPIRA®), epoxymexrenone, fadrozole, pregn-4-ene-7,21-dicarboxylic acid, 9,11-epoxy-17-hydroxy-3-oxo, γ -lactone, methyl ester, (7 α ,11 α ,17 β .)-; pregn-4-ene-7,21-dicarboxylic acid, 9,11-epoxy-17-hydroxy-3-oxo-dimethyl ester, (7 α ,11 α ,17 β .)-; 3'H-cyclopropa(6,7)pregna-4,6-diene-21-carboxylic acid, 9,11-epoxy-6,7-dihydro-17-hydroxy-3-oxo-, γ -lactone, (6 β ,7 β ,11 α ,17 β .)-; pregn-4-ene-7,21-dicarboxylic acid, 9,11-epoxy-17-hydroxy-3-oxo-, 7-(1-methylethyl) ester, monopotassium salt, (7 α ,11 α ,17 β .)-; pregn-4-ene-7,21-dicarboxylic acid, 9,11-epoxy-17-hydroxy-3-oxo-, 7-

methyl ester, monopotassium salt, (7 α ,11 α ,17 β)-; 3'H-cyclopropa(6,7) pregna-1,4,6-triene-21-carboxylic acid, 9,11-epoxy-6,7-dihydro-17-hydroxy-3-oxo-, γ -lactone, (6 β ,7 β ,11 α)-; 3'H-cyclopropa(6,7)pregna-4,6-diene-21-carboxylic acid, 9,11-epoxy-6,7-dihydro-17-hydroxy-3-oxo-, methyl ester, (6 β ,7 β ,11 α ,17 β)-; 3'H-cyclopropa (6,7)pregna-4,6-diene-21-carboxylic acid, 9,11-epoxy-6,7-dihydro-17-hydroxy-3-oxo-, monopotassium salt, (6 β ,7 β ,11 α ,17 β)-; 3'H-cyclopropa(6,7)pregna-1,4,6-triene-21-carboxylic acid, 9,11-epoxy-6,7-dihydro-17-hydroxy-3-oxo-, γ -lactone, (6 β ,7 β ,11 α ,17 β)-; pregn-4-ene-7,21-dicarboxylic acid, 9,11-epoxy-17-hydroxy-3-oxo-, γ -lactone, ethyl ester, (7 α ,11 α ,17 β)-; pregn-4-ene-7,21-dicarboxylic acid, 9,11-epoxy-17-hydroxy-3-oxo-, γ -lactone, 1-methylethyl ester, (7 α ,11 α ,17 β)-; RU-28318, and the like. Suitable aldosterone antagonists are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, 13th Edition; and on STN Express, file phar and file registry.

In some embodiments the aldosterone antagonist is eplerenone or spironolactone (a potassium sparing diuretic that acts like an aldosterone antagonist). In more particular embodiments eplerenone is administered in an amount of about 25 milligrams to about 300 milligrams as a single dose or as multiple doses per day; the spironolactone is administered in an amount of about 25 milligrams to about 150 milligrams as a single dose or as multiple doses per day.

Suitable α -adrenergic receptor antagonists include, but are not limited to, phentolamine, tolazoline, idazoxan, deriglidole, RX 821002, BRL 44408, BRL 44409, BAM 1303, labetalol, ifenprodil, rauwolscine, corynathine, raubasine, tetrahydroalstonine, apoyohimbine, akuammigine, β -yohimbine, yohimbol, yohimbine, pseudoyohimbine, epi-3 α -yohimbine, 10-hydroxy-yohimbine, 11-hydroxy-yohimbine, tamsulosin, benoxathian, atipamezole, BE 2254, WB 4101, HU-723, tedisamil, mirtazipine, setiptiline, reboxitine, delequamine, naftopil, saterinone, SL 89.0591, ARC 239, urapidil, 5-methylurapidil, monatepi, haloperidol, indoramin, SB 216469, moxislyte, trazodone, dapiprozole, efaroxan, Recordati 15/2739, SNAP 1069, SNAP 5089, SNAP 5272, RS 17053, SL 89.0591, KMD 3213, spiperone, AH 11110A, chloroethylclonidine, BMY 7378, niguldipine, and the like. Suitable α -adrenergic receptor antagonists are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

Suitable angiotensin II antagonists include, but are not limited to, angiotensin, abitesartan, candesartan, candesartan cilexetil, elisartan, embusartan, enoltasartan, eprosartan, fonsartan, forasartan, glycylosartan, irbesartan, losartan, olmesartan, milfasartan, medoxomil, ripisartan, pomisartan, prazosartan, saprisartan, saralasin, sarmesin, tasosartan, telmisartan, valsartan, zolasartan, 3-(2'(tetrazole-5-yl)-1,1'-biphen-4-yl)methyl-5,7-dimethyl-2-ethyl-3H-imidazo(4,5-b)pyridine, antibodies to angiotensin II, A-81282, A-81988, BAY 106734, BIBR-363, BIBS-39, BIBS-222, BMS-180560, BMS-184698, BMS-346567, CGP-38560A, CGP-42112A, CGP-48369, CGP-49870, CGP-63170, CI-996, CP-148130, CL-329167, CV-11194, CV-11974, DA-2079, DE-3489, DMP-811, DuP-167, DuP-532, DuP-753, E-1477, E-4177, E-4188, EMD-66397, EMD-666R4, EMD-73495, EMD-66684, EXP-063, EXP-929, EXP-3134, EXP-3174, EXP-6155, EXP-6803, EXP-7711, EXP-9270, EXP-9954, FK-739, FRI 153332, GA-0050, GA-0056, HN-65021, HOE-720, HR-720, ICI-D6888, ICI-D7155, ICI-D8731, KRI-1177, KT3-671, KT-3579, KW-3433, L-158809, L-158978, L-159282 (MK-996), L-159689, L-159874, L-161177, L-162154, L-162234, L-162441, L-163007, L-163017, LF-70156, LRB-057, LRB-081, LRB-087, LY-235656, LY-266099, LY-285434, LY-301875, LY-302289, LY-315995, ME-3221, MK-954, PD-123177, PD-123319, PD-126055, PD-150304, RG-13647, RWJ-38970, RWJ-46458, S-8307, S-8308, SC-51757, SC-54629, SC-52458, SC-52459, SK 1080, SL-910102, SR-47436, TAK-536, UP-2696, U-96849, U-97018, UK-77778, UP-275-22, WAY-126227, WK-1260, WK-1360, WK-1492, WY 126227, YH-1498, YM-358, YM-31472, X-6803, XH-148, XR-510, ZD-6888, ZD-7155, ZD-8731, ZD 8131, the compounds of ACS registry numbers 133240-46-7, 135070-05-2, 139958-16-0, 145160-84-5, 147403-03-0, 153806-29-2, 439904-54-8P, 439904-55-9P, 439904-56-0P, 439904-57-1P, 439904-58-2P, 155918-60-8P, 155918-61-9P, 272438-16-1P, 272446-75-0P, 223926-77-0P, 169281-89-4, 165113-17-7P, 165113-18-8P, 165113-19-9P, 165113-20-2P, 165113-13-3P, 165113-14-4P, 165113-15-5P, 165113-16-6P, 165113-21-3P, 165113-22-4P, 165113-23-5P, 165113-24-6P, 165113-25-7P, 165113-26-8P, 165113-27-9P, 165113-28-0P, 165113-29-1P, 165113-30-4P, 165113-31-5P, 165113-32-6P, 165113-33-7P, 165113-34-8P, 165113-35-9P, 165113-36-0P, 165113-37-1P, 165113-38-2P, 165113-39-3P, 165113-40-6P, 165113-41-7P, 165113-42-8P, 165113-43-9P, 165113-44-0P, 165113-45-1P, 165113-46-2P, 165113-47-3P, 165113-48-4P, 165113-49-5P, 165113-50-8P, 165113-51-9P, 165113-52-0P, 165113-53-1P, 165113-54-2P, 165113-55-3P, 165113-56-4P, 165113-57-5P, 165113-58-6P, 165113-59-7P, 165113-60-0P, 165113-61-1P, 165113-62-2P, 165113-63-3P, 165113-64-4P, 165113-65-5P, 165113-66-6P, 165113-67-7P, 165113-68-8P, 165113-69-9P,

165113-70-2P, 165113-71-3P, 165113-72-4P, 165113-73-5P, 165113-74-6P, 114798-27-5,
114798-28-6, 114798-29-7, 124749-82-2, 114798-28-6, 124749-84-4, 124750-88-5, 124750-
91-0, 124750-93-2, 161946-65-2P, 161947-47-3P, 161947-48-4P, 161947-51-9P, 161947-52-
0P, 161947-55-3P, 161947-56-4P, 161947-60-0P, 161947-61-1P, 161947-68-8P, 161947-69-
5 9P, 161947-70-2P, 161947-71-3P, 161947-72-4P, 161947-74-6P, 161947-75-7P, 161947-81-
5P, 161947-82-6P, 161947-83-7P, 161947-84-8P, 161947-85-9P, 161947-86-0P, 161947-87-
1P, 161947-88-2P, 161947-89-3P, 161947-90-6P, 161947-91-7P, 161947-92-8P, 161947-93-
9P, 161947-94-0P, 161947-95-1P, 161947-96-2P, 161947-97-3P, 161947-98-4P, 161947-99-
5P, 161948-00-1P, 161948-01-2P, 161948-02-3P, 168686-32-6P, 167301-42-0P, 166813-82-
10 7P, 166961-56-4P, 166961-58-6P, 158872-96-9P, 158872-97-0P, 158807-14-8P, 158807-15-
9P, 158807-16-0P, 158807-17-1P, 158807-18-2P, 158807-19-3P, 158807-20-6P, 155884-08-
5P, 154749-99-2, 167371-59-7P, 244126-99-6P, 177848-35-0P, 141309-82-2P, and the like.
Suitable angiotensin II antagonists are described more fully in the literature, such as in
Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-
15 Hill, 1995; and the Merck Index on CD-ROM, 13th Edition; and on STN Express, file phar
and file registry.

In some embodiments the angiotensin II antagonists are candesartan, eprosartan,
irbesartan, losartan, omlesartan, telmisartan or valsartan. In more particular embodiments the
candesartan is administered as candesartan cilexetil in an amount of about 15 milligrams to
20 about 100 milligrams as a single dose or as multiple doses per day; the eprosartan, is
administered as eprosartan mesylate in an amount of about 400 milligrams to about 1600
milligrams as a single dose or as multiple doses per day; the irbesartan is administered in an
amount of about 75 milligrams to about 1200 milligrams as a single dose or as multiple doses
per day; the losartan is administered as losartan potassium in an amount of about 25
25 milligrams to about 100 milligrams as a single dose or as multiple doses per day; the
omlesartan is administered as omlesartan medoxomil in an amount of about 5 milligrams to
about 40 milligrams as a single dose or as multiple doses per day; the telmisartan is
administered in an amount of about 20 milligrams to about 80 milligrams as a single dose or
as multiple doses per day; the valsartan is administered in an amount of about 80 milligrams
30 to about 320 milligrams as a single dose or as multiple doses per day.

Suitable angiotensin-converting enzyme inhibitors (ACE inhibitors) include, but are
not limited to, alacepril, benazepril (LOTENSIN®, CIBACEN®), benazeprilat, captopril,
ceronapril, cilazapril, delapril, duinapril, enalapril, enalaprilat, fasidotril, fosinopril,

fosinoprilat, gemopatrilat, glycopril, idrapril, imidapril, lisinopril, moexipril, moveltipril, naphthopidil, omapatrilat, pentopril, perindopril, perindoprilat, quinapril, quinaprilat, ramipril, ramiprilat, rentipril, saralasin acetate, spirapril, temocapril, trandolapril, trandolaprilat, urapidil, zofenopril, acylmercapto and mercaptoalkanoyl pralines, carboxyalkyl dipeptides, carboxyalkyl dipeptide, phosphinylalkanoyl pralines, registry no.796406, AVE 7688, BP1.137, CHF 1514, E 4030, ER 3295, FPL-66564, MDL 100240, RL 6134, RL 6207, RL 6893, SA 760, S-5590, Z 13752A, and the like. Suitable angiotensin-converting enzyme inhibitors are described more fully in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Twelfth Edition, Version 12:1, 1996; and on STN Express, file phar and file registry.

In some embodiments the angiotensin-converting enzyme inhibitors are benazepril, captopril, enalapril, fosinopril, lisinopril, moexipril, quinapril, ramipril, trandolapril or trandolaprilat. In more particular embodiments the benazepril is administered as benazepril hydrochloride in an amount of about 5 milligrams to about 80 milligrams as a single dose or as multiple doses per day; the captopril is administered in an amount of about 12.5 milligrams to about 450 milligrams as a single dose or as multiple doses per day; the enalapril is administered as enalapril maleate in an amount of about 2.5 milligrams to about 40 milligrams as a single dose or as multiple doses per day; the fosinopril is administered as fosinopril sodium in an amount of about 5 milligrams to about 60 milligrams as a single dose or as multiple doses per day; the lisinopril is administered in an amount of about 2.5 milligrams to about 75 milligrams as a single dose or as multiple doses per day; the moexipril is administered as moexipril hydrochloride in an amount of about 7.5 milligrams to about 45 milligrams as a single dose or as multiple doses per day; the quinapril is administered as quinapril hydrochloride in an amount of about 5 milligrams to about 40 milligrams as single or multiple doses per day; the ramipril hydrochloride in an amount of about 1.25 milligrams to about 40 milligrams as single or multiple doses per day; the trandolapril is administered as in an amount of about 0.5 milligrams to about 4 milligrams as single or multiple doses per day; the trandolaprilat is administered as in an amount of about 0.5 milligrams to about 4 milligrams as single or multiple doses per day.

Suitable antidiabetic compounds include, but are not limited to, acarbose, acetohexamide, buformin, carbutamide, chlorpropamide, glibornuride, gliclazide, glimepiride, glipizide, gliquidone, glisoxepid, glyburide, glybuthiazol(e), glybuzole, glyhexamide,

glymidine, glypinamide, insulin, metformin, miglitol, nateglinide, phenbutamide, phenformin, pioglitazone, repaglinide, rosiglitazone, tolazamide, tolbutamide, tolcyclamide, troglitazone, voglibose, and the like. Suitable antidiabetic compounds are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

Suitable anti-hyperlipidemic compounds include, but are not limited to, statins or HMG-CoA reductase inhibitors, such as, for example, atorvastatin (LIPITOR®), bervastatin, cerivastatin (BAYCOL®), dalvastatin, fluindostatin (Sandoz XU-62-320), fluvastatin, glenvastatin, lovastatin (MEVACOR®), mevastatin, pravastatin (PRAVACHOL®), rosuvastatin (CRESTRO®), simvastatin (ZOCOR®), velostatin (also known as synvinolin), VYTORIN™ (ezetimibe/simvastatin), GR-95030, SQ 33,600, BMY 22089, BMY 22,566, CI 980, and the like; gemfibrozil, cholestyramine, colestipol, niacin, nicotinic acid, bile acid sequestrants, such as, for example, cholestyramine, colesevelam, colestipol, poly(methyl-(3-trimethylaminopropyl) imino-trimethylene dihalide) and the like; probucol; fibric acid agents or fibrates, such as, for example, bezafibrate (Bezalip™), beclobrate, binifibrate, ciprofibrate, clinofibrate, clofibrate, etofibrate, fenofibrate (Lipidil™, Lipidil Micro™), gemfibrozil (Lopid™), nicofibrate, pirifibrate, ronifibrate, simfibrate, theofibrate and the like; cholesterol ester transfer protein (CETP) inhibitors, such as for example, CGS 25159, CP-529414 (torcetrapid), JTT-705, substituted N-[3-(1,1,2,2-tetrafluoroethoxy)benzyl]-N-(3-phenoxyphenyl)-trifluoro-3-amino-2-propanols, N,N-disubstituted trifluoro-3-amino-2-propanols, PD 140195 (4-phenyl-5-tridecyl-4H-1,2,4- triazole-3-thiol), SC-794, SC-795, SCH 58149, and the like.

In some embodiments the anti-hyperlipidemic compounds are atorvastatin, fluvastatin, lovastatin, pravastatin, rosuvastatin or simvastatin. In more particular embodiments the atorvastatin is administered in an amount of about 10 milligrams to about 80 milligrams as a single dose or as multiple doses per day; the fluvastatin is administered in an amount of about 20 milligrams to about 80 milligrams as a single dose or as multiple doses per day; the lovastatin is administered in an amount of about 10 milligrams to about 80 milligrams as a single dose or as multiple doses per day; the pravastatin is administered in an amount of about 10 milligrams to about 80 milligrams as a single dose or as multiple doses per day; the rosuvastatin is administered in an amount of about 5 milligrams to about 40 milligrams as a single dose or as multiple doses per day; the simvastatin is administered in an amount of

about 5 milligrams to about 80 milligrams as a single dose or as multiple doses per day.

Suitable antioxidants include, but are not limited to, small-molecule antioxidants and antioxidant enzymes. Suitable small-molecule antioxidants include, but are not limited to, hydralazine compounds, glutathione, vitamin C, vitamin E, cysteine, N-acetyl-cysteine, β -carotene, ubiquinone, ubiquinol-10, tocopherols, coenzyme Q, superoxide dismutase mimetics, such as, for example, 2,2,6,6-tetramethyl-1-piperidinyloxy (TEMPO), DOXYL, PROXYL nitroxide compounds; 4-hydroxy-2,2,6,6-tetramethyl-1-piperidinyloxy (Tempol), M-40401, M-40403, M-40407, M-40419, M-40484, M-40587, M-40588, and the like.

Suitable antioxidant enzymes include, but are not limited to, superoxide dismutase, catalase, glutathione peroxidase, NADPH oxidase inhibitors, such as, for example, apocynin, aminoguanidine, ONO 1714, S17834 (benzo(b)pyran-4-one derivative), and the like; xanthine oxidase inhibitors, such as, for example, allopurinol, oxypurinol, amflutizole, diethyldithiocarbamate, 2-styrylchromones, chrysin, luteolin, kaempferol, quercetin, myricetin, isorhamnetin, benzophenones such as 2,2',4,4'-tetrahydroxybenzophenone, 3,4,5,2',3',4'-hexahydroxybenzophenone and 4,4'-dihydroxybenzophenone; benzothiazinone analogues such as 2-amino-4H-1,3-benzothiazine-4-one, 2-guanidino-4H-1,3-benzothiazin-4-one and rhodanine; N-hydroxyguanidine derivative such as, PR5 (1-(3, 4-dimethoxy-2-chlorobenzylideneamino)-3-hydroxyguanidine); 6-formylpterin, and the like. The antioxidant enzymes can be delivered by gene therapy as a viral vector and/or a non-viral vector. Suitable antioxidants are described more fully in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

In some embodiments the antioxidants are apocynin, hydralazine compounds and superoxide dismutase mimetics.

Suitable antithrombotic and vasodilator compounds include, but are not limited to, abciximab, acetoxyphenol, acetylsalicylic acid, argatroban, bamethan, benfurodil, benziodarone, betahistine, bisamyl, brovincamine, bufenide, citicoline, clobenfurol, clopidogrel, cyclandelate, dalteparin, dipyridamol, droprenilamine, enoxaparin, fendiline, ifenprodil, iloprost, indobufen, isobogrel, isoxsuprine, heparin, lamifiban, midrodine, nadroparin, nicotinoyl alcohol, nylidrin, ozagrel, perhexiline, phenylpropanolamine, prenylamine, papaveroline, reviparin sodium salt, ridogrel, suloctidil, tinofedrine, tinzaparin, trifusal, vintoprol, xanthinal niacinate, and the like. Suitable antithrombotic and vasodilator compounds are described more fully in the literature, such as in Goodman and Gilman, The

Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

Suitable β -adrenergic antagonists include, but are not limited to, acebutolol, alprenolol, amosulalol, arotinolol, atenolol, befunolol, betaxolol, bevantolol, bisoprolol, bopindolol, bucindolol, bucumolol, bufetolol, bufuralol, bunitrolol, bupranolol, butofilolol, carazolol, capsinolol, carteolol, carvedilol (COREG®), celiprolol, cetamolol, cindolol, cloranolol, dilevalol, diprafenone, epanolol, ersentilide, esmolol, esprolol, hedroxalol, indenolol, labetalol, landiolol, laniolol, levobunolol, mepindolol, methylpranol, metindol, metipranolol, metrizoranolol, metoprolol, moprolol, nadolol, nadoxolol, nebivolol, nifenalol, nipradilol, oxprenolol, penbutolol, pindolol, practolol, pronethalol, propranolol, sotalol, sotalolnadolol, sulfinalol, taliprolol, talinolol, tertatolol, tilisolol, timolol, toliprolol, tomalolol, trimepranol, xamoterol, xibenolol, 2-(3-(1,1-dimethylethyl)-amino-2-hydroxypropoxy)-3-pyridenecarbonitrilHCl, 1-butylamino-3-(2,5-dichlorophenoxy)-2-propanol, 1-isopropylamino-3-(4-(2-cyclopropylmethoxyethyl) phenoxy)-2-propanol, 3-isopropylamino-1-(7-methylindan-4-yloxy)-2-butanol, 2-(3-t-butylamino-2-hydroxy-propylthio)-4-(5-carbamoyl-2-thienyl)thiazol, 7-(2-hydroxy-3-t-butylaminpropoxy)phthalide, Acc 9369, AMO-140, BIB-16S, CP-331684, Fr-172516, ISV-208, L-653328, LM-2616, SB-226552, SR-58894A, SR-59230A, TZC-5665, UK-1745, YM-430, and the like. Suitable β -adrenergic antagonists are described more fully in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, 13th Edition; and on STN Express, file phar and file registry.

In some embodiments the β -adrenergic antagonists are atenolol, bisoprolol, carvedilol, metoprolol, nebivolol, propranolol or timolol. In more particular embodiments the atenolol is administered in an amount of about 50 milligrams to about 200 milligrams as a single dose or as multiple doses per day; the bisoprolol is administered as bisoprolol fumarate in an amount of about 2.5 milligrams to about 30 milligrams as a single dose or as multiple doses per day; the carvedilol is administered in an amount of about 3.125 milligrams to about 200 milligrams as a single dose or as multiple doses per day; the metoprolol is administered as metoprolol tartarate or metoprolol succinate in an amount of about 25 milligrams to about 300 milligrams as a single dose or as multiple doses per day; the nebivolol is administered as nebivolol hydrochloride in an amount of about 2.5 milligrams to about 20 milligrams as a single dose or as multiple doses per day; the propranolol is administered as propranolol hydrochloride in an amount of about 40 milligrams to about 240 milligrams as a single dose

or as multiple doses per day; the timolol is administered as timolol maleate in an amount of about 10 milligrams to about 30 milligrams as a single dose or as multiple doses per day.

Suitable calcium channel blockers include, but are not limited to, amlodipine (NORVASC®), anipamil, aranidipine, amrinone, azelnidipine, barnidipine, bencyclane, benidipine, bepridil, cilnidipine, cinnarizine, clentiazem, diltiazem, dotarizine, efonidipine, elgodipine, fantofarone, felodipine, fendiline, flunarizine, fluspirilene, furnidipine, gallopamil, ipenoxazone, isradipine, lacidipine, lemildipine, lercanidipine, lomerizine, manidipine, mibefradil, monatepil, nicardipine, nifedipine, niguldipine, niludipine, nilvadipine, nimodipine, nisoldipine, nitrendipine, nivaldipine, oxodipine, perhexilene, phenytoin, phenytprenylamine, pranidipine, ranolazine, ryosidine, semotiadil, tamolarizine, temiverine hydrochloride, terodiline, tiapamil, vatanidipine hydrochloride, verapamil, ziconotide, AE-0047, CAI, JTV-519, CHF-1521, L-651582, NS-7, NW-1015, RO-2933, SB-237376, SL-34.0829-08, S-312d, SD-3212, TA-993, YM-430, and the like. Suitable calcium channel blockers are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

In some embodiments the calcium channel blockers are amlodipine, diltiazem, isradipine, nicardipine, nifedipine, nimodipine, nisoldipine, nitrendipine, verapamil.

Suitable carbonic anhydrase inhibitors include, but are not limited to, acetazolamide, brinzolamide, dorzolamide, ethoxzolamide, 6-hydroxy-2-benzothiazolesulfonamide, methazolamide, thiophene sulfonamide, an aromatic sulfonamide, an ester of 6-hydroxy-2-benzothiazolesulfonamide, an ester of 5-hydroxy-2-benzothiazolesulfonamide, and the like. Suitable carbonic anhydrase inhibitors are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, 13th Edition; and on STN Express, file phar and file registry.

In some embodiments the carbonic anhydrase inhibitors are brinzolamide and dorzolamide.

Suitable digitals include, but are not limited to, digoxin and digoxitin. In some embodiments the digoxin is administered to achieve a steady state blood serum concentration of at least about 0.7 nanograms per ml to about 2.0 nanograms per ml.

Suitable diuretics include, but are not limited to, thiazides (such as, for example,

althiazide, bendroflumethiazide, benzclortriazide, benzhydrochlorothiazide, benzthiazide, buthiazide, chlorothiazide, cyclophenethiazide, cyclothiazide, epithiazide, ethiazide, hydrobenzthiazide, hydrochlorothiazide, hydroflumethiazide, methylclothiazide, methylcyclothiazide, penflutazide, polythiazide, teclothiazide, trichlormethiazide, triflumethazide, and the like); alilusem, ambuside, amiloride, aminometradine, azosemide, bemetizide, bumetanide, butazolamide, butizide, canrenone, carperitide, chloraminophenamide, chlorazanyl, chlormerodrin, chlorthalidone, cicletanide, clofenamide, clopamide, clorexolone, conivaptan, daglutril, dichlorophenamide, disulfamide, ethacrynic acid, ethoxzolamide, etozolon, fenoldopam, fenquizone, furosemide, indapamide, mebutizide, mefruside, meralluride, mercaptomerin sodium, mercumallylic acid, mersalyl, methazolamide, meticane, metolazone, mozavaptan, muzolimine, N-(5-1,3,4-thiadiazol-2-yl)acetamide, nesiritide, pamabrom, paraflutizide, piretanide, protheobromine, quinethazone, scoparius, spironolactone, theobromine, ticrynafen, torsemide, torvaptan, triamterene, tripamide, ularitide, xipamide or potassium, AT 189000, AY 31906, BG 9928, BG 9791, C 2921, DTI 0017, JDL 961, KW 3902, MCC 134, SLV 306, SR 121463, WAY 140288, ZP 120, and the like. Suitable diuretics are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, 13th Edition; and on STN Express, file phar and file registry.

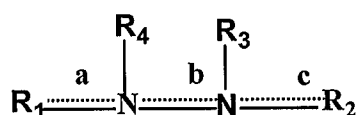
Depending on the diuretic employed, potassium may also be administered to the patient in order to optimize the fluid balance while avoiding hypokalemic alkalosis. The administration of potassium can be in the form of potassium chloride or by the daily ingestion of foods with high potassium content such as, for example, bananas or orange juice. The method of administration of these compounds is described in further detail in U.S. Patent No. 4,868,179, the disclosure of which is incorporated by reference herein in its entirety.

In some embodiments the diuretics are amiloride, furosemide, chlorthalidone, hydrochlorothiazide or triamterene. In more particular embodiments the amiloride is administered as amiloride hydrochloride in an amount of about 5 milligrams to about 15 milligrams as a single dose or as multiple doses per day; the furosemide is administered in an amount of about 10 milligrams to about 600 milligrams as a single dose or as multiple doses per day; the chlorthalidone is administered in an amount of about 15 milligrams to about 150 milligrams as a single dose or as multiple doses per day; the hydrochlorothiazide is

administered in an amount of about 12.5 milligrams to about 300 milligrams as a single dose or as multiple doses per day; the triamterene is administered in an amount of about 35 milligrams to about 225 milligrams as a single dose or as multiple doses per day.

Suitable endothelin antagonists include, but are not limited to, atrasentan, bosentan, darusentan, endothelin, enrasentan, sitaxsentan, sulfonamide endothelin antagonists, tezosentan, BMS 193884, BQ-123, SQ 28608, and the like. Suitable endothelin antagonists are described more fully in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

Suitable hydralazine compounds include, but are not limited to, compounds having the formula:



wherein a, b and c are independently a single or double bond; R₁ and R₂ are each independently a hydrogen, an alkyl, an ester or a heterocyclic ring, wherein alkyl, ester and heterocyclic ring are as defined herein; R₃ and R₄ are each independently a lone pair of electrons or a hydrogen, with the proviso that at least one of R₁, R₂, R₃ and R₄ is not a hydrogen. Exemplary hydralazine compounds include budralazine, cadralazine, dihydralazine, endralazine, hydralazine, pildralazine, todralazine, and the like. Suitable hydralazine compounds are described more fully in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

In some embodiments the hydralazine compound is hydralazine or a pharmaceutically acceptable salt thereof such as hydralazine hydrochloride. In more particular embodiments the hydralazine is administered as hydralazine hydrochloride in an amount of about 10 milligrams to about 300 milligrams as a single dose or as multiple doses per day.

Suitable H₂ receptor antagonists include, but are not limited to, burimamide, cimetidine, ebrotidin, famotidine, nizatidine, roxatidine, rantidine, tiotidine, and the like. Suitable H₂ receptor antagonists are described more fully in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995, Pgs. 901-915; the Merck Index on CD-ROM, 13th Edition; and in WO 00/28988

assigned to NitroMed Inc., the disclosures of which are incorporated herein by reference in their entirety.

Suitable neutral endopeptidase inhibitors include, but are not limited to, atrial natriuretic peptides, diazapins, azepinones, ecadotril, fasidotril, fasidotrilat, omapatrilat, sampatrilat, BMS 189,921, Z 13752 A, and the like. Neutral endopeptidase inhibitors are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

Suitable NSAIDs include, but are not limited to, acetaminophen, acemetacin, aceclofenac, alminoprofen, amfenac, bendazac, benoxaprofen, bromfenac, bucloxic acid, butibufen, carprofen, cinmetacin, clopirac, diclofenac, etodolac, felbinac, fenclozic acid, fenbufen, fenoprofen, fentiazac, flunoxaprofen, flurbiprofen, ibufenac, ibuprofen, indomethacin, isofezolac, isoxepac, indoprofen, ketoprofen, lonazolac, loxoprofen, metiazinic acid, mofezolac, miroprofen, naproxen, oxaprozin, pirozolac, pirprofen, pranoprofen, protizinic acid, salicylamide, sulindac, suprofen, suxibuzone, tiaprofenic acid, tolmetin, xenbucin, ximoprofen, zaltoprofen, zomepirac, aspirin, acemetcin, bumadizon, carprofenac, clidanac, diflunisal, enfenamic acid, fendosal, flufenamic acid, flunixin, gentisic acid, ketorolac, meclofenamic acid, mefenamic acid, mesalamine, prodrugs thereof, and the like. Suitable NSAIDs are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995, Pgs. 617-657; the Merck Index on CD-ROM, 13th Edition; and in U.S. Patent Nos. 6,057,347 and 6,297,260 assigned to NitroMed Inc., the disclosures of which are incorporated herein by reference in their entirety.

In some embodiments the NSAIDs are acetaminophen, diclofenac, flurbiprofen, ibuprofen, indomethacin, ketoprofen, naproxen or aspirin. In more particular embodiments the acetaminophen is administered in an amount of about 325 milligrams to about 4 grams as a single dose or as multiple doses per day; the diclofenac is administered in an amount of about 50 milligrams to about 250 milligrams as a single dose or as multiple doses per day; the flurbiprofen is administered in an amount of about 100 milligrams to about 300 milligrams as a single dose or as multiple doses per day; the ibuprofen is administered in an amount of about 400 milligrams to about 3.2 grams as a single dose or as multiple doses per day; the indomethacin is administered in an amount of about 25 milligrams to about 200 milligrams as a single dose or as multiple doses per day; the ketoprofen is administered in an amount of

about 50 milligrams to about 300 milligrams as a single dose or as multiple doses per day; the naproxen is administered in an amount of about 250 milligrams to about 1.5 grams as a single dose or as multiple doses per day; the aspirin is administered in an amount of about 10 milligrams to about 2 grams as a single dose or as multiple doses per day.

5 Suitable phosphodiesterase inhibitors include but are not limited to, fluminast, piclamilast, rolipram, Org 20241, MCI-154, roflumilast, toborinone, posicar, lixazinone, zaprinast, sildenafil, pyrazolopyrimidinones, motapizone, pimobendan, zardaverine, siguazodan, CI 930, EMD 53998, imazodan, saterinone, loprinone hydrochloride, 3-pyridinecarbonitrile derivatives, acefylline, albifylline, bamifylline, denbufylline, diphylline, doxofylline, etofylline, torbafylline, theophylline, nanterinone, pentoxofylline, proxyphylline, 10 cilostazol, cilostamide, MS 857, piroximone, milrinone, amrinone, tolafentrine, dipyridamole, papaveroline, E4021, thienopyrimidine derivatives, triflusal, ICOS-351, tetrahydropiperazino(1,2-b)beta-carboline-1,4-dione derivatives, carboline derivatives, 2-pyrazolin-5-one derivatives, fused pyridazine derivatives, quinazoline derivatives, anthranilic acid derivatives, imidazoquinazoline derivatives, tadalafil, vardenafil, and in Goodman and 15 Gilman, The Pharmacological Basis of Therapeutics (9th Ed.), McGraw-Hill, Inc. (1995), The Physician's Desk Reference (49th Ed.), Medical Economics (1995), Drug Facts and Comparisons (1993 Ed), Facts and Comparisons (1993), and the Merck Index on CD-ROM, 13th Edition; and the like. Phosphodiesterase inhibitors and their nitrosated and/or nitrosylated 20 derivatives are also disclosed in U. S. Patent Nos. 5,932,538, 5,994,294, 5,874,437, 5,958,926 reissued as U.S. Patent No. RE 03772346, 172,060, 6,197,778, 6,177,428, 6,172,068, 6,221,881, 6,232,321, 6,197,782, 6,133,272, 6,211,179, 6,316,457 and 6,331,542, the disclosures of each of which are incorporated herein by reference in their entirety.

 Suitable potassium channel blockers include, but are not limited to, nicorandil, 25 pinacidil, cromakalim (BRL 34915), aprikalim, bimakalim, emakalim, lemakalim, minoxidil, diazoxide, 9-chloro-7-(2-chlorophenyl)-5H-pyrimido(5,4,-d)(2)-benzazepine, Ribl, CPG-11952, CGS-9896, ZD 6169, diazixide, Bay X 9227, P1075, Bay X 9228, SDZ PCO 400, WAY-120,491, WAY-120,129, Ro 31-6930, SR 44869, BRL 38226, S 0121, SR 46142A, CGP 42500, SR 44994, artilide fumarate, lorazepam, temazepam, 30 rilmazafone, nimetazepam, midazolam, lormetazepam, loprazolam, ibutilide fumarate, haloxazolam, flunitrazepam, estazolam, doxefazepam, clonazepam, cinolazepam, brotizolam, and the like. Suitable potassium channel blockers are described more fully in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics

(9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

Suitable platelet reducing agents include, but are not limited to, fibrinolytic agents such as for example, anicrod, anistreplase, bisobrin lactate, brinolase, Hageman factor (i.e. factor XII) fragments, plasminogen activators such as, for example, streptokinase, tissue plasminogen activators (TPA), urokinase, pro-Urokinase, recombinant TPA, plasmin, plasminogen, and the like; anti-coagulant agents including but are not limited to, inhibitors of factor Xa, factor TFPI, factor VIIa, factor IXc, factor Va, factor VIIIa, inhibitors of other coagulation factors, and the like; vitamin K antagonists, such as, for example, coumarin, coumarin derivatives (e.g., warfarin sodium); glycosaminoglycans such as, for example, heparins both in unfractionated form and in low molecular weight form; ardeparin sodium, bivalirudin, bromindione, coumarin, dalteparin sodium, danaparoid sodium; dazoxiben hydrochloride, desirudin, dicumarol, efegatran sulfate, enoxaparin sodium, ifetroban, ifetroban sodium, lyapolate sodium, nafamostat mesylate, phenprocoumon, sulfatide, tinzaparin sodium, retaplase; trifenagrel, warfarin, dextrans and the like; abciximab, acadesine, anipamil, argatroban, aspirin, clopidogrel, diadenosine 5',5'''-P₁,P₄-tetrphosphate (Ap₄A) analogs, difibrotide, dilazep dihydrochloride, dipyridamole, dopamine, 3-methoxytyramine, glucagon, glycoprotein IIb/IIIa antagonists, such as, for example, Ro-43-8857, L-700,462, iloprost, isocarbacyclin methyl ester, itazigrel, ketanserin, BM-13.177, lamifiban, lifarizine, molsidomine, nifedipine, oxagrelate, prostaglandins, platelet activating factor antagonists such as, for example, lexipafant, prostacyclins, pyrazines, pyridinol carbamate, ReoPro (i.e., abciximab), sulfinpyrazone, synthetic compounds BN-50727, BN-52021, CV-4151, E-5510, FK-409, GU-7, KB-2796, KBT-3022, KC-404, KF-4939, OP-41483, TRK-100, TA-3090, TFC-612, ZK-36374, 2,4,5,7-tetrathiaoctane, 2,4,5,7-tetrathiaoctane 2,2-dioxide, 2,4,5-trithiahexane, theophyllin pentoxifyllin, thromboxane and thromboxane synthetase inhibitors such as, for example, picotamide, sulotroban, ticlopidine, tirofiban, trapidil, ticlopidine, trifenagrel, trilinolein, 3-substituted 5,6-bis(4-methoxyphenyl)-1,2,4-triazines; antibodies to glycoprotein IIb/IIIa; anti-serotonin drugs, such as, for example, clopidogrel; sulfinpyrazone and the like; aspirin; dipyridamole; clofibrate; pyridinol carbamate; glucagon, caffeine; theophyllin pentoxifyllin; ticlopidine, and the like.

Suitable prostaglandins include, but are not limited to, naturally occurring prostaglandins such as, for example, arbaprostil, alprostadil, beraprost, carboprost, cloprostenol, dimoxaprost, enprostil, enisoprost, fluprostenol, fenprostalene, gemeprost,

latanoprost, limaprost, meteneprost, mexiprostil, misoprostol, misoprost, misoprostol acid, nocloprost, ornoprostil, prostalene, PGE₁, PGE₂, PGF₁, PGF_{2α}, rioprostil, rosaprostol, remiprostol, sulprostone, trimoprostil, tiprostanide, travoprost, unoprostone, viprostol, viprostol. Suitable prostaglandins are described more fully in the literature, such as in
5 Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, 13th Edition; and on STN Express, file phar and file registry.

In some embodiments the prostaglandins are cloprostenol, fluprostenol and travoprost.

10 Suitable proton pump inhibitors include, but are not limited to, disulprazole, esomeprazole, lansoprazole, leminoprazole, omeprazole, pantoprazole, rabeprazole, timoprazole, tenatoprazole, 2-(2-benzimidazolyl)-pyridine, tricyclic imidazole, thienopyridine benzimidazole, fluoroalkoxy substituted benzimidazole, dialkoxy benzimidazole, N-substituted 2-(pyridylalkenesulfinyl) benzimidazole, cycloheptenepyridine,
15 5-pyrrolyl-2-pyridylmethylsulfinyl benzimidazole, alkylsulfinyl benzimidazole, fluoro-pyridylmethylsulfinyl benzimidazole, imidazo(4,5-b)pyridine, RO 18-5362, IY 81149, 4-amino-3-carbonyl quinoline, 4-amino-3-acylnaphthyridine, 4-aminoquinoline, 4-amino-3-acylquinoline, 3-butyryl-4-(2-methylphenylamino)-8-(2-hydroxyethoxy)quinoline, quinazoline, tetrahydroisoquinolin-2-yl pyrimidine, YH 1885, 3-substituted 1,2,4-
20 thiadiazolo(4,5-a) benzimidazole, 3-substituted imidazo(1,2-d)-thiadiazole, 2-sulfinylnicotinamide, pyridylsulfinylbenzimidazole, pyridylsulfinyl thienoimidazole, thienoimidazole-toluidine, 4,5-dihydrooxazole, thienoimidazole-toluidine, Hoe-731, imidazo(1,2-a)pyridine, pyrrolo(2,3-b)pyridine, and the like. Suitable proton pump inhibitors are described more fully in the literature, such as in Goodman and Gilman, The
25 Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; the Merck Index on CD-ROM, 13th Edition; and in WO 00/50037 assigned to NitroMed Inc., the disclosures of which are incorporated herein by reference in their entirety.

Suitable renin inhibitors include, but are not limited to, aldosterone, aliskiren (SPP-100), ditekiren, enalkrein (A-64662), medullipin, terlkiren, tonin, zankiren, RO 42-5892
30 (remikiren), A 62198, A 64662, A 65317, A 69729, A 72517 (zankiren), A 74273, CP 80794, CGP 29287, CGP-38560A, EMD 47942, ES 305, ES 1005, ES 8891, FK 906, FK 744, H 113, H-142, KRI 1314, pepstatin A, RO 44-9375 (ciprokiren), RO 42-5892, RO 66-1132, RO 66-1168, SP 500, SP 800, SR-43845, SQ 34017, U 71038, YM-21095, YM-

26365, urea derivatives of peptides, amino acids connected by nonpeptide bonds, di- and tri-peptide derivatives (e.g., Act-A, Act-B, Act-C, ACT-D, and the like), amino acids and derivatives thereof, diol sulfonamides and sulfinyls, modified peptides, peptidyl beta-aminoacyl aminodiol carbamates, monoclonal antibodies to renin. Suitable renin inhibitors are described more fully in U.S. Patent Nos. 5,116,835, 5,114,937, 5,106,835, 5,104,869, 5,095,119, 5,098,924), 5,095,006, 5,089,471, 5,075,451, 5,066,643, 5,063,208, 4,845,079, 5,055,466, 4,980,283, 4,885,292), 4,780,401, 5,071,837, 5,064,965, 5,063,207, 5,036,054, 5,036,053, 5,034,512, and 4,894,437, the disclosures of each of which are incorporated herein by reference in their entirety; and in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

Suitable COX-2 inhibitors include, but are not limited to, nimesulide, celecoxib (CELEBREX®), etoricoxib (ARCOXIA®), flosulide, lumiracoxib (PREXIG®, COX-189), parecoxib (DYNSTAT®), rofecoxib (VIOXX®), tiracoxib (JTE-522), valdecoxib (BEXTRA®), ABT 963, BMS 347070, CS 502, DuP 697, GW-406381, NS-386, SC-57666, SC-58125, SC-58635, and the like, and mixtures of two or more thereof. Suitable COX-2 inhibitors are in U.S. Patent Nos. 5,344,991, 5,380,738, 5,393,790, 5,409,944, 5,434,178, 5,436,265, 5,466,823, 5,474,995, 5,510,368, 5,536,752, 5,550,142, 5,552,422, 5,604,253, 5,604,260, 5,639,780, 5,932,598 and 6,633,272, and in WO 94/03387, WO 94/15723, WO 94/20480, WO 94/26731, WO 94/27980, WO 95/00501, WO 95/15316, WO 96/03387, WO 96/03388, WO 96/06840, WO 96/21667, WO 96/31509, WO 96/36623, WO 97/14691, WO 97/16435, WO 01/45703 and WO 01/87343, the disclosures of each of which are incorporated herein by reference in their entirety; and in the literature, such as in Goodman and Gilman, The Pharmacological Basis of Therapeutics (9th Edition), McGraw-Hill, 1995; and the Merck Index on CD-ROM, Thirteenth Edition; and on STN Express, file phar and file registry.

In some embodiments the COX-2 inhibitors are celecoxib, etoracoxib, lumiracoxib, paracoxib, rofecoxib or valdecoxib. In more particular embodiments the celecoxib is administered in an amount of about 100 milligrams to about 800 milligrams as a single dose or as multiple doses per day; the etoricoxib is administered in an amount of about 50 milligrams to about 200 milligrams as a single dose or as multiple doses per day; the lumiracoxib is administered in an amount of about 40 milligrams to about 1200 milligrams as

a single dose or as multiple doses per day; the paracoxib is administered in an amount of about 20 milligrams to about 100 milligrams as a single dose or as multiple doses per day; the rofecoxib is administered in an amount of about 12.5 milligrams to about 50 milligrams as a single dose or as multiple doses per day; the valdecoxib is administered in an amount of about 10 milligrams to about 40 milligrams as a single dose or as multiple doses per day.

Suitable steroids include, but are not limited to, 21-acetoxypregnenolone, alcolometasone, algestone, amcinonide, beclomethasone, betamethasone, budesonide, chlorprednisone, clobetasol, clobetasone, clocortolone, cloprednol, corticosterone, cortisone, corticazol (cortivatol), deflazacort, desonide, desoximetasone, dexamethasone, diflorasone, diflucortolone, difluprednate, enoxolone, fluzacort, flucloronide, flumethasone, flunisolide, flucinolone acetate, fluocininide, fluocortin butyl, fluocortolone, fluorometholone, fluperolone acetate, fluprednidene acetate, fluprednisolone, flurandrenolide, fluticasone propionate, fluticasone propionate, formocortal, halcinonide, halobetasol propionate, halometasone, haloprednone acetate, hydrocortamate, hydrocortisone and its derivatives (such as phosphate, 21-sodium succinate and the like), hydrocortisone terbutate, isoflupredone, loteprednol etabonate, mazipredone, medrysone, meprednisone, methylprednisolone, mometasone furoate, paremethasone, prednicarbate, prednisolone and its derivatives (such as 21-stearoylglycolate, sodium phosphate and the like), prednisone, prednival, prednylidene and its derivatives (such as 21-diethylaminoacetate and the like), rimexolone, tixocortol, trimcinolone and its derivatives (such as acetate, benetonide and the like), and the like.

Suitable NSAIDs are described more fully in the literature, such as in Goodman and Gilman, *The Pharmacological Basis of Therapeutics* (9th Edition), McGraw-Hill, 1995, Pgs. 617-657; the Merck Index on CD-ROM, 13th Edition; and in U.S. Patent Nos. 6,057,347 and 6,297,260 assigned to NitroMed Inc., the disclosures of which are incorporated herein by reference in their entirety.

In some embodiments the steroids are dexamethasone, fluorometholone, hydrocortisone, and prednisolone.

The invention provides compositions comprising (i) a nitric oxide enhancing angiotensin II antagonist compound or pharmaceutically acceptable salt thereof, and (ii) at least one compound is selected from the group consisting of an aldosterone antagonist, an angiotensin II antagonist, an angiotensin-converting enzyme (ACE) inhibitor, a β -adrenergic antagonist, a calcium channel blocker, a diuretic, a hydralazine compound and a renin inhibitor in one or more pharmaceutically acceptable carriers. In other embodiments of the

invention the aldosterone antagonist is eplerenone or spironolactone; the angiotensin II antagonist is candesartan, candesartan cilexetil, eprosartan mesylate, irbesartan, losartan, medoxomil, telmisartan, trandolapril, trandolaprilat or valsartan; the angiotensin-converting enzyme inhibitor is benazepril hydrochloride, captopril, enalapril maleate, fosinopril sodium, lisinopril, moexipril hydrochloride, quinapril hydrochloride, ramipril; the β -adrenergic antagonist is bisoprolol fumarate, carvedilol, metoprolol tartrate, propranolol hydrochloride or timolol maleate; the calcium channel blockers is amlodipine, diltiazem, isradipine, nicardipine, nifedipine, nimodipine, nisoldipine, nitrendipine, verapamil; the diuretic is amiloride hydrochloride, chlorthalidone, hydrochlorothiazide or triamterene; the hydralazine compound is hydralazine hydrochloride; and the renin inhibitor is aliskiren, ciprokiren, ditekiren, enalkrein, medullipin, remikiren, terliren, tonin or zankiren.

The invention provides compositions comprising (i) a nitric oxide enhancing angiotensin II antagonist compound (ii) a nitric oxide enhancing compound, such as, isosorbide dinitrate and/or isosorbide mononitrate (preferably isosorbide dinitrate), and (iii) a hydralazine compound (such as hydralazine hydrochloride). In one embodiment, the hydralazine hydrochloride can be administered in an amount of about 30 milligrams per day to about 400 milligrams per day; the isosorbide dinitrate can be administered in an amount of about 10 milligrams per day to about 200 milligrams per day; or the isosorbide mononitrate can be administered in an amount of about 5 milligrams per day to about 120 milligrams per day. In another embodiment, the hydralazine hydrochloride can be administered in an amount of about 50 milligrams per day to about 300 milligrams per day; the isosorbide dinitrate can be administered in an amount of about 20 milligrams per day to about 160 milligrams per day; or the isosorbide mononitrate can be administered in an amount of about 15 milligrams per day to about 100 milligrams per day. In yet another embodiment, the hydralazine hydrochloride can be administered in an amount of about 37.5 milligrams to about 75 milligrams one to four times per day; the isosorbide dinitrate can be administered in an amount of about 20 milligrams to about 40 milligrams one to four times per day; or the isosorbide mononitrate can be administered in an amount of about 10 milligrams to about 20 milligrams one to four times per day. In another embodiment of the methods of the invention, the patient can be administered a composition comprising about 225 mg hydralazine hydrochloride and about 120 mg isosorbide dinitrate once per day (i.e., q.d.). In another embodiment of the methods of the invention, the patient can be administered a composition comprising about 112.5 mg hydralazine hydrochloride and about 60 mg

isosorbide dinitrate twice per day (i.e., b.i.d.). In another embodiment of the methods of the invention, the patient can be administered a composition comprising about 56.25 mg hydralazine hydrochloride and about 30 mg isosorbide dinitrate twice per day (i.e., b.i.d.). In another embodiment of the methods of the invention, the patient can be administered a composition comprising about 75 mg hydralazine hydrochloride and about 40 mg isosorbide dinitrate three times per day (i.e., t.i.d.). In another embodiment of the methods of the invention, the patient can be administered a composition comprising about 37.5 mg hydralazine hydrochloride and about 20 mg isosorbide dinitrate three times per day (i.e., t.i.d.). The particular amounts of hydralazine and isosorbide dinitrate or isosorbide mononitrate can be administered as a single dose once a day; or in multiple doses several times throughout the day; or as a sustained-release oral formulation, or as an injectable formulation.

The invention provides methods for treating cardiovascular disorders by administering to the patient in need thereof an effective amount of the compounds and/or compositions described herein. For example, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound. In another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and at least one nitric oxide enhancing compound. In yet another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and, at least one therapeutic agent, including but not limited to, such as, for example, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs), phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, steroids, and combinations of two or more thereof. In another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and, at least one therapeutic agent, and, at least one nitric oxide enhancing compound. In one embodiment the cardiovascular disorder is hypertension, heart failure, arterial stiffness,

postmyocardial infarction, stroke and/or diastolic dysfunction. The nitric oxide enhancing angiotensin II antagonist compounds, nitric oxide enhancing compounds, and/or therapeutic agents can be administered separately or as components of the same composition in one or more pharmaceutically acceptable carriers.

5 The invention provides methods for treating renovascular diseases by administering to the patient in need thereof an effective amount of the compounds and/or compositions described herein. For example, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound. In another
10 embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and at least one nitric oxide enhancing compound. In yet another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and, at least one therapeutic agent, including but not limited to, such as, for example, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists,
15 angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs),
20 phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, steroids, and combinations of two or more thereof. In another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and, at least one therapeutic agent,
25 and, at least one nitric oxide enhancing compound. In one embodiment the renovascular disease is renal failure, renal insufficiency, renal deterioration associated with severe hypertension or renovascular hypertension. The nitric oxide enhancing angiotensin II antagonist compounds, nitric oxide enhancing compounds, and/or therapeutic agents can be administered separately or as components of the same composition in one or more
30 pharmaceutically acceptable carriers.

 The invention provides methods for treating diabetes; treating diseases resulting from oxidative stress; treating endothelial dysfunctions; treating diseases caused by endothelial dysfunctions; treating cirrhosis; treating pre-eclampsia; treating osteoporosis;

treating nephropathy; treating peripheral vascular diseases; treating portal hypertension; treating central nervous system disorders; treating metabolic syndrome; and treating hyperlipidemia. by administering to the patient in need thereof an effective amount of the compounds and/or compositions described herein. For example, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound. In another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and at least one nitric oxide enhancing compound. In yet another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and, at least one therapeutic agent, including but not limited to, such as, for example, aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H_2 receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs), phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2 (COX-2) inhibitors, steroids, and combinations of two or more thereof. In another embodiment, the patient can be administered an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound, and, at least one therapeutic agent, and, at least one nitric oxide enhancing compound. The nitric oxide enhancing angiotensin II antagonist compounds, nitric oxide enhancing compounds, and/or therapeutic agents can be administered separately or as components of the same composition in one or more pharmaceutically acceptable carriers.

When administered separately, the nitric oxide enhancing angiotensin II antagonist compound, nitric oxide enhancing compound and/or therapeutic agent can be administered about the same time as part of the overall treatment regimen, i.e., as a combination therapy. "About the same time" includes administering the at least one nitric oxide enhancing angiotensin II antagonist compound, simultaneously, sequentially, at the same time, at different times on the same day, or on different days, as long as they are administered as part of an overall treatment regimen, i.e., combination therapy or a therapeutic cocktail.

When administered in vivo, the compounds and compositions of the invention can be

administered in combination with pharmaceutically acceptable carriers and in dosages described herein. When the compounds and compositions of the invention are administered as a combination of at least one nitric oxide enhancing angiotensin II antagonist compound and/or at least one nitric oxide enhancing compound and/or therapeutic agent, they can also
5 be used in combination with one or more additional compounds which are known to be effective against the specific disease state targeted for treatment. The nitric oxide enhancing compounds, therapeutic agents and/or other additional compounds can be administered simultaneously with, subsequently to, or prior to administration of the nitric oxide enhancing angiotensin II antagonist compounds.

10 The compounds and compositions of the invention can be administered by any available and effective delivery system including, but not limited to, orally, buccally, parenterally, by inhalation, by topical application, or transdermally, in dosage unit formulations containing conventional nontoxic pharmaceutically acceptable carriers, adjuvants, and vehicles, as desired. Parenteral includes subcutaneous injections, intravenous,
15 intramuscular, intrasternal injection, or infusion techniques. In one embodiment of the invention the nitric oxide enhancing angiotensin II antagonist compound is administered orally, parentally or by inhalation.

Transdermal compound administration, which is known to one skilled in the art, involves the delivery of pharmaceutical compounds via percutaneous passage of the
20 compound into the systemic circulation of the patient. Topical administration can also involve the use of transdermal administration such as transdermal patches or iontophoresis devices. Other components can be incorporated into the transdermal patches as well. For example, compositions and/or transdermal patches can be formulated with one or more preservatives or bacteriostatic agents including, but not limited to, methyl hydroxybenzoate, propyl hydroxybenzoate, chlorocresol, benzalkonium chloride, and the like. Dosage forms
25 for topical administration of the compounds and compositions can include creams, sprays, lotions, gels, ointments, eye drops, nose drops, ear drops, and the like. In such dosage forms, the compositions of the invention can be mixed to form white, smooth, homogeneous, opaque cream or lotion with, for example, benzyl alcohol 1% or 2% (wt/wt) as a preservative,
30 emulsifying wax, glycerin, isopropyl palmitate, lactic acid, purified water and sorbitol solution. In addition, the compositions can contain polyethylene glycol 400. They can be mixed to form ointments with, for example, benzyl alcohol 2% (wt/wt) as preservative, white petrolatum, emulsifying wax, and tenox II (butylated hydroxyanisole, propyl gallate, citric

acid, propylene glycol). Woven pads or rolls of bandaging material, e.g., gauze, can be impregnated with the compositions in solution, lotion, cream, ointment or other such form can also be used for topical application. The compositions can also be applied topically using a transdermal system, such as one of an acrylic-based polymer adhesive with a resinous crosslinking agent impregnated with the composition and laminated to an impermeable backing.

The compositions can also be applied topically using a transdermal system, such as one of an acrylic-based polymer adhesive with a resinous crosslinking agent impregnated with the composition and laminated to an impermeable backing. In a particular embodiment, the compositions of the invention are administered as a transdermal patch, more particularly as a sustained-release transdermal patch. The transdermal patches of the invention can include any conventional form such as, for example, adhesive matrix, polymeric matrix, reservoir patch, matrix or monolithic-type laminated structure, and are generally comprised of one or more backing layers, adhesives, penetration enhancers, an optional rate controlling membrane and a release liner which is removed to expose the adhesives prior to application. Polymeric matrix patches also comprise a polymeric-matrix forming material. Suitable transdermal patches are described in more detail in, for example, U. S. Patent Nos. 5,262,165, 5,948,433, 6,010,715 and 6,071,531, the disclosure of each of which are incorporated herein in their entirety.

Solid dosage forms for oral administration can include capsules, sustained-release capsules, tablets, sustained release tablets, chewable tablets, sublingual tablets, effervescent tablets, pills, powders, granules and gels. In such solid dosage forms, the active compounds can be admixed with at least one inert diluent such as sucrose, lactose or starch. Such dosage forms can also comprise, as in normal practice, additional substances other than inert diluents, e.g., lubricating agents such as magnesium stearate. In the case of capsules, tablets, effervescent tablets, and pills, the dosage forms can also comprise buffering agents. Soft gelatin capsules can be prepared to contain a mixture of the active compounds or compositions of the invention and vegetable oil. Hard gelatin capsules can contain granules of the active compound in combination with a solid, pulverulent carrier such as lactose, saccharose, sorbitol, mannitol, potato starch, corn starch, amylopectin, cellulose derivatives of gelatin. Tablets and pills can be prepared with enteric coatings.

Liquid dosage forms for oral administration can include pharmaceutically acceptable emulsions, solutions, suspensions, syrups, and elixirs containing inert diluents commonly

used in the art, such as water. Such compositions can also comprise adjuvants, such as wetting agents, emulsifying and suspending agents, and sweetening, flavoring, and perfuming agents.

Suppositories for vaginal or rectal administration of the compounds and compositions of the invention can be prepared by mixing the compounds or compositions with a suitable nonirritating excipient such as cocoa butter and polyethylene glycols which are solid at room temperature but liquid at rectal temperature, such that they will melt in the rectum and release the drug.

Injectable preparations, for example, sterile injectable aqueous or oleaginous suspensions can be formulated according to the known art using suitable dispersing agents, wetting agents and/or suspending agents. The sterile injectable preparation can also be a sterile injectable solution or suspension in a nontoxic parenterally acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that can be used are water, Ringer's solution, and isotonic sodium chloride solution. Sterile fixed oils are also conventionally used as a solvent or suspending medium.

The compositions of this invention can further include conventional excipients, i.e., pharmaceutically acceptable organic or inorganic carrier substances suitable for parenteral application which do not deleteriously react with the active compounds. Suitable pharmaceutically acceptable carriers include, for example, water, salt solutions, alcohol, vegetable oils, polyethylene glycols, gelatin, lactose, amylose, magnesium stearate, talc, surfactants, silicic acid, viscous paraffin, perfume oil, fatty acid monoglycerides and diglycerides, petroethral fatty acid esters, hydroxymethyl-cellulose, polyvinylpyrrolidone, and the like. The pharmaceutical preparations can be sterilized and if desired, mixed with auxiliary agents, e.g., lubricants, preservatives, stabilizers, wetting agents, emulsifiers, salts for influencing osmotic pressure, buffers, colorings, flavoring and/or aromatic substances and the like which do not deleteriously react with the active compounds. For parenteral application, particularly suitable vehicles consist of solutions, preferably oily or aqueous solutions, as well as suspensions, emulsions, or implants. Aqueous suspensions may contain substances which increase the viscosity of the suspension and include, for example, sodium carboxymethyl cellulose, sorbitol and/or dextran. Optionally, the suspension may also contain stabilizers.

The composition, if desired, can also contain minor amounts of wetting agents, emulsifying agents and/or pH buffering agents. The composition can be a liquid solution,

suspension, emulsion, tablet, pill, capsule, sustained release formulation, or powder. The composition can be formulated as a suppository, with traditional binders and carriers such as triglycerides. Oral formulations can include standard carriers such as pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharine, cellulose, magnesium carbonate, and the like.

Various delivery systems are known and can be used to administer the compounds or compositions of the invention, including, for example, encapsulation in liposomes, microbubbles, emulsions, microparticles, microcapsules and the like. The required dosage can be administered as a single unit or in a sustained release form.

The bioavailability of the compositions can be enhanced by micronization of the formulations using conventional techniques such as grinding, milling, spray drying and the like in the presence of suitable excipients or agents such as phospholipids or surfactants.

Sustained release dosage forms of the invention may comprise microparticles and/or nanoparticles having a therapeutic agent dispersed therein or may comprise the therapeutic agent in pure, preferably crystalline, solid form. For sustained release administration, microparticle dosage forms comprising pure, preferably crystalline, therapeutic agents are administered. The therapeutic dosage forms of this aspect of the invention may be of any configuration suitable for sustained release.

Nanoparticle sustained release therapeutic dosage forms are preferably biodegradable and, optionally, bind to the vascular smooth muscle cells and enter those cells, primarily by endocytosis. The biodegradation of the nanoparticles occurs over time (e.g., 30 to 120 days; or 10 to 21 days) in prelysosomal vesicles and lysosomes. Larger microparticle therapeutic dosage forms of the invention release the therapeutic agents for subsequent target cell uptake with only a few of the smaller microparticles entering the cell by phagocytosis. A practitioner in the art will appreciate that the precise mechanism by which a target cell assimilates and metabolizes a dosage form of the invention depends on the morphology, physiology and metabolic processes of those cells. The size of the particle sustained release therapeutic dosage forms is also important with respect to the mode of cellular assimilation. For example, the smaller nanoparticles can flow with the interstitial fluid between cells and penetrate the infused tissue. The larger microparticles tend to be more easily trapped interstitially in the infused primary tissue, and thus are useful to deliver anti-proliferative therapeutic agents.

Particular sustained release dosage forms of the invention comprise biodegradable

microparticles or nanoparticles. More particularly, biodegradable microparticles or nanoparticles are formed of a polymer containing matrix that biodegrades by random, nonenzymatic, hydrolytic scissioning to release therapeutic agent, thereby forming pores within the particulate structure.

5 In a particular embodiment, the compositions of the invention are orally administered as a sustained release tablet or a sustained release capsule. For example, the sustained release formulations can comprise an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound or a pharmaceutically acceptable salt thereof, and, optionally at least one nitric oxide enhancing compound, or the sustained release formulations
10 can comprise an effective amount of at least one nitric oxide enhancing angiotensin II antagonist compound or a pharmaceutically acceptable salt thereof, and at least one nitric oxide enhancing compound, and, optionally at least one therapeutic agent

The compounds and compositions of the invention can be formulated as pharmaceutically acceptable salt forms. Pharmaceutically acceptable salts include, for
15 example, alkali metal salts and 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 may be prepared from an inorganic acid or from an organic acid. Examples of such inorganic acids include, but are not limited to, hydrochloric, hydrobromic, hydroiodic, nitric, carbonic, sulfuric and phosphoric acid and the like.
20 Appropriate organic acids include, but are not limited to, aliphatic, cycloaliphatic, aromatic, heterocyclic, carboxylic and sulfonic classes of organic acids, such as, for example, formic, acetic, propionic, succinic, glycolic, gluconic, lactic, malic, tartaric, citric, ascorbic, glucuronic, maleic, fumaric, pyruvic, aspartic, glutamic, benzoic, anthranilic, mesylic, salicylic, p-hydroxybenzoic, phenylacetic, mandelic, embonic (pamoic), methanesulfonic,
25 ethanesulfonic, benzenesulfonic, pantothenic, toluenesulfonic, 2-hydroxyethanesulfonic, sulfanilic, stearic, algenic, β -hydroxybutyric, cyclohexylaminosulfonic, galactaric and galacturonic acid and the like. Suitable pharmaceutically-acceptable base addition salts include, but are not limited to, metallic salts made from aluminum, calcium, lithium, magnesium, potassium, sodium and zinc or organic salts made from primary, secondary and
30 tertiary amines, cyclic amines, N,N'-dibenzylethylenediamine, chlorprocaine, choline, diethanolamine, ethylenediamine, meglumine (N-methylglucamine) and procaine and the like. All of these salts may be prepared by conventional means from the corresponding compound by reacting, for example, the appropriate acid or base with the compound. In one

embodiment, the pharmaceutically acceptable salts of the compounds of the invention include the nitrate salt.

While individual needs may vary, determination of optimal ranges for effective amounts of the compounds and/or compositions is within the skill of the art. Generally, the dosage required to provide an effective amount of the compounds and compositions, which can be adjusted by one of ordinary skill in the art, will vary depending on the age, health, physical condition, sex, diet, weight, extent of the dysfunction of the recipient, frequency of treatment and the nature and scope of the dysfunction or disease, medical condition of the patient, the route of administration, pharmacological considerations such as the activity, efficacy, pharmacokinetic and toxicology profiles of the particular compound used, whether a drug delivery system is used, and whether the compound is administered as part of a drug combination.

The amount of a given nitric oxide enhancing angiotensin II antagonist compound that will be effective in the treatment of a particular disorder or condition will depend on the nature of the disorder or condition, and can be determined by standard clinical techniques, including reference to Goodman and Gilman, supra; The Physician's Desk Reference, Medical Economics Company, Inc., Oradell, N.J., 1995; and Drug Facts and Comparisons, Inc., St. Louis, MO, 1993. The precise dose to be used in the formulation will also depend on the route of administration, and the seriousness of the disease or disorder, and should be decided by the physician and the patient's circumstances.

The invention also provides pharmaceutical kits comprising one or more containers filled with one or more of the ingredients of the pharmaceutical compounds and/or compositions of the invention, including, at least, one or more of the novel nitric oxide enhancing angiotensin II antagonist compound, and one or more of the nitric oxide enhancing compounds described herein. Associated with such kits can be additional therapeutic agents or compositions (e.g., aldosterone antagonists, alpha-adrenergic receptor antagonists, angiotensin II antagonists, angiotensin-converting enzyme (ACE) inhibitors, antidiabetic compounds, anti-hyperlipidemic compounds, antioxidants, antithrombotic and vasodilator compounds, β -adrenergic antagonists, calcium channel blockers, carbonic anhydrase inhibitors, digitalis, diuretics, endothelin antagonists, hydralazine compounds, H₂ receptor antagonists, neutral endopeptidase inhibitors, nonsteroidal antiinflammatory compounds (NSAIDs), phosphodiesterase inhibitors, potassium channel blockers, platelet reducing agents, prostaglandins, proton pump inhibitors, renin inhibitors, selective cyclooxygenase-2

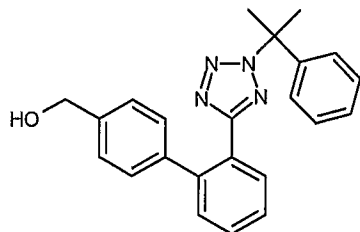
(COX-2) inhibitors, steroids, and the like, and combinations of two or more thereof), devices for administering the compositions, and notices in the form prescribed by a governmental agency regulating the manufacture, use or sale of pharmaceuticals or biological products which reflects approval by the agency of manufacture, use or sale for humans.

5

EXAMPLES

Example 1: L-valine, N-[5-(nitrooxy)-1-oxopentyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-

1a. [1,1'-Biphenyl]-4-methanol, 2'-[2-(1-methyl-1-phenylethyl)-2H-tetrazol-5-yl]-



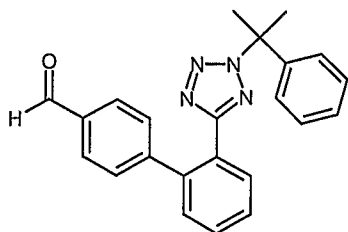
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To a suspension of [1,1'-biphenyl]-4-carboxylic acid, 2'-[2-(1-methyl-1-phenylethyl)-2H-tetrazol-5-yl]-, methyl ester (prepared according to U.S. Patent 5,412,102 Example 3; 9.0 g, 22.6 mmol) in toluene (60 mL), cooled to -78 °C, was added dropwise DIBAL (16.1 mL, 1.5 M in toluene, 24.2 mmol). The reaction mixture was stirred at -78 °C for 1 hour and TLC showed the presence of starting material. Additional DIBAL (16.1 mL, 1.5 M in toluene, 24.2 mmol) was added. After 1.5 hours, the reaction was quenched with 1 N HCl (35 mL) and diluted with ethyl acetate and allowed to warm to room temperature. The ethyl acetate layer was separated and the aqueous layer was extracted with ethyl acetate. The combined ethyl acetate extracts were washed with 1N HCl, water and brine, dried over magnesium sulfate, filtered and evaporated to give the title compound as a white solid (8.2 g, 98% yield): mp 119-121 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.85 (d, *J* = 8.4 Hz, 1H), 7.44 (m, 3H), 7.25 (m, 3H), 7.19 (d, *J* = 8.4 Hz, 2H), 7.13 (d, *J* = 8.4 Hz, 2H), 6.95 (m, 2H), 4.64 (d, *J* = 5.2 Hz, 2H), 2.00 (s, 6H); Mass spectrum (API-TIS) *m/z* 371 (MH⁺), 388 (MNH₄⁺).

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1b. [1,1'-Biphenyl]-4-carboxaldehyde, 2'-[2-(1-methyl-1-phenylethyl)-2H-tetrazol-5-yl]-

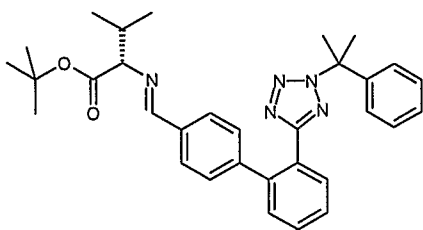


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To a solution of oxalyl chloride (2.62 g, 20.6 mmol) in dichloromethane (65 mL) at -

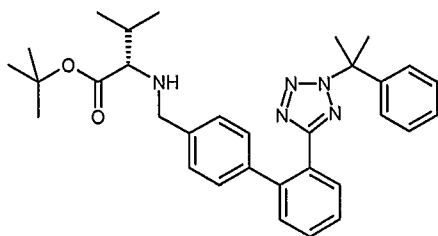
60 °C was added dropwise DMSO (3.3 g, 42.2 mmol) in dichloromethane (5 mL). The resulting mixture was stirred at -60 °C for 2 minutes. A solution of the product of Example 1a (7.0 g, 18.9 mmol) in dichloromethane (35 mL) was then added dropwise and the mixture was stirred at -60 °C for 15 minutes. Triethylamine (9.8 g, 96.8 mmol) was added dropwise and the mixture was stirred at -60 °C for 2 minutes and then allowed to warm to room temperature. Water was added and the reaction mixture was extracted with dichloromethane. The organic phase was washed with water and brine, dried over magnesium sulfate, filtered and evaporated to give a white solid which was suspended in hexane and collected to give title compound as a white solid (6.7 g, 96% yield): mp 95 - 97 °C; ¹H NMR (400 MHz, CDCl₃) δ 9.95 (s, 1H), 7.94 (d, *J* = 8 Hz, 1H), 7.68 (d, *J* = 8 Hz, 2H), 7.51 (m, 2H), 7.40 (m, 1H), 7.26 (m, 5H), 6.93 (m, 2H), 2.00 (s, 6H); Mass spectrum (API-TIS) *m/z* 369 (MH⁺).

1c. L-valine, *N*-[[2'-[2-(1-methyl-1-phenylethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methylene]-, 1,1-dimethylethyl ester, (*E*)-



The product of Example 1b (2.0 g, 5.4 mmol) and L-valine, 1,1-dimethylethyl ester, hydrochloride (2.3 g, 11.1 mmol; prepared as described in *Tetrahedron*, 41(23), 5633-5636, 1985) in benzene (150 mL) was heated at reflux for 7 hours to remove the water formed using a Dean-Stark apparatus. The solvent was removed under vacuum and title product was obtained as a slightly yellow solid which was used directly to the next step without further purification.

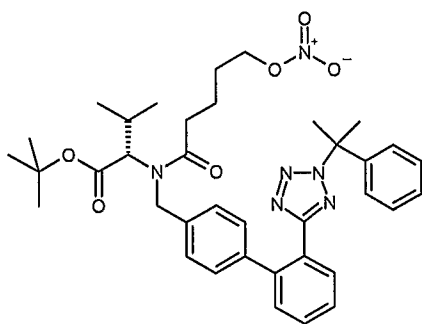
1d. L-valine, *N*-[[2'-[2-(1-methyl-1-phenylethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-, 1,1-dimethylethyl ester



To the product of Example 1c (5.4 mmol) in THF (15 mL) at 0 °C was added

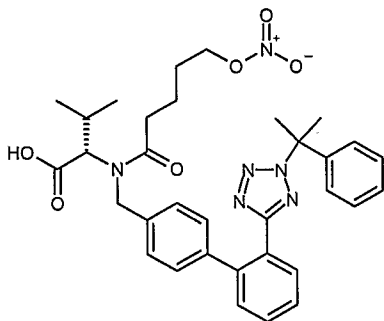
dropwise a solution of sodium cyanoborohydride (0.40 g, 6.4 mmol) in methanol (3 mL). The resulting mixture was stirred at room temperature for 20 hours. The solvent was evaporated under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 92:8 hexane:ethyl acetate) to give the title compound as a colorless oil (2.4 g, 84% yield): ^1H NMR (400 MHz, CDCl_3) δ 7.82 (m, 1H), 7.50-7.40 (m, 3H), 7.22 (m, 5H), 7.08 (d, $J = 6.4$ Hz, 2H), 6.95 (m, 2H), 3.79 (d, $J = 12$ Hz, 1H), 3.54 (d, $J = 12$ Hz, 1H), 2.87 (d, $J = 8$ Hz, 1H), 1.99 (s, 6H), 1.88 (m, 1H), 1.46 (s, 9H), 0.93 (d, $J = 8$ Hz, 6H); Mass spectrum (API-TIS) m/z 526 (MH^+).

1e. L-valine, *N*-[[2'-[2-(1-methyl-1-phenylethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-*N*-[5-(nitrooxy)-1-oxopentyl]-, 1,1-dimethylethyl ester



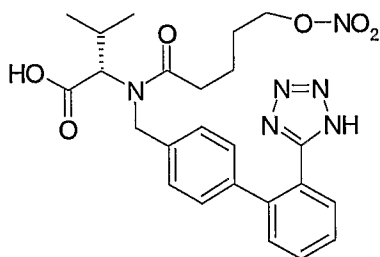
Oxalyl chloride (0.87 g, 6.9 mmol) was added dropwise to a solution of 5-pentanoic acid, 5-(nitrooxy)- (0.74 g, 4.5 mmol, prepared according to U.S. Application no. 60/655,414, Example 4a) in dichloromethane (10 mL), followed by the addition of DMF (~15 μL). The resulting mixture was stirred at room temperature for 1.5 hours followed by the removal of the solvent. The resulting residue was dried under vacuum for 10 minutes, dissolved in dichloromethane (2 mL) and was added to the product of Example 1d (2.0 g, 3.8 mmol) in dichloromethane (10 mL) and triethylamine (0.69 g, 6.82 mmol) at 0 $^\circ\text{C}$. The reaction mixture was warmed to room temperature and stirred at room temperature for 20 hours. The solvent was removed under vacuum and the crude product was purified by column chromatography (silica gel, elution: 85:15 hexane:ethyl acetate) to give the title compound as a colorless oil (2.1 g, 82% yield): ^1H NMR (400 MHz, CDCl_3) δ 7.80 (m, 1H), 7.50-7.25 (m, 7H), 7.13-6.96 (m, 5H), 4.77-3.84 (m, 5H), 2.62-2.23 (m, 3H), 2.02 (s, 6H), 1.81-1.61 (m, 4H), 1.32 (m, 9H), 0.99-0.72 (m, 6H); Mass spectrum (API-TIS) m/z 671 (MH^+), 688 (MNH_4^+).

- 1f. L-valine, *N*-[[2'-[2-(1-methyl-1-phenylethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-*N*-[5-(nitrooxy)-1-oxopentyl]-



Hydrogen chloride solution (17 mL, 4.0 M in 1,4-dioxane, 68.0 mmol) was added to the product of Example 1e (1.7 g, 2.5 mmol). The resulting mixture was stirred at room temperature for 4 hours. The solvent was removed under vacuum and product was dried under vacuum and used directly in the next step without further purification: Mass spectrum (API-TIS) *m/z* 615 (MH^+), 632 (MNH_4^+).

- 1g. L-valine, *N*-[5-(nitrooxy)-1-oxopentyl]-*N*-[[2'-(1*H*-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-

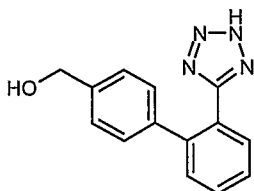


To the product of Example 1f (2.5 mmol) and pentaerythritol tetrakis(2-mercaptoacetate) (1.2 g, 2.8 mmol) in dry acetonitrile (20 mL) was added boron trifluoride-diethyl etherate (1.39 g, 9.8 mmol) dropwise at room temperature. The reaction mixture was stirred at room temperature for 3 hours. Ethyl acetate was added followed by the extraction with an aqueous solution of 10% sodium carbonate aqueous solution. The basic aqueous layer was washed with ethyl acetate, then acidified with concentrated hydrochloric acid to adjust the pH to 3. The acidic aqueous phase was extracted with ethyl acetate. The ethyl acetate extract was washed with water and brine, evaporated to yield an oil which was purified by column chromatography (silica gel, eluting with 85:15 dichloromethane:methanol) to give the title compound as a white solid (0.48 g, 38% yield):

mp 108 -111 °C; ^1H NMR (400 MHz, CD_3OD) δ 7.61-7.45 (m, 4H), 7.18-6.99 (m, 4H), 4.7-4.0 (m, 5H), 2.8-2.2 (m, 3H), 1.78-1.61 (m, 4H), 1.01 (m, 3H), 0.85-0.79 (m, 3H); Mass spectrum (API-TIS) m/z 497 (MH^+), 514 (MNH_4^+).

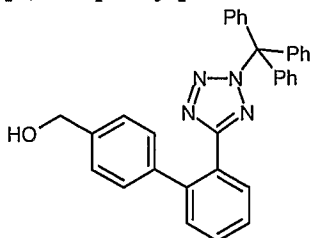
Example 2: L-valine, N-[6-(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-

2a. [1,1'-Biphenyl]-4-methanol, 2'-(2H-tetrazol-5-yl)-



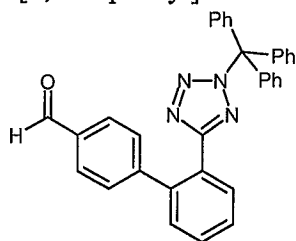
A solution of [1,1'-biphenyl]-2-carbonitrile, 4'-(hydroxymethyl)- (3.3 g, 15.8 mmol, prepared according to U.S. Patent No. 5,399,578, Example 1a) and azidotributyltin (10.0 g, 30.1 mmol) in xylene (65 mL) was stirred at 115 °C for 48 hours. Additional azidotributyltin (5.0 g, 15.1 mmol) was added and the reaction was stirred at 120 °C for another 48 hours. The reaction mixture was concentrated to a small volume (~ 30 mL xylene was removed) and ethyl acetate was added and extracted three times with sodium hydroxide (10% aqueous solution, total volume ~200 mL). The basic aqueous layer was washed with ethyl acetate and then neutralized with concentrated HCl to ~pH 4. This aqueous layer was extracted with ethyl acetate. The organic phase was washed with water, brine, dried over magnesium sulfate, filtered and evaporated to give title product as a slightly yellow foam which was used directly in the next step without further purification (4.1 g, 100% crude yield): Mass spectrum (API-TIS) m/z 253 (MH^+), 270 (MNH_4^+), 275 (MNa^+).

2b. [1,1'-Biphenyl]-4-methanol, 2'-[2-(triphenylmethyl)-2H-tetrazol-5-yl]-



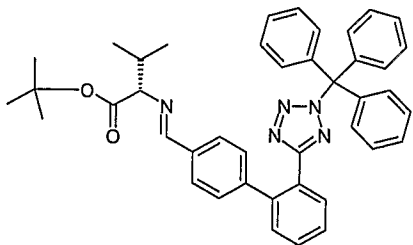
To the product of Example 2a (3.4 g, 13.5 mmol) and triethylamine (1.65 g, 16.30 mmol) in dichloromethane (15 mL) at 0 °C was added dropwise a solution of tritylchloride (4.13 g, 14.8 mmol) in dichloromethane (10 mL). The reaction was stirred at 0 °C for 1 hour and then at room temperature 2 hours. Dichloromethane was added and the reaction mixture was washed with water and brine. The organic phase was separated, dried over magnesium sulfate, filtered and evaporated to give a slightly yellow foam which was purified by column chromatography (silica gel, elution: 3:1 hexane:ethyl acetate) to give the title product as a white solid (3.91 g, 59% yield): mp 163-165 °C; ¹H NMR (400 Mz, CDCl₃) δ 7.94 (dd, *J* = 1.3, 8 Hz, 1H), 7.51-7.10 (m, 16H), 6.88 (d, *J* = 8 Hz, 6H), 4.56 (d, *J* = 4 Hz, 2H); Mass spectrum (API-TIS) *m/z* 512 (MNH₄⁺), 517 (MNa⁺).

2c. [1,1'-Biphenyl]-4-carboxaldehyde, 2'-[2-(triphenylmethyl)-2H-tetrazol-5-yl]-



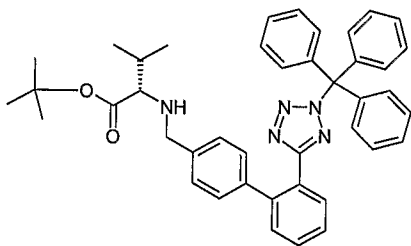
To a solution of oxalyl chloride (2.11 g, 16.62 mmol) in dichloromethane (50 mL) at -60 °C was added dropwise DMSO (2.65 g, 33.92 mmol) in dichloromethane solution (4 mL). The resulting mixture was stirred at -60 °C for 2 minutes. The product of Example 2b (7.52 g, 15.20 mmol) in dichloromethane (25 mL) was added dropwise and the reaction mixture was stirred at -60 °C for 15 minutes. Triethylamine (7.91 g, 78.17 mmol) was added dropwise and the reaction mixture was stirred at -60 °C for 2 minutes and then allowed to warm to room temperature. Water was added and the mixture was extracted with dichloromethane. The organic phase was washed with water, brine, dried over magnesium sulfate, filtered and evaporated to give a white solid which was suspended in hexane and collected to give the title compound as a white solid (7.1 g, 95% yield): mp 153-155 °C; ¹H NMR (400 Mz, CDCl₃) δ 9.89 (s, 1H), 8.05 (m, 1H), 7.59 (d, *J* = 8 Hz, 2H), 7.38-7.20 (m, 12H), 7.52 (m, 2H), 6.86 (d, *J* = 8 Hz, 6H).

- 2d. L-valine, *N*-[[2'-[2-(triphenylmethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methylene]-, 1,1-dimethylethyl ester, (*E*)-



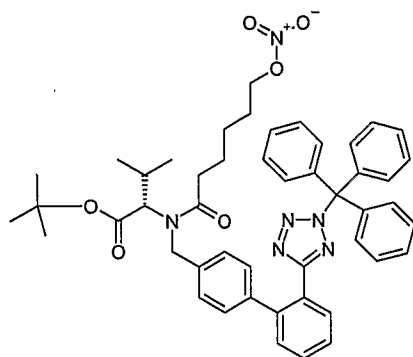
The product of Example 2c (3.0 g, 6.1 mmol) and L-valine, 1,1-dimethylethyl ester, hydrochloride (2.5 g, 12.0 mmol; prepared as described in *Tetrahedron*, 41(23), 5633-36, 1985) in benzene (150 mL) were heated at reflux for 7 hours to remove the formed water using a Dean-Stark apparatus. The solvent was removed under vacuum and the title product was obtained as a slightly yellow solid which was used directly to the next step without further purification: Mass spectrum (API-TIS) m/z 648 (MH^+).

- 2e. L-valine, *N*-[[2'-[2-(triphenylmethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-, 1,1-dimethylethyl ester



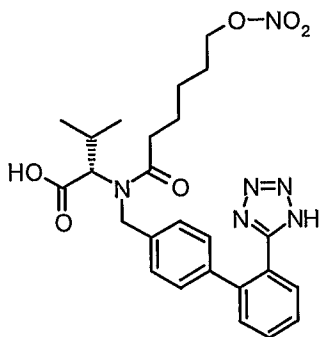
To the product of Example 2d (6.1 mmol) in THF (45 mL) at 0 °C was added dropwise sodium cyanoborohydride (0.45 g, 7.2 mmol) in methanol (9 mL). The reaction mixture was stirred at room temperature for 20 hours. The solvent was evaporated under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 92:8 hexane:ethyl acetate) to give the title compound as a white foam (3.2 g, 81% yield): mp 52 -54 °C; 1H NMR (400 Mz, $CDCl_3$) δ 7.90-7.37 (m, 3H), 7.32-7.22 (m, 10H), 7.12-7.05 (m, 4H), 6.89 (m, 6H), 3.72 (d, J = 12.8Hz, 1H), 3.49 (d, J = 12.8 Hz, 1H), 2.86 (d, J = 6 Hz, 1H), 1.87 (m, 1H), 1.48 (s, 9H), 0.93 (m, 6H); Mass spectrum (API-TIS) m/z 650 (MH^+)

- 2f. L-valine, *N*-[6-(nitrooxy)-1-oxohexyl]-*N*-[[2'-[2-(triphenylmethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-, 1,1-dimethylethyl ester



- 5 Oxalyl chloride (0.44 g, 3.47 mmol) was added dropwise to a solution of hexanoic acid, 6-(nitrooxy)- (0.41 g, 2.32 mmol, prepared according to U.S. Application no. 60/655,414, Example 4a) in dichloromethane (5 mL). DMF (~15 μ L) was added and the reaction mixture was stirred at room temperature for 1.5 hours. The solvent was removed and the residue was dried under vacuum for 30 minutes, dissolved in DMF (1 mL) and was added
- 10 to a DMF suspension (4 mL) of the product of Example 2e (1.0 g, 1.54 mmol) and potassium carbonate (0.74 g, 5.35 mmol) at 0 °C. The reaction mixture was stirred at 0 °C for 1 hour and then at room temperature for 20 hours. Water was added to the reaction mixture and the mixture was extracted with ethyl acetate. The organic layer was separated, evaporated to
- 15 yield the crude product which was purified by column chromatography (silica gel, eluting with 85:15 hexane:ethyl acetate) to give the title compound as a white foam (0.52 g, 42% yield): ^1H NMR (400 Mz, CDCl_3) δ 7.32 (m, 1H), 7.45 (m, 2H), 7.35-7.25 (m, 10H), 7.1-6.9 (m, 10H), 4.7-3.83 (m, 5H), 2.60-2.10 (m, 3H), 1.78-1.51 (m, 4H), 1.28 (m, 9H), 0.95 (m, 3H), 0.85-0.70 (m, 3H); Mass spectrum (API-TIS) m/z 809 (MH^+), 826 (MNH_4^+).

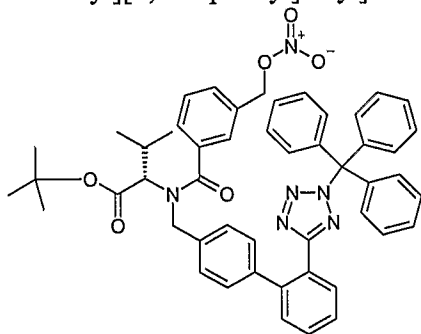
2g. L-valine, N-[6-(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



The product of Example 2f (0.51 g, 0.63 mmol) in hydrogen chloride solution (5.1 mL, 4.0 M in 1,4-dioxane, 20.4 mmol) was stirred at room temperature for 6 hours. The solvent was removed under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 85:15 dichloromethane:methanol) to give the title compound as a white solid (0.18 g, 56% yield): mp 196 °C (with decomposition); ¹H NMR (400 Mz, CD₃OD) δ 7.58-7.38 (m, 4H), 7.14-6.98 (m, 4H), 4.90-3.96 (m, 5H), 2.77-2.05 (m, 3H), 1.78-1.21 (m, 6H), 1.01 (m, 3H), 0.85-0.78 (m, 3H); Mass spectrum (API-TIS) *m/z* 511 (MH⁺), 528 (MNH₄⁺), 533 (MNa⁺).

Example 3: L-valine, N-[3-[(nitrooxy)methyl]benzoyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-

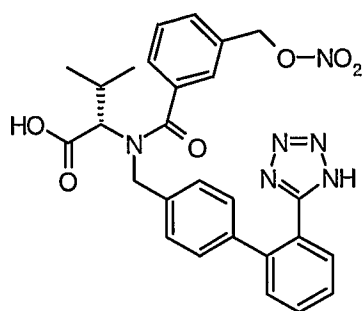
3a. L-valine, N-[3-[(nitrooxy)methyl]benzoyl]-N-[[2'-[2-(triphenylmethyl)-2H-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-, 1,1-dimethylethyl ester



Oxalyl chloride (0.346 g, 2.73 mmol) was added dropwise to 3- benzoic acid, 3-[(nitrooxy)methyl]- (0.358 g, 1.82 mmol, prepared according to US 2004/0024057; WO2004/004648, Example 43) in dichloromethane (5 mL). DMF (~15 μL) was added and the reaction mixture was stirred at room temperature for 1 hour. The solvent was removed, the residue after drying under vacuum for 1.5 hours, was dissolved in dichloromethane (2

mL) and was added to the product of Example 2e (1.0 g, 1.54 mmol) and triethylamine (0.28 g, 2.77 mmol) in dichloromethane (5 mL) of at 0 °C. The reaction mixture was warmed to room temperature and stirred at room temperature for 20 hours. The solvent was removed under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 85:15 hexane:ethyl acetate) to give the title compound as a light yellow foam (0.68g, 54% yield): ¹H NMR (400 Mz, CDCl₃) δ 7.85-6.93 (m, 27H), 5.43 (s, 2H), 4.91 (d, *J* = 12 Hz, 1H), 4.44 (d, *J* = 12 Hz, 1H), 3.85 (m, 1H), 2.30 (m, 1H), 1.28 (m, 9H), 0.74 (m, 6H); Mass spectrum (API-TIS) *m/z* 829 (MH⁺), 846 (MNH₄⁺).

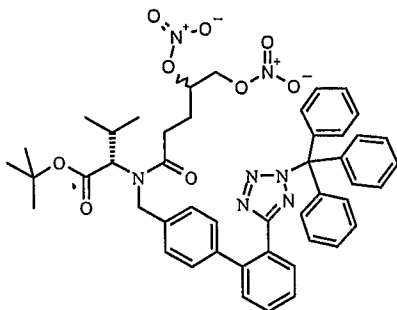
3b. L-valine, N-[3-[(nitrooxy)methyl]benzoyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



The product of Example 3a (0.6 g, 0.72 mmol) in hydrogen chloride solution (6.0 mL, 4.0 M in 1,4-dioxane, 24.0 mmol) was stirred at room temperature for 12 hours. The solvent was removed under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 80:10 dichloromethane:methanol) to give the title compound as a white solid (0.2 g, 71% yield): mp 151 °C (with decomposition); ¹H NMR (400 Mz, CD₃OD) δ 7.46-7.67 (m, 7H), 7.29-6.91 (m, 5H), 5.55-5.42 (m, 2H), 4.80-3.91 (m, 3H), 2.45-2.28 (m, 1H), 1.10-0.72 (m, 6H); Mass spectrum (API-TIS) *m/z* 531 (MH⁺), 548 (MNH₄⁺), 553 (MNa⁺).

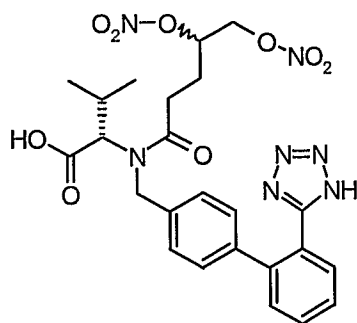
Example 4: L-valine, N-[4,5-bis(nitrooxy)-1-oxopentyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-

- 4a. L-valine, N-[4,5-bis(nitrooxy)-1-oxopentyl]-N-[[2'-[2-(triphenylmethyl)-2H-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-, 1,1-dimethylethyl ester



Oxalyl chloride (0.43 g, 3.40 mmol) was added dropwise to pentanoic acid, 4,5-bis(nitrooxy)- (0.51 g, 2.27 mmol, prepared according to U.S. Application No. 60/655,414, Example 22a) in dichloromethane (5 mL). DMF (~15 μ L) was added and the reaction mixture was stirred at room temperature for 1 hour. The solvent was removed and the residue after drying under vacuum for 1.5 hours, was dissolved in dichloromethane (1 mL) and was added to a DMF suspension (4 mL) of the product of Example 2e (1.0 g, 1.54 mmol) and potassium carbonate (0.73 g, 5.28 mmol) at 0 $^{\circ}$ C. Water was added to the reaction mixture and extracted with ethyl acetate. The organic layer was separated, evaporated to yield crude product which was purified by column chromatography (silica gel, eluting with 85:15 hexane:ethyl acetate) to give the title compound as a white foam (0.41 g, 31% yield): ^1H NMR (400 Mz, CDCl_3) δ 7.84 (m, 1H), 7.50-7.25 (m, 13H), 7.11-6.92 (m, 9H), 5.50-5.29 (m, 1H), 4.82-3.77 (m, 5H), 2.75-2.20 (m, 3H), 2.10-1.85 (m, 2H), 1.30 (m, 9H), 1.00-0.70 (m, 6H); Mass spectrum (API-TIS) m/z 856 (MH^+), 873 (MNH_4^+).

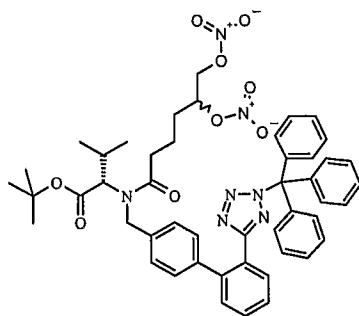
- 4b. L-valine, N-[4,5-bis(nitrooxy)-1-oxopentyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



A mixture of the product of Example 4a (0.41 g, 0.48 mmol) in hydrogen chloride solution (5.0 mL, 4.0 M in 1,4-dioxane, 20.0 mmol) was stirred at room temperature for 6 hours. The solvent was removed under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 85:15 dichloromethane:methanol) to give the title compound as a white solid (0.09 g, 34% yield): mp 182 °C (with decomposition) ¹H NMR (400 Mz, CD₃OD) δ 7.62-7.42 (m, 4H), 7.22-6.98 (m, 4H), 5.51-5.32 (m, 1H), 4.94-3.92 (m, 5H), 2.98-2.15 (m, 3H), 2.08-1.80 (m, 2H), 1.02 (m, 3H), 0.83 (m, 3H); Mass spectrum (API-TIS) *m/z* 558 (MH⁺), 575 (MNH₄⁺), 580 (MNa⁺).

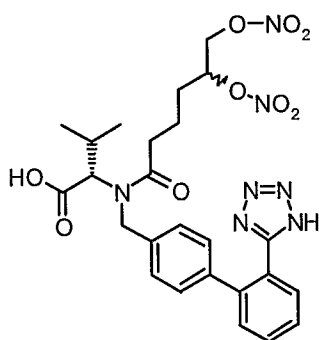
Example 5: L-valine, N-[5,6-bis(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-

5a. L-valine, *N*-[5,6-bis(nitrooxy)-1-oxohexyl]-*N*-[[2'-[2-(triphenylmethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-, 1,1-dimethylethyl ester



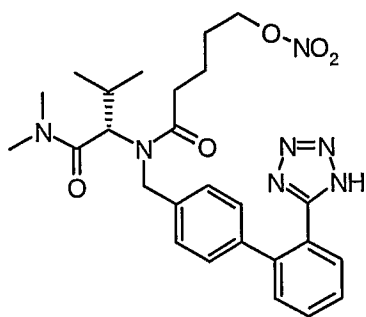
To the product of Example 2e (0.8 g, 1.23 mmol) and hexanoic acid, 5,6-bis(nitrooxy)- (0.44 g, 1.85 mmol, prepared according to *J. Med. Chem.*, 48, 1322-1329, 2005) in dichloromethane (15 mL) was added dimethylaminopyridine (DMAP) (0.18 g, 1.47 mmol) and 1,3-dicyclohexylcarbodiimide (DCC) (0.31 g, 1.50 mmol). The reaction was stirred at room temperature overnight, filtered and the filtrate was concentrated to yield a crude mixture that was purified by column chromatography (silica gel, eluting with 80:20 hexane:ethyl acetate) to give the title compound as an oil (0.14 g, 10% yield): Mass spectrum (API-TIS) m/z 870 (MH^+), 887 (MNH_4^+).

5b. L-valine, N-[5,6-bis(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



The product of Example 5a (0.2 g, 0.23 mmol) in hydrogen chloride solution (2.0 mL, 4.0 M in 1,4-dioxane, 8.0 mmol) was stirred at room temperature for 6 hours. The solvent was removed under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 85:15 dichloromethane:methanol) to give the title compound as a white solid (0.098 g, 75% yield): mp 192 °C (with decomposition); 1H NMR (400 Mz, CD_3OD) δ 7.60-7.40 (m, 4H), 7.24-6.98 (m, 4H), 5.44-5.25 (m, 1H), 4.90-3.94 (m, 5H), 2.84-2.10 (m, 3H), 1.80-1.62 (m, 4H), 1.02 (m, 3H), 0.85-0.79 (m, 3H); Mass spectrum (API-TIS) m/z 572 (MH^+), 589 (MNH_4^+), 594 (MNa^+).

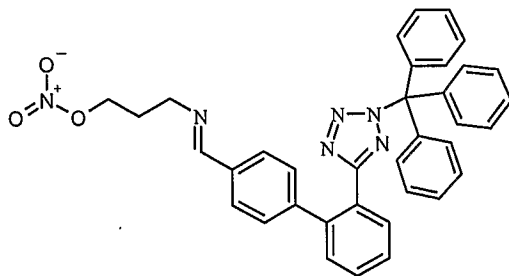
Example 6: Pentanamide, N-[(1S)-1-[(dimethylamino)carbonyl]-2-methylpropyl]-5 (nitrooxy)-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



To the product of Example 1g (0.33 g, 0.66 mmol) and triethylamine (0.26 g, 2.57 mmol) in dichloromethane (7 mL) was added dimethylamine hydrochloride (0.11 g, 1.35 mmol) followed by DMAP (0.02 g, 0.16 mmol) and 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride (EDAC) (0.15 g, 0.78 mmol). The reaction mixture was stirred at room temperature for 20 hours, diluted with dichloromethane and washed with water, brine and evaporated to yield crude mixture which was purified by column chromatography (silica gel, eluting with 85:15 dichloromethane:methanol) to give the title compound as a white solid (0.045 g, 13% yield): mp 75 - 78 °C; ¹H NMR (400 Mz, CDCl₃) δ 7.90 (d, *J* = 7.6 Hz, 1H), 7.58 (t, *J* = 6.8 Hz, 1H), 7.50 (t, *J* = 6.8 Hz, 1H), 7.48 (d, *J* = 6.8 Hz, 1H), 7.06 (d, *J* = 8 Hz, 2H), 6.87 (d, *J* = 8 Hz, 2H), 5.37 (d, *J* = 10.8 Hz, 1H), 4.60 (dd, *J* = 17.6, 32 Hz, 2H), 4.37 (t, *J* = 6 Hz, 2H), 3.16 (s, 3H), 2.60 (s, 3H), 2.38 (m, 1H), 2.21 (m, 2H), 1.70 (m, 4H), 0.80 (m, 6H); Mass spectrum (API-TIS) *m/z* 524 (MH⁺), 546 (MNa⁺).

Example 7: Pentanamide, *N*-[3-(nitrooxy)propyl]-*N*-[[2'-(1*H*-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-

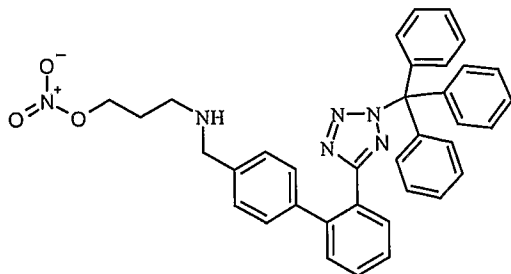
7a. 1-Propanol, 3-[[*(1E)*]-[2'-[2-(triphenylmethyl)-2*H*-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methylene]amino]-, nitrate (ester)



The product of Example 2c (1.0 g, 2.03 mmol) and 1-propanol, 3-amino-, nitrate (ester), nitrate (1:1) (salt) (744 mg, 4.06 mmol, prepared according to WO 2005/030135, Example 8a) in benzene (50 mL) were heated at reflux for 5 hours to remove the water formed using a Dean-Stark apparatus. . The solvent was removed under vacuum and the title product was obtained as a slightly yellow solid which was used directly to the next step

without further purification: Mass spectrum (API-TIS) m/z 595 (MH^+).

7b. 1-Propanol, 3-[[[2'-[2-(triphenylmethyl)-2H-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]amino]-, nitrate (ester)



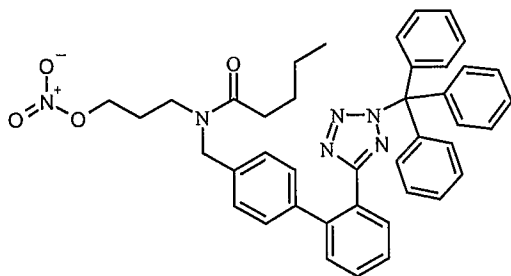
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To the product of Example 7a (2.03 mmol) in THF (15 mL) at 0 °C was added dropwise a solution of sodium cyanoborohydride (151 mg, 2.4 mmol) in methanol (3 mL). The reaction mixture was stirred at room temperature for 1 hour. The solvent was evaporated under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 1:1 hexane:ethyl acetate) to give the title compound as a colorless oil (850 mg, 70% yield): 1H NMR (400 Mz, $CDCl_3$) δ 7.92 (m, 1H), 7.51-7.38 (m, 3H), 7.33-7.23 (m, 9H), 7.07 (m, 4H), 6.89 (m, 6H), 4.52 (t, J = 6.5 Hz, 2H), 3.66 (s, 2H), 2.68 (t, J = 6.7 Hz, 2H), 1.84 (m, 2H); Mass spectrum (API-TIS) m/z 597 (MH^+), 619 (MNa^+).

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7c. Pentanamide, *N*-[3-(nitrooxy)propyl]-*N*-[[2'-[2-(triphenylmethyl)-2H-tetrazol-5-yl][1,1'-biphenyl]-4-yl]methyl]-

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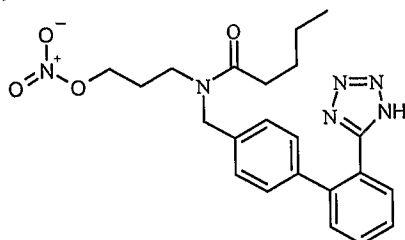


Valeroyl chloride (205 mg, 1.7 mmol) was added dropwise to a suspension of the product of Example 7b (850 mg, 1.42 mmol) and potassium carbonate (589 mg, 4.26 mmol) in DMF (10 mL) at 0 °C. After the addition, the reaction mixture was warmed to room temperature and stirred at room temperature for 4 hours. Water was added and the reaction mixture was extracted with ethyl acetate. The organic layer was separated and evaporated to yield the crude product which was purified by column chromatography (silica gel, eluting with 3:1 hexane:ethyl acetate) to give the title compound as a white foam (720 mg, 75% yield).

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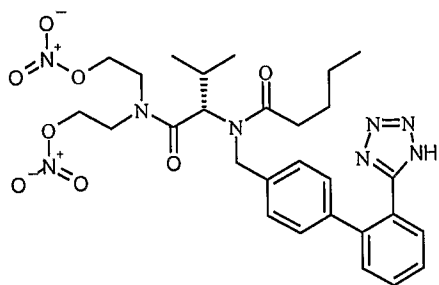
yield): mp 43.1-48.2 °C; ¹H NMR (400 Mz, CDCl₃) δ 7.97-7.90 (m, 1H), 7.48 (m, 2H), 7.39-7.23 (m, 10H), 7.15-7.01 (m, 3H), 6.93-6.88 (m, 7H), 4.52-4.25 (m, 4H), 3.32-3.16 (m, 2H), 2.30 (m, 2H), 1.89 (m, 2H), 1.71-1.56 (m, 2H), 1.42-1.25 (m, 2H), 0.97-0.86 (m, 3H); Mass spectrum (API-TIS) *m/z* 681 (MH⁺), 698 (MNH₄⁺), 703 (MNa⁺).

7d. Pentanamide, *N*-[3-(nitrooxy)propyl]-*N*-[[2'-(1*H*-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



The product of Example 7c (580 mg, 0.85 mmol) in hydrogen chloride solution (5.8 mL, 4.0 M in 1,4-dioxane, 23.2 mmol) was stirred at room temperature for 10 minutes. Solvent was removed under vacuum and the crude product was purified by column chromatography (silica gel, eluting with 9:1 dichloromethane:isopropyl alcohol, and then by another column chromatography (silica gel, eluting with 980:20:2 dichloromethane:isopropyl alcohol:AcOH) to give the title compound as a white foam (180 mg, 48% yield): mp 54-59 °C; ¹H NMR (400 Mz, CDCl₃) δ 7.95 (d, *J* = 7.6 Hz, 1H), 7.61-7.41 (m, 3H), 7.20-7.11 (m, 4H), 4.71-4.39 (m, 4H), 3.37 (m, 2H), 2.30 (m, 2H), 1.92 (m, 2H), 1.54 (m, 2H), 1.28 (m, 2H), 0.86 (m, 3H); Mass spectrum (API-TIS) *m/z* 439 (MH⁺), 456 (MNH₄⁺), 461 (MNa⁺); Anal. Calcd for C₂₂H₂₆N₆O₄: C, 60.26; H, 5.98; N, 19.17. Found: C, 60.14; H, 6.04; N, 18.90.

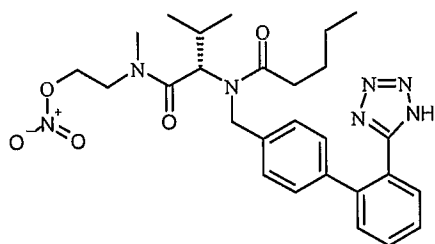
Example 8: Pentanamide, *N*-[(1*S*)-1-[[bis[2-(nitrooxy)ethyl]amino]carbonyl]-2-methylpropyl]-*N*-[[2'-(1*H*-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



To a mixture of valsartan (1.0 g, 2.30 mmol, purchased from Onbio, Inc.) and triethylamine (0.90 g, 8.89 mmol) in dichloromethane (25 mL) was added ethanol, 2,2'-

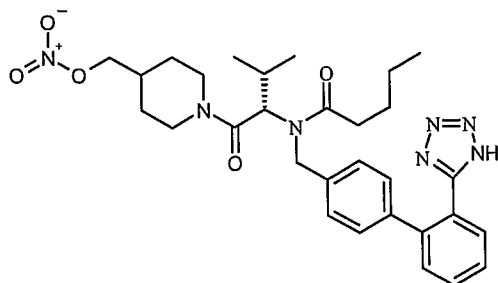
iminobis-, dinitrate (ester), nitrate (1:1) (salt) (1.19 g, 4.60 mmol, prepared as described in U.S. Patent Application No. 60/692,228, Example 49a) followed by DMAP (0.068 g, 0.56 mmol) and EDAC (0.53 g, 2.76 mmol). The reaction mixture was stirred at room temperature for 6 hours, diluted with dichloromethane and washed with 5% HCl aqueous solution, water and brine. The organic layer was dried over magnesium sulfate, filtered and evaporated to give crude mixture which was purified by column chromatography (silica gel, eluting with 600:400:2.5 hexane:ethyl acetate:acetic acid) to give the title compound as a white foam (0.38 g, 27% yield): mp 87 - 90 °C; ¹H NMR (400 Mz, CDCl₃) δ 7.99-7.90 (m, 1H), 7.69-6.94 (m, 7H), 5.81-5.28 (m, 1H), 4.87-4.11 (m, 6H), 4.05-3.29 (m, 4H), 2.51-2.08 (m, 3H), 1.60 (m, 2H), 1.25 (m, 2H), 1.02-0.81 (m, 9H); Mass spectrum (API-TIS) *m/z* 613 (MH⁺).

Example 9: Pentanamide, *N*-[(1*S*)-2-methyl-1-[[methyl]2-(nitrooxy)ethyl]amino]carbonyl]propyl]-*N*-[[2'-(1*H*-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



To a mixture of valsartan (1.0 g, 2.30 mmol, purchased from Onbio, Inc.) and triethylamine (0.90 g, 8.89 mmol) in dichloromethane (25 mL) was added ethanol, 2-(methylamino)-, nitrate (ester), nitrate (1:1) (salt) (0.84 g, 4.60 mmol, prepared according to US 2004/0024057; Example 17c) followed by DMAP (0.068 g, 0.56 mmol) and EDAC (0.53 g, 2.76 mmol). The reaction mixture was stirred at room temperature for 6 hours, diluted with dichloromethane and washed with 5% HCl aqueous solution, water and brine. The organic layer was dried over magnesium sulfate, filtered and evaporated to give the crude mixture which was purified by column chromatography (silica gel, eluting with 600:400:2.5 hexane:ethyl acetate:acetic acid) to give the title compound as a white foam (0.25 g, 20% yield): mp 86 - 89 °C; ¹H NMR (400 Mz, CDCl₃) δ 7.97 (m, 1H), 7.72-6.96 (m, 7H), 5.57-5.30 (m, 1H), 4.84-4.11 (m, 4H), 3.97-3.45 (m, 2H), 3.39-3.21 (m, 3H), 2.56-2.13 (m, 3H), 1.70-1.56 (m, 2H), 1.38-1.23 (m, 2H), 1.00-0.82 (m, 9H); Mass spectrum (API-TIS) *m/z* 538 (MH⁺), 560 (MNa⁺).

Example 10: Pentanamide, *N*-[(1*S*)-2-methyl-1-[[4-[(nitrooxy)methyl]-1-piperidiny]carbonyl]propyl]-*N*-[[2'-(1*H*-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



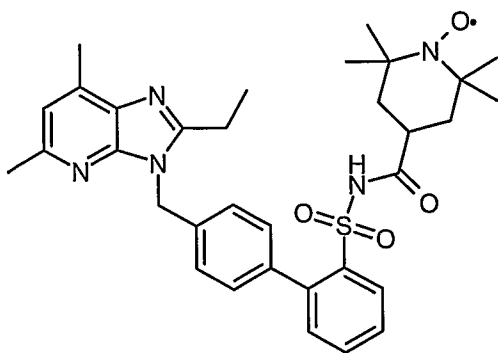
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To a mixture of valsartan (1.0 g, 2.30 mmol, purchased from Onbio, Inc.) and triethylamine (0.90 g, 8.89 mmol) in dichloromethane (25 mL) was added 4-piperidinemethanol, nitrate (ester), nitrate (1:1) (salt) (1.03 g, 4.60 mmol, prepared according to US 2004/0024057; Example 19a) followed by DMAP (0.068 g, 0.56 mmol) and EDAC (0.53 g, 2.76 mmol). The reaction mixture was stirred at room temperature for 6 hours, diluted with dichloromethane and washed with 5% HCl aqueous solution, water and brine. The organic layer was dried over magnesium sulfate, filtered and evaporated to give the crude mixture which was purified by column chromatography (silica gel, eluting with 600:400:2.5 hexane:ethyl acetate:acetic acid) to give the title compound as a white foam (0.49 g, 37% yield): mp 86 - 88 °C; ¹H NMR (400 Mz, CDCl₃) δ 8.02-7.91 (m, 1H), 7.60-7.39 (m, 3H), 7.13-6.89 (m, 4H), 5.42-5.28 (m, 1H), 4.74-4.12 (m, 6H), 3.10-2.53 (m, 2H), 2.37-2.10 (m, 3H), 2.05-1.80 (m, 4H), 1.59 (m, 2H), 1.17 (m, 2H), 1.06-0.75 (m, 9H); Mass spectrum (API-TIS) *m/z* 578(MH⁺), 600 (MNa⁺).

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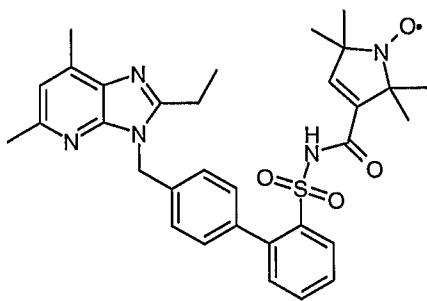
Example 11: 1-Piperidinyloxy, 4-[[[4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]amino]carbonyl]-2,2,6,6-tetramethyl-

20



To a solution of 4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl]-1,1'-biphenyl-2-sulfonamide (300 mg, 0.71 mmol, prepared as described in *J. Med. Chem.*, 37(24), 4068-4072, (1994), compound 7) and 4-carboxy-2,2,6,6-tetramethylpiperidinyloxy (157 mg, 0.75 mmol, purchased from Sigma-aldrich) was added N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride (EDAC) (163 mg, 0.85 mmol) and dimethylaminopyridine (DMAP) (8.7 mg, 0.071 mmol) at room temperature under argon. The reaction mixture was stirred overnight and washed with water (3 ml), brine (3 ml), dried (Na₂SO₄) and concentrated. The residue was chromatographed on silica gel eluting with MeOH:CH₂Cl₂ (3:97) to give the title compound as a orange solid (270 mg, 63% yield). Mp 135-138°C. ¹H NMR (400 MHz, CDCl₃) δ 8.28 (m, 1H), 7.63-7.58 (m, 2H), 7.30-6.90 (m, 6H), 5.50 (s, 2H), 2.87 (m, 2H), 2.7-2.5 (m, 6H), 1.38 (bs, 3H). Mass spectrum (API-TIS) *m/z* 603 (MH⁺). Anal. calcd. for C₃₃H₄₀N₅O₄S·1/2 mol CHCl₃: C, 60.73; H, 6.16; N, 10.57. Found: C, 60.80; H, 6.24; N, 10.44.

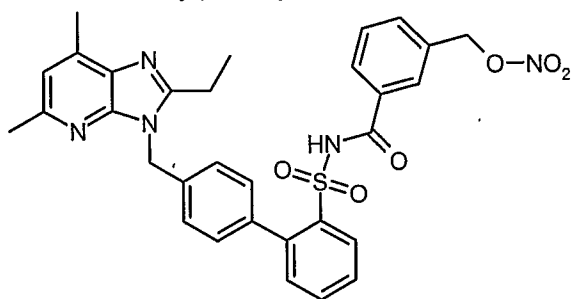
Example 12: 1H-Pyrrol-1-yloxy, 3-[[[4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]amino]carbonyl]-2,5-dihydro-2,2,5,5-tetramethyl-



The title compound was prepared using the procedure described in Example 10 from 4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl]-1,1'-biphenyl-2-sulfonamide

(200 mg, 0.47 mmol), 2,2,5,5-tetramethyl-3-pyrrolin-1-oxyl-3-carboxylic acid (96 mg, 0.52 mmol, purchased from Sigma-Aldrich), EDAC (108 mg, 0.56 mmol) and DMAP (5.7 mg, 0.047 mmol). After work-up a pure yellow solid was obtained (130 mg, 48% yield). Mp 145-148°C. ¹H NMR (400MHz, CDCl₃) δ 8.30 (m, 1H), 7.62-7.55 (m, 2H), 7.33-6.93 (m, 6H), 5.46 (s, 2H), 2.86 (m, 2H), 2.64-2.57 (m, 6H), 1.36 (bs, 3H). Mass spectrum (API-TIS) *m/z* 587 (MH⁺). Anal. calcd. for C₃₂H₃₆N₅O₄S·1/2 mol CHCl₃: C, 60.39; H, 5.69; N, 10.83. Found: C, 60.51; H, 5.75; N, 10.75.

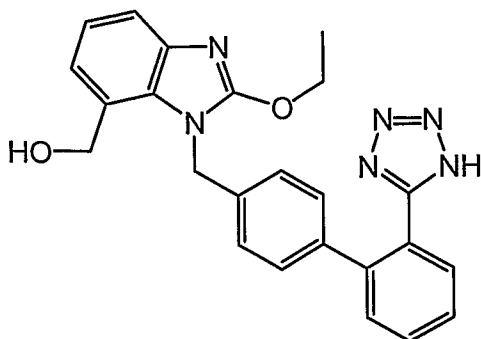
Example 13: Benzamide, N-[[4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]-3-[(nitrooxy)methyl]-



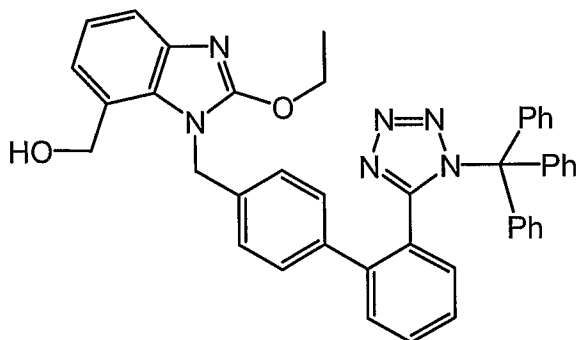
The title compound was prepared using the procedure described in Example 10 from 4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl]-1,1'-biphenyl-2-sulfonamide (200 mg, 0.47 mmol), 3-[(nitrooxy)methyl]-benzoic acid (101 mg, 0.52 mmol, prepared as described in US 2004/0024057), EDAC (108 mg, 0.56 mmol) and DMAP (5.7 mg, 0.047 mmol). After work-up a pure white solid was obtained (50 mg, 18% yield). Mp 123°C (with decomposition). ¹H NMR (400MHz, CDCl₃) δ 8.34 (d, *J* = 7.6Hz, 1H), 7.61-7.54 (m, 3H), 7.51 (d, *J* = 7.6Hz, 1H), 7.34 (d, *J* = 7.6Hz, 1H), 7.29-7.20 (m, 2H), 7.14 (d, *J* = 8.4Hz, 2H), 6.97 (d, *J* = 8.4Hz, 2H), 6.89 (s, 1H), 5.42 (s, 2H), 5.34 (s, 2H), 2.79 (q, *J* = 7.6Hz, 2H), 2.61 (s, 3H), 2.54 (s, 3H), 1.31 (t, *J* = 7.6Hz, 3H). Mass spectrum (API-TIS) *m/z* 600 (MH⁺). Anal. calcd. for C₃₁H₂₉N₅O₆S·3/4 mol CHCl₃: C, 55.33; H, 4.35; N, 10.16. Found: C, 55.88; H, 4.37; N, 10.06.

Example 14: 1H-benzimidazole-7-methanol, 2-ethoxy-1-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-, nitrate (ester)

14a. 1H-benzimidazole-7-methanol, 2-ethoxy-1-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-



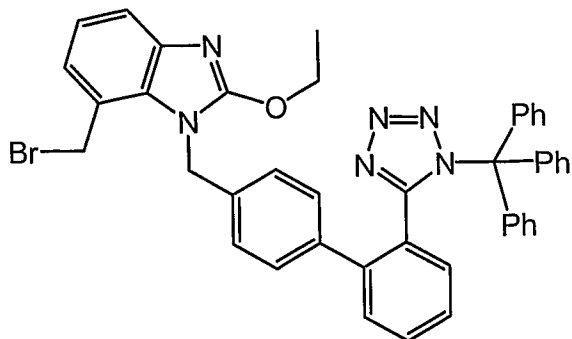
To a stirred suspension of candesartan (8.81 g, 20 mmol) in THF (150 mL) at -78 °C was added 2M THF solution of LAH (35 mL, 70 mmol). After resulting mixture was stirred at room -78 °C for 30 minutes and warmed to room temperature, and stirred at room temperature for 4 hours and then at 50 °C for 2 hours. The reaction was quenched with water and acidified with 10% HCl, extracted with ethyl acetate. The organic layer was washed with water and brine, dried over magnesium sulfate, filtered and evaporated. The crude mixture was purified by column chromatography (silica gel, elution: 92:8 dichloromethane:methanol) to give the title compound as a white solid (8.22 g, 96.5 % yield): mp 131.7-135.2 °C. Mass spectrum (API-TIS) m/z 427 (MH^+).
14b.



To a stirred solution of the product of Example 14a (8.12 g, 19 mmol) and triethylamine (2.41 g, 23.8 mmol) in dichloromethane (30 mL) at 0 °C was added dropwise a solution of tritylchloride (6.36 g, 22.8 mmol) in dichloromethane (15 mL). The resulting mixture was stirred at 0 °C for 1 hour and then at room temperature 2 hours. Additional dichloromethane was added and washed with water and brine. The organic phase was separated and dried over magnesium sulfate, filtered and evaporated to give a slightly yellow foam which was purified by column chromatography (silica gel, elution: 3:2 hexane:ethyl acetate) to give the product

as a white solid (7.5 g, 58.9%): mp 180.9-183.7 °C. Mass spectrum (API-TIS) m/z 669 (MH^+).

14c.

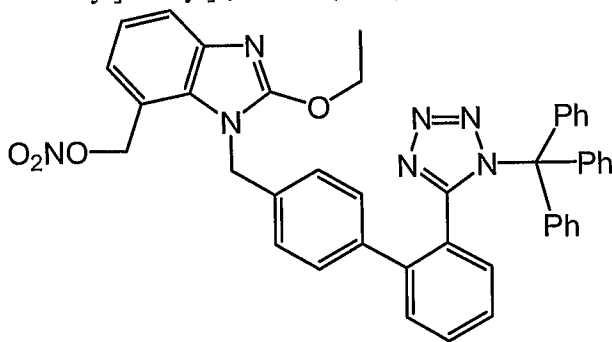


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To a stirred solution of the the product of Example 14b (1 g, 1.5 mmol) and carbon tetrabromide (0.796 g, 2.4 mmol) in dry dichloromethane (15 mL) at 0 °C was added triphenylphosphine (0.629 g, 2.4 mmol). The resulting mixture was stirred at 0 °C for 30 minutes.

10 The solvent was removed and the mixture was purified by column chromatography (silica gel, elution: 3:1 hexane/ethyl acetate) to give the product as a white foam (950 mg, 86.7% yield): mp 70.0-77.8 °C. Mass spectrum (API-TIS) m/z 731 (MH^+).

14d. 1H-benzimidazole-7-methanol, 2-ethoxy-1-[[2'-(1H-tetrazol-5-yl)[1,1'- biphenyl]-4-yl]methyl]-, nitrate (ester)

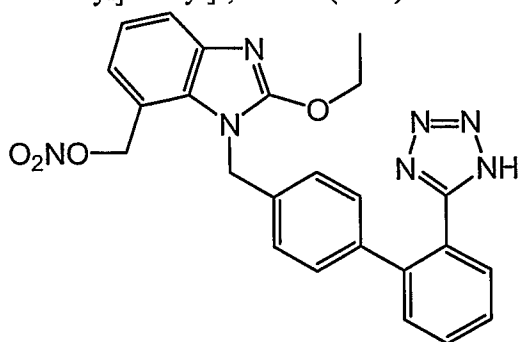


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To a stirred solution of the the product of Example 14c (500 mg, 0.683 mmol) in acetonitrile (2 mL) was added silver nitrate (174 mg, 1.02 mmol). The resulting mixture was stirred at room temperature for 16 hours. The solvent was removed and the mixture was purified by column chromatography (silica gel, elution: 3:1 hexane/ethyl acetate) to give product as a

20 white foam (280 mg, 57.4%): mp 58.2-65.5 °C. Mass spectrum (API-TIS) m/z 714 (MH^+).

14e. 1H-benzimidazole-7-methanol, 2-ethoxy-1-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-, nitrate (ester)



To a solution of the product of Example 14d (250 mg, 0.35 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (1.0 mL, 13.4 mmol) at 0 °C. The resulting mixture was stirred at room temperature for 6 hours. The solvent was removed and the mixture was purified by column chromatography (silica gel, elution: 95:5 chloroform:methanol) to give the title compound as a white solid. (85 mg, 51.4 % yield): mp 126 °C (dec.). ¹H NMR (400MHz, CDCl₃) δ 8.21 (d, *J* = 7.2Hz, 1H), 7.65-7.57 (m, 3H), 7.29 (d, *J* = 7.6Hz, 1H), 7.02 (d, *J* = 7.6Hz, 1H), 6.91-6.81 (m, 5H), 6.13(d, *J* = 8.0 Hz, 1H), 5.38 (s, 2H), 5.15 (s, 2H), 4.23-4.21 (m, 2H), 1.43-1.39 (m, 3H). Mass spectrum (API-TIS) *m/z* 472 (MH⁺). Anal. calcd. for C₂₄H₂₁N₇O_{4.1/3} CHCl₃: C, 57.17; H, 4.21; N, 19.18. Found: C, 56.91; H, 4.18; N, 18.86.

Example 15: Human angiotensin II type 1 receptor binding assay

The Human angiotensin II type 1 receptor binding assay was performed by Cerep, Seattle, WA, using the procedure described in Bergsma et al; *Biochem. Biophys. Res. Commun.*, **183** : 989-995 (1992). The results are presented in Table 1 and are expressed as a percent inhibition of control specific binding and/or IC₅₀ obtained in the presence of testing compounds.

Table 1

Example #	AT ₁ Binding	
	Human	
	IC ₅₀ (nM)	% Inhibition at 100 nM
Valsartan ^a	7.4	94
MK 996 ^b		91
1g	18	86
2f		12

3b		5
4b		2
5b		-1
6		83
7d		21
8		4
9		8
10		22
11		88
12		78
13		73

^a Purchased form Onbio, Inc.

^b Synthesized as described in *J. Med. Chem.*, 37(24), 4068-4072, (1994) compound 7

The disclosure of each patent, patent application and publication cited or described in
5 the present specification is hereby incorporated by reference herein in its entirety.

Although the invention has been set forth in detail, one skilled in the art will
appreciate that numerous changes and modifications can be made to the invention, and that
such changes and modifications can be made without departing from the spirit and scope of
the invention.

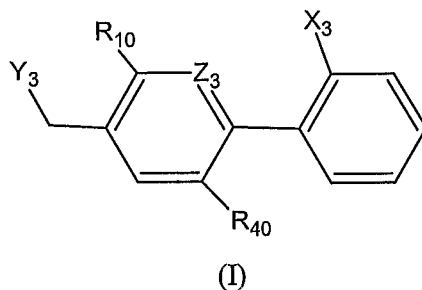
10

CLAIMS

What is claimed is:

1. A compound of Formula (I), (II), (III), (IV), (V), (VI), (VII), (VIII) or a pharmaceutically acceptable salt thereof:

5 wherein the compound of Formula (I) is:



wherein:

10 X₃ is:

(1) 	(2)
(3) 	(4)
(5) 	(6)

(7) -N(D₁)-S(O)₂-K;

(8) -N(D₁)-C(O)-N(D₁)-K;

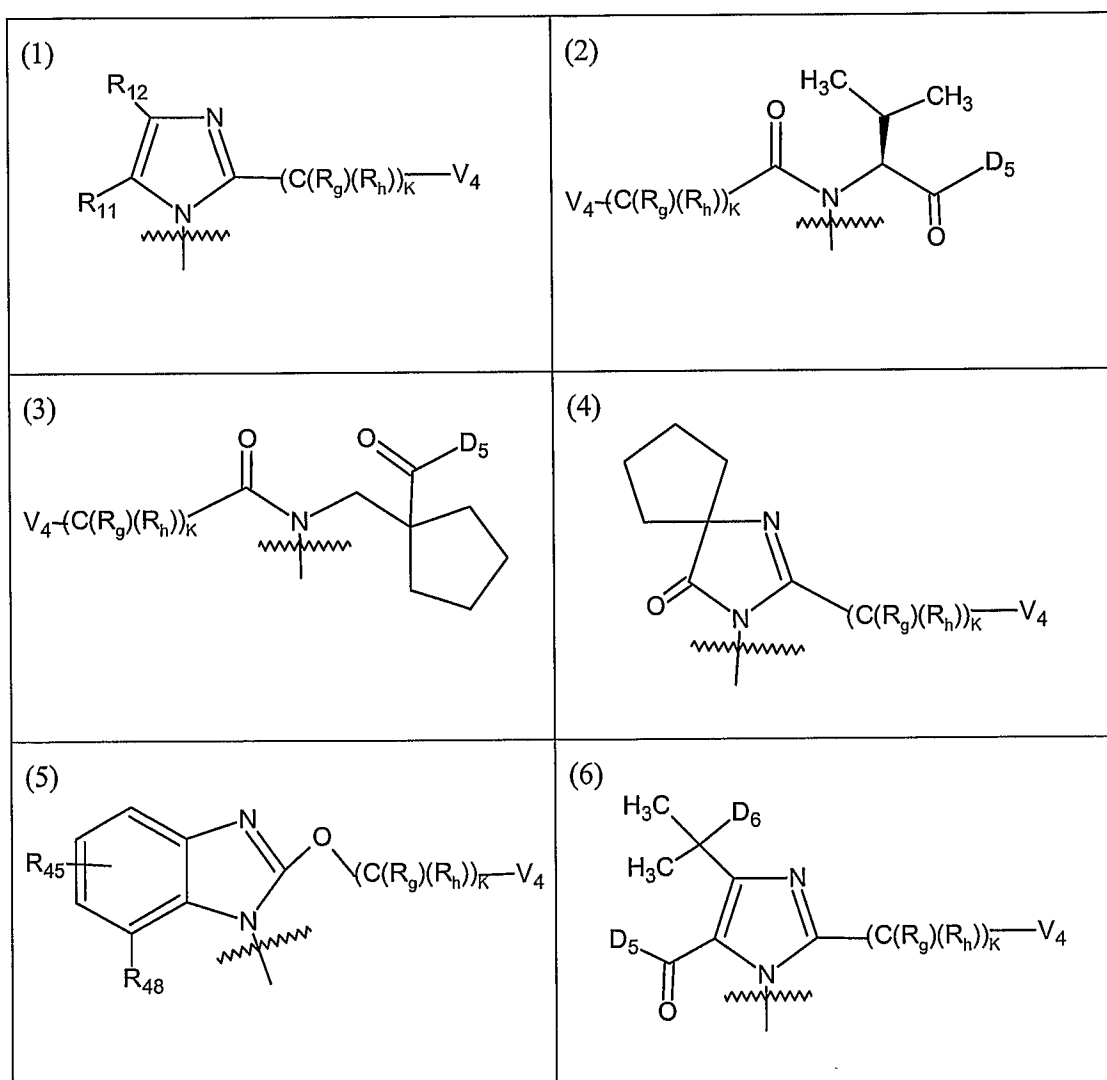
(9) -C(O)-D₅;

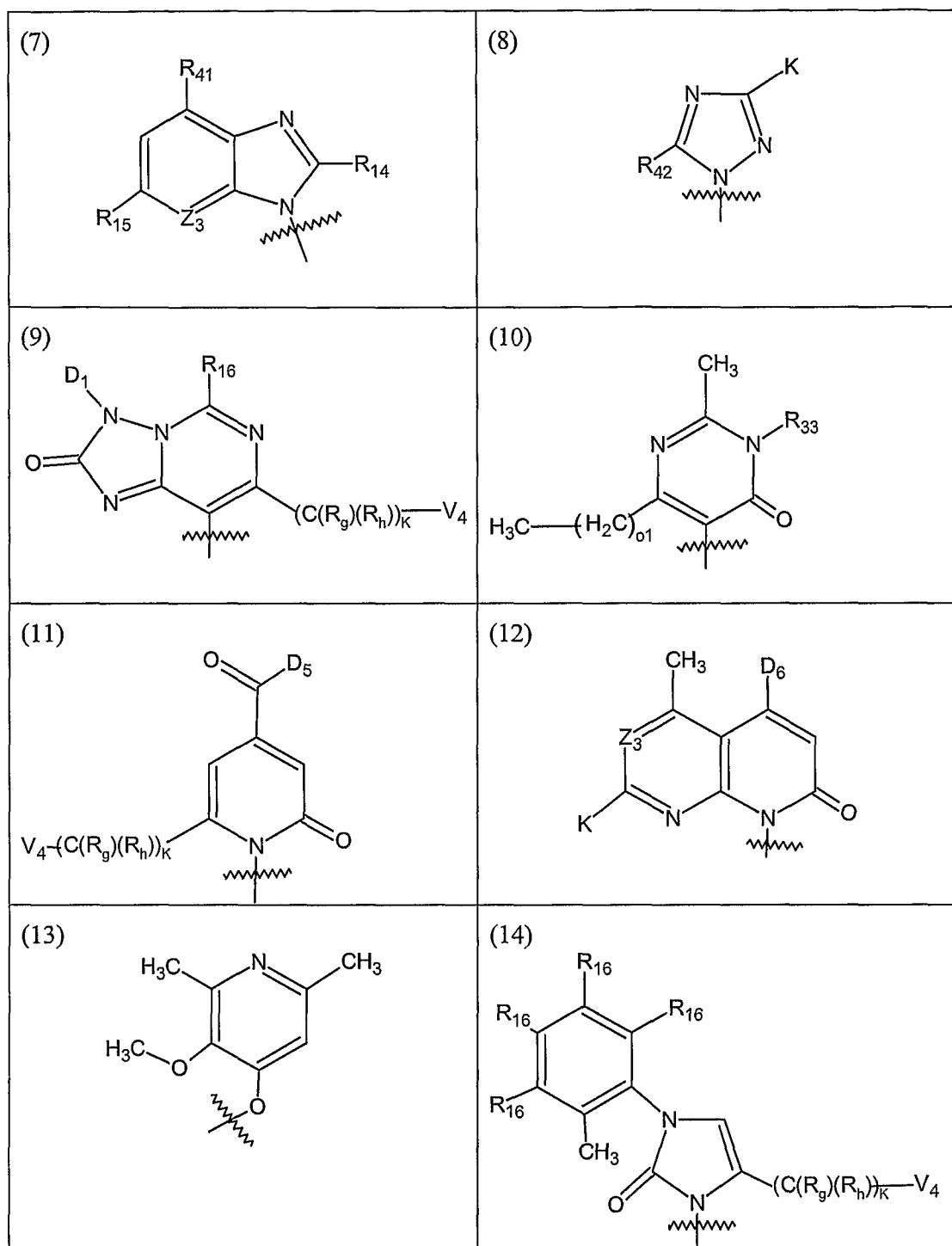
- (10) $-\text{C}(\text{O})-\text{CH}_2-\text{NH}(\text{D}_1)$;
 (11) $-\text{S}(\text{O})_2-\text{N}(\text{D}_1)-\text{C}(\text{O})-\text{K}$;
 (12) $-\text{S}(\text{O})_2-\text{N}(\text{D}_1)-\text{C}(\text{O})-\text{ND}_1-\text{K}$;
 (13) $-\text{S}(\text{O})_2-\text{N}(\text{D}_1)-\text{D}_6$;
 (14) $-\text{S}(\text{O})_2-\text{N}(\text{D}_1)-\text{S}(\text{O})_2-\text{K}$;
 (15) $-\text{N}(\text{D}_1)-\text{S}(\text{O})_2-\text{N}(\text{D}_1)-\text{C}(\text{O})-\text{K}$; or
 (16) $-\text{S}(\text{O})_2-\text{N}(\text{D}_1)-\text{C}(\text{O})-\text{U}_3-\text{K}$;

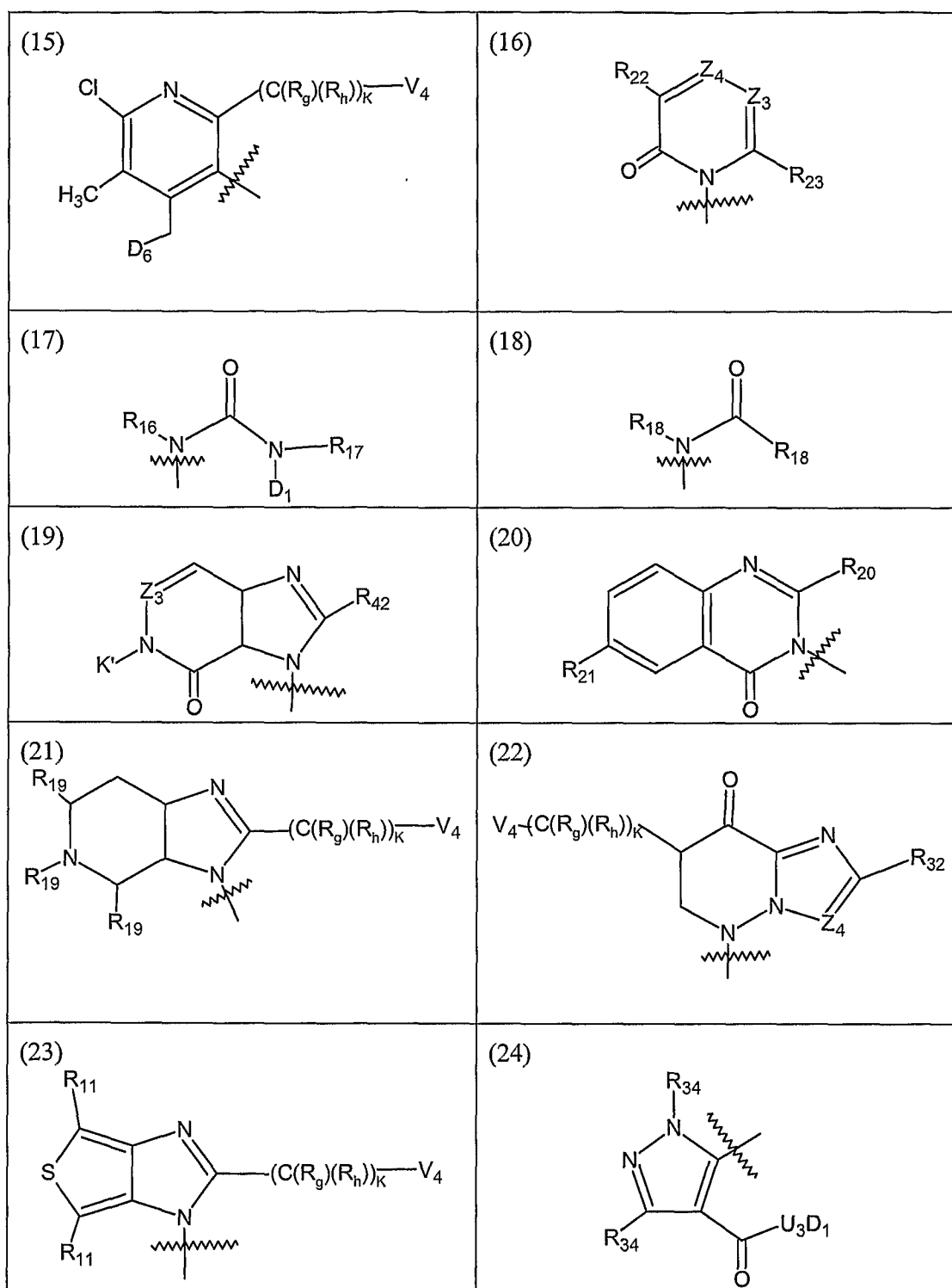
Z_3 is $-\text{CH}$ or a nitrogen atom;

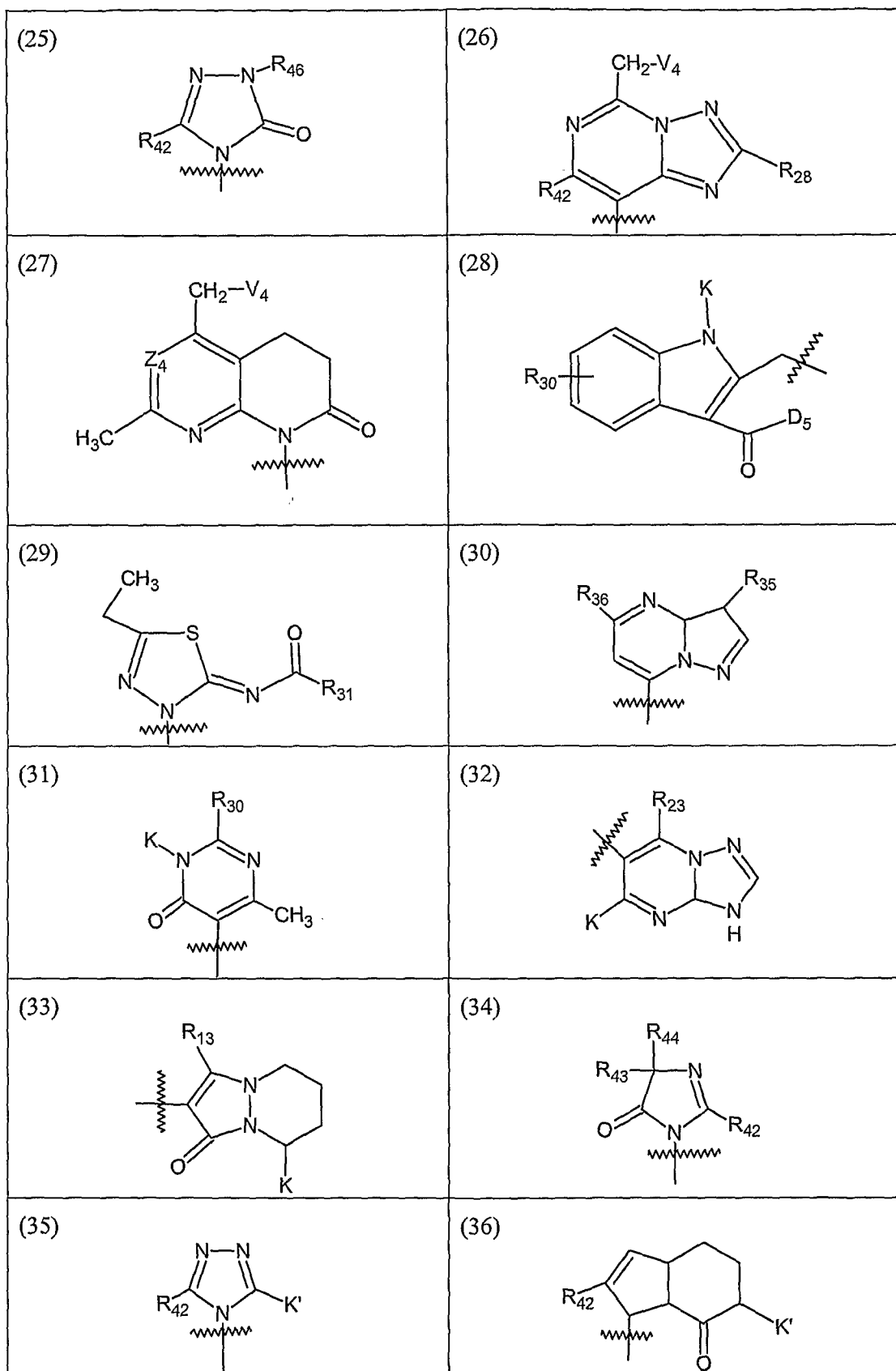
R_{10} is a fluorine or a hydrogen atom;

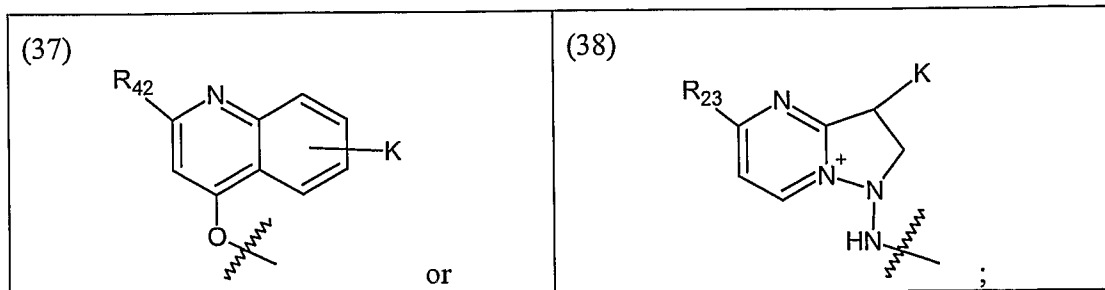
Y_3 is:











Z₄ is C-R₂₉, a nitrogen or -C-K;

R₁₁ is:

- (1) -CH₂-D₆;
- (2) -C(O)-D₅;
- (3) -C(O)-O-CH(CH₃)-O-C(O)-OR₁₃; or
- (4) -CH₂-N(D₁)-C(O)-OR₁₃;

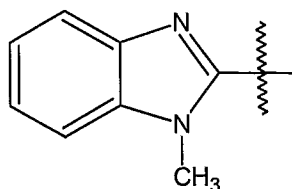
R₁₂ is a chlorine, -SCH₃ or a haloalkyl;

R₁₃ is a lower alkyl or K;

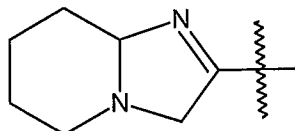
R₁₄ is a lower alkyl, a cycloalkyl or -(C(R_g)R_h))_k-V₄;

R₁₅ is:

- (1) hydrogen;
- (2) a lower alkyl;
- (3)



(4)



(5) -C(O)-D₆; or

(6) K;

R₁₆ is a hydrogen, a lower alkyl, an alkoxy, -D₆, a cyano, -C(O)-D₅, NH(D₁), K or an alkylcarbonyl;

R₁₇ is an aryl or a cycloalkyl;

R₁₈ at each occurrence is independently selected from a lower alkyl, an alkoxyalkyl, an

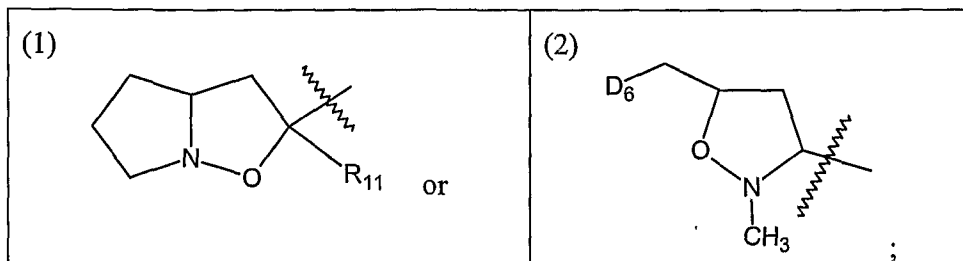
alkylcarboxylic acid, an hydroxyalkyl, an arylalkoxy, an arylalkyl, an aryl or K;

R_{19} is a hydrogen or $-C(O)-D_5$;

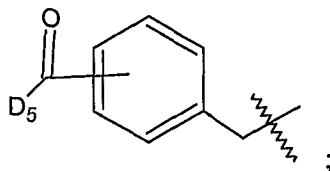
R_{20} is a hydrogen, a lower alkyl, an alkylaryl or K;

R_{21} is:

5



R_{22} is a hydrogen, $-C(O)-D_5$, K or



R_{23} is a lower alkyl or an alkoxyalkyl;

10

R_{27} is a lower alkyl, an aryl an arylalkyl or $-(CH_2)_k-C(O)D_5$;

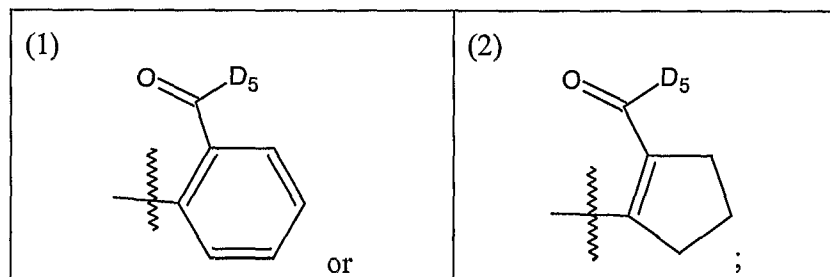
R_{28} is $-D_6$, $-S(O)_2-N(D_1)H$, $-N(D_1)H$, $-C(O)-D_5$ or CH_2-D_6 ;

R_{29} is a hydrogen, a lower alkyl or $-C(O)-D_5$;

R_{30} is a lower alkyl or a haloalkyl;

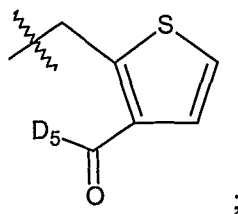
R_{31} is:

15



R_{32} is a hydrogen, an alkyl, an aryl or $-(C(R_g)R_h))_k-V_4$;

R_{33} is $-(CH_2)_2-D_6$ or



R_{34} is a hydrogen, a lower alkyl, a lower haloalkyl, an aryl, an arylalkyl or $-(\text{C}(\text{R}_g)\text{R}_h)_k\text{-V}_4$;

R_{35} is a hydrogen or a lower alkyl;

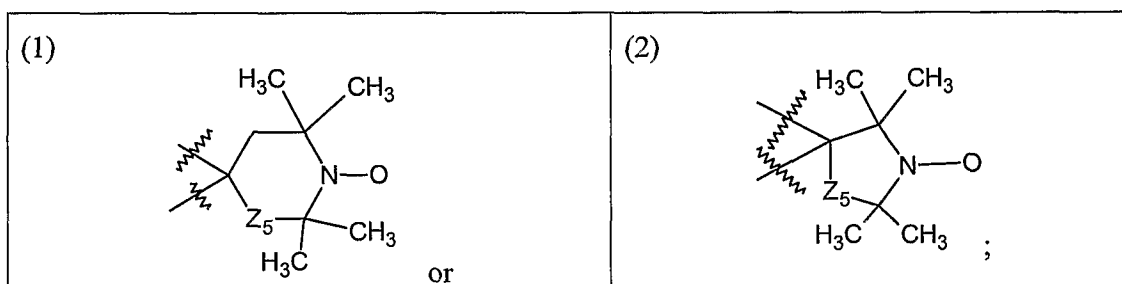
R_{36} is an alkoxy, $-\text{D}_6$ an amino group or $-\text{N}(\text{R}_{13})(\text{R}_{13})$;

R_{40} is a hydrogen, a lower alkyl, an alkoxyalkyl or $-(\text{C}(\text{R}_g)\text{R}_h)_k\text{-V}_4$;

R_{41} is a hydrogen or a lower alkyl;

R_{42} is a lower alkyl or $-(\text{C}(\text{R}_g)\text{R}_h)_k\text{-V}_4$;

R_{43} and R_{44} taken together are:



R_{45} is a hydrogen or K;

R_{46} is an alkyl group, an aryl group or K;

R_{48} is $-\text{C}(\text{O})\text{-D}_5$, $-\text{OK}$, $-\text{C}(\text{O})\text{-K}$ or $\text{C}(=\text{N-OR}_{81})$;

R_{81} is a hydrogen, an alkyl group, an aryl group, an alkylsulfonyl group, an arylsulfonyl group, a carboxylic ester, an alkylcarbonyl group, an arylcarbonyl group, a carboxamido group, an alkoxyalkyl group or an alkoxyaryl group;

R_g and R_h are each independently a hydrogen, a lower alkyl group, $-\text{CH}_2\text{-U}_3\text{-V}_5$ or V_4 ;

or R_g and R_h taken together with the carbon atom to which they are attached are an oxo group or an aryl group;

Z_5 is $-\text{CH}_2$ or oxygen;

o_1 is an integer from 0 to 3;

k is an integer from 1 to 6;

D_1 is a hydrogen or K;

D_5 is $-U_3D_1$ or K' ;

D_6 is $-OD_1$ or K' ;

K is $-(W_3)_a-E_b-(C(R_e)(R_f))_{p1}-E_c-(C(R_e)(R_f))_x-(W_3)_d-(C(R_e)(R_f))_y-(W_3)_i-E_j-(W_3)_g-(C(R_e)(R_f))_z-V_4$;

5 K' is $-G-E_c-(C(R_e)(R_f))_x-W_d-(C(R_e)(R_f))_y-W_i-E_j-W_g-(C(R_e)(R_f))_z-V_4$;

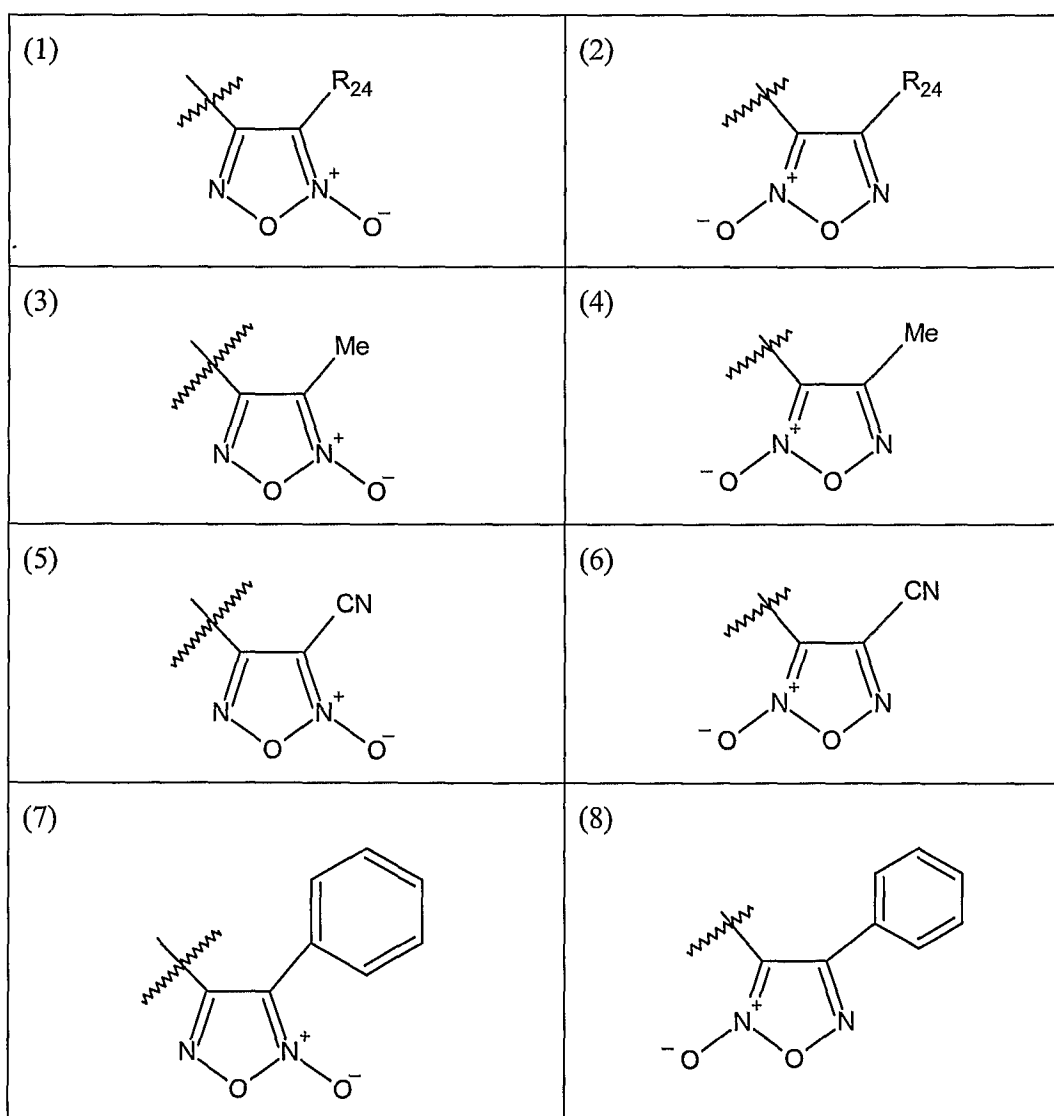
a, b, c, d, g, i and j are each independently an integer from 0 to 3;

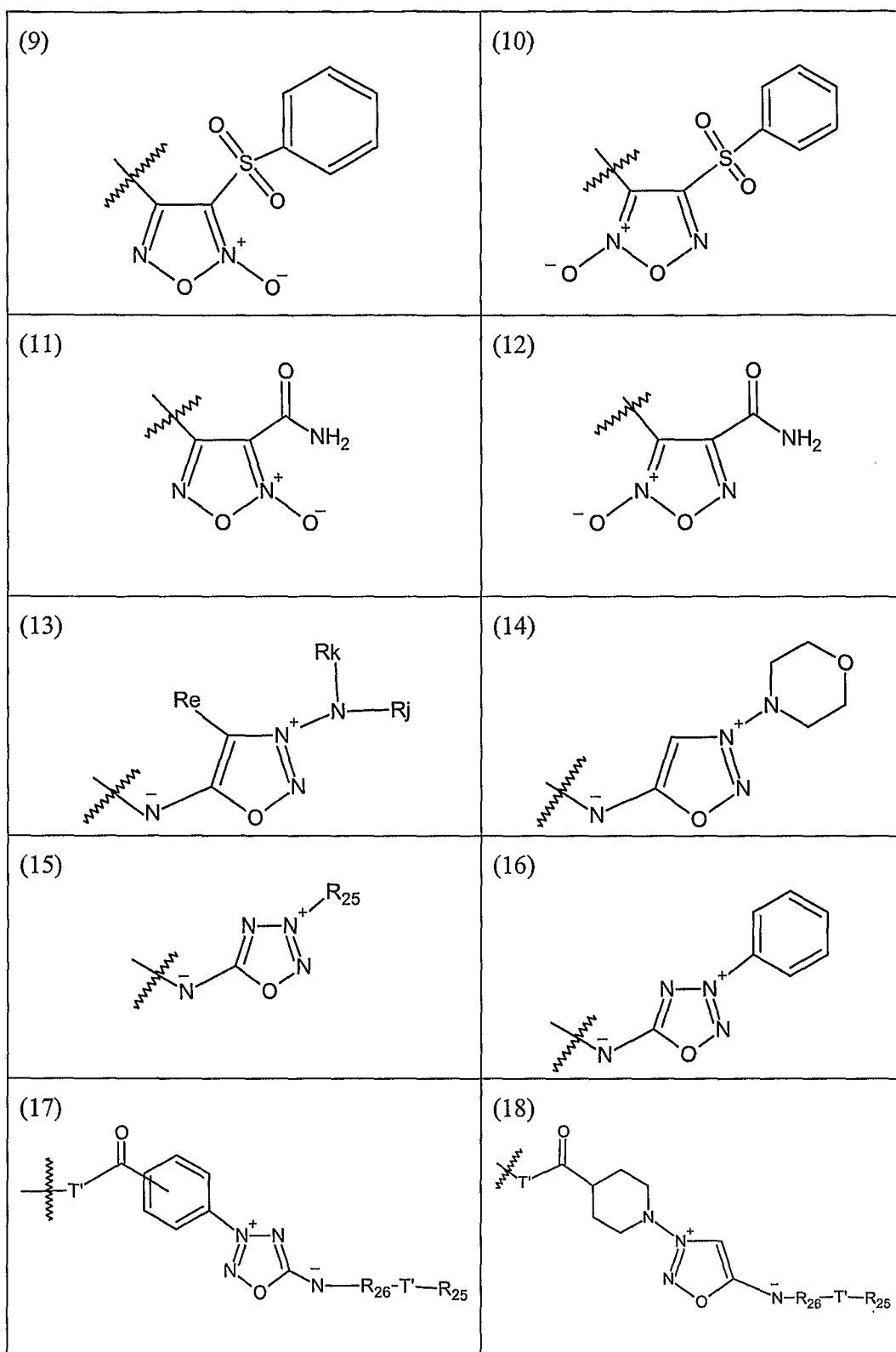
p_1, x, y and z are each independently an integer from 0 to 10;

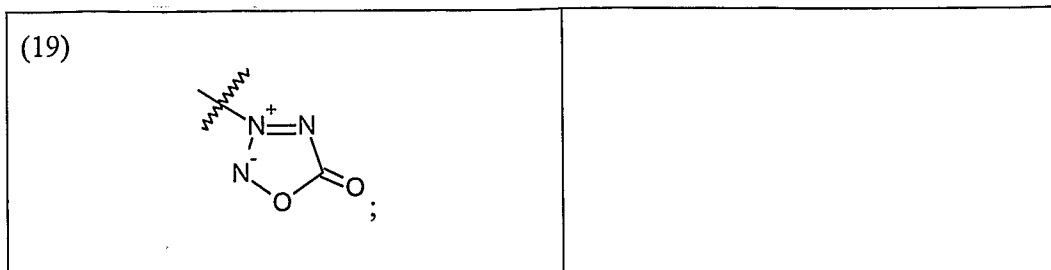
G is a heterocyclic ring or T_3 ;

V_4 is $V_3, R_e, -U_3-V_5$ or V_6 ;

10 V_3 is:







R_{24} is $-C_6H_4R_{37}$, $-CN$, $-S(O)_2-C_6H_4R_{37}$, $-C(O)-N(R_a)(R_i)$, $-NO_2$, $-C(O)-OR_{25}$ or $-S(O)_2-R_{25}$;

R_{25} is an aryl group, a lower alkyl group, a haloalkyl group, a hydroxyalkyl group or an arylalkyl group;

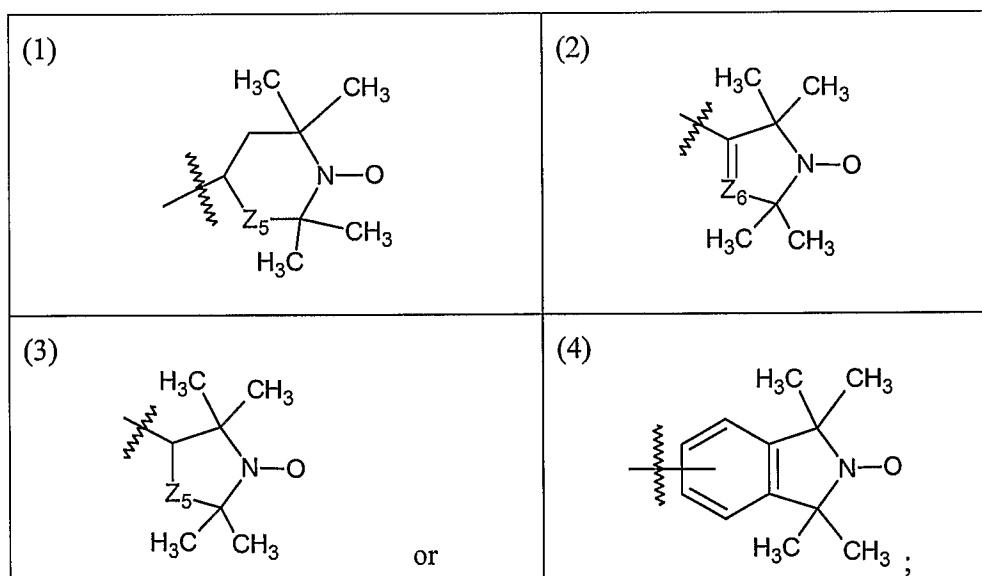
R_{26} is $-C(O)-$ or $-S(O)_2-$;

R_{37} is a hydrogen, $-CN$, $-S(O)_2-R_{25}$, $-C(O)-N(R_a)(R_i)$, $-NO_2$ or $-C(O)-OR_{25}$;

T' is oxygen, sulfur or NR_6 ;

R_6 is a hydrogen, a lower alkyl group, or an aryl group;

V_6 is:

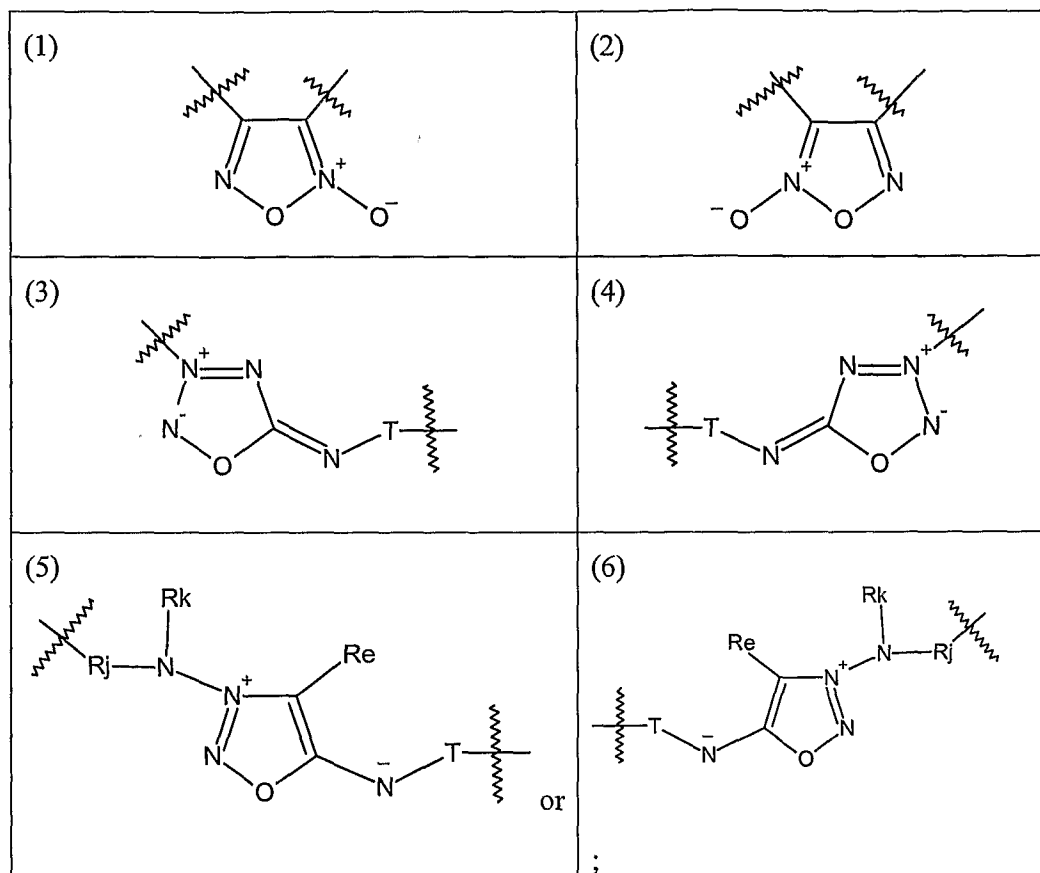


Z_5 is $-CH_2$ or oxygen;

Z_6 is $-CH$ or nitrogen;

W_3 at each occurrence is independently $-C(O)-$, $-C(S)-$, $-T_3-$, $-(C(R_e)(R_f))_h-$, $-N(R_a)R_i$, an alkyl group, an aryl group, a heterocyclic ring, an arylheterocyclic ring, $-(CH_2CH_2O)_{q1}-$ or a heterocyclic nitric oxide donor;

E at each occurrence is independently $-T_3-$, an alkyl group, an aryl group, $-(C(R_e)(R_f))_h-$, a heterocyclic ring, an arylheterocyclic ring, $-(CH_2CH_2O)_{q1}-$ or Y_4 ; Y_4 is:



T is a $-S(O)_o-$; a carbonyl or a covalent bond;

o is an integer from 0 to 2;

R_j and R_k are independently selected from an alkyl group, an aryl group, or R_j and R_k taken together with the nitrogen atom to which they are attached are a heterocyclic ring;

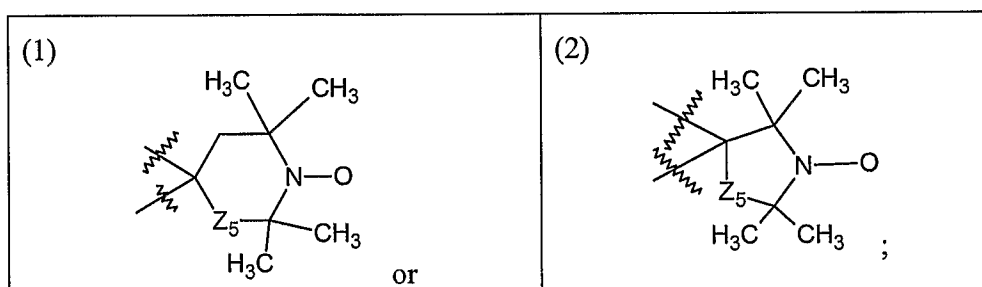
T_3 at each occurrence is independently a covalent bond, a carbonyl, an oxygen, $-S(O)_o-$ or $-N(R_a)R_i$;

h is an integer from 1 to 10;

q_1 is an integer from 1 to 5;

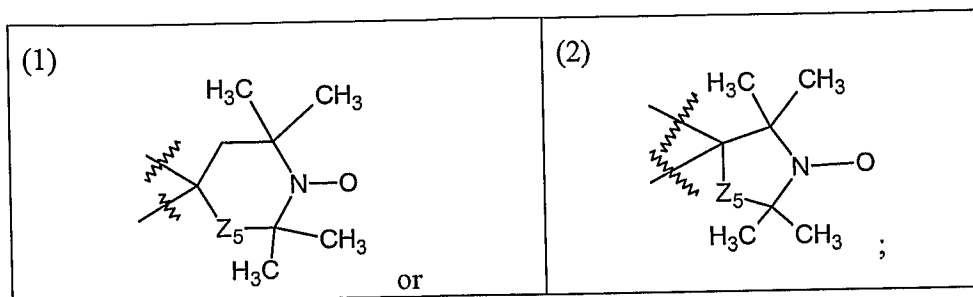
R_e and R_f are each independently a hydrogen, an alkyl, a cycloalkoxy, a halogen, a hydroxy, an hydroxyalkyl, an alkoxyalkyl, an arylheterocyclic ring, an alkylaryl, an alkylcycloalkyl, an alkylheterocyclic ring, a cycloalkylalkyl, a cycloalkylthio, an arylalkylthio, an arylalkylthioalkyl, an alkylthioalkyl, a cycloalkenyl, an heterocyclicalkyl, an alkoxy, a

haloalkoxy, an amino, an alkylamino, a dialkylamino, an arylamino, a diarylamino, an
 alkylarylamino, an alkoxyhaloalkyl, a sulfonic acid, a sulfonic ester, an alkylsulfonic acid, an
 arylsulfonic acid, an arylalkoxy, an alkylthio, an arylthio, a cyano, an aminoalkyl, an
 aminoaryl, an aryl, an arylalkyl, an alkylaryl, a carboxamido, an alkylcarboxamido, an
 5 arylcarboxamido, an amidyl, a carboxyl, a carbamoyl, an alkylcarboxylic acid, an
 arylcarboxylic acid, an alkylcarbonyl, an arylcarbonyl, an ester, a carboxylic ester, an
 alkylcarboxylic ester, an arylcarboxylic ester, a sulfonamido, an alkylsulfonamido, an
 arylsulfonamido, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfonyl, arylsulphonyloxy, a
 sulfonic ester, an alkyl ester, an aryl ester, a urea, a phosphoryl, a nitro, -U₃-V₅, V₆, -
 10 (C(R_o)(R_p))_{k1}-U₃-V₅, -(C(R_o)(R_p))_{k1}-U₃-V₃, -(C(R_o)(R_p))_{k1}-U₃-V₆, -(C(R_o)(R_p))_{k1}-U₃-C(O)-V₆,
 or R_e and R_f taken together with the carbons to which they are attached form a carbonyl, a
 methanthial, a heterocyclic ring, a cycloalkyl group, an aryl group, an oxime, an imine, a
 hydrazone, a bridged cycloalkyl group,



R_o and R_p are each independently a hydrogen, an alkyl, a cycloalkoxy, a halogen, a
 hydroxy, an hydroxyalkyl, an alkoxyalkyl, an arylheterocyclic ring, an alkylaryl, an
 alkylcycloalkyl, an alkylheterocyclic ring, a cycloalkylalkyl, a cycloalkylthio, an arylalklythio,
 an arylalklythioalkyl, an alkylthioalkyl a cycloalkenyl, an heterocyclicalkyl, an alkoxy, a
 20 haloalkoxy, an amino, an alkylamino, a dialkylamino, an arylamino, a diarylamino, an
 alkylarylamino, an alkoxyhaloalkyl, a sulfonic acid, a sulfonic ester, an alkylsulfonic acid, an
 arylsulfonic acid, an arylalkoxy, an alkylthio, an arylthio, a cyano an aminoalkyl, an
 aminoaryl, an aryl, an arylalkyl, an alkylaryl, a carboxamido, an alkylcarboxamido, an
 arylcarboxamido, an amidyl, a carboxyl, a carbamoyl, an alkylcarboxylic acid, an
 25 arylcarboxylic acid, an alkylcarbonyl, an arylcarbonyl, an ester, a carboxylic ester, an
 alkylcarboxylic ester, an arylcarboxylic ester, a sulfonamido, an alkylsulfonamido, an
 arylsulfonamido, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfonyl, arylsulphonyloxy, a
 sulfonic ester, an alkyl ester, an aryl ester, a urea, a phosphoryl, a nitro, -U₃-V₅, V₆, or R_o and

R_p taken together with the carbons to which they are attached form a carbonyl, a methanthial, a heterocyclic ring, a cycloalkyl group, an aryl group, an oxime, an imine, a hydrazone a bridged cycloalkyl group,



5

U_3 is an oxygen, sulfur or $-N(R_a)R_i$;

V_5 is $-\text{NO}$ or $-\text{NO}_2$ (i.e. an oxidized nitrogen);

k_1 is an integer from 1 to 3;

R_a is a lone pair of electrons, a hydrogen or an alkyl group;

10

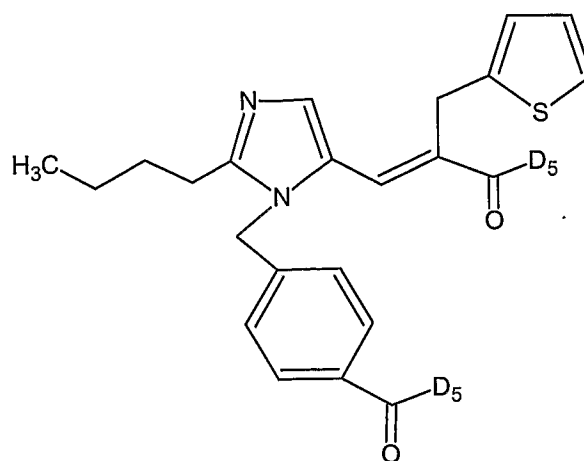
R_i is a hydrogen, an alkyl, an aryl, an alkylcarboxylic acid, an arylcarboxylic acid, an alkylcarboxylic ester, an arylcarboxylic ester, an alkylcarboxamido, an arylcarboxamido, an alkylaryl, an alkylsulfinyl, an alkylsulfonyl, an alkylsulfonyloxy, an arylsulfinyl, an arylsulfonyl, an arylsulfonyloxy, a sulfonamido, a carboxamido, a carboxylic ester, an aminoalkyl, an aminoaryl, $-\text{CH}_2-\text{C}-(U_3-V_5)(R_e)(R_f)$, a bond to an adjacent atom creating a double bond to that atom or $-(\text{N}_2\text{O}_2)^-\cdot\text{M}_1^+$, wherein M_1^+ is an organic or inorganic cation; and

15

with the proviso that the compound of Formula (I) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (I) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed;

20

wherein the compound of Formula (II) is:



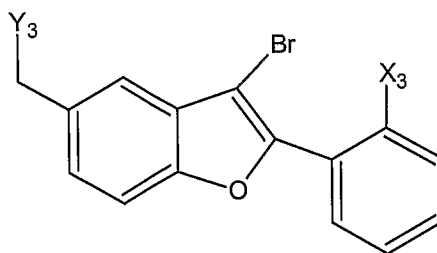
(II)

wherein:

D₅ is as defined herein; and

with the proviso that the compound of Formula (II) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (II) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed;

wherein the compound of Formula (III) is:



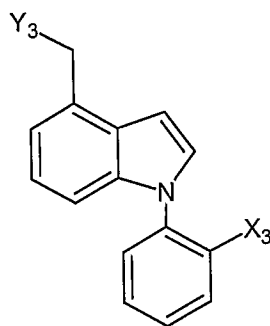
(III)

wherein:

X₃ and Y₃ are as defined herein; and

with the proviso that the compound of Formula (III) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (III) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed;

wherein the compound of Formula (IV) is:



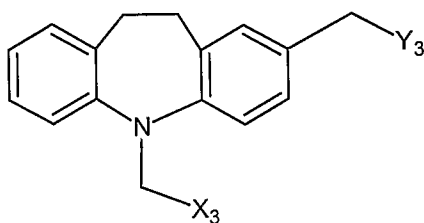
(IV)

wherein:

X_3 and Y_3 are as defined herein; and

with the proviso that the compound of Formula (IV) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (IV) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed;

wherein the compound of Formula (V) is:



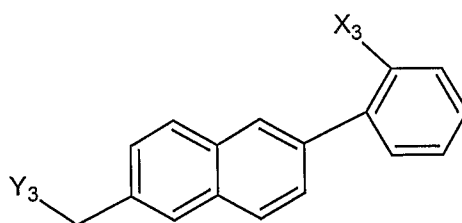
(V)

wherein:

X_3 and Y_3 are as defined herein; and

with the proviso that the compound of Formula (V) must contain at least one nitric oxide enhancing group linked to the angiotensin II antagonist compound of Formula (V) through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be hydrolyzed;

wherein the compound of Formula (VI) is:



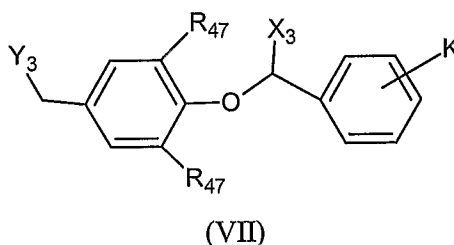
(VI)

wherein:

X_3 and Y_3 are as defined herein; and

with the proviso that the compound of Formula (VI) must contain at least one nitric
oxide enhancing group linked to the angiotensin II antagonist compound of Formula (VI)
through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be
hydrolyzed;

wherein the compound of Formula (VII) is:



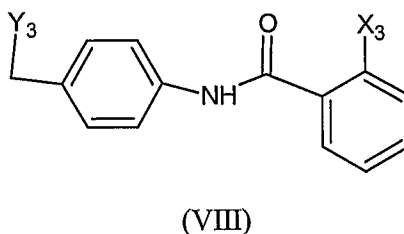
wherein:

R_{47} is a lower alkyl or $-(C(R_g)R_h))_k-V_4$;

X_3 , Y_3 , R_g , R_h , V_4 , K and k are as defined herein; and

with the proviso that the compound of Formula (VII) must contain at least one nitric
oxide enhancing group linked to the angiotensin II antagonist compound of Formula (VII)
through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be
hydrolyzed;

wherein the compound of Formula (VIII) is:



wherein:

X_3 and Y_3 are as defined herein; and

with the proviso that the compound of Formula (VIII) must contain at least one nitric
oxide enhancing group linked to the angiotensin II antagonist compound of Formula (VIII)
through an oxygen atom, a nitrogen atom or a sulfur atom via a bond or moiety that can be
hydrolyzed.

2. A composition comprising the compound of claim 1 and a pharmaceutically acceptable carrier.

3. The compound of claim 1, wherein the compound of Formula (I) is a nitric oxide enhancing abitesartan, a nitric oxide enhancing candesartan, a nitric oxide enhancing elisartan, a nitric oxide enhancing embusartan, a nitric oxide enhancing enoltasartan, a nitric oxide enhancing fonsartan, a nitric oxide enhancing forasartan, a nitric oxide enhancing glycylosartan, a nitric oxide enhancing irbesartan, a nitric oxide enhancing losartan, a nitric oxide enhancing olmesartan, a nitric oxide enhancing milfasartan, a nitric oxide enhancing pomisartan, a nitric oxide enhancing ripisartan, a nitric oxide enhancing tasosartan, a nitric oxide enhancing telmisartan, a nitric oxide enhancing valsartan, a nitric oxide enhancing CL-329167, a nitric oxide enhancing MK 996, a nitric oxide enhancing SR-47436, a nitric oxide enhancing YM 358, or a nitric oxide enhancing any of the following compounds of ACS registry number 124750-92-1, 133240-46-7, 135070-05-2, 139958-16-0, 145160-84-5, 147403-03-0, 153806-29-2, 439904-54-8P, 439904-55-9P, 439904-56-0P, 439904-57-1P, 439904-58-2P, 155918-60-8P, 155918-61-9P, 272438-16-1P, 272446-75-0P, 223926-77-0P, 169281-89-4, 439904-65-1P, 165113-01-9P, 165113-02-0P, 165113-03-1P, 165113-03-2P, 165113-05-3P, 165113-06-4P, 165113-07-5P, 165113-08-6P, 165113-09-7P, 165113-10-0P, 165113-11-1P, 165113-12-2P, 165113-17-7P, 165113-18-8P, 165113-19-9P, 165113-20-2P, 165113-13-3P, 165113-14-4P, 165113-15-5P, 165113-16-6P, 165113-21-3P, 165113-22-4P, 165113-23-5P, 165113-24-6P, 165113-25-7P, 165113-26-8P, 165113-27-9P, 165113-28-0P, 165113-29-1P, 165113-30-4P, 165113-31-5P, 165113-32-6P, 165113-33-7P, 165113-34-8P, 165113-35-9P, 165113-36-0P, 165113-37-1P, 165113-38-2P, 165113-39-3P, 165113-40-6P, 165113-41-7P, 165113-42-8P, 165113-43-9P, 165113-44-0P, 165113-45-1P, 165113-46-2P, 165113-47-3P, 165113-48-4P, 165113-49-5P, 165113-50-8P, 165113-51-9P, 165113-52-0P, 165113-53-1P, 165113-54-2P, 165113-55-3P, 165113-56-4P, 165113-57-5P, 165113-58-6P, 165113-59-7P, 165113-60-0P, 165113-61-1P, 165113-62-2P, 165113-63-3P, 165113-64-4P, 165113-65-5P, 165113-66-6P, 165113-67-7P, 165113-68-8P, 165113-69-9P, 165113-70-2P, 165113-71-3P, 165113-72-4P, 165113-73-5P, 165113-74-6P, 114798-27-5, 114798-28-6, 114798-29-7, 124749-82-2, 114798-28-6, 124749-84-4, 124750-88-5, 124750-91-0, 124750-93-2, 161946-65-2P, 161947-47-3P, 161947-48-4P, 161947-51-9P, 161947-52-0P, 161947-55-3P, 161947-56-4P, 161947-60-0P, 161947-61-1P, 161947-68-8P, 161947-69-9P, 161947-70-2P, 161947-71-3P, 161947-72-4P, 161947-74-6P, 161947-75-7P, 161947-81-5P, 161947-82-6P, 161947-83-7P, 161947-84-8P, 161947-85-9P, 161947-86-0P, 161947-87-1P, 161947-

88-2P, 161947-89-3P, 161947-90-6P, 161947-91-7P, 161947-92-8P, 161947-93-9P, 161947-94-0P, 161947-95-1P, 161947-96-2P, 161947-97-3P, 161947-98-4P, 161947-99-5P, 161948-00-1P, 161948-01-2P, 161948-02-3P, 168686-32-6P, 167301-42-0P, 166813-82-7P, 166961-56-4P, 166961-58-6P, 158872-96-9P, 158872-97-0P, 158807-14-8P, 158807-15-9P, 158807-16-0P, 158807-17-1P, 158807-18-2P, 158807-19-3P, 158807-20-6P, 155884-08-5P, 154749-99-2, 167371-59-7P, 244126-99-6P, 177848-35-0P and 141309-82-2P; the compound of Formula (II) is a nitric oxide enhancing eprosartan; the compound of Formula (III) is a nitric oxide enhancing saprisartan or a nitric oxide enhancing zolasartan; the compound of Formula (IV) is a nitric oxide enhancing BMS 180560; the compound of Formula (V) is a nitric oxide enhancing KW 3433; the compound of Formula (VI) is a nitric oxide enhancing GA 0056; and the compound of Formula (VII) is a nitric oxide enhancing L 158,809.

4. A method for treating a cardiovascular disease in a patient in need thereof comprising administering to the patient an effective amount of the composition of claim 2.

5. The method of claim 4, wherein the cardiovascular disease is heart failure, restenosis, hypertension, diastolic dysfunction, a coronary artery disease, myocardial infarction, cerebral infarction, arterial stiffness, atherosclerosis, atherogenesis, cerebrovascular disease, angina, aneurysm, ischemic heart disease, cerebral ischemia, myocardial ischemia, thrombosis, platelet aggregation, platelet adhesion, smooth muscle cell proliferation, a vascular or non-vascular complications associated with the use of a medical device, a wound associated with the use of a medical device, vascular or non-vascular wall damage, peripheral vascular disease, neointimal hyperplasia following percutaneous transluminal coronary angiograph, vascular grafting, coronary artery bypass surgery, thromboembolic events, post-angioplasty restenosis, coronary plaque inflammation, hypercholesterolemia, embolism, stroke, shock, arrhythmia, atrial fibrillation or atrial flutter, thrombotic occlusion and reclusion cerebrovascular incidents, left ventricular dysfunction and hypertrophy.

6. The method of claim 5, wherein the cardiovascular disease is hypertension, heart failure, arterial stiffness, postmyocardial infarction, stroke and/or diastolic dysfunction.

7. A method for treating a renovascular disease in a patient in need thereof comprising administering to the patient an effective amount of the composition of claim 2.

8. The method of claim 7, wherein the renovascular disease is renal failure, renal insufficiency, renal deterioration associated with severe hypertension or renovascular

hypertension.

9. A method for treating diabetes; treating diseases resulting from oxidative stress; treating endothelial dysfunctions; treating a disease caused by endothelial dysfunctions; treating cirrhosis; treating pre-eclampsia; treating osteoporosis; treating nephropathy; treating a peripheral vascular disease; treating portal hypertension; treating an ophthalmic disorder; treating metabolic syndrome; or treating hyperlipidemia in a patient in need thereof comprising administering to the patient an effective amount of the composition of claim 2.

10. The composition of claim 2, further comprising (i) at least one therapeutic agent; (ii) at least one nitric oxide enhancing compound; or (iii) at least one therapeutic agent and at least one nitric oxide enhancing compound.

11. The composition of claim 10, wherein the therapeutic agent is an aldosterone antagonist, an α -adrenergic receptor antagonist, an angiotensin II antagonist, an angiotensin-converting enzyme inhibitor, an antidiabetic compound, an anti-hyperlipidemic compound, an antioxidant, an antithrombotic and vasodilator compound, a β -adrenergic antagonist, a calcium channel blocker, a carbonic anhydrase inhibitor, a digitalis, a diuretic, an endothelin antagonist, a hydralazine compound, a H_2 receptor antagonist, an neutral endopeptidase inhibitor, a nonsteroidal antiinflammatory compound, a phosphodiesterase inhibitor, a potassium channel blocker, a platelet reducing agent, a prostaglandin, a proton pump inhibitor, a renin inhibitor, a selective cyclooxygenase-2 inhibitor, a steroid, or a combination of two or more thereof.

12. The composition of claim 11, wherein the therapeutic agent is at least one compound selected from the group consisting of an aldosterone antagonist, an angiotensin II antagonist, an angiotensin-converting enzyme (ACE) inhibitor, a β -adrenergic antagonist, a calcium channel blocker, a diuretic, a hydralazine compound and a renin inhibitor.

13. The composition of claim 12, wherein the aldosterone antagonist is eplerenone or spironolactone; the angiotensin II antagonist is candesartan, candesartan cilexetil, eprosartan mesylate, irbesartan, losartan, medoxomil, telmisartan, trandolapril, trandolaprilat or valsartan; the angiotensin-converting enzyme inhibitor is benazepril hydrochloride, captopril, enalapril maleate, fosinopril sodium, lisinopril, moexipril hydrochloride, quinapril hydrochloride, ramipril; the β -adrenergic antagonist is bisoprolol fumarate, carvedilol, metoprolol tartrate, propranolol hydrochloride or timolol maleate; the calcium channel blockers is amlodipine, diltiazem, isradipine, nifedipine, nimodipine, nisoldipine,

nitrendipine, verapamil; the diuretic is amiloride hydrochloride, chlorthalidone, hydrochlorothiazide or triamterene; the hydralazine compound is hydralazine hydrochloride; and the renin inhibitor is aliskiren, ciprokiren, ditekiren, enalkrein, medullipin, remikiren, terliren, tonin or zankiren.

5 14. The composition of claim 10, wherein the nitric oxide enhancing compound is selected from the group consisting of a S-nitrosothiol, a nitrite, a nitrate, a S-nitrothiol, a sydnonimine, a NONOate, a N-nitrosoamine, a N-hydroxyl nitrosamine, a nitrosimine, a diazetine dioxide, an oxatriazole 5-imine, an oxime, a hydroxylamine, a N-hydroxyguanidine, a hydroxyurea, a furoxan or a nitroxide.

10 15. The method of claims 4, 7 or 9, further comprising administering (i) at least one therapeutic agent; (ii) at least one nitric oxide enhancing compound (iii) at least one therapeutic agent and at least one nitric oxide enhancing compound.

15 16 The method of claim 15, wherein the therapeutic agent is an aldosterone antagonist, an α -adrenergic receptor antagonist, an angiotensin II antagonist, an angiotensin-converting enzyme inhibitor, an antidiabetic compound, an anti-hyperlipidemic compound, an antioxidant, an antithrombotic and vasodilator compound, a β -adrenergic antagonist, a calcium channel blocker, a carbonic anhydrase inhibitor, a digitali, a diuretic, an endothelin antagonist, a hydralazine compound, a H_2 receptor antagonist, a neutral endopeptidase inhibitor, a nonsteroidal antiinflammatory compound, a phosphodiesterase inhibitor, a potassium channel blocker, a platelet reducing agent, a prostaglandin, a proton pump inhibitor, a renin inhibitor, a selective cyclooxygenase-2 inhibitor, a steroid, or a combination of two or more thereof.

20 17. The method of claim 15, wherein the nitric oxide enhancing compound is selected from the group consisting of a S-nitrosothiol, a nitrite, a nitrate, a S-nitrothiol, a sydnonimine, a NONOate, a N-nitrosoamine, a N-hydroxyl nitrosamine, a nitrosimine, a diazetine dioxide, an oxatriazole 5-imine, an oxime, a hydroxylamine, a N-hydroxyguanidine, a hydroxyurea, a furoxan or a nitroxide.

 18. A kit comprising at least one compound of claim 1.

30 19. The kit of claim 18, further comprising further comprising (i) at least one therapeutic agent; (ii) at least one nitric oxide enhancing compound; or (iii) at least one therapeutic agent and at least one nitric oxide enhancing compound.

 20. The kit of claim 19, wherein the (i) at least one therapeutic agent; (ii) at least one nitric oxide enhancing compound; or (iii) at least one therapeutic agent and at least one

nitric oxide enhancing compound are in the form of separate components in the kit.

21. A compound selected from the group consisting of:

L-valine, N-[5-(nitrooxy)-1-oxopentyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

L-valine, N-[6-(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

5 L-valine, N-[3-[(nitrooxy)methyl]benzoyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

L-valine, N-[4,5-bis(nitrooxy)-1-oxopentyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

10 L-valine, N-[5,6-bis(nitrooxy)-1-oxohexyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

pentanamide, N-[(1S)-1-[(dimethylamino)carbonyl]-2-methylpropyl]-5-(nitrooxy)-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

pentanamide, N-[3-(nitrooxy)propyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

15 pentanamide, N-[(1S)-1-[[bis[2-(nitrooxy)ethyl]amino]carbonyl]-2-methylpropyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

pentanamide, N-[(1S)-2-methyl-1-[[methyl[2-(nitrooxy)ethyl]amino]carbonyl]propyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

20 pentanamide, N-[(1S)-2-methyl-1-[[4-[(nitrooxy)methyl]-1-piperidinyl]carbonyl]propyl]-N-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-;

1-piperidinyloxy, 4-[[[4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]amino]carbonyl]-2,2,6,6-tetramethyl-;

1H-pyrrol-1-yloxy, 3-[[[4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]amino]carbonyl]-2,5-dihydro-2,2,5,5-tetramethyl-;

25 benzamide, N-[[4'-[(2-ethyl-5,7-dimethyl-3H-imidazo[4,5-b]pyridin-3-yl)methyl][1,1'-biphenyl]-2-yl]sulfonyl]-3-[(nitrooxy)methyl]-;

1H-benzimidazole-7-methanol, 2-ethoxy-1-[[2'-(1H-tetrazol-5-yl)[1,1'-biphenyl]-4-yl]methyl]-, nitrate (ester); and pharmaceutically acceptable salts thereof.