

GLUTAMATE AGGRECANASE INHIBITORS

[0001] Throughout this application, various publications are referenced. The disclosures of these publications in their entireties are hereby incorporated by reference into this application in order to more fully describe the state of the art as known to those skilled therein as of the date of the invention described and claimed herein.

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Related Application

[0003] This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application No. 60/697,590 filed on July 11, 2005, which is hereby incorporated by reference herein in its entirety.

Field of the Invention

[0004] The present invention relates to compounds and their use as, for example, metalloproteinase inhibitors.

Background of the Invention

[0005] Metalloproteinases, including matrix metalloproteinases and aggrecanases, are known to have a role in the breakdown of connective tissue. Matrix metalloproteinases ("MMPs") constitute a superfamily of proteolytic enzymes that are genetically related and capable of degrading almost all the constituents of extracellular matrix and basement membrane that restrict cell movement. Aggrecanases are members of the ADAMTS (A disintegrin and metalloproteinase with thrombospondin motifs) family of proteins. Aggrecanase-1 and aggrecanase-2 have been designated ADAMTS-4 and ADAMTS-5, respectively (Tang BL, *Int J Biochem Cell Biol* 2001, 33, 33-44).

[0006] The ADAMTS family is involved in cleaving aggrecan, a cartilage component also known as the large aggregating chondroitin sulphate proteoglycan (Abbaszade I et al., *J Biol Chem* 1999, 274, 23443-23450), procollagen processing

(Colige A et al., *Proc Natl Acad Sci USA* 1997, 94, 2374-2379), angiogenesis (Vazquez F et al., *J Biol Chem* 1999, 274, 23349-23357), inflammation (Kuno K et al., *J Biol Chem* 1997, 272, 556-562) and tumor invasion (Masui T. et al., *J Biol Chem* 1997, 272, 556-562). MMPs have been shown to cleave aggrecan as well.

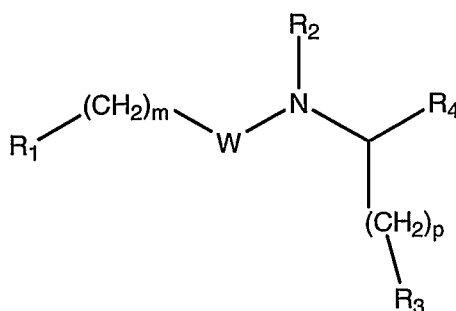
[0007] The loss of aggrecan has been implicated in the degradation of articular cartilage in arthritic diseases, for example osteoarthritis is a debilitating disease which affects at least 30 million Americans. Degradation of articular cartilage and the resulting chronic pain can severely reduce quality of life. An early and important characteristic of the osteoarthritic process is loss of aggrecan from the extracellular matrix, resulting in deficiencies in the biomechanical characteristics of the cartilage. Likewise, MMPs and aggrecanases are known to play a role in many disorders in which extracellular protein degradation or destruction occurs, such as cancer, asthma, chronic obstructive pulmonary disease ("COPD"), atherosclerosis, age-related macular degeneration, myocardial infarction, corneal ulceration and other ocular surface diseases, hepatitis, aortic aneurysms, tendonitis, central nervous system diseases, abnormal wound healing, angiogenesis, restenosis, cirrhosis, multiple sclerosis, glomerulonephritis, graft versus host disease, diabetes, inflammatory bowel disease, shock, intervertebral disc degeneration, stroke, osteopenia, and periodontal diseases.

[0008] Therefore, metalloproteinase inhibitors, including inhibitors of MMPs and aggrecanases, are needed.

[0009] The present invention is directed to these and other important ends.

Summary of the Invention

[0010] In one embodiment, the invention provides compounds of the Formula (I):



(I)

and pharmaceutically acceptable salts thereof,

wherein

W is $-\text{C}(\text{O})-$, $-\text{OC}(\text{O})-$, $-\text{NHC}(\text{O})-$, $-\text{C}(\text{O})\text{O}-$, or $-\text{C}(\text{O})\text{NH}-$;

R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, $-(\text{CH}_2)_n\text{R}_{11}$, $-\text{OH}$, or $-\text{O}-(\text{C}_1-\text{C}_6)$ alkyl;

R₃ is $-\text{CO}_2\text{H}$, $-\text{CONH}_2$, $-\text{CONHOH}$, $-\text{CONHSO}_2\text{R}_7$, tetrazole, $-\text{SO}_2\text{NHR}_7$, $-\text{SO}_3\text{H}$, $-\text{PO}(\text{OH})\text{NH}_2$, $-\text{PO}(\text{OH})\text{OR}_7$, $-\text{CONHR}_7$, $-\text{COOR}_7$, an acid mimetic group, or a 5 or 6-membered heterocycloalkyl or heteroaryl containing 1 to 4 heteroatoms selected from O, N, S;

R₄ is $-\text{CO}_2\text{H}$, $-\text{CONH}_2$, $-(\text{CH}_2)_n\text{OR}_7$, or $-\text{CONR}_9\text{R}_{10}$;

R₅ is aryl, heteroaryl, $-(\text{CH}_2)_n$ -aryl, $-(\text{CH}_2)_n$ -heteroaryl, $-\text{O}$ -aryl, $-\text{O}$ -heteroaryl, $-\text{S}$ -aryl, $-\text{S}$ -heteroaryl, $-\text{NH}$ -aryl, $-\text{NH}$ -heteroaryl, $-\text{CO}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{CO}$ -aryl, $-\text{CO}$ -heteroaryl, $-\text{SO}_2-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{SO}_2$ -aryl, $-\text{SO}_2$ -heteroaryl, $-\text{SO}_2\text{NH}$ -aryl, $-\text{SO}_2\text{NH}$ -heteroaryl, $-\text{NHSO}_2-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{NHSO}_2$ -aryl, $-\text{NHSO}_2$ -heteroaryl, $-\text{NHCO}$ -aryl, $-\text{NHCO}$ -heteroaryl, $-\text{CONH}$ -aryl, $-\text{CONH}$ -heteroaryl, (C₁-C₆) alkyl, $-\text{O}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{S}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{NH}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{NHCO}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{CONH}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{O}-(\text{C}_3-\text{C}_6)$ cycloalkyl, $-\text{S}-(\text{C}_3-\text{C}_6)$ cycloalkyl, $-\text{NH}-(\text{C}_3-\text{C}_6)$ cycloalkyl, $-\text{NHCO}-(\text{C}_3-\text{C}_6)$ cycloalkyl, or $-\text{CONH}-(\text{C}_3-\text{C}_6)$ cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, $-\text{CN}$, $-\text{OCF}_3$, $-\text{CF}_3$, $-\text{NO}_2$, $-\text{OH}$, $-\text{SH}$, $-\text{NR}_7\text{R}_8$, $-\text{CONR}_7\text{R}_8$, $-\text{NR}_8\text{COR}_7$, $-\text{NR}_8\text{CO}_2\text{R}_7$, $-\text{CO}_2\text{R}_7$, $-\text{COR}_7$, $-\text{SO}_2-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{SO}_2$ -aryl, $-\text{SO}_2$ -heteroaryl, $-\text{SO}_2\text{R}_7$, $-\text{NR}_7\text{SO}_2\text{R}_8$, $-\text{SO}_2\text{NR}_7\text{R}_8$, (C₁-C₆) alkyl, $-\text{O}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{S}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{NH}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{NHCO}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{CONH}-(\text{C}_1-\text{C}_6)$ alkyl, $-\text{O}-(\text{C}_3-\text{C}_6)$ cycloalkyl, $-\text{S}-(\text{C}_3-\text{C}_6)$ cycloalkyl, $-\text{NH}-(\text{C}_3-\text{C}_6)$ cycloalkyl, $-\text{NHCO}-(\text{C}_3-\text{C}_6)$ cycloalkyl, $-\text{CONH}-(\text{C}_3-\text{C}_6)$ cycloalkyl, heterocycloalkyl, $-(\text{C}_1-\text{C}_6)$

alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₉ and R₁₀ are each independently hydrogen, (C₁-C₆) alkyl, (C₁-C₆) alkyl-OH, (C₁-C₆) alkyl-O-(C₁-C₆) alkyl, aryl, cycloalkyl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₉ and R₁₀ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

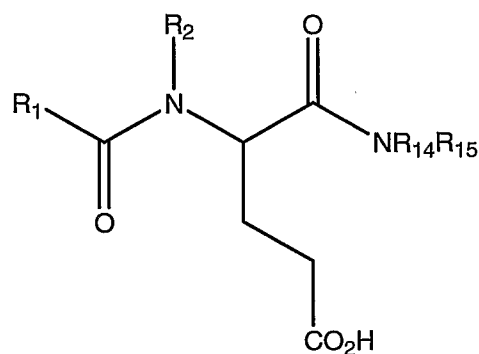
R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl;

m is 0-4;

n is 0-4; and

p is 0-2.

[0011] In another embodiment, the invention provides compounds of the Formula (II):



(II)

and pharmaceutically acceptable salts thereof,

wherein

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_pR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₁₄ and R₁₅ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, heterocycloalkyl -(CH₂)_n- aryl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₁₄ and R₁₅ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

p is 0-2, and

R₁, R₁₁, R₁₂, and n are as described above for compounds of the Formula (I).

[0012] In another embodiment, the compounds or pharmaceutically acceptable salts of the compounds of Formula (I) or Formula (II) are useful as pharmaceutical compositions comprising compounds or pharmaceutically acceptable salts of compounds of Formula (I) or Formula (II) and a pharmaceutically acceptable carrier.

[0013] In one embodiment, the compounds or pharmaceutically acceptable salts of the compounds of the Formula (I) or Formula (II) are useful as metalloproteinase modulators.

[0014] In one embodiment, the invention provides methods for treating a metalloproteinase-related disorder, comprising administering to an animal in need thereof the compounds or pharmaceutically acceptable salts of compounds of Formula (I) or Formula (II) in an amount effective to treat a metalloproteinase-related disorder.

[0015] In one embodiment, the invention provides methods of synthesizing the compounds or pharmaceutically acceptable salts of compounds of Formula (I) or Formula (II). In another embodiment, the invention provides compounds or pharmaceutically acceptable salts of compounds of Formula (I) or Formula (II) made by particular processes.

Description of the Invention

[0016] All recitations of a group, such as alkyl, are understood for the purposes of this specification to encompass both substituted and unsubstituted forms.

[0017] The term "alkyl", as used herein, whether used alone or as part of another group, refers to a substituted or unsubstituted aliphatic hydrocarbon chain and includes, but is not limited to, straight and branched chains containing from 1 to 12 carbon atoms, or in some instances, from 1 to 6 carbon atoms, unless explicitly specified otherwise. For example, methyl, ethyl, propyl, isopropyl, butyl, i-butyl and t-butyl are encompassed by the term "alkyl." (C₁-C₆)-alkyl includes straight and branched chain aliphatic groups having from 1 to 6 carbons. Specifically included within the definition of "alkyl" are those aliphatic hydrocarbon chains that are optionally substituted. The alkyl may suitably be a (C₁-C₃)-alkyl. In one embodiment, an alkyl is optionally substituted with one or more of the following groups: -halogen, -N(R')₂, methylenedioxy, ethylenedioxy, -NHSO₂R', -NR'COR', -NHCO₂R', -NO₂, -SO₂N(R')₂, -SO₂R', -OR', -COR', -CO₂R', -CON(R')₂, or -CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl.

[0018] The carbon number as used in the definitions herein refers to carbon backbone and carbon branching, but does not include carbon atoms of the substituents, such as alkoxy substitutions and the like.

[0019] The term "alkenyl", as used herein, whether used alone or as part of another group, refers to a substituted or unsubstituted hydrocarbon chain and includes, but is not limited to, straight and branched chains having 2 to 8 carbon atoms e.g. 2 to 6 carbon atoms and containing at least one double bond. In one embodiment, the alkenyl moiety has 1 or 2 double bonds. Such alkenyl moieties may exist in the E or Z conformations and the compounds of this invention include both conformations. (C₂-C₆)-alkenyl includes a 2 to 6 carbon straight or branched chain having at least one carbon-carbon double bond. Specifically included within the definition of "alkenyl" are those

aliphatic hydrocarbon chains that are optionally substituted. In one embodiment, a heteroatom, such as O, S or N, attached to an alkenyl is not attached to a carbon atom that is bonded to a double bond. In one embodiment, an alkenyl is optionally substituted with one or more of the following groups: -halogen, $-N(R')_2$, methylenedioxy, ethylenedioxy, $-NHSO_2R'$, $-NR'COR'$, $-NHCO_2R'$, $-NO_2$, $-SO_2N(R')_2$, $-SO_2R'$, $-OR'$, $-COR'$, $-CO_2R'$, $-CON(R')_2$, or $-CN$, wherein each R' is independently hydrogen, unsubstituted (C_1-C_6) -alkyl, or unsubstituted aryl.

[0020] The term "alkynyl", as used herein, whether used alone or as part of another group, refers to a hydrocarbon moiety containing at least one carbon-carbon triple bond. (C_2-C_6) alkynyl includes a 2 to 6 carbon straight or branched chain having at least one carbon-carbon triple bond. In one embodiment, an alkynyl is optionally substituted with one or more of the following groups: -halogen, $-N(R')_2$, methylenedioxy, ethylenedioxy, $-NHSO_2R'$, $-NR'COR'$, $-NHCO_2R'$, $-NO_2$, $-SO_2N(R')_2$, $-SO_2R'$, $-OR'$, $-COR'$, $-CO_2R'$, $-CON(R')_2$, or $-CN$, wherein each R' is independently hydrogen, unsubstituted (C_1-C_6) -alkyl, or unsubstituted aryl.

[0021] The term "cycloalkyl" refers to a monocyclic, bicyclic, tricyclic, fused, bridged, or spiro monovalent saturated or unsaturated non-aromatic hydrocarbon ring system of 3-15 carbon atoms e.g. 3 to 6 carbon atoms. Any suitable ring position of the cycloalkyl moiety may be covalently linked to the defined chemical structure. Examples of cycloalkyl moieties include, but are not limited to, cyclopropyl, cyclopropylmethyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, norbornyl, adamantyl, spiro[4.5]decanyl, and homologs, isomers, and the like. C_3-C_6 cycloalkyl includes monocyclic, saturated rings of 3 to 6 carbons. In one embodiment, a cycloalkyl is optionally substituted with one or more of the following groups: -V-halogen, $-(C_1-C_6)$ -alkyl, $-(C_2-C_6)$ -alkenyl, $-(C_2-C_6)$ -alkynyl, $-V-N(R')_2$, methylenedioxy, ethylenedioxy, $-V-NHSO_2R'$, $-V-NR'COR'$, $-V-NHCO_2R'$, $-V-NO_2$, $-V-SO_2N(R')_2$, $-V-SO_2R'$, $-V-OR'$, $-V-COR'$, $-V-CO_2R'$, $-V-CON(R')_2$, or $-V-CN$, wherein each R' is independently hydrogen, unsubstituted (C_1-C_6) -alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C_1-C_6) -alkyl. Cycloalkylalkyl when used herein refers to a (C_1-C_6) -alkyl group as defined above substituted by a C_3 to C_{15} cycloalkyl group as defined above, e.g. cyclohexylmethyl and cyclohexylethyl.

[0022] "Heteroaryl" refers to a 5 to 6 membered aromatic heterocyclic ring which contains from 1 to 4 heteroatoms selected from the group consisting of oxygen, nitrogen, and sulfur atoms in the ring, and to which may be fused with a carbocyclic or heterocyclic ring at any possible position (e.g. fused to one or more carbocyclic or heterocyclic rings, each having 5-8 ring atoms, the fused heterocyclic ring containing from 1 to 4 heteroatoms selected from the group consisting of oxygen, nitrogen, and sulfur atoms in the ring), e.g. it is suitably a bicyclic or tricyclic ring. Exemplary heteroaryl groups include, but are not limited to, furanyl, furazanyl, homopiperaziny, imidazoliny, isothiazolyl, isoxazolyl, oxadiazolyl, oxazolyl, pyrimidinyl, phenanthridinyl, pyranyl, pyrazinyl, pyrazoliny, pyrazolyl, pyridazinyl, pyridooxazolyl, pyridoimidazolyl, pyridothiazolyl, pyridinyl, pyrimidinyl, pyrrolinyl, thiadiazinyl, thiadiazolyl, thienyl, thienothiazolyl, thienooxazolyl, thienoimidazolyl, thiophenyl, triazinyl, and triazolyl. In one embodiment, a heteroaryl is optionally substituted with one or more of the following groups: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedio, ethylenedio, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0023] "Heterocycloalkyl" refers to a 5 to 7-membered saturated or unsaturated nonaromatic ring containing carbon atoms and from 1 to 4 heteroatoms selected from N, O, and S which may suitably be monocyclic or may be fused to one or more further rings to provide a polycyclic moiety e.g. a bicyclic or tricyclic moiety. The further ring(s) may be carbocyclic rings(s) or they may contain from 1 to 4 further heteroatoms selected from N, O and S, preferably they are carbocyclic rings. The further ring(s) may be saturated, unsaturated or aromatic rings(s), preferably they are non-aromatic rings. Exemplary heterocycloalkyl groups include, but are not limited to, azepanyl, azetidiny, aziridinyl, imidazolidinyl, morpholiny, oxazolidinyl, oxazolidinyl, piperazinyl, piperidinyl, pyrazolidinyl, pyrrolidinyl, quinuclidinyl, tetrahydrofuranyl, and thiomorpholiny. In one embodiment, a heterocycloalkyl is optionally substituted with one or more of the following: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedio, ethylenedio, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN,

wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0024] The term "aryl" as used herein as a group or part of a group refers to an aromatic carbocyclic ring system, e.g., of from 6 to 14 carbon atoms such as phenyl, which may be optionally substituted. An aryl group may be fused with a carbocyclic or heterocyclic ring at any possible position (e.g. fused to one or more carbocyclic or heterocyclic rings, each having 5-8 ring atoms, the fused heterocyclic ring containing from 1 to 4 heteroatoms selected from the group consisting of oxygen, nitrogen, and sulfur atoms in the ring). "Phenyl", as used herein, whether used alone or as part of another group, refers to a substituted or unsubstituted phenyl group. The aryl fused with a carbocyclic ring may suitably be a bicyclic aryl or a tricyclic aryl. In one embodiment, an aryl group such as phenyl is optionally substituted with one or more of the following: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0025] The term "biphenyl" as used herein refers to two phenyl groups connected at one carbon site on each ring. In one embodiment, one or both phenyl groups is independently optionally substituted with one or more of the following groups: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0026] The term "biaryl" as used herein refers to two aryl groups connected at one carbon site on each ring. In one embodiment, one or both aryl groups is independently optionally substituted with one or more of the following groups: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen,

unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0027] The term “bicyclic aryl” as used herein refers to two fused carbocyclic groups, wherein one or both of the carbocyclic groups is aromatic. For example, a bicyclic aryl can contain from 8 to 12 ring atoms. In one embodiment, one or both carbocyclic groups of the bicyclic aryl is independently optionally substituted with one or more of the following groups: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0028] The term “tricyclic aryl” as used herein refers to three fused carbocyclic groups, wherein two or three of the carbocyclic groups is aromatic. For example, a tricyclic aryl can contain from 13 to 18 ring atoms. In one embodiment, one or more of the carbocyclic groups of the tricyclic aryl are independently optionally substituted with one or more of the following groups: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0029] The term “bicyclic heteroaryl” as used herein refers to two fused cyclic groups, wherein one or both of the cyclic groups is aromatic and contains one to four heteroatoms selected from O, S, and N. For example, a bicyclic heteroaryl can contain from 8 to 12 ring atoms, and from 1 to 3 heteroatoms selected from O, N, and S in each ring. In one embodiment, one or both cyclic groups is independently optionally substituted with one or more of the following groups: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0030] The term "tricyclic heteroaryl" as used herein refers to three fused cyclic groups, wherein two or three of the cyclic groups is aromatic and at least one aromatic group contains 1 to 4 heteroatoms selected from O, S, and N. For example, a tricyclic aryl can contain from 13 to 18 ring atoms, and from 1 to 3 heteroatoms selected from O, N, and S in each ring. In one embodiment, the cyclic groups are independently substituted with one or more of the following groups: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0031] An optionally substituted moiety may be substituted with one or more substituents, examples of which are as illustrated herein. In one embodiment, an "optionally substituted" moiety is substituted with one or more of the following: -V-halogen, -(C₁-C₆)-alkyl, -(C₂-C₆)-alkenyl, -(C₂-C₆)-alkynyl, -V-N(R')₂, methylenedioxy, ethylenedioxy, -V-NHSO₂R', -V-NR'COR', -V-NHCO₂R', -V-NO₂, -V-SO₂N(R')₂, -V-SO₂R', -V-OR', -V-COR', -V-CO₂R', -V-CON(R')₂, or -V-CN, wherein each R' is independently hydrogen, unsubstituted (C₁-C₆)-alkyl, or unsubstituted aryl; and wherein each V is independently a bond or (C₁-C₆)-alkyl.

[0032] When such moieties are substituted, for example, they may typically be mono-, di-, tri- or persubstituted. Examples for a halogen substituent include 1-bromo vinyl, 1-fluoro vinyl, 1,2-difluoro vinyl, 2,2-difluorovinyl, 1,2,2-trifluorovinyl, 1,2-dibromo ethane, 1,2 difluoro ethane, 1-fluoro-2-bromo ethane, CF₂F₃, CF₂CF₂CF₃, and the like.

[0033] The term halogen includes bromine, chlorine, fluorine, and iodine.

[0034] For the sake of simplicity, connection points ("-") are not depicted. When an atom or compound is described to define a variable, it is understood that it is intended to replace the variable in a manner to satisfy the valency of the atom or compound. For example, if "X*" was C(R*)=C(R*), both carbon atoms form a part of the ring in order to satisfy their respective valences. Likewise, when divalent substituents are presented, it is understood that they are not limited to the order listed, for example, as used in this specification "OCH₂" encompasses CH₂O and OCH₂.

[0035] The term “administer”, “administering”, or “administration”, as used herein refers to either directly administering a compound or pharmaceutically acceptable salt of the compound or a composition to a animal, or administering a prodrug derivative or analog of the compound or pharmaceutically acceptable salt of the compound or composition to the animal, which can form an equivalent amount of active compound within the animal’s body.

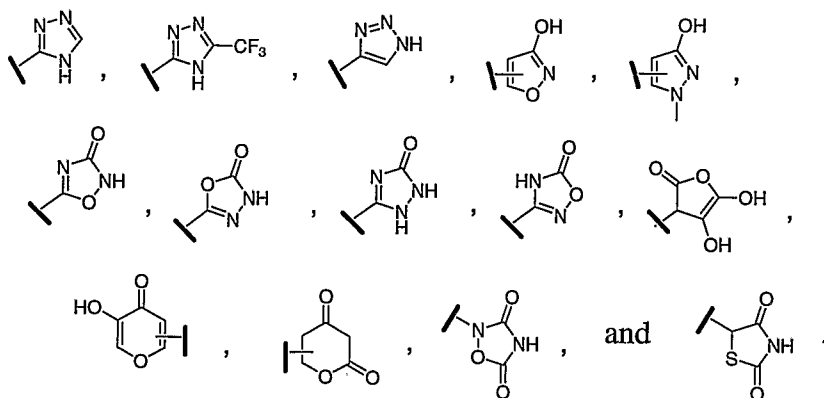
[0036] The term “animal” as used herein includes, without limitation, a human, mouse, rat, guinea pig, dog, cat, horse, cow, pig, monkey, chimpanzee, baboon, or rhesus. In one embodiment, the animal is a mammal. In another embodiment, the animal is a human.

[0037] The term “amine protecting group” as used herein refers to a moiety that temporarily blocks an amine reactive site in a compound. Generally, this is done so that a chemical reaction can be carried out at another reactive site in a multifunctional compound or to otherwise stabilize the amine. In one embodiment, an amine protecting group is selectively removable by a chemical reaction. An exemplary amine protecting group is a 9-fluorenylmethoxycarbonyl protecting group. Another exemplary amine protecting group is a carbamate protecting group. Carbamate protecting groups include, without limitation, t-butyl carbamate, methyl carbamate, ethyl carbamate, 2,2,2-trichloroethyl carbamate, 2-(trimethylsilyl)ethyl carbamate, 1,1-dimethyl-2,2,2-trichloroethyl carbamate, benzyl carbamate, p-methoxybenzyl carbamate, p-nitrobenzylcarbamate, p-bromobenzyl carbamate, p-chlorobenzyl carbamate, and 2,4-dichlorobenzyl carbamate. *See, Greene and Wuts, Protecting Groups in Organic Synthesis*, Second Edition, John Wiley & Sons (1991).

[0038] The term “carboxylic acid protecting group” as used herein refers to a moiety that temporarily blocks a carboxylic acid reactive site in a compound. Generally, this is done so that a chemical reaction can be carried out at another reactive site in a multifunctional compound or to otherwise stabilize the carboxylic acid. In one embodiment, a carboxylic acid protecting group is selectively removable by a chemical reaction. An exemplary carboxylic acid protecting group is an alkyl ester protecting group, such as a tert-butyl ester.

[0039] The term “acid mimetic group” as used herein refers to a moiety that has chemical and physical similarities producing broadly similar biological properties to an

acid. In one embodiment, an acid mimetic group is a 5 or 6-membered heterocycle containing 1 to 4 heteroatoms selected from O, N, S. Exemplary acid mimetic groups include:



[0040] The term “conditions effective to” as used herein refers to synthetic reaction conditions which will be apparent to those skilled in the art of synthetic organic chemistry.

[0041] The term “effective amount” as used herein refers to an amount of a compound or pharmaceutically acceptable salt of a compound that, when administered to an animal, is effective to prevent, to at least partially ameliorate, or to cure, a condition from which the animal suffers or is suspected to suffer.

[0042] The term “metalloproteinase-related disorder” used herein refers to a condition for which it would be beneficial to modulate activity of the metalloproteinase. Exemplary metalloproteinase-related disorders include, without limitation, arthritic disorders, osteoarthritis, cancer, rheumatoid arthritis, asthma, chronic obstructive pulmonary disease, atherosclerosis, age-related macular degeneration, myocardial infarction, corneal ulceration and other ocular surface diseases, hepatitis, aortic aneurysms, tendonitis, central nervous system diseases, abnormal wound healing, angiogenesis, restenosis, cirrhosis, multiple sclerosis, glomerulonephritis, graft versus host disease, diabetes, inflammatory bowel disease, shock, intervertebral disc degeneration, stroke, osteopenia, and periodontal diseases.

[0043] The term “metalloproteinase modulator” refers to a compound that is capable of modulating the expression of a metalloproteinase. For example, a metalloproteinase modulator may enhance metalloproteinase expression. A metalloproteinase modulator may also be an inhibitor of a metalloproteinase.

[0044] The term “isolated and purified” as used herein refers to an isolate that is separate from other components of a reaction mixture or a natural source. In certain embodiments, the isolate contains at least about 50%, at least about 55%, at least about 60%, at least about 65%, at least about 70%, at least about 75%, at least about 80%, at least about 85%, at least about 90%, at least about 95%, or at least about 98% of the compound or pharmaceutically acceptable salt of the compound by weight of the isolate.

[0045] As used herein, a compound of the invention includes a pharmaceutically acceptable salt thereof. The term “pharmaceutically acceptable salt” as used herein refers to a salt of an acid and a basic nitrogen atom of a compound of the present invention. Exemplary salts include, but are not limited to, sulfate, citrate, acetate, oxalate, chloride, hydrochloride, bromide, hydrobromide, iodide, nitrate, bisulfate, phosphate, acid phosphate, isonicotinate, lactate, salicylate, acid citrate, tartrate, oleate, tannate, pantothenate, bitartrate, ascorbate, succinate, maleate, gentisinate, fumarate, gluconate, glucaronate, saccharate, formate, benzoate, glutamate, methanesulfonate, ethanesulfonate, benzenesulfonate, p-toluenesulfonate, camphorsulfonate, naphthalenesulfonate, propionate, succinate, fumarate, maleate, malonate, mandelate, malate, phthalate, and pamoate. The term “pharmaceutically acceptable salt” as used herein also refers to a salt of a compound of the present invention having an acidic functional group, such as a carboxylic acid functional group, and a base. Exemplary bases include, but are not limited to, hydroxide of alkali metals including sodium, potassium, and lithium; hydroxides of alkaline earth metals such as calcium and magnesium; hydroxides of other metals, such as aluminum and zinc; ammonia, organic amines such as unsubstituted or hydroxyl-substituted mono-, di-, or tri-alkylamines, dicyclohexylamine; tributyl amine; pyridine; N-methyl, N-ethylamine; diethylamine; triethylamine; mono-, bis-, or tris-(2-OH-(C₁-C₆)-alkylamine), such as N,N-dimethyl-N-(2-hydroxyethyl)amine or tri-(2-hydroxyethyl)amine; N-methyl-D-glucamine; morpholine; thiomorpholine; piperidine; pyrrolidine; and amino acids such as arginine, lysine, and the like. The term “pharmaceutically acceptable salt” also includes a hydrate of a compound of the present invention.

[0046] The term “substantially free of its corresponding opposite enantiomer” as used herein means that the compound contains no more than about 10% by weight of its corresponding opposite enantiomer. In other embodiments, the compound that is substantially free of its corresponding opposite enantiomer contains no more than about

5%, no more than about 1%, no more than about 0.5%, or no more than about 0.1% by weight of its corresponding opposite enantiomer. An enantiomer that is substantially free of its corresponding opposite enantiomer includes a compound that has been isolated and purified or has been prepared substantially free of its corresponding opposite enantiomer.

[0047] The term "tautomer" as used herein refers to compounds produced by the phenomenon wherein a proton of one atom of a molecule shifts to another atom. *See*, Jerry March, *Advanced Organic Chemistry: Reactions, Mechanisms and Structures*, Fourth Edition, John Wiley & Sons, pages 69-74 (1992).

[0048] The following abbreviations as used herein mean: Ac is acetate; boc is t-butyl carbamate; Bu is butyl; DIEA is diisopropylethylamine; DMF is dimethylformamide; DMSO is dimethylsulfoxide; ESI is electrospray ionization; Et is ethyl; HPLC is high pressure liquid chromatography; HRMS is high resolution mass spectrometry; Me is methyl; MS is mass spectrometry; m/z is mass-to-charge ratio; r.t. is retention time; TFA is trifluoroacetic acid; THF is tetrahydrofuran; Fmoc is 9-fluorenylmethoxycarbonyl; DEA is diethylamine; DME is dimethoxyethane; Bop is benzotriazole-1-yl-oxy-tris-(dimethylamino)-phosphonium hexafluorophosphate; PyBop is benzotriazole-1-yl-oxy-tris-pyrrolidino-phosphonium hexafluorophosphate; HBTU is O-benzotriazole-N,N,N',N'-tetramethyl-uronium-hexafluoro-phosphate; and EDC is 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride.

Compounds and Pharmaceutically Acceptable Salts of Compounds of the Invention

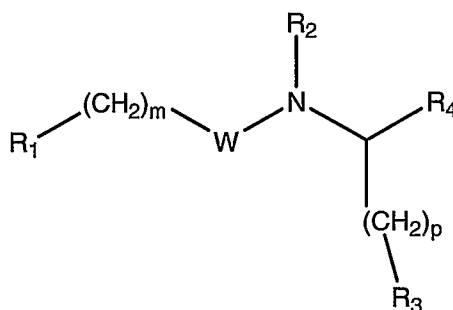
[0049] The compounds or pharmaceutically acceptable salts of compounds of the present invention can contain an asymmetric carbon atom and some of the compounds or pharmaceutically acceptable salts of compounds of the invention can contain one or more asymmetric centers, and can thus give rise to optical isomers and diastereomers. While depicted without respect to stereochemistry in the compounds or pharmaceutically acceptable salts of compounds of the present invention, the present invention includes such optical isomers and diastereomers, as well as racemic and resolved, enantiomerically pure R and S stereoisomers, and also other mixtures of the R and S stereoisomers and pharmaceutically acceptable salts thereof. Where a stereoisomer is provided, it can in some embodiments be provided substantially free of its corresponding opposite enantiomer.

[0050] In addition, the compounds and pharmaceutically acceptable salts of compounds of the present invention can exist as tautomers. Such tautomers can be transient or isolatable as a stable product. These tautomers are within the scope of the present invention.

[0051] Prodrugs of the compounds or pharmaceutically acceptable salts of compounds are also within the scope of the present invention.

Compounds of the Formula (I)

[0052] In one embodiment, the present invention is directed to compounds of the Formula (I):



(I)

and pharmaceutically acceptable salts thereof,
wherein

W is -C(O)-, -OC(O)-, -NHC(O)-, -C(O)O-, or -C(O)NH-;

R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_nR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₃ is -CO₂H, -CONH₂, -CONHOH, -CONHSO₂R₇, tetrazole, -SO₂NHR₇, -SO₃H, -PO(OH)NH₂, -PO(OH)OR₇, -CONHR₇, -COOR₇, an acid mimetic group, or a 5 or 6-membered heterocycloalkyl or heteroaryl containing 1 to 4 heteroatoms selected from O, N, S;

R₄ is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl, -CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₉ and R₁₀ are each independently hydrogen, (C₁-C₆) alkyl, (C₁-C₆) alkyl-OH,

(C₁-C₆) alkyl-O-(C₁-C₆) alkyl, aryl, cycloalkyl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₉ and R₁₀ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl;

m is 0-4;

n is 0-4; and

p is 0-2.

[0053] In one embodiment, W is -CO.

[0054] In another embodiment, R₃ is -CO₂H.

[0055] In one embodiment, R₁ is bicyclic aryl optionally substituted with one or more of R₅ and R₆.

[0056] In another embodiment, R₁ is tricyclic aryl optionally substituted with one or more of R₅ and R₆.

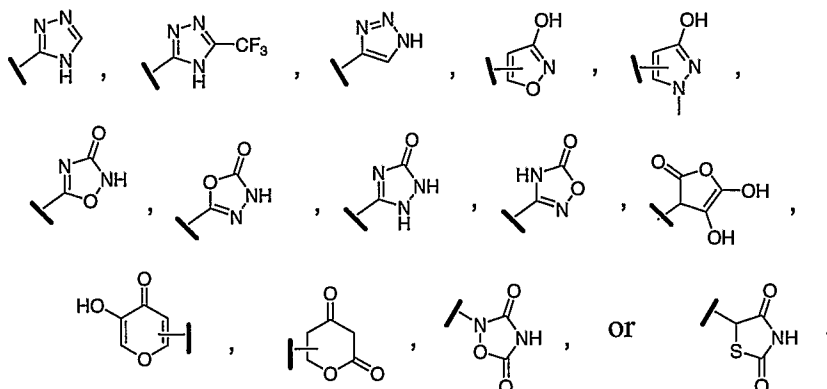
[0057] In one embodiment, R₁ is biphenyl optionally substituted with one or more of R₅ and R₆.

[0058] In one embodiment, m is 0-2. In another embodiment, m is 0.

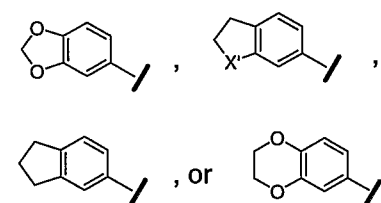
[0059] In one embodiment, p is 0-2. In another embodiment, p is 2.

[0060] In another embodiment, m is 0 and p is 2.

[0061] In another embodiment, R₃ is



[0062] In another embodiment, R₅ is



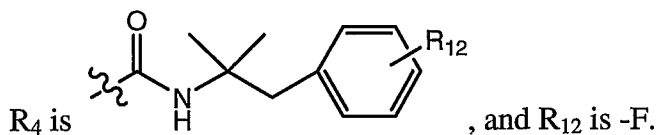
wherein X' is O, S, or NH.

[0063] In one embodiment, R₄ is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀.

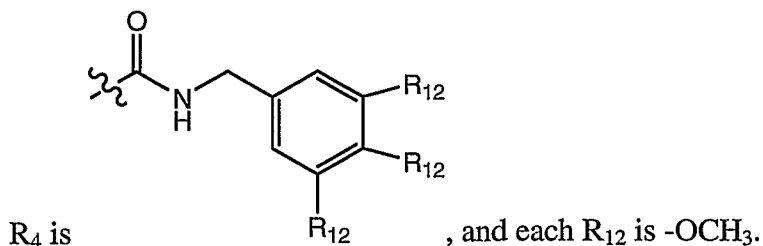
[0064] In one embodiment, W is $-\text{CO}$, R_2 is hydrogen, R_3 is $-\text{CO}_2\text{H}$, R_1 is biphenyl optionally substituted with one or more of R_5 and R_6 , R_4 is $-\text{CONR}_9\text{R}_{10}$, m is 0, and p is 2.

[0065] In another embodiment, when R₄ is other than hydrogen, the compound or pharmaceutically acceptable salt of the compound is the S-enantiomer with respect to the carbon to which R₄ is bound.

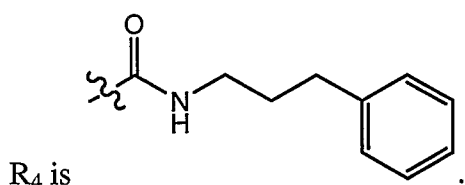
[0066] In one embodiment, R₂ is hydrogen,



[0067] In one embodiment, R₂ is hydrogen,

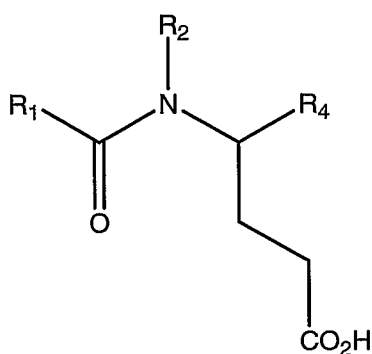


[0068] In another embodiment, R₂ is hydrogen; and



Compounds of the Formula (Ia)

[0069] In one embodiment, the invention is directed to compounds of the Formula (Ia):



(Ia)

and pharmaceutically acceptable salts thereof,

wherein

R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_nR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₄ is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl, -CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆)

cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₉ and R₁₀ are each independently hydrogen, (C₁-C₆) alkyl, (C₁-C₆) alkyl-OH, (C₁-C₆) alkyl-O-(C₁-C₆) alkyl, aryl, cycloalkyl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₉ and R₁₀ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

R_{13} is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; and
n is 0-4.

[0070] In one embodiment, R_1 is bicyclic aryl optionally substituted with one or more of R_5 and R_6 .

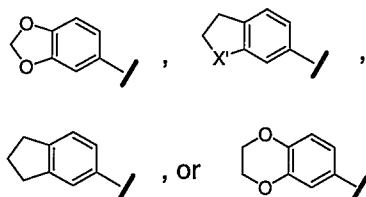
[0071] In another embodiment, R_1 is tricyclic aryl optionally substituted with one or more of R_5 and R_6 .

[0072] In one embodiment, R_1 is biphenyl optionally substituted with one or more of R_5 and R_6 .

[0073] In one embodiment, R_4 is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀.

[0074] In one embodiment, R_1 is biphenyl optionally substituted with one or more of R_5 and R_6 , and R_4 is -CONR₉R₁₀.

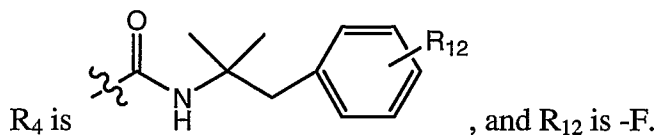
[0075] In another embodiment, R_5 is



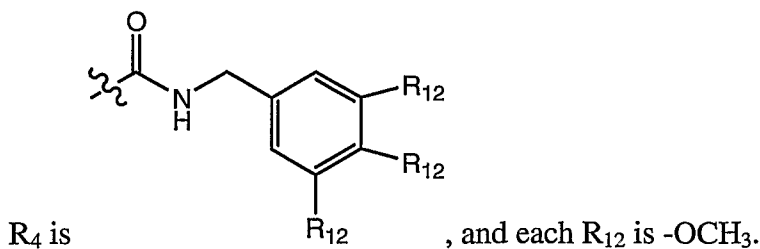
wherein X' is O, S, or NH.

[0076] In another embodiment, when R_4 is other than hydrogen, the compound or pharmaceutically acceptable salt of the compound is the S-enantiomer with respect to the carbon to which R_4 is bound.

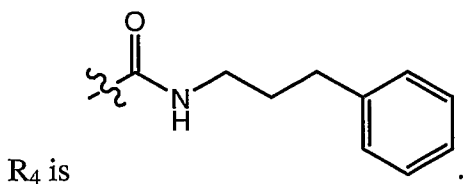
[0077] In one embodiment, R_2 is hydrogen,



[0078] In one embodiment, R_2 is hydrogen,

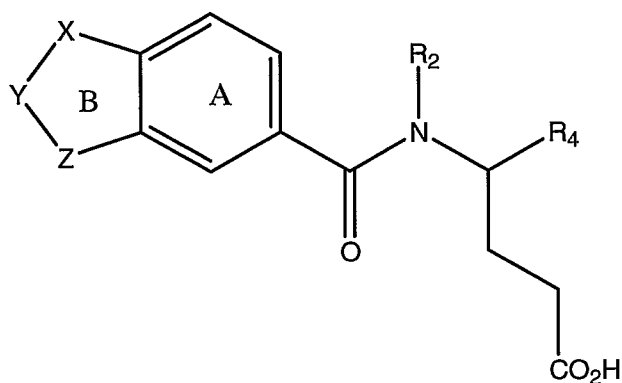


[0079] In another embodiment, R_2 is hydrogen; and



Compounds of the Formula (Ib)

[0080] In one embodiment, the invention is directed to compounds of the Formula (Ib):



(Ib)

and pharmaceutically acceptable salts thereof,

wherein

X, Y, and Z are each independently $(CH_2)_n$, O, S, NR_7 , CO, or SO_2 ; or X, Y, and Z form a benzene in ring B; ring A and ring B are each independently optionally substituted with one or more of R_5 and R_6 ;

R_2 is hydrogen, (C_1-C_6) alkyl, (C_2-C_6) alkenyl, (C_2-C_6) alkynyl, $-(CH_2)_nR_{11}$, -OH, or -O- (C_1-C_6) alkyl;

R_4 is $-CO_2H$, $-CONH_2$, $-(CH_2)_nOR_7$, or $-CONR_9R_{10}$;

R_5 is aryl, heteroaryl, $-(CH_2)_n$ -aryl, $-(CH_2)_n$ -heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO- (C_1-C_6) alkyl, -CO-aryl, -CO-heteroaryl, $-SO_2$ - (C_1-C_6) alkyl, $-SO_2$ -aryl, $-SO_2$ -heteroaryl, $-SO_2NH$ -aryl, $-SO_2NH$ -heteroaryl, $-NHSO_2$ - (C_1-C_6) alkyl, $-NHSO_2$ -aryl, $-NHSO_2$ -heteroaryl, $-NHCO$ -aryl, $-NHCO$ -heteroaryl, -CONH-aryl,

-CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₉ and R₁₀ are each independently hydrogen, (C₁-C₆) alkyl, (C₁-C₆) alkyl-OH, (C₁-C₆) alkyl-O-(C₁-C₆) alkyl, aryl, cycloalkyl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₉ and R₁₀ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R_{11} is aryl, heteroaryl, or cycloalkyl;

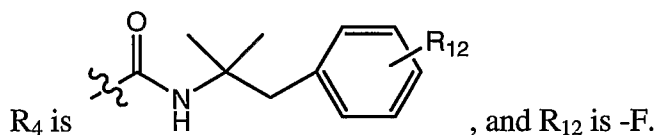
R_{13} is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; and

n is 0-4.

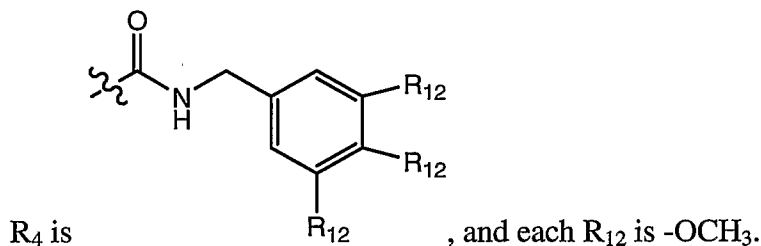
[0081] In one embodiment, R_4 is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀.

[0082] In another embodiment, when R_4 is other than hydrogen, the compound or pharmaceutically acceptable salt of the compound is the S-enantiomer with respect to the carbon to which R_4 is bound.

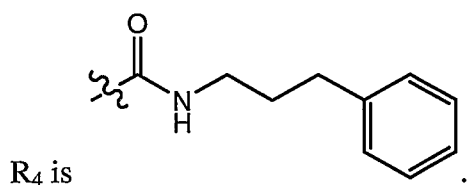
[0083] In one embodiment, R_2 is hydrogen,



[0084] In one embodiment, R_2 is hydrogen;

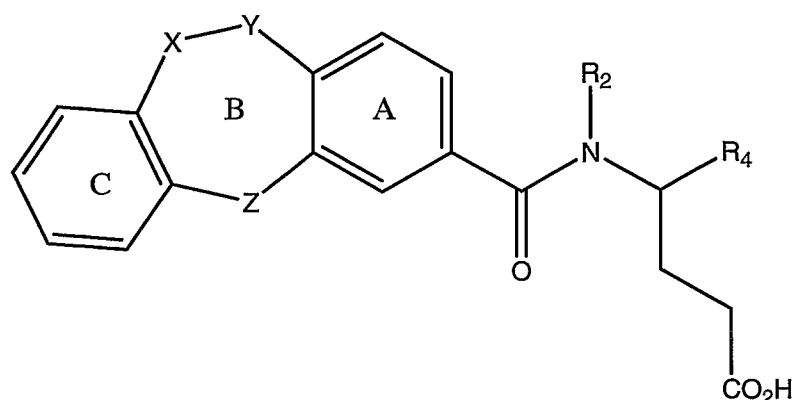


[0085] In another embodiment, R_2 is hydrogen; and



Compounds of the Formula (Ic)

[0086] In one embodiment, the invention is directed to compounds of the Formula (Ic):



(Ic)

and pharmaceutically acceptable salts thereof,

wherein

X, Y, and Z are each independently $(\text{CH}_2)_n$, O, S, NR_7 , CO, or SO_2 ; or X, Y, and Z form a benzene in ring B; ring A, ring B, and ring C are each independently optionally substituted with one or more of R_5 and R_6 ;

R_2 is hydrogen, $(\text{C}_1\text{-C}_6)$ alkyl, $(\text{C}_2\text{-C}_6)$ alkenyl, $(\text{C}_2\text{-C}_6)$ alkynyl, $-(\text{CH}_2)_n\text{R}_{11}$, -OH, or -O- $(\text{C}_1\text{-C}_6)$ alkyl;

R_4 is $-\text{CO}_2\text{H}$, $-\text{CONH}_2$, $-(\text{CH}_2)_n\text{OR}_7$, or $-\text{CONR}_9\text{R}_{10}$;

R_5 is aryl, heteroaryl, $-(\text{CH}_2)_n\text{-aryl}$, $-(\text{CH}_2)_n\text{-heteroaryl}$, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, $-\text{CO}-(\text{C}_1\text{-C}_6)$ alkyl, $-\text{CO-aryl}$, $-\text{CO-heteroaryl}$, $-\text{SO}_2-(\text{C}_1\text{-C}_6)$ alkyl, $-\text{SO}_2\text{-aryl}$, $-\text{SO}_2\text{-heteroaryl}$, $-\text{SO}_2\text{NH-aryl}$, $-\text{SO}_2\text{NH-heteroaryl}$, $-\text{NHSO}_2-(\text{C}_1\text{-C}_6)$ alkyl, $-\text{NHSO}_2\text{-aryl}$, $-\text{NHSO}_2\text{-heteroaryl}$, $-\text{NHCO-aryl}$, $-\text{NHCO-heteroaryl}$, $-\text{CONH-aryl}$, $-\text{CONH-heteroaryl}$, $(\text{C}_1\text{-C}_6)$ alkyl, -O- $(\text{C}_1\text{-C}_6)$ alkyl, -S- $(\text{C}_1\text{-C}_6)$ alkyl, -NH- $(\text{C}_1\text{-C}_6)$ alkyl, $-\text{NHCO}-(\text{C}_1\text{-C}_6)$ alkyl, $-\text{CONH}-(\text{C}_1\text{-C}_6)$ alkyl, -O- $(\text{C}_3\text{-C}_6)$ cycloalkyl, -S- $(\text{C}_3\text{-C}_6)$ cycloalkyl, -NH- $(\text{C}_3\text{-C}_6)$ cycloalkyl, $-\text{NHCO}-(\text{C}_3\text{-C}_6)$ cycloalkyl, or $-\text{CONH}-(\text{C}_3\text{-C}_6)$ cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R_6 , and when R_5 is substituted with more than one R_6 , the substituents can be identical or different;

R_6 and R_{12} are each independently hydrogen, halogen, -CN, $-\text{OCF}_3$, $-\text{CF}_3$, $-\text{NO}_2$, -OH, -SH, $-\text{NR}_7\text{R}_8$, $-\text{CONR}_7\text{R}_8$, $-\text{NR}_8\text{COR}_7$, $-\text{NR}_8\text{CO}_2\text{R}_7$, $-\text{CO}_2\text{R}_7$, $-\text{COR}_7$, $-\text{SO}_2-(\text{C}_1\text{-C}_6)$ alkyl, $-\text{SO}_2\text{-aryl}$, $-\text{SO}_2\text{-heteroaryl}$, $-\text{SO}_2\text{R}_7$, $-\text{NR}_7\text{SO}_2\text{R}_8$,

-SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₉ and R₁₀ are each independently hydrogen, (C₁-C₆) alkyl, (C₁-C₆) alkyl-OH, (C₁-C₆) alkyl-O-(C₁-C₆) alkyl, aryl, cycloalkyl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₉ and R₁₀ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

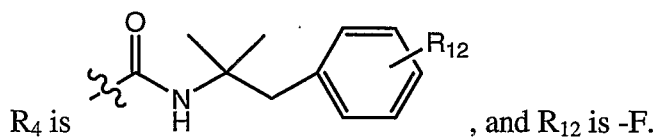
R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; and

n is 0-4.

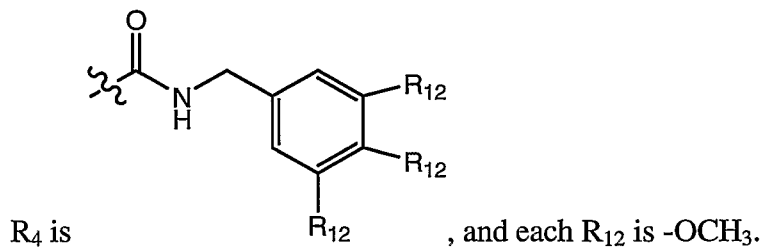
[0087] In one embodiment, R₄ is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀.

[0088] In another embodiment, when R₄ is other than hydrogen, the compound or pharmaceutically acceptable salt of the compound is the S-enantiomer with respect to the carbon to which R₄ is bound.

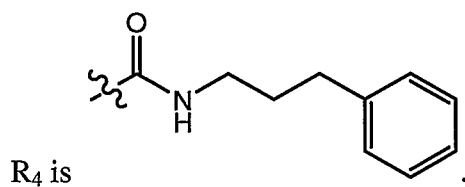
[0089] In one embodiment, R_2 is hydrogen,



[0090] In one embodiment, R_2 is hydrogen;

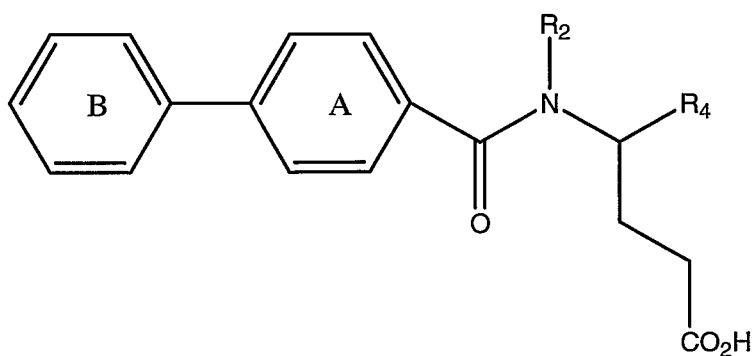


[0091] In another embodiment, R_2 is hydrogen; and



Compounds of the Formula (Id)

[0092] In one embodiment, the invention is directed to compounds of the Formula (Id):



(Id)

and pharmaceutically acceptable salts thereof,

wherein

ring A and ring B are each independently optionally substituted with one or more of R_5 and R_6 ;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_nR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₄ is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl, -CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached

may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R_9 and R_{10} are each independently hydrogen, (C_1-C_6) alkyl, (C_1-C_6) alkyl-OH, (C_1-C_6) alkyl-O- (C_1-C_6) alkyl, aryl, cycloalkyl, heteroaryl, (C_2-C_6) alkenyl, (C_2-C_6) alkynyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more R_{12} ; or R_9 and R_{10} together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R_{11} is aryl, heteroaryl, or cycloalkyl;

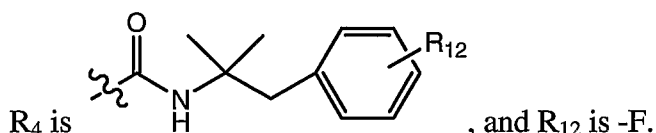
R_{13} is halogen, -O- (C_1-C_6) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C_1-C_6) alkyl, aryl, heteroaryl, (C_2-C_6) alkenyl, (C_2-C_6) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O- (C_1-C_6) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; and

n is 0-4.

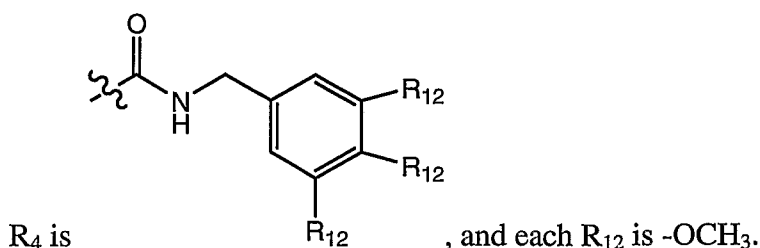
[0093] In one embodiment, R_4 is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀.

[0094] In another embodiment, when R_4 is other than hydrogen, the compound or pharmaceutically acceptable salt of the compound is the S-enantiomer with respect to the carbon to which R_4 is bound.

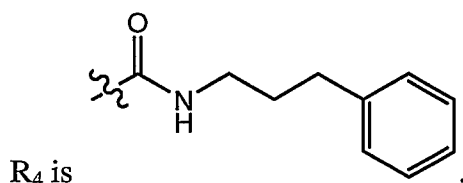
[0095] In one embodiment, R_2 is hydrogen,



[0096] In one embodiment, R_2 is hydrogen;

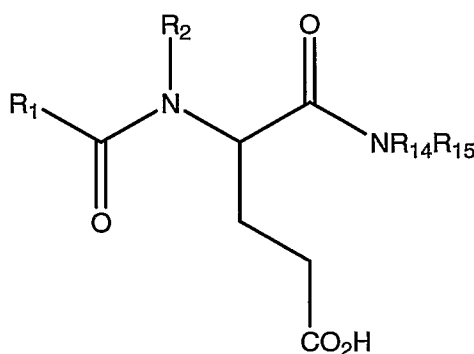


[0097] In another embodiment, R_2 is hydrogen; and



Compounds of the Formula (II)

[0098] In another embodiment, the invention provides compounds of the Formula (II):



(II)

and pharmaceutically acceptable salts thereof,
wherein

R₁ is phenyl, (C₁-C₆) alkyl substituted with phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_pR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl,

-NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl, -CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl;

R₁₄ and R₁₅ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl,

(C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, heterocycloalkyl -(CH₂)_n-aryl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₁₄ and R₁₅ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

n is 0-4, and

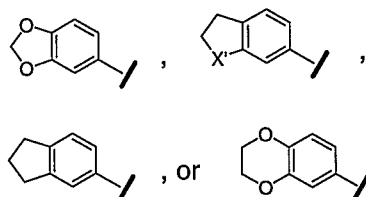
p is 0-2.

[0099] In one embodiment, R₁ is bicyclic aryl optionally substituted with one or more of R₅ and R₆.

[0100] In another embodiment, R₁ is tricyclic aryl optionally substituted with one or more of R₅ and R₆.

[0101] In one embodiment, R₁ is biphenyl optionally substituted with one or more of R₅ and R₆.

[0102] In another embodiment, R₅ is



wherein X' is O, S, or NH.

[0103] In another embodiment, R₂ is hydrogen.

[0104] In one embodiment, the compound of Formula (I) is *N*²-(4-benzoylbenzoyl)-*N*¹-benzyl-L-α-glutamine, *N*-(4-benzoylbenzoyl)-L-glutamic acid, *N*¹-(1,3-benzodioxol-5-ylmethyl)-*N*²-(1,1'-biphenyl-4-ylcarbonyl)-L-α-glutamine, *N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-butyl-L-α-glutamine, *N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclopropyl-L-α-glutamine, *N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclohexyl-L-α-glutamine, *N*¹-benzyl-*N*²-(4-thien-2-ylbenzoyl)-L-α-glutamine, *N*¹-benzyl-*N*²-[4-(2-furyl)benzoyl]-L-α-glutamine, *N*¹-benzyl-*N*²-[(4'-ethynyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine, *N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(4-fluorobenzyl)-L-α-glutamine, *N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclooctyl-L-α-glutamine, *N*¹-benzyl-*N*²-(4-bromobenzoyl)-L-α-glutamine, *N*¹-benzyl-*N*²-[(2',5'-dimethyl-1,1'-biphenyl-4-

yl)carbonyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethoxybenzyl)-L- α -glutamine, N^1 -benzyl- N^2 -(4-pyridin-4-ylbenzoyl)-L- α -glutamine, N^1 -benzyl- N^2 -[(3',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(4'-ethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(3'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(2'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(2',6'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclopentyl-L- α -glutamine, N^1 -[2-(acetylamino)ethyl]- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine, N^1 -2-adamantyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine, N^1 -(2-adamantylmethyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -(4-pyridin-2-ylbenzoyl)-L- α -glutamine, N^1 -benzyl- N^2 -(4-pyridin-3-ylbenzoyl)-L- α -glutamine, N^1 -benzyl- N^2 -[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3,4-dimethoxyphenyl)ethyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxyethyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-methoxyphenyl)ethyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(1-naphthylmethyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methylbenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-furylmethyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dichlorobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(trifluoromethoxy)benzyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethoxy)benzyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(methylthio)benzyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-methoxyphenyl)ethyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dimethoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dichlorobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-difluorobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy- N^1 -[3-(trifluoromethoxy)benzyl]-L-glutamamide, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy-

N^1 -[2-(3-methoxyphenyl)ethyl]-L-glutamamide, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy- N^1 -(3,4,5-trimethoxybenzyl)-L-glutamamide, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-dimethoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-dimethoxybenzyl)- N^5 -hydroxy-L-glutamamide, N^1 -benzyl- N^2 -[(4'-vinyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)-L- α -glutamine, N^1 -benzyl- N^2 -[(4'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(4'-propoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(4'-butoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -{[4'-(cyclobutylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine, N^1 -benzyl- N^2 -{[4'-(cyclohexylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine, N^2 -{[4'-(allyloxy)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)- N^5 -hydroxy-L-glutamamide, N^2 -(1,1'-biphenyl-4-ylacetyl)- N^1 -(3-methoxybenzyl)-L- α -glutamine, N^2 -[(3-fluorophenyl)acetyl]- N^1 -(3-methoxybenzyl)-L- α -glutamine, N^2 -{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine, N^1 -benzyl- N^2 -{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine, N^1 -benzyl- N^2 -{[4'-[(4-fluorobenzoyl)amino]-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine, N^2 -{[4'-(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine, N^1 -benzyl- N^2 -(5-phenyl-2-furoyl)-L- α -glutamine, N^1 -benzyl- N^2 -[5-(3-ethoxyphenyl)-2-furoyl]-L- α -glutamine, N^1 -benzyl- N^2 -[5-(3,5-dimethylphenyl)-2-furoyl]-L- α -glutamine, N^1 -benzyl- N^2 -(2,2'-bifuran-5-ylcarbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -(5-thien-2-yl-2-furoyl)-L- α -glutamine, N^2 -[(2,2'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]- N^1 -(3-methoxybenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-phenylethyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethyl)benzyl]-L- α -glutamine, N^1 -(4-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine, N^1 -(3-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(trifluoromethyl)benzyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(2-fluoro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-fluorobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamine, N^1 -benzyl- N^2 -(1,1'-biphenyl-3-ylcarbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -(3-thien-2-ylbenzoyl)-L- α -glutamine, N^1 -benzyl- N^2 -[(3-chloro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,

N^1 -benzyl- N^2 -[(3-fluoro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(2,6-dimethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-chlorophenyl)ethyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-fluorobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-difluorobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methylbenzyl)-L- α -glutamine, N^1 -benzyl- N^2 -({4'-[(3-methoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -({4'-[(3,5-dimethoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -{[4'-(2-naphthylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -2,3-dihydro-1*H*-inden-2-yl-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,3-dimethylbenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenylbutyl)-L- α -glutamine, N^1 -(2-benzylphenyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methoxy-1,1'-biphenyl-3-yl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methylbenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-fluoro-3-(trifluoromethyl)benzyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -heptyl-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-vinylbenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-thien-2-ylbenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^1 -benzyl- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine, N^1 -(3-methoxybenzyl)- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-*tert*-butylbenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-iodobenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-vinylbenzyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(*sec*-butyl)-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(cyclopropylmethyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[4-(dimethylamino)benzyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-bromophenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-biphenyl-4-ylethyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2'-ethoxybiphenyl-4-yl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-ethynylbiphenyl-4-yl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4-(2-thienyl)phenyl]ethyl}-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-2-ylphenyl)ethyl]-L- α -

glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[3-(dimethylamino)benzyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-diphenylpropyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-dimethylbutyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -isopropyl-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(pyridin-4-ylmethyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 , N^1 -diethyl-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethylpropyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-4-yl]ethyl}-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-3-yl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-3-yl]ethyl}-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-3-yl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-4-yl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-bromophenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -pentyl-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-4-ylphenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(*tert*-butyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{4'-(trifluoromethyl)biphenyl-3-yl]methyl}-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2,2-dimethylpropyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[4'-ethynylbiphenyl-3-yl]methyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-pyridin-2-ylbenzyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -hexyl-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1-methyl-1-phenylethyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1,3,3-tetramethylbutyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-morpholin-4-ylethyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-hydroxy-1,1-dimethylethyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-fluorophenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-thienyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-chlorophenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(5-hydroxypentyl)-L- α -glutamine, 3-

[(biphenyl-4-ylmethyl)amino]-3-oxopropanoic acid, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -propyl-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-pyridin-2-ylphenyl)ethyl]-L- α -glutamine, N^2 -2-naphthoyl- N^1 -(3-phenylpropyl)-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamine, N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamine, N^2 -(4-phenoxybenzoyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -hexyl-L- α -glutamine, N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -hexyl-L- α -glutamine, N^1 -hexyl- N^2 -(4-phenoxybenzoyl)-L- α -glutamine, N^1 -hexyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine, N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]- N^1 -(3-phenylpropyl)-L- α -glutamine, N^2 -(4-phenoxybenzoyl)- N^1 -(3-phenylpropyl)-L- α -glutamine, N -[4-(pyrimidin-2-ylamino)benzoyl]-L-glutamic acid, N -(1,1'-biphenyl-4-ylcarbonyl)-D-glutamic acid, N -[4-(pyrimidin-2-ylamino)benzoyl]-L- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)-D- α -glutamine, N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-hydroxybutyl)-L- α -glutamine, N^1 -benzyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -[4-(pyrimidin-2-ylamino)benzoyl]-L- α -glutamine, (4S)-4-[(1,1'-biphenyl-4-ylcarbonyl)amino]-5-hydroxypentanoic acid, N -({4'-[(phenylacetyl)amino]-1,1'-biphenyl-4-yl}carbonyl)-L-glutamic acid, N -[4'-{[(3-methyl-1-benzofuran-2-yl)carbonyl]amino}-1,1'-biphenyl-4-yl]carbonyl]-L-glutamic acid, N -{4'-[(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid, N -{4'-[(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid, N -{4'-[(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid, N -({4'-[(1-benzofuran-2-ylcarbonyl)amino]-1,1'-biphenyl-4-yl}carbonyl)-L-glutamic acid, N^1 -(1,1-dimethyl-2-phenylethyl)- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine, N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine, N^1 -(6-hydroxyhexyl)- N^2 -(4-phenoxybenzoyl)-L- α -glutamine, N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine, N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -(3-phenoxybenzoyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -(9H-fluoren-4-

ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^1 -1-adamantyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine, N^1 -1-adamantyl- N^2 -(4-phenoxybenzoyl)-L- α -glutamine, N^1 -1-adamantyl- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine, N^1 -1-adamantyl- N^2 -(9H-fluoren-9-ylcarbonyl)-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -(3-methylbenzyl)-L- α -glutamine, N^1 -(3-methylbenzyl)- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine, N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(3-methylbenzyl)-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -propyl-L- α -glutamine, N^1 -benzyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine, N^1 -benzyl- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -(9H-fluoren-9-ylcarbonyl)-L- α -glutamine, N^1 -benzyl- N^2 -(3-phenoxybenzoyl)-L- α -glutamine, N^1 -(1-methyl-1-phenylethyl)- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine, N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(1-methyl-1-phenylethyl)-L- α -glutamine, N^1 -(1-methyl-1-phenylethyl)- N^2 -(3-phenoxybenzoyl)-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1S)-1-phenylethyl]-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -[(1S)-1-phenylethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1S)-1-(4-fluorophenyl)ethyl]-L- α -glutamine, tert-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1-phenylethyl)-L- α -glutamate, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1R)-1-(4-fluorophenyl)ethyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1R)-1-phenylethyl]-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -[(1R)-1-phenylethyl]-L- α -glutamine, N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine, N^1 -(6-hydroxyhexyl)- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)- N^1 -9H-fluoren-9-yl-L- α -glutamine, N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[(3'-ethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -[(2'-ethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -[(4'-methoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -(4-bromobenzoyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -[(3'-methoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, 4'-{[(1S)-3-carboxy-1-{[(3,4,5-trimethoxybenzyl)amino]carbonyl}propyl)amino]carbonyl}biphenyl-3-carboxylic acid, N^2 -[(4'-ethylbiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, N-benzyl- N^2 -[4-(2-naphthyl)benzoyl]-L- α -glutamine, N^2 -[(3',4'-dimethoxybiphenyl-4-

yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*²-[(2',4'-dimethoxybiphenyl-4-yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*-(3,4,5-trimethoxybenzyl)-*N*²-[(3',4',5'-trimethoxybiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-(biphenyl-4-ylcarbonyl)-*L*- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(3'-methoxybiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*²-[(3',4'-dimethoxybiphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(2'-ethoxybiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*²-(4-bromobenzoyl)-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine, *N*-[(1*S*)-1-benzyl-2-hydroxyethyl]-*N*²-(biphenyl-4-ylcarbonyl)-*L*- α -glutamine, *N*-[(1*S*)-1-benzyl-2-hydroxyethyl]-*N*²-(9H-fluoren-2-ylcarbonyl)-*L*- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-(4-bromobenzoyl)-*L*- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*²-[4-(1,3-benzodioxol-5-yl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine, *N*²-[(2',4'-dimethoxybiphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine, *N*²-[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-({4'-[(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*L*- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*L*- α -glutamine, *N*²-(biphenyl-4-ylcarbonyl)-*N*-methyl-*N*-(2-phenylethyl)-*L*- α -glutamine, *N*²-[(4'-sec-butylbiphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(4'-isopropylbiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-(1,1':4',1''-terphenyl-4-ylcarbonyl)-*L*- α -glutamine, *N*²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine, *N*²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-({3'-[(dimethylamino)carbonyl]biphenyl-4-yl}carbonyl)-*L*- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-[(3',5'-dimethylbiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*²-(9H-fluoren-2-ylcarbonyl)-*N*-methyl-*N*-(2-phenylethyl)-*L*- α -glutamine, *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(3'-methylbiphenyl-4-yl)carbonyl]-*L*- α -glutamine, *N*²-({4'-[(3,5-dimethylbenzyl)oxy]biphenyl-4-yl}carbonyl)-

N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*²-[(4'-{[3,5-bis(trifluoromethyl)benzyl]oxy}biphenyl-4-yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*²-[(3'-isopropylbiphenyl-4-yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*²-[(4'-isopropylbiphenyl-4-yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-[4-(1-benzofuran-5-yl)benzoyl]-L- α -glutamine, *N*-(1-adamantylmethyl)-*N*²-[4-(1H-indol-5-yl)benzoyl]-L- α -glutamine, *N*²-[(3'-ethoxybiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(3'-methoxybiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(3'-isopropylbiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*²-[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(4'-isobutylbiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*²-(1,1':4',1''-terphenyl-4-ylcarbonyl)-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*-benzyl-*N*²-{[3'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-L- α -glutamine, *N*-benzyl-*N*²-{[4'-(3-fluorobenzyl)oxy]biphenyl-4-yl}carbonyl}-L- α -glutamine, *N*-benzyl-*N*²-{[4'-(benzyloxy)biphenyl-4-yl]carbonyl}-L- α -glutamine, *N*-benzyl-*N*²-[4-(phenylethynyl)benzoyl]-L- α -glutamine, *N*-benzyl-*N*²-{4-[(9-hydroxy-9H-fluoren-9-yl)ethynyl]benzoyl}-L- α -glutamine, *N*-benzyl-*N*²-{4-[(1E)-3-oxo-3-phenylprop-1-en-1-yl]benzoyl}-L- α -glutamine, *N*-(3,4,5-trimethoxybenzyl)-*N*²-[(2',4',6'-trimethylbiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-{[4'-(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl}-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(3'-ethoxybiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*²-{[4'-(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl}-*N*-(6-hydroxyhexyl)-L- α -glutamine, *N*²-{[4'-(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl}-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*²-(4-bromobenzoyl)-*N*-(3-methylbenzyl)-L- α -glutamine, *N*²-[4-(1,3-benzodioxol-5-yl)benzoyl]-*N*-(3-methylbenzyl)-L- α -glutamine, *N*²-(biphenyl-4-ylcarbonyl)-*N*-butyl-*N*-methyl-L- α -glutamine, *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-butyl-*N*²-(9H-fluoren-2-ylcarbonyl)-*N*-methyl-L- α -glutamine, *N*²-(biphenyl-4-ylcarbonyl)-*N*-[2-(3,4-dimethoxyphenyl)ethyl]-*N*-methyl-L- α -glutamine, *N*²-[4-(1,3-benzodioxol-5-yl)benzoyl]-

N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, *N*-[2-(3,4-dimethoxyphenyl)ethyl]-*N*²-(9H-fluoren-2-ylcarbonyl)-*N*-methyl-L- α -glutamine, *N*²-(9H-fluoren-2-ylcarbonyl)-*N*-[(2*R*)-2-phenylpropyl]-L- α -glutamine, *N*²-(biphenyl-4-ylcarbonyl)-*N*-[(2*R*)-2-phenylpropyl]-L- α -glutamine, *N*-benzyl-*N*²-{4-[(4-hydroxycyclohexyl)ethynyl]benzoyl}-L- α -glutamine, *N*²-{4-[(3-aminophenyl)ethynyl]benzoyl}-*N*-benzyl-L- α -glutamine, *N*-benzyl-*N*²-[4-(3-hydroxy-3,3-diphenylprop-1-yn-1-yl)benzoyl]-L- α -glutamine, *N*-benzyl-*N*²-{4-[(3-methoxyphenyl)ethynyl]benzoyl}-L- α -glutamine, *N*²-[(3'-hydroxybiphenyl-4-yl)carbonyl]-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-{4'-[(hydroxymethyl)biphenyl-4-yl]carbonyl}-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(4'-methylbiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*²-(biphenyl-4-ylcarbonyl)-*N*¹-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L-glutamamide, *N*²-{4'-[(3-tert-butylphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, *N*²-{4'-[(3,5-di-tert-butylphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-{4'-[(3-ethylphenoxy)methyl]biphenyl-4-yl}carbonyl)-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-{4'-[(3-methoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)-L- α -glutamine, *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(3'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*²-(biphenyl-4-ylcarbonyl)-*N*¹-[2-(4-fluorophenyl)-1,2-dimethylethyl]-*N*⁵-hydroxy-L-glutamanide, *N*²-[4-(5-bromo-2-thienyl)benzoyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, *N*-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-*N*²-[(3'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*²-[(3',4'-difluorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(3',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(2',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(2',5'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(2',6'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(3',5'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(2',3'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-(4-

pyrimidin-5-ylbenzoyl)-L- α -glutamine, N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N^2 -[(3',5'-difluorobiphenyl-4-yl)carbonyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]- N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, N^2 -(biphenyl-4-ylcarbonyl)-N-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -{[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl}-N-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -{[4'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, N^2 -{[4'-(bromomethyl)biphenyl-4-yl]carbonyl}-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[4-(2-thienyl)benzoyl]-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[4-(2-furyl)benzoyl]-L- α -glutamine, N^2 -{[4'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-N-(3-methylbenzyl)-L- α -glutamine, N^2 -{[3'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-N-(3-methylbenzyl)-L- α -glutamine, N^2 -[4-(2,3-dihydro-1-benzofuran-5-yl)benzoyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[(3'-chloro-4'-fluorobiphenyl-4-yl)carbonyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -{[3'-(bromomethyl)biphenyl-4-yl]carbonyl}-N-(3-methylbenzyl)-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[4-(3-thienyl)benzoyl]-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[4-(5-methyl-2-thienyl)benzoyl]-L- α -glutamine, N^2 -[4-(5-chloro-2-thienyl)benzoyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[4-(2-thienyl)benzoyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -{[5-(3-methoxyphenyl)-2-thienyl]carbonyl}-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine, N^2 -(2,2'-bithien-5-ylcarbonyl)-N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -{[6-(3-methoxyphenyl)pyridin-3-yl]carbonyl}-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine, N^2 -[(3-fluorobiphenyl-4-yl)carbonyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(5-pyridin-4-yl-2-thienyl)carbonyl]-L- α -glutamine, N^2 -{[5-(3-chloro-

4-fluorophenyl)-2-thienyl]carbonyl}-N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine, N²-[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N²-{[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl}-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-[4-(2-thienyl)benzoyl]-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-{[5-(3-methoxyphenyl)-2-thienyl]carbonyl}-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine, N²-(2,2'-bithien-5-ylcarbonyl)-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-[(5-pyridin-4-yl-2-thienyl)carbonyl]-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-[4-(5-chloro-2-thienyl)benzoyl]-L- α -glutamine, N²-{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-(5-phenyl-2-furoyl)-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-{[5-(3-methoxyphenyl)-2-thienyl]carbonyl}-L- α -glutamine, N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine, N²-{[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl}-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N²-(2,2'-bithien-5-ylcarbonyl)-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-[4-(5-formyl-2-thienyl)benzoyl]-L- α -glutamine, N²-[4-(5-acetyl-2-thienyl)benzoyl]-N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-N²-[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-(5-phenyl-2-furoyl)-L- α -glutamine, N-(1,1-dimethyl-2-phenylethyl)-N²-[4-(5-formyl-2-thienyl)benzoyl]-L- α -glutamine, N²-[4-(5-acetyl-2-thienyl)benzoyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-

N^2 -[3-(5-chloro-2-thienyl)benzoyl]-L- α -glutamine, N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[3-(2-thienyl)benzoyl]-L- α -glutamine,
 N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -{[5-(4-chlorophenyl)-2-thienyl]carbonyl}-L- α -glutamine, N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -{[5-(4-fluorophenyl)-2-thienyl]carbonyl}-L- α -glutamine, N^2 -[4-(5-bromo-2-thienyl)benzoyl]- N -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[4-(5-bromo-2-thienyl)benzoyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N -(1,1-dimethyl-2-phenylethyl)- N^2 -{[5-(4-fluorophenyl)-2-thienyl]carbonyl}-L- α -glutamine, N^2 -[3-(5-chloro-2-thienyl)benzoyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N -(1,1-dimethyl-2-phenylethyl)- N^2 -[3-(2-thienyl)benzoyl]-L- α -glutamine, N^2 -[(3'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[(4'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[(4'-fluorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[(3'-fluorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(3-phenyl-2-thienyl)carbonyl]-L- α -glutamine, N^2 -[(4'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[(3'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -{[5-(4-fluorophenyl)-2-thienyl]carbonyl}-L- α -glutamine, N^2 -{[5-(4-chlorophenyl)-2-thienyl]carbonyl}- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(3-phenyl-2-thienyl)carbonyl]-L- α -glutamine, N^2 -(4-bromobenzoyl)- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(4'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(3'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine, N^2 -[4-(5-chloro-2-thienyl)benzoyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamine, N^2 -{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -{[5-(4-chlorophenyl)-2-thienyl]carbonyl}- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -{[5-(3,4-difluorophenyl)-2-thienyl]carbonyl}- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine, N^2 -[(4'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine, N^2 -[(4'-[(1,3-benzodioxol-5-yloxy)methyl]biphenyl-4-

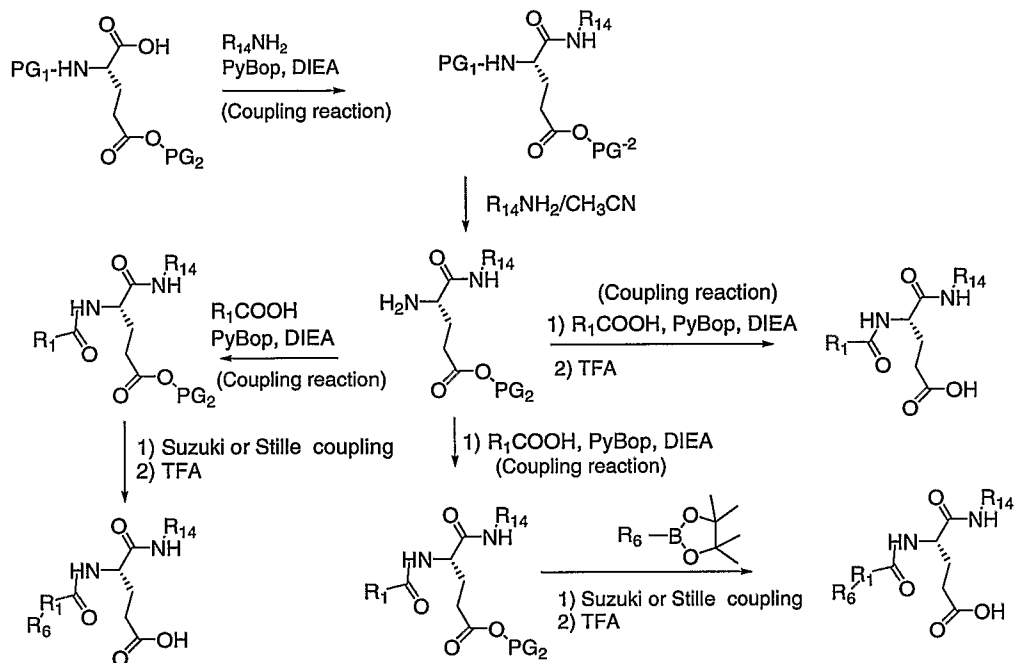
yl}carbonyl)-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine, *N*²-{[3'-(benzyloxy)biphenyl-4-yl]carbonyl}-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*²-({3'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*²-({3'-[(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-(3,4,5-trimethoxybenzyl)-*L*- α -glutamine, *N*²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*L*- α -glutamine, *N*-benzyl-*N*²-{[4'-(biphenyl-3-ylmethoxy)biphenyl-4-yl]carbonyl}-*L*- α -glutamine, *N*-benzyl-*N*²-({4'-[(3'-methoxybiphenyl-3-yl)methoxy]biphenyl-4-yl}carbonyl)-*L*- α -glutamine, *N*²-({4'-[(3,5-dimethoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(3-methylbenzyl)-*L*- α -glutamine, *N*²-({3'-[(3,5-dimethoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(3-methylbenzyl)-*L*- α -glutamine, *N*²-({3'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl}carbonyl)-*N*-(3-methylbenzyl)-*L*- α -glutamine, *N*²-({3'-[(3-ethylphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(3-methylbenzyl)-*L*- α -glutamine, *N*-benzyl-*N*²-{[4'-(biphenyl-2-ylmethoxy)biphenyl-4-yl]carbonyl}-*L*- α -glutamine, or *N*-benzyl-*N*²-({4'-[(3'-methoxybiphenyl-2-yl)methoxy]biphenyl-4-yl}carbonyl)-*L*- α -glutamine.

Methods for Making the Compounds and Pharmaceutically Acceptable Salts of Compounds of the Invention

[0105] The compounds and pharmaceutically acceptable salts of compounds of the present invention can be prepared using a variety of methods starting from commercially available compounds, known compounds, or compounds prepared by known methods. General synthetic routes to many of the compounds of the invention are included in the following schemes. It is understood by those skilled in the art that protection and deprotection steps not shown in the Schemes may be required for these syntheses, and that the order of steps may be changed to accommodate functionality in the target molecule.

[0106] As used in the schemes, PG₁ is an amine protecting group; PG₂ is a carboxylic acid protecting group; and R₁, R₂, R₆, R₁₂, R₁₃, R₁₄, and R₁₅ are defined as above.

General synthetic schemes for preparation of compounds



[0107] The amide formation between a carboxylic acid and an amine is carried out using a coupling reagent in a solvent such as DMF. Coupling reagents that may be used include benzotriazole-1-yl-oxy-tris-(dimethylamino)-phosphonium hexafluorophosphate (Bop reagent), benzotriazole-1-yl-oxy-tris-pyrrolidino-phosphonium hexafluorophosphate (PyBop reagent), O-benzotriazole-N,N,N',N'-tetramethyl-uronium-hexafluoro-phosphate (HBTU), 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide hydrochloride (EDC), and other known or commercially available coupling reagents.

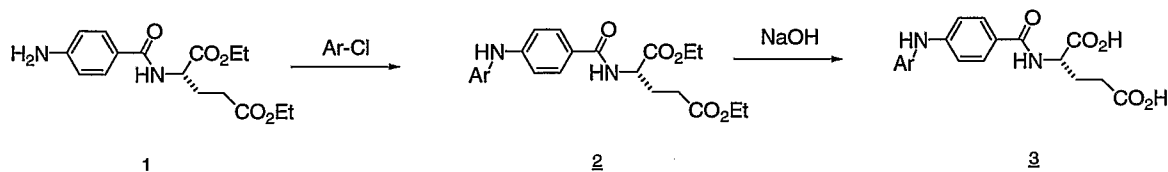
[0108] Cross coupling is generally referred to as Suzuki or Stille coupling reactions.

[0109] The amine protecting group is cleaved under mild conditions with an amine base to afford the free amine. A variety of amine bases may be used, including for example, diethylamine, piperidine, morpholine, dicyclohexylamine, p-dimethylaminopyridine, or diisopropylethylamine in a solvent, such as acetonitrile or DMF.

[0110] Hydrolysis of the carboxylic acid protecting group is carried out using TFA, NaOH, LiOH, potassium carbonate, or the like.

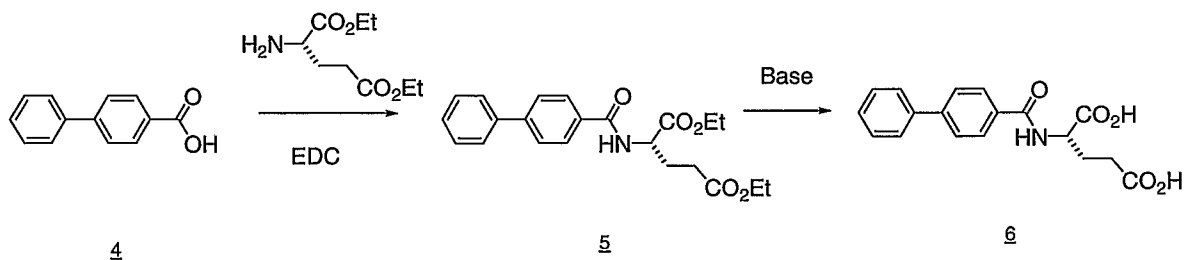
[0111] Scheme 1 demonstrates the preparation of compounds of the invention in two steps from N-(4-aminobenzoyl)-L-glutamic diethyl ester (**1**). Heating an aryl or heteroaryl chloride such as chloropyridine with N-(4-aminobenzoyl)-L-glutamic diethyl ester gave the diethyl ester (**2**), which was hydrolyzed with bases such as NaOH, LiOH, or the like to provide (**3**).

Scheme 1



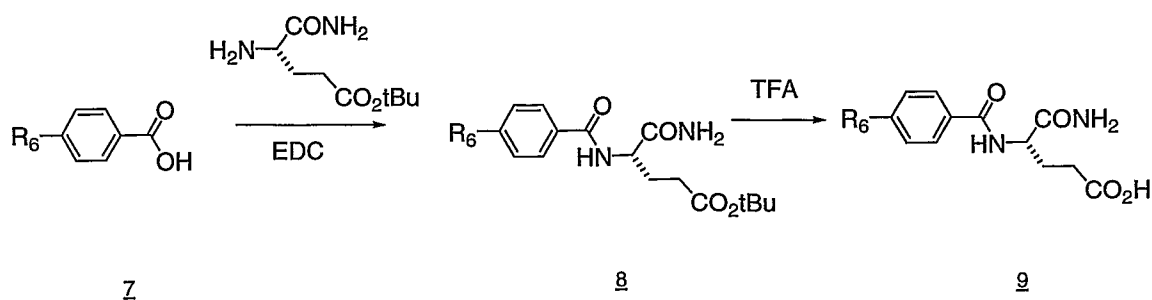
[0112] Scheme 2 provides the preparation of a compound of the invention in two steps from biphenylcarboxylic acid (**4**). Amide formation was carried out using a coupling reagent, such as EDC. Hydrolysis of the diethyl ester (**5**) under basic conditions gave the final product dicarboxylic acid (**6**).

Scheme 2



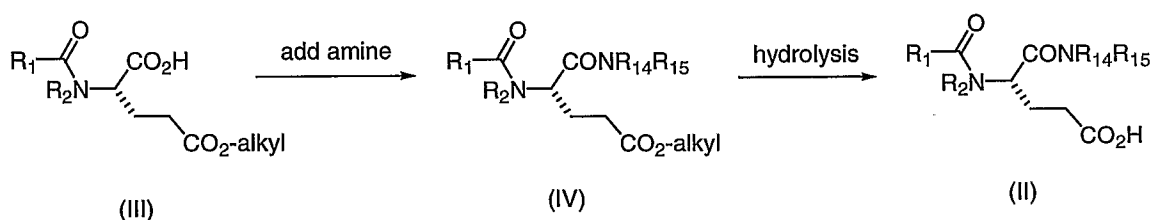
[0113] Scheme 3 provides the preparation of compounds of the invention in two steps. Coupling of the amine and carboxylic acid (**7**) was carried out using a coupling reagent such as EDC. The tert-butyl protecting group on (**8**) was hydrolyzed in acidic conditions (TFA in dichloromethane) to provide the product (**9**).

Scheme 3



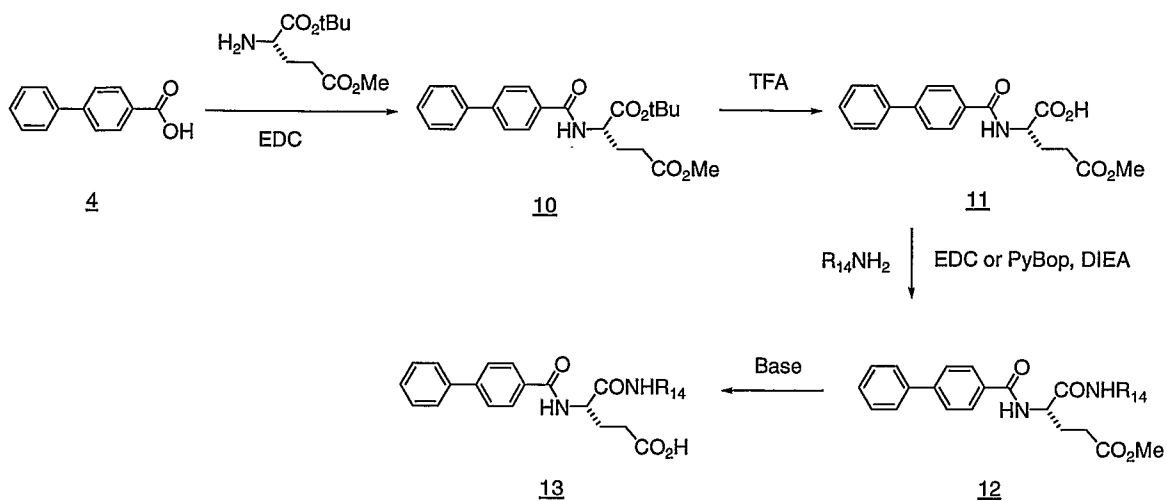
[0114] Scheme 4 demonstrates the synthesis of a compound or pharmaceutically acceptable salt of a compound of the Formula (II). As shown in Scheme 4, a compound of the Formula (III) is treated with an amine under conditions effective to provide a compound of the Formula (IV). Hydrolysis of the alkyl ester provides a compound of the Formula (II).

Scheme 4



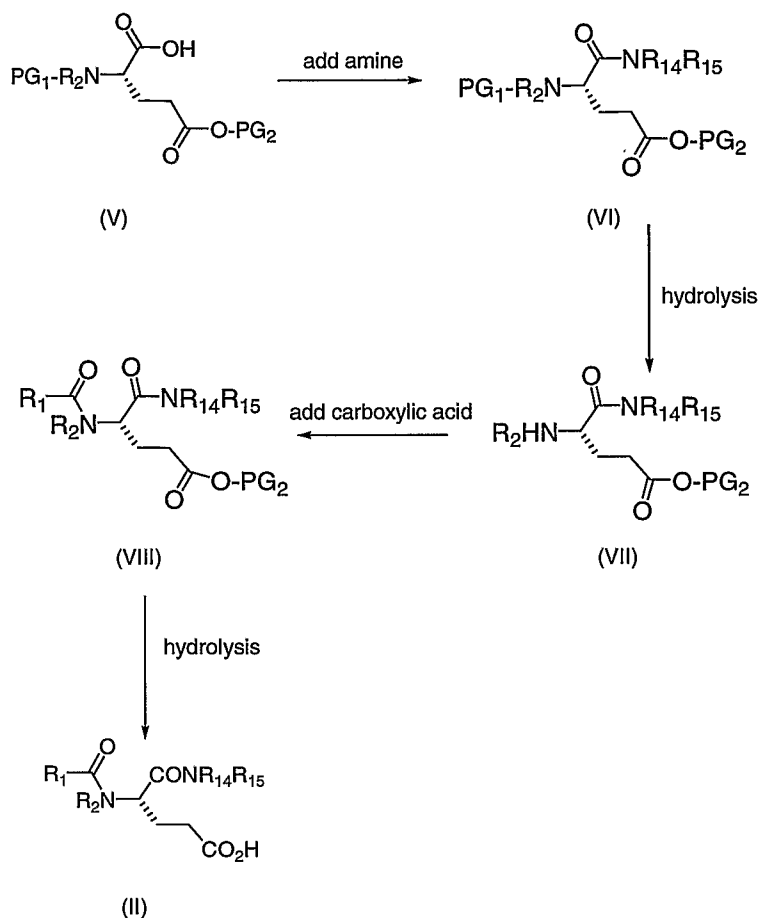
[0115] Scheme 5 provides the synthesis of compounds of the Formula (II) following the general procedures set forth in Scheme 4. Coupling of commercially available amines, amines known in the literature, or other amines with biphenylcarboxylic acid (**4**, or fluorencarboxylic acids or other carboxylic acids) can be carried out in EDC, PyBop/DIEA, or other coupling reagents as described above in the general scheme. Hydrolysis of the tert-butyl ester (**10**) was carried out using TFA. The second coupling reaction of the carboxylic acid (**11**) with a variety of amines was carried out using a similar procedure as employed in the first step. Finally, the methyl ester (**12**) was hydrolyzed with NaOH/MeOH in THF to provide (**13**).

Scheme 5



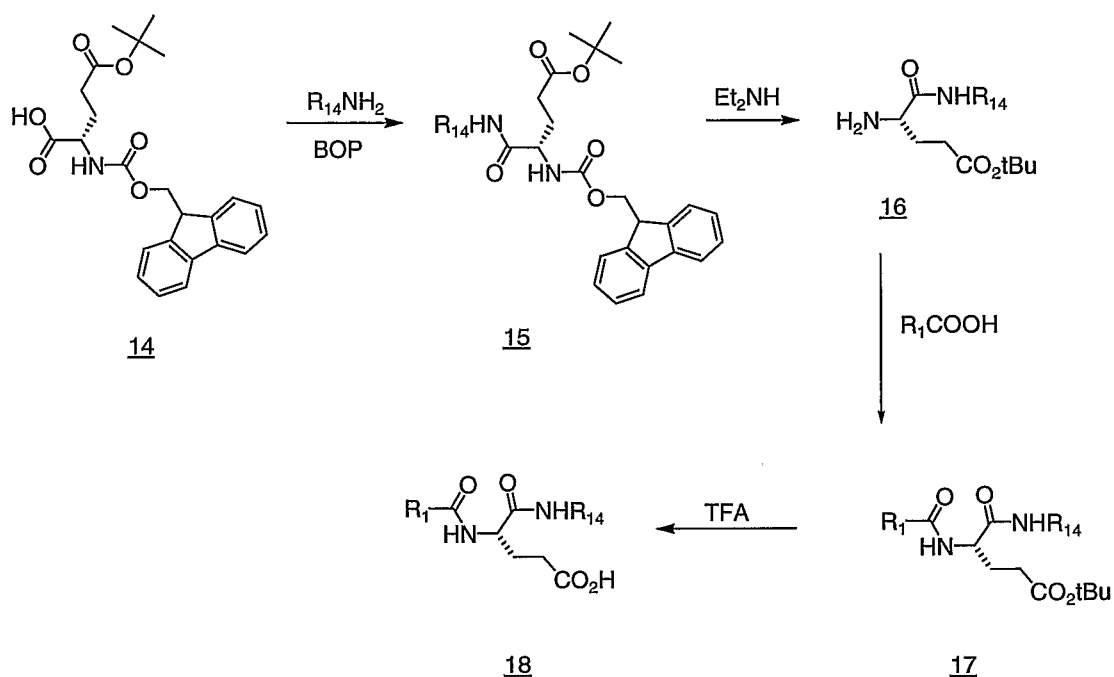
[0116] Scheme 6 demonstrates the synthesis of a compound or pharmaceutically acceptable salt of a compound of the Formula (II). As shown in Scheme 6, a compound of the Formula (V) is treated with an amine under conditions effective to provide a compound of the Formula (VI). Hydrolysis of the amine protecting group provides a compound of the Formula (VII), which is coupled with a carboxylic acid under conditions effective to provide a compound of the Formula (VIII). Hydrolysis of the protected carboxylic acid provides a compound of the Formula (II).

Scheme 6



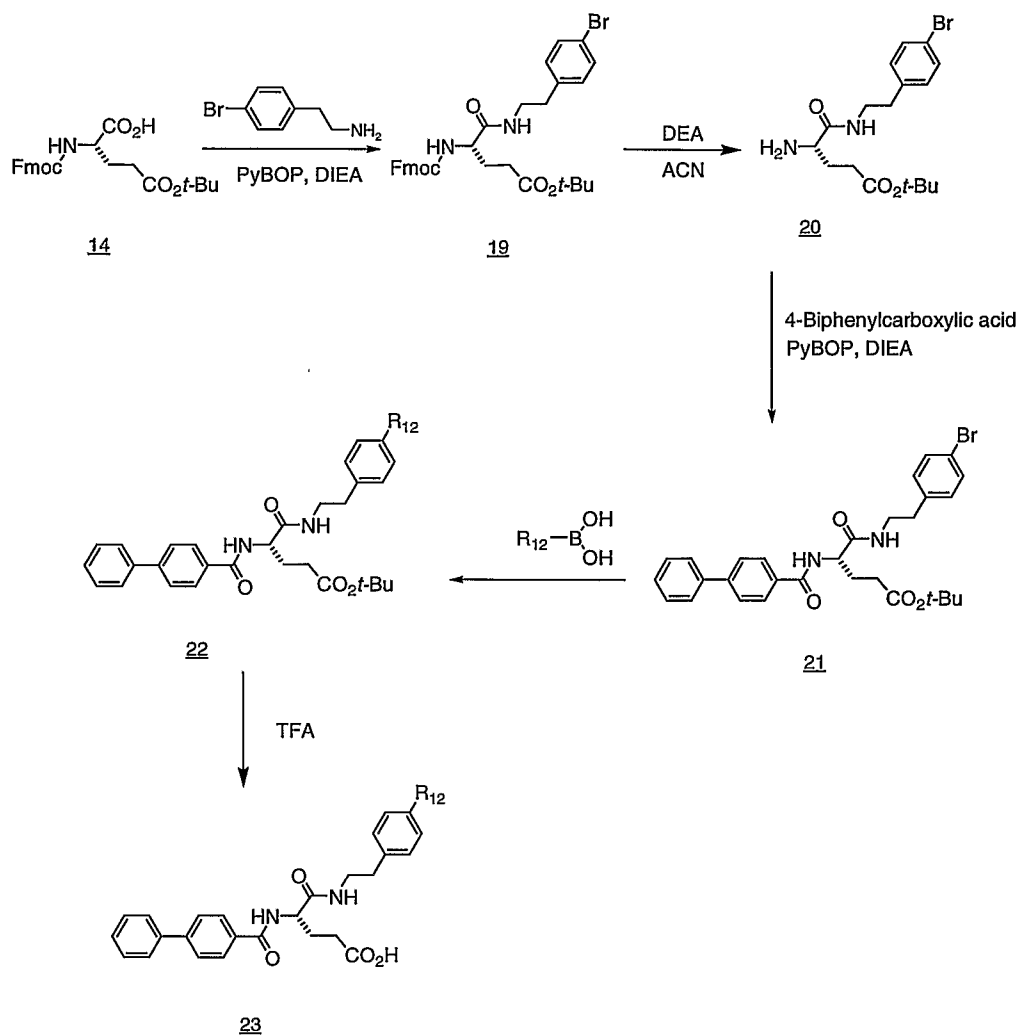
[0117] Scheme 7 provides the synthesis of compounds of the Formula (II) following the general procedures set forth in Scheme 6. In scheme 7, Fmoc-glu(Obut)OH (**14**) was reacted with a known or commercially available primary or secondary amine. Hydrolysis of the Fmoc protecting group of (**15**) was carried out with diethylamine in acetonitrile. The amine (**16**) was then coupled with a carboxylic acid (e.g. 4-biphenylcarboxylic acid or fluorencarboxylic acid) and the resulting tert-butyl ester (**17**) was hydrolyzed using TFA in dichloromethane to provide (**18**).

Scheme 7



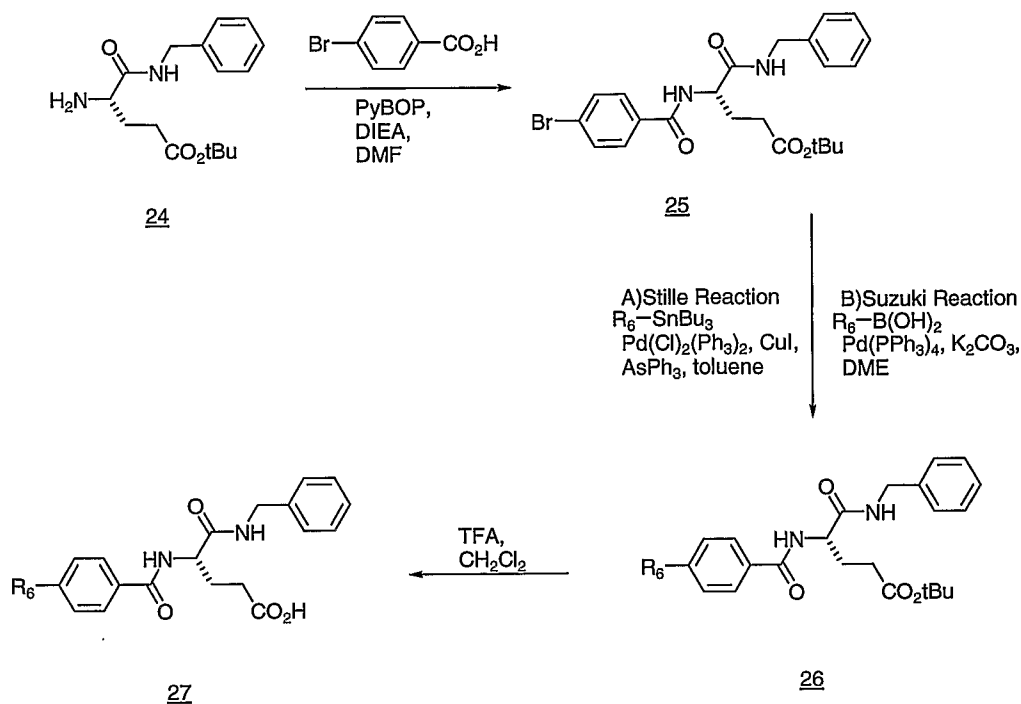
[0118] Scheme 8 demonstrates the preparation of compounds of the invention similar to the procedure described in scheme 7. Bromo or iodophenethylamine (or bromo or iodo benzylamine) was coupled with the Fmoc protected amino acid (**14**). Removal of the Fmoc protecting group of (**19**) was carried out in base and the resulting compound (**20**) was reacted with 4-biphenylcarboxylic acid (or fluorencarboxylic acid or other carboxylic acid). Cross-coupling of the bromo or iodo intermediate (**21**) with a boronic ester or stannyl reagent (via Suzuki or Stille method) gave the coupling product t-butyl ester (**22**), which was then hydrolyzed to give the final carboxylic acid product (**23**).

Scheme 8



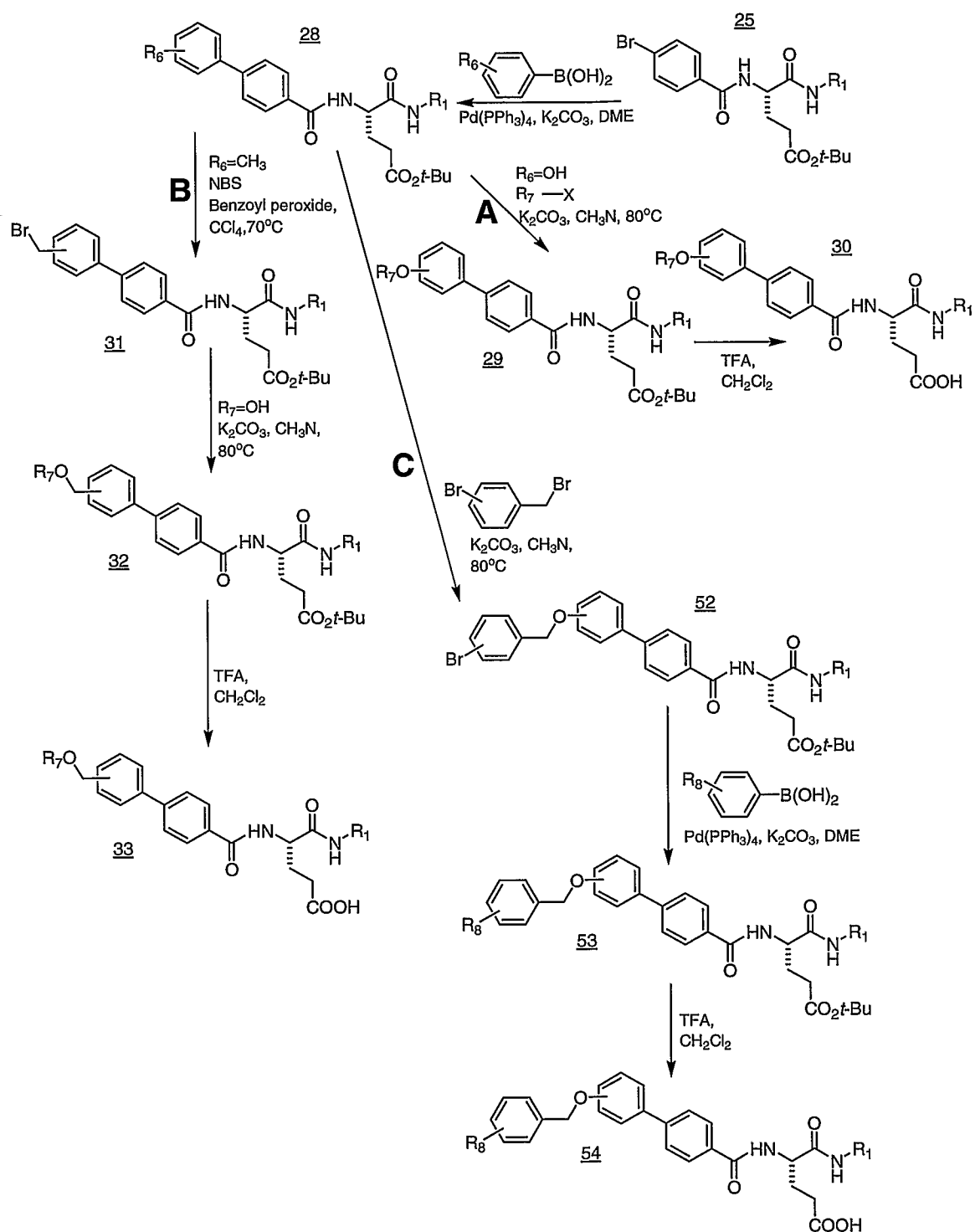
[0119] Scheme 9 demonstrates the preparation of compounds of the invention in three steps from bromo compounds. Cross coupling of (25) with either a boronic ester or a stannyl compound using either Suzuki or Stille coupling gave the tert-butyl ester (26), which was then hydrolyzed to the carboxylic acid (27).

Scheme 9



[0120] Scheme 10 provides compounds of the invention prepared in three or four steps from bromo compounds. Suzuki coupling of (**25**) with the 4-hydroxyphenylboronic acid gave the intermediate (**28**). Path A: Alkylation of the phenolic compound with an alkylhalide or benzyl halide provided (**29**), followed by acid hydrolysis to give the carboxylic acid (**30**). Path B: The brominated compound (**31**) was treated with an alcohol to give (**32**), followed by acid hydrolysis to give the carboxylic acid (**33**). Path C: The intermediate (**28**) was treated a bromobenzylbromide compound to provide (**52**), followed by treatment with phenylboronic acid to provide (**53**), which was then acid hydrolyzed to give (**54**).

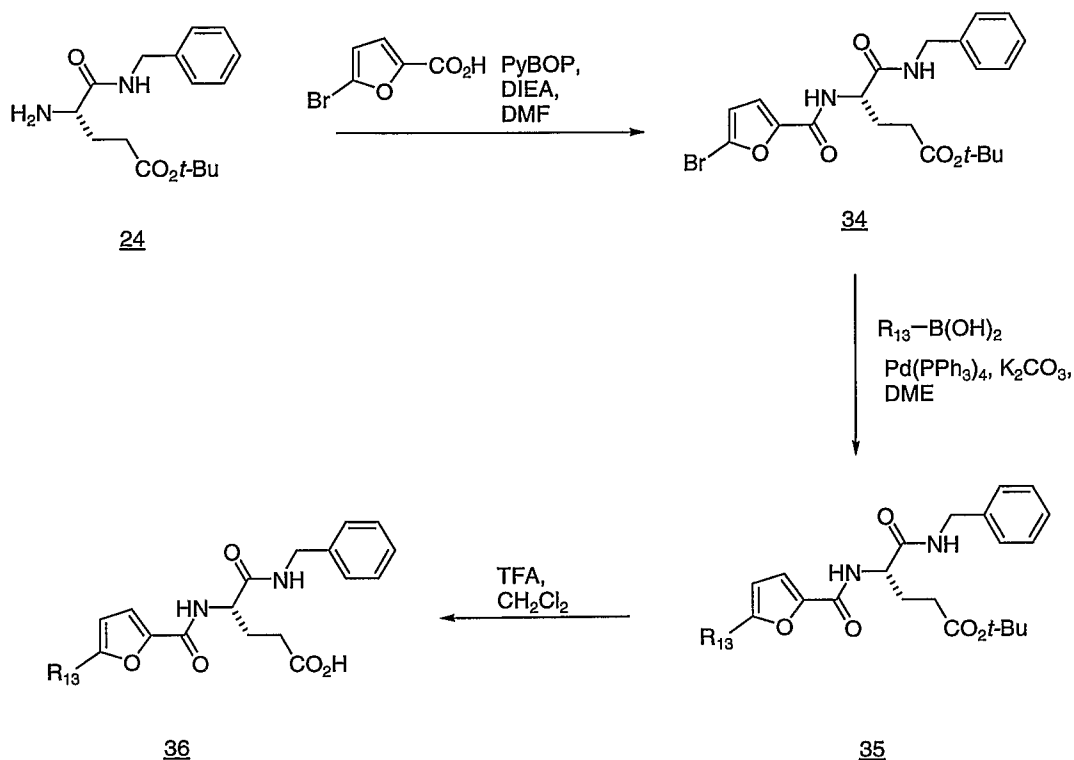
Scheme 10



[0121] Scheme 11 provides compounds of the invention prepared in a similar manner described in scheme 10, except 5-bromofuroic acid was used in the first coupling

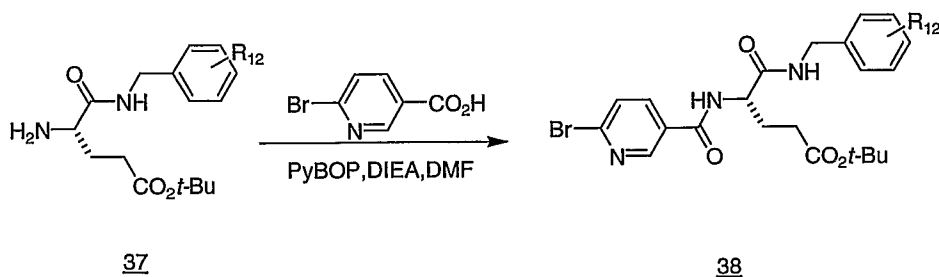
reaction step. The bromo intermediate (**34**) was then reacted with a boronic acid and hydrolysis of the resulting tert-butyl ester (**35**) in acid provided the carboxylic acid (**36**).

Scheme 11



[0122] Scheme 12 provides compounds of the invention prepared according to the procedure described in scheme 11, except 6-bromonicotinic acid was used to couple with the amino intermediate (**37**) to afford (**38**).

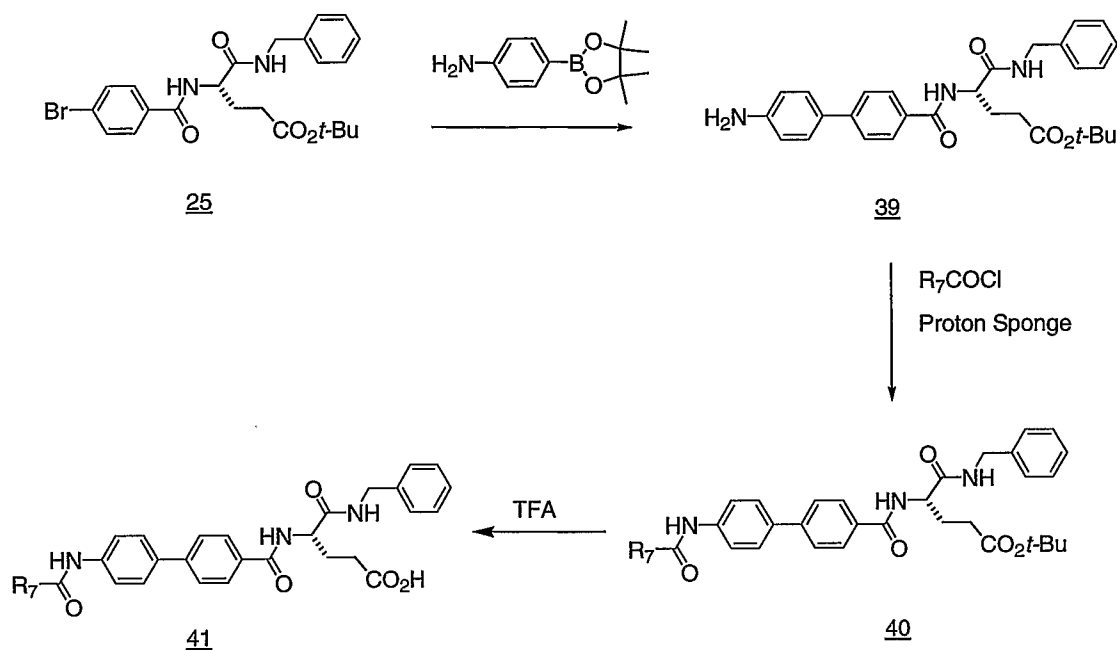
Scheme 12



[0123] Scheme 13 provides compounds of the invention prepared according to the procedure described in scheme 10, except 4-(4,4,5,5)-tetramethyl-1,3,2-dioxaborolan-2-yl)aniline was used in the Suzuki coupling reaction with (**25**). The amino intermediate

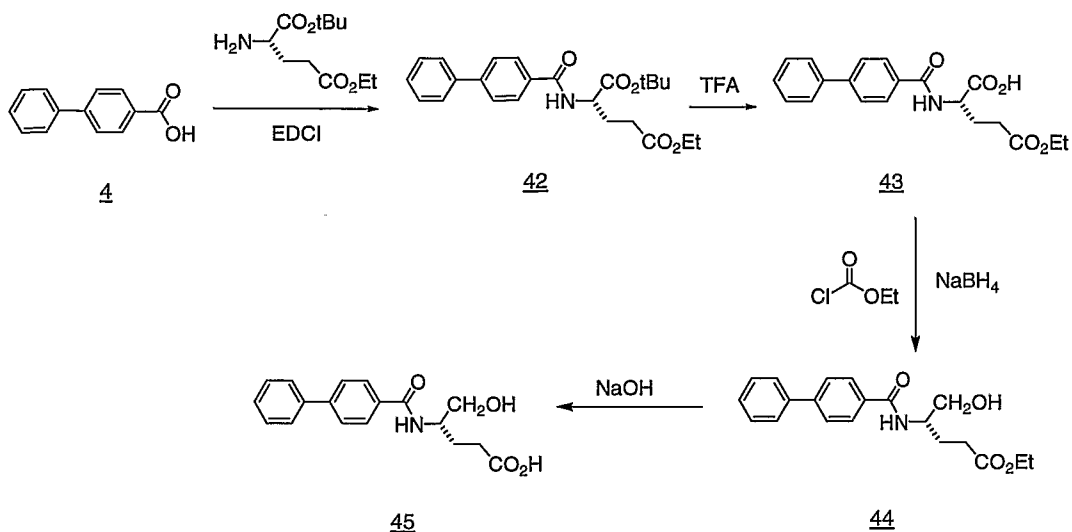
(**39**) was then acylated with an acid chloride and the tert-butyl ester (**40**) was hydrolyzed in acidic conditions to give the desired carboxylic acid (**41**).

Scheme 13



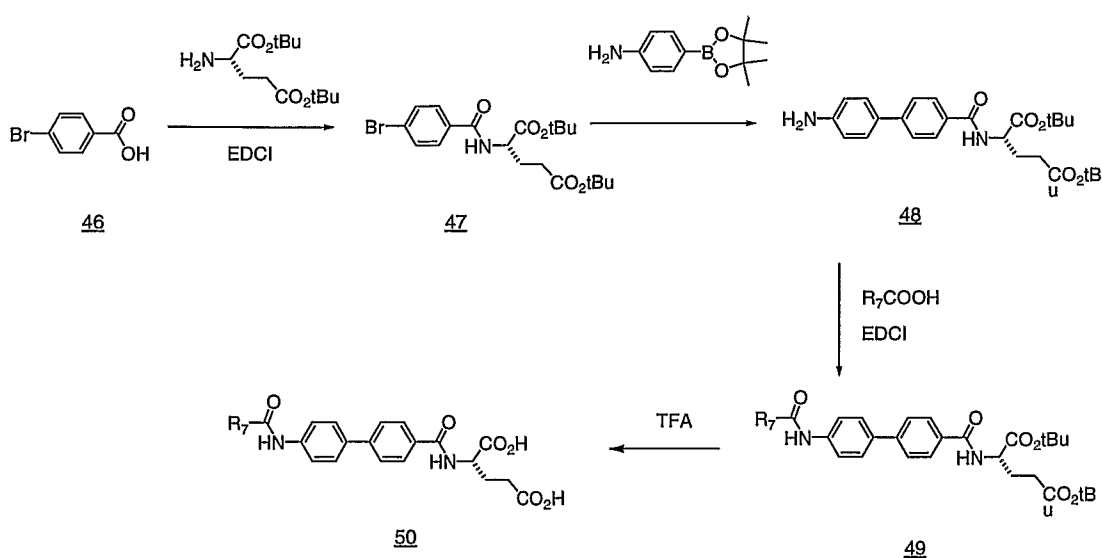
[0124] Scheme 14 demonstrates the preparation of compounds of the invention in four steps. The L-glutamic acid α -tert-butyl ester γ -ethyl ester was reacted with 4-biphenylcarboxylic acid (**4**, or other carboxylic acid) using EDC, PyBop, Bop, or other coupling agent. Hydrolysis of the alpha tert-butyl ester (**42**) in trifluoroacetic acid gave the alpha carboxylic acid intermediate (**43**) in good yield. Treatment of the acid with a base (e.g. triethylamine) and ethyl chloroformate followed by sodium borohydride gave the corresponding alcohol (**44**). The ethyl ester was then hydrolyzed in basic conditions to give the final product (**45**).

Scheme 14



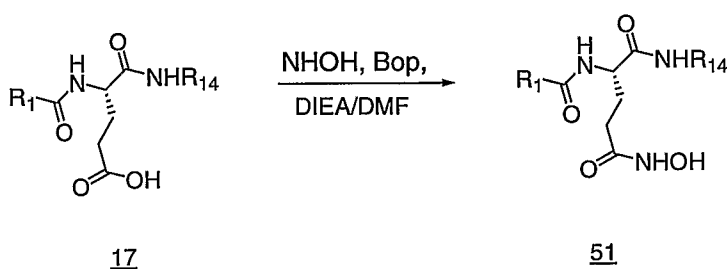
[0125] Scheme 15 provides compounds of the invention prepared in four steps from bromobenzoic acid. L-glutamic acid di-tert butyl ester was coupled with the bromobenzoic acid (**46**). Suzuki coupling of the bromo compound (**47**) with 4-(4,4,5,5)-tetramethyl-1,3,2-dioxaborolan-2-yl)aniline gave the amino intermediate (**48**) in good yield. Acylation of the amine with an acid chloride gave the acylated product (**49**), and hydrolysis of the tert-butyl ester in acidic conditions gave the final dicarboxylic acid (**50**).

Scheme 15



[0126] Scheme 16 provides compounds of the invention prepared in a single step from a carboxylic acid. A carboxylic acid of the invention (**17**) is reacted with Bop, hydroxylamine hydrochloride, and DIEA to afford the hydroxamic acid (**51**).

Scheme 16



[0127] One of skill in the art will recognize that Schemes 1-16 can be adapted to produce other compounds and pharmaceutically acceptable salts of compounds according to the present invention.

Therapeutic Administration

[0128] When administered to an animal, the compounds or pharmaceutically acceptable salts of the compounds of the invention can be administered neat or as a component of a composition that comprises a physiologically acceptable carrier or vehicle. A composition of the invention can be prepared using a method comprising admixing the compound or a pharmaceutically acceptable salt of the compound and a physiologically acceptable carrier, excipient, or diluent. Admixing can be accomplished using methods well known for admixing a compound or a pharmaceutically acceptable salt of the compound and a physiologically acceptable carrier, excipient, or diluent.

[0129] The present compositions, comprising compounds or pharmaceutically acceptable salts of the compounds of the invention can be administered orally. The compounds or pharmaceutically acceptable salts of compounds of the invention can also be administered by any other convenient route, for example, by infusion or bolus injection, by absorption through epithelial or mucocutaneous linings (*e.g.*, oral, rectal, vaginal, and intestinal mucosa, etc.) and can be administered together with another therapeutic agent. Administration can be systemic or local. Various known delivery

systems, including encapsulation in liposomes, microparticles, microcapsules, and capsules, can be used.

[0130] Methods of administration include, but are not limited to, intradermal, intramuscular, intraperitoneal, intravenous, subcutaneous, intranasal, epidural, oral, sublingual, intracerebral, intravaginal, transdermal, rectal, by inhalation, or topical, particularly to the ears, nose, eyes, or skin. In some instances, administration will result of release of the compound or a pharmaceutically acceptable salt of the compound into the bloodstream. The mode of administration is left to the discretion of the practitioner.

[0131] In one embodiment, the compound or a pharmaceutically acceptable salt of the compound is administered orally.

[0132] In another embodiment, the compound or a pharmaceutically acceptable salt of the compound is administered intravenously.

[0133] In another embodiment, it may be desirable to administer the compound or a pharmaceutically acceptable salt of the compound locally. This can be achieved, for example, by local infusion during surgery, topical application, *e.g.*, in conjunction with a wound dressing after surgery, by injection, by means of a catheter, by means of a suppository or edema, or by means of an implant, said implant being of a porous, non-porous, or gelatinous material, including membranes, such as sialastic membranes, or fibers.

[0134] In certain embodiments, it can be desirable to introduce the compound or a pharmaceutically acceptable salt of the compound into the central nervous system, circulatory system or gastrointestinal tract by any suitable route, including intraventricular, intrathecal injection, paraspinal injection, epidural injection, enema, and by injection adjacent to the peripheral nerve. Intraventricular injection can be facilitated by an intraventricular catheter, for example, attached to a reservoir, such as an Ommaya reservoir.

[0135] Pulmonary administration can also be employed, *e.g.*, by use of an inhaler or nebulizer, and formulation with an aerosolizing agent, or via perfusion in a fluorocarbon or synthetic pulmonary surfactant. In certain embodiments, the compound or a pharmaceutically acceptable salt of the compound can be formulated as a suppository, with traditional binders and excipients such as triglycerides.

[0136] In another embodiment, the compound or a pharmaceutically acceptable salt of the compound can be delivered in a vesicle, in particular a liposome (see Langer, *Science* 1990, 249, 1527-1533 and Treat et al., *Liposomes in the Therapy of Infectious Disease and Cancer* 1989, 317-327 and 353-365).

[0137] In yet another embodiment, the compound or a pharmaceutically acceptable salt of the compound can be delivered in a controlled-release system or sustained-release system (see, e.g., Goodson, in *Medical Applications of Controlled Release* 1984, vol. 2, 115-138). Other controlled or sustained-release systems discussed in the review by Langer, *Science* 1990, 249, 1527-1533 can be used. In one embodiment, a pump can be used (Langer, *Science* 1990, 249, 1527-1533; Sefton, *CRC Crit. Ref. Biomed. Eng.* 1987, 14, 201; Buchwald et al., *Surgery* 1980, 88, 507; and Saudek et al., *N. Engl. J Med.* 1989, 321, 574). In another embodiment, polymeric materials can be used (see *Medical Applications of Controlled Release* (Langer and Wise, eds., 1974); *Controlled Drug Bioavailability, Drug Product Design and Performance* (Smolen and Ball, eds., 1984); Ranger and Peppas, *J. Macromol. Sci. Rev. Macromol. Chem.* 1983, 2, 61; Levy et al., *Science* 1935, 228, 190; During et al., *Ann. Neural.* 1989, 25, 351; and Howard et al., *J. Neurosurg.* 1989, 71, 105).

[0138] In yet another embodiment, a controlled- or sustained-release system can be placed in proximity of a target of the compound or a pharmaceutically acceptable salt of the compound, e.g., the reproductive organs, thus requiring only a fraction of the systemic dose.

[0139] The present compositions can optionally comprise a suitable amount of a physiologically acceptable excipient.

[0140] Such physiologically acceptable excipients can be liquids, such as water and oils, including those of petroleum, animal, vegetable, or synthetic origin, such as peanut oil, soybean oil, mineral oil, sesame oil and the like. The physiologically acceptable excipients can be saline, gum acacia, gelatin, starch paste, talc, keratin, colloidal silica, urea and the like. In addition, auxiliary, stabilizing, thickening, lubricating, and coloring agents can be used. In one embodiment the physiologically acceptable excipients are sterile when administered to an animal. The physiologically acceptable excipient should be stable under the conditions of manufacture and storage and should be preserved against the contaminating action of microorganisms. Water is a

particularly useful excipient when the compound or a pharmaceutically acceptable salt of the compound is administered intravenously. Saline solutions and aqueous dextrose and glycerol solutions can also be employed as liquid excipients, particularly for injectable solutions. Suitable physiologically acceptable excipients also include starch, glucose, lactose, sucrose, gelatin, malt, rice, flour, chalk, silica gel, sodium stearate, glycerol monostearate, talc, sodium chloride, dried skim milk, glycerol, propylene, glycol, water, ethanol and the like. The present compositions, if desired, can also contain minor amounts of wetting or emulsifying agents, or pH buffering agents.

[0141] Liquid carriers may be used in preparing solutions, suspensions, emulsions, syrups, and elixirs. The compound or pharmaceutically acceptable salt of the compound of this invention can be dissolved or suspended in a pharmaceutically acceptable liquid carrier such as water, an organic solvent, a mixture of both, or pharmaceutically acceptable oils or fat. The liquid carrier can contain other suitable pharmaceutical additives including solubilizers, emulsifiers, buffers, preservatives, sweeteners, flavoring agents, suspending agents, thickening agents, colors, viscosity regulators, stabilizers, or osmo-regulators. Suitable examples of liquid carriers for oral and parenteral administration include water (particular containing additives as above, *e.g.*, cellulose derivatives, including sodium carboxymethyl cellulose solution), alcohols (including monohydric alcohols and polyhydric alcohols, *e.g.*, glycols) and their derivatives, and oils (*e.g.*, fractionated coconut oil and arachis oil). For parenteral administration the carrier can also be an oily ester such as ethyl oleate and isopropyl myristate. Sterile liquid carriers are used in sterile liquid form compositions for parenteral administration. The liquid carrier for pressurized compositions can be halogenated hydrocarbon or other pharmaceutically acceptable propellant.

[0142] The present compositions can take the form of solutions, suspensions, emulsion, tablets, pills, pellets, capsules, capsules containing liquids, powders, sustained-release formulations, suppositories, emulsions, aerosols, sprays, suspensions, or any other form suitable for use. In one embodiment, the composition is in the form of a capsule. Other examples of suitable physiologically acceptable excipients are described in *Remington's Pharmaceutical Sciences* 1447-1676 (Alfonso R. Gennaro, ed., 19th ed. 1995).

[0143] In one embodiment, the compound or a pharmaceutically acceptable salt of the compound is formulated in accordance with routine procedures as a composition adapted for oral administration to humans. Compositions for oral delivery can be in the form of tablets, lozenges, buccal forms, troches, aqueous or oily suspensions or solutions, granules, powders, emulsions, capsules, syrups, or elixirs for example. Orally administered compositions can contain one or more agents, for example, sweetening agents such as fructose, aspartame or saccharin; flavoring agents such as peppermint, oil of wintergreen, or cherry; coloring agents; and preserving agents, to provide a pharmaceutically palatable preparation. In powders, the carrier can be a finely divided solid, which is an admixture with the finely divided compound or pharmaceutically acceptable salt of the compound. In tablets, the compound or pharmaceutically acceptable salt of the compound is mixed with a carrier having the necessary compression properties in suitable proportions and compacted in the shape and size desired. The powders and tablets can contain up to about 99% of the compound or pharmaceutically acceptable salt of the compound.

[0144] Capsules may contain mixtures of the compounds or pharmaceutically acceptable salts of the compounds with inert fillers and/or diluents such as pharmaceutically acceptable starches (*e.g.*, corn, potato, or tapioca starch), sugars, artificial sweetening agents, powdered celluloses (such as crystalline and microcrystalline celluloses), flours, gelatins, gums, etc.

[0145] Tablet formulations can be made by conventional compression, wet granulation, or dry granulation methods and utilize pharmaceutically acceptable diluents, binding agents, lubricants, disintegrants, surface modifying agents (including surfactants), suspending or stabilizing agents (including, but not limited to, magnesium stearate, stearic acid, sodium lauryl sulfate, talc, sugars, lactose, dextrin, starch, gelatin, cellulose, methyl cellulose, microcrystalline cellulose, sodium carboxymethyl cellulose, carboxymethylcellulose calcium, polyvinylpyrrolidone, alginic acid, acacia gum, xanthan gum, sodium citrate, complex silicates, calcium carbonate, glycine, sucrose, sorbitol, dicalcium phosphate, calcium sulfate, lactose, kaolin, mannitol, sodium chloride, low melting waxes, and ion exchange resins. Surface modifying agents include nonionic and anionic surface modifying agents. Representative examples of surface modifying agents include, but are not limited to, poloxamer 188, benzalkonium chloride, calcium stearate,

cetostearyl alcohol, cetomacrogol emulsifying wax, sorbitan esters, colloidal silicon dioxide, phosphates, sodium dodecylsulfate, magnesium aluminum silicate, and triethanolamine.

[0146] Moreover, when in a tablet or pill form, the compositions can be coated to delay disintegration and absorption in the gastrointestinal tract, thereby providing a sustained action over an extended period of time. Selectively permeable membranes surrounding an osmotically active driving compound or a pharmaceutically acceptable salt of the compound are also suitable for orally administered compositions. In these latter platforms, fluid from the environment surrounding the capsule can be imbibed by the driving compound, which swells to displace the agent or agent composition through an aperture. These delivery platforms can provide an essentially zero order delivery profile as opposed to the spiked profiles of immediate release formulations. A time-delay material such as glycerol monostearate or glycerol stearate can also be used. Oral compositions can include standard excipients such as mannitol, lactose, starch, magnesium stearate, sodium saccharin, cellulose, and magnesium carbonate. In one embodiment the excipients are of pharmaceutical grade.

[0147] In another embodiment, the compound or a pharmaceutically acceptable salt of the compound can be formulated for intravenous administration. Typically, compositions for intravenous administration comprise sterile isotonic aqueous buffer. Where necessary, the compositions can also include a solubilizing agent. Compositions for intravenous administration can optionally include a local anesthetic such as lignocaine to lessen pain at the site of the injection. Generally, the ingredients are supplied either separately or mixed together in unit dosage form, for example, as a dry lyophilized powder or water-free concentrate in a hermetically sealed container such as an ampule or sachette indicating the quantity of active agent. Where the compound or a pharmaceutically acceptable salt of the compound is to be administered by infusion, it can be dispensed, for example, with an infusion bottle containing sterile pharmaceutical grade water or saline. Where the compound or a pharmaceutically acceptable salt of the compound is administered by injection, an ampule of sterile water for injection or saline can be provided so that the ingredients can be mixed prior to administration.

[0148] In another embodiment, the compound or pharmaceutically acceptable salt of the compound can be administered transdermally through the use of a transdermal

patch. Transdermal administrations include administrations across the surface of the body and the inner linings of the bodily passages including epithelial and mucosal tissues. Such administrations can be carried out using the present compounds or pharmaceutically acceptable salts of the compounds, in lotions, creams, foams, patches, suspensions, solutions, and suppositories (*e.g.*, rectal or vaginal).

[0149] Transdermal administration can be accomplished through the use of a transdermal patch containing the compound or pharmaceutically acceptable salt of the compound and a carrier that is inert to the compound or pharmaceutically acceptable salt of the compound, is non-toxic to the skin, and allows delivery of the agent for systemic absorption into the blood stream via the skin. The carrier may take any number of forms such as creams or ointments, pastes, gels, or occlusive devices. The creams or ointments may be viscous liquid or semisolid emulsions of either the oil-in-water or water-in-oil type. Pastes comprised of absorptive powders dispersed in petroleum or hydrophilic petroleum containing the active ingredient may also be suitable. A variety of occlusive devices may be used to release the compound or pharmaceutically acceptable salt of the compound into the blood stream, such as a semi-permeable membrane covering a reservoir containing the compound or pharmaceutically acceptable salt of the compound with or without a carrier, or a matrix containing the active ingredient.

[0150] The compounds or pharmaceutically acceptable salts of the compounds of the invention may be administered rectally or vaginally in the form of a conventional suppository. Suppository formulations may be made from traditional materials, including cocoa butter, with or without the addition of waxes to alter the suppository's melting point, and glycerin. Water-soluble suppository bases, such as polyethylene glycols of various molecular weights, may also be used.

[0151] The compound or a pharmaceutically acceptable salt of the compound can be administered by controlled-release or sustained-release means or by delivery devices that are known to those of ordinary skill in the art. Such dosage forms can be used to provide controlled- or sustained-release of one or more active ingredients using, for example, hydropropylmethyl cellulose, other polymer matrices, gels, permeable membranes, osmotic systems, multilayer coatings, microparticles, liposomes, microspheres, or a combination thereof to provide the desired release profile in varying proportions. Suitable controlled- or sustained-release formulations known to those skilled

in the art, including those described herein, can be readily selected for use with the active ingredients of the invention. The invention thus encompasses single unit dosage forms suitable for oral administration such as, but not limited to, tablets, capsules, gelcaps, and caplets that are adapted for controlled- or sustained-release.

[0152] In one embodiment a controlled- or sustained-release composition comprises a minimal amount of the compound or a pharmaceutically acceptable salt of the compound to treat or prevent a metalloproteinase-related disorder in a minimal amount of time. Advantages of controlled- or sustained-release compositions include extended activity of the drug, reduced dosage frequency, and increased compliance by the animal being treated. In addition, controlled- or sustained-release compositions can favorably affect the time of onset of action or other characteristics, such as blood levels of the compound or a pharmaceutically acceptable salt of the compound, and can thus reduce the occurrence of adverse side effects.

[0153] Controlled- or sustained-release compositions can initially release an amount of the compound or a pharmaceutically acceptable salt of the compound that promptly produces the desired therapeutic or prophylactic effect, and gradually and continually release other amounts of the compound or a pharmaceutically acceptable salt of the compound to maintain this level of therapeutic or prophylactic effect over an extended period of time. To maintain a constant level of the compound or a pharmaceutically acceptable salt of the compound in the body, the compound or a pharmaceutically acceptable salt of the compound can be released from the dosage form at a rate that will replace the amount of the compound or a pharmaceutically acceptable salt of the compound being metabolized and excreted from the body. Controlled- or sustained-release of an active ingredient can be stimulated by various conditions, including but not limited to, changes in pH, changes in temperature, concentration or availability of enzymes, concentration or availability of water, or other physiological conditions or compounds.

[0154] In certain embodiments, the present invention is directed to prodrugs of the compounds or pharmaceutically acceptable salts of compounds of the present invention. Various forms of prodrugs are known in the art, for example as discussed in Bundgaard, ed., *Design of Prodrugs*, Elsevier (1985); Widder et al., ed., *Methods in Enzymology*, vol. 4, Academic Press (1985); Krogsgaard-Larsen et al., ed., *Design and Application of*

Prodrugs", *Textbook of Drug Design and Development*, Chapter 5, 113-191 (1991); Bundgaard et al., *Journal of Drug Delivery Reviews* 1992, 8, 1-38; Bundgaard et al., *J. Pharmaceutical Sciences* 1988, 77, 285 et seq.; and Higuchi and Stella, eds., *Prodrugs as Drug Delivery Systems*, American Chemical Society (1975).

[0155] The amount of the compound or a pharmaceutically acceptable salt of the compound is an amount that is effective for treating or preventing a metalloproteinase-related disorder. In addition, *in vitro* or *in vivo* assays can optionally be employed to help identify optimal dosage ranges. The precise dose to be employed can also depend on the route of administration, the condition, the seriousness of the condition being treated, as well as various physical factors related to the individual being treated, and can be decided according to the judgment of a health-care practitioner. Equivalent dosages may be administered over various time periods including, but not limited to, about every 2 hours, about every 6 hours, about every 8 hours, about every 12 hours, about every 24 hours, about every 36 hours, about every 48 hours, about every 72 hours, about every week, about every two weeks, about every three weeks, about every month, and about every two months. The number and frequency of dosages corresponding to a completed course of therapy will be determined according to the judgment of a health-care practitioner. The effective dosage amounts described herein refer to total amounts administered; that is, if more than one compound or a pharmaceutically acceptable salt of the compound is administered, the effective dosage amounts correspond to the total amount administered.

[0156] The amount of the compound or a pharmaceutically acceptable salt of the compound that is effective for treating or preventing a metalloproteinase-related disorder will typically range from about 0.001 mg/kg to about 250 mg/kg of body weight per day, in one embodiment, from about 1 mg/kg to about 250 mg/kg body weight per day, in another embodiment, from about 1 mg/kg to about 50 mg/kg body weight per day, and in another embodiment, from about 1 mg/kg to about 20 mg/kg of body weight per day.

[0157] In one embodiment, the pharmaceutical composition is in unit dosage form, *e.g.*, as a tablet, capsule, powder, solution, suspension, emulsion, granule, or suppository. In such form, the composition is sub-divided in unit dose containing appropriate quantities of the active ingredient; the unit dosage form can be packaged compositions, for example, packeted powders, vials, ampoules, prefilled syringes or sachets containing liquids. The unit dosage form can be, for example, a capsule or tablet

itself, or it can be the appropriate number of any such compositions in package form. Such unit dosage form may contain from about 1 mg/kg to about 250 mg/kg, and may be given in a single dose or in two or more divided doses.

[0158] The compound or a pharmaceutically acceptable salt of the compound can be assayed *in vitro* or *in vivo* for the desired therapeutic or prophylactic activity prior to use in humans. Animal model systems can be used to demonstrate safety and efficacy.

[0159] Thus, in one embodiment, the invention provides a composition comprising an effective amount of the compound or a pharmaceutically acceptable salt of the compound of the present invention and a pharmaceutically acceptable carrier.

[0160] In another embodiment, the pharmaceutically acceptable carrier is suitable for oral administration and the composition comprises an oral dosage form.

Therapeutic or Prophylactic Uses

[0161] In one embodiment, the compounds or pharmaceutically acceptable salts of the compounds of the present invention are useful as metalloproteinase modulators. Accordingly, the compounds and pharmaceutically acceptable salts of the compounds of the present invention are useful for treating an animal with a metalloproteinase-related disorder.

[0162] In one embodiment, the invention provides a method for treating a metalloproteinase-related disorder, comprising administering to an animal in need thereof a compound or a pharmaceutically acceptable salt of the compound of Formula (I) or Formula (II) in an amount effective to treat a metalloproteinase-related disorder. In another embodiment, the compound or pharmaceutically acceptable salt of the compound is of the Formula (Ia), (Ib), (Ic), or (Id).

[0163] In one embodiment, the metalloproteinase is a matrix metalloproteinase or an aggrecanase.

[0164] In another embodiment, the aggrecanase is aggrecanase-1 or aggrecanase-2.

[0165] In one embodiment, the metalloproteinase-related disorder is selected from the group consisting of arthritic disorders, osteoarthritis, cancer, rheumatoid arthritis, asthma, chronic obstructive pulmonary disease, atherosclerosis, age-related macular degeneration, myocardial infarction, corneal ulceration and other ocular surface diseases,

hepatitis, aortic aneurysms, tendonitis, central nervous system diseases, abnormal wound healing, angiogenesis, restenosis, cirrhosis, multiple sclerosis, glomerulonephritis, graft versus host disease, diabetes, inflammatory bowel disease, shock, intervertebral disc degeneration, stroke, osteopenia, and periodontal diseases.

[0166] In another embodiment, the metalloproteinase-related disorder is osteoarthritis.

[0167] In one embodiment, the present invention is directed to a method for modulating the activity of a metalloproteinase in an animal in need thereof, comprising contacting the metalloproteinase with an effective amount of a compound or pharmaceutically acceptable salt of the compound of Formula (I) or Formula (II). In one embodiment, the method further comprises determining the activity of the metalloproteinase. In one embodiment, the step of determining the activity of the metalloproteinase is performed before the step of contacting the metalloproteinase with the compound or a pharmaceutically acceptable salt of the compound. In another embodiment, the step of determining the activity of the metalloproteinase is performed after the step of contacting the metalloproteinase with the compound or a pharmaceutically acceptable salt of the compound. In another embodiment, the compound or pharmaceutically acceptable salt of the compound is of the Formula (Ia), (Ib), (Ic), or (Id).

[0168] The compounds and pharmaceutically acceptable salts of the compounds of Formula (I) or Formula (II) are also useful in the manufacture of medicaments for treating a metalloproteinase-related disorder in an animal. In another embodiment, the compound or pharmaceutically acceptable salt of the compound is of the Formula (Ia), (Ib), (Ic), or (Id).

[0169] Accordingly, in one embodiment, the invention provides the use of a compound or pharmaceutically acceptable salt of the compound of Formula (I) or Formula (II) for the manufacture of a medicament for treating a metalloproteinase-related disorder. In another embodiment, the compound or pharmaceutically acceptable salt of the compound is of the Formula (Ia), (Ib), (Ic), or (Id).

[0170] In one embodiment, the metalloproteinase is a matrix metalloproteinase or an aggrecanase.

[0171] In another embodiment, the aggrecanase is aggrecanase-1 or aggrecanase-2.

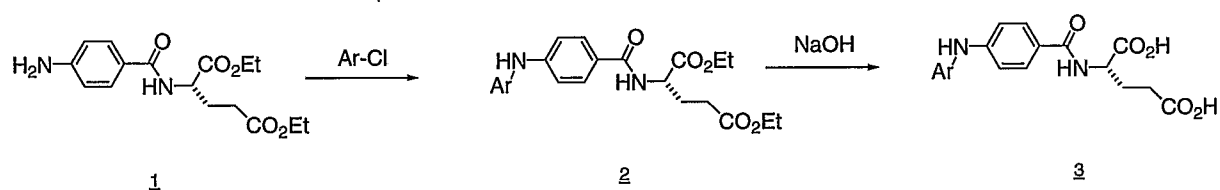
[0172] In one embodiment, the metalloproteinase-related disorder is selected from the group consisting of arthritic disorders, osteoarthritis, cancer, rheumatoid arthritis, asthma, chronic obstructive pulmonary disease, atherosclerosis, age-related macular degeneration, myocardial infarction, corneal ulceration and other ocular surface diseases, hepatitis, aortic aneurysms, tendonitis, central nervous system diseases, abnormal wound healing, angiogenesis, restenosis, cirrhosis, multiple sclerosis, glomerulonephritis, graft versus host disease, diabetes, inflammatory bowel disease, shock, intervertebral disc degeneration, stroke, osteopenia, and periodontal diseases.

[0173] In another embodiment, the metalloproteinase-related disorder is osteoarthritis.

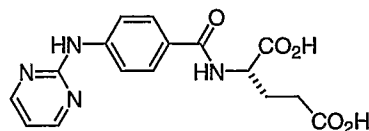
[0174] In one embodiment, the present invention is directed to the use of a compound or pharmaceutically acceptable salt of the compound of Formula (I) or Formula (II) for the manufacture of a medicament for modulating the activity of a metalloproteinase. In one embodiment, the medicament is also for determining the activity of the receptor. In another embodiment, the compound or pharmaceutically acceptable salt of the compound is of the Formula (Ia), (Ib), (Ic), or (Id).

Examples

Scheme 1



Example 1: N-[4-(pyrimidin-2-ylamino)benzoyl]-L-glutamic acid

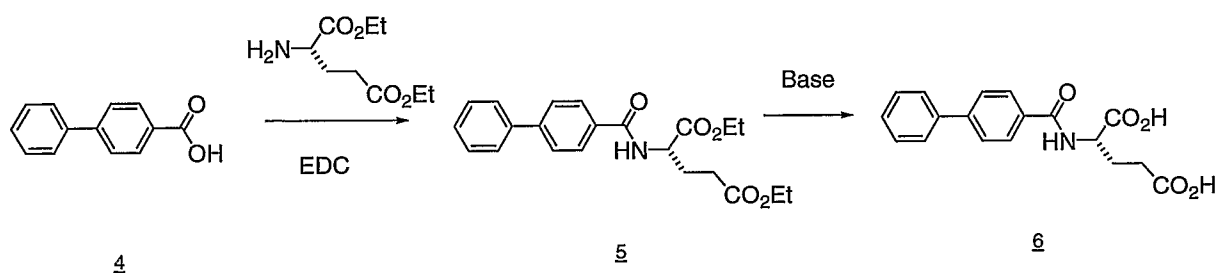


[0175] Step A: 2-[4-(pyrimidin-2-ylamino)-benzoylamino]-pentanedioic acid diethyl ester

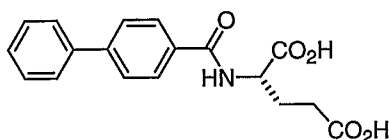
2-Chloropyrimidine (0.72 g, 6.3 mmol) and N-(4-aminobenzoyl)-L-glutamic acid diethyl ester (2.04 g, 6.3 mmol, 1 equiv.) were dissolved in DMF (4 mL) and the resulting mixture was heated to 110 °C for 3 hrs. Reaction was complete as determined by TLC. The mixture was cooled to room temperature and partitioned between ethyl acetate and water. The organic phase was washed with brine, dried over MgSO₄, and concentrated by rotavap. The residue was purified by column chromatography (silica gel, 50% EtOAc/hexane) to afford 1.75 g of desired product 2-[4-(pyrimidin-2-ylamino)-benzoylamino]-pentanedioic acid diethyl ester in 69% yield. MS (ESI) *m/z* 399.

[0176] Step B: N-[4-(pyrimidin-2-ylamino)benzoyl]-L-glutamic acid
A solution of 2-[4-(pyrimidin-2-ylamino)-benzoylamino]-pentanedioic acid diethyl ester (250 mg, 0.62 mmol) in THF (4 mL) was added to MeOH (4 mL), followed by the addition of 1N NaOH solution (5 mL, 5 mmol, 8 equiv.). The mixture was stirred at room temperature overnight. Reaction was complete as determined by HPLC. Solvents were removed by rotavap and a small amount of water (5 mL) was added to make a homogeneous solution. 1N HCl was added dropwise until the solution reached a pH of 4. The solid precipitate was collected by filtration, washed with EtOAc, and dried in vacuum oven. The product N-[4-(pyrimidin-2-ylamino)benzoyl]-L-glutamic acid (120 mg) was isolated in 45% yield. MS (ESI) *m/z* 343.

Scheme 2



Example 2: N-(1,1'-biphenyl-4-ylcarbonyl)-D-glutamic acid



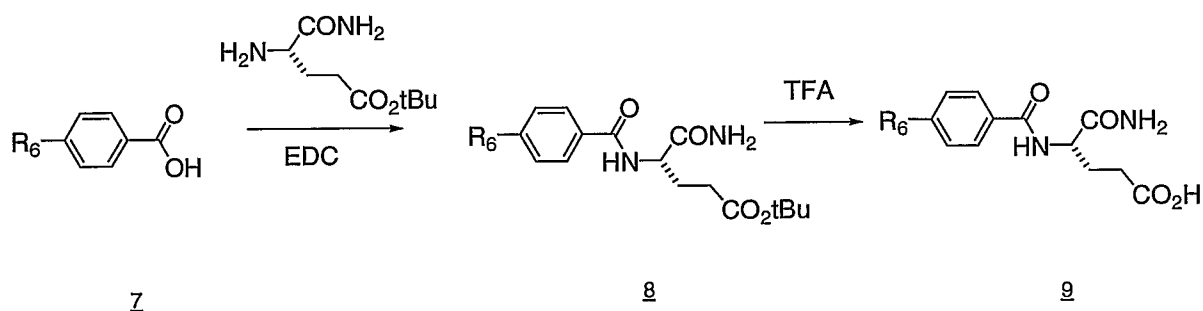
[0177] Step A: 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid diethyl ester

A solution of 4-biphenylcarboxylic acid (670 mg, 3.4 mmol) and (809 mg, 3.4 mmol, 1 equiv.) in dry DMF (20 mL) was added to EDCI (801 mg, 5.1 mmol, 1.5 equiv.), triethylamine (853 mg, 8.4 mmol, 2.5 equiv.) and DMAP (82 mg, 0.7 mmol, 20%). The mixture was stirred at room temperature overnight. Reaction was complete as determined by TLC. The mixture was diluted with EtOAc and washed with H₂O, brine, and dried over magnesium sulfate. Solvent was removed and the residue subject to column chromatography (silica gel, 50% EtOAc/hexane). 660 mg of desired product 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid diethyl ester was isolated in 51% yield. MS (ESI) *m/z* 382.

[0178] Step B: N-(1,1'-biphenyl-4-ylcarbonyl)-D-glutamic acid

A solution of 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid diethyl ester (250 mg, 0.65 mmol) in THF (6 mL) was added to MeOH (6 mL), followed by the addition of 1N NaOH solution (5.2 mL, 5.2 mmol, 8 eq.). The mixture was stirred at room temperature overnight. Reaction was complete as determined by HPLC. Solvents were removed by rotavap and a small amount of water (5 mL) was added to make a homogeneous solution. 1N HCl was added dropwise until the solution reached a pH of 4. The solid precipitate was collected by filtration, washed with EtOAc, and dried in vacuum oven. Product N-(1,1'-biphenyl-4-ylcarbonyl)-D-glutamic acid (189 mg) was isolated in 89% yield. MS (ESI) *m/z* 326.

Scheme 3



Example 3: N²-[4-(pyrimidin-2-ylamino)benzoyl]-L-alpha-glutamine

[0179] Step A: 4-Carbamoyl-4-[4-(pyrimidin-2-ylamino)-benzoylamino]-butyric acid tert-butyl ester

4-(Pyrimidin-2-ylamino)-benzoic acid (1.80 g, 8.4 mmol, 1 equiv.) and EDCI (2.41 g, 12.6 mmol, 1.5 equiv.) were dissolved in DMF (60 mL) under N₂. The mixture was stirred at room temperature for 20 minutes, followed by the addition of H-Glu (OtBu)-

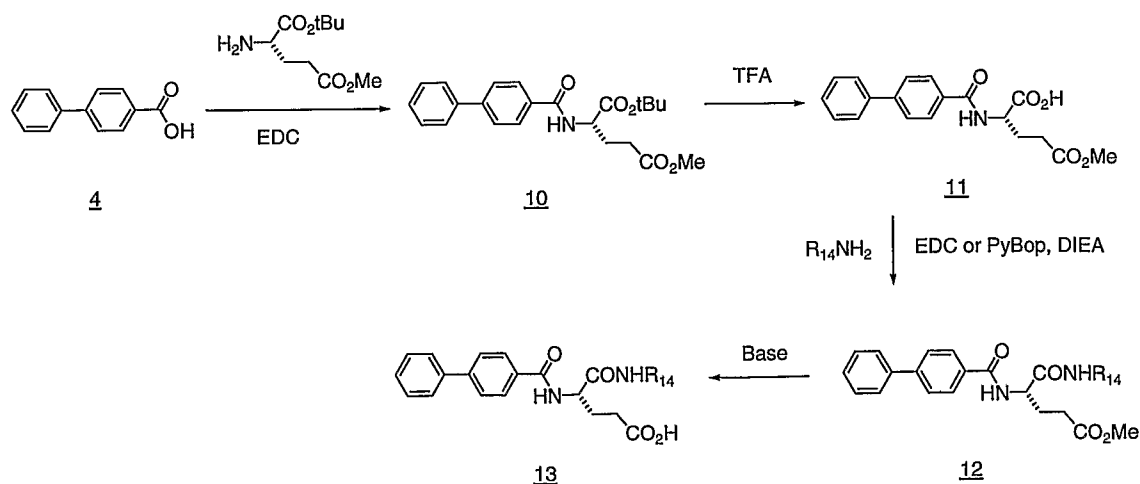
NH₂ (2 g, 8.4 mmol, 1 equiv), Et₃N (2.92 mL, 20.9 mmol, 2.5 equiv.), and DMAP (0.512 g, 4.2 mmol, 0.5 equiv). The mixture was allowed to stir at room temperature overnight. Reaction was complete as determined by TLC. DMF was removed by rotovap and the residue was dissolved in EtOAc. The organic layer was washed with brine and dried over MgSO₄. Most of the solvent was removed by rotavap and a solid was precipitated from the mixture during solvent evaporation. The solid was collected by filtration and washed with EtOAc. 823 mg of 4-Carbamoyl-4-[4-(pyrimidin-2-ylamino)-benzoylamino]-butyric acid tert-butyl ester was obtained in 25 % yield. MS (ESI) *m/z* 400.

[0180] Step B: N²-[4-(pyrimidin-2-ylamino)benzoyl]-L- α -glutamine
4-Carbamoyl-4-[4-(pyrimidin-2-ylamino)-benzoylamino]-butyric acid tert-butyl ester was dissolved in dichloroethane (10 mL), followed by the addition of TFA (5 mL). The mixture was stirred at room temperature for 4 hrs. TLC indicated the reaction was complete. Solvents were then removed by rotavap and the residue was washed with EtOAc. A solid was collected by filtration and dried in vacuum oven overnight. 4-Carbamoyl-4-[4-(pyrimidin-2-ylamino)-benzoylamino]-butyric acid was obtained in quantitative yield (285 mg). MS (ESI) *m/z* 344.

Example 4: N²-(1,1'-biphenyl-4-ylcarbonyl)-D- α -glutamine

[0181] The title compound was prepared according to the procedures similar to that described for Example 3. Yield 95%, MS (ESI) *m/z* 327.

Scheme 5



Example 5: N²-(1,1'-biphenyl-4-ylcarbonyl)-N¹-(4-hydroxybutyl)-L-alpha-glutamine

[0182] Step A: 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 1-tert-butyl ester 5-methyl ester

A solution of 4-diphenyl carboxylic acid (3.57 g, 18 mmol, 1.0 equiv.) in DMF (40 mL) was added to EDCI (4.28 g, 22.3 mmol, 1.24 equiv.) and stirred at room temperature for 0.5 hrs. H-Glu(OMe)Ot-Bu (5.02 g, 19.8 mmol, 1.1 equiv.) was added, followed by the addition of Et₃N (6.77 mL, 48.6 mmol, 2.7 equiv.) and DMAP (330 mg, 2.7 mmol, 15%). The mixture was stirred overnight under N₂. Reaction was complete as determined by TLC. The reaction mixture was diluted with EtOAc, washed with H₂O, then brine solution. The organic layer was separated and then dried over MgSO₄. After concentration, crude was purified by column chromatography (Silica gel, 20% EtOAc / Hexane) to afford 3.2 g of 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 1-tert-butyl ester 5-methyl ester in 44.7% yield. MS (ESI) *m/z* 396.

[0183] Step B: 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 5-methyl ester
A solution of 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 1-tert-butyl ester 5-methyl ester (1.5 g, 3.8 mmol) in dichloroethane (26 mL) was added to TFA (13 mL) at room temperature. The mixture was stirred for 4 hrs. and TLC indicated the reaction was complete. Solvent was removed by rotovap. The solid thus obtained was dried under vacuum to provide 1.128 g of 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 5-methyl ester [G9591-161-1] in 87% yield. MS (ESI) *m/z* 342.

[0184] Step C: 4-[(Biphenyl-4-carbonyl)-amino]-4-(4-hydroxy-butylcarbamoyl)-butyric acid methyl ester

A solution of 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 5-methyl ester (400 mg, 1.2 mmol, 1 equiv.) in DMF (10 mL) was added to EDCI (337 mg, 1.8 mmol, 1.5 equiv.). The solution was stirred at room temperature under N₂ for 40 min. 4-Amino-1-butanol (0.11 mL, 1.2 mmol, 1 equiv.) was added, followed by addition of Et₃N (0.41 mL, 2.9 mmol, 2.5 equiv.) and DMAP (72 mg, 0.59 mmol, 0.5 equiv.). The mixture was stirred overnight under N₂. The reaction mixture was then poured into cold water and a solid precipitated from the solution. The solid was collected by filtration and dried under vacuum to give 229 mg of 4-[(Biphenyl-4-carbonyl)-amino]-4-(4-hydroxy-butylcarbamoyl)-butyric acid methyl ester in 47% yield.

MS (ESI) *m/z* 413.

[0185] Step D: N²-(1,1'-biphenyl-4-ylcarbonyl)-N¹-(4-hydroxybutyl)-L-alpha-glutamine

A solution of 4-[(Biphenyl-4-carbonyl)-amino]-4-(4-hydroxy-butylcarbonyl)-butyric acid methyl ester (229 mg, 0.56 mmol, 1 equiv.) in THF (10 mL) and MeOH (2.8 mL) was added to 1N NaOH (2.8 mL, 2.8 mmol, 5 equiv.). The solution was stirred at room temperature for 2.5 hrs. After TLC indicated the reaction was complete, the solvent was evaporated and the residue was dissolved in H₂O. After adjusting the pH of the solution to 3 using 1N HCl, a solid precipitated from the solution. The solid was collected by filtration and washed with water. After drying, 120 mg of N²-(1,1'-biphenyl-4-ylcarbonyl)-N¹-(4-hydroxybutyl)-L-alpha-glutamine was isolated in 54.1% yield. MS (ESI) *m/z* 399.

Example 6:

[0186] The following compounds were prepared according to the procedures similar to those described in Example 5.

Example 6A: N²-(1,1'-biphenyl-4-ylcarbonyl)-N¹-2,3-dihydro-1H-inden-2-yl-L-α-glutamine

[0187] Step C: methyl N²-(1,1'-biphenyl-4-ylcarbonyl)-N¹-2,3-dihydro-1H-inden-2-yl-L-α-glutamate

Described as above according to the procedure in Example 5, except PyBop/DIEA (or Bop/DIEA) was used. MS (ESI) *m/z* 457.2; MS (ESI) *m/z* 913.4; HRMS: calcd for C₂₈H₂₈N₂O₄ + H⁺, 457.21218; found (ESI-FTMS, [M+H]¹⁺), 457.21403.

[0188] Step D: N²-(1,1'-biphenyl-4-ylcarbonyl)-N¹-2,3-dihydro-1H-inden-2-yl-L-α-glutamine

MS (ESI) *m/z* 441.2; MS (ESI) *m/z* 883.3; HRMS: calcd for C₂₇H₂₆N₂O₄ + H⁺, 443.19653; found (ESI-FTMS, [M+H]¹⁺), 443.19699.

Example 6B: N²-(biphenyl-4-ylcarbonyl)-N¹-(2-hydroxy-1,1-dimethylethyl)-L-α-glutamine

[0189] Step C: methyl N²-(biphenyl-4-ylcarbonyl)-N¹-(2-hydroxy-1,1-dimethylethyl)-L-α-glutamate

Described as above according to the procedure in Example 5, except PyBop/DIEA (or Bop/DIEA) was used. MS (ESI) m/z 413.1; MS (ESI) m/z 825.2; HRMS: calcd for $C_{23}H_{28}N_2O_5 + H^+$, 413.20710; found (ESI-FTMS, $[M+H]^{1+}$), 413.20705.

[0190] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-hydroxy-1,1-dimethylethyl)-L- α -glutamine

MS (ESI) m/z 399.1; MS (ESI) m/z 797.3; HRMS: calcd for $C_{22}H_{26}N_2O_5 + H^+$, 399.19145; found (ESI-FTMS, $[M+H]^{1+}$), 399.19217.

Example 6C: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1,3,3-tetramethylbutyl)-L- α -glutamine

[0191] Step C: methyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1,3,3-tetramethylbutyl)-L- α -glutamate

Described as above according to the procedure in Example 5, except PyBop/DIEA (or Bop/DIEA) was used. MS (ESI) m/z 453.2; MS (ESI) m/z 905.4; HRMS: calcd for $C_{27}H_{36}N_2O_4 + H^+$, 453.27478; found (ESI-FTMS, $[M+H]^{1+}$), 453.27588.

[0192] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1,3,3-tetramethylbutyl)-L- α -glutamine

MS (ESI) m/z 439.2; MS (ESI) m/z 877.4; HRMS: calcd for $C_{26}H_{34}N_2O_4 + H^+$, 439.25913; found (ESI-FTMS, $[M+H]^{1+}$), 439.25974.

Example 6D: N^1 -(1,1-dimethyl-2-phenylethyl)- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine

[0193] Step A: 1-tert-butyl 5-methyl-N-(9H-fluoren-2-ylcarbonyl)-L-glutamate
Described as above according to the procedure in Example 5, except 2-fluorene-carboxylic acid was used. MS (ESI) m/z 410.2; MS (ESI) m/z 819.4; HRMS: calcd for $C_{24}H_{27}NO_5 + Na^+$, 432.17814; found (ESI-FTMS, $[M+Na]^{1+}$), 432.17902.

[0194] Step B: (2S)-2-[(9H-fluoren-2-ylcarbonyl)amino]-5-methoxy-5-oxopentanoic acid

MS (ESI) m/z 354.1; MS (ESI) m/z 707.3; HRMS: calcd for $C_{20}H_{19}NO_5 + H^+$, 354.13360; found (ESI-FTMS, $[M+H]^{1+}$), 354.13428.

[0195] Step C: methyl N^1 -(1,1-dimethyl-2-phenylethyl)- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamate

MS (ESI) m/z 485.3; MS (ESI) m/z 969.5; MS (ESI) m/z 507.3; HRMS: calcd for $C_{30}H_{32}N_2O_4 + Na^+$, 507.22543; found (ESI-FTMS, $[M+Na]^+$), 507.22863.

[0196] Step D: N^1 -(1,1-dimethyl-2-phenylethyl)- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine

MS (ESI) m/z 471.3; MS (ESI) m/z 941.5.

Example 6E: N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine

[0197] Step A: described as above according to the procedure in Example 5, except 2-fluorene-carboxylic acid was used.

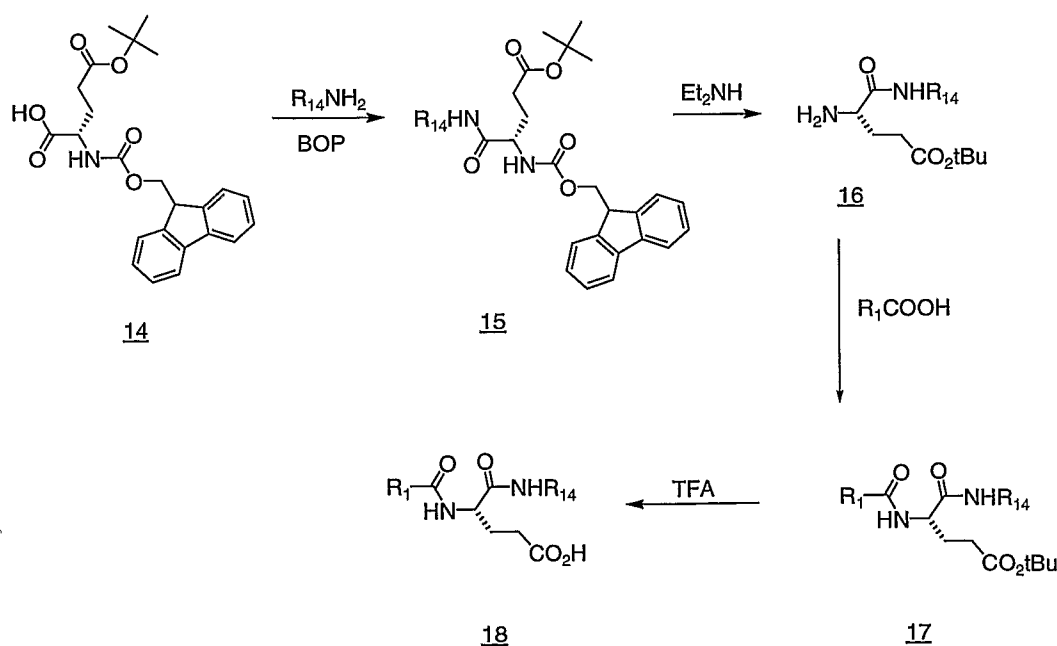
[0198] Step C: methyl N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamate

MS (ESI) m/z 519.2; MS (ESI) m/z 1037.5; HRMS: calcd for $C_{30}H_{31}ClN_2O_4 + H^+$, 519.20451; found (ESI-FTMS, $[M+H]^+$), 519.20406.

[0199] Step D: N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine

MS (ESI) m/z 505.2; MS (ESI) m/z 1009.5.

Scheme 7



Example 7: N^1 -(1,3-benzodioxol-5-ylmethyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0200] Step A: *tert*-butyl N^1 -(1,3-benzodioxol-5-ylmethyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

In a 50 mL round bottom flask, Fmoc-L-Glu-(OtBu)-OH (2.127 g, 5 mmol) was dissolved in DMF (10 mL) and stirred at room temperature under nitrogen. PyBOP (2.6 g, 5 mmol) was added to the stirring mixture followed by piperonylamine (0.755 g, 5 mmol), and DIEA (1.2 equivalent) added dropwise. The mixture was stirred overnight (18-24 hr) at room temperature under nitrogen. The reaction mixture was then poured into 150 mL of water and the solid was collected and washed with water. The wet solid was then dissolved in ethyl acetate (ca. 500 mL), and washed consecutively with 10% HCl (aq.), NaHCO₃ (satd.), and NaCl (satd.). The organic phase was dried over MgSO₄ (anh.) and concentrated. The crude product was redissolved in acetone and hexanes were added. The precipitated solid was filtered, washed with hexanes and dried in a vacuum desiccator overnight to give 1.56 g of *tert*-butyl N^1 -(1,3-benzodioxol-5-ylmethyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate as fine white solid. MS (ESI) m/z 559.1; HRMS: calcd for C₃₂H₃₄N₂O₇ + H⁺, 559.24388; found (ESI_FT, [M+H]¹⁺), 559.24348.

[0201] Step B: *tert*-butyl N^1 -(1,3-benzodioxol-5-ylmethyl)-L- α -glutamate

The Fmoc-ester product (1.5 g, 2.7 mmol) was (partially) dissolved in acetonitrile (17 mL) and stirred at room temperature under nitrogen. The mixture was fully dissolved about 30 min after addition of diethylamine (4.2 mL) and was stirred for two hours. After reaction completion, the mixture is carefully concentrated (<30°C) under reduced pressure by rotary evaporator. The crude product (clear oil) was then filtered through a short flash column. The column was gradient eluted starting with 5% Acetone/CH₂Cl₂ until the Fmoc byproduct was removed and ramped to 50% Acetone/CH₂Cl₂ while the product eluted. The desired fractions were collected and concentrated giving 0.8 g clear oil. MS (ESI) m/z 337.1; HRMS: calcd for C₁₇H₂₄N₂O₅ + H⁺, 337.17580; found (ESI_FT, [M+H]¹⁺), 337.17605.

[0202] Step C: *tert*-butyl N^1 -(1,3-benzodioxol-5-ylmethyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamate

The free amine (0.36 g, 1.07 mmol) was dissolved in DMF (5 mL) and stirred at rt under

nitrogen. 4-Biphenyl carboxylic acid (0.557 g, 1.07 mmol) was added followed by PyBOP reagent (0.21 g, 1.07 mmol) with vigorous stirring. The reaction mixture was cooled to 0°C and DIEA (1.2 equiv.) was added dropwise. The reaction was complete in 14-24 hours. The reaction mixture was then poured into 100 mL water and the solid collected. The solid was redissolved in ethyl acetate and washed with 10% HCl (aq.), NaHCO₃ (satd.), and NaCl (satd.). The organic phase was dried over Na₂SO₄ (anh.) and concentrated. Acetone was added to the residue and diluted with hexanes. The precipitate was collected and dried in a vacuum desiccator overnight to give 0.4 g of desired product. MS (ESI) *m/z* 517.2; HRMS: calcd for C₃₀H₃₂N₂O₆ + H⁺, 517.23331; found (ESI_FT, [M+H]¹⁺), 517.23311.

[0203] Step D: *N*¹-(1,3-benzodioxol-5-ylmethyl)-*N*²-(1,1'-biphenyl-4-ylcarbonyl)-L-α-glutamine

The *t*-butyl ester (0.31 g, 0.6 mmol) was dissolved in CH₂Cl₂ (4 mL) and stirred at rt under nitrogen. Trifluoroacetic acid (4 mL) dissolved in CH₂Cl₂ (4 mL) is added to the solution and the light yellow solution is stirred at rt for 2 hours. The mixture is evaporated and diluted toluene (10 mL), evaporated to fully remove the TFA. A solid is obtained and dissolved in minimum acetone (ca. 25-50 mL) warmed slightly and hexanes added. The white solid was collected and dried in a vacuum desiccator to yield 0.214 g product. MS (ESI) *m/z* 461.1; HRMS: calcd for C₂₆H₂₄N₂O₆ + H⁺, 461.17071; found (ESI_FT, [M+H]¹⁺), 461.1704.

Example 8:

[0204] The following compounds were prepared according to the procedures similar to those of Example 7.

Example 8A: *N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclohexyl-L-α-glutamine

[0205] Step A: *tert*-butyl *N*¹-cyclohexyl-*N*²-[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L-α-glutamate

MS (ESI) *m/z* 507.2; HRMS: calcd for C₃₀H₃₈N₂O₅ + H⁺, 507.28535; found (ESI_FT, [M+H]¹⁺), 507.28583.

[0206] Step B: *tert*-butyl *N*¹-cyclohexyl-L-α-glutamate

MS (ESI) *m/z* 285.2; HRMS: calcd for C₁₅H₂₈N₂O₃ + H⁺, 285.21727; found (ESI_FT,

$[M+H]^{1+}$), 285.21644.

[0207] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclohexyl-L- α -glutamate

MS (ESI) m/z 465.2; HRMS: calcd for $C_{28}H_{36}N_2O_4 + H^+$, 465.27478; found (ESI_FT, $[M+H]^{1+}$), 465.27386.

[0208] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclohexyl-L- α -glutamine
HRMS: calcd for $C_{24}H_{28}N_2O_4 + H^+$, 409.21218; found (ESI_FT, $[M+H]^{1+}$), 409.21163.

Example 8B: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclopropyl-L- α -glutamine

[0209] Step A: *tert*-butyl N^1 -cyclopropyl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 465.1; HRMS: calcd for $C_{27}H_{32}N_2O_5 + H^+$, 465.23840; found (ESI_FT, $[M+H]^{1+}$), 465.23816.

[0210] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclopropyl-L- α -glutamate

MS (ESI) m/z 423.2; HRMS: calcd for $C_{25}H_{30}N_2O_4 + H^+$, 423.22783; found (ESI_FT, $[M+H]^{1+}$), 423.22725.

[0211] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclopropyl-L- α -glutamine
MS (ESI) m/z 367.1; MS (ESI) m/z 733.2; HRMS: calcd for $C_{21}H_{22}N_2O_4 + H^+$, 367.16523; found (ESI_FT, $[M+H]^{1+}$), 367.16454.

Example 8C: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -butyl-L- α -glutamine

[0212] Step A: *tert*-butyl N^1 -butyl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 481.2; MS (ESI) m/z 503.2; HRMS: calcd for $C_{28}H_{36}N_2O_5 + H^+$, 481.26970; found (ESI_FT, $[M+H]^{1+}$), 481.26789.

[0213] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -butyl-L- α -glutamate

MS (ESI) m/z 439.1; MS (ESI) m/z 877.3; HRMS: calcd for $C_{26}H_{34}N_2O_4 + H^+$, 439.25913; found (ESI_FT, $[M+H]^{1+}$), 439.25884.

[0214] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -butyl-L- α -glutamine
MS (ESI) m/z 381.2; MS (ESI) m/z 763.3; HRMS: calcd for $C_{22}H_{26}N_2O_4 + H^+$,

383.19653; found (ESI_FT, $[M+H]^+$), 383.19514.

Example 8D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-fluorobenzyl)-L- α -glutamine

[0215] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(4-fluorobenzyl)-L- α -glutamate

MS (ESI) m/z 533.2; HRMS: calcd for $C_{31}H_{33}FN_2O_5 + H^+$, 533.24463; found (ESI_FT, $[M+H]^+$), 533.24546.

[0216] Step B: *tert*-butyl N^1 -(4-fluorobenzyl)-L- α -glutamate

MS (ESI) m/z 311.1; HRMS: calcd for $C_{16}H_{23}FN_2O_3 + H^+$, 311.17655; found (ESI_FT, $[M+H]^+$), 311.17696.

[0217] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-fluorobenzyl)-L- α -glutamate

MS (ESI) m/z 491.2; HRMS: calcd for $C_{29}H_{31}FN_2O_4 + H^+$, 491.23406; found (ESI_FT, $[M+H]^+$), 491.23339.

[0218] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-fluorobenzyl)-L- α -glutamine

MS (ESI) m/z 435.1; HRMS: calcd for $C_{25}H_{23}FN_2O_4 + H^+$, 435.17146; found (ESI_FT, $[M+H]^+$), 435.17056.

Example 8E: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclooctyl-L- α -glutamine

[0219] Step A: *tert*-butyl N^1 -cyclooctyl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 535.2; HRMS: calcd for $C_{32}H_{42}N_2O_5 + H^+$, 535.31665; found (ESI_FT, $[M+H]^+$), 535.31782.

[0220] Step B: *tert*-butyl N^1 -cyclooctyl-L- α -glutamate

MS (ESI_FT) m/z 313.24821; MS (ESI_FT) m/z 313.24857; HRMS: calcd for $C_{17}H_{32}N_2O_3 + H^+$, 313.24857; found (ESI_FT, $[M+H]^+$), 313.24821.

[0221] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclooctyl-L- α -glutamate

MS (ESI) m/z 493.4; MS (ESI) m/z 985.6; HRMS: calcd for $C_{30}H_{40}N_2O_4 + H^+$, 493.30608; found (ESI_FTMS, $[M+H]^+$), 493.30412.

[0222] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclooctyl-L- α -glutamine

MS (ESI) m/z 437.3; MS (ESI) m/z 873.6; HRMS: calcd for $C_{26}H_{32}N_2O_4 + H^+$, 437.24348; found (ESI_FT, $[M+H]^+$), 437.24272.

Example 8F: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethoxybenzyl)-L- α -glutamine

[0223] Step A: *tert*-butyl N^1 -(3,4-dimethoxybenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 575.3; MS (ESI) m/z 1149.6; HRMS: calcd for $C_{33}H_{38}N_2O_7 + H^+$, 575.27518; found (ESI_FT, $[M+H]^+$), 575.27609.

[0224] Step B: *tert*-butyl N^1 -(3,4-dimethoxybenzyl)-L- α -glutamate

MS (ESI+) m/z 353.2; MS (ESI+) m/z 297.1; HRMS: calcd for $C_{18}H_{28}N_2O_5 + H^+$, 353.20710; found (ESI_FT, $[M+H]^+$), 353.20629.

[0225] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethoxybenzyl)-L- α -glutamate

MS (ESI+) m/z 533.3; HRMS: calcd for $C_{31}H_{36}N_2O_6 + H^+$, 533.26461; found (ESI_FT, $[M+H]^+$), 533.26323.

[0226] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethoxybenzyl)-L- α -glutamine

MS (ESI-) m/z 475.3; HRMS: calcd for $C_{27}H_{28}N_2O_6 + H^+$, 477.20201; found (ESI_FT, $[M+H]^+$), 477.20053.

Example 8G: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclopentyl-L- α -glutamine

[0227] Step A: *tert*-butyl N^1 -cyclopentyl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI+) m/z 493.3; MS (ESI+) m/z 437.2; HRMS: calcd for $C_{29}H_{36}N_2O_5 + H^+$, 493.26970; found (ESI_FT, $[M+H]^+$), 493.26812.

[0228] Step B: *tert*-butyl N^1 -cyclopentyl-L- α -glutamate

MS (ESI) m/z 271.2; HRMS: calcd for $C_{14}H_{26}N_2O_3 + H^+$, 271.20162; found (ESI_FT, $[M+H]^+$), 271.202.

[0229] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclopentyl-L- α -glutamate

MS (ESI) m/z 451.3; MS (ESI) m/z 901.6; HRMS: calcd for $C_{27}H_{34}N_2O_4 + H^+$,

451.25913; found (ESI_FT, $[M+H]^+$), 451.25803.

[0230] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -cyclopentyl-L- α -glutamine
MS (ESI) m/z 395.2; MS (ESI) m/z 789.4; HRMS: calcd for $C_{23}H_{26}N_2O_4 + H^+$,
395.19653; found (ESI_FT, $[M+H]^+$), 395.19564.

Example 8H: N^1 -2-adamantyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0231] Step A: *tert*-butyl N^1 -2-adamantyl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate
MS (ESI) m/z 559.4; MS (ESI) m/z 1117.7; HRMS: calcd for $C_{34}H_{42}N_2O_5 + H^+$,
559.31665; found (ESI_FT, $[M+H]^+$), 559.31524.

[0232] Step B: *tert*-butyl N^1 -2-adamantyl-L- α -glutamate
MS (ESI) m/z 337.2; MS (ESI) m/z 673.5; HRMS: calcd for $C_{19}H_{32}N_2O_3 + H^+$,
337.24857; found (ESI_FT, $[M+H]^+$), 337.2475.

[0233] Step C: *tert*-butyl N^1 -2-adamantyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamate
MS (ESI) m/z 517.3; MS (ESI) m/z 1033.6; HRMS: calcd for $C_{32}H_{40}N_2O_4 + H^+$,
517.30608; found (ESI_FT, $[M+H]^+$), 517.30505.

[0234] Step D: N^1 -2-adamantyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine
MS (ESI) m/z 461.3; MS (ESI) m/z 921.5; HRMS: calcd for $C_{28}H_{32}N_2O_4 + H^+$,
461.24348; found (ESI_FT, $[M+H]^+$), 461.24227.

Example 8I: N^1 -(2-adamantylmethyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0235] Step A: *tert*-butyl N^1 -(2-adamantylmethyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate
MS (ESI) m/z 573.3; MS (ESI) m/z 1145.5; HRMS: calcd for $C_{35}H_{44}N_2O_5 + H^+$,
573.33230; found (ESI_FT, $[M+H]^+$), 573.33089.

[0236] Step B: *tert*-butyl N^1 -(2-adamantylmethyl)-L- α -glutamate
MS (ESI) m/z 351.2; HRMS: calcd for $C_{20}H_{34}N_2O_3 + H^+$, 351.26422; found (ESI_FT, $[M+H]^+$), 351.26491.

[0237] Step C: *tert*-butyl N^1 -(2-adamantylmethyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamate

MS (ESI) m/z 531.3; MS (ESI) m/z 1061.4; HRMS: calcd for $C_{33}H_{42}N_2O_4 + H^+$, 531.32173; found (ESI_FT, $[M+H]^+$), 531.32031.

[0238] Step D: N^1 -(2-adamantylmethyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

MS (ESI) m/z 475.2; MS (ESI) m/z 949.3; HRMS: calcd for $C_{29}H_{34}N_2O_4 + H^+$, 475.25913; found (ESI_FT, $[M+H]^+$), 475.25734.

Example 8J: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxyethyl)-L- α -glutamine

[0239] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(2-methoxyethyl)-L- α -glutamate

MS (ESI) m/z 483.2; MS (ESI) m/z 965.3; HRMS: calcd for $C_{27}H_{34}N_2O_6 + H^+$, 483.24896; found (ESI_FT, $[M+H]^+$), 483.24851.

[0240] Step B: *tert*-butyl N^1 -(2-methoxyethyl)-L- α -glutamate

MS (ESI) m/z 261.1; HRMS: calcd for $C_{12}H_{24}N_2O_4 + H^+$, 261.18088; found (ESI_FT, $[M+H]^+$), 261.18071.

[0241] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxyethyl)-L- α -glutamate

MS (ESI) m/z 441.2; MS (ESI) m/z 881.3; HRMS: calcd for $C_{25}H_{32}N_2O_5 + H^+$, 441.23840; found (ESI_FT, $[M+H]^+$), 441.23803.

[0242] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxyethyl)-L- α -glutamine

MS (ESI) m/z 385.1; MS (ESI) m/z 769.2; HRMS: calcd for $C_{21}H_{24}N_2O_5 + H^+$, 385.17580; found (ESI_FT, $[M+H]^+$), 385.17538.

Example 8K: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methoxybenzyl)-L- α -glutamine

[0243] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(4-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 545.2; MS (ESI) m/z 1089.3; HRMS: calcd for $C_{32}H_{36}N_2O_6 + H^+$, 545.26461; found (ESI_FT, $[M+H]^+$), 545.26277.

[0244] Step B: *tert*-butyl N^1 -(4-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 323.2; HRMS: calcd for $C_{17}H_{26}N_2O_4 + H^+$, 323.19653; found (ESI_FT, $[M+H]^+$), 323.19702.

[0245] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 503.2; MS (ESI) m/z 1005.4; HRMS: calcd for $C_{30}H_{34}N_2O_5 + H^+$, 503.25405; found (ESI_FT, $[M+H]^+$), 503.25435.

[0246] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methoxybenzyl)-L- α -glutamine

MS (ESI) m/z 445.2; MS (ESI) m/z 891.5; HRMS: calcd for $C_{26}H_{26}N_2O_5 + H^+$, 447.19145; found (ESI_FT, $[M+H]^+$), 447.19235.

Example 8L: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3,4-dimethoxyphenyl)ethyl]-L- α -glutamine

[0247] Step A: *tert*-butyl N^1 -[2-(3,4-dimethoxyphenyl)ethyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 589.2; MS (ESI) m/z 1177.3; HRMS: calcd for $C_{34}H_{40}N_2O_7 + H^+$, 589.29083; found (ESI_FT, $[M+H]^+$), 589.28932.

[0248] Step B: *tert*-butyl N^1 -[2-(3,4-dimethoxyphenyl)ethyl]-L- α -glutamate
MS (ESI) m/z 367.2; HRMS: calcd for $C_{19}H_{30}N_2O_5 + H^+$, 367.22275; found (ESI_FT, $[M+H]^+$), 367.22308.

[0249] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3,4-dimethoxyphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 547.3; MS (ESI) m/z 1093.4; HRMS: calcd for $C_{32}H_{38}N_2O_6 + H^+$, 547.28026; found (ESI_FT, $[M+H]^+$), 547.280241.

[0250] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3,4-dimethoxyphenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 491.2; MS (ESI) m/z 981.2; HRMS: calcd for $C_{28}H_{30}N_2O_6 + H^+$, 491.21766; found (ESI_FT, $[M+H]^+$), 491.21697.

Example 8M: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-methoxyphenyl)ethyl]-L- α -glutamine

[0251] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(4-methoxyphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 559.2; MS (ESI) m/z 1117.3; HRMS: calcd for $C_{33}H_{38}N_2O_6 + H^+$,

559.28026; found (ESI_FT, $[M+H]^+$), 559.27899.

[0252] Step B: *tert*-butyl N^1 -[2-(4-methoxyphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 337.1; MS (ESI) m/z 673.3; HRMS: calcd for $C_{18}H_{28}N_2O_4 + H^+$, 337.21218; found (ESI_FT, $[M+H]^+$), 337.21196.

[0253] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-methoxyphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 517.2; MS (ESI) m/z 1033.4; HRMS: calcd for $C_{31}H_{36}N_2O_5 + H^+$, 517.26970; found (ESI_FT, $[M+H]^+$), 517.26875.

[0254] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-methoxyphenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 461.2; MS (ESI) m/z 921.3; HRMS: calcd for $C_{27}H_{28}N_2O_5 + H^+$, 461.20710; found (ESI_FT, $[M+H]^+$), 461.2062.

Example 8N: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(1-naphthylmethyl)-L- α -glutamine

[0255] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(1-naphthylmethyl)-L- α -glutamate

MS (ESI) m/z 565.2; MS (ESI) m/z 1129.4; HRMS: calcd for $C_{35}H_{36}N_2O_5 + H^+$, 565.26970; found (ESI_FT, $[M+H]^+$), 565.26849.

[0256] Step B: *tert*-butyl N^1 -(1-naphthylmethyl)-L- α -glutamate

MS (ESI) m/z 343.1; MS (ESI) m/z 685.3; HRMS: calcd for $C_{20}H_{26}N_2O_3 + H^+$, 343.20162; found (ESI_FT, $[M+H]^+$), 343.2014.

[0257] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(1-naphthylmethyl)-L- α -glutamate

MS (ESI) m/z 523.2; MS (ESI) m/z 1045.4; HRMS: calcd for $C_{33}H_{34}N_2O_4 + H^+$, 523.25913; found (ESI_FT, $[M+H]^+$), 523.2583.

[0258] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(1-naphthylmethyl)-L- α -glutamine

MS (ESI) m/z 467.2; MS (ESI) m/z 933.3; HRMS: calcd for $C_{29}H_{26}N_2O_4 + H^+$, 467.19653; found (ESI_FT, $[M+H]^+$), 467.19528.

Example 8O: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methylbenzyl)-L- α -glutamine

[0259] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-methylbenzyl)-L- α -glutamate

MS (ESI) m/z 529.1; MS (ESI) m/z 1057.4; HRMS: calcd for $C_{32}H_{36}N_2O_5 + H^+$, 529.26970; found (ESI_FT, $[M+H]^+$), 529.26804.

[0260] Step B: *tert*-butyl N^1 -(3-methylbenzyl)-L- α -glutamate

MS (ESI) m/z 307.1; MS (ESI) m/z 613.3; HRMS: calcd for $C_{17}H_{26}N_2O_3 + H^+$, 307.20162; found (ESI_FT, $[M+H]^+$), 307.20079.

[0261] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methylbenzyl)-L- α -glutamate

HRMS: calcd for $C_{30}H_{34}N_2O_4 + H^+$, 487.25913; found (ESI_FT, $[M+H]^+$), 487.25842.

[0262] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methylbenzyl)-L- α -glutamine

HRMS: calcd for $C_{26}H_{26}N_2O_4 + H^+$, 431.19653; found (ESI_FT, $[M+H]^+$), 431.19568.

Example 8P: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-furylmethyl)-L- α -glutamine

[0263] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(2-furylmethyl)-L- α -glutamate

MS (ESI) m/z 505.2; HRMS: calcd for $C_{29}H_{32}N_2O_6 + H^+$, 505.23331; found (ESI_FT, $[M+H]^+$), 505.23263.

[0264] Step B: *tert*-butyl N^1 -(2-furylmethyl)-L- α -glutamate

HRMS: calcd for $C_{14}H_{22}N_2O_4 + H^+$, 283.16523; found (ESI_FT, $[M+H]^+$), 283.16497.

[0265] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-furylmethyl)-L- α -glutamate

HRMS: calcd for $C_{27}H_{30}N_2O_5 + H^+$, 463.22275; found (ESI_FT, $[M+H]^+$), 463.22212.

[0266] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-furylmethyl)-L- α -glutamine

HRMS: calcd for $C_{23}H_{22}N_2O_5 + H^+$, 407.16015; found (ESI_FT, $[M+H]^+$), 407.15957.

Example 8Q: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methoxybenzyl)-L- α -glutamine

[0267] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 545.3; MS (ESI) m/z 1089.5; HRMS: calcd for $C_{32}H_{36}N_2O_6 + H^+$,

545.26461; found (ESI_FT, $[M+H]^{1+}$), 545.26286.

[0268] Step B: *tert*-butyl N^1 -(3-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 323.3; MS (ESI) m/z 645.7; HRMS: calcd for $C_{17}H_{26}N_2O_4 + H^+$, 323.19653; found (ESI_FT, $[M+H]^{1+}$), 323.19687.

[0269] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 503.2; MS (ESI) m/z 1005.5; HRMS: calcd for $C_{30}H_{34}N_2O_5 + H^+$, 503.25405; found (ESI_FT, $[M+H]^{1+}$), 503.25322.

[0270] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-methoxybenzyl)-L- α -glutamine

MS (ESI) m/z 447.2; MS (ESI) m/z 893.3; HRMS: calcd for $C_{26}H_{26}N_2O_5 + H^+$, 447.19145; found (ESI_FT, $[M+H]^{1+}$), 447.19079.

Example 8R: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0271] Step A: *tert*-butyl N^2 -[(9H-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 605.2; MS (ESI) m/z 1209.4; HRMS: calcd for $C_{34}H_{40}N_2O_8 + H^+$, 605.28574; found (ESI_FT, $[M+H]^{1+}$), 605.28453.

[0272] Step B: *tert*-butyl N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 383.1; MS (ESI) m/z 765.3; HRMS: calcd for $C_{19}H_{30}N_2O_6 + H^+$, 383.21766; found (ESI_FT, $[M+H]^{1+}$), 383.21755.

[0273] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 563.3; MS (ESI) m/z 1125.5; HRMS: calcd for $C_{32}H_{38}N_2O_7 + H^+$, 563.27518; found (ESI_FT, $[M+H]^{1+}$), 563.2744.

[0274] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

MS (ESI) m/z 507.2; MS (ESI) m/z 1013.4; HRMS: calcd for $C_{28}H_{30}N_2O_7 + H^+$, 507.21258; found (ESI_FT, $[M+H]^{1+}$), 507.21179.

Example 8S: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dichlorobenzyl)-L- α -glutamine

[0275] Step A: *tert*-butyl N^1 -(2,4-dichlorobenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 583.1; HRMS: calcd for $C_{31}H_{32}Cl_2N_2O_5 + H^+$, 583.17610; found (ESI_FT, $[M+H]^+$), 583.1742.

[0276] Step B: *tert*-butyl N^1 -(2,4-dichlorobenzyl)-L- α -glutamate

MS (ESI) m/z 361.1; MS (ESI) m/z 721.2; HRMS: calcd for $C_{16}H_{22}Cl_2N_2O_3 + H^+$, 361.10802; found (ESI_FT, $[M+H]^+$), 361.10891.

[0277] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dichlorobenzyl)-L- α -glutamate

MS (ESI) m/z 541.2; MS (ESI) m/z 1081.3; HRMS: calcd for $C_{29}H_{30}Cl_2N_2O_4 + H^+$, 541.16554; found (ESI_FT, $[M+H]^+$), 541.16693.

[0278] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dichlorobenzyl)-L- α -glutamine

MS (ESI) m/z 483.1; MS (ESI) m/z 967.2; HRMS: calcd for $C_{25}H_{22}Cl_2N_2O_4 + H^+$, 485.10294; found (ESI_FT, $[M+H]^+$), 485.10231.

Example 8T: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(trifluoromethoxy)benzyl]-L- α -glutamine

[0279] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[4-(trifluoromethoxy)benzyl]-L- α -glutamate

MS (ESI) m/z 599.1; MS (ESI) m/z 1197.3; HRMS: calcd for $C_{32}H_{33}F_3N_2O_6 + H^+$, 599.23635; found (ESI_FT, $[M+H]^+$), 599.23521.

[0280] Step B: *tert*-butyl N^1 -[4-(trifluoromethoxy)benzyl]-L- α -glutamate

MS (ESI) m/z 377.1; HRMS: calcd for $C_{17}H_{23}F_3N_2O_4 + H^+$, 377.16827; found (ESI_FT, $[M+H]^+$), 377.16901.

[0281] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(trifluoromethoxy)benzyl]-L- α -glutamate

MS (ESI) m/z 557.2; MS (ESI) m/z 1113.4; HRMS: calcd for $C_{30}H_{31}F_3N_2O_5 + H^+$, 557.22578; found (ESI_FT, $[M+H]^+$), 557.22537.

[0282] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(trifluoromethoxy)benzyl]-L- α -glutamine

MS (ESI) m/z 501.2; MS (ESI) m/z 1001.3; HRMS: calcd for $C_{26}H_{23}F_3N_2O_5 + H^+$,

501.16318; found (ESI_FT, $[M+H]^+$), 501.16263.

Example 8U: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethoxy)benzyl]-L- α -glutamine

[0283] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[3-(trifluoromethoxy)benzyl]-L- α -glutamate

MS (ESI) m/z 599.2; MS (ESI) m/z 1197.4; HRMS: calcd for $C_{32}H_{33}F_3N_2O_6 + H^+$, 599.23635; found (ESI_FT, $[M+H]^+$), 599.23596.

[0284] Step B: *tert*-butyl N^1 -[3-(trifluoromethoxy)benzyl]-L- α -glutamate

MS (ESI) m/z 377.1; MS (ESI) m/z 753.3; HRMS: calcd for $C_{17}H_{23}F_3N_2O_4 + H^+$, 377.16827; found (ESI_FT, $[M+H]^+$), 377.1691.

[0285] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethoxy)benzyl]-L- α -glutamate

MS (ESI) m/z 557.2; MS (ESI) m/z 1113.4; HRMS: calcd for $C_{30}H_{31}F_3N_2O_5 + H^+$, 557.22578; found (ESI_FT, $[M+H]^+$), 557.22558.

[0286] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethoxy)benzyl]-L- α -glutamine

MS (ESI) m/z 499.1; MS (ESI) m/z 999.3; HRMS: calcd for $C_{26}H_{23}F_3N_2O_5 + H^+$, 501.16318; found (ESI_FT, $[M+H]^+$), 501.16265.

Example 8V: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(methylthio)benzyl]-L- α -glutamine

[0287] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[4-(methylthio)benzyl]-L- α -glutamate

MS (ESI) m/z 561.2; MS (ESI) m/z 1121.4; HRMS: calcd for $C_{32}H_{36}N_2O_5S + H^+$, 561.24177; found (ESI_FT, $[M+H]^+$), 561.24183.

[0288] Step B: *tert*-butyl N^1 -[4-(methylthio)benzyl]-L- α -glutamate

MS (ESI) m/z 339.2; MS (ESI) m/z 677.3; HRMS: calcd for $C_{17}H_{26}N_2O_3S + H^+$, 339.17369; found (ESI_FT, $[M+H]^+$), 339.1748.

[0289] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(methylthio)benzyl]-L- α -glutamate

MS (ESI) m/z 519.2; MS (ESI) m/z 1037.4; HRMS: calcd for $C_{30}H_{34}N_2O_4S + H^+$,

519.23120; found (ESI_FT, $[M+H]^{1+}$), 519.23078.

[0290] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-(methylthio)benzyl]-L- α -glutamine

MS (ESI) m/z 461.1; MS (ESI) m/z 923.3; HRMS: calcd for $C_{26}H_{26}N_2O_4S + H^+$, 463.16860; found (ESI_FT, $[M+H]^{1+}$), 463.16807.

Example 8W: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenoxybenzyl)-L- α -glutamine

[0291] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(4-phenoxybenzyl)-L- α -glutamate

MS (ESI) m/z 607.3; MS (ESI) m/z 1213.5; HRMS: calcd for $C_{37}H_{38}N_2O_6 + H^+$, 607.28026; found (ESI_FT, $[M+H]^{1+}$), 607.27904.

[0292] Step B: *tert*-butyl N^1 -(4-phenoxybenzyl)-L- α -glutamate

MS (ESI) m/z 385.2; MS (ESI) m/z 769.4; HRMS: calcd for $C_{22}H_{28}N_2O_4 + H^+$, 385.21218; found (ESI_FT, $[M+H]^{1+}$), 385.21141.

[0293] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenoxybenzyl)-L- α -glutamate

MS (ESI) m/z 565.3; MS (ESI) m/z 1129.5; HRMS: calcd for $C_{35}H_{36}N_2O_5 + H^+$, 565.26970; found (ESI_FT, $[M+H]^{1+}$), 565.27062.

[0294] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenoxybenzyl)-L- α -glutamine

MS (ESI) m/z 507.2; MS (ESI) m/z 1015.4; HRMS: calcd for $C_{31}H_{28}N_2O_5 + H^+$, 509.20710; found (ESI_FT, $[M+H]^{1+}$), 509.20657.

Example 8X: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-methoxyphenyl)ethyl]-L- α -glutamine

[0295] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(3-methoxyphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 559.3; MS (ESI) m/z 1117.6; HRMS: calcd for $C_{33}H_{38}N_2O_6 + H^+$, 559.28026; found (ESI_FT, $[M+H]^{1+}$), 559.28074.

[0296] Step B: *tert*-butyl N^1 -[2-(3-methoxyphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 337.2; HRMS: calcd for $C_{18}H_{28}N_2O_4 + H^+$, 337.21218; found (ESI_FT, $[M+H]^{1+}$), 337.21275.

[0297] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-methoxyphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 517.3; MS (ESI) m/z 1033.6; HRMS: calcd for $C_{31}H_{36}N_2O_5 + H^+$, 517.26970; found (ESI_FT, $[M+H]^+$), 517.27068.

[0298] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-methoxyphenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 461.2; MS (ESI) m/z 921.4; HRMS: calcd for $C_{27}H_{28}N_2O_5 + H^+$, 461.20710; found (ESI_FT, $[M+H]^+$), 461.20723.

Example 8Y: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dimethoxybenzyl)-L- α -glutamine

[0299] Step A: *tert*-butyl N^1 -(2,4-dimethoxybenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 575.3; MS (ESI) m/z 1149.5; HRMS: calcd for $C_{33}H_{38}N_2O_7 + H^+$, 575.27518; found (ESI_FT, $[M+H]^+$), 575.275181.

[0300] Step B: *tert*-butyl N^1 -(2,4-dimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 353.2; MS (ESI) m/z 705.4; HRMS: calcd for $C_{18}H_{28}N_2O_5 + H^+$, 353.20710; found (ESI_FT, $[M+H]^+$), 353.20767.

[0301] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 533.3; MS (ESI) m/z 1065.6; HRMS: calcd for $C_{31}H_{36}N_2O_6 + H^+$, 533.26461; found (ESI_FT, $[M+H]^+$), 533.26569.

[0302] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dimethoxybenzyl)-L- α -glutamine

MS (ESI) m/z 477.2; MS (ESI) m/z 953.4; HRMS: calcd for $C_{27}H_{28}N_2O_6 + H^+$, 477.20201; found (ESI_FT, $[M+H]^+$), 477.2019.

Example 8Z: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxybenzyl)-L- α -glutamine

[0303] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(2-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 545.2; HRMS: calcd for $C_{32}H_{36}N_2O_6 + H^+$, 545.26461; found (ESI_FT, $[M+H]^+$), 545.26356.

[0304] Step B: *tert*-butyl N^1 -(2-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 323.2; MS (ESI) m/z 645.4; HRMS: calcd for $C_{17}H_{26}N_2O_4 + H^+$, 323.19653; found (ESI_FT, $[M+H]^+$), 323.19657.

[0305] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 503.2; MS (ESI) m/z 1005.5; HRMS: calcd for $C_{30}H_{34}N_2O_5 + H^+$, 503.25405; found (ESI_FT, $[M+H]^+$), 503.2546.

[0306] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxybenzyl)-L- α -glutamine

MS (ESI) m/z 447.2; MS (ESI) m/z 893.4; HRMS: calcd for $C_{26}H_{26}N_2O_5 + H^+$, 447.19145; found (ESI_FT, $[M+H]^+$), 447.19143.

Example 8AA: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-difluorobenzyl)-L- α -glutamine

[0307] Step A: *tert*-butyl N^1 -(3,5-difluorobenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 551.2; MS (ESI) m/z 1101.4; HRMS: calcd for $C_{31}H_{32}F_2N_2O_5 + H^+$, 551.23521; found (ESI_FT, $[M+H]^+$), 551.23338.

[0308] Step B: *tert*-butyl N^1 -(3,5-difluorobenzyl)-L- α -glutamate

MS (ESI) m/z 329.1; MS (ESI) m/z 657.3; HRMS: calcd for $C_{16}H_{22}F_2N_2O_3 + H^+$, 329.16712; found (ESI_FT, $[M+H]^+$), 329.16762.

[0309] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-difluorobenzyl)-L- α -glutamate

MS (ESI) m/z 509.2; MS (ESI) m/z 1017.3; HRMS: calcd for $C_{29}H_{30}F_2N_2O_4 + H^+$, 509.22464; found (ESI_FTMS, $[M+H]^+$), 509.22463.

[0310] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-difluorobenzyl)-L- α -glutamine

MS (ESI) m/z 451.1; MS (ESI) m/z 903.3; HRMS: calcd for $C_{25}H_{22}F_2N_2O_4 + H^+$, 453.16204; found (ESI_FTMS, $[M+H]^+$), 453.16222.

Example 8BB: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dichlorobenzyl)-L- α -glutamine

[0311] Step A: *tert*-butyl N^1 -(3,4-dichlorobenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 583.1; MS (ESI) m/z 1165.2; HRMS: calcd for $C_{31}H_{32}Cl_2N_2O_5 + H^+$, 583.17610; found (ESI_FT, $[M+H]^+$), 583.17528.

[0312] Step B: *tert*-butyl N^1 -(3,4-dichlorobenzyl)-L- α -glutamate

MS (ESI) m/z 361.1; MS (ESI) m/z 721.2; HRMS: calcd for $C_{16}H_{22}Cl_2N_2O_3 + H^+$, 361.10802; found (ESI_FT, $[M+H]^+$), 361.10861.

[0313] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dichlorobenzyl)-L- α -glutamate

MS (ESI) m/z 541.2; MS (ESI) m/z 1081.3; HRMS: calcd for $C_{29}H_{30}Cl_2N_2O_4 + H^+$, 541.16554; found (ESI_FT, $[M+H]^+$), 541.16685.

[0314] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dichlorobenzyl)-L- α -glutamine

MS (ESI) m/z 483.1; MS (ESI) m/z 967.2; HRMS: calcd for $C_{25}H_{22}Cl_2N_2O_4 + H^+$, 485.10294; found (ESI_FTMS, $[M+H]^+$), 485.10288.

Example 8CC: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-dimethoxybenzyl)-L- α -glutamine

[0315] Step A: *tert*-butyl N^1 -(3,5-dimethoxybenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 575.3; HRMS: calcd for $C_{33}H_{38}N_2O_7 + H^+$, 575.27518; found (ESI_FTMS, $[M+H]^+$), 575.27468.

[0316] Step B: *tert*-butyl N^1 -(3,5-dimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 353.2; HRMS: calcd for $C_{18}H_{28}N_2O_5 + H^+$, 353.20710; found (ESI_FTMS, $[M+H]^+$), 353.20732.

[0317] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-dimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 533.3; MS (ESI) m/z 1065.5; HRMS: calcd for $C_{31}H_{36}N_2O_6 + H^+$, 533.26461; found (ESI_FTMS, $[M+H]^+$), 533.26474.

[0318] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-dimethoxybenzyl)-L- α -glutamine

MS (ESI) m/z 477.2; MS (ESI) m/z 953.4; HRMS: calcd for $C_{27}H_{28}N_2O_6 + H^+$,

477.20201; found (ESI-FTMS, $[M+H]^{1+}$), 477.202.

Example 8DD: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)-L- α -glutamine

[0319] Step A: *tert*-butyl N^1 -(3,4-dimethylbenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 543.3; MS (ESI) m/z 1085.4; HRMS: calcd for $C_{33}H_{38}N_2O_5 + H^+$, 543.28535; found (ESI_FTMS, $[M+H]^{1+}$), 543.28604.

[0320] Step B: *tert*-butyl N^1 -(3,4-dimethylbenzyl)-L- α -glutamate

MS (ESI) m/z 321.2; HRMS: calcd for $C_{18}H_{28}N_2O_3 + H^+$, 321.21727; found (ESI_FTMS, $[M+H]^{1+}$), 321.21716.

[0321] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)-L- α -glutamate

MS (ESI) m/z 501.3; MS (ESI) m/z 1001.4; HRMS: calcd for $C_{31}H_{36}N_2O_4 + H^+$, 501.27478; found (ESI_FTMS, $[M+H]^{1+}$), 501.2735.

[0322] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)-L- α -glutamine

MS (ESI) m/z 445.2; MS (ESI) m/z 889.3; HRMS: calcd for $C_{27}H_{28}N_2O_4 + H^+$, 445.21218; found (ESI_FTMS, $[M+H]^{1+}$), 445.21199.

Example 8EE: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methylbenzyl)-L- α -glutamine

[0323] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(2-methylbenzyl)-L- α -glutamate

MS (ESI) m/z 529.2; MS (ESI) m/z 1057.4; HRMS: calcd for $C_{32}H_{36}N_2O_5 + H^+$, 529.26970; found (ESI_FTMS, $[M+H]^{1+}$), 529.27003.

[0324] Step B: *tert*-butyl N^1 -(2-methylbenzyl)-L- α -glutamate

MS (ESI) m/z 307.2; MS (ESI) m/z 613.4; HRMS: calcd for $C_{17}H_{26}N_2O_3 + H^+$, 307.20162; found (ESI_FTMS, $[M+H]^{1+}$), 307.20094.

[0325] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methylbenzyl)-L- α -glutamate

MS (ESI) m/z 487.2; MS (ESI) m/z 973.3; HRMS: calcd for $C_{30}H_{34}N_2O_4 + H^+$, 487.25913; found (ESI_FTMS, $[M+H]^{1+}$), 487.2588.

[0326] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methylbenzyl)-L- α -glutamine

MS (ESI) m/z 431.2; MS (ESI) m/z 861.3; HRMS: calcd for $C_{26}H_{26}N_2O_4 + H^+$, 431.19653; found (ESI_FTMS, $[M+H]^+$), 431.1966.

Example 8FF: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamine

[0327] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-phenylpropyl)-L- α -glutamate

MS (ESI) m/z 543.3; HRMS: calcd for $C_{33}H_{38}N_2O_5 + H^+$, 543.28535; found (ESI_FTMS, $[M+H]^+$), 543.2847.

[0328] Step B: *tert*-butyl N^1 -(3-phenylpropyl)-L- α -glutamate

MS (ESI) m/z 321.2; MS (ESI) m/z 641.4; HRMS: calcd for $C_{18}H_{28}N_2O_3 + H^+$, 321.21727; found (ESI_FTMS, $[M+H]^+$), 321.2167.

[0329] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamate

MS (ESI) m/z 501.3; HRMS: calcd for $C_{31}H_{36}N_2O_4 + H^+$, 501.27478; found (ESI_FTMS, $[M+H]^+$), 501.2742.

[0330] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamine

MS (ESI) m/z 445.2; HRMS: calcd for $C_{27}H_{28}N_2O_4 + H^+$, 445.21218; found (ESI_FTMS, $[M+H]^+$), 445.2121.

Example 8GG: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -2,3-dihydro-1*H*-inden-2-yl-L- α -glutamine

[0331] Step A: *tert*-butyl N^1 -2,3-dihydro-1*H*-inden-2-yl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 541.2; MS (ESI) m/z 1081.4; HRMS: calcd for $C_{33}H_{36}N_2O_5 + H^+$, 541.26970; found (ESI_FTMS, $[M+H]^+$), 541.27088.

[0332] Step B: *tert*-butyl N^1 -2,3-dihydro-1*H*-inden-2-yl-L- α -glutamate

MS (ESI) m/z 319.1; MS (ESI) m/z 637.3; HRMS: calcd for $C_{18}H_{26}N_2O_3 + H^+$, 319.20162; found (ESI_FTMS, $[M+H]^+$), 319.20275.

[0333] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -2,3-dihydro-1*H*-inden-2-yl-L- α -glutamate

MS (ESI) m/z 499.2; MS (ESI) m/z 997.4; HRMS: calcd for $C_{31}H_{34}N_2O_4 + H^+$, 499.25913; found (ESI-FTMS, $[M+H]^+$), 499.258.

[0334] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -2,3-dihydro-1*H*-inden-2-yl-L- α -glutamine

MS (ESI) m/z 441.2; MS (ESI) m/z 883.3; HRMS: calcd for $C_{27}H_{26}N_2O_4 + H^+$, 443.19653; found (ESI-FTMS, $[M+H]^+$), 443.19699.

Example 8HH: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,3-dimethylbenzyl)-L- α -glutamine

[0335] Step A: *tert*-butyl N^1 -(2,3-dimethylbenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 543.2; MS (ESI) m/z 1085.4; HRMS: calcd for $C_{33}H_{38}N_2O_5 + H^+$, 543.28535; found (ESI-FTMS, $[M+H]^+$), 543.28623.

[0336] Step B: *tert*-butyl N^1 -(2,3-dimethylbenzyl)-L- α -glutamate

MS (ESI) m/z 321.2; MS (ESI) m/z 641.4; HRMS: calcd for $C_{18}H_{28}N_2O_3 + H^+$, 321.21727; found (ESI-FTMS, $[M+H]^+$), 321.2186.

[0337] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,3-dimethylbenzyl)-L- α -glutamate

MS (ESI) m/z 501.2; MS (ESI) m/z 1001.4; HRMS: calcd for $C_{31}H_{36}N_2O_4 + H^+$, 501.27478; found (ESI-FTMS, $[M+H]^+$), 501.27629.

[0338] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,3-dimethylbenzyl)-L- α -glutamine

MS (ESI) m/z 443.2; HRMS: calcd for $C_{27}H_{28}N_2O_4 + H^+$, 445.21218; found (ESI-FTMS, $[M+H]^+$), 445.21354.

Example 8II: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenylbutyl)-L- α -glutamine

[0339] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(4-phenylbutyl)-L- α -glutamate

MS (ESI) m/z 557.2; MS (ESI) m/z 1113.4; HRMS: calcd for $C_{34}H_{40}N_2O_5 + H^+$, 557.30100; found (ESI-FTMS, $[M+H]^+$), 557.30162.

[0340] Step B: *tert*-butyl N^1 -(4-phenylbutyl)-L- α -glutamate

MS (ESI) m/z 335.2; HRMS: calcd for $C_{19}H_{30}N_2O_3 + H^+$, 335.23292; found (ESI-FTMS, $[M+H]^+$), 335.23453;

[0341] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenylbutyl)-L- α -glutamate

MS (ESI) m/z 515.3; MS (ESI) m/z 1029.5; HRMS: calcd for $C_{32}H_{38}N_2O_4 + H^+$, 515.29043; found (ESI-FTMS, $[M+H]^+$), 515.29152.

[0342] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenylbutyl)-L- α -glutamine

MS (ESI) m/z 459.2; MS (ESI) m/z 917.4; HRMS: calcd for $C_{28}H_{30}N_2O_4 + H^+$, 459.22783; found (ESI-FTMS, $[M+H]^+$), 459.22972.

Example 8JJ: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamine

[0343] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-iodobenzyl)-L- α -glutamate

MS (ESI) m/z 641.1; MS (ESI) m/z 1281.1; HRMS: calcd for $C_{31}H_{33}IN_2O_5 + H^+$, 641.15070; found (ESI-FTMS, $[M+H]^+$), 641.15111.

[0344] Step B: *tert*-butyl N^1 -(3-iodobenzyl)-L- α -glutamate

MS (ESI) m/z 419.1; MS (ESI) m/z 837.1; HRMS: calcd for $C_{16}H_{23}IN_2O_3 + H^+$, 419.08262; found (ESI-FTMS, $[M+H]^+$), 419.08459.

[0345] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamate

MS (ESI) m/z 599.1; MS (ESI) m/z 1197.1; HRMS: calcd for $C_{29}H_{31}IN_2O_4 + H^+$, 599.14013; found (ESI-FTMS, $[M+H]^+$), 599.1414.

[0346] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamine

MS (ESI) m/z 543.1; MS (ESI) m/z 1085.1; MS (ESI) m/z 601.1; HRMS: calcd for $C_{25}H_{23}IN_2O_4 + H^+$, 543.07753; found (ESI-FTMS, $[M+H]^+$), 543.07723.

Example 8KK: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-*tert*-butylbenzyl)-L- α -glutamine

[0347] Step A: *tert*-butyl N^1 -(4-*tert*-butylbenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 571.3; MS (ESI) m/z 1141.6; HRMS: calcd for $C_{35}H_{42}N_2O_5 + H^+$, 571.31665; found (ESI-FT, $[M+H]^{1+}$), 571.31581.

[0348] Step B: *tert*-butyl N^1 -(4-*tert*-butylbenzyl)-L- α -glutamate

MS (ESI) m/z 349.2; HRMS: calcd for $C_{20}H_{32}N_2O_3 + H^+$, 349.24857; found (ESI-FTMS, $[M+H]^{1+}$), 349.2489.

[0349] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-*tert*-butylbenzyl)-L- α -glutamate

MS (ESI) m/z 529.2; MS (ESI) m/z 1057.4; HRMS: calcd for $C_{33}H_{40}N_2O_4 + H^+$, 529.30608; found (ESI-FTMS, $[M+H]^{1+}$), 529.30622.

[0350] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-*tert*-butylbenzyl)-L- α -glutamine

MS (ESI) m/z 473.2; MS (ESI) m/z 945.3; MS (ESI) m/z 531.2; HRMS: calcd for $C_{29}H_{32}N_2O_4 + H^+$, 473.24348; found (ESI-FTMS, $[M+H]^{1+}$), 473.24348.

Example 8LL: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-iodobenzyl)-L- α -glutamine

[0351] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(4-iodobenzyl)-L- α -glutamate

MS (ESI) m/z 641.1; MS (ESI) m/z 1281.1; HRMS: calcd for $C_{31}H_{33}IN_2O_5 + H^+$, 641.15070; found (ESI-FTMS, $[M+H]^{1+}$), 641.15129.

[0352] Step B: *tert*-butyl N^1 -(4-iodobenzyl)-L- α -glutamate

MS (ESI) m/z 419; HRMS: calcd for $C_{16}H_{23}IN_2O_3 + H^+$, 419.08262; found (ESI-FTMS, $[M+H]^{1+}$), 419.08332.

[0353] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-iodobenzyl)-L- α -glutamate

MS (ESI) m/z 599; MS (ESI) m/z 1197; HRMS: calcd for $C_{29}H_{31}IN_2O_4 + H^+$, 599.14013; found (ESI-FTMS, $[M+H]^{1+}$), 599.1407.

[0354] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-iodobenzyl)-L- α -glutamine

MS (ESI) m/z 543; MS (ESI) m/z 1085; HRMS: calcd for $C_{25}H_{23}IN_2O_4 + H^+$, 543.07753; found (ESI-FTMS, $[M+H]^{1+}$), 543.07755.

Example 8MM: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethylpropyl)-L- α -glutamine

[0355] Step A: *tert*-butyl N^1 -(1,1-dimethylpropyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 495.3; HRMS: calcd for $C_{29}H_{38}N_2O_5 + H^+$, 495.28535; found (ESI-FT, $[M+H]^+$), 495.28577.

[0356] Step B: *tert*-butyl N^1 -(1,1-dimethylpropyl)-L- α -glutamate

MS (ESI) m/z 273.2; HRMS: calcd for $C_{14}H_{28}N_2O_3 + H^+$, 273.21727; found (ESI-FTMS, $[M+H]^+$), 273.21738.

[0357] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethylpropyl)-L- α -glutamate

MS (ESI) m/z 453.2; MS (ESI) m/z 905.5; HRMS: calcd for $C_{27}H_{36}N_2O_4 + H^+$, 453.27478; found (ESI-FTMS, $[M+H]^+$), 453.27627.

[0358] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethylpropyl)-L- α -glutamine

MS (ESI) m/z 397.2; MS (ESI) m/z 793.4; HRMS: calcd for $C_{23}H_{28}N_2O_4 + H^+$, 397.21218; found (ESI-FTMS, $[M+H]^+$), 397.2139.

Example 8NN: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0359] Step A: *tert*-butyl N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 591.1; MS (ESI) m/z 1181.2; HRMS: calcd for $C_{34}H_{39}ClN_2O_5 + H^+$, 591.26203; found (ESI-FTMS, $[M+H]^+$), 591.26263.

[0360] Step B: *tert*-butyl N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamate

MS (ESI) m/z 369.1; MS (ESI) m/z 737.2; HRMS: calcd for $C_{19}H_{29}ClN_2O_3 + H^+$, 369.19395; found (ESI-FTMS, $[M+H]^+$), 369.19351.

[0361] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamate

MS (ESI) m/z 549.1; MS (ESI) m/z 1097.2; RMS: calcd for $C_{32}H_{37}ClN_2O_4 + H^+$, 549.25146; found (ESI-FTMS, $[M+H]^+$), 549.25189.

[0362] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine

MS (ESI) m/z 493.1; HRMS: calcd for $C_{28}H_{29}ClN_2O_4 + H^+$, 493.18886; found (ESI-FTMS, $[M+H]^+$), 493.1895.

Example 8OO: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0363] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamate

MS (ESI) m/z 575.3; MS (ESI) m/z 1149.4; HRMS: calcd for $C_{34}H_{39}FN_2O_5 + H^+$, 575.29158; found (ESI-FTMS, $[M+H]^+$), 575.29261.

[0364] Step B: *tert*-butyl N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamate

MS (ESI) m/z 353.2; HRMS: calcd for $C_{19}H_{29}FN_2O_3 + H^+$, 353.22350; found (ESI-FTMS, $[M+H]^+$), 353.22526.

[0365] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamate

MS (ESI) m/z 533.2; MS (ESI) m/z 1065.4; HRMS: calcd for $C_{32}H_{37}FN_2O_4 + H^+$, 533.28101; found (ESI-FTMS, $[M+H]^+$), 533.28063.

[0366] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

MS (ESI) m/z 477.2; MS (ESI) m/z 953.3; HRMS: calcd for $C_{28}H_{29}FN_2O_4 + H^+$, 477.21841; found (ESI-FTMS, $[M+H]^+$), 477.21783.

Example 8PP: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0367] Step A: *tert*-butyl N^1 -(1,1-dimethyl-2-phenylethyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 557.2; HRMS: calcd for $C_{34}H_{40}N_2O_5 + H^+$, 557.30100; found (ESI-FTMS, $[M+H]^+$), 557.2994.

[0368] Step B: *tert*-butyl N^1 -(1,1-dimethyl-2-phenylethyl)-L- α -glutamate

MS (ESI) m/z 335.1; MS (ESI) m/z 669.3; HRMS: calcd for $C_{19}H_{30}N_2O_3 + H^+$, 335.23292; found (ESI-FTMS, $[M+H]^+$), 335.23259.

[0369] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethyl-2-phenylethyl)-L- α -glutamate

MS (ESI) m/z 515.2; MS (ESI) m/z 1029.3; HRMS: calcd for $C_{32}H_{38}N_2O_4 + H^+$, 515.29043; found (ESI-FTMS, $[M+H]^+$), 515.29018.

[0370] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

MS (ESI) m/z 459.1; MS (ESI) m/z 917.3; HRMS: calcd for $C_{28}H_{30}N_2O_4 + H^+$, 459.22783; found (ESI-FTMS, $[M+H]^+$), 459.22858.

Example 8QQ: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-isopropoxypropyl)-L- α -glutamine

[0371] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-isopropoxypropyl)-L- α -glutamate

MS (ESI) m/z 525.3; MS (ESI) m/z 1049.5; HRMS: calcd for $C_{30}H_{40}N_2O_6 + H^+$, 525.29591; found (ESI-FTMS, $[M+H]^+$), 525.29528.

[0372] Step B: *tert*-butyl N^1 -(3-isopropoxypropyl)-L- α -glutamate

MS (ESI) m/z 303.2; HRMS: calcd for $C_{15}H_{30}N_2O_4 + H^+$, 303.22783; found (ESI-FTMS, $[M+H]^+$), 303.22747.

[0373] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-isopropoxypropyl)-L- α -glutamate

MS (ESI) m/z 483.3; MS (ESI) m/z 965.5; HRMS: calcd for $C_{28}H_{38}N_2O_5 + H^+$, 483.28535; found (ESI-FTMS, $[M+H]^+$), 483.28364.

[0374] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-isopropoxypropyl)-L- α -glutamine

MS (ESI) m/z 427.2; MS (ESI) m/z 853.4; MS (ESI) m/z 449.2; HRMS: calcd for $C_{24}H_{30}N_2O_5 + H^+$, 427.22275; found (ESI-FTMS, $[M+H]^+$), 427.22227.

Example 8RR: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-methylbutyl)-L- α -glutamine

[0375] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-methylbutyl)-L- α -glutamate

MS (ESI) m/z 495.2; MS (ESI) m/z 989.5; HRMS: calcd for $C_{29}H_{38}N_2O_5 + H^+$, 495.28535; found (ESI-FTMS, $[M+H]^+$), 495.28729.

[0376] Step B: *tert*-butyl N^1 -(3-methylbutyl)-L- α -glutamate

MS (ESI) m/z 273.2; HRMS: calcd for $C_{14}H_{28}N_2O_3 + H^+$, 273.21727; found (ESI-FTMS, $[M+H]^+$), 273.21718.

[0377] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-methylbutyl)-L- α -glutamate

MS (ESI) m/z 453.3; MS (ESI) m/z 905.5; MS (ESI) m/z 475.2; HRMS: calcd for $C_{27}H_{36}N_2O_4 + H^+$, 453.27478; found (ESI-FTMS, $[M+H]^+$), 453.27427.

[0378] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-methylbutyl)-L- α -glutamine

MS (ESI) m/z 397.2; MS (ESI) m/z 793.3; HRMS: calcd for $C_{23}H_{28}N_2O_4 + H^+$, 397.21218; found (ESI-FTMS, $[M+H]^+$), 397.21129.

Example 8SS: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)ethyl]-L- α -glutamine

[0379] Step A: *tert*-butyl N^2 -[(9H-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(4-fluorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 547.2; MS (ESI) m/z 1093.3; HRMS: calcd for $C_{32}H_{35}FN_2O_5 + H^+$, 547.26028; found (ESI-FTMS, $[M+H]^+$), 547.26067.

[0380] Step B: *tert*-butyl N^1 -[2-(4-fluorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 325.1; HRMS: calcd for $C_{17}H_{25}FN_2O_3 + H^+$, 325.19220; found (ESI-FTMS, $[M+H]^+$), 325.19212.

[0381] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 505.2; MS (ESI) m/z 1009.3; HRMS: calcd for $C_{30}H_{33}FN_2O_4 + H^+$, 505.24971; found (ESI-FTMS, $[M+H]^+$), 505.25021.

[0382] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 449.1; MS (ESI) m/z 897.2; HRMS: calcd for $C_{26}H_{25}FN_2O_4 + H^+$, 449.18711; found (ESI-FTMS, $[M+H]^+$), 449.18705.

Example 8TT: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-fluorophenyl)ethyl]-L- α -glutamine

[0383] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(2-fluorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 547.2; MS (ESI) m/z 1093.3; HRMS: calcd for $C_{32}H_{35}FN_2O_5 + H^+$, 547.26028; found (ESI-FTMS, $[M+H]^{1+}$), 547.26138.

[0384] Step B: *tert*-butyl N^1 -[2-(2-fluorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 325.1; MS (ESI) m/z 649.3; HRMS: calcd for $C_{17}H_{25}FN_2O_3 + H^+$, 325.19220; found (ESI-FTMS, $[M+H]^{1+}$), 325.19217.

[0385] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-fluorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 505.2; MS (ESI) m/z 1009.3; HRMS: calcd for $C_{30}H_{33}FN_2O_4 + H^+$, 505.24971; found (ESI-FTMS, $[M+H]^{1+}$), 505.2497.

[0386] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-fluorophenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 449.1; MS (ESI) m/z 897.2; HRMS: calcd for $C_{26}H_{25}FN_2O_4 + H^+$, 449.18711; found (ESI-FTMS, $[M+H]^{1+}$), 449.18744.

Example 8UU: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)ethyl]-L- α -glutamine

[0387] Step A: *tert*-butyl N^1 -[2-(4-chlorophenyl)ethyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 563.1; MS (ESI) m/z 1125.2; HRMS: calcd for $C_{32}H_{35}ClN_2O_5 + Na^+$, 585.21267; found (ESI-FTMS, $[M+Na]^{1+}$), 585.21454.

[0388] Step B: *tert*-butyl N^1 -[2-(4-chlorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 341.1; MS (ESI) m/z 681.2; HRMS: calcd for $C_{17}H_{25}ClN_2O_3 + H^+$, 341.16265; found (ESI-FTMS, $[M+H]^{1+}$), 341.16311.

[0389] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 521.2; MS (ESI) m/z 1041.3; HRMS: calcd for $C_{30}H_{33}ClN_2O_4 + Na^+$, 543.20210; found (ESI-FTMS, $[M+Na]^{1+}$), 543.20393.

[0390] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 463.1; MS (ESI) m/z 927.1; HRMS: calcd for $C_{26}H_{25}ClN_2O_4 + H^+$,

465.15756; found (ESI-FTMS, $[M+H]^{1+}$), 465.15776.

Example 8VV: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-chlorophenyl)ethyl]-L- α -glutamine

[0391] Step A: *tert*-butyl N^1 -[2-(2-chlorophenyl)ethyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 563.1; MS (ESI) m/z 1125.2; HRMS: calcd for $C_{32}H_{35}ClN_2O_5 + H^+$, 563.23073; found (ESI-FTMS, $[M+H]^{1+}$), 563.23042.

[0392] Step B: *tert*-butyl N^1 -[2-(2-chlorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 341.2; MS (ESI) m/z 681.3; MS (ESI) m/z 703.3; HRMS: calcd for $C_{17}H_{25}ClN_2O_3 + H^+$, 341.16265; found (ESI-FTMS, $[M+H]^{1+}$), 341.16301.

[0393] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-chlorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 521.2; MS (ESI) m/z 1041.4; HRMS: calcd for $C_{30}H_{33}ClN_2O_4 + H^+$, 521.22016; found (ESI-FTMS, $[M+H]^{1+}$), 521.22075.

[0394] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-chlorophenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 465; MS (ESI) m/z 487; HRMS: calcd for $C_{26}H_{25}ClN_2O_4 + H^+$, 465.15756; found (ESI-FTMS, $[M+H]^{1+}$), 465.15834.

Example 8WW: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-thienyl)ethyl]-L- α -glutamine

[0395] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(2-thienyl)ethyl]-L- α -glutamate

MS (ESI) m/z 535.1; MS (ESI) m/z 1069.2; HRMS: calcd for $C_{30}H_{34}N_2O_5S + H^+$, 535.22612; found (ESI-FTMS, $[M+H]^{1+}$), 535.22756.

[0396] Step B: *tert*-butyl N^1 -[2-(2-thienyl)ethyl]-L- α -glutamate

MS (ESI) m/z 313.1; MS (ESI) m/z 625.2; HRMS: calcd for $C_{15}H_{24}N_2O_3S + H^+$, 313.15804; found (ESI-FTMS, $[M+H]^{1+}$), 313.15788.

[0397] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-thienyl)ethyl]-L- α -glutamate

MS (ESI) m/z 493.2; MS (ESI) m/z 985.4; HRMS: calcd for $C_{28}H_{32}N_2O_4S + H^+$, 493.21555; found (ESI-FTMS, $[M+H]^{1+}$), 493.21561.

[0398] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-thienyl)ethyl]-L- α -glutamine
MS (ESI) m/z 437.1; MS (ESI) m/z 873.3; HRMS: calcd for $C_{24}H_{24}N_2O_4S + H^+$, 437.15295; found (ESI-FTMS, $[M+H]^+$), 437.15163.

Example 8XX: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-fluorobenzyl)-L- α -glutamine

[0399] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-fluorobenzyl)-L- α -glutamate
MS (ESI) m/z 533.2; HRMS: calcd for $C_{31}H_{33}FN_2O_5 + H^+$, 533.24463; found (ESI-FTMS, $[M+H]^+$), 533.2447.

[0400] Step B: *tert*-butyl N^1 -(3-fluorobenzyl)-L- α -glutamate
MS (ESI) m/z 311.2; HRMS: calcd for $C_{16}H_{23}FN_2O_3 + H^+$, 311.17655; found (ESI-FTMS, $[M+H]^+$), 311.1764.

[0401] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-fluorobenzyl)-L- α -glutamate
MS (ESI) m/z 491.2; MS (ESI) m/z 981.4; HRMS: calcd for $C_{29}H_{31}FN_2O_4 + H^+$, 491.23406; found (ESI-FTMS, $[M+H]^+$), 491.2339.

[0402] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-fluorobenzyl)-L- α -glutamine
MS (ESI) m/z 435.1; MS (ESI) m/z 869.2; HRMS: calcd for $C_{25}H_{23}FN_2O_4 + H^+$, 435.17146; found (ESI-FTMS, $[M+H]^+$), 435.1712.

Example 8YY: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-chlorophenyl)ethyl]-L- α -glutamine

[0403] Step A: *tert*-butyl N^1 -[2-(3-chlorophenyl)ethyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate
MS m/z 03-305496LMS; HRMS: calcd for $C_{32}H_{35}ClN_2O_5 + H^+$, 563.23073; found (ESI-FTMS, $[M+H]^+$), 563.2309.

[0404] Step B: *tert*-butyl N^1 -[2-(3-chlorophenyl)ethyl]-L- α -glutamate
MS (ESI) m/z 341.1; HRMS: calcd for $C_{17}H_{25}ClN_2O_3 + H^+$, 341.16265; found (ESI-FTMS, $[M+H]^+$), 341.1611.

[0405] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-chlorophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 521.1; MS (ESI) m/z 1041.1; HRMS: calcd for $C_{30}H_{33}ClN_2O_4 + H^+$, 521.22016; found (ESI-FTMS, $[M+H]^{1+}$), 521.22136.

[0406] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-chlorophenyl)ethyl]-L- α -glutamine

MS (ESI-) m/z 463.2; MS (ESI-) m/z 197; HRMS: calcd for $C_{26}H_{25}ClN_2O_4 + H^+$, 465.15756; found (ESI-FTMS, $[M+H]^{1+}$), 465.15709.

Example 8ZZ: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-fluorobenzyl)-L- α -glutamine

[0407] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(2-fluorobenzyl)-L- α -glutamate

MS (ESI) m/z 533.1; MS (ESI) m/z 1065.1; HRMS: calcd for $C_{31}H_{33}FN_2O_5 + H^+$, 533.24463; found (ESI_FTMS, $[M+H]^{1+}$), 533.24461.

[0408] Step B: *tert*-butyl N^1 -(2-fluorobenzyl)-L- α -glutamate

MS (ESI) m/z 311.1; MS (ESI) m/z 621.2; HRMS: calcd for $C_{16}H_{23}FN_2O_3 + H^+$, 311.17655; found (ESI_FTMS, $[M+H]^{1+}$), 311.1762.

[0409] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-fluorobenzyl)-L- α -glutamate

MS (ESI) m/z 491.1; MS (ESI) m/z 981.2; HRMS: calcd for $C_{29}H_{31}FN_2O_4 + H^+$, 491.23406; found (ESI-FTMS, $[M+H]^{1+}$), 491.23526.

[0410] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-fluorobenzyl)-L- α -glutamine

MS (ESI-) m/z 433.1; HRMS: calcd for $C_{25}H_{23}FN_2O_4 + H^+$, 435.17146; found (ESI-FTMS, $[M+H]^{1+}$), 435.17161.

Example 8AAA: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-difluorobenzyl)-L- α -glutamine

[0411] Step A: *tert*-butyl N^1 -(3,4-difluorobenzyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 551.2; MS (ESI) m/z 1101.4; HRMS: calcd for $C_{31}H_{32}F_2N_2O_5 + H^+$, 551.23521; found (ESI_FT, $[M+H]^{1+}$), 551.23407.

[0412] Step B: *tert*-butyl N^1 -(3,4-difluorobenzyl)-L- α -glutamate

MS (ESI) m/z 329; MS (ESI) m/z 657.2; HRMS: calcd for $C_{16}H_{22}F_2N_2O_3 + H^+$, 329.16712; found (ESI-FTMS, $[M+H]^+$), 329.1664.

[0413] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-difluorobenzyl)-L- α -glutamate

MS (ESI) m/z 509.1; MS (ESI) m/z 1017.1; HRMS: calcd for $C_{29}H_{30}F_2N_2O_4 + H^+$, 509.22464; found (ESI-FTMS, $[M+H]^+$), 509.22485.

[0414] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-difluorobenzyl)-L- α -glutamine

MS (ESI-) m/z 451.1; HRMS: calcd for $C_{25}H_{22}F_2N_2O_4 + H^+$, 453.16204; found (ESI-FTMS, $[M+H]^+$), 453.1614.

Example 8BBB: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(sec-butyl)-L- α -glutamine

[0415] Step A: *tert*-butyl N^1 -(sec-butyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 481.2; HRMS: calcd for $C_{28}H_{36}N_2O_5 + H^+$, 481.26970; found (ESI-FTMS, $[M+H]^+$), 481.26966.

[0416] Step B: *tert*-butyl N^1 -(sec-butyl)-L- α -glutamate

MS (ESI) m/z 259.1; HRMS: calcd for $C_{13}H_{26}N_2O_3 + H^+$, 259.20162; found (ESI-FTMS, $[M+H]^+$), 259.20164.

[0417] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(sec-butyl)-L- α -glutamate

MS (ESI) m/z 439.2; MS (ESI) m/z 877.4; HRMS: calcd for $C_{26}H_{34}N_2O_4 + H^+$, 439.25913; found (ESI-FTMS, $[M+H]^+$), 439.25972.

[0418] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(sec-butyl)-L- α -glutamine

MS (ESI) m/z 383.1; MS (ESI) m/z 765.3; MS (ESI) m/z 441.2; HRMS: calcd for $C_{22}H_{26}N_2O_4 + H^+$, 383.19653; found (ESI-FTMS, $[M+H]^+$), 383.19745.

Example 8CCC: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(cyclopropylmethyl)-L- α -glutamine

[0419] Step A: *tert*-butyl N^1 -(cyclopropylmethyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 479.2; MS (ESI) m/z 957.3; HRMS: calcd for $C_{28}H_{34}N_2O_5 + H^+$, 479.25405; found (ESI-FTMS, $[M+H]^{1+}$), 479.25563.

[0420] Step B: *tert*-butyl N^1 -(cyclopropylmethyl)-L- α -glutamate

MS (ESI) m/z 257.1; HRMS: calcd for $C_{13}H_{24}N_2O_3 + H^+$, 257.18597; found (ESI-FTMS, $[M+H]^{1+}$), 257.18608.

[0421] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(cyclopropylmethyl)-L- α -glutamate

MS (ESI) m/z 437.2; MS (ESI) m/z 873.3; HRMS: calcd for $C_{26}H_{32}N_2O_4 + H^+$, 437.24348; found (ESI-FTMS, $[M+H]^{1+}$), 437.24446.

[0422] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(cyclopropylmethyl)-L- α -glutamine

MS (ESI) m/z 381.1; MS (ESI) m/z 761.2; HRMS: calcd for $C_{22}H_{24}N_2O_4 + H^+$, 381.18088; found (ESI-FTMS, $[M+H]^{1+}$), 381.18186.

Example 8DDD: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-morpholin-4-ylethyl)-L- α -glutamine

[0423] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(2-morpholin-4-ylethyl)-L- α -glutamate

MS (ESI) m/z 538.3; HRMS: calcd for $C_{30}H_{39}N_3O_6 + H^+$, 538.29116; found (ESI-FTMS, $[M+H]^{1+}$), 538.29233.

[0424] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-morpholin-4-ylethyl)-L- α -glutamate

MS (ESI) m/z 496.2; HRMS: calcd for $C_{28}H_{37}N_3O_5 + H^+$, 496.28060; found (ESI-FTMS, $[M+H]^{1+}$), 496.28079.

[0425] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-morpholin-4-ylethyl)-L- α -glutamine

MS (ESI) m/z 440.2; HRMS: calcd for $C_{24}H_{29}N_3O_5 + H^+$, 440.21800; found (ESI-FTMS, $[M+H]^{1+}$), 440.21827.

Example 8EEE: N^2 -(biphenyl-4-ylcarbonyl)- N^1,N^1 -diethyl-L- α -glutamine

[0426] Step A: *tert*-butyl N^1,N^1 -diethyl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 481.3; MS (ESI) m/z 961.5; HRMS: calcd for $C_{28}H_{36}N_2O_5 + Na^+$, 503.25164; found (ESI-FTMS, $[M+Na]^+$), 503.25163.

[0427] Step B: *tert*-butyl N^1,N^1 -diethyl-L- α -glutamate

MS (ESI) m/z 259.2; HRMS: calcd for $C_{13}H_{26}N_2O_3 + H^+$, 259.20162; found (ESI-FTMS, $[M+H]^+$), 259.20149.

[0428] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1,N^1 -diethyl-L- α -glutamate

MS (ESI) m/z 439.2; MS (ESI) m/z 877.4; HRMS: calcd for $C_{26}H_{34}N_2O_4 + H^+$, 439.25913; found (ESI-FTMS, $[M+H]^+$), 439.26093.

[0429] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1,N^1 -diethyl-L- α -glutamine

MS (ESI) m/z 383.2; MS (ESI) m/z 765.4; HRMS: calcd for $C_{22}H_{26}N_2O_4 + H^+$, 383.19653; found (ESI-FTMS, $[M+H]^+$), 383.19675.

Example 8FFF: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-phenylethyl)-L- α -glutamine

[0430] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(2-phenylethyl)-L- α -glutamate

MS (ESI) m/z 529.2; HRMS: calcd for $C_{32}H_{36}N_2O_5 + H^+$, 529.26970; found (ESI-FTMS, $[M+H]^+$), 529.2693.

[0431] Step B: *tert*-butyl N^1 -(2-phenylethyl)-L- α -glutamate

HRMS: calcd for $C_{17}H_{26}N_2O_3 + H^+$, 307.20162; found (ESI-FTMS, $[M+H]^+$), 307.2011.

[0432] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-phenylethyl)-L- α -glutamate

MS (ESI) m/z 487.2; MS (ESI) m/z 973.3; HRMS: calcd for $C_{30}H_{34}N_2O_4 + H^+$, 487.25913; found (ESI-FTMS, $[M+H]^+$), 487.2588.

[0433] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-phenylethyl)-L- α -glutamine

MS (ESI) m/z 431.2; MS (ESI) m/z 861.3; HRMS: calcd for $C_{26}H_{26}N_2O_4 + H^+$, 431.19653; found (ESI-FTMS, $[M+H]^+$), 431.1963.

Example 8GGG: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethyl)benzyl]-L- α -glutamine

[0434] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[3-(trifluoromethyl)benzyl]-L- α -glutamate

MS (ESI) m/z 583.2; HRMS: calcd for $C_{32}H_{33}F_3N_2O_5 + H^+$, 583.24143; found (ESI_FTMS, $[M+H]^+$), 583.2409.

[0435] Step B: *tert*-butyl N^1 -[3-(trifluoromethyl)benzyl]-L- α -glutamate
HRMS: calcd for $C_{17}H_{23}F_3N_2O_3 + H^+$, 361.17335; found (ESI_FTMS, $[M+H]^+$), 361.173.

[0436] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethyl)benzyl]-L- α -glutamate
MS (ESI) m/z 541.2; MS (ESI) m/z 1081.3; HRMS: calcd for $C_{30}H_{31}F_3N_2O_4 + H^+$, 541.23087; found (ESI_FTMS, $[M+H]^+$), 541.2301.

[0437] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethyl)benzyl]-L- α -glutamine
MS (ESI) m/z 485.2; MS (ESI) m/z 969.3; HRMS: calcd for $C_{26}H_{23}F_3N_2O_4 + H^+$, 485.16827; found (ESI_FTMS, $[M+H]^+$), 485.1682.

Example 8HHH: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(trifluoromethyl)benzyl]-L- α -glutamine

[0438] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(trifluoromethyl)benzyl]-L- α -glutamate
MS (ESI) m/z 583.2; HRMS: calcd for $C_{32}H_{33}F_3N_2O_5 + H^+$, 583.24143; found (ESI_FT, $[M+H]^+$), 583.24162.

[0439] Step B: *tert*-butyl N^1 -[2-(trifluoromethyl)benzyl]-L- α -glutamate
HRMS: calcd for $C_{17}H_{23}F_3N_2O_3 + H^+$, 361.17335; found (ESI_FTMS, $[M+H]^+$), 361.1725.

[0440] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(trifluoromethyl)benzyl]-L- α -glutamate
MS (ESI) m/z 541.2; MS (ESI) m/z 1081.2; HRMS: calcd for $C_{30}H_{31}F_3N_2O_4 + H^+$, 541.23087; found (ESI_FTMS, $[M+H]^+$), 541.23091.

[0441] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(trifluoromethyl)benzyl]-L- α -glutamine
MS (ESI) m/z 485; MS (ESI) m/z 969; HRMS: calcd for $C_{26}H_{23}F_3N_2O_4 + H^+$, 485.16827; found (ESI_FTMS, $[M+H]^+$), 485.168.

Example 8III: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methylbenzyl)-L- α -glutamine

[0442] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(4-methylbenzyl)-L- α -glutamate

MS (ESI) m/z 529.2; MS (ESI) m/z 1057.4; HRMS: calcd for $C_{32}H_{36}N_2O_5 + H^+$, 529.26970; found (ESI-FT, $[M+H]^+$), 529.26796.

[0443] Step B: *tert*-butyl N^1 -(4-methylbenzyl)-L- α -glutamate

HRMS: calcd for $C_{17}H_{26}N_2O_3 + H^+$, 307.20162; found (ESI-FTMS, $[M+H]^+$), 307.20274.

[0444] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methylbenzyl)-L- α -glutamate

HRMS: calcd for $C_{30}H_{34}N_2O_4 + H^+$, 487.25913; found (ESI-FTMS, $[M+H]^+$), 487.25856.

[0445] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methylbenzyl)-L- α -glutamine

HRMS: calcd for $C_{26}H_{26}N_2O_4 + H^+$, 431.19653; found (ESI-FTMS, $[M+H]^+$), 431.19627.

Example 8JJJ: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -heptyl-L- α -glutamine

[0446] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -heptyl-L- α -glutamate

MS (ESI) m/z 523.3; MS (ESI) m/z 1045.5; HRMS: calcd for $C_{31}H_{42}N_2O_5 + H^+$, 523.31665; found (ESI-FTMS, $[M+H]^+$), 523.31783.

[0447] Step B: *tert*-butyl N^1 -heptyl-L- α -glutamate

HRMS: calcd for $C_{16}H_{32}N_2O_3 + H^+$, 301.24857; found (ESI-FTMS, $[M+H]^+$), 301.2499.

[0448] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -heptyl-L- α -glutamate

HRMS: calcd for $C_{29}H_{40}N_2O_4 + H^+$, 481.30608; found (ESI-FTMS, $[M+H]^+$), 481.30706.

[0449] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -heptyl-L- α -glutamine

HRMS: calcd for $C_{25}H_{32}N_2O_4 + H^+$, 425.24348; found (ESI-FTMS, $[M+H]^+$), 425.24417.

Example 8KKK: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-bromophenyl)ethyl]-L- α -glutamine

[0450] Step A: *tert*-butyl N^1 -[2-(4-bromophenyl)ethyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 607.1; HRMS: calcd for $C_{32}H_{35}BrN_2O_5 + H^+$, 607.18021; found (ESI-FTMS, $[M+H]^+$), 607.18182.

[0451] Step B: *tert*-butyl N^1 -[2-(4-bromophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 385; HRMS: calcd for $C_{17}H_{25}BrN_2O_3 + H^+$, 385.11213; found (ESI-FTMS, $[M+H]^+$), 385.11309.

[0452] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-bromophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 565.1; MS (ESI) m/z 1129.1; HRMS: calcd for $C_{30}H_{33}BrN_2O_4 + H^+$, 565.16965; found (ESI-FTMS, $[M+H]^+$), 565.17.

[0453] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-bromophenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 507.2; HRMS: calcd for $C_{26}H_{25}BrN_2O_4 + H^+$, 509.10705; found (ESI-FTMS, $[M+H]^+$), 509.10906.

Example 8LLL: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-dimethylbutyl)-L- α -glutamine

[0454] Step A: *tert*-butyl N^1 -(3,3-dimethylbutyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 509.3; MS (ESI) m/z 1017.5; HRMS: calcd for $C_{30}H_{40}N_2O_5 + H^+$, 509.30100; found (ESI-FTMS, $[M+H]^+$), 509.30165.

[0455] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-dimethylbutyl)-L- α -glutamate

MS (ESI) m/z 467.3; MS (ESI) m/z 933.5; MS (ESI) m/z 489.3; HRMS: calcd for $C_{28}H_{38}N_2O_4 + H^+$, 467.29043; found (ESI-FTMS, $[M+H]^+$), 467.29134.

[0456] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-dimethylbutyl)-L- α -glutamine
HRMS: calcd for $C_{24}H_{30}N_2O_4 + H^+$, 411.22783; found (ESI-FTMS, $[M+H]^+$), 411.22929.

Example 8MMM: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-bromophenyl)ethyl]-L- α -glutamine

[0457] Step A: *tert*-butyl N^1 -[2-(3-bromophenyl)ethyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 607.1; MS (ESI) m/z 1213.3; HRMS: calcd for $C_{32}H_{35}BrN_2O_5 + H^+$, 607.18021; found (ESI-FTMS, $[M+H]^{1+}$), 607.18017.

[0458] Step B: *tert*-butyl N^1 -[2-(3-bromophenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 385.1; MS (ESI) m/z 769.2; HRMS: calcd for $C_{17}H_{25}BrN_2O_3 + H^+$, 385.11213; found (ESI-FTMS, $[M+H]^{1+}$), 385.11175.

[0459] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-bromophenyl)ethyl]-L- α -glutamate

HRMS: calcd for $C_{30}H_{33}BrN_2O_4 + H^+$, 565.16965; found (ESI-FTMS, $[M+H]^{1+}$), 565.16854.

[0460] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-bromophenyl)ethyl]-L- α -glutamine

HRMS: calcd for $C_{26}H_{25}BrN_2O_4 + H^+$, 509.10705; found (ESI-FTMS, $[M+H]^{1+}$), 509.10648.

Example 8NNN: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-fluoro-3-(trifluoromethyl)benzyl]-L- α -glutamine

[0461] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[4-fluoro-3-(trifluoromethyl)benzyl]-L- α -glutamate

MS (ESI) m/z 601.2; MS (ESI) m/z 1201.3; HRMS: calcd for $C_{32}H_{32}F_4N_2O_5 + H^+$, 601.23201; found (ESI-FTMS, $[M+H]^{1+}$), 601.23172.

[0462] Step B: *tert*-butyl N^1 -[4-fluoro-3-(trifluoromethyl)benzyl]-L- α -glutamate

HRMS: calcd for $C_{17}H_{22}F_4N_2O_3 + H^+$, 379.16393; found (ESI-FTMS, $[M+H]^{1+}$), 379.16566.

[0463] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-fluoro-3-(trifluoromethyl)benzyl]-L- α -glutamate

HRMS: calcd for $C_{30}H_{30}F_4N_2O_4 + H^+$, 559.22145; found (ESI-FTMS, $[M+H]^{1+}$), 559.22077.

[0464] Step D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-fluoro-3-(trifluoromethyl)benzyl]-L- α -glutamine
HRMS: calcd for $C_{26}H_{22}F_4N_2O_4 + H^+$, 503.15885; found (ESI-FTMS, $[M+H]^{1+}$), 503.1582.

Example 8000: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-diphenylpropyl)-L- α -glutamine

[0465] Step A: *tert*-butyl N^1 -(3,3-diphenylpropyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate
MS (ESI) m/z 619.3; MS (ESI) m/z 1237.6; HRMS: calcd for $C_{39}H_{42}N_2O_5 + H^+$, 619.31665; found (ESI-FTMS, $[M+H]^{1+}$), 619.31658.

[0466] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-diphenylpropyl)-L- α -glutamate
HRMS: calcd for $C_{37}H_{40}N_2O_4 + H^+$, 577.30608; found (ESI-FTMS, $[M+H]^{1+}$), 577.30483.

[0467] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-diphenylpropyl)-L- α -glutamine
HRMS: calcd for $C_{33}H_{32}N_2O_4 + H^+$, 521.24348; found (ESI-FTMS, $[M+H]^{1+}$), 521.24166.

Example 8PPP: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -isopropyl-L- α -glutamine

[0468] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -isopropyl-L- α -glutamate
MS (ESI) m/z 467.2; MS (ESI) m/z 933.5; HRMS: calcd for $C_{27}H_{34}N_2O_5 + Na^+$, 489.23599; found (ESI-FTMS, $[M+Na]^{1+}$), 489.23577.

[0469] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -isopropyl-L- α -glutamate
MS (ESI) m/z 425.2; MS (ESI) m/z 447.2; MS (ESI) m/z 871.4; HRMS: calcd for $C_{25}H_{32}N_2O_4 + Na^+$, 447.22543; found (ESI-FTMS, $[M+Na]^{1+}$), 447.22701.

[0470] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -isopropyl-L- α -glutamine
MS (ESI) m/z 367.2; MS (ESI) m/z 735.3; MS (ESI) m/z 481.2; HRMS: calcd for $C_{21}H_{24}N_2O_4 + Na^+$, 391.16283; found (ESI-FTMS, $[M+Na]^{1+}$), 391.16451.

Example 8QQQ: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(pyridin-4-ylmethyl)-L- α -glutamine

[0471] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(pyridin-4-ylmethyl)-L- α -glutamate

MS (ESI) m/z 516.3; HRMS: calcd for $C_{30}H_{33}N_3O_5 + H^+$, 516.24930; found (ESI-FTMS, $[M+H]^{1+}$), 516.24875.

[0472] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(pyridin-4-ylmethyl)-L- α -glutamate

MS (ESI) m/z 474.2; HRMS: calcd for $C_{28}H_{31}N_3O_4 + H^+$, 474.23873; found (ESI-FTMS, $[M+H]^{1+}$), 474.24265.

[0473] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(pyridin-4-ylmethyl)-L- α -glutamine

HRMS: calcd for $C_{24}H_{23}N_3O_4 + H^+$, 418.17613; found (ESI-FTMS, $[M+H]^{1+}$), 418.17812.

Example 8RRR: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -pentyl-L- α -glutamine

[0474] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -pentyl-L- α -glutamate

MS (ESI) m/z 495.2; MS (ESI) m/z 989.5; HRMS: calcd for $C_{29}H_{38}N_2O_5 + Na^+$, 517.26729; found (ESI-FTMS, $[M+Na]^{1+}$), 517.26785.

[0475] Step B: *tert*-butyl N^1 -pentyl-L- α -glutamate

MS (ESI) m/z 273.2; HRMS: calcd for $C_{14}H_{28}N_2O_3 + H^+$, 273.21727; found (ESI-FTMS, $[M+H]^{1+}$), 273.21761.

[0476] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -pentyl-L- α -glutamate

MS (ESI) m/z 453.2; MS (ESI) m/z 905.5; HRMS: calcd for $C_{27}H_{36}N_2O_4 + H^+$, 453.27478; found (ESI-FTMS, $[M+H]^{1+}$), 453.27694.

[0477] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -pentyl-L- α -glutamine

MS (ESI) m/z 397.2; MS (ESI) m/z 793.4; HRMS: calcd for $C_{23}H_{28}N_2O_4 + H^+$, 397.21218; found (ESI-FTMS, $[M+H]^{1+}$), 397.2136.

Example 8SSS: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(*tert*-butyl)-L- α -glutamine

[0478] Step A: *tert*-butyl N^1 -(*tert*-butyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-*L*- α -glutamate

MS (ESI) m/z 481.2; MS (ESI) m/z 961.5; HRMS: calcd for $C_{28}H_{36}N_2O_5 + H^+$, 481.26970; found (ESI-FTMS, $[M+H]^{1+}$), 481.27074.

[0479] Step B: *tert*-butyl N^1 -(*tert*-butyl)-*L*- α -glutamate

MS (ESI) m/z 259.1; MS (ESI) m/z 517.3; HRMS: calcd for $C_{13}H_{26}N_2O_3 + H^+$, 259.20162; found (ESI-FTMS, $[M+H]^{1+}$), 259.20174.

[0480] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(*tert*-butyl)-*L*- α -glutamate

MS (ESI) m/z 439.2; MS (ESI) m/z 877.4; HRMS: calcd for $C_{26}H_{34}N_2O_4 + H^+$, 439.25913; found (ESI-FTMS, $[M+H]^{1+}$), 439.25922.

[0481] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(*tert*-butyl)-*L*- α -glutamine

MS (ESI) m/z 383.2; MS (ESI) m/z 765.3; HRMS: calcd for $C_{22}H_{26}N_2O_4 + H^+$, 383.19653; found (ESI-FTMS, $[M+H]^{1+}$), 383.19812.

Example 8TTT: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1-methyl-1-phenylethyl)-*L*- α -glutamine

[0482] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(1-methyl-1-phenylethyl)-*L*- α -glutamate

MS (ESI) m/z 543.2; MS (ESI) m/z 1085.4; HRMS: calcd for $C_{33}H_{38}N_2O_5 + H^+$, 543.28535; found (ESI-FTMS, $[M+H]^{1+}$), 543.28707.

[0483] Step B: *tert*-butyl N^1 -(1-methyl-1-phenylethyl)-*L*- α -glutamate

MS (ESI) m/z 321.1; MS (ESI) m/z 641.3; HRMS: calcd for $C_{18}H_{28}N_2O_3 + H^+$, 321.21727; found (ESI-FTMS, $[M+H]^{1+}$), 321.21716.

[0484] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1-methyl-1-phenylethyl)-*L*- α -glutamate

MS (ESI) m/z 501.2; MS (ESI) m/z 1001.4; HRMS: calcd for $C_{31}H_{36}N_2O_4 + H^+$, 501.27478; found (ESI-FTMS, $[M+H]^{1+}$), 501.27462.

[0485] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1-methyl-1-phenylethyl)-*L*- α -glutamine

HRMS: calcd for $C_{27}H_{28}N_2O_4 + H^+$, 445.21218; found (ESI-FTMS, $[M+H]^{1+}$), 445.21311.

Example 8UUU: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2,2-dimethylpropyl)-L- α -glutamine

[0486] Step A: *tert*-butyl N^1 -(2,2-dimethylpropyl)- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 495.2; MS (ESI) m/z 989.4; HRMS: calcd for $C_{29}H_{38}N_2O_5 + H^+$, 495.28535; found (ESI-FTMS, $[M+H]^{1+}$), 495.2859.

[0487] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2,2-dimethylpropyl)-L- α -glutamate

MS (ESI) m/z 453.2; MS (ESI) m/z 905.4; HRMS: calcd for $C_{27}H_{36}N_2O_4 + H^+$, 453.27478; found (ESI-FTMS, $[M+H]^{1+}$), 453.2764.

[0488] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2,2-dimethylpropyl)-L- α -glutamine

MS (ESI) m/z 397.1; MS (ESI) m/z 793.3; HRMS: calcd for $C_{23}H_{28}N_2O_4 + H^+$, 397.21218; found (ESI-FTMS, $[M+H]^{1+}$), 397.21242.

Example 8VVV: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -hexyl-L- α -glutamine

[0489] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -hexyl-L- α -glutamate

MS (ESI) m/z 509.3; MS (ESI) m/z 1017.5; HRMS: calcd for $C_{30}H_{40}N_2O_5 + H^+$, 509.30100; found (ESI-FTMS, $[M+H]^{1+}$), 509.30265.

[0490] Step B: *tert*-butyl N^1 -hexyl-L- α -glutamate

HRMS: calcd for $C_{15}H_{30}N_2O_3 + H^+$, 287.23292; found (ESI-FTMS, $[M+H]^{1+}$), 287.23282.

[0491] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -hexyl-L- α -glutamate

MS (ESI) m/z 467.2; MS (ESI) m/z 933.4; HRMS: calcd for $C_{28}H_{38}N_2O_4 + H^+$, 467.29043; found (ESI-FTMS, $[M+H]^{1+}$), 467.29169.

[0492] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -hexyl-L- α -glutamine

MS (ESI) m/z 411.1; MS (ESI) m/z 821.3; HRMS: calcd for $C_{24}H_{30}N_2O_4 + H^+$, 411.22783; found (ESI-FTMS, $[M+H]^{1+}$), 411.22833.

Example 8WWW: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(5-hydroxypentyl)-L- α -glutamine

[0493] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(5-hydroxypentyl)-L- α -glutamate

MS (ESI) m/z 511.2; MS (ESI) m/z 1021.4; HRMS: calcd for $C_{29}H_{38}N_2O_6 + H^+$, 511.28026; found (ESI-FTMS, $[M+H]^{1+}$), 511.28078.

[0494] Step B: *tert*-butyl N^1 -(5-hydroxypentyl)-L- α -glutamate

HRMS: calcd for $C_{14}H_{28}N_2O_4 + H^+$, 289.21218; found (ESI-FTMS, $[M+H]^{1+}$), 289.21245.

[0495] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(5-hydroxypentyl)-L- α -glutamate

HRMS: calcd for $C_{27}H_{36}N_2O_5 + H^+$, 469.26970; found (ESI-FTMS, $[M+H]^{1+}$), 469.27133.

[0496] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(5-hydroxypentyl)-L- α -glutamine

HRMS: calcd for $C_{23}H_{28}N_2O_5 + H^+$, 413.20710; found (ESI-FTMS, $[M+H]^{1+}$), 413.20657.

Example 8XXX: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine

[0497] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(6-hydroxyhexyl)-L- α -glutamate

MS (ESI) m/z 525.2; MS (ESI) m/z 1049.4; HRMS: calcd for $C_{30}H_{40}N_2O_6 + Na^+$, 547.27786; found (ESI-FTMS, $[M+Na]^{1+}$), 547.27869.

[0498] Step B: *tert*-butyl N^1 -(6-hydroxyhexyl)-L- α -glutamate

HRMS: calcd for $C_{15}H_{30}N_2O_4 + H^+$, 303.22783; found (ESI-FTMS, $[M+H]^{1+}$), 303.22841.

[0499] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamate

HRMS: calcd for $C_{28}H_{38}N_2O_5 + H^+$, 483.28535; found (ESI-FTMS, $[M+H]^{1+}$), 483.28725.

[0500] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine

HRMS: calcd for $C_{24}H_{30}N_2O_5 + H^+$, 427.22275; found (ESI-FTMS, $[M+H]^{1+}$), 427.22304.

Example 8YYY: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -propyl-L- α -glutamine

[0501] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -propyl-L- α -glutamate

MS (ESI) m/z 467.1; MS (ESI) m/z 933.1; MS (ESI) m/z 955.1; HRMS: calcd for $C_{27}H_{34}N_2O_5 + H^+$, 467.25405; found (ESI-FTMS, $[M+H]^+$), 467.25527.

[0502] Step B: *tert*-butyl N^1 -propyl-L- α -glutamate

MS (ESI) m/z 245.1; MS (ESI) m/z 489.2; HRMS: calcd for $C_{12}H_{24}N_2O_3 + H^+$, 245.18597; found (ESI-FTMS, $[M+H]^+$), 245.1861.

[0503] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -propyl-L- α -glutamate
HRMS: calcd for $C_{25}H_{32}N_2O_4 + H^+$, 425.24348; found (ESI-FTMS, $[M+H]^+$), 425.24455.

[0504] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -propyl-L- α -glutamine
HRMS: calcd for $C_{21}H_{24}N_2O_4 + H^+$, 369.18088; found (ESI-FTMS, $[M+H]^+$), 369.18091.

Example 8ZZZ: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[4-(dimethylamino)benzyl]-L- α -glutamine

[0505] Step A: *tert*-butyl N^1 -[4-(dimethylamino)benzyl]- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 558.2; HRMS: calcd for $C_{33}H_{39}N_3O_5 + H^+$, 558.29625; found (ESI-FTMS, $[M+H]^+$), 558.29668.

[0506] Step B: *tert*-butyl N^1 -[4-(dimethylamino)benzyl]-L- α -glutamate

MS (ESI) m/z 336.2; MS (ESI) m/z 671.3; HRMS: calcd for $C_{18}H_{29}N_3O_3 + H^+$, 336.22817; found (ESI-FTMS, $[M+H]^+$), 336.22836.

[0507] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[4-(dimethylamino)benzyl]-L- α -glutamate

MS (ESI) m/z 516.2; HRMS: calcd for $C_{31}H_{37}N_3O_4 + H^+$, 516.28568; found (ESI-FTMS, $[M+H]^+$), 516.28631.

[0508] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[4-(dimethylamino)benzyl]-L- α -glutamine

MS (ESI) m/z 460.1; HRMS: calcd for $C_{27}H_{29}N_3O_4 + H^+$, 460.22308; found (ESI-FTMS, $[M+H]^+$), 460.22347.

Example 8AAAA: N^1 -(4-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0509] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(4-nitrobenzyl)-L- α -glutamate

MS (ESI) m/z 560.3; MS (ESI) m/z 1119.5; HRMS: calcd for $C_{31}H_{33}N_3O_7 + H^+$, 560.23913; found (ESI_FTMS, $[M+H]^{1+}$), 560.23944.

[0510] Step B: *tert*-butyl N^1 -(4-nitrobenzyl)-L- α -glutamate

MS (ESI) m/z 338.2; HRMS: calcd for $C_{16}H_{23}N_3O_5 + H^+$, 338.17105; found (ESI-FTMS, $[M+H]^{1+}$), 338.17116.

[0511] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-nitrobenzyl)-L- α -glutamate

MS (ESI) m/z 518.2; MS (ESI) m/z 1035.5; HRMS: calcd for $C_{29}H_{31}N_3O_6 + H^+$, 518.22856; found (ESI-FTMS, $[M+H]^{1+}$), 518.22861.

[0512] Step C': Reductive alkylation of *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-nitrobenzyl)-L- α -glutamate with 30 % formalin in water and 10 % Pd/C gave *tert*-butyl N^1 -(4-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamate

MS (ESI) m/z 488.2; MS (ESI) m/z 975.4; HRMS: calcd for $C_{29}H_{33}N_3O_4 + H^+$, 488.25438; found (ESI_FTMS, $[M+H]^{1+}$), 488.2542.

[0513] Step D: N^1 -(4-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

MS (ESI) m/z 432.2; HRMS: calcd for $C_{25}H_{25}N_3O_4 + H^+$, 432.19178; found (ESI_FTMS, $[M+H]^{1+}$), 432.1915.

Example 8BBBB: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[3-(dimethylamino)benzyl]-L- α -glutamine

[0514] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-nitrobenzyl)-L- α -glutamate

MS (ESI) m/z 560.3; MS (ESI) m/z 1119.4; HRMS: calcd for $C_{31}H_{33}N_3O_7 + H^+$, 560.23913; found (ESI_FTMS, $[M+H]^{1+}$), 560.23892.

[0515] Step B: *tert*-butyl N^1 -(3-nitrobenzyl)-L- α -glutamate

MS (ESI) m/z 338.1; MS (ESI) m/z 675.3; HRMS: calcd for $C_{16}H_{23}N_3O_5 + H^+$, 338.17105; found (ESI-FTMS, $[M+H]^+$), 338.17102.

[0516] Step C: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-nitrobenzyl)-L- α -glutamate

MS (ESI) m/z 518.2; MS (ESI) m/z 1035.4; HRMS: calcd for $C_{29}H_{31}N_3O_6 + H^+$, 518.22856; found (ESI-FTMS, $[M+H]^+$), 518.22868.

[0517] Step C': Reductive alkylation of *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-nitrobenzyl)-L- α -glutamate 30 % formalin and 10% Pd/C gave *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[3-(dimethylamino)benzyl]-L- α -glutamate

MS (ESI) m/z 516.2; HRMS: calcd for $C_{31}H_{37}N_3O_4 + H^+$, 516.28568; found (ESI-FTMS, $[M+H]^+$), 516.28548.

[0518] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[3-(dimethylamino)benzyl]-L- α -glutamine

MS (ESI) m/z 460.3; HRMS: calcd for $C_{27}H_{29}N_3O_4 + H^+$, 460.22308; found (ESI-FTMS, $[M+H]^+$), 460.22304.

Example 8CCCC: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-nitrobenzyl)-L- α -glutamine

[0519] MS (ESI) m/z 462.2; MS (ESI) m/z 923.2; HRMS: calcd for $C_{25}H_{23}N_3O_6 + H^+$, 462.16596; found (ESI-FTMS, $[M+H]^+$), 462.16599.

Example 8DDDD: N^1 -(3-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0520] HRMS: calcd for $C_{25}H_{25}N_3O_4 + H^+$, 432.19178; found (ESI-FTMS, $[M+H]^+$), 432.1917.

Example 8EEEE: N^1 -benzyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0521] Step A: *tert*-butyl N^1 -benzyl- N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]-L- α -glutamate

MS (ESI) m/z 458 (M-tBut).

[0522] Step B: *tert*-butyl N^1 -benzyl-L- α -glutamate

MS (ESI) m/z 293.

[0523] Step C: *tert*-butyl N^1 -benzyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamate

MS (ESI) m/z 473.

[0524] Step D: N^1 -benzyl- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

MS (ESI) m/z 417.

Example 8FFFF: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamine

[0525] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamate

Described as above according to the procedure of Example 7, except Fmoc-D-Glu-(OtBu)-OH was used as starting material for the first step. HRMS: calcd for $C_{34}H_{39}FN_2O_5 + H^+$, 575.29158; found (ESI-FTMS, $[M+H]^+$), 575.2927.

[0526] Step B: *tert*-butyl N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamate

HRMS: calcd for $C_{19}H_{29}FN_2O_3 + H^+$, 353.22350; found (ESI-FTMS, $[M+H]^+$), 353.22483.

[0527] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamate

HRMS: calcd for $C_{32}H_{37}FN_2O_4 + H^+$, 533.28101; found (ESI-FTMS, $[M+H]^+$), 533.28347.

[0528] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamine

MS (ESI) m/z 477.1; MS (ESI) m/z 499; MS (ESI) m/z 953.1; HRMS: calcd for $C_{28}H_{29}FN_2O_4 + H^+$, 477.21841; found (ESI-FTMS, $[M+H]^+$), 477.21815.

Example 8GGGG: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]- α -glutamine

[0529] Step A: *tert*-butyl N^2 -[(9*H*-fluoren-9-ylmethoxy)carbonyl]- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]- α -glutamate

Described as above according to the procedure of Example 7, except Fmoc-DL-Glu-(OtBu)-OH (racemic mixture) was used as starting material for the first step. HRMS: calcd for $C_{34}H_{39}FN_2O_5 + H^+$, 575.29158; found (ESI-FTMS, $[M+H]^{1+}$), 575.29217.

[0530] Step B: *tert*-butyl N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]- α -glutamate

HRMS: calcd for $C_{19}H_{29}FN_2O_3 + H^+$, 353.22350; found (ESI-FTMS, $[M+H]^{1+}$), 353.22429.

[0531] Step C: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]- α -glutamate

HRMS: calcd for $C_{32}H_{37}FN_2O_4 + H^+$, 533.28101; found (ESI-FTMS, $[M+H]^{1+}$), 533.28268.

[0532] Step D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]- α -glutamine

MS (ESI) m/z 477.1; MS (ESI) m/z 953.1; HRMS: calcd for $C_{28}H_{29}FN_2O_4 + H^+$, 477.21841; found (ESI-FTMS, $[M+H]^{1+}$), 477.21805.

Example 8HHHH: 4-Benzylcarbamoyl-4-[4-(pyrimidin-2-ylamino)-benzoylamino-butyric acid tert-butyric acid]

[0533] Step C: 4-Benzylcarbamoyl-4-[4-(pyrimidin-2-ylamino)-benzoylamino-butyric acid tert-butyl ester

MS (ESI) m/z 488.

[0534] Step D: 4-Benzylcarbamoyl-4-[4-(pyrimidin-2-ylamino)-benzoylamino-butyric acid tert-butyric acid

MS (ESI) m/z 432.

Example 8IIII: N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamine

[0535] Step A: *tert*-butyl N^2 -[(9H-fluoren-9-ylmethoxy)carbonyl]- N^1 -(3-phenylpropyl)-L- α -glutamate

1,9(Fmoc)L-glutamic acid -*tert*-butylester monohydrate (1.33g, 3.00mmol) was dissolved in DMF (8mL) under nitrogen. BOP (1.33g, 3.00mmol) was added as a solid, followed by 3-phenyl-1-propylamine (427mL, 3mmol). Finally DIEA (627mL, 3.6mmol) was added dropwise. The reaction was monitored by TLC, and stirred for 24 hrs. The

reaction mixture was then added to stirring H₂O (400mL). After stirring for 1 hour, clumps of white solid were formed. The clumps were broken up with a spatula and stirred for an additional 30 minutes. The solid was filtered and washed with H₂O. The solid was then dissolved in CH₂Cl₂ and dried with Na₂SO₄. The solution was filtered and concentrated, leaving a white solid. The solid was dissolved in minimal acetone and hexanes were added. The solvents were then removed and the white solid was dried under vacuum. Yield 1.58g of *tert*-butyl *N*¹-[(9H-fluoren-9-ylmethoxy)carbonyl]-*N*¹-(3-phenylpropyl)-L- α -glutamate at 97% yield.

MS (ESI) *m/z* 543.3; HRMS: calcd for C₃₃H₃₈N₂O₅ + H⁺, 543.2853; found (ESI-FTMS, [M+H]¹⁺), 543.2847.

[0536] Step B: *tert*-butyl *N*¹-(3-phenylpropyl)-L- α -glutamate

Tert-butyl *N*²-[(9H-fluoren-9-ylmethoxy)carbonyl]-*N*¹-(3-phenylpropyl)-L- α -glutamate (1.5g, 2.76mmol) was partially dissolved in CH₃CN (15mL). DEA (2.9mL, 27.6mmol) was added, which was fully dissolved within 10 minutes. The reaction was monitored by TLC and was complete at 2 hrs. The solvent was removed and the remaining material dried under vacuum. The material was purified on a short silica column using 5%Acetone/CH₂Cl₂ to elute the Fmoc by-product and then 50%Acetone/CH₂Cl₂ to elute the product. The clear oil present at the end was dried shortly under vacuum, and then taken to the next step immediately. It was never fully solvent free so the yield of *tert*-butyl *N*¹-(3-phenylpropyl)-L- α -glutamate was 1.65g, and was assumed to be quantitative. MS (ESI) *m/z* 321.2; MS (ESI) *m/z* 641.4; HRMS: calcd for C₁₈H₂₈N₂O₃ + H⁺, 321.2173; found (ESI-FTMS, [M+H]¹⁺), 321.2167.

[0537] Step C: *tert*-butyl *N*²-(9H-fluoren-2-ylcarbonyl)-*N*¹-(3-phenylpropyl)-L- α -glutamate

Tert-butyl *N*¹-(3-phenylpropyl)-L- α -glutamate (350mg, 1.09mmol) was dissolved in DMF (5mL), in a 20mL vial under nitrogen. 2-Fluorenicarboxylic acid (229mg, 1.09mmol) and BOP (530mg, 1.20mmol) were added as solids and dissolved. Finally DIEA (228mL, 1.31mmol) was added, and the reaction stirred overnight. Monitored by TLC, the reaction was complete after stirring overnight. The reaction mixture was added to H₂O (100mL), precipitating a pale yellow solid. The solid was filtered and dried in a dessicator overnight. Once dry, the solid was taken up in a small amount of acetone, and hexanes were added to precipitate a pale yellow solid. The solid was filtered, washed

with hexanes and dried in a dessicator. Yield 293mg of *tert*-butyl *N*²-(9*H*-fluoren-2-ylcarbonyl)-*N*¹-(3-phenylpropyl)-*L*-α-glutamate at 52% yield. MS (ESI) *m/z* 513.3; MS (ESI) *m/z* 1025.6; MS (ESI) *m/z* 535.3; HRMS: calcd for C₃₂H₃₆N₂O₄ + H⁺, 513.27478; found (ESI-FTMS, [M+H]¹⁺), 513.2766.

[0538] Step D: *N*²-(9*H*-fluoren-2-ylcarbonyl)-*N*¹-(3-phenylpropyl)-*L*-α-glutamine
Tert-butyl *N*²-(9*H*-fluoren-2-ylcarbonyl)-*N*¹-(3-phenylpropyl)-*L*-α-glutamate (273mg, 0.533mmol) was dissolved in CH₂Cl₂ (1.5mL). TFA (1.23mL, 16.0mmol) was diluted in CH₂Cl₂ (2mL) and was then slowly added to the first solution. The reaction was monitored by TLC and complete at 2 hrs. The solvent was removed with a nitrogen blower and the remaining yellow oil dried under vacuum. The yellow oil was then dissolved in minimal acetone and hexanes was added precipitating a white solid. The solid was filtered, washed with hexanes and then dried under vacuum. The reaction yielded 194mg of *N*²-(9*H*-fluoren-2-ylcarbonyl)-*N*¹-(3-phenylpropyl)-*L*-α-glutamine at an 80% yield. MS (ESI) *m/z* 457.3; MS (ESI) *m/z* 913.5.

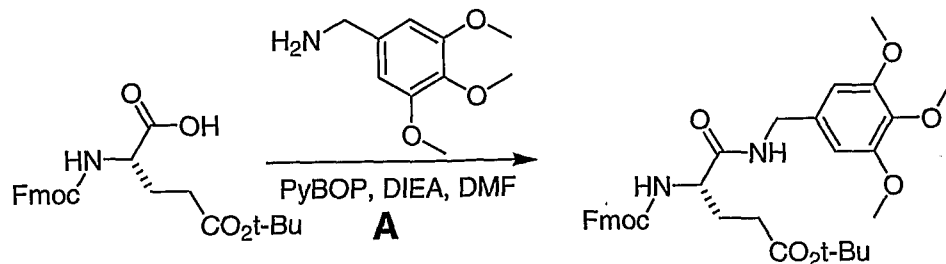
Example 8JJJJ: *N*²-(9*H*-fluoren-1-ylcarbonyl)-*N*¹-(3-phenylpropyl)-*L*-α-glutamine

[0539] Step C: *tert*-butyl *N*²-(9*H*-fluoren-1-ylcarbonyl)-*N*¹-(3-phenylpropyl)-*L*-α-glutamate

MS (ESI) *m/z* 513.3; MS (ESI) *m/z* 1025.6; HRMS: calcd for C₃₂H₃₆N₂O₄ + H⁺, 513.27478; found (ESI-FTMS, [M+H]¹⁺), 513.27653.

[0540] Step D: *N*²-(9*H*-fluoren-1-ylcarbonyl)-*N*¹-(3-phenylpropyl)-*L*-α-glutamine
 MS (ESI) *m/z* 457.3; MS (ESI) *m/z* 913.5; MS (ESI) *m/z* 479.3.

Example 8KKKK: *N*²-(9*H*-fluoren-2-ylcarbonyl)-*N*¹-(3,4,5-trimethoxybenzyl)-*L*-α-glutamine



[0541] Step A: *tert*-butyl *N*²-[(9*H*-fluoren-9-ylmethoxy)carbonyl]-*N*¹-(3,4,5-trimethoxybenzyl)-*L*-α-glutamate

MS (ESI) m/z 605.2; MS (ESI) m/z 1209.4; HRMS: calcd for $C_{34}H_{40}N_2O_8 + H^+$, 605.28574; found (ESI_FT, $[M+H]^+$), 605.28453.

[0542] Step B: *tert*-butyl N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate
MS (ESI) m/z 383.1; MS (ESI) m/z 765.3; HRMS: calcd for $C_{19}H_{30}N_2O_6 + H^+$, 383.21766; found (ESI_FT, $[M+H]^+$), 383.21755.

[0543] Step C: *tert*-butyl N^2 -(9*H*-fluoren-2-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate
MS (ESI) m/z 575.4; MS (ESI) m/z 1149.7; HRMS: calcd for $C_{33}H_{38}N_2O_7 + H^+$, 575.27518; found (ESI-FTMS, $[M+H]^+$), 575.27604.

[0544] Step D: N^2 -(9*H*-fluoren-2-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine
MS (ESI) m/z 519.3; MS (ESI) m/z 1037.6; HRMS: calcd for $C_{29}H_{30}N_2O_7 + H^+$, 519.21258; found (ESI-FTMS, $[M+H]^+$), 519.2133.

Example 8LLLL: N^2 -(9*H*-fluoren-1-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0545] Step C: *tert*-butyl N^2 -(9*H*-fluoren-1-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate
MS (ESI) m/z 575.4; MS (ESI) m/z 1149.7; HRMS: calcd for $C_{33}H_{38}N_2O_7 + H^+$, 575.27518; found (ESI-FTMS, $[M+H]^+$), 575.2761.

[0546] Step D: N^2 -(9*H*-fluoren-1-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine
MS (ESI) m/z 519.3; MS (ESI) m/z 1037.6; MS (ESI) m/z 541.3; HRMS: calcd for $C_{29}H_{30}N_2O_7 + H^+$, 519.21258; found (ESI-FTMS, $[M+H]^+$), 519.21329.

Example 8MMMM: N^2 -[(9-oxo-9*H*-fluoren-2-yl)carbonyl]- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0547] Step C: *tert*-butyl N^2 -[(9-oxo-9*H*-fluoren-2-yl)carbonyl]- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate
MS (ESI) m/z 589.4; MS (ESI) m/z 1177.7; MS (ESI) m/z 606.4; HRMS: calcd for $C_{33}H_{36}N_2O_8 + H^+$, 589.25444; found (ESI-FTMS, $[M+H]^+$), 589.25507.

[0548] Step D: N^2 -[(9-oxo-9*H*-fluoren-2-yl)carbonyl]- N^1 -(3,4,5-

trimethoxybenzyl)-L- α -glutamine

MS (ESI) m/z 531.3; MS (ESI) m/z 1063.5; HRMS: calcd for $C_{29}H_{28}N_2O_8 + H^+$, 533.19184; found (ESI-FTMS, $[M+H]^+$), 533.19236.

Example 8NNNN: N^2 -(4-phenoxybenzoyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

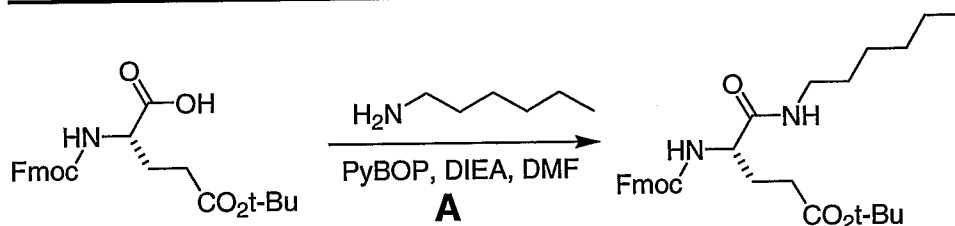
[0549] Step C: *tert*-butyl N^2 -(4-phenoxybenzoyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamate

MS (ESI) m/z 579.3; MS (ESI) m/z 1157.7; HRMS: calcd for $C_{32}H_{38}N_2O_8 + H^+$, 579.27009; found (ESI-FTMS, $[M+H]^+$), 579.2719.

[0550] Step D: N^2 -(4-phenoxybenzoyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

MS (ESI) m/z 523.3; MS (ESI) m/z 1045.5.

Example 8OOOO: N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -hexyl-L- α -glutamine



[0551] Step A: *tert*-butyl N^2 -[(9H-fluoren-9-ylmethoxy)carbonyl]- N^1 -hexyl-L- α -glutamate

MS (ESI) m/z 509.3; MS (ESI) m/z 1017.5; HRMS: calcd for $C_{30}H_{40}N_2O_5 + H^+$, 509.30100; found (ESI-FTMS, $[M+H]^+$), 509.30265.

[0552] Step B: *tert*-butyl N^1 -hexyl-L- α -glutamate

HRMS: calcd for $C_{15}H_{30}N_2O_3 + H^+$, 287.23292; found (ESI-FTMS, $[M+H]^+$), 287.23282.

[0553] Step C: *tert*-butyl N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -hexyl-L- α -glutamate

MS (ESI) m/z 479.1; MS (ESI) m/z 979.2; MS (ESI) m/z 501.1; HRMS: calcd for $C_{29}H_{38}N_2O_4 + H^+$, 479.29043; found (ESI-FTMS, $[M+H]^+$), 479.29145.

[0554] Step D: N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -hexyl-L- α -glutamine

MS (ESI) m/z 423.3; MS (ESI) m/z 845.6; MS (ESI) m/z 445.3.

Example 8PPPP: N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -hexyl-L- α -glutamine

[0555] Step C: *tert*-butyl N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -hexyl-L- α -glutamate
MS (ESI) m/z 479.1; MS (ESI) m/z 957.3; MS (ESI) m/z 979.2; HRMS: calcd for $C_{29}H_{38}N_2O_4 + H^+$, 479.29043; found (ESI-FTMS, $[M+H]^+$), 479.29145.

[0556] Step D: N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -hexyl-L- α -glutamine
MS (ESI) m/z 423.3; MS (ESI) m/z 845.5; MS (ESI) m/z 445.3.

Example 8QQQQ: N^1 -hexyl- N^2 -(4-phenoxybenzoyl)-L- α -glutamine

[0557] Step C: *tert*-butyl N^1 -hexyl- N^2 -(4-phenoxybenzoyl)-L- α -glutamate
MS (ESI) m/z 483.1; MS (ESI) m/z 965.3; MS (ESI) m/z 987.3; HRMS: calcd for $C_{28}H_{38}N_2O_5 + H^+$, 483.28535; found (ESI-FTMS, $[M+H]^+$), 483.28715.

[0558] Step D: N^1 -hexyl- N^2 -(4-phenoxybenzoyl)-L- α -glutamine
MS (ESI) m/z 427.3; MS (ESI) m/z 853.5; MS (ESI) m/z 449.3.

Example 8RRRR: N^1 -hexyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine

[0559] Step C: *tert*-butyl N^1 -hexyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamate
MS (ESI) m/z 493.1; MS (ESI) m/z 985.3; HRMS: calcd for $C_{29}H_{36}N_2O_5 + H^+$, 493.26970; found (ESI-FTMS, $[M+H]^+$), 493.27119.

[0560] Step D: N^1 -hexyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine
MS (ESI) m/z 437.3; MS (ESI) m/z 873.5; MS (ESI) m/z 1309.8.

Example 8SSSS: N^2 -(4-benzoylbenzoyl)- N^1 -benzyl-L- α -glutamine

[0561] Step C: *tert*-butyl N^2 -(4-benzoylbenzoyl)- N^1 -benzyl-L- α -glutamate
MS (ESI) m/z 501.2; MS (ESI) m/z 523.2; HRMS: calcd for $C_{30}H_{32}N_2O_5 + H^+$, 501.23840; found (ESI+, $[M+H]^+$), 501.23859.

[0562] Step D: N^2 -(4-benzoylbenzoyl)- N^1 -benzyl-L- α -glutamine
MS (ESI) m/z 445.2; HRMS: calcd for $C_{26}H_{24}N_2O_5 + H^+$, 445.17580; found (ESI+, $[M+H]^+$), 445.17619.

Example 8TTTT: N^1 -(6-hydroxyhexyl)- N^2 -(4-phenoxybenzoyl)-L- α -glutamine

[0563] MS (ESI) m/z 443.2; MS (ESI) m/z 885.5; HRMS: calcd for $C_{24}H_{30}N_2O_6 + H^+$, 443.21766; found (ESI-FTMS, $[M+H]^+$), 443.21905.

Example 8UUUU: N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine

[0564] MS (ESI) m/z 437.3; MS (ESI) m/z 551.3; HRMS: calcd for $C_{25}H_{30}N_2O_5 + H^+$, 439.22275; found (ESI-FTMS, $[M+H]^+$), 439.22374.

Example 8VVVV: N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0565] MS (ESI) m/z 519.1; MS (ESI) m/z 1037.2; MS (ESI) m/z 536.1; HRMS: calcd for $C_{29}H_{30}N_2O_7 + H^+$, 519.21258; found (ESI-FTMS, $[M+H]^+$), 519.213.

Example 8WWW: N^2 -(3-phenoxybenzoyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0566] MS (ESI) m/z 523.1; MS (ESI) m/z 1045.2; MS (ESI) m/z 545.1; HRMS: calcd for $C_{28}H_{30}N_2O_8 + H^+$, 523.20749; found (ESI-FTMS, $[M+H]^+$), 523.20712.

Example 8XXXX: N^2 -(9H-fluoren-4-ylcarbonyl)- N^1 -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0567] MS (ESI) m/z 519.1; MS (ESI) m/z 1037.2; HRMS: calcd for $C_{29}H_{30}N_2O_7 + H^+$, 519.21258; found (ESI-FTMS, $[M+H]^+$), 519.21308.

Example 8YYYY: N^1 -1-adamantyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine

[0568] MS (ESI) m/z 485.3; MS (ESI) m/z 971.6; MS (ESI) m/z 521.3; HRMS: calcd for $C_{29}H_{30}N_2O_5 + H^+$, 487.22275; found (ESI-FTMS, $[M+H]^+$), 487.22272.

Example 8ZZZZ: N^1 -1-adamantyl- N^2 -(4-phenoxybenzoyl)-L- α -glutamine

[0569] MS (ESI) m/z 477.1; MS (ESI) m/z 953.3; MS (ESI) m/z 499.1; HRMS: calcd for $C_{28}H_{32}N_2O_5 + H^+$, 477.23840; found (ESI-FTMS, $[M+H]^+$), 477.23857.

Example 8AAAAA: N¹-1-adamantyl-N²-(9H-fluoren-2-ylcarbonyl)-L- α -glutamine

[0570] MS (ESI) m/z 473.3; MS (ESI) m/z 945.5; HRMS: calcd for C₂₉H₃₂N₂O₄ + H⁺, 473.24348; found (ESI-FTMS, [M+H]¹⁺), 473.24374.

Example 8BBBBB: N¹-1-adamantyl-N²-(9H-fluoren-9-ylcarbonyl)-L- α -glutamine

[0571] MS (ESI) m/z 471.3; MS (ESI) m/z 585.3; MS (ESI) m/z 943.6; HRMS: calcd for C₂₉H₃₂N₂O₄ + H⁺, 473.24348; found (ESI-FTMS, [M+H]¹⁺), 473.2437.

Example 8CCCCC: N²-(9H-fluoren-2-ylcarbonyl)-N¹-(3-methylbenzyl)-L- α -glutamine

[0572] HRMS: calcd for C₂₇H₂₆N₂O₄ + H⁺, 443.19653; found (ESI-FTMS, [M+H]¹⁺), 443.1974.

Example 8DDDDD: N¹-(3-methylbenzyl)-N²-[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine

[0573] HRMS: calcd for C₂₇H₂₄N₂O₅ + H⁺, 457.17580; found (ESI-FTMS, [M+H]¹⁺), 457.17616.

Example 8EEEEEE: N²-(9H-fluoren-9-ylcarbonyl)-N¹-(3-methylbenzyl)-L- α -glutamine

[0574] HRMS: calcd for C₂₇H₂₆N₂O₄ + H⁺, 443.19653; found (ESI-FTMS, [M+H]¹⁺), 443.19709.

Example 8FFFFFF: N²-(9H-fluoren-2-ylcarbonyl)-N¹-propyl-L- α -glutamine

[0575] HRMS: calcd for C₂₂H₂₄N₂O₄ + H⁺, 381.18088; found (ESI-FTMS, [M+H]¹⁺), 381.18117.

Example 8GGGGG: 4-[(9H-fluoren-9-carbonyl)-amino]-4-propylcarbamoyl-butyric acid

[0576] MS (ESI) m/z 395.1; MS (ESI) m/z 789.2; MS (ESI) m/z 811.2; HRMS: calcd for C₂₂H₂₄N₂O₄ + H⁺, 381.18088; found (ESI-FTMS, [M+H]¹⁺), 395.16097.

Example 8HHHHH: 4-[(9-Oxo-9H-fluorene-2-carbonyl)-amino]-4-propylcarbamoyl-butyric acid

[0577] MS (ESI) m/z 381.1; MS (ESI) m/z 403.1; MS (ESI) m/z 761.2; HRMS: calcd for $C_{22}H_{22}N_2O_5 + H^+$, 395.16015; found (ESI-FTMS, $[M+H]^+$), 381.18165.

Example 8IIIII: N¹-benzyl-N²-[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine

[0578] MS (ESI) m/z 441.2; MS (ESI) m/z 883.3; HRMS: calcd for $C_{26}H_{22}N_2O_5 + H^+$, 443.16015; found (ESI-FTMS, $[M+H]^+$), 443.16063.

Example 8JJJJJ: N¹-benzyl-N²-(9H-fluoren-2-ylcarbonyl)-L- α -glutamine

[0579] MS (ESI) m/z 427.2; MS (ESI) m/z 855.3; HRMS: calcd for $C_{26}H_{24}N_2O_4 + H^+$, 429.18088; found (ESI-FTMS, $[M+H]^+$), 429.18148.

Example 8KKKKK: N¹-benzyl-N²-(9H-fluoren-9-ylcarbonyl)-L- α -glutamine

[0580] MS (ESI) m/z 429; MS (ESI) m/z 857; MS (ESI) m/z 451; HRMS: calcd for $C_{26}H_{24}N_2O_4 + H^+$, 429.18088; found (ESI-FTMS, $[M+H]^+$), 429.1815.

Example 8LLLLL: N¹-benzyl-N²-(3-phenoxybenzoyl)-L- α -glutamine

[0581] MS (ESI) m/z 433; MS (ESI) m/z 455; MS (ESI) m/z 865; HRMS: calcd for $C_{25}H_{24}N_2O_5 + H^+$, 433.17580; found (ESI-FTMS, $[M+H]^+$), 433.17696.

Example 8MMMMM: N¹-(1-methyl-1-phenylethyl)-N²-[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine

[0582] MS (ESI) m/z 471.2; MS (ESI) m/z 941.5; MS (ESI) m/z 493.2; HRMS: calcd for $C_{28}H_{26}N_2O_5 + H^+$, 471.19145; found (ESI-FTMS, $[M+H]^+$), 471.19271.

Example 8NNNNN: N²-(9H-fluoren-9-ylcarbonyl)-N¹-(1-methyl-1-phenylethyl)-L- α -glutamine

[0583] MS (ESI) m/z 455.1; MS (ESI) m/z 911.3; HRMS: calcd for $C_{28}H_{28}N_2O_4 + H^+$, 457.21218; found (ESI-FTMS, $[M+H]^+$), 457.214.

Example 800000: N¹-(1-methyl-1-phenylethyl)-N²-(3-phenoxybenzoyl)-L- α -glutamine

[0584] MS (ESI) m/z 461.2; MS (ESI) m/z 921.5; MS (ESI) m/z 483.2; HRMS: calcd for C₂₇H₂₈N₂O₅ + H⁺, 461.20710; found (ESI-FTMS, [M+H]¹⁺), 461.20882.

Example 8PPPPP: N²-(biphenyl-4-ylcarbonyl)-N¹-[(1S)-1-phenylethyl]-L- α -glutamine

[0585] MS (ESI) m/z 431.2; MS (ESI) m/z 861.4; MS (ESI) m/z 453.2; HRMS: calcd for C₂₆H₂₆N₂O₄ + H⁺, 431.19653; found (ESI-FTMS, [M+H]¹⁺), 431.19802.

Example 800000: N²-(9H-fluoren-2-ylcarbonyl)-N¹-[(1S)-1-phenylethyl]-L- α -glutamine

[0586] MS (ESI) m/z 443.2; MS (ESI) m/z 885.4; MS (ESI) m/z 465.2; HRMS: calcd for C₂₇H₂₆N₂O₄ + H⁺, 443.19653; found (ESI-FTMS, [M+H]¹⁺), 443.19772.

Example 8RRRRR: N²-(biphenyl-4-ylcarbonyl)-N¹-[(1S)-1-(4-fluorophenyl)ethyl]-L- α -glutamine

[0587] MS (ESI) m/z 449.2; MS (ESI) m/z 897.4; HRMS: calcd for C₂₆H₂₅FN₂O₄ + H⁺, 449.18711; found (ESI-FTMS, [M+H]¹⁺), 449.18839.

Example 8SSSSS: tert-butyl N²-(biphenyl-4-ylcarbonyl)-N¹-(1-phenylethyl)-L- α -glutamate

[0588] MS(ESI) m/z 505.3.

Example 8TTTTT: N²-(biphenyl-4-ylcarbonyl)-N¹-[(1R)-1-(4-fluorophenyl)ethyl]-L- α -glutamine

[0589] MS (ESI) m/z 449.2; MS (ESI) m/z 897.5; MS (ESI) m/z 471.2; HRMS: calcd for C₂₆H₂₅FN₂O₄ + H⁺, 449.18711; found (ESI-FTMS, [M+H]¹⁺), 449.18679.

Example 8UUUUU: N²-(biphenyl-4-ylcarbonyl)-N¹-[(1R)-1-phenylethyl]-L- α -glutamine

[0590] MS (ESI) m/z 431.2; MS (ESI) m/z 861.5; MS (ESI) m/z 453.2; HRMS: calcd for $C_{26}H_{26}N_2O_4 + H^+$, 431.19653; found (ESI-FTMS, $[M+H]^{1+}$), 431.19828.

Example 8VVVVV: N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -(1R)-1-phenylethyl]-L- α -glutamine

[0591] MS (ESI) m/z 443.2; MS (ESI) m/z 885.5; MS (ESI) m/z 465.2; HRMS: calcd for $C_{27}H_{26}N_2O_4 + H^+$, 443.19653; found (ESI-FTMS, $[M+H]^{1+}$), 443.19676.

Example 8WWWW: N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine

[0592] MS (ESI) m/z 437.3; MS (ESI) m/z 875.5; HRMS: calcd for $C_{25}H_{30}N_2O_5 + H^+$, 439.22275; found (ESI-FTMS, $[M+H]^{1+}$), 439.22313.

Example 8XXXXX: N^1 -(6-hydroxyhexyl)- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine

[0593] MS (ESI) m/z 453.2; HRMS: calcd for $C_{25}H_{28}N_2O_6 + H^+$, 453.20201; found (ESI-FTMS, $[M+H]^{1+}$), 453.2027.

Example 8YYYYY: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -9H-fluoren-9-yl]-L- α -glutamine

[0594] MS (ESI) m/z 489.1; MS (ESI) m/z 979.2; HRMS: calcd for $C_{31}H_{26}N_2O_4 + H^+$, 491.19653; found (ESI-FTMS, $[M+H]^{1+}$), 491.19778.

Example 8ZZZZZ: N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0595] MS (ESI) m/z 489.2; MS (ESI) m/z 977.4; HRMS: calcd for $C_{29}H_{29}FN_2O_4 + H^+$, 489.21841; found (ESI-FTMS, $[M+H]^{1+}$), 489.21827.

Example 8AAAAA: N-(1-adamantylmethyl)- N^2 -(biphenyl-4-ylcarbonyl)-L- α -glutamine

[0596] MS (ESI) m/z 475.2; MS (ESI) m/z 949.5; HRMS: calcd for $C_{29}H_{34}N_2O_4 + H^+$, 475.25913; found (ESI-FTMS, $[M+H]^{1+}$), 475.25916.

Example 8BBBBBB: N-[(1S)-1-benzyl-2-hydroxyethyl]-N²-(9H-fluoren-2-ylcarbonyl)-L- α -glutamine

[0597] MS (ESI) m/z 473.2; MS (ESI) m/z 945.4; HRMS: calcd for C₂₈H₂₈N₂O₅ + H⁺, 473.20710; found (ESI-FTMS, [M+H]¹⁺), 473.2073.

Example 8CCCCCC: N²-(biphenyl-4-ylcarbonyl)-N-methyl-N-(2-phenylethyl)-L- α -glutamine

[0598] MS (ESI) m/z 445.4; MS (ESI) m/z 889.7; HRMS: calcd for C₂₇H₂₈N₂O₄ + H⁺, 445.21218; found (ESI-FTMS, [M+H]¹⁺), 445.21312.

Example 8DDDDDD: N²-(9H-fluoren-2-ylcarbonyl)-N-methyl-N-(2-phenylethyl)-L- α -glutamine

MS (ESI) m/z 457.4; MS (ESI) m/z 913.7; HRMS: calcd for C₂₈H₂₈N₂O₄ + H⁺, 457.21218; found (ESI-FTMS, [M+H]¹⁺), 457.21146.

Example 8EEEEEE: N²-(biphenyl-4-ylcarbonyl)-N-butyl-N-methyl-L- α -glutamine

[0599] MS (ESI) m/z 397.2; MS (ESI) m/z 793.4; MS (ESI) m/z 419.2; HRMS: calcd for C₂₃H₂₈N₂O₄ + H⁺, 397.21218; found (ESI-FTMS, [M+H]¹⁺), 397.21249.

Example 8FFFFFF: N-butyl-N²-(9H-fluoren-2-ylcarbonyl)-N-methyl-L- α -glutamine

[0600] MS (ESI) m/z 409.3; MS (ESI) m/z 817.5; HRMS: calcd for C₂₄H₂₈N₂O₄ + H⁺, 409.21218; found (ESI-FTMS, [M+H]¹⁺), 409.21227.

Example 8GGGGGG: N²-(biphenyl-4-ylcarbonyl)-N-[2-(3,4-dimethoxyphenyl)ethyl]-N-methyl-L- α -glutamine

[0601] MS (ESI) m/z 505.3; MS (ESI) m/z 527.3; MS (ESI) m/z 1009.6; HRMS: calcd for C₂₉H₃₂N₂O₆ + H⁺, 505.23331; found (ESI-FTMS, [M+H]¹⁺), 505.23512.

Example 8HHHHHH: N²-[4-(1,3-benzodioxol-5-yl)benzoyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0602] MS (ESI) m/z 521.1; MS (ESI) m/z 1041.3; HRMS: calcd for C₂₉H₂₉FN₂O₆ + H⁺, 521.20824; found (ESI-FTMS, [M+H]¹⁺), 521.20872.

Example 8IIIII: N-[2-(3,4-dimethoxyphenyl)ethyl]-N²-(9H-fluoren-2-ylcarbonyl)-N-methyl-L- α -glutamine

[0603] MS (ESI) m/z 517.2; MS (ESI) m/z 1033.3; HRMS: calcd for C₃₀H₃₂N₂O₆ + H⁺, 517.23331; found (ESI-FTMS, [M+H]¹⁺), 517.23342.

Example 8JJJJJJ: N²-(9H-fluoren-2-ylcarbonyl)-N-[(2R)-2-phenylpropyl]-L- α -glutamine

[0604] MS (ESI) m/z 457.2; MS (ESI) m/z 913.3; MS (ESI) m/z 479.1; HRMS: calcd for C₂₈H₂₈N₂O₄ + H⁺, 457.21218; found (ESI-FTMS, [M+H]¹⁺), 457.21246.

Example 8KKKKKK: N²-(biphenyl-4-ylcarbonyl)-N-[(2R)-2-phenylpropyl]-L- α -glutamine

[0605] MS (ESI) m/z 445.2; MS (ESI) m/z 889.3; HRMS: calcd for C₂₇H₂₈N₂O₄ + H⁺, 445.21218; found (ESI-FTMS, [M+H]¹⁺), 445.21285.

Example 8LLLLLL: N²-(biphenyl-4-ylcarbonyl)-N¹-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L-glutamamide

[0606] MS (ESI) m/z 476.2; MS (ESI) m/z 951.5; HRMS: calcd for C₂₈H₃₀FN₃O₃ + H⁺, 476.23440; found (ESI-FTMS, [M+H]¹⁺), 476.23543.

Example 8MMMMMM: N-[(1S)-1-benzyl-2-hydroxyethyl]-N²-(biphenyl-4-ylcarbonyl)-L- α -glutamine

[0607] MS (ESI) m/z 461.2; MS (ESI) m/z 921.4; MS (ESI) m/z 943.4; HRMS: calcd for C₂₇H₂₈N₂O₅ + H⁺, 461.20710; found (ESI-FTMS, [M+H]¹⁺), 461.20748.

Example 8NNNNNN: N¹-benzyl-N²-(4-bromobenzoyl)-L- α -glutamine

[0608] MS (ESI) m/z 419.1; MS (ESI) m/z 837.2; HRMS: calcd for C₁₉H₁₉BrN₂O₄ + H⁺, 419.06009; found (ESI_FT, [M+H]¹⁺), 419.05998.

Example 8OOOOOO: N¹-[2-(acetylamino)ethyl]-N²-(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0609] MS (ESI) m/z 410.2; MS (ESI) m/z 821.5; HRMS: calcd for $C_{22}H_{25}N_3O_5 + H^+$, 412.18670; found (ESI-FT, $[M+H]^+$), 412.18628.

Example 8PPPPPP: N^2 -(1,1'-biphenyl-4-ylacetyl)- N^1 -(3-methoxybenzyl)-L- α -glutamine

[0610] The title compound was prepared according to procedures similar to those described in Example 7, except biphenylacetic acid was used. MS (ESI) m/z 461.2; MS (ESI) m/z 921.4; HRMS: calcd for $C_{27}H_{28}N_2O_5 + H^+$, 461.20710; found (ESI-FTMS, $[M+H]^+$), 461.20514.

Example 8QQQQQQ: N^1 -(2-benzylphenyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine

[0611] MS (ESI-) m/z 491.3; HRMS: calcd for $C_{31}H_{28}N_2O_4 + H^+$, 493.21218; found (ESI-FTMS, $[M+H]^+$), 493.21319.

Example 8RRRRRR: N^2 -2-naphthoyl- N^1 -(3-phenylpropyl)-L- α -glutamine

[0612] MS (ESI) m/z 419.1; MS (ESI) m/z 837.1; MS (ESI) m/z 441.1; HRMS: calcd for $C_{25}H_{26}N_2O_4 + H^+$, 419.19653; found (ESI-FTMS, $[M+H]^+$), 419.19678.

Example 8SSSSSS: N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]- N^1 -(3-phenylpropyl)-L- α -glutamine

[0613] MS (ESI) m/z 471.3; MS (ESI) m/z 941.5; HRMS: calcd for $C_{28}H_{26}N_2O_5 + H^+$, 471.19145; found (ESI-FTMS, $[M+H]^+$), 471.19142.

Example 8TTTTTT: N^2 -(4-phenoxybenzoyl)- N^1 -(3-phenylpropyl)-L- α -glutamine

[0614] HRMS: calcd for $C_{27}H_{28}N_2O_5 + H^+$, 461.20710; found (ESI-FTMS, $[M+H]^+$), 461.20673.

Example 8UUUUUU: N^1 -benzyl- N^2 -[4-(pyrimidin-2-ylamino)benzoyl]-L- α -glutamine

[0615] MS m/z 02-101699GMS.

Example 8VVVVVV: N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine

[0616] MS (ESI) m/z 439.2; HRMS: calcd for $C_{25}H_{30}N_2O_5 + H^+$, 439.22275; found (ESI-FTMS, $[M+H]^+$), 439.22379.

Example 8WWWWW: N^2 -[4-(5-bromo-2-thienyl)benzoyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0617] MS (ESI) m/z 561.3; MS (ESI) m/z 1121.5; HRMS: calcd for $C_{26}H_{26}BrFN_2O_4S + H^+$, 561.08534; found (ESI-FTMS, $[M+H]^+$), 561.08472.

Example 8XXXXXX: N-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]- N^2 -[(3'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0618] MS (ESI) m/z 517.3; MS (ESI) m/z 1033.5; MS (ESI) m/z 539.3; HRMS: calcd for $C_{26}H_{26}ClFN_2O_4S + H^+$, 517.13586; found (ESI-FTMS, $[M+H]^+$), 517.13517.

[0619] MS (ESI) m/z 517.3; MS (ESI) m/z 1033.6; MS (ESI) m/z 539.3; HRMS: calcd for $C_{26}H_{26}ClFN_2O_4S + H^+$, 517.13586; found (ESI-FTMS, $[M+H]^+$), 517.13686.

Example 8YYYYYY: N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0620] MS (ESI) m/z 513.4; MS (ESI) m/z 1025.7; MS (ESI) m/z 535.3; HRMS: calcd for $C_{28}H_{27}F_3N_2O_4 + H^+$, 513.19957; found (ESI-FTMS, $[M+H]^+$), 513.19837.

[0621] MS (ESI) m/z 513.4; MS (ESI) m/z 1025.8; MS (ESI) m/z 535.4; HRMS: calcd for $C_{28}H_{27}F_3N_2O_4 + H^+$, 513.19957; found (ESI-FTMS, $[M+H]^+$), 513.20152.

Example 8ZZZZZZ: N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0622] MS (ESI) m/z 529.2; MS (ESI) m/z 1057.5; HRMS: calcd for $C_{28}H_{27}ClF_2N_2O_4 + H^+$, 529.17002; found (ESI-FTMS, $[M+H]^+$), 529.16931.

Example 8AAAAAAA: N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0623] MS (ESI) m/z 529.2; MS (ESI) m/z 1057.5; HRMS: calcd for $C_{28}H_{27}ClF_2N_2O_4 + H^+$, 529.17002; found (ESI-FTMS, $[M+H]^{1+}$), 529.16951.

Example 8BBBBBBB: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',5'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0624] MS (ESI) m/z 529.3; MS (ESI) m/z 1057.5; MS (ESI) m/z 551.2; HRMS: calcd for $C_{28}H_{27}ClF_2N_2O_4 + H^+$, 529.17002; found (ESI-FTMS, $[M+H]^{1+}$), 529.16954.

Example 8CCCCCCC: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',6'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0625] MS (ESI) m/z 529.2; MS (ESI) m/z 1057.4; HRMS: calcd for $C_{28}H_{27}ClF_2N_2O_4 + H^+$, 529.17002; found (ESI-FTMS, $[M+H]^{1+}$), 529.16943.

Example 8DDDDDDD: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(3',5'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0626] MS (ESI) m/z 529.3; MS (ESI) m/z 1057.5; MS (ESI) m/z 551.3; HRMS: calcd for $C_{28}H_{27}ClF_2N_2O_4 + H^+$, 529.17002; found (ESI-FTMS, $[M+H]^{1+}$), 529.17191.

Example 8EEEEEEE: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',3'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0627] HRMS: calcd for $C_{28}H_{27}ClF_2N_2O_4 + H^+$, 529.17002; found (ESI-FTMS, $[M+H]^{1+}$), 529.17167.

Example 8FFFFFFF: N -(1,1-dimethyl-2-phenylethyl)- N^2 -(4-pyrimidin-5-ylbenzoyl)-L- α -glutamine

[0628] MS (ESI) m/z 461.2; MS (ESI) m/z 921.4; HRMS: calcd for $C_{26}H_{28}N_4O_4 + H^+$, 461.21833; found (ESI-FTMS, $[M+H]^{1+}$), 461.21863.

Example 8GGGGGGG: N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0629] MS (ESI) m/z 495.2; MS (ESI) m/z 989.4; HRMS: calcd for $C_{28}H_{28}F_2N_2O_4 + H^+$, 495.20899; found (ESI-FTMS, $[M+H]^{1+}$), 495.21035.

Example 8HHHHHHH: N^2 -[(3',5'-difluorobiphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0630] MS (ESI) m/z 495.2; MS (ESI) m/z 989.4; MS (ESI) m/z 517.2; HRMS: calcd for $C_{28}H_{28}F_2N_2O_4 + H^+$, 495.20899; found (ESI-FTMS, $[M+H]^{1+}$), 495.21017.

Example 8IIIIII: N -[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]- N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0631] MS (ESI) m/z 533.3; MS (ESI) m/z 1067.7; HRMS: calcd for $C_{26}H_{25}ClF_2N_2O_4S + H^+$, 535.12644; found (ESI-FTMS, $[M+H]^{1+}$), 535.1267.

Example 8JJJJJJJ: N^2 -(biphenyl-4-ylcarbonyl)- N -[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-L- α -glutamine

[0632] MS (ESI) m/z 499.4; MS (ESI) m/z 997.7; MS (ESI) m/z 521.4; HRMS: calcd for $C_{26}H_{27}ClN_2O_4S + H^+$, 499.14528; found (ESI-FTMS, $[M+H]^{1+}$), 499.14616.

Example 8KKKKKKK: N^2 -[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl]- N -[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-L- α -glutamine

[0633] MS (ESI) m/z 557.3; MS (ESI) m/z 1113.6; HRMS: calcd for $C_{24}H_{23}Cl_2FN_2O_4S_2 + H^+$, 557.05331; found (ESI-FTMS, $[M+H]^{1+}$), 557.05439.

Example 8LLLLLLL: N^2 -[4'-(hydroxymethyl)biphenyl-4-yl]carbonyl]- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0634] MS (ESI) m/z 537.1; MS (ESI) m/z 1073.3; HRMS: calcd for $C_{29}H_{32}N_2O_8 + H^+$, 537.22314; found (ESI-FTMS, $[M+H]^{1+}$), 537.22326.

Example 8MMMMMMM: N^2 -[4'-(bromomethyl)biphenyl-4-yl]carbonyl]- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0635] MS (ESI) m/z 599.1; MS (ESI) m/z 1197.1; HRMS: calcd for $C_{29}H_{31}BrN_2O_7 + H^+$, 599.13874; found (ESI-FTMS, $[M+H]^{1+}$), 599.13934.

Example 8NNNNNNN: *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[4-(2-thienyl)benzoyl]-L- α -glutamine

[0636] MS (ESI) *m/z* 483.3; MS (ESI) *m/z* 965.5; HRMS: calcd for C₂₆H₂₇FN₂O₄S + H⁺, 483.17483; found (ESI-FTMS, [M+H]¹⁺), 483.1743.

Example 8OOOOOOO: *N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[4-(2-furyl)benzoyl]-L- α -glutamine

[0637] MS (ESI) *m/z* 467.3; MS (ESI) *m/z* 933.6; HRMS: calcd for C₂₆H₂₇FN₂O₅ + H⁺, 467.19768; found (ESI-FTMS, [M+H]¹⁺), 467.19704.

Example 8PPPPPPP: *N*²-[4'-(hydroxymethyl)biphenyl-4-yl]carbonyl]-*N*-(3-methylbenzyl)-L- α -glutamine

[0638] MS (ESI) *m/z* 459.1; MS (ESI) *m/z* 919.5; HRMS: calcd for C₂₇H₂₈N₂O₅ + H⁺, 461.20710; found (ESI-FTMS, [M+H]¹⁺), 461.20822.

Example 8QOOOOOOO: *N*²-[3'-(hydroxymethyl)biphenyl-4-yl]carbonyl]-*N*-(3-methylbenzyl)-L- α -glutamine

[0639] MS (ESI) *m/z* 459.2; HRMS: calcd for C₂₇H₂₈N₂O₅ + H⁺, 461.20710; found (ESI-FTMS, [M+H]¹⁺), 461.20807.

Example 8RRRRRRR: *N*²-[4-(2,3-dihydro-1-benzofuran-5-yl)benzoyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0640] MS (ESI) *m/z* 517.3; MS (ESI) *m/z* 1035.7; HRMS: calcd for C₃₀H₃₁FN₂O₅ + H⁺, 519.22898; found (ESI-FTMS, [M+H]¹⁺), 519.22989.

Example 8SSSSSSS: *N*²-[(3'-chloro-4'-fluorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0641] MS (ESI) *m/z* 529.3; MS (ESI) *m/z* 1057.6; HRMS: calcd for C₂₈H₂₇ClF₂N₂O₄ + H⁺, 529.17002; found (ESI-FTMS, [M+H]¹⁺), 529.17061.

Example 8TTTTTTT: *N*²-[3'-(bromomethyl)biphenyl-4-yl]carbonyl]-*N*-(3-methylbenzyl)-L- α -glutamine

[0642] MS (ESI) m/z 521.1; HRMS: calcd for $C_{27}H_{27}BrN_2O_4 + H^+$, 523.12270; found (ESI-FTMS, $[M+H]^+$), 523.12235.

Example 8UUUUUUU: N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[4-(3-thienyl)benzoyl]-L- α -glutamine

[0643] MS (ESI) m/z 483.1; MS (ESI) m/z 965.3; HRMS: calcd for $C_{26}H_{27}FN_2O_4S + H^+$, 483.17483; found (ESI-FTMS, $[M+H]^+$), 483.17572.

Example 8VVVVVVV: N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[4-(5-methyl-2-thienyl)benzoyl]-L- α -glutamine

[0644] MS (ESI) m/z 495.4; MS (ESI) m/z 991.7; HRMS: calcd for $C_{27}H_{29}FN_2O_4S + H^+$, 497.19048; found (ESI-FTMS, $[M+H]^+$), 497.19118.

Example 8WWWWWW: N^2 -[4-(5-chloro-2-thienyl)benzoyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0645] MS (ESI) m/z 515.3; MS (ESI) m/z 1031.7; HRMS: calcd for $C_{26}H_{26}ClFN_2O_4S + H^+$, 517.13586; found (ESI-FTMS, $[M+H]^+$), 517.13644.

[0646] MS (ESI) m/z 515.3; MS (ESI) m/z 1031.6; HRMS: calcd for $C_{26}H_{26}ClFN_2O_4S + H^+$, 517.13586; found (ESI-FTMS, $[M+H]^+$), 517.13658.

Example 8XXXXXXXX: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[4-(2-thienyl)benzoyl]-L- α -glutamine

[0647] MS (ESI) m/z 497.3; MS (ESI) m/z 995.6; HRMS: calcd for $C_{26}H_{27}ClN_2O_4S + H^+$, 499.14528; found (ESI-FTMS, $[M+H]^+$), 499.14509.

Example 8YYYYYYY: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[5-(3-methoxyphenyl)-2-thienyl]carbonyl]-L- α -glutamine

[0648] MS (ESI) m/z 529.3; MS (ESI) m/z 1057.5; HRMS: calcd for $C_{27}H_{29}ClN_2O_5S + H^+$, 529.15585; found (ESI-FTMS, $[M+H]^+$), 529.15608.

Example 8ZZZZZZZ: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[5-phenyl-2-thienyl]carbonyl]-L- α -glutamine

[0649] MS (ESI) m/z 499.2; MS (ESI) m/z 997.5; HRMS: calcd for $C_{26}H_{27}ClN_2O_4S + H^+$, 499.14528; found (ESI-FTMS, $[M+H]^+$), 499.14644.

Example 8AAAAAAA: N^2 -(2,2'-bithien-5-ylcarbonyl)- N -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0650] MS (ESI) m/z 505.1; MS (ESI) m/z 1009.1; HRMS: calcd for $C_{24}H_{25}ClN_2O_4S_2 + H^+$, 505.10170; found (ESI-FTMS, $[M+H]^+$), 505.10282.

Example 8BBBBBBB: N^2 -[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0651] MS (ESI) m/z 517.5; MS (ESI) m/z 1035.9; HRMS: calcd for $C_{30}H_{31}FN_2O_5 + H^+$, 519.22898; found (ESI-FTMS, $[M+H]^+$), 519.22971.

Example 8CCCCCCC: N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[6-(3-methoxyphenyl)pyridin-3-yl]carbonyl]-L- α -glutamine

[0652] MS (ESI) m/z 508.4; HRMS: calcd for $C_{28}H_{30}FN_3O_5 + H^+$, 508.22423; found (ESI-FTMS, $[M+H]^+$), 508.22472.

Example 8DDDDDDD: N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine

[0653] MS (ESI) m/z 478.4; HRMS: calcd for $C_{27}H_{28}FN_3O_4 + H^+$, 478.21366; found (ESI-FTMS, $[M+H]^+$), 478.21435.

Example 8EEEEEEE: N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine

[0654] MS (ESI) m/z 483.2; MS (ESI) m/z 965.4; HRMS: calcd for $C_{26}H_{27}FN_2O_4S + H^+$, 483.17483; found (ESI-FTMS, $[M+H]^+$), 483.17576.

Example 8FFFFFFF: N^2 -[(3-fluorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0655] MS (ESI) m/z 495.3; MS (ESI) m/z 989.6; HRMS: calcd for $C_{28}H_{28}F_2N_2O_4 + H^+$, 495.20899; found (ESI-FTMS, $[M+H]^+$), 495.20963.

Example 8GGGGGGGG: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(5-pyridin-4-yl-2-thienyl)carbonyl]-*L*- α -glutamine

[0656] MS (ESI) *m/z* 500.3; HRMS: calcd for C₂₅H₂₆ClN₃O₄S + H⁺, 500.14053; found (ESI-FTMS, [M+H]¹⁺), 500.13984.

Example 8HHHHHHHH: *N*²-[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl]-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*L*- α -glutamine

[0657] MS (ESI) *m/z* 549.3; HRMS: calcd for C₂₆H₂₅Cl₂FN₂O₄S + H⁺, 551.09689; found (ESI-FTMS, [M+H]¹⁺), 551.09834.

Example 8IIIIIII: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-*L*- α -glutamine

[0658] MS (ESI) *m/z* 535.4; MS (ESI) *m/z* 1069.8; HRMS: calcd for C₃₀H₃₁ClN₂O₅ + H⁺, 535.19943; found (ESI-FTMS, [M+H]¹⁺), 535.20047.

Example 8JJJJJJJJ: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-*L*- α -glutamine

[0659] MS (ESI) *m/z* 500.3; HRMS: calcd for C₂₅H₂₆ClN₃O₄S + H⁺, 500.14053; found (ESI-FTMS, [M+H]¹⁺), 500.1423.

Example 8KKKKKKKK: *N*²-[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine

[0660] MS (ESI) *m/z* 501.4; MS (ESI) *m/z* 1001.8; HRMS: calcd for C₃₀H₃₂N₂O₅ + H⁺, 501.23840; found (ESI-FTMS, [M+H]¹⁺), 501.23954.

Example 8LLLLLLLL: *N*²-[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine

[0661] MS (ESI) *m/z* 515.3; MS (ESI) *m/z* 1031.7; HRMS: calcd for C₂₆H₂₆ClFN₂O₄S + H⁺, 517.13586; found (ESI-FTMS, [M+H]¹⁺), 517.13443.

Example 8MMMMMMM: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[4-(2-thienyl)benzoyl]-L- α -glutamine

[0662] MS (ESI) *m/z* 465.2; MS (ESI) *m/z* 929.4; HRMS: calcd for C₂₆H₂₈N₂O₄S + H⁺, 465.18425; found (ESI-FTMS, [M+H]¹⁺), 465.18402.

Example 8NNNNNNNN: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[5-(3-methoxyphenyl)-2-thienyl]carbonyl]-L- α -glutamine

[0663] MS (ESI) *m/z* 495.2; MS (ESI) *m/z* 989.4; HRMS: calcd for C₂₇H₃₀N₂O₅S + H⁺, 495.19482; found (ESI-FTMS, [M+H]¹⁺), 495.1942.

Example 8OOOOOOOO: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine

[0664] MS (ESI) *m/z* 465.2; MS (ESI) *m/z* 929.4; HRMS: calcd for C₂₆H₂₈N₂O₄S + H⁺, 465.18425; found (ESI-FTMS, [M+H]¹⁺), 465.18359.

Example 8PPPPPPPP: *N*²-(2,2'-bithien-5-ylcarbonyl)-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0665] MS (ESI) *m/z* 469.3; MS (ESI) *m/z* 939.6; HRMS: calcd for C₂₄H₂₆N₂O₄S₂ + H⁺, 471.14067; found (ESI-FTMS, [M+H]¹⁺), 471.1403.

Example 8QQQQQQQQ: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(5-pyridin-4-yl-2-thienyl)carbonyl]-L- α -glutamine

[0666] MS (ESI) *m/z* 466.4; HRMS: calcd for C₂₅H₂₇N₃O₄S + H⁺, 466.17950; found (ESI-FTMS, [M+H]¹⁺), 466.17836.

Example 8RRRRRRRR: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine

[0667] MS (ESI) *m/z* 466.3; HRMS: calcd for C₂₅H₂₇N₃O₄S + H⁺, 466.17950; found (ESI-FTMS, [M+H]¹⁺), 466.17912.

Example 8SSSSSSSS: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[4-(5-chloro-2-thienyl)benzoyl]-L- α -glutamine

[0668] HRMS: calcd for $C_{26}H_{26}Cl_2N_2O_4S + H^+$, 533.10631; found (ESI-FTMS, $[M+H]^+$), 533.10629.

Example 8TTTTTTTTT: N^2 -{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0669] MS (ESI) m/z 500.3; MS (ESI) m/z 999.6; HRMS: calcd for $C_{25}H_{26}ClN_3O_4S + H^+$, 500.14053; found (ESI-FTMS, $[M+H]^+$), 500.14123.

Example 8UUUUUUUUU: N-(1,1-dimethyl-2-phenylethyl)- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine

[0670] MS (ESI) m/z 460.4; HRMS: calcd for $C_{27}H_{29}N_3O_4 + H^+$, 460.22308; found (ESI-FTMS, $[M+H]^+$), 460.22319.

Example 8VVVVVVVVV: N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -(5-phenyl-2-furoyl)-L- α -glutamine

[0671] MS (ESI) m/z 483.3; MS (ESI) m/z 965.6; MS (ESI) m/z 987.6; HRMS: calcd for $C_{26}H_{27}ClN_2O_5 + H^+$, 483.16813; found (ESI-FTMS, $[M+H]^+$), 483.16818.

Example 8WWWWWWWW: N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-L- α -glutamine

[0672] MS (ESI) m/z 534.3; HRMS: calcd for $C_{25}H_{25}Cl_2N_3O_4S + H^+$, 534.10156; found (ESI-FTMS, $[M+H]^+$), 534.10123.

Example 8XXXXXXXXX: N-[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine

[0673] MS (ESI) m/z 494.4; HRMS: calcd for $C_{27}H_{28}ClN_3O_4 + H^+$, 494.18411; found (ESI-FTMS, $[M+H]^+$), 494.18423.

Example 8YYYYYYYY: N-[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -{[5-(3-methoxyphenyl)-2-thienyl]carbonyl}-L- α -glutamine

[0674] MS (ESI) m/z 513.3; MS (ESI) m/z 1025.7; HRMS: calcd for $C_{27}H_{29}FN_2O_5S + H^+$, 513.18540; found (ESI-FTMS, $[M+H]^+$), 513.18635.

Example 8ZZZZZZZZ: N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine

[0675] MS (ESI) m/z 484.3; HRMS: calcd for $C_{25}H_{26}FN_3O_4S + H^+$, 484.17008; found (ESI-FTMS, $[M+H]^+$), 484.17109.

Example 8AAAAAAAAA: N^2 -[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0676] MS (ESI) m/z 535.2; MS (ESI) m/z 557.2; MS (ESI) m/z 1069.5; HRMS: calcd for $C_{26}H_{25}ClF_2N_2O_4S + H^+$, 535.12644; found (ESI-FTMS, $[M+H]^+$), 535.12696.

[0677] MS (ESI) m/z 533.3; MS (ESI) m/z 1067.6; HRMS: calcd for $C_{26}H_{25}ClF_2N_2O_4S + H^+$, 535.12644; found (ESI-FTMS, $[M+H]^+$), 535.12796.

Example 8BBBBBBBBB: N^2 -(2,2'-bithien-5-ylcarbonyl)- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0678] MS (ESI) m/z 489.3; MS (ESI) m/z 977.5; HRMS: calcd for $C_{24}H_{25}FN_2O_4S_2 + H^+$, 489.13125; found (ESI-FTMS, $[M+H]^+$), 489.13208.

Example 8CCCCCCCCC: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[4-(5-formyl-2-thienyl)benzoyl]-L- α -glutamine

[0679] MS (ESI) m/z 527.1; MS (ESI) m/z 1053.1; MS (ESI) m/z 549; HRMS: calcd for $C_{27}H_{27}ClN_2O_5S + H^+$, 527.14020; found (ESI-FTMS, $[M+H]^+$), 527.14185.

Example 8DDDDDDDDD: N^2 -[4-(5-acetyl-2-thienyl)benzoyl]- N -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0680] MS (ESI) m/z 541.1; MS (ESI) m/z 1081.2; MS (ESI) m/z 563.1; HRMS: calcd for $C_{28}H_{29}ClN_2O_5S + H^+$, 541.15585; found (ESI-FTMS, $[M+H]^+$), 541.15471.

Example 8EEEEEEEEEE: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine

[0681] MS (ESI) m/z 500.3; HRMS: calcd for $C_{25}H_{26}ClN_3O_4S + H^+$, 500.14053; found (ESI-FTMS, $[M+H]^+$), 500.14163.

Example 8FFFFFFFFF: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine

[0682] MS (ESI) *m/z* 466.3; HRMS: calcd for C₂₅H₂₇N₃O₄S + H⁺, 466.17950; found (ESI-FTMS, [M+H]¹⁺), 466.18052.

Example 8GGGGGGGGG: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-(5-phenyl-2-furoyl)-L- α -glutamine

[0683] MS (ESI) *m/z* 449.3; MS (ESI) *m/z* 897.6; MS (ESI) *m/z* 471.3; HRMS: calcd for C₂₆H₂₈N₂O₅ + H⁺, 449.20710; found (ESI-FTMS, [M+H]¹⁺), 449.20772.

Example 8HHHHHHHHH: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[4-(5-formyl-2-thienyl)benzoyl]-L- α -glutamine

[0684] MS (ESI) *m/z* 493.3; MS (ESI) *m/z* 985.6; MS (ESI) *m/z* 515.3; HRMS: calcd for C₂₇H₂₈N₂O₅S + H⁺, 493.17917; found (ESI-FTMS, [M+H]¹⁺), 493.18011.

Example 8IIIIIIIII: *N*²-[4-(5-acetyl-2-thienyl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0685] MS (ESI) *m/z* 507.3; MS (ESI) *m/z* 1013.7; MS (ESI) *m/z* 529.3; HRMS: calcd for C₂₈H₃₀N₂O₅S + H⁺, 507.19482; found (ESI-FTMS, [M+H]¹⁺), 507.19518.

Example 8JJJJJJJJJ: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[3-(5-chloro-2-thienyl)benzoyl]-L- α -glutamine

[0686] MS (ESI) *m/z* 533.3; MS (ESI) *m/z* 1065.5; MS (ESI) *m/z* 555.3; HRMS: calcd for C₂₆H₂₆Cl₂N₂O₄S + H⁺, 533.10631; found (ESI-FTMS, [M+H]¹⁺), 533.10835.

Example 8KKKKKKKKK: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[3-(2-thienyl)benzoyl]-L- α -glutamine

[0687] MS (ESI) *m/z* 499.3; MS (ESI) *m/z* 997.6; MS (ESI) *m/z* 521.3; HRMS: calcd for C₂₆H₂₇ClN₂O₄S + H⁺, 499.14528; found (ESI-FTMS, [M+H]¹⁺), 499.14679.

Example 8LLLLLLLLL: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-{[5-(4-chlorophenyl)-2-thienyl]carbonyl}-L- α -glutamine

[0688] MS (ESI) *m/z* 533.3; MS (ESI) *m/z* 1065.5; MS (ESI) *m/z* 555.3; HRMS: calcd for C₂₆H₂₆Cl₂N₂O₄S + H⁺, 533.10631; found (ESI-FTMS, [M+H]¹⁺), 533.10784.

Example 8MMMMMMMMM: *N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-{[5-(4-fluorophenyl)-2-thienyl]carbonyl}-L- α -glutamine

[0689] MS (ESI) *m/z* 517.3; MS (ESI) *m/z* 539.3; MS (ESI) *m/z* 1033.6; HRMS: calcd for C₂₆H₂₆ClFN₂O₄S + H⁺, 517.13586; found (ESI-FTMS, [M+H]¹⁺), 517.13691.

Example 8NNNNNNNNN: *N*²-[4-(5-bromo-2-thienyl)benzoyl]-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0690] MS (ESI) *m/z* 577.2; MS (ESI) *m/z* 1153.4; HRMS: calcd for C₂₆H₂₆BrClN₂O₄S + H⁺, 577.05579; found (ESI-FTMS, [M+H]¹⁺), 577.05597.

Example 8OOOOOOOOO: *N*²-[4-(5-bromo-2-thienyl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0691] MS (ESI) *m/z* 543.1; MS (ESI) *m/z* 1085.2; HRMS: calcd for C₂₆H₂₇BrN₂O₄S + H⁺, 543.09477; found (ESI-FTMS, [M+H]¹⁺), 543.0965; HRMS: calcd for C₂₆H₂₇BrN₂O₄S + H⁺, 543.09477; found (ESI-FTMS, [M+H]¹⁺), 543.09494.

Example 8PPPPPPPPP: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-{[5-(4-fluorophenyl)-2-thienyl]carbonyl}-L- α -glutamine

[0692] MS (ESI) *m/z* 483.2; MS (ESI) *m/z* 965.4; MS (ESI) *m/z* 505.2; HRMS: calcd for C₂₆H₂₇FN₂O₄S + H⁺, 483.17483; found (ESI-FTMS, [M+H]¹⁺), 483.17634.

Example 8QOOOOOOOOO: *N*²-[3-(5-chloro-2-thienyl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0693] MS (ESI) *m/z* 499.2; MS (ESI) *m/z* 997.3; MS (ESI) *m/z* 521.1; HRMS: calcd for C₂₆H₂₇ClN₂O₄S + H⁺, 499.14528; found (ESI-FTMS, [M+H]¹⁺), 499.14544.

Example 8RRRRRRRRRR: N^2 -(1,1-dimethyl-2-phenylethyl)- N^2 -[3-(2-thienyl)benzoyl]-L- α -glutamine

[0694] MS (ESI) m/z 465.2; MS (ESI) m/z 929.4; MS (ESI) m/z 487.2; HRMS: calcd for $C_{26}H_{28}N_2O_4S + H^+$, 465.18425; found (ESI-FTMS, $[M+H]^+$), 465.18439.

Example 8SSSSSSSSSS: N^2 -[(3'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0695] HRMS: calcd for $C_{28}H_{28}ClFN_2O_4 + H^+$, 511.17944; found (ESI-FTMS, $[M+H]^+$), 511.17974.

Example 8TTTTTTTTTT: N^2 -[(4'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0696] HRMS: calcd for $C_{28}H_{28}ClFN_2O_4 + H^+$, 511.17944; found (ESI-FTMS, $[M+H]^+$), 511.17972.

Example 8UUUUUUUUUU: N^2 -(4'-fluorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0697] HRMS: calcd for $C_{28}H_{28}F_2N_2O_4 + H^+$, 495.20899; found (ESI-FTMS, $[M+H]^+$), 495.20933.

Example 8VVVVVVVVVV: N^2 -[(3'-fluorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0698] HRMS: calcd for $C_{28}H_{28}F_2N_2O_4 + H^+$, 495.20899; found (ESI-FTMS, $[M+H]^+$), 495.20937.

Example 8WWWWWWWWW: N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(3-phenyl-2-thienyl)carbonyl]-L- α -glutamine

[0699] HRMS: calcd for $C_{26}H_{27}ClN_2O_4S + H^+$, 499.14528; found (ESI-FTMS, $[M+H]^+$), 499.14664.

Example 8XXXXXXXXXX: N^2 -[(4'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0700] MS (ESI) m/z 527.3; MS (ESI) m/z 1053.7; MS (ESI) m/z 549.3; HRMS: calcd for $C_{28}H_{28}Cl_2N_2O_4 + H^+$, 527.14989; found (ESI-FTMS, $[M+H]^+$), 527.15049.

[0701] HRMS: calcd for $C_{28}H_{28}Cl_2N_2O_4 + H^+$, 527.14989; found (ESI-FTMS, $[M+H]^+$), 527.14931.

Example 8YYYYYYYYYY: N^2 -[(3'-chlorobiphenyl-4-yl)carbonyl]- N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- L - α -glutamine

[0702] MS (ESI) m/z 527.3; MS (ESI) m/z 1053.7; MS (ESI) m/z 549.3; HRMS: calcd for $C_{28}H_{28}Cl_2N_2O_4 + H^+$, 527.14989; found (ESI-FTMS, $[M+H]^+$), 527.15048.

Example 8ZZZZZZZZZZ: N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[5-(4-fluorophenyl)-2-thienyl]carbonyl]- L - α -glutamine

[0703] MS (ESI) m/z 501.3; MS (ESI) m/z 1001.6; MS (ESI) m/z 523.3; HRMS: calcd for $C_{26}H_{26}F_2N_2O_4S + H^+$, 501.16541; found (ESI-FTMS, $[M+H]^+$), 501.16642.

[0704] MS (ESI) m/z 501.3; MS (ESI) m/z 1001.6; MS (ESI) m/z 523.3; HRMS: calcd for $C_{26}H_{26}F_2N_2O_4S + H^+$, 501.16541; found (ESI-FTMS, $[M+H]^+$), 501.16709.

Example 8AAAAAAAAAA: N^2 -[5-(4-chlorophenyl)-2-thienyl]carbonyl]- N -(1,1-dimethyl-2-phenylethyl)- L - α -glutamine

[0705] MS (ESI) m/z 499.1; MS (ESI) m/z 997.2; HRMS: calcd for $C_{26}H_{27}ClN_2O_4S + H^+$, 499.14528; found (ESI-FTMS, $[M+H]^+$), 499.14552.

Example 8BBBBBBBBBB: N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(3-phenyl-2-thienyl)carbonyl]- L - α -glutamine

[0706] MS (ESI) m/z 465.2; MS (ESI) m/z 929.4; MS (ESI) m/z 951.4; HRMS: calcd for $C_{26}H_{28}N_2O_4S + H^+$, 465.18425; found (ESI-FTMS, $[M+H]^+$), 465.18455.

Example 8CCCCCCCCCCC: N^2 -(4-bromobenzoyl)- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- L - α -glutamine

[0707] MS (ESI) m/z 479.3; MS (ESI) m/z 957.5; MS (ESI) m/z 501.2; HRMS: calcd for $C_{22}H_{24}BrFN_2O_4 + H^+$, 479.09762; found (ESI-FTMS, $[M+H]^+$), 479.0983.

Example 8DDDDDDDDDD: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(4'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0708] MS (ESI) *m/z* 477.3; MS (ESI) *m/z* 499.3; MS (ESI) *m/z* 953.7; HRMS: calcd for C₂₈H₂₉FN₂O₄ + H⁺, 477.21841; found (ESI-FTMS, [M+H]¹⁺), 477.21891.

Example 8EEEEEEEEEEE: *N*-(1,1-dimethyl-2-phenylethyl)-*N*²-[(3'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine

[0709] MS (ESI) *m/z* 477.3; MS (ESI) *m/z* 499.3; MS (ESI) *m/z* 953.7; HRMS: calcd for C₂₈H₂₉FN₂O₄ + H⁺, 477.21841; found (ESI-FTMS, [M+H]¹⁺), 477.21875.

Example 8FFFFFFFFFF: *N*²-[4-(5-chloro-2-thienyl)benzoyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamine

[0710] MS (ESI) *m/z* 517.2; MS (ESI) *m/z* 539.2; MS (ESI) *m/z* 1033.5; HRMS: calcd for C₂₆H₂₆ClFN₂O₄S + H⁺, 517.13586; found (ESI-FTMS, [M+H]¹⁺), 517.1365.

Example 8GGGGGGGGGG: *N*²-{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0711] MS (ESI) *m/z* 518.2; HRMS: calcd for C₂₅H₂₅ClFN₃O₄S + H⁺, 518.13111; found (ESI-FTMS, [M+H]¹⁺), 518.13169.

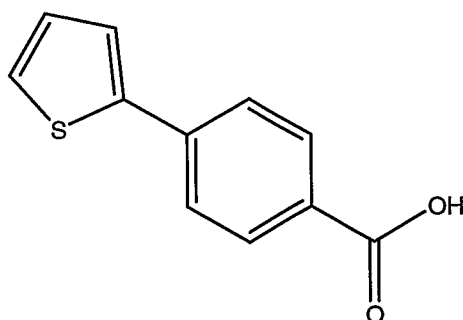
Example 8HHHHHHHHHH: *N*²-{[5-(4-chlorophenyl)-2-thienyl]carbonyl}-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0712] MS (ESI) *m/z* 517.3; MS (ESI) *m/z* 539.3; MS (ESI) *m/z* 1033.6; HRMS: calcd for C₂₆H₂₆ClFN₂O₄S + H⁺, 517.13586; found (ESI-FTMS, [M+H]¹⁺), 517.1363.

Example 8IIIIIIIII: *N*²-{[5-(3,4-difluorophenyl)-2-thienyl]carbonyl}-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0713] MS (ESI) *m/z* 519.3; MS (ESI) *m/z* 1037.7; MS (ESI) *m/z* 541.3; HRMS: calcd for C₂₆H₂₅F₃N₂O₄S + H⁺, 519.15599; found (ESI-FTMS, [M+H]¹⁺), 519.1568.

[0714] The following intermediates (R₁COOH in scheme 7) were prepared and used in the preparation of some of the compounds of Example 8:

Example 8JJJJJJJJJ: 4-(2-thienyl)benzoic acid

[0715] 4-iodobenzoic acid (3g, 12.1mmol), 2-thiopheneboronic acid (3.10g, 24.2mmol), and $\text{Pd}(\text{PPh}_3)_4$ (1.4g, 1.21mmol) were dissolved in DMF (75mL) in a 350mL screw-cap pressure vessel. In a separate flask, K_2CO_3 (5.02g, 36.3mmol) was dissolved in H_2O (12mL) and was then added to the reaction. The flask was sealed, heated to 100°C and stirred overnight (17h).

[0716] The reaction was then diluted with H_2O (150mL), placed in a sep. funnel, and 1N NaOH was added to raise the pH to 10. The aqueous layer was washed with EtOAc (2x250mL). The aqueous layer was kept, activated charcoal was added, and the mixture heated and stirred. Celite was added, followed by the mixture being filtered through celite. The filtrate was then acidified with concentrated HCl. At pH 7 a tan solid starts to precipitate. The pH was lowered to 5 and the solid formed is filtered out. The solid was partially dissolved in a small amount of toluene, which was then removed to remove some of the water still present. This step was repeated, then the solid was dried under vacuum. Yield – 2.01g tan solid, 81%. MS (ESI) m/z 202.9; HRMS: calcd for $\text{C}_{11}\text{H}_8\text{O}_2\text{S} + \text{H}^+$, 205.03178; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 205.03127.

[0717] The following compounds were prepared according to the procedure similar to the one described in Example 8JJJJJJJJJ, from appropriate commercially available reagents:

i: 5-(3-methoxyphenyl)thiophene-2-carboxylic acid

MS (ESI) m/z 233.1; HRMS: calcd for $\text{C}_{12}\text{H}_{10}\text{O}_3\text{S} + \text{H}^+$, 235.04234; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 235.04226;

ii. 2,2'-bithiophene-5-carboxylic acid

MS (ESI) m/z 209.1; HRMS: calcd for $C_9H_6O_2S_2 + H^+$, 210.98820; found (ESI-FTMS, $[M+H]^{1+}$), 210.98816;

iii. 5-pyridin-4-ylthiophene-2-carboxylic acid

MS (ESI) m/z 206.1; HRMS: calcd for $C_{10}H_7NO_2S + H^+$, 206.02703; found (ESI-FTMS, $[M+H]^{1+}$), 206.02691;

iv. 4-(5-chloro-2-thienyl)benzoic acid

HRMS: calcd for $C_{11}H_7ClO_2S - H^+$, 236.97825; found (ESI-FTMS, $[M-H]^{1-}$), 236.97751;

v. 5-phenyl-2-furoic acid

HRMS: calcd for $C_{11}H_8O_3 + H^+$, 189.05462; found (ESI-FTMS, $[M+H]^{1+}$), 189.05445;

vi. 4-(5-acetyl-2-thienyl)benzoic acid

MS (ESI) m/z 245.1; HRMS: calcd for $C_{13}H_{10}O_3S + H^+$, 247.04234; found (ESI-FTMS, $[M+H]^{1+}$), 247.04223;

vii. 3-(5-chloro-2-thienyl)benzoic acid

MS (ESI) m/z 237; HRMS: calcd for $C_{11}H_7ClO_2S - H^+$, 236.97825; found (ESI-FTMS, $[M-H]^{1-}$), 236.97757;

viii. 3-(2-thienyl)benzoic acid

MS (ESI) m/z 203.1; HRMS: calcd for $C_{11}H_8O_2S + H^+$, 205.03178; found (ESI-FTMS, $[M+H]^{1+}$), 205.03194;

ix. 5-(4-chlorophenyl)thiophene-2-carboxylic acid

MS (ESI) m/z 237; MS (ESI) m/z 283; MS (ESI) m/z 475.1; HRMS: calcd for $C_{11}H_7ClO_2S - H^+$, 236.97825; found (ESI-FTMS, $[M-H]^{1-}$), 236.97825;

x. 3-phenylthiophene-2-carboxylic acid

MS (ESI) m/z 203.1; MS (ESI) m/z 249.1; HRMS: calcd for $C_{11}H_8O_2S + H^+$, 205.03178; found (ESI-FTMS, $[M+H]^+$), 205.03177;

xi. 4'-chlorobiphenyl-4-carboxylic acid

MS (ESI) m/z 231.1; HRMS: calcd for $C_{13}H_9ClO_2 - H^+$, 231.02183; found (ESI-FTMS, $[M-H]^+$), 231.02129;

xii. 3'-chlorobiphenyl-4-carboxylic acid

MS (ESI) m/z 231.1; HRMS: calcd for $C_{13}H_9ClO_2 - H^+$, 231.02183; found (ESI-FTMS, $[M-H]^+$), 231.02128;

xiii. 5-(3,4-difluorophenyl)thiophene-2-carboxylic acid

MS (ESI) m/z 239; MS (ESI) m/z 285.1; MS (ESI) m/z 479.1; HRMS: calcd for $C_{11}H_6F_2O_2S + H^+$, 241.01293; found (ESI-FTMS, $[M+H]^+$), 241.01183;

xiv. 5-(2,4-difluorophenyl)thiophene-2-carboxylic acid

MS (ESI) m/z 239; MS (ESI) m/z 285; HRMS: calcd for $C_{11}H_6F_2O_2S + H^+$, 241.01293; found (ESI-FTMS, $[M+H]^+$), 241.01187;

xv. 4-phenoxybenzoic acid

MS (ESI) m/z 213.1; HRMS: calcd for $C_{13}H_{10}O_3 + H^+$, 215.07027; found (ESI-FTMS, $[M+H]^+$), 215.07029;

xvi. 4-(2,3-dihydro-1-benzofuran-6-yl)benzoic acid

MS (ESI) m/z 239.1; HRMS: calcd for $C_{15}H_{12}O_3 - H^+$, 239.07137; found (ESI-FTMS, $[M-H]^+$), 239.07131;

xvii. 5-(3-chloro-4-fluorophenyl)thiophene-2-carboxylic acid

MS (ESI) m/z 255.1; MS (ESI) m/z 511.2; HRMS: calcd for $C_{11}H_6ClFO_2S - H^+$, 254.96883; found (ESI-FTMS, $[M-H]^{-1}$), 254.96892;

xviii. 5-pyridin-3-ylthiophene-2-carboxylic acid

MS (ESI) m/z 206.1; HRMS: calcd for $C_{10}H_7NO_2S + H^+$, 206.02703; found (ESI-FTMS, $[M+H]^{1+}$), 206.02708;

xix. 6-(5-chloro-2-thienyl)nicotinic acid

MS (ESI) m/z 238;

xx. 6-phenylnicotinic acid

MS (ESI) m/z 200.1; HRMS: calcd for $C_{12}H_9NO_2 + H^+$, 200.07061; found (ESI-FTMS, $[M+H]^{1+}$), 200.07052;

xxi. 4-(1,3-thiazol-2-yl)benzoic acid

mp 235 - 237 °C; MS (ESI) m/z 206; MS (ESI) m/z 204;

xxii. 4-(5-bromo-2-thienyl)benzoic acid

MS (ESI) m/z 281; MS (ESI) m/z 394.8;

xxiii. 5-(4-fluorophenyl)thiophene-2-carboxylic acid

MS (ES) m/z 221.0; MS (ES) m/z 443.0;

xxiv. 4-[5-(aminosulfonyl)-2-thienyl]benzoic acid

MS (ESI) m/z 282.1; MS (ESI) m/z 565.2;

xxv. 4-(5-cyano-2-thienyl)benzoic acid

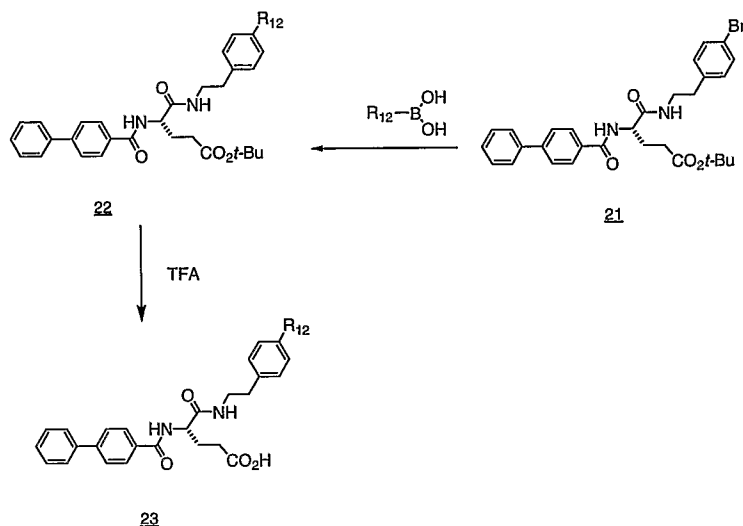
MS (ESI) m/z 228.1;

xxvi. 3'-fluorobiphenyl-4-carboxylic acid

MS (ESI) m/z 215.1;

xxvii. 3',4'-difluorobiphenyl-4-carboxylic acidMS (ESI) m/z 233;**xxviii. 2',4'-difluorobiphenyl-4-carboxylic acid**MS (ESI) m/z 233.1;**xxix. 2',5'-difluorobiphenyl-4-carboxylic acid**MS (ESI) m/z 233.1;**xxx. 3',5'-difluorobiphenyl-4-carboxylic acid**MS (ESI) m/z 233.1;**xxxi. 2',6'-difluorobiphenyl-4-carboxylic acid**MS (ESI) m/z 233.1;**xxxii. 2',3'-difluorobiphenyl-4-carboxylic acid**MS (ESI) m/z 233;**xxxiii. 4-(5-methyl-2-thienyl)benzoic acid**MS (ESI) m/z 217.1; HRMS: calcd for $C_{12}H_{10}O_2S + H^+$, 219.04743; found (ESI-FTMS, $[M+H]^+$), 219.04744;**xxxiv. 6-(3-methoxyphenyl)nicotinic acid**MS (ESI) m/z 230.1;**xxxv. 3-fluorobiphenyl-4-carboxylic acid**MS (ESI) m/z 215.1; HRMS: calcd for $C_{13}H_9FO_2 + H^+$, 217.06593; found (ESI-FTMS, $[M+H]^+$), 217.06598.

Scheme 8



Example 9: *N*²-(biphenyl-4-ylcarbonyl)-*N*¹-[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamine

[0718] Step A: *tert*-butyl *N*²-(biphenyl-4-ylcarbonyl)-*N*¹-[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamate

tert-butyl *N*²-(biphenyl-4-ylcarbonyl)-*N*¹-[2-(4-bromophenyl)ethyl]-L- α -glutamate (333 mg, 0.59 mmol, 1 equiv.) was dissolved in DME (5 mL) and the mixture was added to 4-formylphenyl boronic acid (0.97 g, 0.65 mmol, 1.1 equiv.) and Pd(PPh₃)₄ (68 mg, 0.059 mmol, 0.1 equiv.) and stirred for 30 minutes prior to the addition of aq. K₂CO₃ (163 mg, 1.18 mmol, 2 equiv.) in 1 mL H₂O. The mixture was capped in a sealed vessel and stirred overnight at 80°C. The reaction was complete as determined by TLC. The mixture was filtered over celite, the solvent was removed, and the resulting tan solid was diluted with EtOAc (20 mL) and washed consecutively with H₂O, 10% HCl, brine, and dried over Na₂SO₄. The solid was purified by column chromatography (silica gel, 41% Acetone/Hexanes) to give 38 mg of *tert*-butyl *N*²-(biphenyl-4-ylcarbonyl)-*N*¹-[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamate in 11% yield.

MS (ESI) *m/z* 591.3; MS (ESI) *m/z* 1181.5; HRMS: calcd for C₃₇H₃₈N₂O₅ + H⁺, 591.28535; found (ESI-FTMS, [M+H]¹⁺), 591.28473.

[0719] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamine
tert-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamate (100 mg, 0.17 mmol, 1 equiv.) was dissolved in CH_2Cl_2 (5 mL) and added to TFA (2 mL). The mixture was stirred at room temperature for 3 hrs. The reaction was complete as determined by TLC. Solvent was removed and the resulting solid was purified by preparative HPLC to give N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamine in 89% yield (80 mg). MS (ESI) m/z 533.1; HRMS: calcd for $\text{C}_{33}\text{H}_{30}\text{N}_2\text{O}_5 + \text{H}^+$, 535.22275; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 535.22464.

Example 10:

[0720] The following compounds were prepared according to procedures similar to those described in Example 9.

Example 10A: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-4-yl]ethyl}-L- α -glutamine

[0721] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-4-yl]ethyl}-L- α -glutamate
MS (ESI) m/z 631.2; MS (ESI) m/z 1261.4; MS (ESI) m/z 653.2; HRMS: calcd for $\text{C}_{37}\text{H}_{37}\text{F}_3\text{N}_2\text{O}_4 + \text{H}^+$, 631.27782; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 631.27719.

[0722] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-4-yl]ethyl}-L- α -glutamine
HRMS: calcd for $\text{C}_{33}\text{H}_{29}\text{F}_3\text{N}_2\text{O}_4 + \text{H}^+$, 575.21522; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 575.21548.

Example 10B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-4-yl)ethyl]-L- α -glutamine

[0723] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-4-yl)ethyl]-L- α -glutamate
MS (ESI) m/z 593.3; MS (ESI) m/z 1185.5; HRMS: calcd for $\text{C}_{37}\text{H}_{40}\text{N}_2\text{O}_5 + \text{H}^+$, 593.30100; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 593.29946.

[0724] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-4-yl)ethyl]-L- α -glutamine

HRMS: calcd for $C_{33}H_{32}N_2O_5 + H^+$, 537.23840; found (ESI-FTMS, $[M+H]^{1+}$), 537.23906.

Example 10C: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-biphenyl-4-ylethyl)-L- α -glutamine

[0725] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-biphenyl-4-ylethyl)-L- α -glutamate

MS (ESI) m/z 563.3; MS (ESI) m/z 1125.5; HRMS: calcd for $C_{36}H_{38}N_2O_4 + H^+$, 563.29043; found (ESI-FTMS, $[M+H]^{1+}$), 563.28977.

[0726] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-biphenyl-4-ylethyl)-L- α -glutamine

HRMS: calcd for $C_{32}H_{30}N_2O_4 + H^+$, 507.22783; found (ESI-FTMS, $[M+H]^{1+}$), 507.22688.

Example 10D: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4-(2-thienyl)phenyl]ethyl}-L- α -glutamine

[0727] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4-(2-thienyl)phenyl]ethyl}-L- α -glutamate

MS (ESI) m/z 569.2; MS (ESI) m/z 1137.4; HRMS: calcd for $C_{34}H_{36}N_2O_4S + H^+$, 569.24685; found (ESI-FTMS, $[M+H]^{1+}$), 569.24702.

[0728] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4-(2-thienyl)phenyl]ethyl}-L- α -glutamine

MS (ESI) m/z 511.1; HRMS: calcd for $C_{30}H_{28}N_2O_4S + H^+$, 513.18425; found (ESI-FTMS, $[M+H]^{1+}$), 513.18417.

Example 10E: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2'-ethoxybiphenyl-4-yl)ethyl]-L- α -glutamine

[0729] MS (ESI) m/z 551.1; MS (ESI) m/z 1101.4; MS (ESI) m/z 573.1; HRMS: calcd for $C_{34}H_{34}N_2O_5 + H^+$, 551.25405; found (ESI-FTMS, $[M+H]^{1+}$), 551.2538.

Example 10F: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-ethynylbiphenyl-4-yl)ethyl]-L- α -glutamine

[0730] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-ethynylbiphenyl-4-yl)ethyl]-L- α -glutamate

MS (ESI) m/z 587.3; MS (ESI) m/z 1173.5; HRMS: calcd for $C_{38}H_{38}N_2O_4 + H^+$, 587.29043; found (ESI-FTMS, $[M+H]^{1+}$), 587.29016.

[0731] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-ethynylbiphenyl-4-yl)ethyl]-L- α -glutamine

MS (ESI) m/z 529.2; HRMS: calcd for $C_{34}H_{30}N_2O_4 + H^+$, 531.22783; found (ESI-FTMS, $[M+H]^{1+}$), 531.22669.

Example 10G: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-2-ylphenyl)ethyl]-L- α -glutamine

[0732] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-2-ylphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 564.3; HRMS: calcd for $C_{35}H_{37}N_3O_4 + H^+$, 564.28568; found (ESI-FTMS, $[M+H]^{1+}$), 564.28472.

[0733] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-2-ylphenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 508.2.

Example 10H: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-4-ylphenyl)ethyl]-L- α -glutamine

[0734] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-4-ylphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 564.2; HRMS: calcd for $C_{35}H_{37}N_3O_4 + H^+$, 564.28568; found (ESI-FTMS, $[M+H]^{1+}$), 564.28648.

[0735] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-4-ylphenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 508.1; MS (ESI) m/z 275.1; HRMS: calcd for $C_{31}H_{29}N_3O_4 + H^+$, 508.22308; found (ESI-FTMS, $[M+H]^{1+}$), 508.22403.

Example 10I: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-pyridin-2-ylphenyl)ethyl]-L- α -glutamine

[0736] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-pyridin-2-ylphenyl)ethyl]-L- α -glutamate

MS (ESI) m/z 564.3; HRMS: calcd for $C_{35}H_{37}N_3O_4 + H^+$, 564.28568; found (ESI-FTMS, $[M+H]^{1+}$), 564.28531.

[0737] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-pyridin-2-ylphenyl)ethyl]-L- α -glutamine

MS (ESI) m/z 508.1; HRMS: calcd for $C_{31}H_{29}N_3O_4 + H^+$, 508.22308; found (ESI-FTMS, $[M+H]^{1+}$), 508.22432.

Example 10J: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-3-yl)ethyl]-L- α -glutamine

[0738] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-3-yl)ethyl]-L- α -glutamate

[0739] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-3-yl)ethyl]-L- α -glutamine

MS (ESI) m/z 535.2; MS (ESI) m/z 1069.3; HRMS: calcd for $C_{33}H_{30}N_2O_5 + H^+$, 535.22275; found (ESI-FTMS, $[M+H]^{1+}$), 535.22147.

Example 10K: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-3-yl]ethyl}-L- α -glutamine

[0740] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-3-yl]ethyl}-L- α -glutamate

HRMS: calcd for $C_{37}H_{37}F_3N_2O_4 + H^+$, 631.27782; found (ESI-FTMS, $[M+H]^{1+}$), 631.27639.

[0741] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-3-yl]ethyl}-L- α -glutamine

MS (ESI) m/z 575.2; HRMS: calcd for $C_{33}H_{29}F_3N_2O_4 + H^+$, 575.21522; found (ESI-FTMS, $[M+H]^{1+}$), 575.21382.

Example 10L: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-3-yl)ethyl]-L- α -glutamine

[0742] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-3-yl)ethyl]-L- α -glutamate

HRMS: calcd for $C_{37}H_{40}N_2O_5 + H^+$, 593.30100; found (ESI-FTMS, $[M+H]^{1+}$), 593.29993.

[0743] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-3-yl)ethyl]-L- α -glutamine

MS (ESI) m/z 537.2; HRMS: calcd for $C_{33}H_{32}N_2O_5 + H^+$, 537.23840; found (ESI-FTMS, $[M+H]^{1+}$), 537.23745.

Example 10M: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-vinylbenzyl)-L- α -glutamine

[0744] Step A: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-vinylbenzyl)-L- α -glutamate

Tert-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamate was used as the starting material. MS (ESI) m/z 499.2; MS (ESI) m/z 997.4; HRMS: calcd for $C_{31}H_{34}N_2O_4 + H^+$, 499.25913; found (ESI-FTMS, $[M+H]^{1+}$), 499.25906.

[0745] Step B: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-vinylbenzyl)-L- α -glutamine

MS (ESI) m/z 443.2; MS (ESI) m/z 885.3; HRMS: calcd for $C_{27}H_{26}N_2O_4 + H^+$, 443.19653; found (ESI-FTMS, $[M+H]^{1+}$), 443.19728.

Example 10N: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-thien-2-ylbenzyl)-L- α -glutamine

[0746] Step A: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-thien-2-ylbenzyl)-L- α -glutamate

Tert-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamate was used as the starting material. MS (ESI) m/z 555.2; MS (ESI) m/z 1109.3; HRMS: calcd for $C_{33}H_{34}N_2O_4S + H^+$, 555.23120; found (ESI-FTMS, $[M+H]^{1+}$), 555.23173.

[0747] Step B: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-thien-2-ylbenzyl)-L- α -glutamine

MS (ESI) m/z 499.1; HRMS: calcd for $C_{29}H_{26}N_2O_4S + H^+$, 499.16860; found (ESI-FTMS, $[M+H]^{1+}$), 499.16976.

Example 10O: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{[4'-(trifluoromethyl)biphenyl-3-yl]methyl}-L- α -glutamine

[0748] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{[4'-(trifluoromethyl)biphenyl-3-yl]methyl}-L- α -glutamate

Tert-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamate was used as the starting material. MS (ESI) m/z 617.2; MS (ESI) m/z 1233.3; HRMS: calcd for $C_{36}H_{35}F_3N_2O_4 + H^+$, 617.26217; found (ESI-FTMS, $[M+H]^+$), 617.26334.

[0749] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{[4'-(trifluoromethyl)biphenyl-3-yl]methyl}-L- α -glutamine

MS (ESI) m/z 559.1; MS (ESI) m/z 1119.1; HRMS: calcd for $C_{32}H_{27}F_3N_2O_4 + H^+$, 561.19957; found (ESI-FTMS, $[M+H]^+$), 561.2001.

Example 10P: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(4'-ethynylbiphenyl-3-yl)methyl]-L- α -glutamine

[0750] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(4'-ethynylbiphenyl-3-yl)methyl]-L- α -glutamate

Tert-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamate was used as the starting material. MS (ESI) m/z 573.2; MS (ESI) m/z 1145.4; HRMS: calcd for $C_{37}H_{36}N_2O_4 + H^+$, 573.27478; found (ESI-FTMS, $[M+H]^+$), 573.27518.

[0751] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(4'-ethynylbiphenyl-3-yl)methyl]-L- α -glutamine

MS (ESI) m/z 517.2; MS (ESI) m/z 1033.3; HRMS: calcd for $C_{33}H_{28}N_2O_4 + H^+$, 517.21218; found (ESI-FTMS, $[M+H]^+$), 517.2125.

Example 10Q: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-pyridin-2-ylbenzyl)-L- α -glutamine

[0752] Step A: *tert*-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-pyridin-2-ylbenzyl)-L- α -glutamate

Tert-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamate was used as the starting material. MS (ESI) m/z 550.2; HRMS: calcd for $C_{34}H_{35}N_3O_4 + H^+$, 550.27003; found (ESI-FTMS, $[M+H]^+$), 550.27066.

[0753] Step B: N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-pyridin-2-ylbenzyl)-L- α -glutamine

MS (ESI) m/z 494.1; HRMS: calcd for $C_{30}H_{27}N_3O_4 + H^+$, 494.20743; found (ESI-FTMS, $[M+H]^+$), 494.20803.

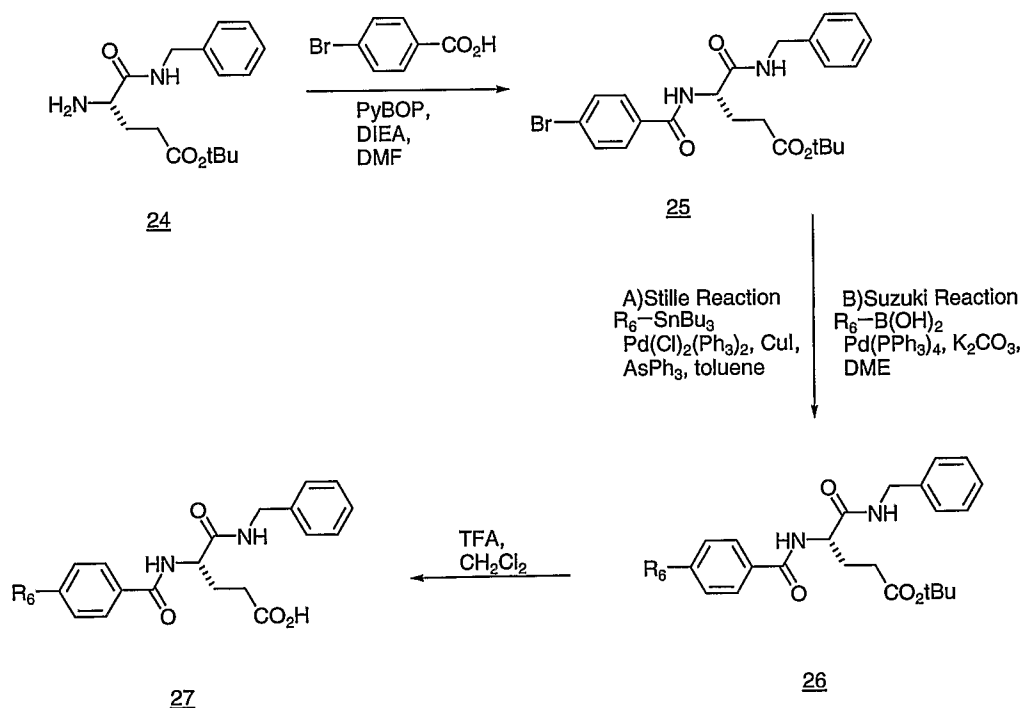
Example 10R: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-vinylbenzyl)-L- α -glutamine

[0754] Step A: *tert*-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-vinylbenzyl)-L- α -glutamate

Tert-butyl N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-iodobenzyl)-L- α -glutamate was used as the starting material. MS (ESI) m/z 499.2; MS (ESI) m/z 997.3; HRMS: calcd for $C_{31}H_{34}N_2O_4 + H^+$, 499.25913; found (ESI-FTMS, $[M+H]^+$), 499.25883.

[0755] Step B: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-vinylbenzyl)-L- α -glutamine
MS (ESI) m/z 443.1; HRMS: calcd for $C_{27}H_{26}N_2O_4 + H^+$, 443.19653; found (ESI-FTMS, $[M+H]^+$), 443.19697.

Scheme 9



Example 11: N^1 -benzyl- N^2 -(4-thien-2-ylbenzoyl)-L- α -glutamine

[0756] Step A: *tert*-butyl N^1 -benzyl- N^2 -(4-bromobenzoyl)-L- α -glutamate

A solution of 4-Amino-4-benzylcarbamoyl-butyric acid *tert*-butyl ester (6.39 g, 21.9

mmol, 1 equiv.) in DMF (18 mL) was added to 4-Bromobenzoic acid (4.39 g, 21.9 mmol, 1 equiv.) and PyBOP (14.7 g, 28.2 mmol, 1.2 equiv.) and the solution was stirred at room temperature under nitrogen. DIEA (4.58 mL, 26.3 mmol, 1.2 equiv.) was then added dropwise and the solution was stirred for 2 hrs. The reaction was complete as determined by TLC. The solution was diluted with EtOAc (250 mL) and washed consecutively with H₂O, 10% HCl, satd. NaHCO₃, brine, and dried over Na₂SO₄. After the solvent was evaporated, the crude residue was dissolved in ether and washed with aq. LiBr (2 x 250 mL) and dried over Na₂SO₄. A light tan solid was obtained, 8.94 g of *tert*-butyl *N*¹-benzyl-*N*²-(4-bromobenzoyl)-L- α -glutamate in 86 % yield.

MS (ESI) *m/z* 475.1; MS (ESI) *m/z* 949.2; HRMS: calcd for C₂₃H₂₇BrN₂O₄ + Na⁺, 497.10464; found (ESI_FTMS, [M+Na]¹⁺), 497.10542.

[0757] Step B: *tert*-butyl *N*¹-benzyl-*N*²-(4-thien-2-ylbenzoyl)-L- α -glutamate
Tert-butyl *N*¹-benzyl-*N*²-(4-bromobenzoyl)-L- α -glutamate (200mg, 0.421mmol) was dissolved in toluene (4mL) under nitrogen. Copper iodide (16.0mg, 0.0841mmol), triphenylarsine (26.0mg, 0.0841mmol), and Pd(Cl)₂(PPh₃)₂ (59mg, 0.0841mmol) were then added as solids. The reaction mixture was then fitted with a condenser and heated to reflux (115°C), for 10 minutes. 2-(Tributylstannyl)-thiophene (267mL, 0.841mmol) was added and immediately the reaction went from orange to black. These are typical Stille reaction conditions. The reaction was monitored by TLC and was complete at 30 minutes. The reaction mixture was filtered through celite and the celite rinsed with MeOH (1mL). Solvent was removed and the remaining yellow residue was dissolved in a minimal amount of CH₂Cl₂. Hexanes were added, precipitating a white solid that was filtered, washed with hexanes, and then dried at reduced pressure. 140mg of *tert*-butyl *N*¹-benzyl-*N*²-(4-thien-2-ylbenzoyl)-L- α -glutamate, a white solid was obtained in 69% yield. MS (ESI) *m/z* 479.1; MS (ESI) *m/z* 957.3; HRMS: calcd for C₂₇H₃₀N₂O₄S + H⁺, 479.19990; found (ESI_FT, [M+H]¹⁺), 479.19826.

[0758] Step C: *N*¹-benzyl-*N*²-(4-thien-2-ylbenzoyl)-L- α -glutamine
Tert-butyl *N*¹-benzyl-*N*²-(4-thien-2-ylbenzoyl)-L- α -glutamate (135mg, 0.282mmol) was dissolved in CH₂Cl₂ (1.5mL) under nitrogen. TFA was diluted in CH₂Cl₂ (2mL), and then added to the reaction. The reaction was monitored by TLC and was complete at 2 hrs. The solvent was removed and the remaining yellow residue was dissolved in toluene, which was then removed (2x) leaving an orange solid. The orange solid was taken up in

acetone, and hexanes added, precipitating a pale orange solid. The solid was filtered, washed with hexanes, and dried at reduced pressure. The pale orange solid was run on a SiO₂ column, using 4%MeOH/CH₂Cl₂. The solvent was removed from the fractions yielding 79mg of *N*¹-benzyl-*N*²-(4-thien-2-ylbenzoyl)-L- α -glutamine, a white solid, at 66% yield. MS (ESI) *m/z* 421.1; MS (ESI) *m/z* 843.3; HRMS: calcd for C₂₃H₂₂N₂O₄S + H⁺, 423.13730; found (ESI_FTMS, [M+H]¹⁺), 423.13742.

Example 12:

[0759] The following compounds were prepared according to procedures similar to those described in Example 11.

Example 12A: *N*¹-benzyl-*N*²-[4-(2-furyl)benzoyl]-L- α -glutamine

[0760] Step B: *tert*-butyl *N*¹-benzyl-*N*²-[4-(2-furyl)benzoyl]-L- α -glutamate
MS (ESI) *m/z* 463.2; MS (ESI) *m/z* 925.3; HRMS: calcd for C₂₇H₃₀N₂O₅ + H⁺, 463.22275; found (ESI_FT, [M+H]¹⁺), 463.22159.

[0761] Step C: *N*¹-benzyl-*N*²-[4-(2-furyl)benzoyl]-L- α -glutamine
MS (ESI) *m/z* 407.1; MS (ESI) *m/z* 813.2; HRMS: calcd for C₂₃H₂₂N₂O₅ + H⁺, 407.16015; found (ESI_FTMS, [M+H]¹⁺), 407.16031.

Example 12B: *N*¹-benzyl-*N*²-[(4'-ethynyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0762] Step B: *tert*-butyl *N*¹-benzyl-*N*²-[(4'-ethynyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate
MS (ESI) *m/z* 497.3; MS (ESI) *m/z* 993.5; HRMS: calcd for C₃₁H₃₂N₂O₄ + H⁺, 497.24348; found (ESI_FTMS, [M+H]¹⁺), 497.24306.

[0763] Step C: *N*¹-benzyl-*N*²-[(4'-ethynyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine
MS (ESI) *m/z* 439.2; MS (ESI) *m/z* 879.4; HRMS: calcd for C₂₇H₂₄N₂O₄ + H⁺, 441.18088; found (ESI_FT, [M+H]¹⁺), 441.18056.

Example 12C: *N*¹-benzyl-*N*²-(4-pyridin-3-ylbenzoyl)-L- α -glutamine

[0764] Step B: *tert*-butyl N^1 -benzyl- N^2 -(4-pyridin-3-ylbenzoyl)-L- α -glutamate
MS (ESI) m/z 474.2; HRMS: calcd for $C_{28}H_{31}N_3O_4 + H^+$, 474.23873; found (ESI_FT, $[M+H]^+$), 474.238741.

[0765] Step C: N^1 -benzyl- N^2 -(4-pyridin-3-ylbenzoyl)-L- α -glutamine
MS (ESI) m/z 418.1; HRMS: calcd for $C_{24}H_{23}N_3O_4 + H^+$, 418.17613; found (ESI_FT, $[M+H]^+$), 418.17555.

Example 12D: N^1 -benzyl- N^2 -[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine

[0766] Step B: *tert*-butyl N^1 -benzyl- N^2 -[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamate
MS (ESI) m/z 480.2; MS (ESI) m/z 959.2; HRMS: calcd for $C_{26}H_{29}N_3O_4S + H^+$, 480.19515; found (ESI_FT, $[M+H]^+$), 480.19659.

[0767] Step C: N^1 -benzyl- N^2 -[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine
MS (ESI) m/z 422.2; MS (ESI) m/z 845.3; HRMS: calcd for $C_{22}H_{21}N_3O_4S + H^+$, 424.13255; found (ESI_FT, $[M+H]^+$), 424.13204.

Example 12E: N^1 -benzyl- N^2 -(4-pyridin-2-ylbenzoyl)-L- α -glutamine

[0768] Step B: *tert*-butyl N^1 -benzyl- N^2 -(4-pyridin-2-ylbenzoyl)-L- α -glutamate
MS (ESI) m/z 474.2; HRMS: calcd for $C_{28}H_{31}N_3O_4 + H^+$, 474.23873; found (ESI_FT, $[M+H]^+$), 474.2401.

[0769] Step C: N^1 -benzyl- N^2 -(4-pyridin-2-ylbenzoyl)-L- α -glutamine
MS (ESI) m/z 418.1; HRMS: calcd for $C_{24}H_{23}N_3O_4 + H^+$, 418.17613; found (ESI_FT, $[M+H]^+$), 418.17517.

Example 12F: N-benzyl- N^2 -[4-(2-naphthyl)benzoyl]-L- α -glutamine

[0770] MS (ESI) m/z 467.2; MS (ESI) m/z 933.4; HRMS: calcd for $C_{29}H_{26}N_2O_4 + H^+$, 467.19653; found (ESI-FTMS, $[M+H]^+$), 467.19661.

Example 12G: N-benzyl- N^2 -[4-(phenylethynyl)benzoyl]-L- α -glutamine

[0771] MS (ESI) m/z 441.2; MS (ESI) m/z 881.4.

Example 12H: N-benzyl-N²-{4-[(9-hydroxy-9H-fluoren-9-yl)ethynyl]benzoyl}-L- α -glutamine

[0772] MS (ESI) m/z 543.1; MS (ESI) m/z 1087.2.

Example 12I: N-benzyl-N²-{4-[(1E)-3-oxo-3-phenylprop-1-en-1-yl]benzoyl}-L- α -glutamine

[0773] MS (ESI) m/z 471.2; MS (ESI) m/z 941.4.

Example 12J: N²-{4-[(3-aminophenyl)ethynyl]benzoyl}-N-benzyl-L- α -glutamine

[0774] MS (ESI) m/z 456.1; MS (ESI) m/z 249.1.

Example 12K: N-benzyl-N²-[4-(3-hydroxy-3,3-diphenylprop-1-yn-1-yl)benzoyl]-L- α -glutamine

[0775] MS (ESI) m/z 545.1; MS (ESI) m/z 1091.2; MS (ESI) m/z 659.1.

Example 12L: N-benzyl-N²-{4-[(3-methoxyphenyl)ethynyl]benzoyl}-L- α -glutamine

[0776] MS (ESI) m/z 471.1; MS (ESI) m/z 941.2.

Example 13:

[0777] The following compounds were prepared according to procedures similar to those described in Example 11, except a Suzuki reaction was used at step B in place of a Stille reaction. Hydrolysis of the ester to the final product followed the same procedure as previously described.

Example 13A: N¹-benzyl-N²-[(3',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0778] Step B: *tert*-butyl N¹-benzyl-N²-[(3',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

Tert-butyl N¹-benzyl-N²-(4-bromobenzoyl)-L- α -glutamate (350mg, 0.736mmol) was dissolved in DME, under nitrogen in a sealed vial. 3,5-Dimethylboronic acid (110mg, 0.736mmol), and Pd(PPh₃)₄ (43mg, 0.037mmol) were added as solids, and the reaction heated to reflux for 10 minutes. At this point 2M K₂CO₃ (735mL, 1.47mmol) was added,

the reaction vial was sealed, and the reaction heated to reflux and monitored by TLC. The reaction was complete at 2 hrs. The aqueous part of the reaction was removed via pipette. The reaction solution was then filtered through celite and the celite rinsed with MeOH. The solvent was removed, leaving a brown solid. The product was purified using a SiO₂ column and 33%EtOAc/Hex as the solvent. The product was obtained as a white solid, yielding 222mg at 60% yield. MS (ESI) *m/z* 501.3; MS (ESI) *m/z* 1001.6; HRMS: calcd for C₃₁H₃₆N₂O₄ + H⁺, 501.27478; found (ESI_FT, [M+H]¹⁺), 501.27332.

[0779] Step C: *N*¹-benzyl-*N*²-[(3',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine

MS (ESI_FT) *m/z* 445.21151; MS (ESI_FT) *m/z* 445.21219; HRMS: calcd for C₂₇H₂₈N₂O₄ + H⁺, 445.21218; found (ESI_FT, [M+H]¹⁺), 445.21151.

Example 13B: *N*¹-benzyl-*N*²-[(2',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine

[0780] Step B: *tert*-butyl *N*¹-benzyl-*N*²-[(2',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamate

MS (ESI) *m/z* 501.3; MS (ESI) *m/z* 1001.6; HRMS: calcd for C₃₁H₃₆N₂O₄ + H⁺, 501.27478; found (ESI_FT, [M+H]¹⁺), 501.27441.

[0781] Step C: *N*¹-benzyl-*N*²-[(2',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine

MS (ESI) *m/z* 445.3; MS (ESI) *m/z* 889.5; HRMS: calcd for C₂₇H₂₈N₂O₄ + H⁺, 445.21218; found (ESI_FT, [M+H]¹⁺), 445.21172.

Example 13C: *N*¹-benzyl-*N*²-[(4'-ethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine

[0782] Step B: *tert*-butyl *N*¹-benzyl-*N*²-[(4'-ethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamate

MS (ESI) *m/z* 501.3; MS (ESI) *m/z* 1001.6; HRMS: calcd for C₃₁H₃₆N₂O₄ + H⁺, 501.27478; found (ESI_FT, [M+H]¹⁺), 501.27326.

[0783] Step C: *N*¹-benzyl-*N*²-[(4'-ethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine

MS (ESI_FT) *m/z* 445.2115; MS (ESI_FT) *m/z* 445.21219; HRMS: calcd for C₂₇H₂₈N₂O₄ + H⁺, 445.21218; found (ESI_FT, [M+H]¹⁺), 445.2115.

Example 13D: N^1 -benzyl- N^2 -[(3'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0784] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(3'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

MS (ESI) m/z 517.3; MS (ESI) m/z 1033.6; HRMS: calcd for $C_{31}H_{36}N_2O_5 + H^+$, 517.26970; found (ESI_FT, $[M+H]^{1+}$), 517.26837.

[0785] Step C: N^1 -benzyl- N^2 -[(3'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

MS (ESI_FT) m/z 461.20568; MS (ESI_FT) m/z 461.2071; HRMS: calcd for $C_{27}H_{28}N_2O_5 + H^+$, 461.20710; found (ESI_FT, $[M+H]^{1+}$), 461.20568.

Example 13E: N^1 -benzyl- N^2 -[(2'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0786] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(2'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

MS (ESI) m/z 517.3; MS (ESI) m/z 1033.5; HRMS: calcd for $C_{31}H_{36}N_2O_5 + H^+$, 517.26970; found (ESI_FT, $[M+H]^{1+}$), 517.26833.

[0787] Step C: N^1 -benzyl- N^2 -[(2'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

MS (ESI_FT) m/z 461.20572; MS (ESI_FT) m/z 461.2071; HRMS: calcd for $C_{27}H_{28}N_2O_5 + H^+$, 461.20710; found (ESI_FT, $[M+H]^{1+}$), 461.20572.

Example 13F: N^1 -benzyl- N^2 -[(2',6'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0788] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(2',6'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

MS (ESI_FT) m/z 501.27323; MS (ESI_FT) m/z 501.27479; HRMS: calcd for $C_{31}H_{36}N_2O_4 + H^+$, 501.27478; found (ESI_FT, $[M+H]^{1+}$), 501.27323.

[0789] Step C: N^1 -benzyl- N^2 -[(2',6'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

MS (ESI_FT) m/z 445.21145; MS (ESI_FT) m/z 445.21219; HRMS: calcd for $C_{27}H_{28}N_2O_4 + H^+$, 445.21218; found (ESI_FT, $[M+H]^{1+}$), 445.21145.

Example 13G: N^1 -benzyl- N^2 -[(4'-vinyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

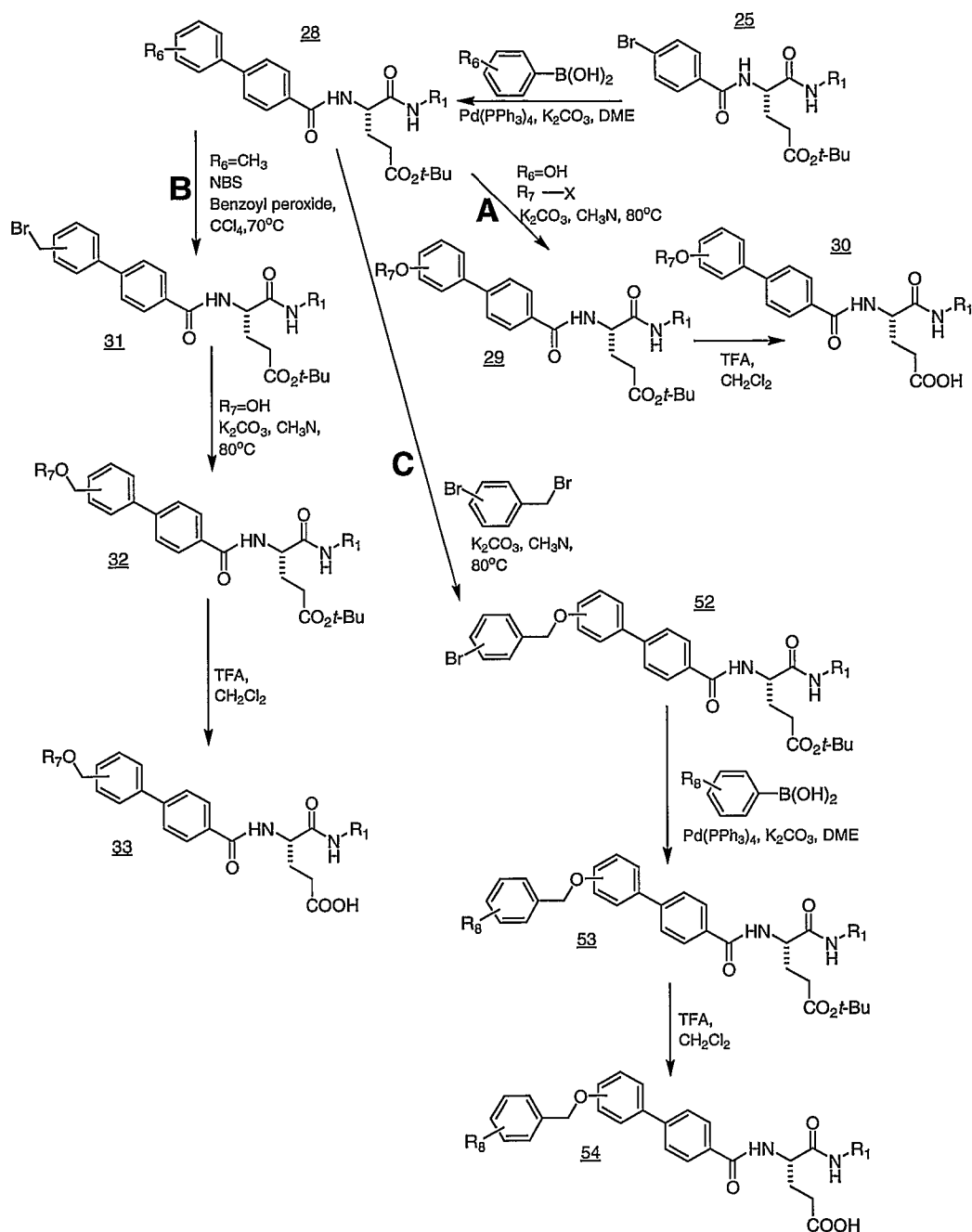
[0790] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(4'-vinyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

MS (ESI) m/z 499.3; MS (ESI) m/z 997.5; HRMS: calcd for $C_{31}H_{34}N_2O_4 + H^+$, 499.25913; found (ESI-FT, $[M+H]^+$), 499.25855.

[0791] Step C: N^1 -benzyl- N^2 -[(4'-vinyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

MS (ESI) m/z 443.2; MS (ESI) m/z 885.4; HRMS: calcd for $C_{27}H_{26}N_2O_4 + H^+$, 443.19653; found (ESI-FTMS, $[M+H]^+$), 443.19675.

Scheme 10

**Example 14: *N*¹-benzyl-*N*²-[(4'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine**

[0792] Step A: *tert*-butyl *N*¹-benzyl-*N*²-[(4'-hydroxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

Tert-butyl *N*¹-benzyl-*N*²-(4-bromobenzoyl)-L- α -glutamate (3.00g, 6.31mmol) was dissolved in DME (40mL), under nitrogen in a 75mL bomb flask. 4-Hydroxyphenylboronic acid (871mg, 6.31mmol), and Pd(PPh₃)₄ (729mg, 0.631mmol)

were added as solids, and the reaction heated to reflux for 30 minutes. At this point K_2CO_3 (1.74g, 12.6mmol) was dissolved in H_2O (8mL), and added to the reaction. The bomb flask was sealed and the reaction was heated to reflux, stirred overnight, and monitored by TLC. The reaction was complete after stirring overnight. The reaction mixture was filtered through celite and the celite rinsed with MeOH. The solvent was removed and the remaining solid was dissolved in EtOAc (200mL) and then washed with 200mL of 10% HCl (2x) and brine. The organic layer (top) was then dried (Na_2SO_4), filtered and concentrated, leaving a dark red oily solid. The product was purified using a SiO_2 column, and 40% Ace/Hex as the solvent. It would not dissolve in this solvent so it was dissolved in Acetone/MeOH (1:1) and dry mounted on the column. The product was obtained as the third spot of the column and as a yellow solid. Yield 1.9g of *tert*-butyl N^1 -benzyl- N^2 -[(4'-hydroxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate at 62% yield. MS (ESI) m/z 487.4; MS (ESI) m/z 533.5; MS (ESI) m/z 975.8; HRMS: calcd for $C_{29}H_{32}N_2O_5 + H^+$, 489.23840; found (ESI_FTMS, $[M+H]^{1+}$), 489.23862.

[0793] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(4'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

Tert-butyl N^1 -benzyl- N^2 -[(4'-hydroxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate (300mg, 0.614mmol) was dissolved in CH_3CN (7mL) in a sealed 20mL vial. K_2CO_3 was added as a solid, the vial sealed and heated to 80°C for 1 hour. Iodoethane (54mL, 0.675mmol) was added, the vial sealed and stirred at 80°C overnight. The reaction was monitored by TLC and was complete after stirring overnight. The solvent was removed via nitrogen blower, and the remaining solid dissolved in CH_2Cl_2 (7mL) and washed with 10% HCl (7mL). The aqueous layer was decanted with a pipette, and the solvent was removed via nitrogen blower. The remaining solid was dissolved in DMSO (2mL) and purified on a Gilson HPLC. Yield: 123mg of *tert*-butyl N^1 -benzyl- N^2 -[(4'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate, a white solid at 39% yield. MS (ESI) m/z 517.2; MS (ESI) m/z 1033.4; HRMS: calcd for $C_{31}H_{36}N_2O_5 + H^+$, 517.26970; found (ESI_FTMS, $[M+H]^{1+}$), 517.26801.

[0794] Step C: N^1 -benzyl- N^2 -[(4'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

The procedure used was similar to that described in Example 13. MS (ESI) m/z 461.2; MS (ESI) m/z 921.4; HRMS: calcd for $C_{27}H_{28}N_2O_5 + H^+$, 461.20710; found (ESI_FTMS, $[M+H]^{1+}$), 461.20542.

Example 15:

[0795] The following compounds were prepared according to procedures similar to those described in Example 14.

Example 15A: N^1 -benzyl- N^2 -[(4'-propoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0796] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(4'-propoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

MS (ESI) m/z 531.3; MS (ESI) m/z 1061.4; HRMS: calcd for $C_{32}H_{38}N_2O_5 + H^+$, 531.28535; found (ESI_FTMS, $[M+H]^{1+}$), 531.2844.

[0797] Step C: N^1 -benzyl- N^2 -[(4'-propoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

MS (ESI) m/z 475.2; MS (ESI) m/z 949.4; HRMS: calcd for $C_{28}H_{30}N_2O_5 + H^+$, 475.22275; found (ESI_FTMS, $[M+H]^{1+}$), 475.22333.

Example 15B: N^1 -benzyl- N^2 -[(4'-butoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0798] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(4'-butoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate

MS (ESI) m/z 545.3; MS (ESI) m/z 1089.5; HRMS: calcd for $C_{33}H_{40}N_2O_5 + H^+$, 545.30100; found (ESI_FTMS, $[M+H]^{1+}$), 545.30048.

[0799] Step C: N^1 -benzyl- N^2 -[(4'-butoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

MS (ESI) m/z 489.3; MS (ESI) m/z 977.4; HRMS: calcd for $C_{29}H_{32}N_2O_5 + H^+$, 489.23840; found (ESI_FTMS, $[M+H]^{1+}$), 489.23871.

Example 15C: N^1 -benzyl- N^2 -[[4'-(cyclobutylmethoxy)-1,1'-biphenyl-4-yl]carbonyl]-L- α -glutamine

[0800] Step B: *tert*-butyl N^1 -benzyl- N^2 -{[4'-(cyclobutylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamate

MS (ESI) m/z 557.3; MS (ESI) m/z 1113.4; HRMS: calcd for $C_{34}H_{40}N_2O_5 + H^+$, 557.30100; found (ESI_FTMS, $[M+H]^+$), 557.30064.

[0801] Step C: N^1 -benzyl- N^2 -{[4'-(cyclobutylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

MS (ESI) m/z 501.3; MS (ESI) m/z 1001.5; HRMS: calcd for $C_{30}H_{32}N_2O_5 + H^+$, 501.23840; found (ESI_FTMS, $[M+H]^+$), 501.23937.

Example 15D: N^1 -benzyl- N^2 -{[4'-(cyclohexylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

[0802] Step B: *tert*-butyl N^1 -benzyl- N^2 -{[4'-(cyclohexylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamate

MS (ESI) m/z 585.3; MS (ESI) m/z 1169.5; HRMS: calcd for $C_{36}H_{44}N_2O_5 + H^+$, 585.33230; found (ESI_FTMS, $[M+H]^+$), 585.33275.

[0803] Step C: N^1 -benzyl- N^2 -{[4'-(cyclohexylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

MS (ESI) m/z 529.3; MS (ESI) m/z 1057.5; HRMS: calcd for $C_{32}H_{36}N_2O_5 + H^+$, 529.26970; found (ESI_FTMS, $[M+H]^+$), 529.27022.

Example 15E: N^2 -{[4'-(allyloxy)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine

[0804] Step B: *tert*-butyl N^2 -{[4'-(allyloxy)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamate

MS (ESI) m/z 529.2; MS (ESI) m/z 1057.4; HRMS: calcd for $C_{32}H_{36}N_2O_5 + H^+$, 529.26970; found (ESI_FTMS, $[M+H]^+$), 529.26804.

[0805] Step C: N^2 -{[4'-(allyloxy)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine

Example 15F: N^1 -benzyl- N^2 -{[4'-(3-methoxybenzyl)oxy]-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

[0806] Step B: *tert*-butyl *N*¹-benzyl-*N*²-({4'-[(3-methoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamate

MS (ESI) *m/z* 609.3; MS (ESI) *m/z* 1217.5; HRMS: calcd for C₃₇H₄₀N₂O₆ + H⁺, 609.29591; found (ESI-FTMS, [M+H]¹⁺), 609.29669.

[0807] Step C: *N*¹-benzyl-*N*²-({4'-[(3-methoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine

MS (ESI) *m/z* 553.2; MS (ESI) *m/z* 1105.3; HRMS: calcd for C₃₃H₃₂N₂O₆ + H⁺, 553.23331; found (ESI-FTMS, [M+H]¹⁺), 553.23235.

Example 15G: *N*¹-benzyl-*N*²-({4'-[(3,5-dimethoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine

[0808] Step B: *tert*-butyl *N*¹-benzyl-*N*²-({4'-[(3,5-dimethoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamate

MS (ESI) *m/z* 639.3; MS (ESI) *m/z* 1277.4; HRMS: calcd for C₃₈H₄₂N₂O₇ + H⁺, 639.30648; found (ESI-FTMS, [M+H]¹⁺), 639.30698.

[0809] Step C: *N*¹-benzyl-*N*²-({4'-[(3,5-dimethoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine

MS (ESI) *m/z* 583.2; MS (ESI) *m/z* 1165.3; HRMS: calcd for C₃₄H₃₄N₂O₇ + H⁺, 583.24388; found (ESI-FTMS, [M+H]¹⁺), 583.2433.

Example 15H: *N*¹-benzyl-*N*²-{[4'-(2-naphthylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

[0810] Step B: *tert*-butyl *N*¹-benzyl-*N*²-{[4'-(2-naphthylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamate

MS (ESI) *m/z* 629.3; HRMS: calcd for C₄₀H₄₀N₂O₅ + H⁺, 629.30100; found (ESI-FTMS, [M+H]¹⁺), 629.30277.

[0811] Step C: *N*¹-benzyl-*N*²-{[4'-(2-naphthylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

MS (ESI) *m/z* 571.3; HRMS: calcd for C₃₆H₃₂N₂O₅ + H⁺, 573.23840; found (ESI-FTMS, [M+H]¹⁺), 573.23779.

Example 15I: N-benzyl-N²-({4'-[(3-fluorobenzyl)oxy]biphenyl-4-yl}carbonyl)-L- α -glutamine

[0812] MS (ESI) *m/z* 541.1; MS (ESI) *m/z* 1081.2.

Example 15J: N-benzyl-N²-{[4'-(benzyloxy)biphenyl-4-yl]carbonyl}-L- α -glutamine

[0813] MS (ESI) *m/z* 523.1; MS (ESI) *m/z* 1045.2.

[0814] The following compounds were prepared according to Scheme 10, Route A:

Example 15K: N²-{[3'-(benzyloxy)biphenyl-4-yl]carbonyl}-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0815] MS (ESI) *m/z* 613.1; MS (ESI) *m/z* 1225.1; HRMS: calcd for C₃₅H₃₆N₂O₈ + H⁺, 613.25444; found (ESI-FTMS, [M+H]¹⁺), 613.25451.

Example 15L: N²-({3'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0816] MS (ESI) *m/z* 673.3; MS (ESI) *m/z* 1345.6; MS (ESI) *m/z* 690.4; HRMS: calcd for C₃₇H₄₀N₂O₁₀ + H⁺, 673.27557; found (ESI-FTMS, [M+H]¹⁺), 673.27431.

Example 15M: N²-({3'-[(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0817] MS (ESI) *m/z* 643.3; MS (ESI) *m/z* 1285.6; HRMS: calcd for C₃₆H₃₈N₂O₉ + H⁺, 643.26501; found (ESI-FTMS, [M+H]¹⁺), 643.26574.

Example 15N: N²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0818] MS (ESI) *m/z* 643.3; MS (ESI) *m/z* 1285.6; HRMS: calcd for C₃₇H₃₉FN₂O₇ + H⁺, 643.28141; found (ESI-FTMS, [M+H]¹⁺), 643.28187.

[0819] The following compounds were prepared according to Scheme 10, Route B:

Example 15O: N^2 -[(4'-[3,5-bis(trifluoromethyl)phenoxy]methyl)biphenyl-4-yl]carbonyl]- N -(1,1-dimethyl-2-phenylethyl)- L - α -glutamine

[0820] Step A: *tert*-butyl N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(4'-methylbiphenyl-4-yl)carbonyl]- L - α -glutamate

tert-butyl N^1 -benzyl- N^2 -(4-bromobenzoyl)- L - α -glutamate (1.00g, 1.93mmol) was dissolved in DME (10mL) under nitrogen and placed in a microwave vial. 4-methylphenyl boronic acid (526mg, 3.87mmol), and $\text{Pd}(\text{PPh}_3)_4$ (334mg, 0.290mmol) were added as solids prior to the addition of K_2CO_3 (800mg, 5.79mmol) dissolved in H_2O (2.3mL). The vial was sealed and heated to 80°C in a microwave for 20 minutes. The solvent was removed and the remaining yellow oil was dissolved in diethyl ether (125mL). The organics were washed consecutively with 10% HCl (125mL), water (125mL) and brine (125mL). The organic layer was dried with MgSO_4 , filtered through celite and the solvent was removed. The sticky solid was purified using on a 40g Combi flash column using an increasing gradient of EtOAc/Hex as the solvent. The product was obtained as a light brown solid. Yield 792 mg of *tert*-butyl N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(4'-methylbiphenyl-4-yl)carbonyl]- L - α -glutamate at 78% yield. MS (ESI) m/z 529.3; HRMS: calcd for $\text{C}_{33}\text{H}_{40}\text{N}_2\text{O}_4 + \text{H}^+$, 529.30608; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 529.30594.

[0821] Step B: *tert*-butyl N^2 -{[4'-(bromomethyl)biphenyl-4-yl]carbonyl}- N -(1,1-dimethyl-2-phenylethyl)- L - α -glutamate

tert-butyl N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(4'-methylbiphenyl-4-yl)carbonyl]- L - α -glutamate (3.5g, 6.62mmol) was dissolved in CCl_4 (50mL) along with N -Bromosuccinimide (2.36g, 13.2mmol) and benzoyl peroxide (321mg, 1.32mmol) in a 100mL flask equipped with a reflux condenser. The reaction mixture stirred overnight at 70°C. The solvent was removed and the residue was purified using a SiO_2 column and 20%EtOAc/Hex as the solvent giving a yellow solid. Yield 1.05g *tert*-butyl N^2 -{[4'-(bromomethyl)biphenyl-4-yl]carbonyl}- N -(1,1-dimethyl-2-phenylethyl)- L - α -glutamate at 57% yield. MS (ESI) m/z 607.1; HRMS: calcd for $\text{C}_{33}\text{H}_{39}\text{BrN}_2\text{O}_4 + \text{H}^+$, 607.21660; found (ESI-FTMS, $[\text{M}+\text{H}]^{1+}$), 607.21591.

[0822] Step C: *tert*-butyl N^2 -[(4'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamate
tert-butyl N^2 -[(4'-(bromomethyl)biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamate (253mg, 0.41mmol) 3,5-bis(trifluoromethyl)phenol (63 μ L, 0.42mmol) and K_2CO_3 (287mg, 2.08mmol) were all combined in a 10mL vial. Acetonitrile (4mL) was added dissolving some of the solids upon heating to 80°C. The reaction was monitored using TLC and MS. The reaction was stirred overnight (18h). The reaction was filtered using a fritted funnel and the solvent was removed. The filtrate was collected and the solvent was removed. The residue was purified using a SiO_2 column and 20%EtOAc/Hex as the solvent giving a white solid. Yield 242mg of *tert*-butyl N^2 -[(4'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamate at 77% yield. MS (ESI) m/z 757.4; HRMS: calcd for $C_{41}H_{42}F_6N_2O_5 + H^+$, 757.30707; found (ESI-FTMS, $[M+H]^+$), 757.30532.

[0823] Step D: N^2 -[(4'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine
tert-butyl N^2 -[(4'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamate (215mg, 0.284mmol) was dissolved in CH_2Cl_2 (3mL) and stirred in a 10mL flask. Trifluoroacetic acid (1.09mL, 14mmol) was added and the solution was stirred for 2 hours. The solvent was removed and the dried under vacuum. The resulting residue was purified using preparative HPLC (ACN/ H_2O , 0.02% TFA). The main peak fractions were collected and after removal of solvent gave the product as a white solid. Yield of 104 mg of N^2 -[(4'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine was obtained in 52% yield. MS (ESI) m/z 699.3; HRMS: calcd for $C_{37}H_{34}F_6N_2O_5 + H^+$, 701.24447; found (ESI-FTMS, $[M+H]^+$), 701.24429.

[0824] The following compounds were prepared according to the procedure described above for example 15O:

Example 15P: N^2 -[(4'-[(1,3-benzodioxol-5-yloxy)methyl]biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-*L*- α -glutamine

[0825] MS (ESI) m/z 609.3; MS (ESI) m/z 1217.6; HRMS: calcd for $C_{36}H_{36}N_2O_7 + H^+$, 609.25953; found (ESI-FTMS, $[M+H]^+$), 609.26109.

Example 15Q: N^2 -({4'-[(3,5-dimethoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)- N -(3-methylbenzyl)-L- α -glutamine

[0826] MS (ESI) m/z 595.4; HRMS: calcd for $C_{35}H_{36}N_2O_7 + H^+$, 597.25953; found (ESI-FTMS, $[M+H]^+$), 597.25901.

Example 15R: N^2 -({3'-[(3,5-dimethoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)- N -(3-methylbenzyl)-L- α -glutamine

[0827] MS (ESI) m/z 595.2; HRMS: calcd for $C_{35}H_{36}N_2O_7 + H^+$, 597.25953; found (ESI-FTMS, $[M+H]^+$), 597.2593.

Example 15S: N^2 -[({3'-[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]- N -(3-methylbenzyl)-L- α -glutamine

[0828] MS (ESI) m/z 671.2; MS (ESI) m/z 1343.7; HRMS: calcd for $C_{35}H_{30}F_6N_2O_5 + H^+$, 673.21317; found (ESI-FTMS, $[M+H]^+$), 673.21279.

Example 15T: N^2 -({3'-[(3-ethylphenoxy)methyl]biphenyl-4-yl}carbonyl)- N -(3-methylbenzyl)-L- α -glutamine

[0829] MS (ESI) m/z 563.3; HRMS: calcd for $C_{35}H_{36}N_2O_5 + H^+$, 565.26970; found (ESI-FTMS, $[M+H]^+$), 565.26999.

[0830] The following compounds were prepared according to Scheme 10, Route C:

Example 15U: N -benzyl- N^2 -[4'-(biphenyl-3-ylmethoxy)biphenyl-4-yl]carbonyl]-L- α -glutamine

[0831] Step A: *tert*-butyl N^1 -benzyl- N^2 -[4'-hydroxy-1,1'-biphenyl-4-yl]carbonyl]-L- α -glutamate
tert-butyl N^1 -benzyl- N^2 -(4-bromobenzoyl)-L- α -glutamate (2.00g, 4.21mmol) was dissolved in DME (20mL) under nitrogen and placed in a 75mL flask. 4-Hydroxyphenyl

boronic acid (638mg, 4.63mmol), and Pd(PPh₃)₄ (729mg, 0.632mmol) were added as solids prior to the addition of K₂CO₃ (1.75g, 12.6mmol) dissolved in H₂O (5mL). The flask was sealed and the reaction was heated to reflux, stirred for two days and monitored by TLC. The reaction mixture was filtered through celite and then rinsed with MeOH. The solvent was removed and the resulting residue was purified using a SiO₂ column and 33%EtOAc/Hex as the solvent. The product was obtained as a white solid. Yield: 514 mg of *tert*-butyl *N*¹-benzyl-*N*²-[(4'-hydroxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamate at 25% yield. MS (ESI) *m/z* 487.4; HRMS: calcd for C₂₉H₃₂N₂O₅ + H⁺, 489.23840; found (ESI_FTMS, [M+H]¹⁺), 489.23862.

[0832] Step B: *tert*-butyl *N*-benzyl-*N*²-({4'-[(3-bromobenzyl)oxy]biphenyl-4-yl}carbonyl)-L- α -glutamate

3,3-bromobenzylbromide and K₂CO₃ were all combined in a 20mL vial. CH₃CN (6mL) was added, dissolving some of the solids upon heating to 80°C. The reaction was monitored using TLC and MS. After 2 hours the reaction was complete. The resulting product quickly precipitated upon cooling of the CH₃CN. The reaction was filtered using a fritted funnel and the filtrate was collected and redissolved in warm CH₃CN. The solution was allowed to crystallize overnight in the freezer. The white solid was collected and washed with cold CH₃CN. Yield: 357mg of *tert*-butyl *N*-benzyl-*N*²-({4'-[(3-bromobenzyl)oxy]biphenyl-4-yl}carbonyl)-L- α -glutamate at 57% yield. MS (ESI) *m/z* 657.2.

[0833] Step C: *tert*-butyl *N*-benzyl-*N*²-{[4'-(biphenyl-3-ylmethoxy)biphenyl-4-yl]carbonyl}-L- α -glutamate

tert-butyl *N*-benzyl-*N*²-({4'-[(3-bromobenzyl)oxy]biphenyl-4-yl}carbonyl)-L- α -glutamate (250mg, 0.38mmol) was dissolved in DME (5mL) under nitrogen in a 75mL bomb flask. Phenylboronic acid (51mg, 0.418mmol), and Pd(PPh₃)₄ (66mg, 0.057mmol) were added as solids prior to the addition of K₂CO₃ (158mg, 1.14mmol) dissolved in H₂O (1.5mL). The bomb flask was sealed and the reaction was heated to reflux, stirred two days and monitored by TLC. The reaction mixture was filtered through celite and the celite rinsed with MeOH. The solvent was removed and the resulting residue was purified using preparative HPLC. The product was obtained as a pale orange solid. Yield: 154 mg of *tert*-butyl *N*-benzyl-*N*²-{[4'-(biphenyl-3-ylmethoxy)biphenyl-4-

yl]carbonyl}-L- α -glutamate at 60% yield. MS (ESI) m/z 655.5; HRMS: calcd for $C_{42}H_{42}N_2O_5 + H^+$, 655.31665; found (ESI-FTMS, $[M+H]^{1+}$), 655.31636.

[0834] Step D: *N*-benzyl- N^2 -{[4'-(biphenyl-3-ylmethoxy)biphenyl-4-yl]carbonyl}-L- α - glutamine

tert-butyl *N*-benzyl- N^2 -{[4'-(biphenyl-3-ylmethoxy)biphenyl-4-yl]carbonyl}-L- α -glutamate (130mg, 0.199mmol) was dissolved in CH_2Cl_2 (3mL) and stirred in a 10mL flask. Trifluoroacetic acid (765uL, 10mmol) was added and the solution was stirred for 2 hours. The solvent was removed and the dried under vacuum. The orange residue was dissolved in minimum acetone and precipitated with hexanes. Yield of 109 mg of *N*-benzyl- N^2 -{[4'-(biphenyl-3-ylmethoxy)biphenyl-4-yl]carbonyl}-L- α - glutamine was obtained in 91% yield. MS (ESI) m/z 599.4; HRMS: calcd for $C_{38}H_{34}N_2O_5 + H^+$, 599.25405; found (ESI-FTMS, $[M+H]^{1+}$), 599.25511.

Example 15V: *N*-benzyl- N^2 -{[4'-(3'-methoxybiphenyl-3-yl)methoxy]biphenyl-4-yl]carbonyl}-L- α -glutamine

[0835] MS (ESI) m/z 627.2; HRMS: calcd for $C_{39}H_{36}N_2O_6 + H^+$, 629.26461; found (ESI-FTMS, $[M+H]^{1+}$), 629.26493.

Example 15W: *N*-benzyl- N^2 -{[4'-(biphenyl-2-ylmethoxy)biphenyl-4-yl]carbonyl}-L- α -glutamine

[0836] MS (ESI) m/z 597.3; HRMS: calcd for $C_{38}H_{34}N_2O_5 + H^+$, 599.25405; found (ESI-FTMS, $[M+H]^{1+}$), 599.25523.

Example 15X: *N*-benzyl- N^2 -{[4'-(3'-methoxybiphenyl-2-yl)methoxy]biphenyl-4-yl]carbonyl}-L- α -glutamine

[0837] MS (ESI) m/z 627.3; HRMS: calcd for $C_{39}H_{36}N_2O_6 + H^+$, 629.26461; found (ESI-FTMS, $[M+H]^{1+}$), 629.26484.

Example 15Y: N^2 -{[4'-(3-*tert*-butylphenoxy)methyl]biphenyl-4-yl]carbonyl}-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0838] Toly-biphenylglutamate (1g, 1.89mmol) was dissolved in CCl_4 (20mL), in a 40mL sealed vial. N-Bromosuccinimide (NBS) (673mg, 3.78mmol) and Benzoyl

peroxide (92mg, 0.378mmol) were added. The reaction was heated to 70°C, and stirred overnight. The reaction was cooled and the solvent removed. The remaining sticky orange solid was purified by silica column chromatography using 20%EtOAc/ Hexanes. 400mg of Bromo-tolyl-biphenylglutamate was obtained, as a pale yellow solid at 36% yield.

[0839] 3-*t*-Butylphenol (56mg, 0.374mmol) was dissolved in CH₃CN in a 20ml sealed vial and K₂CO₃ (258mg, 1.87mmol) was added. The reaction was heated to 80°C and stirred for 30 minutes. The Bromo-tolyl-biphenylglutamate (250mg, 0.411mmol) was added and the reaction stirred at 80°C overnight. The reaction was filtered, the solvent was removed and the remainder of the reaction was purified by silica column chromatography to give the title compound as a white solid was obtained in 87% yield.

[0840] MS (ESI) m/z 621.2; MS (ESI) m/z 1241.4; HRMS: calcd for C₃₉H₄₄N₂O₅ + H⁺, 621.33230; found (ESI-FTMS, [M+H]¹⁺), 621.33234.

[0841] The following compounds were prepared according to procedures similar to those described in Example 15Y:

Example 15Z: N²-({4'-[(3,5-di-*tert*-butylphenoxy)methyl]biphenyl-4-yl}carbonyl)-N-(1,1-dimethyl-2-phenylethyl)-L-α-glutamine

[0842] MS (ESI) m/z 675.3; MS (ESI) m/z 1351.6; HRMS: calcd for C₄₃H₅₂N₂O₅ + H⁺, 677.39490; found (ESI-FTMS, [M+H]¹⁺), 677.39504.

Example 15AA: N-(1,1-dimethyl-2-phenylethyl)-N²-({4'-[(3-ethylphenoxy)methyl]biphenyl-4-yl}carbonyl)-L-α-glutamine

[0843] MS (ESI) m/z 593.2; MS (ESI) m/z 1185.4; HRMS: calcd for C₃₇H₄₀N₂O₅ + H⁺, 593.30100; found (ESI-FTMS, [M+H]¹⁺), 593.30054.

Example 15BB: N-(1,1-dimethyl-2-phenylethyl)-N²-({4'-[(3-methoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)-L-α-glutamine

[0844] MS (ESI) m/z 595.3; MS (ESI) m/z 1189.6; HRMS: calcd for C₃₆H₃₈N₂O₆ + H⁺, 595.28026; found (ESI-FTMS, [M+H]¹⁺), 595.28031.

Example 16: N²-[(3'-ethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0845] The title compound was prepared according to procedures similar to those described in Examples 7 and 11. MS (ESI) m/z 551.2; MS (ESI) m/z 1101.4; MS (ESI) m/z 573.2; HRMS: calcd for C₃₀H₃₄N₂O₈ + H⁺, 551.23879; found (ESI-FTMS, [M+H]¹⁺), 551.23735.

[0846] The following compounds were prepared according to procedures similar to those described in Example 16.

Example 17A: N²-[(2'-ethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0847] MS (ESI) m/z 551.2; MS (ESI) m/z 1101.4; MS (ESI) m/z 573.2; HRMS: calcd for C₃₀H₃₄N₂O₈ + H⁺, 551.23879; found (ESI-FTMS, [M+H]¹⁺), 551.23739.

Example 17B: N²-[(4'-methoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0848] MS (ESI) m/z 537.2; MS (ESI) m/z 1073.4; MS (ESI) m/z 559.2; HRMS: calcd for C₂₉H₃₂N₂O₈ + H⁺, 537.22314; found (ESI-FTMS, [M+H]¹⁺), 537.22188.

Example 17C: N²-[(3'-methoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0849] HRMS: calcd for C₂₉H₃₂N₂O₈ + H⁺, 537.22314; found (ESI-FTMS, [M+H]¹⁺), 537.22188.

Example 17D: 4'-[(((1S)-3-carboxy-1-[(3,4,5-trimethoxybenzyl)amino]carbonyl}propyl)amino]carbonyl}biphenyl-3-carboxylic acid

[0850] MS (ESI) m/z 551.1; MS (ESI) m/z 1101.3; MS (ESI) m/z 573.1; HRMS: calcd for C₂₉H₃₀N₂O₉ + H⁺, 551.20241; found (ESI-FTMS, [M+H]¹⁺), 551.2008.

Example 17E: N²-[(4'-ethylbiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0851] MS (ESI) m/z 535.2; MS (ESI) m/z 1069.4; HRMS: calcd for C₃₀H₃₄N₂O₇ + H⁺, 535.24388; found (ESI-FTMS, [M+H]¹⁺), 535.2425.

Example 17F: N²-[(3',4'-dimethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0852] MS (ESI) m/z 567.2; MS (ESI) m/z 1133.5; MS (ESI) m/z 589.2; HRMS: calcd for C₃₀H₃₄N₂O₉ + H⁺, 567.23371; found (ESI-FTMS, [M+H]¹⁺), 567.23327.

Example 17G: N²-[(2',4'-dimethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0853] MS (ESI) m/z 567.2; MS (ESI) m/z 1133.5; HRMS: calcd for C₃₀H₃₄N₂O₉ + H⁺, 567.23371; found (ESI-FTMS, [M+H]¹⁺), 567.23397.

Example 17H: N-(3,4,5-trimethoxybenzyl)-N²-[(3',4',5'-trimethoxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0854] MS (ESI) m/z 597.2; MS (ESI) m/z 1193.4; HRMS: calcd for C₃₁H₃₆N₂O₁₀ + H⁺, 597.24427; found (ESI-FTMS, [M+H]¹⁺), 597.24385.

Example 17I: N-(1,1-dimethyl-2-phenylethyl)-N²-[(3'-methoxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0855] MS (ESI) m/z 489.2; MS (ESI) m/z 977.4; MS (ESI) m/z 511.2; HRMS: calcd for C₂₉H₃₂N₂O₅ + H⁺, 489.23840; found (ESI-FTMS, [M+H]¹⁺), 489.2373.

Example 17J: N²-[(3',4'-dimethoxybiphenyl-4-yl)carbonyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0856] MS (ESI) m/z 519.2; MS (ESI) m/z 1037.5; HRMS: calcd for C₃₀H₃₄N₂O₆ + H⁺, 519.24896; found (ESI-FTMS, [M+H]¹⁺), 519.248971.

Example 17K: N-(1,1-dimethyl-2-phenylethyl)-N²-[(2'-ethoxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0857] MS (ESI) m/z 503.2; MS (ESI) m/z 1005.5; HRMS: calcd for C₃₀H₃₄N₂O₅ + H⁺, 503.25405; found (ESI-FTMS, [M+H]¹⁺), 503.25421.

Example 17L: N-(1,1-dimethyl-2-phenylethyl)-N²-[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0858] MS (ESI) m/z 491.2; MS (ESI) m/z 981.5; HRMS: calcd for C₂₉H₃₁FN₂O₄ + H⁺, 491.23406; found (ESI-FTMS, [M+H]¹⁺), 491.23402.

Example 17M: 4-[(4'-Methoxy-3'-methyl-biphenyl-4-carbonyl)-amino]-4-(3,4,5-trimethoxy-benzylcarbamoyl)-butyric acid

[0859] MS (ESI) m/z 551.2; MS (ESI) m/z 1101.5; MS (ESI) m/z 1123.5.

Example 17N: 4-(4-Benzo[1,3]dioxol-5-yl-benzoylamino)-4-(3,4,5-trimethoxy-benzylcarbamoyl)-butyric acid

[0860] MS (ESI) m/z 551.2; MS (ESI) m/z 1101.4.

Example 17O: N-(1-adamantylmethyl)-N²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0861] MS (ESI) m/z 491.4; MS (ESI) m/z 981.7; HRMS: calcd for C₂₉H₃₄N₂O₅ + H⁺, 491.25405; found (ESI-FTMS, [M+H]¹⁺), 491.25465.

Example 17P: N²-[4-(1,3-benzodioxol-5-yl)benzoyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0862] MS (ESI) m/z 503.2; MS (ESI) m/z 1005.4; MS (ESI) m/z 525.2; HRMS: calcd for C₂₉H₃₀N₂O₆ + H⁺, 503.21766; found (ESI-FTMS, [M+H]¹⁺), 503.21771.

Example 17Q: N²-[(2',4'-dimethoxybiphenyl-4-yl)carbonyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0863] MS (ESI) m/z 519.2; MS (ESI) m/z 1037.5; MS (ESI) m/z 541.2; HRMS: calcd for C₃₀H₃₄N₂O₆ + H⁺, 519.24896; found (ESI-FTMS, [M+H]¹⁺), 519.24917.

Example 17R: N²-[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0864] MS (ESI) m/z 539.3; MS (ESI) m/z 1077.6; MS (ESI) m/z 561.3; HRMS: calcd for C₂₉H₃₁FN₂O₇ + H⁺, 539.21881; found (ESI-FTMS, [M+H]¹⁺), 539.2182.

Example 17S: N²-[(4'-sec-butylbiphenyl-4-yl)carbonyl]-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0865] MS (ESI) m/z 515.4; MS (ESI) m/z 1029.9; HRMS: calcd for C₃₂H₃₈N₂O₄ + H⁺, 515.29043; found (ESI-FTMS, [M+H]¹⁺), 515.29203.

Example 17T: N-(1,1-dimethyl-2-phenylethyl)-N²-[(4'-isopropylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0866] MS (ESI) m/z 501.4; MS (ESI) m/z 1001.8; HRMS: calcd for C₃₁H₃₆N₂O₄ + H⁺, 501.27478; found (ESI-FTMS, [M+H]¹⁺), 501.27468.

Example 17U: N-(1,1-dimethyl-2-phenylethyl)-N²-(1,1':4',1''-terphenyl-4-ylcarbonyl)-L- α -glutamine

[0867] MS (ESI) m/z 535.4; MS (ESI) m/z 1069.8; HRMS: calcd for C₃₄H₃₄N₂O₄ + H⁺, 535.25913; found (ESI-FTMS, [M+H]¹⁺), 535.26044.

Example 17V: N²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0868] MS (ESI) m/z 521.3; MS (ESI) m/z 1043.7; HRMS: calcd for C₂₈H₃₀N₂O₈ + H⁺, 523.20749; found (ESI-FTMS, [M+H]¹⁺), 523.20878.

Example 17W: N-(1-adamantylmethyl)-N²-({3'-[(dimethylamino)carbonyl]biphenyl-4-yl}carbonyl)-L- α -glutamine

[0869] MS (ESI) m/z 546.4; MS (ESI) m/z 1091.9; HRMS: calcd for C₃₂H₃₉N₃O₅ + H⁺, 546.29625; found (ESI-FTMS, [M+H]¹⁺), 546.29678.

Example 17X: N-(1-adamantylmethyl)-N²-[(3',5'-dimethylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0870] MS (ESI) m/z 503.4; MS (ESI) m/z 1005.8; HRMS: calcd for C₃₁H₃₈N₂O₄ + H⁺, 503.29043; found (ESI-FTMS, [M+H]¹⁺), 503.29107.

Example 17Y: N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-[(3'-methylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0871] MS (ESI) m/z 491.4; MS (ESI) m/z 981.7; MS (ESI) m/z 513.3; HRMS: calcd for C₂₉H₃₁FN₂O₄ + H⁺, 491.23406; found (ESI-FTMS, [M+H]¹⁺), 491.23228.

Example 17Z: N²-[(3'-isopropylbiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0872] MS (ESI) m/z 549.4; MS (ESI) m/z 1097.9; HRMS: calcd for C₃₁H₃₆N₂O₇ + H⁺, 549.25953; found (ESI-FTMS, [M+H]¹⁺), 549.26013.

Example 17AA: N²-[(4'-isopropylbiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0873] MS (ESI) m/z 549.4; MS (ESI) m/z 1097.9; HRMS: calcd for C₃₁H₃₆N₂O₇ + H⁺, 549.25953; found (ESI-FTMS, [M+H]¹⁺), 549.26066.

Example 17BB: N-(1-adamantylmethyl)-N²-[4-(1-benzofuran-5-yl)benzoyl]-L- α -glutamine

[0874] MS (ESI) m/z 515.4; MS (ESI) m/z 1029.9; HRMS: calcd for C₃₁H₃₄N₂O₅ + H⁺, 515.25405; found (ESI-FTMS, [M+H]¹⁺), 515.25447.

Example 17CC: N-(1-adamantylmethyl)-N²-[4-(1H-indol-5-yl)benzoyl]-L- α -glutamine

[0875] MS (ESI) m/z 514.4; MS (ESI) m/z 1027.7; HRMS: calcd for C₃₁H₃₅N₃O₄ + H⁺, 514.27003; found (ESI-FTMS, [M+H]¹⁺), 514.27038.

Example 17DD: N²-[(3'-ethoxybiphenyl-4-yl)carbonyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0876] MS (ESI) m/z 521.4; MS (ESI) m/z 1041.7; HRMS: calcd for $C_{30}H_{33}FN_2O_5 + H^+$, 521.24463; found (ESI-FTMS, $[M+H]^{1+}$), 521.24248.

Example 17EE: N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-[(3'-methoxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0877] MS (ESI) m/z 507.3; MS (ESI) m/z 1013.7; HRMS: calcd for $C_{29}H_{31}FN_2O_5 + H^+$, 507.22898; found (ESI-FTMS, $[M+H]^{1+}$), 507.22717.

Example 17FF: N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-[(3'-isopropylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0878] MS (ESI) m/z 519.4; MS (ESI) m/z 1037.7; HRMS: calcd for $C_{31}H_{35}FN_2O_4 + H^+$, 519.26536; found (ESI-FTMS, $[M+H]^{1+}$), 519.26474.

Example 17GG: N²-[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0879] MS (ESI) m/z 509.3; MS (ESI) m/z 1017.7; HRMS: calcd for $C_{29}H_{30}F_2N_2O_4 + H^+$, 509.22464; found (ESI-FTMS, $[M+H]^{1+}$), 509.22537.

Example 17HH: N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-[(4'-isobutylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0880] MS (ESI) m/z 533.4; MS (ESI) m/z 1065.8; HRMS: calcd for $C_{32}H_{37}FN_2O_4 + H^+$, 533.28101; found (ESI-FTMS, $[M+H]^{1+}$), 533.28214.

Example 17II: N²-(1,1':4',1''-terphenyl-4-ylcarbonyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0881] MS (ESI) m/z 581.2; MS (ESI) m/z 1163.4; HRMS: calcd for $C_{34}H_{34}N_2O_7 + H^+$, 583.24388; found (ESI-FTMS, $[M+H]^{1+}$), 583.24414.

Example 17JJ: N-benzyl-N²-[(3'-(hydroxymethyl)biphenyl-4-yl)carbonyl]-L- α -glutamine

[0882] MS (ESI) m/z 445.1; MS (ESI) m/z 891.2.

Example 17KK: N-(3,4,5-trimethoxybenzyl)-N²-[(2',4',6'-trimethylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0883] HRMS: calcd for C₃₁H₃₆N₂O₇ + H⁺, 549.25953; found (ESI-FTMS, [M+H]¹⁺), 549.25817.

Example 17LL: N-(1,1-dimethyl-2-phenylethyl)-N²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0884] MS (ESI) m/z 475.2; MS (ESI) m/z 949.4; HRMS: calcd for C₂₈H₃₀N₂O₅ + H⁺, 475.22275; found (ESI-FTMS, [M+H]¹⁺), 475.22358.

Example 17MM: N-(1,1-dimethyl-2-phenylethyl)-N²-[(3'-ethoxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0885] MS (ESI) m/z 503.2; MS (ESI) m/z 1005.3; MS (ESI) m/z 525.1; HRMS: calcd for C₃₀H₃₄N₂O₅ + H⁺, 503.25405; found (ESI-FTMS, [M+H]¹⁺), 503.25252.

Example 17NN: N²-[4-(1,3-benzodioxol-5-yl)benzoyl]-N-(3-methylbenzyl)-L- α -glutamine

[0886] MS (ESI) m/z 475.1; MS (ESI) m/z 949.2; HRMS: calcd for C₂₇H₂₆N₂O₆ + H⁺, 475.18636; found (ESI-FTMS, [M+H]¹⁺), 475.1872.

Example 17OO: N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-[(4'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0887] MS (ESI) m/z 493.2; MS (ESI) m/z 985.4; HRMS: calcd for C₂₈H₂₉FN₂O₅ + H⁺, 493.21333; found (ESI-FTMS, [M+H]¹⁺), 493.21327.

Example 17PP: N²-[4-(1,3-benzodioxol-5-yl)benzoyl]-N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine

[0888] (1): MS (ESI) m/z 521.1; MS (ESI) m/z 1041.3; HRMS: calcd for C₂₉H₂₉FN₂O₆ + H⁺, 521.20824; found (ESI-FTMS, [M+H]¹⁺), 521.20872; (2): MS (ESI) m/z 521.2; MS (ESI) m/z 1041.3.

Example 17QQ: N-benzyl-N²-{4-[(4-hydroxycyclohexyl)ethynyl]benzoyl}-L- α -glutamine

[0889] MS (ESI) m/z 463.1; MS (ESI) m/z 925.3.

Example 17RR: N²-[(3'-hydroxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0890] HRMS: calcd for C₂₈H₃₀N₂O₈ + H⁺, 523.20749; found (ESI-FTMS, [M+H]¹⁺), 523.20809.

Example 17SS: N-(1,1-dimethyl-2-phenylethyl)-N²-{[4'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-L- α -glutamine

[0891] MS (ESI) m/z 487.1; MS (ESI) m/z 975.2; HRMS: calcd for C₂₉H₃₂N₂O₅ + H⁺, 489.23840; found (ESI-FTMS, [M+H]¹⁺), 489.2389.

Example 17TT: N-(1,1-dimethyl-2-phenylethyl)-N²-[(4'-methylbiphenyl-4-yl)carbonyl]-L- α -glutamine

[0892] MS (ESI) m/z 473.1; MS (ESI) m/z 945.3; HRMS: calcd for C₂₉H₃₂N₂O₄ + H⁺, 473.24348; found (ESI-FTMS, [M+H]¹⁺), 473.24409.

Example 17UU: N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N²-[(3'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine

[0893] MS (ESI) m/z 493.2; MS (ESI) m/z 985.4.

Example 17VV: N¹-benzyl-N²-(4-pyridin-4-ylbenzoyl)-L- α -glutamine

[0894] MS (ESI) m/z 418.2; HRMS: calcd for C₂₄H₂₃N₃O₄ + H⁺, 418.17613; found (ESI_FT, [M+H]¹⁺), 418.17461.

Example 17WW: N¹-benzyl-N²-(1,1'-biphenyl-3-ylcarbonyl)-L- α -glutamine

[0895] MS (ESI) m/z 417.1; MS (ESI) m/z 833.1; HRMS: calcd for C₂₅H₂₄N₂O₄ + H⁺, 417.18088; found (ESI-FTMS, [M+H]¹⁺), 417.18049.

Example 17XX: N¹-benzyl-N²-(3-thien-2-ylbenzoyl)-L- α -glutamine

[0896] MS (ESI) m/z 423.1; MS (ESI) m/z 845; HRMS: calcd for $C_{23}H_{22}N_2O_4S + H^+$, 423.13730; found (ESI-FTMS, $[M+H]^{1+}$), 423.1383.

Example 17YY: N^1 -benzyl- N^2 -[(3-chloro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0897] MS (ESI) m/z 451.1; MS (ESI) m/z 901; HRMS: calcd for $C_{25}H_{23}ClN_2O_4 + H^+$, 451.14191; found (ESI-FTMS, $[M+H]^{1+}$), 451.1417.

Example 17ZZ: N^1 -benzyl- N^2 -[(3-fluoro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0898] HRMS: calcd for $C_{25}H_{23}FN_2O_4 + H^+$, 435.17146; found (ESI-FTMS, $[M+H]^{1+}$), 435.17091.

Example 17AAA: N^1 -benzyl- N^2 -[(2,6-dimethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine

[0899] HRMS: calcd for $C_{27}H_{28}N_2O_6 + H^+$, 477.20201; found (ESI-FTMS, $[M+H]^{1+}$), 477.20098.

Example 17BBB: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methoxy-1,1'-biphenyl-3-yl)-L- α -glutamine

[0900] MS (ESI) m/z 509.2; MS (ESI) m/z 1017.2; HRMS: calcd for $C_{31}H_{28}N_2O_5 + H^+$, 509.20710; found (ESI-FTMS, $[M+H]^{1+}$), 509.20875.

Example 18: N^2 -({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0901] MS (ESI) m/z 673.4; MS (ESI) m/z 1345.9; HRMS: calcd for $C_{37}H_{40}N_2O_{10} + H^+$, 673.27557; found (ESI-FTMS, $[M+H]^{1+}$), 673.27498.

Example 19:

[0902] The following compounds were prepared according to procedures similar to those described in Example 18.

Example 19A: N-(1-adamantylmethyl)- N^2 -({4'-[(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-L- α -glutamine

[0903] MS (ESI) m/z 611.5; MS (ESI) m/z 1222; HRMS: calcd for C₃₇H₄₂N₂O₆ + H⁺, 611.31156; found (ESI-FTMS, [M+H]¹⁺), 611.31164.

Example 19B: N-(1-adamantylmethyl)-N²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-L-α-glutamine

[0904] MS (ESI) m/z 641.5; MS (ESI) m/z 1282; HRMS: calcd for C₃₈H₄₄N₂O₇ + H⁺, 641.32213; found (ESI-FTMS, [M+H]¹⁺), 641.32171.

Example 19C: N²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-N-(1,1-dimethyl-2-phenylethyl)-L-α-glutamine

[0905] MS (ESI) m/z 625.5; MS (ESI) m/z 1249.9; HRMS: calcd for C₃₇H₄₀N₂O₇ + H⁺, 625.29083; found (ESI-FTMS, [M+H]¹⁺), 625.2906.

Example 19D: N²-({4'-[(3,5-dimethylbenzyl)oxy]biphenyl-4-yl}carbonyl)-N-(3,4,5-trimethoxybenzyl)-L-α-glutamine

[0906] MS (ESI) m/z 641.5; MS (ESI) m/z 1282.

Example 19E: N²-({4'-[(3,5-bis(trifluoromethyl)benzyl)oxy]biphenyl-4-yl}carbonyl)-N-(3,4,5-trimethoxybenzyl)-L-α-glutamine

[0907] MS (ESI) m/z 749.5; MS (ESI) m/z 771.5; HRMS: calcd for C₃₇H₃₄F₆N₂O₈ + H⁺, 749.22921; found (ESI-FTMS, [M+H]¹⁺), 749.2297.

Example 19F: N-(1,1-dimethyl-2-phenylethyl)-N²-({4'-[(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-L-α-glutamine

[0908] MS (ESI) m/z 595.3; MS (ESI) m/z 1189.5; HRMS: calcd for C₃₆H₃₈N₂O₆ + H⁺, 595.28026; found (ESI-FTMS, [M+H]¹⁺), 595.28185.

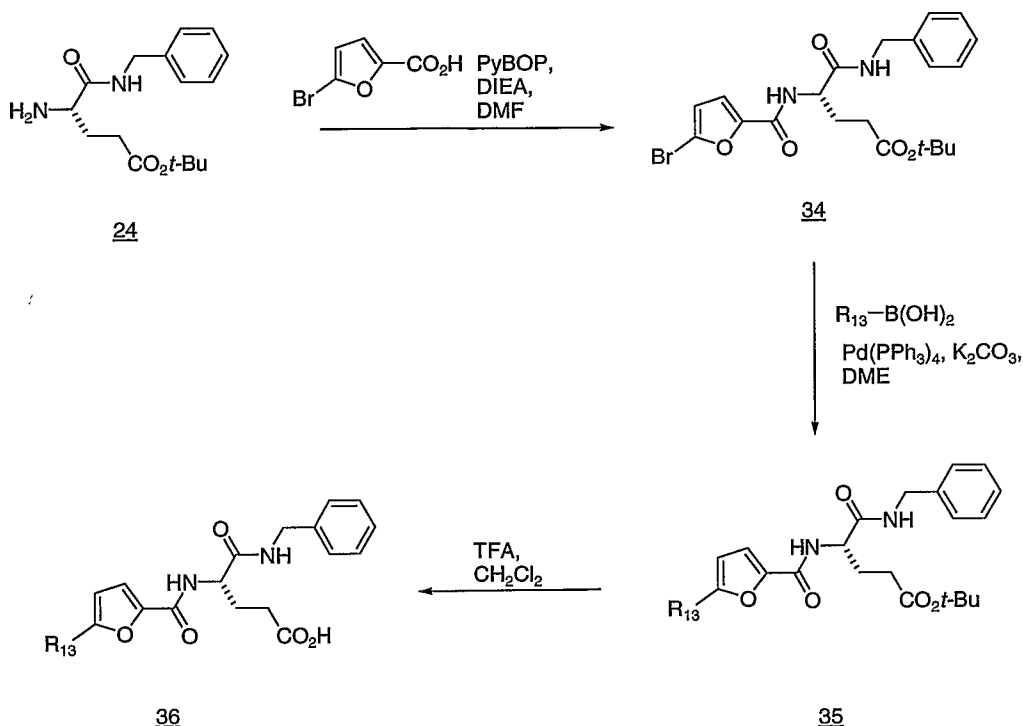
Example 19G: N²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-N-(6-hydroxyhexyl)-L-α-glutamine

[0909] MS (ESI) m/z 591.2; HRMS: calcd for C₃₃H₄₀N₂O₈ + H⁺, 593.28574; found (ESI-FTMS, [M+H]¹⁺), 593.28726.

Example 19H: N^2 -(4'-[(3-methoxybenzyl)oxy]biphenyl-4-yl)carbonyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0910] MS (ESI-FTMS) m/z 643.26499; MS (ESI-FTMS) m/z 643.26501; HRMS: calcd for $C_{36}H_{38}N_2O_9 + H^+$, 643.26501; found (ESI-FTMS, $[M+H]^+$), 643.26499.

Scheme 11



Example 20: N^1 -benzyl- N^2 -(5-phenyl-2-furoyl)-L- α -glutamine

[0911] Step A: *tert*-butyl N^1 -benzyl- N^2 -(5-bromo-2-furoyl)-L- α -glutamate
Tert-butyl N^1 -benzyl-L- α -glutamate (2.33g, 7.98mmol) was dissolved in DMF (7mL) under nitrogen. 5-Bromofuroic acid (1.52g, 7.98mmol) was added, followed by addition of PyBOP (5.00g, 9.6mmol). Finally, DIEA (1.67mL, 9.6mmol) was added dropwise over 5 minutes via addition funnel. The reaction was monitored by TLC and stirred overnight. The solution was diluted with EtOAc (250 mL), washed consecutively with H_2O , 10% HCl, saturated $NaHCO_3$, brine, and then dried over Na_2SO_4 . After solvent was evaporated, the crude residue was dissolved in ether and washed with aq. LiBr (2 x 250 mL) and dried over Na_2SO_4 . Ether was removed, leaving an oil which was further purified on a SiO_2 column using 33%-40%EtOAc/Hex as the solvent. The product was

the third spot off the column and a sticky orange solid. Yield 1.60g of *tert*-butyl *N*¹-benzyl-*N*²-(5-bromo-2-furoyl)-L- α -glutamate at 43% yield.

[0912] Step B: *tert*-butyl *N*¹-benzyl-*N*²-(5-phenyl-2-furoyl)-L- α -glutamate
HRMS: calcd for C₂₇H₃₀N₂O₅ + Na⁺, 485.20469; found (ESI_FTMS, [M+Na]¹⁺), 485.20466.

[0913] Step C: *N*¹-benzyl-*N*²-(5-phenyl-2-furoyl)-L- α -glutamine
HRMS: calcd for C₂₃H₂₂N₂O₅ + H⁺, 407.16015; found (ESI_FTMS, [M+H]¹⁺), 407.15841.

Example 21:

[0914] The following compounds were prepared according to procedures similar to those described in Example 20.

Example 21A: *N*¹-benzyl-*N*²-[5-(3-ethoxyphenyl)-2-furoyl]-L- α -glutamine

[0915] Step B: *tert*-butyl *N*¹-benzyl-*N*²-[5-(3-ethoxyphenyl)-2-furoyl]-L- α -glutamate
HRMS: calcd for C₂₉H₃₄N₂O₆ + H⁺, 507.24896; found (ESI_FTMS, [M+H]¹⁺), 507.24894.

[0916] Step C: *N*¹-benzyl-*N*²-[5-(3-ethoxyphenyl)-2-furoyl]-L- α -glutamine
HRMS: calcd for C₂₅H₂₆N₂O₆ + H⁺, 451.18636; found (ESI_FTMS, [M+H]¹⁺), 451.18545.

Example 21B: *N*¹-benzyl-*N*²-[5-(3,5-dimethylphenyl)-2-furoyl]-L- α -glutamine

[0917] Step B: *tert*-butyl *N*¹-benzyl-*N*²-[5-(3,5-dimethylphenyl)-2-furoyl]-L- α -glutamate
HRMS: calcd for C₂₉H₃₄N₂O₅ + H⁺, 491.25405; found (ESI_FTMS, [M+H]¹⁺), 491.2538.

[0918] Step C: *N*¹-benzyl-*N*²-[5-(3,5-dimethylphenyl)-2-furoyl]-L- α -glutamine
HRMS: calcd for C₂₅H₂₆N₂O₅ + H⁺, 435.19145; found (ESI_FTMS, [M+H]¹⁺), 435.19034.

Example 21C: *N*¹-benzyl-*N*²-(2,2'-bifuran-5-ylcarbonyl)-L- α -glutamine

[0919] Step B: *tert*-butyl *N*¹-benzyl-*N*²-(2,2'-bifuran-5-ylcarbonyl)-L- α -glutamate

HRMS: calcd for C₂₅H₂₈N₂O₆ + H⁺, 453.20201; found (ESI_FTMS, [M+H]¹⁺), 453.20173.

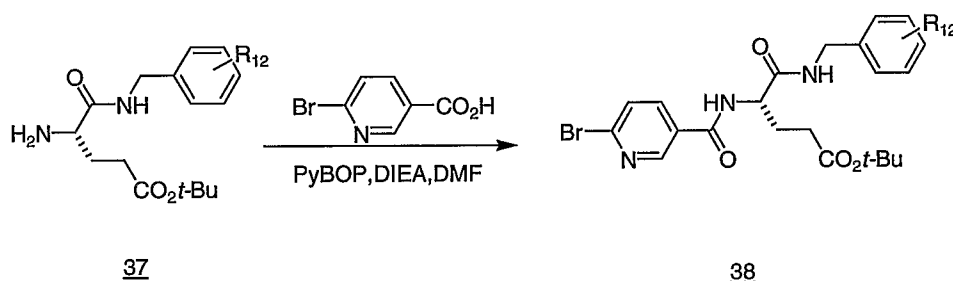
[0920] Step C: *N*¹-benzyl-*N*²-(2,2'-bifuran-5-ylcarbonyl)-L- α -glutamine
HRMS: calcd for C₂₁H₂₀N₂O₆ + H⁺, 397.13941; found (ESI_FTMS, [M+H]¹⁺), 397.13777.

Example 21D: *N*¹-benzyl-*N*²-(5-thien-2-yl-2-furoyl)-L- α -glutamine

[0921] Step B: *tert*-butyl *N*¹-benzyl-*N*²-(5-thien-2-yl-2-furoyl)-L- α -glutamate
HRMS: calcd for C₂₅H₂₈N₂O₅S + H⁺, 469.17917; found (ESI_FTMS, [M+H]¹⁺), 469.1789.

[0922] Step C: *N*¹-benzyl-*N*²-(5-thien-2-yl-2-furoyl)-L- α -glutamine
HRMS: calcd for C₂₁H₂₀N₂O₅S + H⁺, 413.11657; found (ESI_FTMS, [M+H]¹⁺), 413.11511.

Scheme 12



Example 22:

[0923] The following compounds were prepared according to procedures similar to those described in Example 20.

Example 22A: *N*¹-benzyl-*N*²-[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine

[0924] Step A: *tert*-butyl *N*¹-benzyl-*N*²-[(6-bromopyridin-3-yl)carbonyl]-L- α -glutamate

MS (ESI) *m/z* 476.1; MS (ESI) *m/z* 951.1; HRMS: calcd for C₂₂H₂₆BrN₃O₄ + H⁺, 476.11794; found (ESI-FTMS, [M+H]¹⁺), 476.11935.

[0925] Step B: *tert*-butyl N^1 -benzyl- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamate

MS (ESI) m/z 474.2; HRMS: calcd for $C_{28}H_{31}N_3O_4 + H^+$, 474.23873; found (ESI-FTMS, $[M+H]^{1+}$), 474.23861.

[0926] Step C: N^1 -benzyl- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine

MS (ESI) m/z 418.1; HRMS: calcd for $C_{24}H_{23}N_3O_4 + H^+$, 418.17613; found (ESI-FTMS, $[M+H]^{1+}$), 418.17674.

Example 22B: N^1 -(3-methoxybenzyl)- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine

[0927] Step A: *tert*-butyl N^2 -[(6-bromopyridin-3-yl)carbonyl]- N^1 -(3-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 506.1; MS (ESI) m/z 1011.1; HRMS: calcd for $C_{23}H_{28}BrN_3O_5 + H^+$, 506.12851; found (ESI-FTMS, $[M+H]^{1+}$), 506.12839.

[0928] Step B: *tert*-butyl N^1 -(3-methoxybenzyl)- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamate

MS (ESI) m/z 504.2; HRMS: calcd for $C_{29}H_{33}N_3O_5 + H^+$, 504.24930; found (ESI-FTMS, $[M+H]^{1+}$), 504.24835.

[0929] Step C: N^1 -(3-methoxybenzyl)- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine

MS (ESI) m/z 448.1; HRMS: calcd for $C_{25}H_{25}N_3O_5 + H^+$, 448.18670; found (ESI-FTMS, $[M+H]^{1+}$), 448.18686.

Example 22C: N^2 -[(2,2'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]- N^1 -(3-methoxybenzyl)-L- α -glutamine

[0930] Step B: *tert*-butyl N^2 -[(2,2'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]- N^1 -(3-methoxybenzyl)-L- α -glutamate

MS (ESI) m/z 531.3; MS (ESI) m/z 1061.4; HRMS: calcd for $C_{32}H_{38}N_2O_5 + H^+$, 531.28535; found (ESI-FTMS, $[M+H]^{1+}$), 531.2855.

[0931] Step C: N^2 -[(2,2'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]- N^1 -(3-methoxybenzyl)-L- α -glutamine

HRMS: calcd for $C_{28}H_{30}N_2O_5 + H^+$, 475.22275; found (ESI-FTMS, $[M+H]^+$), 475.22271.

Example 22D: N^2 -(4-bromobenzoyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine

[0932] MS (ESI) m/z 507; MS (ESI) m/z 1015.1; HRMS: calcd for $C_{22}H_{25}BrN_2O_7 + H^+$, 509.09179; found (ESI-FTMS, $[M+H]^+$), 509.09078.

Example 22E: N^2 -(4-bromobenzoyl)-N-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine

[0933] MS (ESI) m/z 461.1; MS (ESI) m/z 921.2; HRMS: calcd for $C_{22}H_{25}BrN_2O_4 + H^+$, 461.10705; found (ESI-FTMS, $[M+H]^+$), 461.10805.

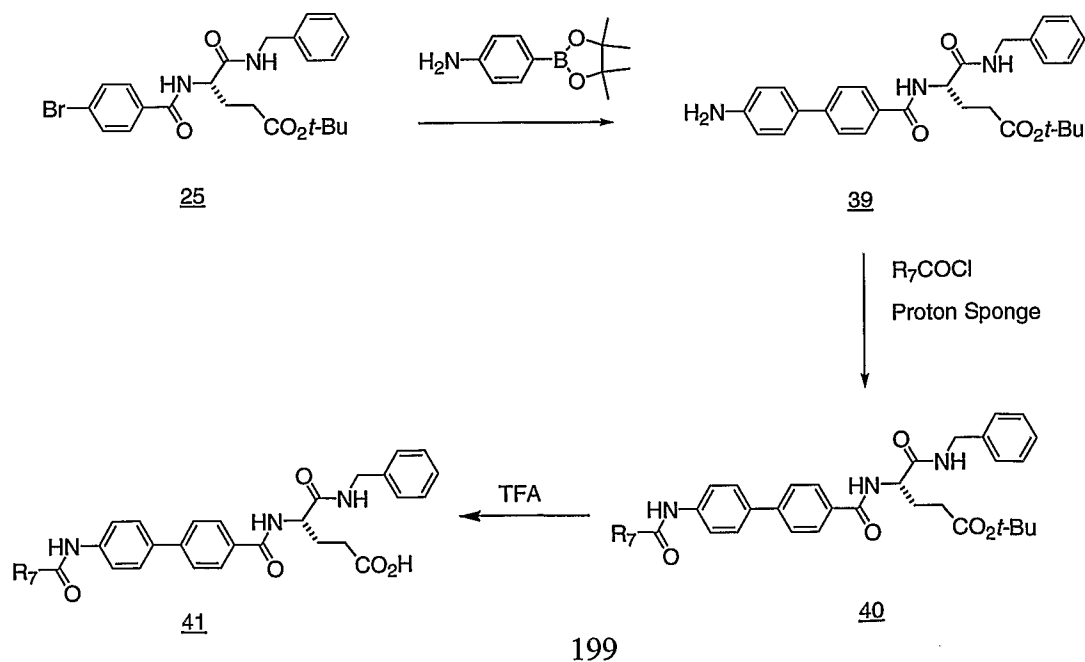
Example 22F: N-(1-adamantylmethyl)- N^2 -(4-bromobenzoyl)-L- α -glutamine

[0934] MS (ESI) m/z 477.3; MS (ESI) m/z 953.5; HRMS: calcd for $C_{23}H_{29}BrN_2O_4 + H^+$, 477.13835; found (ESI-FTMS, $[M+H]^+$), 477.13801.

Example 22G: N^2 -(4-bromobenzoyl)-N-(3-methylbenzyl)-L- α -glutamine

[0935] MS (ESI-FTMS) m/z 433.07562; MS (ESI-FTMS) m/z 433.07575; HRMS: calcd for $C_{20}H_{21}BrN_2O_4 + H^+$, 433.07575; found (ESI-FTMS, $[M+H]^+$), 433.07562.

Scheme 13



Example 23: N^2 -{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine

[0936] Step A: *tert*-butyl N^2 -[(4'-amino-1,1'-biphenyl-4-yl)carbonyl]- N^1 -benzyl-L- α -glutamate

4-Benzylcarbamoyl-4-(4-bromo-benzoylamino)-butyric acid *tert*-butyl ester (3.0 g, 6.31 mmol, 1 equiv.) was dissolved in DME (60 mL) was added to 4-(4,4,5,5,-tetramethyl-1,3,2-dioxaborolan-2-yl)aniline (1.38 g, 6.31 mmol, 1 equiv.) and Pd(PPh₃)₄ (728 mg, 0.063 mmol, 0.1 equiv.). The mixture was stirred for 30 minutes prior to the addition of aq. K₂CO₃ (1.74 g, 12.6 mmol, 2 equiv.) in 12 mL H₂O. The mixture was capped in a sealed vessel and stirred overnight at 80°C. The reaction was complete as determined by TLC. The mixture was filtered over celite, the solvent was removed, and the resulting tan solid was diluted with EtOAc (200 mL) and washed consecutively with H₂O, 10% HCl, and brine, and then dried over Na₂SO₄. The solid was purified by column chromatography (silica gel, 41% Acetone/Hexanes) to give 1.89 g of *tert*-butyl N^2 -[(4'-amino-1,1'-biphenyl-4-yl)carbonyl]- N^1 -benzyl-L- α -glutamate in 61% yield. MS (ESI) m/z 488.2; HRMS: calcd for C₂₉H₃₃N₃O₄ + H⁺, 488.25438; found (ESI_FTMS, [M+H]¹⁺), 488.25433.

[0937] Step B: isopropyl N^2 -{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamate

4-[(4'-Amino-biphenyl-4-carbonyl)-amino]-4-benzylcarbamoyl-butyric acid *tert*-butyl ester (300 mg, 0.62 mmol, 1 equiv.) was dissolved in CH₂Cl₂ (20 mL) and cooled to 0°C followed by the addition of proton sponge (266 mg, 1.24 mmol, 2 equiv.). The mixture was stirred 30 minutes prior to the addition of acetyl chloride (48 μ L, 0.68 mmol, 1.1 equiv.) The mixture was stirred at 0°C for 1.5 hrs and allowed to warm to room temperature. Reaction was complete as determined by TLC. The mixture was washed consecutively with H₂O, NaHCO₃ satd., and brine, and then dried over Na₂SO₄. The tan solid was purified by preparative HPLC to give 85 mg of isopropyl N^2 -{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamate in 26% yield. MS (ESI) m/z 557.2; MS (ESI) m/z 279.1.

[0938] Step C: N^2 -{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine

4-[(4'-Acetylamino-biphenyl-4-carbonyl)-amino]-4-benzylcarbamoyl-butyric acid *tert*-

butyl ester (75 mg) was dissolved in dichloroethane (4 mL) and added to TFA (2 mL). The mixture was stirred at room temperature for 3 hrs. Reaction was complete as determined by TLC. The solvent was removed and the resulting solid was purified by preparative HPLC to give N^2 -{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine in 54% yield (37 mg).
MS (ESI) m/z 474.2; MS (ESI) m/z 947.3; HRMS: calcd for $C_{27}H_{27}N_3O_5 + H^+$, 474.20235; found (ESI_FTMS, $[M+H]^{1+}$), 474.20274.

Example 24:

[0939] The following compounds were prepared according to procedures similar to those described in Example 23.

Example 24A: N^1 -benzyl- N^2 -{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

[0940] Step B: *tert*-butyl N^1 -benzyl- N^2 -{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamate
MS (ESI) m/z 582.3; MS (ESI) m/z 1163.5; HRMS: calcd for $C_{34}H_{35}N_3O_6 + H^+$, 582.25986; found (ESI_FTMS, $[M+H]^{1+}$), 582.26058.

[0941] Step C: N^1 -benzyl- N^2 -{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine
MS (ESI) m/z 526.2; MS (ESI) m/z 1051.3; HRMS: calcd for $C_{30}H_{27}N_3O_6 + H^+$, 526.19726; found (ESI_FTMS, $[M+H]^{1+}$), 526.19773.

Example 24B: N^1 -benzyl- N^2 -{[4'-[(4-fluorobenzoyl)amino]-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

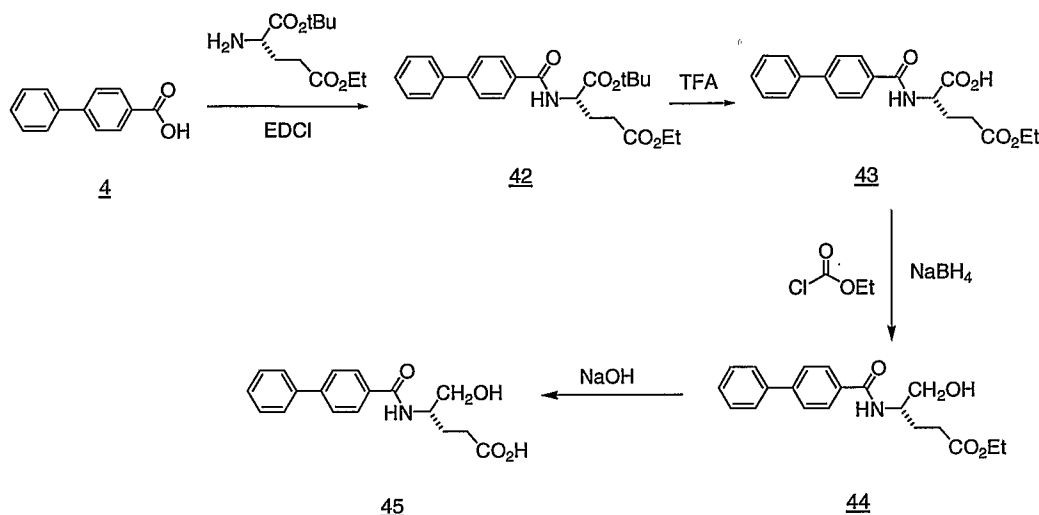
[0942] Step B: *tert*-butyl N^1 -benzyl- N^2 -{[4'-[(4-fluorobenzoyl)amino]-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamate

[0943] Step C: N^1 -benzyl- N^2 -{[4'-[(4-fluorobenzoyl)amino]-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine

Example 24C: N^2 -{[4'-(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine

[0944] HRMS: calcd for $C_{32}H_{29}N_3O_5 - H^+$, 534.20345; found (ESI-FTMS, $[M-H]^+$), 534.2024.

Scheme 14



Example 25: 4-[(Biphenyl-4-carbonyl)-amino]-5-hydroxy-pentanoic acid

[0945] Step A: 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 1-tert-butyl ester 5-methyl ester

4-Diphenyl carboxylic acid (3.57 g, 18 mmol) and EDCI (4.28 g, 22.3 mmol, 1.2 equiv.) were dissolved in DMF (40 mL). The mixture was stirred at room temperature for 0.5 hrs. H-Glu(OMe)OtBu (5.02 g, 19.8 mmol, 1.1 equiv.) was added, followed by the addition of Et₃N (6.77 mL, 48.6 mmol, 2.7 equiv.) and DMAP (330 mg, 2.7 mmol, 15%). The mixture was stirred overnight under N₂. The reaction mixture was then diluted with EtOAc and washed with H₂O and brine. The organic layer was dried over MgSO₄, concentrated, and purified by column chromatography (20% EtOAc / Hexane) to afford 3.2 g of 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 1-tert-butyl ester 5-methyl ester in 44.7% yield. MS (ESI) *m/z* 396.

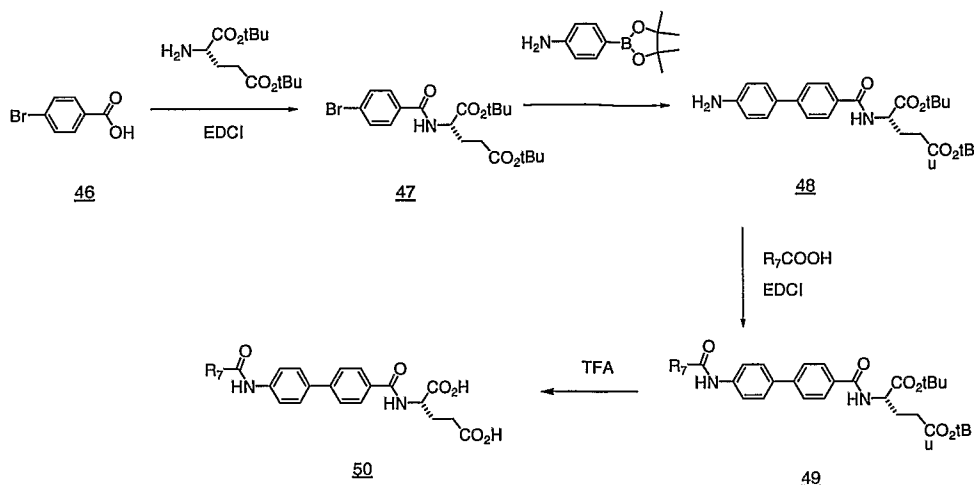
[0946] Step B: 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 5-methyl ester
2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 1-tert-butyl ester 5-methyl ester (1.5 g, 3.8 mmol) was dissolved in dichloroethane (26 mL) and the mixture was added to TFA (13 mL). The mixture was stirred at room temperature for 4 hrs. TLC indicated the reaction was complete. Solvent was evaporated by rotovap. The solid obtained was washed with EtOAc and water. After drying, 2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 5-methyl ester was obtained in 87% yield (1.128 g). MS (ESI) *m/z* 342.

[0947] Step C: 4-[(Biphenyl-4-carbonyl)-amino]-5-hydroxy-pentanoic acid methyl ester

2-[(Biphenyl-4-carbonyl)-amino]-pentanedioic acid 5-methyl ester (1.128g, 3.30mmol, 1.0 equiv.) was dissolved in THF (35 mL). The mixture was cooled to -20°C , followed by the addition of Et_3N (343 mg, 3.3 mmol, 1.0 equiv.) and ethyl chloroformate (358 mg, 3.3 mmol, 1.0 equiv.). After stirring for 20 minutes, NaBH_4 (375 mg, 9.9 mmol, 3 equiv.) was added and the temperature was raised to -10°C . After stirring for 5 min, MeOH (30mL) was introduced and the mixture was further stirred for 20 min at this temperature and then at 0°C for 20 min. 1N HCl was then added slowly to quench the reaction. Solvent was evaporated and the residue partitioned between EtOAc and H_2O . The organic layer was washed with brine, dried over MgSO_4 , and removed solvent by rotavap. The crude mixture was then purified by column chromatography (silica gel, 3 % MeOH / CH_2Cl_2) to afford 333 mg of 4-[(Biphenyl-4-carbonyl)-amino]-5-hydroxy-pentanoic acid methyl ester in 31 % yield. MS (ESI) m/z 328.

[0948] Step D: 4-[(Biphenyl-4-carbonyl)-amino]-5-hydroxy-pentanoic acid
A solution of 4-[(Biphenyl-4-carbonyl)-amino]-5-hydroxy-pentanoic acid methyl ester (333 mg, 1.06 mmol) in THF (10 mL) and MeOH (1.27 mL) was added to 1N NaOH (1.27 mL, 1.27 mmol, 1.2 equiv) at room temperature. The mixture was stirred for 2 hours and TLC indicated the reaction was complete. Solvent was removed and the residue was dissolved in water. After adjusting the pH to 4 with 1N HCl, solid precipitated from the solution. The solid was then collected by filtration, washed with water, and dried under vacuum overnight to afford 240 mg of 4-[(Biphenyl-4-carbonyl)-amino]-5-hydroxy-pentanoic acid in 76.7% yield. MS (ESI) m/z 314.

Scheme 15



Example 26: N-({4'-[(phenylacetyl)amino]-1,1'-biphenyl-4-yl}carbonyl)-L-glutamic acid

[0949] Step A: 2-(4-Bromo-benzoylamino)-pentanedioic acid di-tert-butyl ester
A solution of 4-Bromobenzoic acid (4 g, 19.9 mmol, 1 equiv) in DMF (140 mL) was added to EDCI (5.72 g, 29.8 mmol, 1.5 equiv.) and the mixture was stirred at room temperature for 25 min. Et₃N (6.9 mL, 49.7 mmol, 2.5 equiv) was then added, followed by addition of DMAP (486 mg, 4.0 mmol, 20%). The reaction mixture was allowed to stir at room temperature overnight. Reaction was complete as determined by TLC. DMF was removed by rotavap and the residue partitioned between EtOAc and brine solution. The organic layer was separated, dried over MgSO₄ and concentrated. The crude mixture was purified by column chromatography (silica gel, 20% EtOAc / Hexane) to give 4.2 g of 2-(4-Bromo-benzoylamino)-pentanedioic acid di-tert-butyl ester in 47.7% yield. MS (ESI) *m/z* 441.

[0950] Step B: 2-[(4'-Amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester
4-(4,4,5,5-Tetramethyl-[1,3,2]dioxaborolan-2-yl)-phenylamine (1.34g, 6.104 mmol, 1 equiv.) and 2-(4-Bromo-benzoylamino)-pentanedioic acid di-tert-butyl ester (2.7g, 6.104 mmol, 1 equiv.) were dissolved in DME (120 mL). A solution of K₂CO₃ (1.68 g, 12.21 mmol, 2 equiv.) in 30 mL of water was injected into the mixture, followed by the addition of Pd(PPh₃)₄ (352 mg, 0.31 mmol, 5%). The mixture was heated to reflux overnight. Reaction was complete as determined by TLC. Regular work-up and column chromatography (silica gel, 30-40% EtOAc / n-Hexane) afforded 2.3 g of 2-[(4'-Amino-

biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester in 83 % yield. MS (ESI) m/z 453.

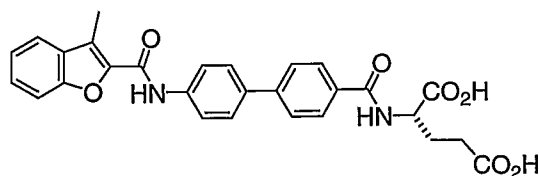
[0951] Step C: Phenylacetyl-amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester

A solution of phenylacetic acid (89 mg, 0.65 mmol, 1 equiv) in DMF (10 mL) was added to EDCI (188 mg, 0.98 mmol, 1.5 equiv.). After stirring for 20 min, 2-[(4'-Amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (297 mg, 0.65 mmol, 1 equiv.) was added, followed by the addition of Et₃N (0.23 mL, 1.64 mmol, 2.5 equiv.) and DMAP (16 mg, 0.13 mmol, 20%). The reaction mixture was allowed to stir at room temperature overnight. Reaction was complete as determined by TLC. DMF was removed and the residue was dissolved in EtOAc. The organic layer was washed with H₂O and brine, and then dried over MgSO₄. After solvent was evaporated, the crude residue was purified by HPLC to give 45 mg of 2-[(4'-Phenylacetyl-amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester in 12 % yield. MS (ESI) m/z 573.

[0952] Step D: N-({4'-[(phenylacetyl)amino]-1,1'-biphenyl-4-yl}carbonyl)-L-glutamic acid

2-[(4'-Phenylacetyl-amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (45 mg) was dissolved in dichloroethane (3 mL) and added to TFA (1 mL). The mixture was stirred at room temperature for 3 hrs. Reaction was complete as determined by TLC. Solvent was removed and the resulting solid was dried under vacuum overnight. N-({4'-[(phenylacetyl)amino]-1,1'-biphenyl-4-yl}carbonyl)-L-glutamic acid was obtained in 84.2% yield (30.3 mg). MS (ESI) m/z 461.

Example 27: N-[(4'-[(3-Methyl-1-benzofuran-2-yl)carbonyl]-amino)-1,1'-biphenyl-4-yl]carbonyl]-L-glutamic acid



[0953] The title compound was prepared according to procedures similar to those described in Example 26.

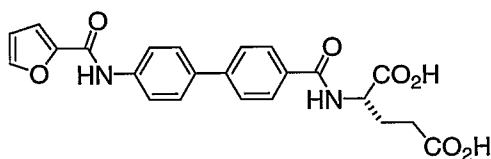
[0954] Step C: 2-({4'-[(3-Methyl-1-benzofuran-2-carbonyl)-amino]-biphenyl-4-carbonyl}-amino)-pentanedioic acid di-tert-butyl ester

EDCI coupling between 3-Methylbenzofuran 2 carboxylic acid (139 mg, 0.79 mmol) and 2-[(4'-Amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (358 mg, 0.79 mmol, 1 equiv.) was carried out according to the procedure in step C of Example 5 to give 2-({4'-[(3-Methyl-benzofuran-2-carbonyl)-amino]-biphenyl-4-carbonyl}-amino)-pentanedioic acid di-tert-butyl ester in 12.4% yield (60 mg). MS (ESI) m/z 611.

[0955] Step D: N-[(4'-{[(3-Methyl-1-benzofuran-2-yl)carbonyl]-amino}-1,1'-biphenyl-4-yl)carbonyl]-L-glutamic acid

Hydrolysis of 2-({4'-[(3-Methyl-benzofuran-2-carbonyl)-amino]-biphenyl-4-carbonyl}-amino)-pentanedioic acid di-tert-butyl ester (60 mg) was carried out according to procedure in step D of Example 5 to give N-[(4'-{[(3-Methyl-1-benzofuran-2-yl)carbonyl]-amino}-1,1'-biphenyl-4-yl)carbonyl]-L-glutamic acid in 59 % yield (28.9 mg). MS (ESI) m/z 499.

Example 28: N-{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid



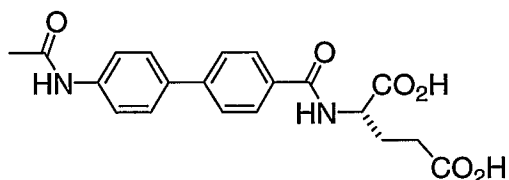
[0956] Step A: 2-({4'-[(Furan-2-carbonyl)-amino]-biphenyl-4-carbonyl}-amino)-pentanedioic acid di-tert-butyl ester

To a solution of 2-[(4'-Amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (350 mg, 0.77 mmol) and 2-Furoic acid (87 mg, 0.77 mmol, 1 equiv.) in DMF (6 mL) was added BOP reagent (409 mg, 0.92 mmol, 1.2 equiv.) and Hunig base (0.16 mL, 0.92 mmol, 1.2 equiv.) under N₂. The mixture was stirred at room temperature overnight. Reaction was complete was determined by LC-MS. The reaction mixture was then poured onto cold water. Solid precipitated from the mixture was collected by filtration. The solid was then dissolved in EtOAc, washed with 1N HCl, saturated NaHCO₃, and brine, and then dried over MgSO₄. After removing the solvent, the solid was dried under vacuum overnight to provide 2-({4'-[(Furan-2-carbonyl)-amino]-biphenyl-4-carbonyl}-amino)-pentanedioic acid di-tert-butyl ester in 87 % yield (369 mg). MS (ESI) m/z 549.

[0957] Step B: N-{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid

2-({4'-[(Furan-2-carbonyl)-amino]-biphenyl-4-carbonyl}-amino)-pentanedioic acid di-tert-butyl ester (369 mg, 0.67 mmol) was dissolved in dichloroethane (10 mL) and added to TFA (5mL) at 0 °C. The cooling bath was removed after the addition was complete. The mixture was stirred at room temperature for 3 hrs. and the reaction was complete as determined by TLC. After removing solvent, the residue was washed 3 times with EtOAc. The solid was then dried under vacuum to give 2-({4'-[(Furan-2-carbonyl)-amino]-biphenyl-4-carbonyl}-amino)-pentanedioic acid in 85.6% yield (251 mg). MS (ESI) m/z 437.

Example 29: N-{{4'-[(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid



[0958] The title compound was prepared according to procedures similar to those described in Example 28.

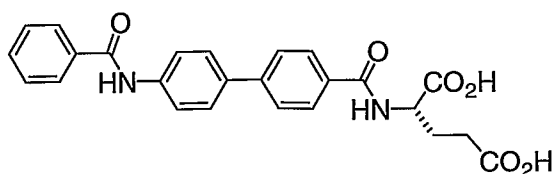
[0959] Step A: 2-[(4'-Acetylamino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester

BOP coupling of 2-[(4'-Amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (350 mg, 0.77 mmol) was carried out according to procedures in step A of Example 6B to give 344 mg of 2-[(4'-Acetylamino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester in 89% yield. MS (ESI) m/z 497.

[0960] Step B: N-{{4'-[(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid

Hydrolysis of 2-[(4'-Acetylamino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (344 mg, 0.69 mmol) was carried out according to procedures in step B for Example 6B to give 212 mg of 2-[(4'-Acetylamino-biphenyl-4-carbonyl)-amino]-pentanedioic acid in 79.7% yield. MS (ESI) m/z 383.

Example 30: N-{{4'-[(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid

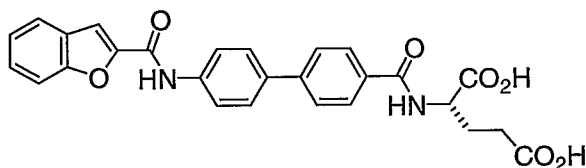


[0961] The title compound was prepared according to procedures similar to those described for Example 6B.

[0962] Step D: N-([4'-(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl)-L-glutamic acid

Hydrolysis of 2-[(4'-Benzoylamino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (191 mg) was carried out according to procedures in step D of Example 6B to give N-([4'-(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl)-L-glutamic acid in 61.6% yield (93.7 mg). MS (ESI) m/z 445.

Example 31: N-([4'-[(1-benzofuran-2-ylcarbonyl)amino]-1,1'-biphenyl-4-yl]carbonyl)-L-glutamic acid



[0963] The title compound was prepared according to the procedures similar to that described for Example 28.

[0964] Step A: 2-([4'-[(Benzofuran-2-carbonyl)-amino]-biphenyl-4-carbonyl]-amino)-pentanedioic acid di-tert-butyl ester

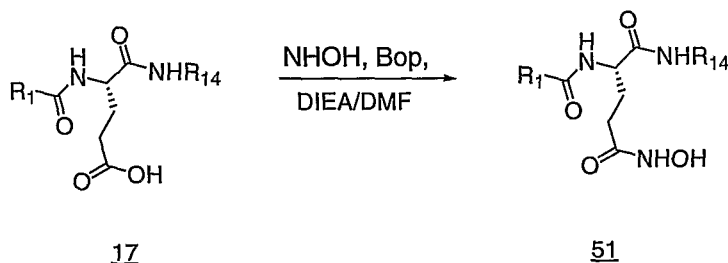
BOP coupling of 2-[(4'-Amino-biphenyl-4-carbonyl)-amino]-pentanedioic acid di-tert-butyl ester (349 mg, 0.77 mmol) with 2-Benzofuran carboxylic acid (124 mg, 0.77 mmol, 1 equiv.) was carried out according to procedures in step A of Example 6B to give 185 mg of 2-([4'-[(Benzofuran-2-carbonyl)-amino]-biphenyl-4-carbonyl]-amino)-pentanedioic acid di-tert-butyl ester in 40% yield. MS (ESI) m/z 597.

[0965] Step B: N-([4'-[(1-benzofuran-2-ylcarbonyl)amino]-1,1'-biphenyl-4-yl]carbonyl)-L-glutamic acid

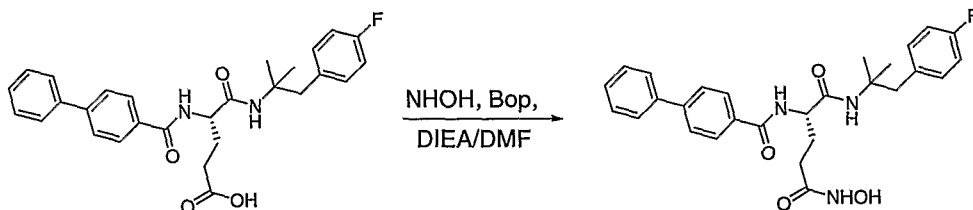
Hydrolysis of 2-([4'-[(Benzofuran-2-carbonyl)-amino]-biphenyl-4-carbonyl]-amino)-pentanedioic acid di-tert-butyl ester (185 mg, 0.31 mmol) was carried out according to procedures in step B of Example 6B to give N-([4'-[(1-benzofuran-2-ylcarbonyl)amino]-

1,1'-biphenyl-4-yl}carbonyl)-L-glutamic acid in 82.5 % yield (124 mg). MS (ESI) m/z 485.

Scheme 16



Example 32: N²-(biphenyl-4-ylcarbonyl)-N¹-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N⁵-hydroxy-L-glutamamide



[0966] To a solution of the starting carboxylic acid (0.476 g, 1 mmol) in DMF (4 mL) under nitrogen is added BOP reagent (0.442 g, 1 mmol), followed by addition of hydroxylamine hydrochloride (0.076 g, 1.1 mmol), and DIEA (0.38 mL, 2.2 mmol). The reaction mixture was stirred for 24 hrs at room temperature. The mixture was then added slowly to 50 mL of water. The resulting white solid was collected, washed several times with water and dried under vacuum to give 350 mg of N²-(biphenyl-4-ylcarbonyl)-N¹-[2-(4-fluorophenyl)-1,1-dimethylethyl]-N⁵-hydroxy-L-glutamamide.

Example 33:

[0967] The following compounds were prepared according to procedures similar to those described in Example 32.

Example 33A: N²-(1,1'-biphenyl-4-ylcarbonyl)-N⁵-hydroxy-N¹-(3,4,5-trimethoxybenzyl)-L-glutamamide

[0968] MS (ESI) m/z 522.2; HRMS: calcd for $C_{28}H_{31}N_3O_7 + H^+$, 522.22348; found (ESI_FTMS, $[M+H]^+$), 522.22365.

Example 33B: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)- N^5 -hydroxy-L-glutamamide

[0969] MS (ESI) m/z 460.2; MS (ESI) m/z 919.4; HRMS: calcd for $C_{27}H_{29}N_3O_4 + H^+$, 460.22308; found (ESI_FTMS, $[M+H]^+$), 460.22328.

Example 33C: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy- N^1 -[2-(3-methoxyphenyl)ethyl]-L-glutamamide

[0970] MS (ESI) m/z 476.2; MS (ESI) m/z 951.4; HRMS: calcd for $C_{27}H_{29}N_3O_5 + H^+$, 476.21800; found (ESI_FTMS, $[M+H]^+$), 476.21792.

Example 33D: N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy- N^1 -[3-(trifluoromethoxy)benzyl]-L-glutamamide

[0971] MS (ESI) m/z 516.2; MS (ESI) m/z 1031.4; HRMS: calcd for $C_{26}H_{24}F_3N_3O_5 + H^+$, 516.17408; found (ESI_FTMS, $[M+H]^+$), 516.17389.

Example 34: *In vitro* fluorescence screen for Aggrecanase-1 inhibitors

Materials and Methods

[0972] This assay is a preliminary screen of potential aggrecanase-1 inhibitors at 11 concentrations to determine their ability to inhibit cleavage of a fluorescent peptide (Abz-TEGEARGSVI-Dap(Dnp)-KK). A GeminiXS fluorimeter (Molecular Devices) was turned on and the temperature was set to 30 °C, ~ 30 min before setting up the assay. The following buffers were used: 50 mM HEPES, pH 7.5; 100 mM NaCl; 5 mM $CaCl_2$; 0.1 % CHAPS; and 5% glycerol. The source of enzyme in the assay was purified recombinant human Aggrecanase-1 (rAgg1), used at 5 μ g/ml (final concentration in the assay). The substrate used in the assay was the peptide (AnaSpec, MWT= 1645.8, stored at 4° C). A stock solution of peptide was prepared at 2 mg/ml in 100 % DMSO. The absorbance at 354 nm ($\epsilon=18172 \text{ M}^{-1}\text{cm}^{-1}$) was measured to determine the exact concentration of the stock solution. The stock solution was then diluted to 62.5 μ M in buffer. The unused 100 % DMSO stock was stored at -80° C. The final concentration of

the substrate in the assay was 25 μ M. Inhibitor solutions were prepared in 100 % DMSO with a 10X starting concentration, and serial dilutions were performed (in duplicate) across the dilution plate in 100 % DMSO.

[0973] The assay was performed as follows: 96-well plates were set up so that the final column of wells was used for controls. The total reaction volume of each well was 100 μ l. Each compound was assayed in duplicate. Buffer was added to the entire 96-well plate (30 μ l/well). rAgg1 was diluted to 25 μ g/ml buffer just prior to addition on the plate, and added to the wells at 20 μ l/well. 10 μ l/ well of 10x inhibitors was added to the appropriate wells from the working plate, except for the control wells, to which are added 10 μ l/ well of a 10X reference control compound or 100% DMSO. The mixtures were incubated for 10-15 min at 30° C. 40 μ l/well of 62.5 μ M peptide substrate was then added to the appropriate wells.

Results

[0974] The reaction was monitored for 30-40 min at 30°C., with $\lambda_{\text{ex}} = 340$ nm and $\lambda_{\text{em}} = 420$ nm. The fluorescence was linear during this time and the slope of the line ($V_{\text{max}}/\text{sec}$) represents the initial reaction rate, v . The maximal rate of cleavage of substrate was determined in the absence of inhibitor. The percent inhibition of activity in the presence of inhibitor was calculated as follows: % inhibition = $(1 - v(\text{Rate, RFU/sec})/\text{Maximal Rate(RFU/sec)}) \times 100$. The IC_{50} was obtained by fitting the initial rate, v , or % inhibition at each concentration of inhibitor to the following equation: $y = (a - d)/(1 + C/IC_{50})^n + d$. The assay results are shown in Tables 1, 2, and 3 below.

[0975] This model describes a sigmoidal curve with an adjustable baseline, a. y is the % inhibition or initial rate of reaction, C is the concentration of inhibitor under test. A is the limiting response as C approaches zero. As C increases without bound, y tends toward its lower limit, d . y is halfway between the lower and upper asymptotes when $C = IC_{50}$. n is the Hill coefficient. The sign of n is positive when the response increases with increasing dose and is negative when the response decreases with increasing dose (inhibition). (See, Knight, C.G. *Methods Enzymol.* 1995, 248, 18-34; Knight, C.G. et al., *FEBS Lett.* 1992, 296, 263-266; Jin, G. et al., *Anal. Biochem.* 2002, 302, 269-275).

Example 35: *In vitro* fluorescence screen for Aggrecanase-2 inhibitors*Materials and Methods*

[0976] A continuous assay was used in which the substrate is a synthetic peptide containing a fluorescent group that is quenched by energy transfer. Cleavage of the peptide by the enzyme results in a large increase in fluorescence. The initial rates of this reaction were compared to the initial rates of reactions containing inhibitors in order to assess the potency of small molecules. The source of enzyme in the assay was purified recombinant human Aggrecanase-2 prepared at Wyeth Research (Biological Chemistry, Cambridge). More specifically, the form used is denoted as Ag2t-Phe₆₂₈-Strep (MW = 41,737). This form is truncated relative to the full-length enzyme and contains an affinity tag. Aliquots of this enzyme were stored at 80°C in 25mM Tris (pH 8.0), 100mM NaCl, 5mM CaCl₂, 10μM ZnCl₂, 10% glycerol. The substrate in the assay was a synthetic peptide that is designed after a portion of brevican, one of the naturally occurring substrates of Aggrecanase-2. This peptide contains the fluorescent group 2-aminobenzoyl (Abz) that is quenched by energy transfer to a 2,4-dinitrophenyl group (Dnp). The peptide (mass = 1740) is >95% pure based on HPLC analysis and has the sequence: Abz TESESRGAIY-Dap(Dnp)-KK-NH₂. Stock solutions of the substrate were prepared with MilliQ water and aliquots were stored at 80°C. The concentration of this substrate stock was spectrophotometrically determined using the extinction coefficient at 354nm of 18,172 M⁻¹ cm⁻¹. The $V_{\max}$ and K_m for this enzyme/substrate reaction were determined to be insensitive to DMSO up to at least 10% (v/v). The assay buffer (pH 7.4) consisted of 50mM Hepes, 100mM NaCl, 5mM CaCl₂, 0.1% CHAPS, 5% glycerol.

[0977] Each well of the 96-well or 384-well plates contained a reaction consisting of assay buffer, purified Agg-2 (diluted with assay buffer), and varied concentrations of inhibitor (prepared by serial dilution in DMSO in 96-well polypropylene plates). The plates were then incubated at room temperature for 10 minutes. The enzymatic reactions were initiated by adding substrate to a final concentration of 25μM and mixed by pipetting up and down. The initial rates of the cleavage reactions were determined at room temperature with a fluorescence plate reader immediately after substrate addition. The Agg-2 assays were run on a Tecan Safire with the following wavelength settings: excitation – 316nm, 12nm bandwidth; emission – 432nm, 12nm bandwidth.

Results

[0978] A plot of time *vs.* RFU, representing the progress curve of the reaction, was generated. The slope for the portion of the progress curve that is most linear was determined. This slope (RFU/min) is the initial rate of the reaction. Plots of the inhibitor concentration *vs.* the initial cleavage rate were fit to the following equation: $y = V_{\max} * (1 - (x^n / (K^n + x^n)))$, whereby x = inhibitor concentration, y = initial rate, $V_{\max}$ = initial rate in the absence of inhibitor, n = slope factor, and $K = IC_{50}$ for the inhibition curve. The assay results are shown in Tables 1, 2, and 3 below.

Example 36: *In vitro* fluorescence assay of MMP-13 activity

Materials and Methods

[0979] A continuous assay was used in which the substrate is a synthetic peptide containing a fluorescent group (7-methoxycoumarin; Mca), which is quenched by energy transfer to a 2,4-dinitrophenyl group. When the peptide was cleaved by MMP, a large increase in fluorescence was observed. The source of enzyme in the assay was the recombinant human catalytic domain of MMP-13 (165 amino acids, residues 104-268, 19kDa) prepared at Wyeth-Research in Cambridge. The substrate used was the peptide Mca-PQGL-(3-[2,4-dinitrophenyl]-L-2,3-diaminopropionyl)-AR-OH. The assay buffer consisted of 50mM Hepes (pH 7.4), 100mM NaCl, 5mM CaCl₂, and 0.005% Brij-35. Each well of the 96-well plates contained a 200μL reaction mixture consisting of assay buffer, purified MMP (final concentration of 0.5nM, prepared by diluting with the assay buffer), and varied concentrations of inhibitor (prepared by serially diluting a given inhibitor in DMSO in 96-well polypropylene plate). The plates were then incubated at 30°C for 15 minutes. The enzymatic reactions were initiated by adding the substrate to a final concentration of 20μM, and mixing 10 times with a pipette. The final DMSO concentration in the assay was 6.0%. The initial rate of the cleavage reaction was determined at 30°C temperature with a fluorescence plate reader (excitation filter of 330nm and emission filter of 395nm) immediately after substrate addition.

Results

[0980] Plots of the inhibitor concentration *vs.* the percent inhibition were fit to the following equation: $y = (a-d)/[1+(x/c)^b]+d$, a general sigmoidal curve with Hill slope, a to

d. x is the inhibitor concentration under test. y is the percent inhibition. a is the limiting response as x approaches zero. As x increases without bound, y tends toward its limit d . c is the inflection point (IC_{50}) for the curve. That is, y is halfway between the lower and upper asymptotes when $x=c$. b is the slope factor or Hill coefficient. (See, Knight, C.G. et al., *FEBS Lett.* 1992, 296, 263-266). The assay results are shown in Tables 1, 2, and 3 below.

Example 37: *In vitro* fluorescence assay of MMP-14 activity

Materials and Materials

[0981] A continuous assay was used in which the substrate is a synthetic peptide containing a fluorescent group (7-methoxycoumarin; Mca), which is quenched by energy transfer to a 2,4-dinitrophenyl group. When the peptide was cleaved by MMP, a large increase in fluorescence was observed. The source of enzyme in the assay was the recombinant human catalytic domain of MMP-14 (177 amino acids corresponding to Tyr89-Gly265 of mature human enzyme; 20 kDa; Chemicon International, Inc. (catalog number CC1041)). The substrate used was the peptide Mca-PQGL-(3-[2,4-dinitrophenyl]-L-2,3-diaminopropionyl)-AR-OH. The assay buffer consisted of 50mM Hepes (pH 7.4), 100mM NaCl, 5mM $CaCl_2$, and 0.005% Brij-35. Each well of the 96-well plates contained a 200 μ L reaction mixture consisting of assay buffer, MMP (final concentration of 25ng/ml, prepared by diluting with the assay buffer), and varied concentrations of inhibitor (prepared by serially diluting a given inhibitor in DMSO in 96-well polypropylene plate). The plates were then incubated at 30°C for 15 minutes. The enzymatic reactions were initiated by adding the substrate to a final concentration of 20 μ M, and mixing 10 times with a pipette. The final DMSO concentration in the assay was 6.0%. The initial rate of the cleavage reaction was determined at 30°C temperature with a fluorescence plate reader (excitation filter of 330nm and emission filter of 395nm) immediately after substrate addition.

Results

[0982] Plots of the inhibitor concentration vs. the percent inhibition were fit to the following equation: $y = (a-d)/[1+(x/c)^b]+d$, a general sigmoidal curve with Hill slope, a to d . x is the inhibitor concentration under test. y is the percent inhibition. a is the limiting

response as x approaches zero. As x increases without bound, y tends toward its limit d . c is the inflection point (IC_{50}) for the curve. That is, y is halfway between the lower and upper asymptotes when $x=c$. b is the slope factor or Hill coefficient. (See, Knight, C.G. et al., *FEBS Lett.* 1992, 296, 263-266). The assay results are shown in Tables 1, 2, and 3 below.

Example 38: *In vitro* fluorescence assay of MMP-2 activity

Materials and Methods

[0983] A continuous assay was used in which the substrate is a synthetic peptide containing a fluorescent group (7-methoxycoumarin; Mca), which is quenched by energy transfer to a 2,4-dinitrophenyl group. When the peptide was cleaved by MMP, a large increase in fluorescence was observed. The source of enzyme in the assay was the recombinant human MMP-2 (66 kDa; Oncogene Research Products (catalog number PF023 from Calbiochem)). The substrate used was the peptide Mca-PQGL-(3-[2,4-dinitrophenyl]-L-2,3-diaminopropionyl)-AR-OH. The assay buffer consisted of 50mM Hepes (pH 7.4), 100mM NaCl, 5mM $CaCl_2$, and 0.005% Brij-35. Each well of the 96-well plates contained a 200 μ L reaction mixture consisting of assay buffer, MMP (final concentration of 25ng/ml, prepared by diluting with the assay buffer), and varied concentrations of inhibitor (prepared by serially diluting a given inhibitor in DMSO in 96-well polypropylene plate). The plates were then incubated at 30°C for 15 minutes. The enzymatic reactions were initiated by adding the substrate to a final concentration of 20 μ M, and mixing 10 times with a pipette. The final DMSO concentration in the assay was 6.0%. The initial rate of the cleavage reaction was determined at 30°C temperature with a fluorescence plate reader (excitation filter of 330nm and emission filter of 395nm) immediately after substrate addition.

Results

[0984] Plots of the inhibitor concentration vs. the percent inhibition were fit to the following equation: $y = (a-d)/[1+(x/c)^b] + d$, a general sigmoidal curve with Hill slope, a to d . x is the inhibitor concentration under test. y is the percent inhibition. a is the limiting response as x approaches zero. As x increases without bound, y tends toward its limit d . c is the inflection point (IC_{50}) for the curve. That is, y is halfway between the lower and

upper asymptotes when $x=c$. b is the slope factor or Hill coefficient. (See, Knight, C.G. et al., *FEBS Lett.* 1992, 296, 263-266). The assay results are shown in Tables 1, 2, and 3 below.

Example 39: *In vitro* articular cartilage model for the inhibition of degradation of proteoglycan by small molecule compounds: Bovine articular cartilage explant cultures

[0985] This *in vitro* procedure was used to evaluate the effect and relative potencies of small molecule compounds to inhibit the degradation of proteoglycan in articular cartilage treated with Interleukin 1 alpha (IL-1 α). Treatment of articular cartilage with IL 1 α induces expression of a cascade of enzymes that initiates cartilage matrix degradation. This assay was utilized to select small molecule compounds that inhibit the enzyme activity and protects cartilage matrix degradation.

Materials and Methods

[0986] Articular cartilage: bovine metacarpal joints were disinfected with 10% Wescodyne followed by 70% ethanol. 6mm articular cartilage discs were prepared and rinsed once in PBS and medium, respectively. The discs were cultured in a stirring flask with serum-free medium for 5 days for equilibrium with one medium change. Small molecule compounds: stock solutions of test small molecule compounds (usually at 5mg/ml) were prepared in DMSO. Working solutions were diluted with DMSO and generally ranged from 0.1 μ g/ml to 10 μ g/ml. The DMSO stocks were stored at 20°C. Articular cartilage explant culture medium: DMEM, 2mM glutamax, 100 U/ml of antibiotic and antimycotic, 50 μ g/ml ascorbate and 10mM Hepes (pH-7.0). Proteoglycan content-Dimethyl methylene blue (DMMB) solution: 1L-16mg DMMB, 10ml 100% ethanol, 29.5ml of 1M NaOH, 3.5 ml of 98% formic acid and water to 1L. Chondroitin sulphate sodium salt: 1.56-200 μ g/ml serial dilutions.

[0987] For the explant culture, cartilage discs were cultured in serum-free medium for 48h or more. Discs were weighed and transferred to a 96-well plate, 1 disc per-well. 0.2ml of medium containing 5ng/ml of IL-1 and different concentrations of compounds were added to each well, with 3 wells allocated for each treatment. The medium was collected at days 1, 2, & 3 and replaced accordingly.

[0988] For the DMMB assay, conditioned medium (CM) samples were diluted with medium. 10ul of each standard or diluted sample was added in duplicate into a 96-well-plate and 200μl of DMMB solution was added into each well. Absorbance at 520nm was measured for each well. Proteoglycan contents in CM were calculated daily.

Results

[0989] The proteoglycan contents are expressed as ug per mg of cartilage. The inhibitory effect of the compounds is expressed as percentage. (See, Tortorella, M.D. et al., *Science* 1999, 284, 1664-1666). The assay results are shown in Tables 1, 2, and 3 below.

TABLE 1

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1	bovine	bovine
8SSSS	>200,000								
7	150		1,800	~ 13,000	3,000	~13,000	>100,000	61	28
8C	110		1,200	~50,000	6,000	~25,000	>100,000	68	34
8B	460		1,900	~50,000	5,600	~25,000	>100,000	54	22
8A	150		900	~40,000	4,400	~25,000	>100,000	75	29
11	110		~ 800	~ 5,000	~ 1,000	~ 2,000	~ 2,000	78	52
12A	700		~ 5,000	~ 6,000	~ 2,000	~ 2,000	~ 2,000	41	18
12B	35000								
8D	220		2,800	~25,000	4,400	17,000	>100,000	67	27
8E	90		746	~25,000	3,700	~25,000	> 200,000	79	34
8NNNNNN	~40,000								
13B	~50,000								
8F	30	12	304	~22,000	5,630	~25,000	> 200,000	81	56
17VV	7900								
13A	1500		~67,000	>100,000	~67,000	> 100,000	>100,000	37	18
13C	9600								
13D	750		~26,000	>200,000	>200,000	>100,000	>100,000	51	25
13E	~ 25,000								
13F	~ 200								
8G	80		614	~50,000	~50,000	~25,000	>100,000	76	39
8OOOOOO	670								
8H	200		266	~50,000	3,310	~25,000	>100,000	85	67
8I	500								
12E	1800								
12C	25000								
12D	> 100,000								
8K	300								

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1	bovine	bovine
8L	55		189	~50,000	10,500	21,500	> 100,000	87	79
8J	360								
8M	120		856	~50,000	8,000	13,000	> 100,000	85	17
8N	290								
8O	75	82	1,300	31,400	5,000	~ 22,000	no inh	69	34
8P	290								
8Q	11	31	400	37,300	6,100	~ 22,000	no inh	66	24
8R	16	5	50	42,400	10,400	~ 22,000	no inh	86	78
8S	150	245	1,300	> 200,000	3,130	~25,000	no inh	51	40
8T	300							51	20
8U	200							63	26
8V	160		1,100	~ 67,000	3,430	~ 30,000	> 100,000	73	45
8W	75		971	~ 22,000	~ 2,500	~25,000	no inh		
8X	100		1,100	~ 67,000	7,000	~ 25,000	no inh		
8Y	50		520	~ 67,000	5,534	~ 25,000	no inh		
8Z	80		680	~ 67,000	3,820	~ 25,000	no inh		
8BB	74		650	19,000	2,300	~ 25,000	no inh		
8AA	370								
33D	< 10		13.4	52	3.3	73.6	~ 1,560		
33C	< 10		25	29	4.5	110	1,500		
Control (33A)	<10		2.6	32	4.7	112	1,750		
8CC	22	19	121	~ 22,000	5,655	~ 25,000	no inh	94	71
13G	~2500								
8DD	94		930	~ 22,000	4,580	16,200	no inh	89	50
14	60% @ 16,700								
15A	> 22,000								
15B	67 % @ 7,500								
15C	50 % @ 7,500								
15D	86% @ 7,500								
15E	3500								
33B	< 30								
8PPPPPP	>33,000								
23	> 6000								
24A	1100								
24B	~2200								
24C	~300								
20	~ 22,000								
21A	2500-7500								
21B	~ 6700								

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1	bovine	bovine
21C	no inh								
21D	no inh								
22C	> 50,000								
8FFF	200		1000						
8GGG, step D	100							57	12
8AAAA	100								
8DDDD	110								
8HHHH	200								
8XX	300								
8FF	26	28						86	50
17WW	no inh								
17XX	no inh								
17YY	2000								
17ZZ	200								
17AAA	no inh								
8YY	530		4500						
8ZZ	210								
8AAA	48	44						83	55
8EE	200								
15F	600								
15G	2200								
15H	200								
6A	150		740	>50,000	29800	> 200,000	> 50,000		
8HH	160								
8II	44	39						75	40
8QQQQQQ	690								
17BBB	900								
8III	120								
8NNN	100	219	1750	14,000	> 10,000	>50,000	> 50,000	60	0
8JJJ	54	54	300	30,000	>20,000	>200,000	>200,000	74	26
8JJ	45	33	1100	17,000	27,000	>200,000	>200,000	70	17
10M	43	54	1100	~20,000	>20,000	>200,000	>50,000	67	35
10N	19	28	970	>50,000	7600	>200,000	>200,000	65	24
8OO	<30	6	44	>50,000	>20,000	>200,000	>200,000	87	40
22A	1000								
22B	200								
8KK	180								
8LL	55		990	24,000	50,000	200,000	200,000	40	0
10R	77	187	1900	>20,000	>20,000	>200,000	>50,000	41	0
8BBB	32	130	700	>50,000		no inh	> 200,000	35	0
8CCC	100							74	26
8ZZZ	100		1600	no inh	13,000	> 200,000	>50,000	72	34
8KKK	120		2000						

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1	bovine	bovine
10C	240		>5000						
10E	370								
10F	130		>30000						
10D	480		3200						
10G	1000		4400						
8BBBB	100							40	0
8OOO	280		1000						
8LLL	230								
8PPP	130								
8QQQ	330								
8EEE	7900								
8MM	58	126	980						
9	200								
10A	840		2100						
10J	260								
10K	380		>100000						
10L	130		2000						
10B	150								
8MMM	40		500						
8RRR	82		680						
10H	300								
8SSS	64		470	>50,000	10300				
10O	470								
8UUU	61	60	660	~50,000	8900	>200,000	no inh		
10P	700								
10Q	98		3000	~50,000		>50,000	no inh		
8PP	<30	10	85	~50,000	6000	>66,600	> 200,000		
8NN	<30	14	133	~50,000	9000	no inh	>200,000		
8VVV	30	38	420	~50,000	5600	>66,600	no inh		
8TTT	>10000								
6C	150								
8DDD	300								
6B	300								
8SS	100		800	~50,000	12400	>66,600	no inh		
8TT	300								
8UU	200								
8WW	70		350	~50,000	13300	> 66,600	no inh		
8VV	100		1900	~50,000	9100	> 66,600	no inh		
8XXX	30		930	~50,000	7900	> 200,000	no inh		
8WWW	36		840	~200,000	7400	> 200,000	no inh		
8YYY	100		1600	> 50,000	9400	> 200,000	no inh		
8GGGG	30		160	>50,000	18600	no inh	no inh		

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1	bovine	bovine
8FFFF	3600								
10I	320								
8RRRRRR	3600								
8KKKK	<30	4							
8LLLL	no inh								
8MMMM	47	57							
8III	<30	9							
8JJJJ	>50000								
8NNNN	3400								
8OOOO	52	60							
8PPPP	>50000								
8QQQQ	9600								
8RRRR	122								
8SSSSSS	146								
8TTTTTT	17300								
1	900								
2	111								
3	12700								
4	1100								
5	1800								
8EEEE, step D	400								
8UUUUUU	4000								
26	5000								
27	400								
28	400								
29	3000								
30	500								
31	1000								
6D	45								
6E	56								
8VVVVVV	46								

Table 2

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1
8TTTT	> 17,000		> 22,000				
8UUUU	> 17,000		~ 67,000				
8VVVV	> 17000		> 67,000				
8WWWW	8300		> 67,000				
8XXXX	> 50,000		>200,000				
8YYYY	1500		>200,000				
8ZZZZ	> 17000		> 22,000				
8AAAAA	372		410				
8BBBBB	> 17000		20900				
8CCCCC	107		11000				
8DDDDD	315		1100				
8EEEE	> 50000		>200,000				
8FFFFF	92		710	>100,000			
8GGGGG	> 50,000						
8HHHHH	357						
8IIII	813		1900				
8JJJJ	191		1100				
8KKKKK	> 50,000		> 22,000				
8LLLLL	> 17,000		>200,000				
8MMMMM	20000		~ 22,000				
8NNNNN	1200		1,893 +/- 76				
8OOOOO	> 50,000		> 200,000				
8PPPPP	157		2967				
8QQQQQ	108		1165				
8RRRRR	129		2905				
8SSSSS	208		2470				
8TTTTT	389		2011				
8UUUUU	317		2119				
8VVVVV	221		1558				
8WWWWW	> 17,000		> 67,000				
8XXXXX	246		1450				
8YYYYY	87		2800	~ 20,000			
8ZZZZZ	<30		63	>100,000			
16	< 30 nM		467				
17A	116		1123				
17B	204		1020				
18D	4400		> 22,000				
17C	< 30 nM		80				
17D	> 17,000		>				

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1
	nM		200,000				
17E	251		1040				
12F	~ 3,000 nM		3,000 - 8,000				
17F	1700		~ 8,300				
17G	1600		3,000 - 8,000				
17H	1000		~ 22,000				
8AAAAAA	534		1759	-			
17I	< 30		217 +/- 8	~100,000			
17J	~5,600		~ 30,000	-			
17K	1200		~ 3,700	-			
17L	133		226	-			
18E	2200		> 11,000	-			
17M	~ 310		> 11,000	-			
17N	40		42	11,200 +/- 1,200			
8MMMMMM	550		5100	-			
8BBBBBB	470		2671	-			
18F	> 67,000		> 67,000	-			
17O	8500		~ 22,000	-			
17P	126		58	-			
17Q	~ 13,000		> 30,000	-			
17R	73		142	6,000 +/- 400			
18	49		50	~ 1,600 nM			
19A	930		1020				
19B	3200		590				
8CCCCCC	2400		> 22000				
17S	4600		10100				
17T	3200		7200				
17U	1800		~ 6700				
19C	140 +/- 20		75				
17V	90		1800				
17W	> 25,000		~ 67000				
17X	2000		~ 22000				
8DDDDDD	2400		> 22000				
17Y	<30		156				
19D	210		223				
19E	49		1120				
17Z	170		3140				
17AA	3500		5700				

Example	Agg1 IC ₅₀ (nM)	K _i (nM)	Agg 2 IC ₅₀ (nM)	MMP-13	MMP-2	MMP-14	MMP-1
17BB	3600		2900				
17CC	2900		2970				
17DD	<30nM		1190				
17EE	<30nM		194				
17FF	690		13900				
17GG	34		113				
17HH	2200		6320				
17II	~ 1000-3000		~ 10,000				
17JJ	2400		19454				
15I	430		1593				
15J	510		~ 3,125				
12G	> 25000		11700				
12H	1200		1635				
12I	> 25000		> 20,000				
17KK	> 25000		> 67,000				
19F	68		163				
17LL	87		1193				
17MM	46		2707				
19G	270		146				
19H	69		158				
18G	~ 8300						
17NN	200		729				
8EEEEEE	5000						
17OO	<30		1677				
8FFFFFFF	3900		18131				
8GGGGGGG	4200						
8HHHHHHH	38		46				
8IIIIII	2900		11908				
8JJJJJJ	300		943				
8KKKKKKK	350		1674				
17QQ	> 25,000		~22000				
12J	~ 8,000		~22000				
12K	~ 25,000		>22000				
12L	~ 22,000		>22000				
17RR	<30		26				
17SS	450		3959				
17TT	120		173				
8LLLLLL	>25000		>100000				
15Y	220		841				
15Z	1400		6036				
15AA	44		327				
15BB	53		527				
17UU	<30		39				

Table 3

Example	Agg1 IC ₅₀ (nM)	K _i Agg1 (nM)	Agg 2 IC ₅₀ (nM)	K _i Agg2 (nM)	MMP -13	MMP- 2	MMP -14	MMP- 8	MMP- 12
8WWWWWW	<03	7.1	50	72		2600		1000	5800
8XXXXXX	<30	<3	20	60		7500		4100	1600
8YYYYYY	<30	13.5	30	160		4700		737	365
8ZZZZZZ	<30		120						
8AAAAAAA	80		550						
8BBBBBBB	110		1000						
8CCCCCCC	50		680						
8DDDDDDD	<30		220						
8EEEEEEE	37		510						
8FFFFFFF	200		4200						
8GGGGGGG	60		160						
8HHHHHHH	50		180						
8IIIIII	<30		42						
8JJJJJJ	<30		53						
8KKKKKKK	<30		<30						
8LLLLLLL	228		3380						
8MMMMMMM	198		614						
8NNNNNNN	<30	<3	<30	37		2150		1210	680
8OOOOOOO	<30		100-400						
8PPPPPPP	3116		48% 16700						
8QQQQQQQ	NT		NT						
8RRRRRRR	70-210		48% 1200						
8SSSSSSS	57	22	230	356					
8TTTTTTT	707		20% 11000						
8UUUUUUU	<30	<3	60	60		5180		2030	410
8VVVVVVV	<30	7	51% 140	305		570		410	770
8WWWWWWW	<30	<3	50	42		1080		370	630
8XXXXXXXX	<30	4.5	20-70	56					
8YYYYYYY	<30	27	200-600	197					
8ZZZZZZZ	<30	12.7	200-600	290					
8AAAAAAA	<30	86	600-1800	1147					
8BBBBBBB	300		200-600						
8CCCCCCC	140		5200						
8DDDDDDD	50		1000						
8EEEEEEE	<30	3.8	60-200	79					
8FFFFFFF	<30		200						
8GGGGGGG	40		3400						
8HHHHHHH	60		3000						
8IIIIII	65% 200		90-270						
8JJJJJJ	<30		800-2500						
8KKKKKKK	70		270-800						
8LLLLLLL	<30	<3	60-200	156					
8MMMMMMM	<30	<3	60-200	38					
8NNNNNNN	<30	<3	70-200	151					
8OOOOOOO	<30		200-600						

Example	Agg1 IC ₅₀ (nM)	K _i Agg1 (nM)	Agg 2 IC ₅₀ (nM)	K _i Agg2 (nM)	MMP -13	MMP- 2	MMP -14	MMP- 8	MMP- 12
8PPPPPPPP	<30		200-600						
8QQQQQQQQ	<30		3300						
8RRRRRRRR	57% 70		7200						
8SSSSSSSS	<30	5.4	70-200	51					
8TTTTTTTT	20-70	37.6	100-300	359					
8UUUUUUUU	100		700						
8VVVVVVVV	60% 16700		50% 50000						
8WWWWWWW	20-70	40.6	100-300	526					
8XXXXXXXX	100		1700						
8YYYYYYYY	<30	6.2	100-300	143					
8ZZZZZZZZ	20-70		9900						
8AAAAAAAAA	<30	6.7	98	45					
8BBBBBBBB	<30	11.5	100-300	681					
8CCCCCCCC	<30		900						
8DDDDDDDD	2400		50% 7400						
8EEEEEEEE	1200		50% 2500						
8FFFFFFFF	270		62% 25000						
8GGGGGGGG	30% 8300		28% 25000						
8HHHHHHHH	<30		500						
8IIIIIII	300-900		5% 2500						
8JJJJJJJ	25% 25000		10% 25000						
8KKKKKKKK	16% 25000		10% 25000						
8LLLLLLLL	<30		>300						
8MMMMMMMM	<30	<3	30-100	87					
8NNNNNNNN	<30	8.3	30-100	69					
8OOOOOOOO	<30	2.7	~30	66		718		349	372
8PPPPPPPP	<30	11.5	30-300	126		7240		2550	2890
8QQQQQQQQ	>900		>8300						
8RRRRRRRR	>8300		100000						
8SSSSSSSS	<30	8.8	200	157					
8TTTTTTTT	<30	6.7	59	54					
8UUUUUUUU	<30	6.9	83	75					
8VVVVVVVV	<30	4.5	77	81					
8WWWWWWW	>25000		>100000						
8XXXXXXXXX	<30	18.2	25	71.6		2610		1790	597
8YYYYYYYY	<30	39.6	250	349		25500		13200	3710
8ZZZZZZZZ	<30	4.7	30-90	123		8280		2440	2860
8AAAAAAAAA	<30	28.9	100-300	204		6970		2230	2240
8BBBBBBBB	22000		>200000						
8CCCCCCCC	1040		7400						
8DDDDDDDD	<30	27.2	90	218		4000		763	628
8EEEEEEEE	<30	23.2	80	180		6400		2500	1070
8FFFFFFFFF	>400		>2700						
8GGGGGGGG	<30	42	>300	723		1300		>5000	>10,000
8HHHHHHHH	<30	11.7	>100	405		8000		3400	>10,000

Example	Agg1 IC ₅₀ (nM)	K _i Agg1 (nM)	Agg 2 IC ₅₀ (nM)	K _i Agg2 (nM)	MMP -13	MMP- 2	MMP -14	MMP- 8	MMP- 12
									00
8IIIIIIII									
15O	52		3132						
15P	<30		255						
15K	<30		379						
15L	47		413						
15M	<30		789						
15N	91		103						
15U	53% 100		600						
15V	47% 40		700						
15Q	158		1939						
15R	560		48% 11000						
15S	30% 1850		41% 33000						
15U	53% 1000		30% 11000						
15W	56% 1900		59% 11000						
15X	46% 1900		52% 11000						

Example 40: Aggrecanase inhibitors in human osteoarthritic cartilage explant studies and effect on Aggrecan metabolism in human osteoarthritic cartilage

[0990] The loss of cartilage matrix in osteoarthritis (OA) is associated with increased loss of type II collagen by collagenases and aggrecan loss by aggrecanases. Depletion of aggrecan is one of the earliest changes observed in osteoarthritis (Lohmander, LS et al., *Arthritis & Rheum* 1993, 36,1214-1222). Aggrecan is a chondroitin sulfate and keratan sulfate-bearing proteoglycan. Aggrecanase 1 and Aggrecanase 2 cleave aggrecan within the interglobular domain at the aggrecanase site between residues Glu³⁷³ and Ala³⁷⁴ (Sandy, JD et al., *J Clin Invest.* 1992, 89, 1512-1516). Aggrecan cleavage by aggrecanase results in the release of a large sulfated glycosaminoglycan (sGAG)-containing aggrecan fragments which diffuse out of the cartilage matrix. Neoepitope antibodies have been generated to recognize these aggrecanase generated aggrecan fragments (Hughes, CE et al., *Biochem J.* 1995, 305, 799-804). Aggrecan fragments in inflammatory and OA synovial fluid have been reported as being generated by cleavage at the aggrecanase site (Malfait, A-M et al., *J*

Biol Chem. 2002, 277, 22201-22208). Inhibiting aggrecanase activity is an attractive therapeutic target for OA. In this example, we investigated the effects of a selective aggrecanase inhibitor on the fate of existing and newly synthesized aggrecan in human OA cartilage.

Materials and Methods

[0991] Human OA Cartilage Explant Culture: Discarded tissues from consented knee replacement patients were obtained from New England Baptist Hospital (Brookline, MA) in sterile phosphate buffered saline (PBS) after about 2-4 hrs post surgery. Cartilage slices were harvested from the knee specimens and washed several times in PBS. These cartilage slices were cut into appropriate pieces (6-8 mm) and rinsed in PBS and then in media and further cultured for additional days as cartilage explants. The medium consisted of Dulbecco's Modified Eagle's medium (DMEM, JRH Biosciences, Lenexa, KS), 50µg/ml ascorbic acid (Wako, Osaka, Japan), 10mM HEPES, pH 7.0 (Mediatech, Herndon, VA), 2mM L-glutamine (Mediatech), 100 U/ml antibiotic-antimycotic solution (Mediatech).

[0992] Test compounds: The test compounds are described in Examples 800, 8NNNNNNN, and 8WWWWWW. Stock solutions of the compounds were prepared at 1mg/ml in DMSO, aliquoted and stored at -20°C. Working solutions of the compounds were made in DMSO and added to the culture for efficacy studies.

[0993] Efficacy study: Cartilage explants were cultured for 2-3 days in DMEM medium in a 37°C and 5% CO₂ environment to equilibrate the tissue. Explants were weighed (~250mg) and placed in wells of a 24-well culture dish in 1 ml of medium and 3 replicates per treatment group. For the efficacy study, cartilage explants were cultured for 6 days in the presence or absence of various concentrations of the test compound. The media was replaced on day 3 and the experiment was terminated on day 6. Total aggrecan content of conditioned media was measured by a colorimetric assay with DMMB (Farndale, RW et al., *Biochim Biophys Acta.* 1986, 883, 173-177).

[0994] Cartilage aggrecan metabolism study: Cartilage metabolism study was performed with test compound 800. Cartilage explants immediately after harvest were cultured in the presence or absence of test compound 800. On day 3, media was collected and replaced with media, test compound and labeled sulfate (³⁵SO₄, 5 mCi,

Perkin Elmer, Boston, MA). On day 6, media was collected, explants washed and replaced with media and test compound 800. On Day 9, media was collected, explants washed and the remaining tissue was digested with Proteinase K (Sigma). Samples were separated on NAP10 columns (Pharmacia, Uppsala, Sweden) to separate free label and newly synthesized labeled aggrecan. Labeled aggrecan molecules were counted using Opti-Fluor (Perkin Elmer) and a liquid scintillation-measuring instrument (Beckman Coulter, Fullerton, CA). The percentage of newly synthesized aggrecan in cartilage and media was estimated.

[0995] Western analysis: Aggrecan fragments in conditioned medium were analyzed by western analysis using neoepitope antibody, BC-3 designed to recognize the Aggrecanase-generated N-terminal interglobular neoepitope ³⁷⁴ARGS. Equal cartilage weight equivalent conditioned media from each replicate well per treatment group was pooled and digested with Chondroitinase ABC (Sigma, St Louis, MO), Keratinase I (Seikagaku America, Falmouth, MA) and Keratinase II (Seikagaku America, Falmouth, MA) for 2 h at 37°C. Samples were concentrated by YM-10 centrifugal filter device (Millipore Corp., Bedford, MA), lyophilized and reconstituted with equal volume of water. Samples were separated under reducing conditions on 4-12% gradient Tris-glycine gels (Invitrogen, Carlsbad, CA). Proteins from the gels were transferred to nitrocellulose membranes. Immunoblots were probed using Mab BC-3 (Abcam, Cambridge, MA). Incubation with primary and alkaline-phosphatase-conjugated secondary goat anti-mouse IgG (Promega Corp., Madison, WI) was performed overnight at 4°C and at room temperature for 1 h, respectively. The immunoblots were incubated with NBT/BCIP substrate (Promega Corp., Madison, WI) at room temperature to achieve optimum color development. The aggrecan fragments containing the ARGS neoepitope were quantitated by densitometry analysis and the percentage inhibition of aggrecan degradation by test compounds was determined.

Results

[0996] Efficacy of test compounds 800, 8NNNNNNN, and 8WWWWWWW: Information on human donors including age and sex are shown in Table 4b, 5b, and 6b. Cartilage from all the donors when placed in culture exhibited Aggrecanase-mediated aggrecan cleavage and when treated with test compounds showed dose dependent

inhibition of Aggrecanase-mediated aggrecan cleavage. Results of the inhibition of aggrecanase activity in terms of inhibition of aggrecanase generated aggrecan fragments by test compounds are shown in Table 4a, 5a, and 6a. Based on these results, EC₅₀ of test compound 8OO was determined to be about 150 ng/ml (Figure 1), EC₅₀ for test compound 8WWWWWW was around 40-160 ng/ml; and EC₅₀ for test compound 8NNNNNNN was less than 40 ng/ml. However, test compound 8WWWWWW and test compound 8NNNNNNN were tested in only 8 and 4 donors, respectively. Test compound 8OO was tested in a total of 15 donors.

[0997] Effect of test compound 8OO on Aggrecan Metabolism: Articular cartilage from 3 human OA donors was analyzed for the effect of test compound 8OO on newly synthesized aggrecan. Cartilage from all 3 donors showed the ability to synthesize new aggrecan molecules that was either in the cartilage matrix or released into conditioned medium. Cartilage from all 3 donors when treated with compound 8OO showed dose dependent increase in newly synthesized aggrecan content of the cartilage matrix and an equivalent decrease in aggrecan released into the medium (Figure 2).

[0998] Aggrecanase activity is a characteristic of human osteoarthritis throughout the disease process. Analysis of aggrecan released from human osteoarthritic articular cartilage revealed significant ongoing degradation of aggrecan by Aggrecanases in human donors tested. Inhibition of Aggrecanase activity by Aggrecanase selective inhibitors reduced release of aggrecan degradation products from the articular cartilage matrix.

[0999] Since newly synthesized aggrecan appeared to be susceptible to degradation by Aggrecanases, selective Aggrecanase inhibition resulted in a net increase in aggrecan incorporation into the cartilage matrix. These results indicate that inhibition of Aggrecanases will reduce aggrecan degradation in human osteoarthritic articular cartilage throughout the disease process, and also result in a net increase in extracellular matrix aggrecan.

Table 4

A) Efficacy of test compound 800 in human explant studies

Compound 800 (BC3 analysis)		
Conc. of compound (ug/ml)	Average of 15 donors	
	% inhibition	SDM
0.02	8.52	
0.04	26.16	5.33
0.08	42.93	7.86
0.15	49.03	7.87
0.3	56.40	5.95
0.6	73.92	5.24
1.25	83.36	5.59
2.5	100.94	4.12
5	98.88	1.32
10	101.60	0.99
~EC50 = 150 ng/ml		

B) Human donor information for test compound 800 studies

Compound 800 (Donor info)	
Sex	Age
F	65
M	83
M	70
F	56
F	76
M	53
F	77
F	74
F	75
M	79
M	61
F	57
M	72
M	70
M	62

Table 5**A) Efficacy of test compound 8WWWWWWW in human explant studies**

Compound 8WWWWWWW (BC3 analysis)		
Conc. of compound (ug/ml)	Average of 8 donors	
	% inhibition	SDM
0.01	2.85	2.85
0.02	46.39	15.95
0.04	23.50	10.57
0.08	76.91	5.99
0.15	88.47	3.25
0.3	95.03	1.70
0.6	98.03	0.90
1.25	100.30	0.55
~EC50 = 40-160 ng/ml		

B) Human donor information for test compound 8WWWWWWW studies

Test compound (Donor info)	
Sex	Age
F	69
F	69
F	63
M	60
M	57
F	72
F	65
F	75

Table 6**A) Efficacy of test compound 8NNNNNNN in human explant studies**

Test compound 8NNNNNNN (BC3 analysis)		
Conc. of compound (ug/ml)	Average of 4 donors	
	% inhibition	SDM
0.04	70.22	
0.08	84.46	
0.15	66.74	10.97
0.3	73.14	19.73
0.6	98.93	0.92
1.25	99.43	1.44
2.5	98.66	2.20
5	100.21	1.15
10	101.15	0.42
~EC50 = less than 40 ng/ml		

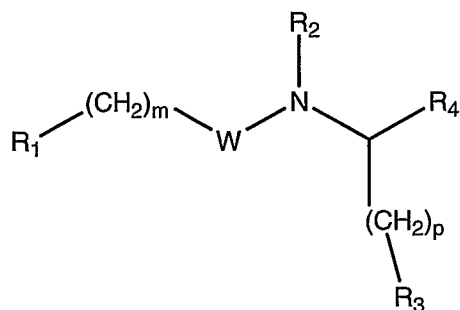
B) Human donor information for test compound 8NNNNNNN studies

Test compound (Donor info)	
Sex	Age
M	63
F	68
F	72
F	60

[1000] While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. A compound of the formula (I):



(I)

or a pharmaceutically acceptable salt thereof,

wherein

W is $-C(O)-$, $-OC(O)-$, $-NHC(O)-$, $-C(O)O-$, or $-C(O)NH-$;

R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, $-(CH_2)_nR_{11}$, $-OH$, or $-O-(C_1-C_6)$ alkyl;

R₃ is $-CO_2H$, $-CONH_2$, $-CONHOH$, $-CONHSO_2R_7$, tetrazole, $-SO_2NHR_7$, $-SO_3H$, $-PO(OH)NH_2$, $-PO(OH)OR_7$, $-CONHR_7$, $-COOR_7$, an acid mimetic group, or a 5 or 6-membered heterocycloalkyl or heteroaryl containing 1 to 4 heteroatoms selected from O, N, S;

R₄ is $-CO_2H$, $-CONH_2$, $-(CH_2)_nOR_7$, or $-CONR_9R_{10}$;

R₅ is aryl, heteroaryl, $-(CH_2)_n$ -aryl, $-(CH_2)_n$ -heteroaryl, $-O$ -aryl, $-O$ -heteroaryl, $-S$ -aryl, $-S$ -heteroaryl, $-NH$ -aryl, $-NH$ -heteroaryl, $-CO-(C_1-C_6)$ alkyl, $-CO$ -aryl, $-CO$ -heteroaryl, $-SO_2-(C_1-C_6)$ alkyl, $-SO_2$ -aryl, $-SO_2$ -heteroaryl, $-SO_2NH$ -aryl, $-SO_2NH$ -heteroaryl, $-NHSO_2-(C_1-C_6)$ alkyl, $-NHSO_2$ -aryl, $-NHSO_2$ -heteroaryl, $-NHCO$ -aryl, $-NHCO$ -heteroaryl, $-CONH$ -aryl, $-CONH$ -heteroaryl, (C₁-C₆) alkyl, $-O-(C_1-C_6)$ alkyl, $-S-(C_1-C_6)$ alkyl, $-NH-(C_1-C_6)$ alkyl, $-NHCO-(C_1-C_6)$ alkyl, $-CONH-(C_1-C_6)$ alkyl, $-O-(C_3-C_6)$ cycloalkyl, $-S-(C_3-C_6)$ cycloalkyl, $-NH-(C_3-C_6)$ cycloalkyl, $-NHCO-(C_3-$

C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₉ and R₁₀ are each independently hydrogen, (C₁-C₆) alkyl, (C₁-C₆) alkyl-OH, (C₁-C₆) alkyl-O-(C₁-C₆) alkyl, aryl, cycloalkyl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₉ and R₁₀ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl

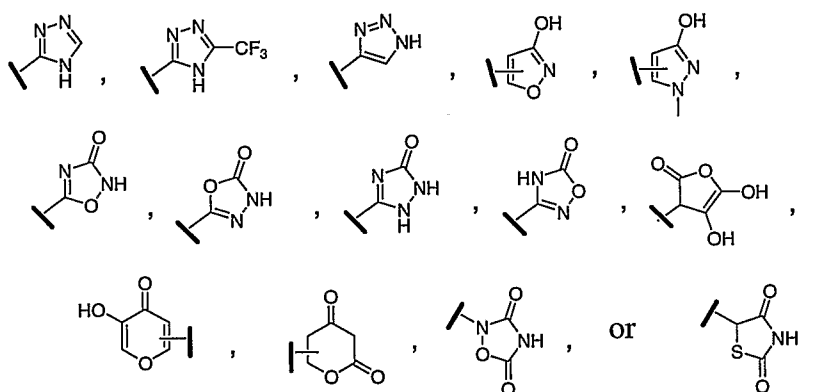
substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-
(C₁-C₆) alkyl,
-(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl;

m is 0-4;

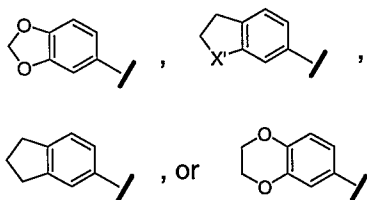
n is 0-4; and

p is 0-2.

2. The compound or salt of claim 1, wherein W is -CO.
3. The compound or salt of claim 1 or claim 2, wherein R₃ is -CO₂H.
4. The compound or salt of any one of claims 1 to 3, wherein R₁ is bicyclic aryl optionally substituted with one or more of R₅ and R₆, wherein R₅ and R₆ are defined as in claim 1.
5. The compound or salt of any one of claims 1 to 3, wherein R₁ is tricyclic aryl optionally substituted with one or more of R₅ and R₆, wherein R₅ and R₆ are defined as in claim 1.
6. The compound or salt of any one of claims 1 to 3, wherein R₁ is biphenyl optionally substituted with one or more of R₅ and R₆, wherein R₅ and R₆ are defined as in claim 1.
7. The compound or salt of any one of claims 1 to 6, wherein m is 0 and p is 2.
8. The compound or salt of any one of claims 1 to 7, wherein R₄ is -CO₂H, -CONH₂, -(CH₂)_nOR₇, or -CONR₉R₁₀, wherein R₇, R₉, R₁₀, and n are defined as in claim 1.
9. The compound or salt of any one of claims 1 to 8, wherein R₃ is



10. The compound or salt of any one of claims 1 to 9, wherein R_5 is



and X' is O, S, or NH.

11. The compound or salt of claim 1, wherein

W is $-\text{CO}_2$,

R₂ is hydrogen,

R₃ is -CO₂H,

R₁ is biphenyl optionally substituted with one or more of R₅ and R₆,

R_4 is -CONR₉R₁₀,

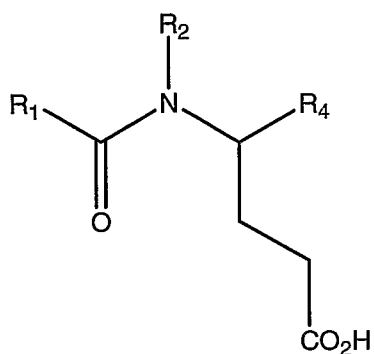
m is 0,

p is 2, and

R_5, R_6, R_9 , and R_{10} are defined as in claim 1.

12. The compound or salt of any one of claims 1 to 11, wherein the compound or pharmaceutically acceptable salt of the compound is the S-enantiomer with respect to the carbon to which R₄ is bound.

13. The compound of claim 1 of the formula (Ia):



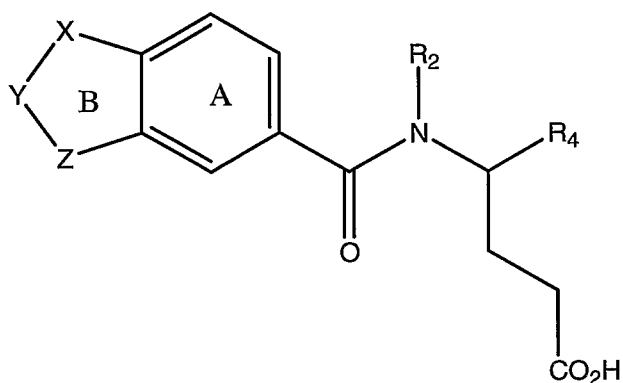
(Ia)

or a pharmaceutically acceptable salt thereof,

wherein

R₁, R₂, and R₄ are defined as in any one of claims 1, 3, 4, 5 or 8.

14. The compound of claim 1 of the formula (Ib):



(Ib)

or a pharmaceutically acceptable salt thereof,

wherein

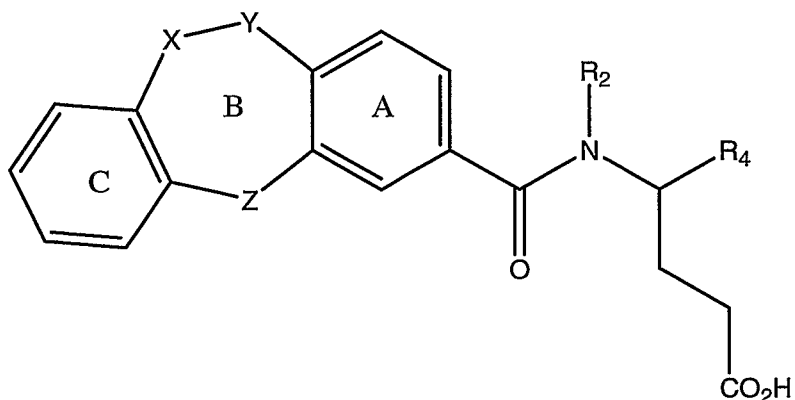
X, Y, and Z are each independently (CH₂)_n, O, S, NR₇, CO, or SO₂; or X, Y, and

Z form a benzene in ring B; ring A and ring B are each independently

optionally substituted with one or more of R₅ and R₆; and

R₂, R₄, R₅, R₆, R₇, and n are as defined in any one of claims 1, 8 or 10.

15. The compound of claim 1 of the formula (Ic):



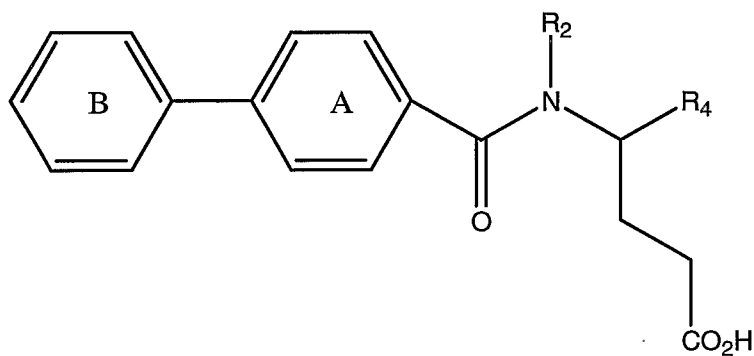
(Ic)

or a pharmaceutically acceptable salt thereof,

wherein

X, Y, and Z are each independently $(CH_2)_n$, O, S, NR_7 , CO, or SO_2 ; or X, Y, and Z form a benzene in ring B; ring A, ring B, and ring C are each independently optionally substituted with one or more of R_5 and R_6 ; and R_2 , R_4 , R_5 , R_6 , R_7 , and n are as defined in any one claims 1, 8 or 10.

16. The compound of claim 1 of the formula (Id):



(Id)

or a pharmaceutically acceptable salt thereof,

wherein

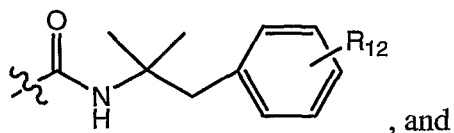
ring A and ring B are each independently optionally substituted with one or more of R_5 and R_6 ; and

R_2 , R_4 , R_5 , and R_6 are as defined in any one of claims 1, 8 and 10.

17. The compound of claim 16 or a pharmaceutically acceptable salt thereof,
wherein

R_2 is hydrogen,

R_4 is

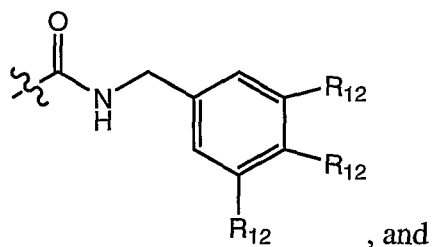


R_{12} is -F.

18. The compound of claim 15 or a pharmaceutically acceptable salt thereof,
wherein
each of X, Y, and Z is independently $(CH_2)_n$, with $n = 1$ for one of X, Y, and Z
and $n = 0$ for the other of X, Y, and Z;

R_2 is hydrogen;

R_4 is

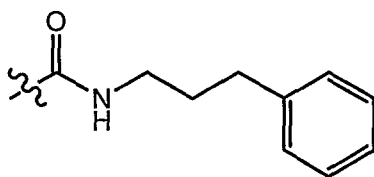


each R_{12} is $-OCH_3$.

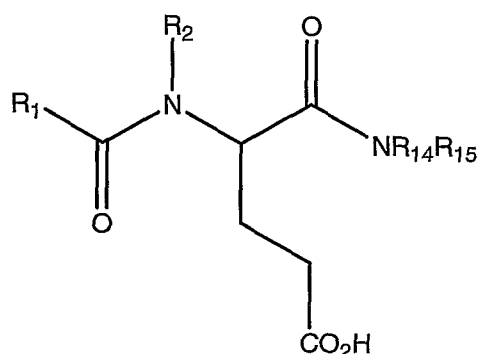
19. The compound of claim 15 or a pharmaceutically acceptable salt thereof,
wherein
each of X, Y, and Z is independently $(CH_2)_n$, with $n = 1$ for one of X, Y, and Z,
and $n = 0$ for the other of X, Y, and Z;

R_2 is hydrogen; and

R_4 is



20. A compound of the formula (II):



(II)

or a pharmaceutically acceptable salt thereof,
wherein

R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_pR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl, -CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂,

-OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl;

R₁₄ and R₁₅ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, heterocycloalkyl -(CH₂)_n-aryl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₁₄ and R₁₅ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

n is 0-4, and

p is 0-2.

21. The compound or pharmaceutically acceptable salt of the compound of claim 1, wherein the compound is

*N*²-(4-benzoylbenzoyl)-*N*¹-benzyl-L-α-glutamine,
N-(4-benzoylbenzoyl)-L-glutamic acid,
*N*¹-(1,3-benzodioxol-5-ylmethyl)-*N*²-(1,1'-biphenyl-4-ylcarbonyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-butyl-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclopropyl-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclohexyl-L-α-glutamine,
*N*¹-benzyl-*N*²-(4-thien-2-ylbenzoyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-[4-(2-furyl)benzoyl]-L-α-glutamine,
*N*¹-benzyl-*N*²-[(4'-ethynyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(4-fluorobenzyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclooctyl-L-α-glutamine,
*N*¹-benzyl-*N*²-(4-bromobenzoyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-[(2',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(3,4-dimethoxybenzyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-(4-pyridin-4-ylbenzoyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-[(3',5'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine,
*N*¹-benzyl-*N*²-[(4'-ethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine,
*N*¹-benzyl-*N*²-[(3'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine,
*N*¹-benzyl-*N*²-[(2'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine,
*N*¹-benzyl-*N*²-[(2',6'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-cyclopentyl-L-α-glutamine,
*N*¹-[2-(acetylamino)ethyl]-*N*²-(1,1'-biphenyl-4-ylcarbonyl)-L-α-glutamine,
*N*¹-2-adamantyl-*N*²-(1,1'-biphenyl-4-ylcarbonyl)-L-α-glutamine,
*N*¹-(2-adamantylmethyl)-*N*²-(1,1'-biphenyl-4-ylcarbonyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-(4-pyridin-2-ylbenzoyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-(4-pyridin-3-ylbenzoyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-[4-(1,3-thiazol-2-yl)benzoyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(4-methoxybenzyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-[2-(3,4-dimethoxyphenyl)ethyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(2-methoxyethyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-[2-(4-methoxyphenyl)ethyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(1-naphthylmethyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(3-methylbenzyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(2-furylmethyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(3-methoxybenzyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(2,4-dichlorobenzyl)-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-[4-(trifluoromethoxy)benzyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-[3-(trifluoromethoxy)benzyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-[4-(methylthio)benzyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(4-phenoxybenzyl)-L-α-glutamine,

N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-methoxyphenyl)ethyl]-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,4-dimethoxybenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methoxybenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dichlorobenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-difluorobenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy- N^1 -[3-(trifluoromethoxy)benzyl]-L-glutamamide,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy- N^1 -[2-(3-methoxyphenyl)ethyl]-L-glutamamide,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^5 -hydroxy- N^1 -(3,4,5-trimethoxybenzyl)-L-glutamamide,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-dimethoxybenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,5-dimethoxybenzyl)- N^5 -hydroxy-L-glutamamide,
 N^1 -benzyl- N^2 -[(4'-vinyl-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -[(4'-ethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -[(4'-propoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -[(4'-butoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -{[4'-(cyclobutylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine,
 N^1 -benzyl- N^2 -{[4'-(cyclohexylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine,
 N^2 -{[4'-(allyloxy)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-dimethylbenzyl)- N^5 -hydroxy-L-glutamamide,
 N^2 -(1,1'-biphenyl-4-ylacetyl)- N^1 -(3-methoxybenzyl)-L- α -glutamine,
 N^2 -[(3-fluorophenyl)acetyl]- N^1 -(3-methoxybenzyl)-L- α -glutamine,
 N^2 -{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine,
 N^1 -benzyl- N^2 -{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine,
 N^1 -benzyl- N^2 -{[4'-(4-fluorobenzoyl)amino]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N^2 -{[4'-(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl}- N^1 -benzyl-L- α -glutamine,
 N^1 -benzyl- N^2 -(5-phenyl-2-furoyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -[5-(3-ethoxyphenyl)-2-furoyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -[5-(3,5-dimethylphenyl)-2-furoyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -(2,2'-bifuran-5-ylcarbonyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -(5-thien-2-yl-2-furoyl)-L- α -glutamine,
 N^2 -[(2,2'-dimethyl-1,1'-biphenyl-4-yl)carbonyl]- N^1 -(3-methoxybenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-phenylethyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[3-(trifluoromethyl)benzyl]-L- α -glutamine,
 N^1 -(4-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine,
 N^1 -(3-aminobenzyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(trifluoromethyl)benzyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -[(2-fluoro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,

N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-fluorobenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-phenylpropyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -(1,1'-biphenyl-3-ylcarbonyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -(3-thien-2-ylbenzoyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -[(3-chloro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -[(3-fluoro-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -[(2,6-dimethoxy-1,1'-biphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(3-chlorophenyl)ethyl]-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-fluorobenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3,4-difluorobenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2-methylbenzyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -({4'-[(3-methoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -({4'-[(3,5-dimethoxybenzyl)oxy]-1,1'-biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -{[4'-(2-naphthylmethoxy)-1,1'-biphenyl-4-yl]carbonyl}-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -2,3-dihydro-1*H*-inden-2-yl-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(2,3-dimethylbenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-phenylbutyl)-L- α -glutamine,
 N^1 -(2-benzylphenyl)- N^2 -(1,1'-biphenyl-4-ylcarbonyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methoxy-1,1'-biphenyl-3-yl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-methylbenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[4-fluoro-3-(trifluoromethyl)benzyl]-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -heptyl-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-iodobenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-vinylbenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(3-thien-2-ylbenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine,
 N^1 -(3-methoxybenzyl)- N^2 -[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-*tert*-butylbenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-iodobenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(4-vinylbenzyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(*sec*-butyl)-L- α -glutamine,
 N^2 -(1,1'-biphenyl-4-ylcarbonyl)- N^1 -(cyclopropylmethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[4-(dimethylamino)benzyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-bromophenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-biphenyl-4-ylethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2'-ethoxybiphenyl-4-yl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-ethynylbiphenyl-4-yl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4-(2-thienyl)phenyl]ethyl}-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-2-ylphenyl)ethyl]-L- α -glutamine,

N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[3-(dimethylamino)benzyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-diphenylpropyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3,3-dimethylbutyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -isopropyl-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(pyridin-4-ylmethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1,N^1 -diethyl-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethylpropyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-4-yl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-4-yl]ethyl}-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-formylbiphenyl-3-yl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{2-[4'-(trifluoromethyl)biphenyl-3-yl]ethyl}-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-3-yl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4'-methoxybiphenyl-4-yl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(3-bromophenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -pentyl-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-pyridin-4-ylphenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(*tert*-butyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -{4'-(trifluoromethyl)biphenyl-3-yl)methyl}-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2,2-dimethylpropyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(4'-ethynylbiphenyl-3-yl)methyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(3-pyridin-2-ylbenzyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -hexyl-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1-methyl-1-phenylethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1,1,3,3-tetramethylbutyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-morpholin-4-ylethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(2-hydroxy-1,1-dimethylethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-fluorophenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-chlorophenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-thienyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(2-chlorophenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(5-hydroxypentyl)-L- α -glutamine,
3-[(biphenyl-4-ylmethyl)amino]-3-oxopropanoic acid,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -propyl-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -

glutamine,
*N*²-(biphenyl-4-ylcarbonyl)-*N*¹-[2-(3-pyridin-2-ylphenyl)ethyl]-L-α-glutamine,
*N*²-2-naphthoyl-*N*¹-(3-phenylpropyl)-L-α-glutamine,
*N*²-(9H-fluoren-2-ylcarbonyl)-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*²-(9H-fluoren-1-ylcarbonyl)-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*²-[(9-oxo-9H-fluoren-2-yl)carbonyl]-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*²-(9H-fluoren-2-ylcarbonyl)-*N*¹-(3-phenylpropyl)-L-α-glutamine,
*N*²-(9H-fluoren-1-ylcarbonyl)-*N*¹-(3-phenylpropyl)-L-α-glutamine,
*N*²-(4-phenoxybenzoyl)-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*²-(9H-fluoren-2-ylcarbonyl)-*N*¹-hexyl-L-α-glutamine,
*N*²-(9H-fluoren-1-ylcarbonyl)-*N*¹-hexyl-L-α-glutamine,
*N*¹-hexyl-*N*²-(4-phenoxybenzoyl)-L-α-glutamine,
*N*¹-hexyl-*N*²-[(9-oxo-9H-fluoren-2-yl)carbonyl]-L-α-glutamine,
*N*²-[(9-oxo-9H-fluoren-2-yl)carbonyl]-*N*¹-(3-phenylpropyl)-L-α-glutamine,
*N*²-(4-phenoxybenzoyl)-*N*¹-(3-phenylpropyl)-L-α-glutamine,
N-[4-(pyrimidin-2-ylamino)benzoyl]-L-glutamic acid,
N-(1,1'-biphenyl-4-ylcarbonyl)-D-glutamic acid,
N-[4-(pyrimidin-2-ylamino)benzoyl]-L-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-D-α-glutamine,
*N*²-(1,1'-biphenyl-4-ylcarbonyl)-*N*¹-(4-hydroxybutyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-(1,1'-biphenyl-4-ylcarbonyl)-L-α-glutamine,
*N*¹-benzyl-*N*²-[4-(pyrimidin-2-ylamino)benzoyl]-L-α-glutamine,
 (4S)-4-[(1,1'-biphenyl-4-ylcarbonyl)amino]-5-hydroxypentanoic acid,
N-{[4'-[(phenylacetyl)amino]-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid,
N-[4'-{[(3-methyl-1-benzofuran-2-yl)carbonyl]amino}-1,1'-biphenyl-4-yl]carbonyl]-L-glutamic acid,
N-{[4'-(2-furoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid,
N-{[4'-(acetylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid,
N-{[4'-(benzoylamino)-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid,
N-{[4'-[(1-benzofuran-2-ylcarbonyl)amino]-1,1'-biphenyl-4-yl]carbonyl}-L-glutamic acid,
*N*¹-(1,1-dimethyl-2-phenylethyl)-*N*²-(9H-fluoren-2-ylcarbonyl)-L-α-glutamine,
*N*¹-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-(9H-fluoren-2-ylcarbonyl)-L-α-glutamine,
*N*²-(9H-fluoren-2-ylcarbonyl)-*N*¹-(6-hydroxyhexyl)-L-α-glutamine,
*N*¹-(6-hydroxyhexyl)-*N*²-(4-phenoxybenzoyl)-L-α-glutamine,
*N*²-(9H-fluoren-9-ylcarbonyl)-*N*¹-(6-hydroxyhexyl)-L-α-glutamine,
*N*²-(9H-fluoren-9-ylcarbonyl)-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*²-(3-phenoxybenzoyl)-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*²-(9H-fluoren-4-ylcarbonyl)-*N*¹-(3,4,5-trimethoxybenzyl)-L-α-glutamine,
*N*¹-1-adamantyl-*N*²-[(9-oxo-9H-fluoren-2-yl)carbonyl]-L-α-glutamine,
*N*¹-1-adamantyl-*N*²-(4-phenoxybenzoyl)-L-α-glutamine,
*N*¹-1-adamantyl-*N*²-(9H-fluoren-2-ylcarbonyl)-L-α-glutamine,
*N*¹-1-adamantyl-*N*²-(9H-fluoren-9-ylcarbonyl)-L-α-glutamine,
*N*²-(9H-fluoren-2-ylcarbonyl)-*N*¹-(3-methylbenzyl)-L-α-glutamine,

N^1 -(3-methylbenzyl)- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine,
 N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(3-methylbenzyl)-L- α -glutamine,
 N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -propyl-L- α -glutamine,
 N^1 -benzyl- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine,
 N^1 -benzyl- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -(9H-fluoren-9-ylcarbonyl)-L- α -glutamine,
 N^1 -benzyl- N^2 -(3-phenoxybenzoyl)-L- α -glutamine,
 N^1 -(1-methyl-1-phenylethyl)- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine,
 N^2 -(9H-fluoren-9-ylcarbonyl)- N^1 -(1-methyl-1-phenylethyl)-L- α -glutamine,
 N^1 -(1-methyl-1-phenylethyl)- N^2 -(3-phenoxybenzoyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1S)-1-phenylethyl]-L- α -glutamine,
 N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -[(1S)-1-phenylethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1S)-1-(4-fluorophenyl)ethyl]-L- α -glutamine,
tert-butyl N^2 -(biphenyl-4-ylcarbonyl)- N^1 -(1-phenylethyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1R)-1-(4-fluorophenyl)ethyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[(1R)-1-phenylethyl]-L- α -glutamine,
 N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -[(1R)-1-phenylethyl]-L- α -glutamine,
 N^2 -(9H-fluoren-1-ylcarbonyl)- N^1 -(6-hydroxyhexyl)-L- α -glutamine,
 N^1 -(6-hydroxyhexyl)- N^2 -[(9-oxo-9H-fluoren-2-yl)carbonyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -9H-fluoren-9-yl-L- α -glutamine,
 N^2 -(9H-fluoren-2-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
 N^2 -[(3'-ethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -[(2'-ethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -[(4'-methoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -(4-bromobenzoyl)-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -[(3'-methoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
4'-{[[(1S)-3-carboxy-1-{[(3,4,5-trimethoxybenzyl)amino]carbonyl}propyl)amino]carbonyl}biphenyl-3-carboxylic acid,
 N^2 -[(4'-ethylbiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
N-benzyl- N^2 -[4-(2-naphthyl)benzoyl]-L- α -glutamine,
 N^2 -[(3',4'-dimethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -[(2',4'-dimethoxybiphenyl-4-yl)carbonyl]-N-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
N-(3,4,5-trimethoxybenzyl)- N^2 -[(3',4',5'-trimethoxybiphenyl-4-yl)carbonyl]-L- α -glutamine,
N-(1-adamantylmethyl)- N^2 -(biphenyl-4-ylcarbonyl)-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)- N^2 -[(3'-methoxybiphenyl-4-yl)carbonyl]-L- α -glutamine,

N^2 -[(3',4'-dimethoxybiphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(2'-ethoxybiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -(4-bromobenzoyl)- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N -[(1S)-1-benzyl-2-hydroxyethyl]- N^2 -(biphenyl-4-ylcarbonyl)-L- α -glutamine,
 N -[(1S)-1-benzyl-2-hydroxyethyl]- N^2 -(9H-fluoren-2-ylcarbonyl)-L- α -glutamine,
 N -(1-adamantylmethyl)- N^2 -(4-bromobenzoyl)-L- α -glutamine,
 N -(1-adamantylmethyl)- N^2 -[(4'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -[4-(1,3-benzodioxol-5-yl)benzoyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N^2 -[(2',4'-dimethoxybiphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N^2 -[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N -(1-adamantylmethyl)- N^2 -({4'-[(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N -(1-adamantylmethyl)- N^2 -({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N -methyl- N -(2-phenylethyl)-L- α -glutamine,
 N^2 -[(4'-sec-butylbiphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(4'-isopropylbiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -(1,1':4',1''-terphenyl-4-ylcarbonyl)-L- α -glutamine,
 N^2 -({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N^2 -[(4'-hydroxybiphenyl-4-yl)carbonyl]- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N -(1-adamantylmethyl)- N^2 -({3'-[(dimethylamino)carbonyl]biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N -(1-adamantylmethyl)- N^2 -[(3',5'-dimethylbiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -(9H-fluoren-2-ylcarbonyl)- N -methyl- N -(2-phenylethyl)-L- α -glutamine,
 N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(3'-methylbiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -({4'-[(3,5-dimethylbenzyl)oxy]biphenyl-4-yl}carbonyl)- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -[(4'-{[3,5-bis(trifluoromethyl)benzyl]oxy}biphenyl-4-yl)carbonyl]- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N^2 -[(3'-isopropylbiphenyl-4-yl)carbonyl]- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine,

N^2 -[(4'-isopropylbiphenyl-4-yl)carbonyl]- N -(3,4,5-trimethoxybenzyl)- L - α -glutamine,
 N -(1-adamantylmethyl)- N^2 -[4-(1-benzofuran-5-yl)benzoyl]- L - α -glutamine,
 N -(1-adamantylmethyl)- N^2 -[4-(1H-indol-5-yl)benzoyl]- L - α -glutamine,
 N^2 -[(3'-ethoxybiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- L - α -glutamine,
 N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(3'-methoxybiphenyl-4-yl)carbonyl]- L - α -glutamine,
 N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(3'-isopropylbiphenyl-4-yl)carbonyl]- L - α -glutamine,
 N^2 -[(3'-fluoro-4'-methylbiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- L - α -glutamine,
 N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(4'-isobutylbiphenyl-4-yl)carbonyl]- L - α -glutamine,
 N^2 -(1,1':4,1''-terphenyl-4-ylcarbonyl)- N -(3,4,5-trimethoxybenzyl)- L - α -glutamine,
 N -benzyl- N^2 -{[3'-(hydroxymethyl)biphenyl-4-yl]carbonyl}- L - α -glutamine,
 N -benzyl- N^2 -{[4'-[(3-fluorobenzyl)oxy]biphenyl-4-yl]carbonyl}- L - α -glutamine,
 N -benzyl- N^2 -{[4'-(benzyloxy)biphenyl-4-yl]carbonyl}- L - α -glutamine,
 N -benzyl- N^2 -[4-(phenylethynyl)benzoyl]- L - α -glutamine,
 N -benzyl- N^2 -{4-[(9-hydroxy-9H-fluoren-9-yl)ethynyl]benzoyl}- L - α -glutamine,
 N -benzyl- N^2 -{4-[(1E)-3-oxo-3-phenylprop-1-en-1-yl]benzoyl}- L - α -glutamine,
 N -(3,4,5-trimethoxybenzyl)- N^2 -[(2',4',6'-trimethylbiphenyl-4-yl)carbonyl]- L - α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -{[4'-[(3-methoxybenzyl)oxy]biphenyl-4-yl]carbonyl}- L - α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(4'-hydroxybiphenyl-4-yl)carbonyl]- L - α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(3'-ethoxybiphenyl-4-yl)carbonyl]- L - α -glutamine,
 N^2 -{[4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl]carbonyl}- N -(6-hydroxyhexyl)- L - α -glutamine,
 N^2 -{[4'-[(3-methoxybenzyl)oxy]biphenyl-4-yl]carbonyl}- N -(3,4,5-trimethoxybenzyl)- L - α -glutamine,
 N^2 -(4-bromobenzoyl)- N -(3-methylbenzyl)- L - α -glutamine,
 N^2 -[4-(1,3-benzodioxol-5-yl)benzoyl]- N -(3-methylbenzyl)- L - α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N -butyl- N -methyl- L - α -glutamine,
 N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(4'-hydroxybiphenyl-4-yl)carbonyl]- L - α -glutamine,
 N -butyl- N^2 -(9H-fluoren-2-ylcarbonyl)- N -methyl- L - α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N -[2-(3,4-dimethoxyphenyl)ethyl]- N -methyl- L - α -glutamine,
 N^2 -[4-(1,3-benzodioxol-5-yl)benzoyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- L - α -glutamine,
 N -[2-(3,4-dimethoxyphenyl)ethyl]- N^2 -(9H-fluoren-2-ylcarbonyl)- N -methyl- L - α -glutamine,
 N^2 -(9H-fluoren-2-ylcarbonyl)- N -[(2R)-2-phenylpropyl]- L - α -glutamine,

N^2 -(biphenyl-4-ylcarbonyl)- N -[(2R)-2-phenylpropyl]-L- α -glutamine,
 N -benzyl- N^2 -{4-[(4-hydroxycyclohexyl)ethynyl]benzoyl}-L- α -glutamine,
 N^2 -{4-[(3-aminophenyl)ethynyl]benzoyl}- N -benzyl-L- α -glutamine,
 N -benzyl- N^2 -[4-(3-hydroxy-3,3-diphenylprop-1-yn-1-yl)benzoyl]-L- α -glutamine,
 N -benzyl- N^2 -{4-[(3-methoxyphenyl)ethynyl]benzoyl}-L- α -glutamine,
 N^2 -[(3'-hydroxybiphenyl-4-yl)carbonyl]- N -(3,4,5-trimethoxybenzyl)-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -{4'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -[(4'-methylbiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L-glutamamide,
 N^2 -({4'-[(3-tert-butylphenoxy)methyl]biphenyl-4-yl}carbonyl)- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N^2 -({4'-[(3,5-di-tert-butylphenoxy)methyl]biphenyl-4-yl}carbonyl)- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -({4'-[(3-ethylphenoxy)methyl]biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -({4'-[(3-methoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)-L- α -glutamine,
 N -[2-(4-fluorophenyl)-1,1-dimethylethyl]- N^2 -[(3'-hydroxybiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -(biphenyl-4-ylcarbonyl)- N^1 -[2-(4-fluorophenyl)-1,2-dimethylethyl]- N^5 -hydroxy-L-glutamanide,
 N^2 -[4-(5-bromo-2-thienyl)benzoyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
 N -[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]- N^2 -[(3'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]- N -[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
 N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',5'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',6'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(3',5'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -[2-(4-chlorophenyl)-1,1-dimethylethyl]- N^2 -[(2',3'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
 N -(1,1-dimethyl-2-phenylethyl)- N^2 -(4-pyrimidin-5-ylbenzoyl)-L- α -glutamine,
 N^2 -[(3',4'-difluorobiphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
 N^2 -[(3',5'-difluorobiphenyl-4-yl)carbonyl]- N -(1,1-dimethyl-2-phenylethyl)-L- α -

glutamine,
N-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-*N*²-[(3',4'-difluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
*N*²-(biphenyl-4-ylcarbonyl)-*N*-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-{[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl}-*N*-[2-(5-chloro-2-thienyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-{[4'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
*N*²-{[4'-(bromomethyl)biphenyl-4-yl]carbonyl}-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[4-(2-thienyl)benzoyl]-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[4-(2-furyl)benzoyl]-L- α -glutamine,
*N*²-{[4'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-*N*-(3-methylbenzyl)-L- α -glutamine,
*N*²-{[3'-(hydroxymethyl)biphenyl-4-yl]carbonyl}-*N*-(3-methylbenzyl)-L- α -glutamine,
*N*²-[4-(2,3-dihydro-1-benzofuran-5-yl)benzoyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-[(3'-chloro-4'-fluorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-{[3'-(bromomethyl)biphenyl-4-yl]carbonyl}-*N*-(3-methylbenzyl)-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[4-(3-thienyl)benzoyl]-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[4-(5-methyl-2-thienyl)benzoyl]-L- α -glutamine,
*N*²-[4-(5-chloro-2-thienyl)benzoyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[4-(2-thienyl)benzoyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-{[5-(3-methoxyphenyl)-2-thienyl]carbonyl}-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine,
*N*²-(2,2'-bithien-5-ylcarbonyl)-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-{[6-(3-methoxyphenyl)pyridin-3-yl]carbonyl}-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine,
*N*²-[(3-fluorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-

L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(5-pyridin-4-yl-2-thienyl)carbonyl]-L- α -glutamine,
*N*²-{[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl}-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine,
*N*²-[4-(2,3-dihydro-1-benzofuran-6-yl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
*N*²-{[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl}-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[4-(2-thienyl)benzoyl]-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-{[5-(3-methoxyphenyl)-2-thienyl]carbonyl}-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[(5-phenyl-2-thienyl)carbonyl]-L- α -glutamine,
*N*²-(2,2'-bithien-5-ylcarbonyl)-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[(5-pyridin-4-yl-2-thienyl)carbonyl]-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[4-(5-chloro-2-thienyl)benzoyl]-L- α -glutamine,
*N*²-{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-(5-phenyl-2-furoyl)-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(6-phenylpyridin-3-yl)carbonyl]-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-{[5-(3-methoxyphenyl)-2-thienyl]carbonyl}-L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-[(5-pyridin-3-yl-2-thienyl)carbonyl]-L- α -glutamine,
*N*²-{[5-(3-chloro-4-fluorophenyl)-2-thienyl]carbonyl}-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-(2,2'-bithien-5-ylcarbonyl)-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[4-(5-formyl-2-thienyl)benzoyl]-L- α -glutamine,
*N*²-[4-(5-acetyl-2-thienyl)benzoyl]-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[4-(1,3-thiazol-2-yl)benzoyl]-L- α -

glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[4-(1,3-thiazol-2-yl)benzoyl]-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-(5-phenyl-2-furoyl)-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[4-(5-formyl-2-thienyl)benzoyl]-L- α -
 glutamine,
*N*²-[4-(5-acetyl-2-thienyl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -
 glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[3-(5-chloro-2-thienyl)benzoyl]-L-
 α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[3-(2-thienyl)benzoyl]-L- α -
 glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-{[5-(4-chlorophenyl)-2-
 thienyl]carbonyl}-L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-{[5-(4-fluorophenyl)-2-
 thienyl]carbonyl}-L- α -glutamine,
*N*²-[4-(5-bromo-2-thienyl)benzoyl]-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-L-
 α -glutamine,
*N*²-[4-(5-bromo-2-thienyl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -
 glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-{[5-(4-fluorophenyl)-2-thienyl]carbonyl}-L-
 α -glutamine,
*N*²-[3-(5-chloro-2-thienyl)benzoyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -
 glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[3-(2-thienyl)benzoyl]-L- α -glutamine,
*N*²-[(3'-chlorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-
 L- α -glutamine,
*N*²-[(4'-chlorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-
 L- α -glutamine,
*N*²-[(4'-fluorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-
 L- α -glutamine,
*N*²-[(3'-fluorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-
 L- α -glutamine,
N-[2-(4-chlorophenyl)-1,1-dimethylethyl]-*N*²-[(3-phenyl-2-thienyl)carbonyl]-L- α -
 glutamine,
*N*²-[(4'-chlorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-
 L- α -glutamine,
*N*²-[(3'-chlorobiphenyl-4-yl)carbonyl]-*N*-[2-(4-chlorophenyl)-1,1-dimethylethyl]-
 L- α -glutamine,
N-[2-(4-fluorophenyl)-1,1-dimethylethyl]-*N*²-{[5-(4-fluorophenyl)-2-
 thienyl]carbonyl}-L- α -glutamine,
*N*²-{[5-(4-chlorophenyl)-2-thienyl]carbonyl}-*N*-(1,1-dimethyl-2-phenylethyl)-L-
 α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[(3-phenyl-2-thienyl)carbonyl]-L- α -
 glutamine,
*N*²-(4-bromobenzoyl)-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
N-(1,1-dimethyl-2-phenylethyl)-*N*²-[(4'-fluorobiphenyl-4-yl)carbonyl]-L- α -
 glutamine,

N-(1,1-dimethyl-2-phenylethyl)-*N*²-[(3'-fluorobiphenyl-4-yl)carbonyl]-L- α -glutamine,
*N*²-[4-(5-chloro-2-thienyl)benzoyl]-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-D- α -glutamine,
*N*²-{[6-(5-chloro-2-thienyl)pyridin-3-yl]carbonyl}-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-{[5-(4-chlorophenyl)-2-thienyl]carbonyl}-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-{[5-(3,4-difluorophenyl)-2-thienyl]carbonyl}-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
*N*²-[(4'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
*N*²-({4'-[(1,3-benzodioxol-5-yloxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(1,1-dimethyl-2-phenylethyl)-L- α -glutamine,
*N*²-{[3'-(benzyloxy)biphenyl-4-yl]carbonyl}-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine, *N*²-({3'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
*N*²-({3'-[(3-methoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-(3,4,5-trimethoxybenzyl)-L- α -glutamine,
*N*²-({4'-[(3,5-dimethoxybenzyl)oxy]biphenyl-4-yl}carbonyl)-*N*-[2-(4-fluorophenyl)-1,1-dimethylethyl]-L- α -glutamine,
N-benzyl-*N*²-{[4'-(biphenyl-3-ylmethoxy)biphenyl-4-yl]carbonyl}-L- α -glutamine,
N-benzyl-*N*²-({4'-[(3'-methoxybiphenyl-3-yl)methoxy]biphenyl-4-yl}carbonyl)-L- α -glutamine,
*N*²-({4'-[(3,5-dimethoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(3-methylbenzyl)-L- α -glutamine,
*N*²-({3'-[(3,5-dimethoxyphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(3-methylbenzyl)-L- α -glutamine,
*N*²-[(3'-{[3,5-bis(trifluoromethyl)phenoxy]methyl}biphenyl-4-yl)carbonyl]-*N*-(3-methylbenzyl)-L- α -glutamine,
*N*²-({3'-[(3-ethylphenoxy)methyl]biphenyl-4-yl}carbonyl)-*N*-(3-methylbenzyl)-L- α -glutamine,
N-benzyl-*N*²-{[4'-(biphenyl-2-ylmethoxy)biphenyl-4-yl]carbonyl}-L- α -glutamine,
 or
N-benzyl-*N*²-({4'-[(3'-methoxybiphenyl-2-yl)methoxy]biphenyl-4-yl}carbonyl)-L- α -glutamine.

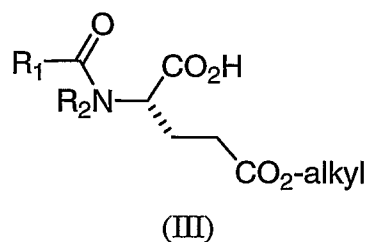
22. A method of modulating the activity of a metalloproteinase in an animal in need thereof comprising contacting the metalloproteinase with an effective amount of a compound or salt claimed in any one of claims 1 to 21.

23. The method of claim 22, wherein the metalloproteinase is a matrix metalloproteinase or an aggrecanase.

24. The method of claim 23, wherein the aggrecanase is aggrecanase-1 or aggrecanase-2.
25. A composition comprising an effective amount of the compound or a pharmaceutically acceptable salt of the compound as claimed in any one of claims 1 to 21 and a pharmaceutically acceptable carrier.
26. The composition of claim 25, wherein the pharmaceutically acceptable carrier is suitable for oral administration and the composition comprises an oral dosage form.
27. A method for treating a metalloproteinase-related disorder, in an animal in need thereof, which comprises, administering an effective dose of the compound as claimed in any one of claims 1 to 21, or a pharmaceutically acceptable salt or hydrate thereof.
28. The method of claim 27, wherein the metalloproteinase is a matrix metalloproteinase or an aggrecanase.
29. The method of claim 28, wherein the aggrecanase is aggrecanase-1 or aggrecanase-2.
30. The method of claim 27, wherein the metalloproteinase-related disorder is selected from the group consisting of arthritic disorders, osteoarthritis, cancer, rheumatoid arthritis, asthma, chronic obstructive pulmonary disease, atherosclerosis, age-related macular degeneration, myocardial infarction, corneal ulceration and other ocular surface diseases, hepatitis, aortic aneurysms, tendonitis, central nervous system diseases, abnormal wound healing, angiogenesis, restenosis, cirrhosis, multiple sclerosis, glomerulonephritis, graft versus host disease, diabetes, inflammatory bowel disease, shock, intervertebral disc degeneration, stroke, osteopenia, and periodontal diseases.
31. The method of claim 30, wherein the metalloproteinase-related disorder is osteoarthritis.

32. A method of synthesizing a compound comprising:

a) treating a compound of the formula (III):



wherein

R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_nR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl, -CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ is hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆)

alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

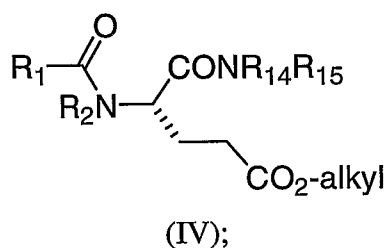
R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; and

n is 0-4;

with an amine, under conditions effective to provide a compound having the formula (IV):



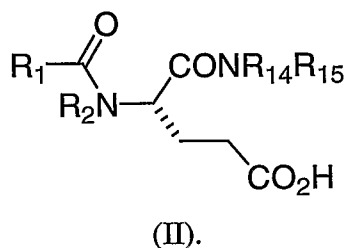
wherein

R₁₄ and R₁₅ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, heterocycloalkyl, -(CH₂)_n-aryl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₁₄ and R₁₅ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S; and

R₁₂ is hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈,

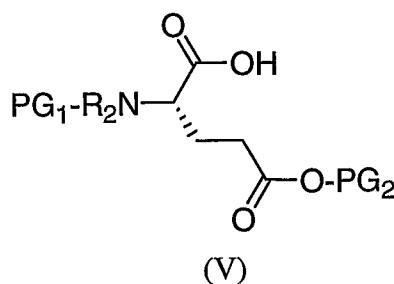
-CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; linear or branched or cyclic (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, or -NH-(C₁-C₆) alkyl; heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl, each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃; and

b) treating the compound of the formula (IV) under conditions effective for hydrolysis of the alkyl ester, thereby providing a compound having the formula (II):



33. A method of synthesizing a compound comprising:

a) treating a compound of the formula (V):



wherein

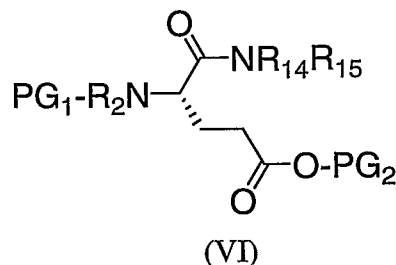
PG₁ is an amine protecting group and PG₂ is a carboxylic acid protecting group;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_nR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₁₁ is aryl, heteroaryl, or cycloalkyl; and

n is 0-4;

with an amine, under conditions effective to provide a compound having the formula (VI):



wherein

R_{14} and R_{15} are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, heterocycloalkyl -(CH₂)_n-aryl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, or heteroaryl optionally substituted with one or more R_{12} ; or R_{14} and R_{15} together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

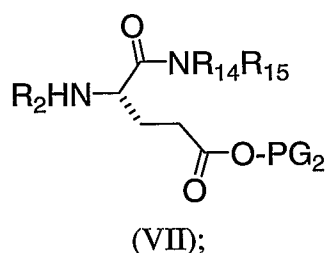
R_{12} is hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R_{13} ;

R_7 and R_8 are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R_7 and R_8 together with the atom to which they are attached

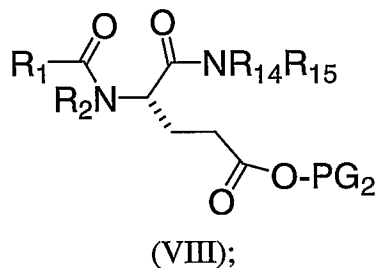
may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S; and

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl;

b) hydrolyzing the amine protecting group of a compound of the formula (VI), under conditions effective to provide a compound having the formula (VII):



c) treating the compound of the formula (VII) with a carboxylic acid, under conditions effective to provide a compound having the formula (VIII):



wherein

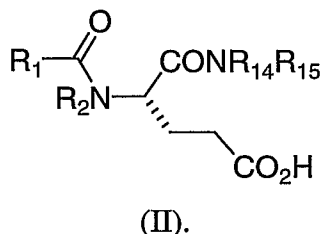
R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl,

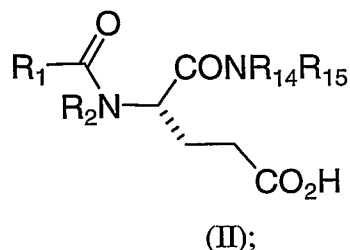
-CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different; and

R₆ is hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃; and

d) treating the compound of the formula (VIII) under conditions effective for hydrolysis of the protected carboxylic acid, thereby providing a compound having the formula (II):

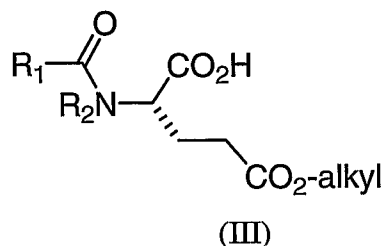


34. A compound of the formula (II):

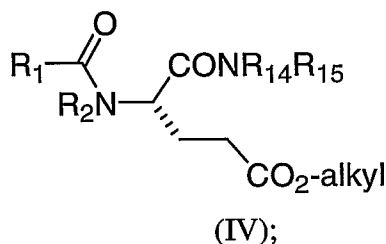


prepared by the method comprising:

a) treating a compound of the formula (III):



with an amine, under conditions effective to provide a compound having the formula (IV):



b) treating the compound of the formula (IV) under conditions effective for hydrolysis of the alkyl ester, thereby providing a compound having the formula (II);

wherein

R_1 is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R_5 or R_6 , and when R_1 is substituted with more than one of R_5 or R_6 , the substituents can be identical or different;

R_2 is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, $-(CH_2)_nR_{11}$, -OH, or -O-(C₁-C₆) alkyl;

R_5 is aryl, heteroaryl, $-(CH_2)_n$ -aryl, $-(CH_2)_n$ -heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl,

-SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl, -CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

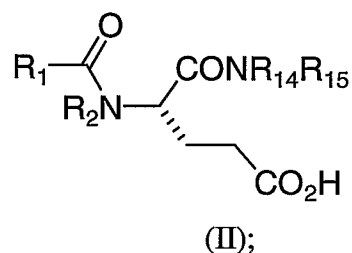
R₁₁ is aryl, heteroaryl, or cycloalkyl;

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl,

$-(CH_2)_n$ -aryl, or $-(CH_2)_n$ -heteroaryl;

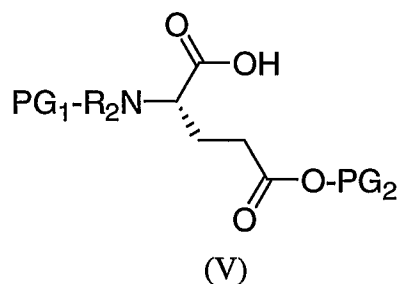
R_{14} and R_{15} are each independently hydrogen, (C_1-C_6) alkyl, aryl, heteroaryl, (C_2-C_6) alkenyl, (C_2-C_6) alkynyl, cycloalkyl, heterocycloalkyl $-(CH_2)_n$ -aryl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, or heteroaryl optionally substituted with one or more R_{12} ; or R_{14} and R_{15} together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S; and n is 0-4.

35. A compound of the formula (II):

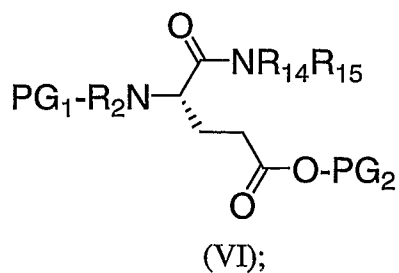


prepared by the method comprising:

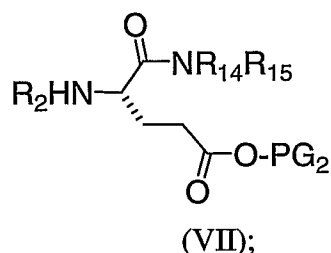
a) treating a compound of the formula (V):



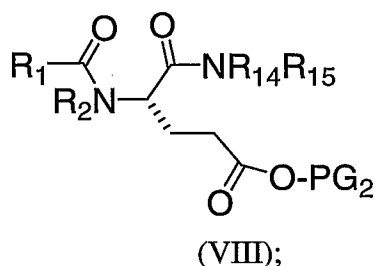
with an amine, under conditions effective to provide a compound having the formula (VI):



b) hydrolyzing the amine protecting group of a compound of the formula (VI), under conditions effective to provide a compound having the formula (VII):



c) treating the compound of the formula (VII) with a carboxylic acid, under conditions effective to provide a compound having the formula (VIII):



d) treating the compound of the formula (VIII) under conditions effective for hydrolysis of the protected carboxylic acid, thereby providing a compound having the formula (II);

wherein

PG₁ is an amine protecting group and PG₂ is a carboxylic acid protecting group;

R₁ is phenyl, heteroaryl, biphenyl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl, each optionally substituted with one or more of R₅ or R₆, and when R₁ is substituted with more than one of R₅ or R₆, the substituents can be identical or different;

R₂ is hydrogen, (C₁-C₆) alkyl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, -(CH₂)_nR₁₁, -OH, or -O-(C₁-C₆) alkyl;

R₅ is aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, -S-heteroaryl, -NH-aryl, -NH-heteroaryl, -CO-(C₁-C₆) alkyl, -CO-aryl, -CO-heteroaryl, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂NH-aryl, -SO₂NH-heteroaryl, -NHSO₂-(C₁-C₆) alkyl, -NHSO₂-aryl, -NHSO₂-heteroaryl, -NHCO-aryl, -NHCO-heteroaryl, -CONH-aryl,

-CONH-heteroaryl, (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, or -CONH-(C₃-C₆) cycloalkyl; each alkyl, aryl, cycloalkyl, or heteroaryl optionally substituted with one or more of R₆, and when R₅ is substituted with more than one R₆, the substituents can be identical or different;

R₆ and R₁₂ are each independently hydrogen, halogen, -CN, -OCF₃, -CF₃, -NO₂, -OH, -SH, -NR₇R₈, -CONR₇R₈, -NR₈COR₇, -NR₈CO₂R₇, -CO₂R₇, -COR₇, -SO₂-(C₁-C₆) alkyl, -SO₂-aryl, -SO₂-heteroaryl, -SO₂R₇, -NR₇SO₂R₈, -SO₂NR₇R₈; (C₁-C₆) alkyl, -O-(C₁-C₆) alkyl, -S-(C₁-C₆) alkyl, -NH-(C₁-C₆) alkyl, -NHCO-(C₁-C₆) alkyl, -CONH-(C₁-C₆) alkyl, -O-(C₃-C₆) cycloalkyl, -S-(C₃-C₆) cycloalkyl, -NH-(C₃-C₆) cycloalkyl, -NHCO-(C₃-C₆) cycloalkyl, -CONH-(C₃-C₆) cycloalkyl, heterocycloalkyl, -(C₁-C₆) alkyl-OR₇, (C₂-C₆) alkynyl, (C₂-C₆) alkenyl, -O-(C₁-C₆) alkyl-(C₃-C₆) cycloalkyl, -O-alkenyl, -O-(C₁-C₆) alkyl substituted with aryl, aryl, heteroaryl, -(CH₂)_n-aryl, -(CH₂)_n-heteroaryl, -O-aryl, -O-heteroaryl, -S-aryl, or -S-heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, heteroaryl, alkenyl, or alkynyl optionally substituted with one or more of R₁₃;

R₇ and R₈ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl; or R₇ and R₈ together with the atom to which they are attached may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S;

R₁₁ is aryl, heteroaryl, or cycloalkyl;

R₁₃ is halogen, -O-(C₁-C₆) alkyl, -CO₂H, -OH, -CF₃, hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl, (C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, cycloalkyl substituted with -OH, aryl substituted with -NH₂, aryl substituted with -O-(C₁-C₆) alkyl, -(CH₂)_n-aryl, or -(CH₂)_n-heteroaryl;

R₁₄ and R₁₅ are each independently hydrogen, (C₁-C₆) alkyl, aryl, heteroaryl,

(C₂-C₆) alkenyl, (C₂-C₆) alkynyl, cycloalkyl, heterocycloalkyl -(CH₂)_n-aryl, bicyclic aryl, tricyclic aryl, bicyclic heteroaryl, or tricyclic heteroaryl; each alkyl, aryl, cycloalkyl, heterocycloalkyl, or heteroaryl optionally substituted with one or more R₁₂; or R₁₄ and R₁₅ together may form a five- to seven-membered cyclic group containing up to 3 heteroatoms selected from N, O, or S; and

n is 0-4.