(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 June 2017 (22.06.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/102796 A1

(51) International Patent Classification:
C07D 417/12 (2006.01) *A61P 29/00* (2006.01)
A61K 31/541 (2006.01)

(21) International Application Number:
PCT/EP2016/080904

(22) International Filing Date:
14 December 2016 (14.12.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/268,302 16 December 2015 (16.12.2015) US

(71) Applicant *(for all designated States except US)*: **F. HOFFMANN-LA ROCHE AG** [CH/CH]; Grenzacherstrasse 124, 4070 Basel (CH).

(71) Applicant *(for US only)*: **GENENTECH, INC.** [US/US]; 1 DNA Way, South San Francisco, California 94080 (US).

(72) Inventors: **FAUBER, Benjamin**; c/o Genentech Inc., 1 DNA Way, South San Francisco, California 94080 (US). **RENE, Olivier**; c/o Genentech Inc., 1 DNA Way, South San Francisco, California 94080 (US).

(74) Agent: **BERNARD, Guillaume**; Grenzacherstrasse 124, 4070 Basel (CH).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

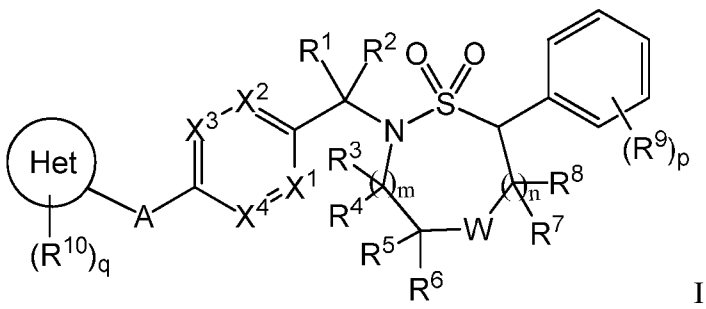
— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: HETEROARYL AMIDE SULTAM DERIVATIVES AS RORc MODULATORS



I

(57) Abstract: Compounds of the formula I: (I) or a pharmaceutical salt thereof, wherein m, n, p, q, Het, A, W, R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} are as defined herein. Also disclosed are methods of making the compounds and using the compounds for treatment of inflammatory diseases such as arthritis.

WO 2017/102796 A1

HETEROARYL AMIDE SULTAM DERIVATIVES AS RORc MODULATORS

FIELD OF THE INVENTION

The invention pertains to compounds that modulate the function of retinoid-receptor related orphan receptor RORc (RORγ) and use of such compounds for treatment of autoimmune diseases

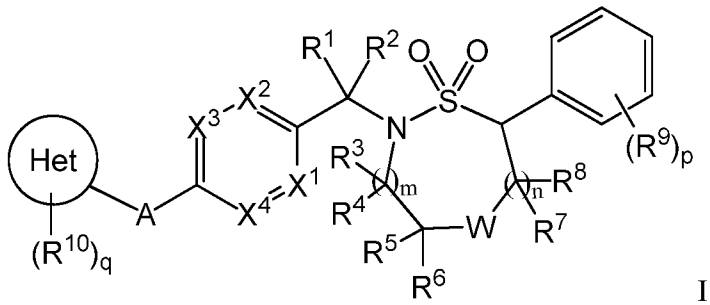
BACKGROUND OF THE INVENTION

T helper 17 cells (Th17) are interleukin (IL)-17 secreting CD4+ T cells involved in pathogenesis of autoimmune diseases such as rheumatoid arthritis, irritable bowel disease, psoriasis, psoriatic arthritis and spondyloarthridities. The retinoic acid-related orphan receptor γ (RORγ or RORc) is recognized as a transcription factor necessary for Th17 cell differentiation. RORc is an orphan member of the nuclear hormone receptor subfamily that includes RORα (RORa) and RORβ (RORb). RORc controls gene transcription by binding to DNA as a monomer. Selective modulation of RORc has been proposed as a route to discovery and development of Th17 cell-associated autoimmune diseases.

There is accordingly a need for compounds that inhibit RORc for use in treatment of autoimmune diseases such as rheumatoid arthritis, irritable bowel disease, psoriasis, psoriatic arthritis and spondyloarthriitis.

SUMMARY OF THE INVENTION

The invention provides compounds of formula I:



I

or a pharmaceutically acceptable salt thereof,

wherein:

m is 0 or 1;

n is 0 or 1;

p is from 0 to 3;

q is from 0 to 3;

Het is:

a five or six membered heteroaryl selected from:

pyrrolyl;

pyrrazolyl;

imidazolyl;

oxazolyl;

thiazolyl;

isoxazolyl;

isothiazolyl;

triazolyl;

oxadiazolyl;

thiadiazolyl;

tetrazolyl;

thiophenyl;

furanyl;

pyridinyl;

pyrimidinyl;

pyridazinyl; or

pyrazinyl; or

a five membered heterocyclyl selected from:

pyrrolidinyl;

oxazolidinyl;

dioxolanyl; or

imidazolidinyl;

A is:

$-(CH_2)_r-C(O)-NH-C_{1-6}$alkylene;

wherein each such C_{1-6}alkenylene may be unsubstituted or substituted once or twice with R^a;

r is: 0 or 1;

W is: $-CR^bR^c-$; -O-; -S-; $-SO_2-$; or $-NR^d-$;

one of X^1, X^2, X^3 and X^4 is N and the others are CR^e; or two of X^1, X^2, X^3 and X^4 are N and the others are CR^e; or three of X^1, X^2, X^3 and X^4 are N and the other is CR^e; or each of X^1, X^2, X^3 and X^4 is CR^e;

R^1, R^2, R^3, R^4, R^5, R^6, R^7 and R^8 each independently is: hydrogen; or C_{1-6}alkyl which may be unsubstituted or substituted one or more times with halo;

or R^3 and R^4 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, $-NR^d-$ or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or R^5 and R^6 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, $-NR^d-$ or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or R^7 and R^8 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, $-NR^d-$ or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^3 and R^4 together with one of R^5 and R^6 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, $-NR^d-$ or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^5 and R^6 together with one of R^7 and R^8 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, $-NR^d-$ or -S-, and which may be unsubstituted or substituted one or more times with R^f;

each R^9 is independently:

C_{1-6}alkyl;

halo;

C_{1-6}alkoxy; or

cyano;

wherein the C_{1-6}alkyl moieties may be unsubstituted or substituted one or more times with halo;

each R^{10} is independently:

amino;

C_{1-6}alkoxy;

C_{1-6}alkyl;

oxo;

hydroxy

halo;

cyano;

halo-C_{1-6}alkyl;

hydroxy-C_{1-6}alkyl;

C_{1-6}alkoxy-C_{1-6}alkyl; or

cyano-C_{1-6}alkyl.

R^a is:

C_{1-6}alkoxy;

C_{1-6}alkoxy-C_{1-6}alkyl;

hydroxy-C_{1-6}alkyl;

C_{3-6}cycloalkyl;

C_{3-6}cycloalkyl-C_{1-6}alkyl;

C_{3-6}cycloalkyloxy;

C_{3-6}cycloalkyl-C_{1-6}alkoxy;

heterocyclyl;

heterocylyl-C_{1-6}alkyl; or

heterocylyl-C_{1-6}alkoxy;

wherein the heterocyclyl moieties are each independently selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, and wherein the heterocycyl moieties and C_{3-6}cycloalkyl moieties each may be unsubstituted or substituted one or more times with R^f;

R^b, R^c, and R^d each independent is:

hydrogen;

C_{1-6}alkyl; or

halo-C_{1-6}alkyl;

or R^b and R^c together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^b and R^c together with one of R^7 and R^8 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^b and R^c together with one of R^5 and R^6 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

each R^e is independently:

hydrogen;

C_{1-6}alkyl;

halo;

C_{1-6}alkoxy; or

cyano;

wherein the C_{1-6}alkyl moieties may be unsubstituted or substituted one or more times with halo; and

R^f is: C_{1-6}alkyl; halo-C_{1-6}alkyl; halo; oxo; hydroxy; or C_{1-6}alkoxy;

provided that the compound is not *N*-(1-(2,5-difluoro-4-(((3*S*,6*R*)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1*H*-imidazole-1-carboxamide.

The invention also provides and pharmaceutical compositions comprising the compounds, methods of using the compounds, and methods of preparing the compounds.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

Unless otherwise stated, the following terms used in this Application, including the specification and claims, have the definitions given below. It must be noted that, as used in

the specification and the appended claims, the singular forms “a”, “an,” and “the” include plural referents unless the context clearly dictates otherwise. In some instances dashes (“-“) may be used interchangeably within definitions (for example, “alkoxyalkyl” omits the dash found in the equivalent term “alkoxy-alkyl”).

“Alkyl” means the monovalent linear or branched saturated hydrocarbon moiety, consisting solely of carbon and hydrogen atoms, having from one to twelve carbon atoms. “Lower alkyl” refers to an alkyl group of one to six carbon atoms, i.e. C_1-C_6alkyl. Examples of alkyl groups include, but are not limited to, methyl, ethyl, propyl, isopropyl, isobutyl, sec-butyl, tert-butyl, pentyl, n-hexyl, octyl, dodecyl, and the like.

"Alkenyl" means a linear monovalent hydrocarbon radical of two to six carbon atoms or a branched monovalent hydrocarbon radical of three to six carbon atoms, containing at least one double bond, *e.g.*, ethenyl, propenyl, and the like.

"Alkynyl" means a linear monovalent hydrocarbon radical of two to six carbon atoms or a branched monovalent hydrocarbon radical of three to six carbon atoms, containing at least one triple bond, *e.g.*, ethynyl, propynyl, and the like.

“Alkylene” means a linear saturated divalent hydrocarbon radical of one to six carbon atoms or a branched saturated divalent hydrocarbon radical of three to six carbon atoms, e.g., methylene, ethylene, 2,2-dimethylethylene, propylene, 2-methylpropylene, butylene, pentylene, and the like.

“Alkoxy” and "alkyloxy", which may be used interchangeably, mean a moiety of the formula –OR, wherein R is an alkyl moiety as defined herein. Examples of alkoxy moieties include, but are not limited to, methoxy, ethoxy, isopropoxy, and the like.

“Alkoxyalkyl” means a moiety of the formula R^a–O–R^b–, where R^a is alkyl and R^b is alkylene as defined herein. Exemplary alkoxyalkyl groups include, by way of example, 2-methoxyethyl, 3-methoxypropyl, 1-methyl-2-methoxyethyl, 1-(2-methoxyethyl)-3-methoxypropyl, and 1-(2-methoxyethyl)-3-methoxypropyl.

“Alkoxyalkoxy’ means a group of the formula -O-R-R’ wherein R is alkylene and R’ is alkoxy as defined herein.

"Alkylcarbonyl" means a moiety of the formula –C(O)–R, wherein R is alkyl as defined herein.

"Alkoxycarbonyl" means a group of the formula -C(O)-R wherein R is alkoxy as defined herein.

"Alkylcarbonylamino" means a group of the formula -R-C(O)-NR'- wherein R is alkyl and R' is hydrogen or alkyl.

"Alkylcarbonylalkyl" means a group of the formula -R-C(O)-R' wherein R is alkylene and R' is alkyl as defined herein.

"Alkoxyalkylcarbonyl" means a moiety of the formula –C(O)–R-R', wherein R is alkylene and R' is alkoxy as defined herein.

"Alkoxycarbonylalkyl" means a group of the formula -R-C(O)-R wherein R is alkylene and R' is alkoxy as defined herein.

"Alkoxycarbonylamino" means a moiety of the formula R-C(O)-NR'-, wherein R is alkoxy and R' is hydrogen or alkyl as defined herein.

"Alkoxycarbonylaminoalkyl" means a moiety of the formula R-C(O)-NR'-R"-, wherein R is alkoxy, R' is hydrogen or alkyl, and R" is alkylene as defined herein.

"Alkoxycarbonylalkoxy"means a group of the formula -O-R-C(O)-R' wherein R is alkylene and R' is alkoxy as defined herein.

"Hydroxycarbonylalkoxy" means a group of the formula -O-R-C(O)-OH wherein R is alkylene as defined herein.

"Alkylaminocarbonylalkoxy" means a group of the formula -O-R-C(O)-NHR' wherein R is alkylene and R' is alkyl as defined herein.

"Dialkylaminocarbonylalkoxy" means a group of the formula -O-R-C(O)-NR'R" wherein R is alkylene and R' and R" are alkyl as defined herein.

"Alkylaminoalkoxy" means a group of the formula -O-R-NHR' wherein R is alkylene and R' is alkyl as defined herein.

"Dialkylaminoalkoxy" means a group of the formula -O-R-NR'R' wherein R is alkylene and R' and R" are alkyl as defined herein.

"Alkylsulfonyl" means a moiety of the formula – SO_2–R, wherein R is alkyl as defined herein.

"Alkylsulfonylalkyl means a moiety of the formula -R'-SO_2-R" where where R' is alkylene and R" is alkyl as defined herein.

"Alkylsulfonylalkoxy" means a group of the formula -O-R-SO_2-R' wherein R is alkylene and R' is alkyl as defined herein.

"Amino means a moiety of the formula -NRR' wherein R and R' each independently is hyrdogen or alkyl as defined herein. "Amino thus includes "alkylamino (where one of R and R' is alkyl and the other is hydrogen) and "dialkylamino (where R and R' are both alkyl.

"Aminocarbonyl" means a group of the formula -C(O)-R wherein R is amino as defined herein.

"N-hydroxy-aminocarbonyl" means a group of the formula -C(O)-NR-OH wherein R is hydrogen or alkyl as defined herein.

"N-alkoxy-aminocarbonyl" means a group of the formula -C(O)-NR-R' wherein R is hydrogen or alkyl and R' is alkoxy as defined herein.

"Aminocarbonylaminoalkyl" means a group of the formula R_2N-C(O)-NR'-R"- wherein each R is independently hydrogen or alkyl, R' is hydrogen or alkyl, and R" is alkylene as defined herein.

"N-alkyl-aminocarbonyl means a group of the formula -C(O)-NH-R wherein R is alkyl as defined herein.

"N-hydroxy-N-alkylaminocarbonyl means a group of the formula -C(O)-NRR' wherein R is alkyl as defined herein and R' is hydroxy.

"N-alkoxy-N-alkylaminocarbonyl" means a group of the formula -C(O)-NRR' wherein R is alkyl and R' is alkoxy as defined herein.

"N,N-di-C_{1-6}alkyl-aminocarbonyl" means a group of the formula -C(O)-NRR' wherein R and R' are alkyl as defined herein.

"Aminosulfonyl" means a group of the formula -SO_2-NH_2.

"N-alkylaminosulfonyl" means a group of the formula -SO_2-NHR wherein R is alkyl as defined herein.

"N,N-dialkylaminosulfonyl" means a group of the formula -SO_2-NRR' wherein R and R' are alkyl as defined herein.

"Alkylsulfonylamino" means a group of the formula -NR'-SO_2-R wherein R id alkyl and R' is hydrogen or alkyl as defined herein.

"N-(alkylsulfonyl)-aminoalkyl" means a group of the formula -R-NH-SO_2-R' wherein R is alkylene and R' is alkyl as defined herein.

"N-(Alkylsulfonyl)aminocarbonyl" means a group of the formula -C(O)-NH-SO_2-R wherein wherein R is alkyl as defined herein.

"N-(Alkylsulfonyl)-N-alkylaminocarbonyl" means a group of the formula -C(O)-NR-SO_2-R' wherein wherein R and R' are alkyl as defined herein.

"N-Alkoxyalkyl-aminocarbonyl" means a group of the formula -C(O)-NR-R'-OR" wherein R is hydrogen or alkyl, R' is alkylene, and R" is alkyl as defined herein.

"N-Hydroxyalkyl-aminocarbonyl" means a group of the formula -C(O)-NR-R'-OH" wherein R is hydrogen or alkyl and R' is alkylene as defined herein.

"Alkoxyamino" means a moiety of the formula -NR-OR' wherein R is hydrogen or alkyl and R' is alkyl as defined herein.

"Alkylsulfanyl" means a moiety of the formula -SR wherein R is alkyl as defined herein.

"Aminoalkyl" means a group -R-R' wherein R' is amino and R is alkylene as defined herein.

"Aminoalkyl" includes aminomethyl, aminoethyl, 1-aminopropyl, 2-aminopropyl, and the like. The amino moiety of "aminoalkyl" may be substituted once or twice with alkyl to provide "alkylaminoalkyl" and "dialkylaminoalkyl" respectively. "Alkylaminoalkyl" includes methylaminomethyl, methylaminoethyl, methylaminopropyl, ethylaminoethyl and the like. "Dialkylaminoalkyl" includes dimethylaminomethyl, dimethylaminoethyl, dimethylaminopropyl, N-methyl-N-ethylaminoethyl, and the like.

"Aminoalkoxy" means a group -OR-R' wherein R' is amino and R is alkylene as defined herein.

"Alkylsulfonylamido" means a moiety of the formula -NR'SO_2-R wherein R is alkyl and R' is hydrogen or alkyl.

"Aminocarbonyloxyalkyl" or "carbamylalkyl" means a group of the formula -R-O-C(O)-NR'R" wherein R is alkylene and R', R" each independently is hydrogen or alkyl as defined herein.

"Alkynylalkoxy" means a group of the formula -O-R-R' wherein R is alkylene and R' is alkynyl as defined herein.

"Aryl" means a monovalent cyclic aromatic hydrocarbon moiety consisting of a mono-, bi- or tricyclic aromatic ring. The aryl group can be optionally substituted as defined herein. Examples of aryl moieties include, but are not limited to, phenyl, naphthyl, phenanthryl,

fluorenyl, indenyl, pentalenyl, azulenyl, oxydiphenyl, biphenyl, methylenediphenyl, aminodiphenyl, diphenylsulfidyl, diphenylsulfonyl, diphenylisopropylidenyl, benzodioxanyl, benzofuranyl, benzodioxylyl, benzopyranyl, benzoxazinyl, benzoxazinonyl, benzopiperadinyl, benzopiperazinyl, benzopyrrolidinyl, benzomorpholinyl, methylenedioxyphenyl, ethylenedioxyphenyl, and the like, of which may be optionally substituted as defined herein.

"Arylalkyl" and "Aralkyl", which may be used interchangeably, mean a radical-R^aR^b where R^a is an alkylene group and R^b is an aryl group as defined herein; *e.g.*, phenylalkyls such as benzyl, phenylethyl, 3-(3-chlorophenyl)-2-methylpentyl, and the like are examples of arylalkyl.

"Arylsulfonyl means a group of the formula -SO_2-R wherein R is aryl as defined herein.

"Aryloxy" means a group of the formula -O-R wherein R is aryl as defined herein.

"Aralkyloxy" means a group of the formula -O-R-R" wherein R is alkylene and R' is aryl as defined herein.

“Carboxy” or “hydroxycarbonyl”, which may be used interchangeably, means a group of the formula -C(O)-OH.

"Cyanoalkyl" ” means a moiety of the formula –R’–R”, where R’ is alkylene as defined herein and R” is cyano or nitrile.

“Cycloalkyl” means a monovalent saturated carbocyclic moiety consisting of mono- or bicyclic rings. Particular cycloalkyl are unsubstituted or substituted with alkyl. Cycloalkyl can optionally be substituted as defined herein. Unless defined otherwise, cycloalkyl may be optionally substitued with one or more substituents, wherein each substituent is independently hydroxy, alkyl, alkoxy, halo, haloalkyl, amino, monoalkylamino, or dialkylamino. Examples of cycloalkyl moieties include, but are not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, and the like, including partially unsaturated (cycloalkenyl) derivatives thereof.

“Cycloalkenyl” means a cycloalkyl as defined herein that includes at least one double bond or unsaturation. Exemplary cycloalkenyl include cyclohexenyl, cyclopentenyl, cyclobutenyl and the like.

“Cycloalkylalkyl” means a moiety of the formula –R’–R”, where R’ is alkylene and R” is cycloalkyl as defined herein.

"Cycloalkylalkoxy" means a group of the formula -O-R-R' wherein R is alkylene and R' is cycloalkyl as defined herein.

"Cycloalkylcarbonyl" means a moiety of the formula –C(O)–R, wherein R is cycloalkyl as defined herein.

"C_{3-6}cycloalkyl-C_{1-6}alkyl-carbonyl" means a moiety of the formula –C(O)–R, wherein R is cycloalkylalkyl as defined herein.

"Cyanoalkylcarbonyl" means a moiety of the formula –C(O)–R-R', wherein R is alkylene as defined herein and R' is cyano or nitrile.

"N-Cyano-aminocarbonyl" means a moiety of the formula –C(O)–NHR, wherein R is cyano or nitrile.

"N-Cyano-N-alkyl-aminocarbonyl" means a moiety of the formula –C(O)–NRR'-R, wherein R' is alkyl as defined herein and R is cyano or nitrile.

"Cycloalkylsulfonyl" means a group of the formula -SO_2-R wherein R is cycloalkyl as defined herein.

"Cycloalkylalkylsulfonyl" means a group of the formula -SO_2-R wherein R is cycloalkylalkyl as defined herein.

"Formyl" means a moiety of the formula –C(O)–H.

"Heteroaryl" means a monocyclic or bicyclic radical of 5 to 12 ring atoms having at least one aromatic ring containing one, two, or three ring heteroatoms selected from N, O, or S, the remaining ring atoms being C, with the understanding that the attachment point of the heteroaryl radical will be on an aromatic ring. The heteroaryl ring may be optionally substituted as defined herein. Examples of heteroaryl moieties include, but are not limited to, optionally substituted imidazolyl, oxazolyl, isoxazolyl, thiazolyl, isothiazolyl, oxadiazolyl, thiadiazolyl, pyrazinyl, thienyl, benzothienyl, thiophenyl, furanyl, pyranyl, pyridyl, pyrrolyl, pyrazolyl, pyrimidyl, quinolinyl, isoquinolinyl, benzofuryl, benzothiophenyl, benzothiopyranyl, benzimidazolyl, benzooxazolyl, benzooxadiazolyl, benzothiazolyl, benzothiadiazolyl, benzopyranyl, indolyl, isoindolyl, triazolyl, triazinyl, quinoxalinyl, purinyl, quinazolinyl, quinolizinyl, naphthyridinyl, pteridinyl, carbazolyl, azepinyl, diazepinyl, acridinyl and the like, each of which may be optionally substituted as defined herein.

Heteroarylalkyl" or "heteroaralkyl" means a group of the formula -R-R' wherein R is alkylene and R' is heteroaryl as defined herein.

"Heteroarylsulfonyl means a group of the formula -SO_2-R wherein R is heteroaryl as defined herein.

"Heteroaryloxy" means a group of the formula -O-R wherein R is heteroaryl as defined herein.

"Heteroaralkyloxy" means a group of the formula -O-R-R" wherein R is alkylene and R' is heteroaryl as defined herein.

The terms "halo", "halogen" and "halide", which may be used interchangeably, refer to a substituent fluoro, chloro, bromo, or iodo.

"Haloalkyl" means alkyl as defined herein in which one or more hydrogen has been replaced with same or different halogen. Exemplary haloalkyls include –CH_2Cl, –CH_2CF_3, –CH_2CCl_3, perfluoroalkyl (e.g., –CF_3), and the like.

"Haloalkoxy" means a moiety of the formula –OR, wherein R is a haloalkyl moiety as defined herein. An exemplary haloalkoxy is difluoromethoxy.

"Heterocycloamino" means a saturated ring wherein at least one ring atom is N, NH or N-alkyl and the remaining ring atoms form an alkylene group.

"Heterocyclyl" means a monovalent saturated moiety, consisting of one to three rings, incorporating one, two, or three or four heteroatoms (chosen from nitrogen, oxygen or sulfur). The heterocyclyl ring may be optionally substituted as defined herein. Examples of heterocyclyl moieties include, but are not limited to, optionally substituted piperidinyl, piperazinyl, morpholinyl, thiomorpholinyl, azepinyl, pyrrolidinyl, azetidinyl, tetrahydropyranyl, tetrahydrofuranyl, oxetanyl and the like. Such heterocyclyl may be optionally substituted as defined herein.

"Heterocyclylalkyl" means a moiety of the formula -R-R' wherein R is alkylene and R' is heterocyclyl as defined herein.

"Heterocyclyloxy" means a moiety of the formula -OR wherein R is heterocyclyl as defined herein.

"Heterocyclylalkoxy" means a moiety of the formula -OR-R' wherein R is alkylene and R' is heterocyclyl as defined herein.

"Hydroxyalkoxy" means a moiety of the formula -OR wherein R is hydroxyalkyl as defined herein.

"Hydroxyalkylamino" means a moiety of the formula -NR-R' wherein R is hydrogen or alkyl and R' is hydroxyalkyl as defined herein.

"Hydroxyalkylaminoalkyl" means a moiety of the formula -R-NR'-R" wherein R is alkylene, R' is hydrogen or alkyl, and R" is hydroxyalkyl as defined herein.

"Hydroxycarbonylalkyl" or "carboxyalkyl" means a group of the formula -R-(CO)-OH where R is alkylene as defined herein.

"Hydroxycarbonylalkoxy" means a group of the formula -O-R-C(O)-OH wherein R is alkylene as defined herein.

"Hydroxyalkylcarbonyl" means a moiety of the formula –C(O)–R-R', wherein R is alkylene as defined herein and R' is hydroxy.

"Hydroxyalkyloxycarbonylalkyl" or "hydroxyalkoxycarbonylalkyl" means a group of the formula -R-C(O)-O-R-OH wherein each R is alkylene and may be the same or different.

"Hydroxyalkyl" means an alkyl moiety as defined herein, substituted with one or more, for example, one, two or three hydroxy groups, provided that the same carbon atom does not carry more than one hydroxy group. Representative examples include, but are not limited to, hydroxymethyl, 2-hydroxyethyl, 2-hydroxypropyl, 3-hydroxypropyl, 1-(hydroxymethyl)-2-methylpropyl, 2-hydroxybutyl, 3-hydroxybutyl, 4-hydroxybutyl, 2,3-dihydroxypropyl, 2-hydroxy-1-hydroxymethylethyl, 2,3-dihydroxybutyl, 3,4-dihydroxybutyl and 2-(hydroxymethyl)-3-hydroxypropyl

"Hydroxycycloalkyl" means a cycloalkyl moiety as defined herein wherein one, two or three hydrogen atoms in the cycloalkyl radical have been replaced with a hydroxy substituent. Representative examples include, but are not limited to, 2-, 3-, or 4-hydroxycyclohexyl, and the like.

"Oxo" means a group of the formula =O (i.e., an oxygen with a double bond). Thus, for example, a 1-oxo-ethyl group is an acetyl group.

"Alkoxy hydroxyalkyl" and "hydroxy alkoxyalkyl", which may be used interchangeably, means an alkyl as defined herein that is substituted at least once with hydroxy and at least once with alkoxy.

"Alkoxy hydroxyalkyl" and "hydroxy alkoxyalkyl" thus encompass, for example, 2-hydroxy-3-methoxy-propan-1-yl and the like.

"Urea"or "ureido" means a group of the formula -NR'-C(O)-NR"R'" wherein R', R" and R'" each independently is hydrogen or alkyl.

"Carbamate" means a group of the formula -O-C(O)-NR'R" wherein R' and R" each independently is hydrogen or alkyl.

"Carboxy" means a group of the formula -O-C(O)-OH.

"Sulfonamido" means a group of the formula -SO_2-NR'R" wherein R', R" and R'" each independently is hydrogen or alkyl.

"Optionally substituted" when used in association with an "aryl", phenyl", "heteroaryl" "cycloalkyl" or "heterocyclyl" moiety means that such moiety may be unsubstituted (i.e., all open valencies are occupied by a hydrogen atom) or substituted with specific groups as related herein.

"Leaving group" means the group with the meaning conventionally associated with it in synthetic organic chemistry, i.e., an atom or group displaceable under substitution reaction conditions. Examples of leaving groups include, but are not limited to, halogen, alkane- or arylenesulfonyloxy, such as methanesulfonyloxy, ethanesulfonyloxy, thiomethyl, benzenesulfonyloxy, tosyloxy, and thienyloxy, dihalophosphinoyloxy, optionally substituted benzyloxy, isopropyloxy, acyloxy, and the like.

"Modulator" means a molecule that interacts with a target. The interactions include, but are not limited to, agonist, antagonist, and the like, as defined herein.

"Optional" or "optionally" means that the subsequently described event or circumstance may but need not occur, and that the description includes instances where the event or circumstance occurs and instances in which it does not.

"Disease" and "Disease state" means any disease, condition, symptom, disorder or indication.

"Inert organic solvent" or "inert solvent" means the solvent is inert under the conditions of the reaction being described in conjunction therewith, including for example, benzene, toluene, acetonitrile, tetrahydrofuran, N,N-dimethylformamide, chloroform, methylene chloride or dichloromethane, dichloroethane, diethyl ether, ethyl acetate, acetone, methyl ethyl ketone, methanol, ethanol, propanol, isopropanol, *tert*-butanol, dioxane, pyridine, and the like. Unless specified to the contrary, the solvents used in the reactions of the present invention are inert solvents.

"Pharmaceutically acceptable" means that which is useful in preparing a pharmaceutical composition that is generally safe, non-toxic, and neither biologically nor otherwise undesirable and includes that which is acceptable for veterinary as well as human pharmaceutical use.

"Pharmaceutically acceptable salts" of a compound means salts that are pharmaceutically acceptable, as defined herein, and that possess the desired pharmacological activity of the parent compound.

It should be understood that all references to pharmaceutically acceptable salts include solvent addition forms (solvates) or crystal forms (polymorphs) as defined herein, of the same acid addition salt.

"Protective group" or "protecting group" means the group which selectively blocks one reactive site in a multifunctional compound such that a chemical reaction can be carried out selectively at another unprotected reactive site in the meaning conventionally associated with it in synthetic chemistry. Certain processes of this invention rely upon the protective groups to block reactive nitrogen and/or oxygen atoms present in the reactants. For example, the terms "amino-protecting group" and "nitrogen protecting group" are used interchangeably herein and refer to those organic groups intended to protect the nitrogen atom against undesirable reactions during synthetic procedures. Exemplary nitrogen protecting groups include, but are not limited to, trifluoroacetyl, acetamido, benzyl (Bn), benzyloxycarbonyl (carbobenzyloxy, CBZ), p-methoxybenzyloxycarbonyl, p-nitrobenzyloxycarbonyl, *tert*-butoxycarbonyl (BOC), and the like. The artisan in the art will know how to chose a group for the ease of removal and for the ability to withstand the following reactions.

"Solvates" means solvent additions forms that contain either stoichiometric or non stoichiometric amounts of solvent. Some compounds have a tendency to trap a fixed molar ratio of solvent molecules in the crystalline solid state, thus forming a solvate. If the solvent is water the solvate formed is a hydrate, when the solvent is alcohol, the solvate formed is an alcoholate. Hydrates are formed by the combination of one or more molecules of water with one of the substances in which the water retains its molecular state as H_2O, such combination being able to form one or more hydrate.

"Arthritis" means a disease or condition that causes damage to joints of the body and pain associated with such joint damage. Arthritis includes rheumatoid arthritis, osteoarthritis,

psoriatic arthritis, septic arthritis, spondyloarthropathies, gouty arthritis, systemic lupus erythematosus and juvenile arthritis, osteoarthritis, and other arthritic conditions.

"Respiratory disorder" refers to, without limitation, chronic obstructive pulmonary disease (COPD), asthma, bronchospasm, and the like.

"Subject" means mammals and non-mammals. Mammals means any member of the mammalia class including, but not limited to, humans; non-human primates such as chimpanzees and other apes and monkey species; farm animals such as cattle, horses, sheep, goats, and swine; domestic animals such as rabbits, dogs, and cats; laboratory animals including rodents, such as rats, mice, and guinea pigs; and the like. Examples of non-mammals include, but are not limited to, birds, and the like. The term "subject" does not denote a particular age or sex.

"Therapeutically effective amount" means an amount of a compound that, when administered to a subject for treating a disease state, is sufficient to effect such treatment for the disease state. The "therapeutically effective amount" will vary depending on the compound, disease state being treated, the severity or the disease treated, the age and relative health of the subject, the route and form of administration, the judgment of the attending medical or veterinary practitioner, and other factors.

The terms "those defined above" and "those defined herein" when referring to a variable incorporates by reference the broad definition of the variable as well as particular definitions, if any.

"Treating" or "treatment" of a disease state includes, inter alia, inhibiting the disease state, *i.e.*, arresting the development of the disease state or its clinical symptoms, and/or relieving the disease state , *i.e.*, causing temporary or permanent regression of the disease state or its clinical symptoms.

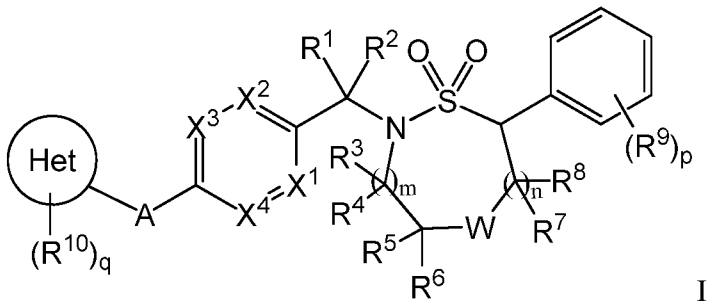
The terms "treating", "contacting" and "reacting" when referring to a chemical reaction means adding or mixing two or more reagents under appropriate conditions to produce the indicated and/or the desired product. It should be appreciated that the reaction which produces the indicated and/or the desired product may not necessarily result directly from the combination of two reagents which were initially added, i.e., there may be one or more intermediates which are produced in the mixture which ultimately leads to the formation of the indicated and/or the desired product.

Nomenclature and Structures

In general, the nomenclature and chemical names used in this Application are based on ChembioOffice™ by CambridgeSoft™. Any open valency appearing on a carbon, oxygen sulfur or nitrogen atom in the structures herein indicates the presence of a hydrogen atom unless indicated otherwise. Where a nitrogen-containing heteroaryl ring is shown with an open valency on a nitrogen atom, and variables such as R^a, R^b or R^c are shown on the heteroaryl ring, such variables may be bound or joined to the open valency nitrogen. Where a chiral center exists in a structure but no specific stereochemistry is shown for the chiral center, both enantiomers associated with the chiral center are encompassed by the structure. Where a structure shown herein may exist in multiple tautomeric forms, all such tautomers are encompassed by the structure. The atoms represented in the structures herein are intended to encompass all naturally occurring isotopes of such atoms. Thus, for example, the hydrogen atoms represented herein are meant to include deuterium and tritium, and the carbon atoms are meant to include C^{13} and C^{14} isotopes. One or more carbon atom(s) of a compound of the invention may be replaced by a silicon atom(s), and it is contemplated that one or more oxygen atom(s) of a compound of the invention may be replaced by a sulfur or selenium atom(s).

Compounds of the Invention

The invention provides compounds of formula I:



I

or a pharmaceutically acceptable salt thereof,

wherein:

m is 0 or 1;

n is 0 or 1;

p is from 0 to 3;

q is from 0 to 3;

Het is:

a five or six membered heteroaryl selected from:

pyrrolyl;
pyrrazolyl;
imidazolyl;
oxazolyl;
thiazolyl;
isoxazolyl;
isothiazolyl;
triazolyl;
oxadiazolyl;
thiadiazolyl;
tetrazolyl;
thiophenyl;
furanyl;
pyridinyl;
pyrimidinyl;
pyridazinyl; or
pyrazinyl; or

a five membered heterocyclyl selected from:

pyrrolidinyl;
oxazolidinyl;
dioxolanyl; or
imidazolidinyl;

A is:

$-(CH_2)_r-C(O)-NH-C_{1-6}$alkylene; or

wherein each such C_{1-6}alkenylene may be unsubstituted or substituted once or twice with R^a;

r is: 0 or 1;

W is: $-CR^bR^c-$; -O-; -S-; $-SO_2-$; or $-NR^d-$;

one of X^1, X^2, X^3 and X^4 is N and the others are CR^e; or two of X^1, X^2, X^3 and X^4 are N and the others are CR^e; or three of X^1, X^2, X^3 and X^4 are N and the other is CR^e; or each of X^1, X^2, X^3 and X^4 is CR^e;

R^1, R^2, R^3, R^4, R^5, R^6, R^7 and R^8 each independently is: hydrogen; or C_{1-6}alkyl which may be unsubstituted or substituted one or more times with halo;

or R^3 and R^4 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or R^5 and R^6 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or R^7 and R^8 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^3 and R^4 together with one of R^5 and R^6 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^5 and R^6 together with one of R^7 and R^8 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

each R^9 is independently:

C_{1-6}alkyl;

halo;

C_{1-6}alkoxy; or

cyano;

wherein the C_{1-6}alkyl moieties may be unsubstituted or substituted one or more times with halo;

each R^{10} is independently:

amino;

C_{1-6}alkoxy;

C_{1-6}alkyl;

oxo;

hydroxy

halo;

cyano;

halo-C_{1-6}alkyl;

hydroxy-C_{1-6}alkyl;

C_{1-6}alkoxy-C_{1-6}alkyl; or

cyano-C_{1-6}alkyl;

R^a is:

C_{1-6}alkoxy;

C_{1-6}alkoxy-C_{1-6}alkyl;

hydroxy-C_{1-6}alkyl;

C_{3-6}cycloalkyl;

C_{3-6}cycloalkyl-C_{1-6}alkyl;

C_{3-6}cycloalkyloxy;

C_{3-6}cycloalkyl-C_{1-6}alkoxy;

heterocyclyl;

heterocylyl-C_{1-6}alkyl; or

heterocylyl-C_{1-6}alkoxy;

wherein the heterocyclyl moieties are each independently selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, and wherein the heterocycyl moieties and C_{3-6}cycloalkyl moieties each may be unsubstituted or substituted one or more times with R^f;

R^b, R^c, and R^d each independent is:

hydrogen;

C_{1-6}alkyl; or

halo-C_{1-6}alkyl;

or R^b and R^c together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one

or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^b and R^c together with one of R^7 and R^8 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^b and R^c together with one of R^5 and R^6 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

each R^e is independently:

hydrogen;

C_{1-6}alkyl;

halo;

C_{1-6}alkoxy; or

cyano;

wherein the C_{1-6}alkyl moieties may be unsubstituted or substituted one or more times with halo; and

R^f is: C_{1-6}alkyl; halo-C_{1-6}alkyl; halo; oxo; hydroxy; or C_{1-6}alkoxy;

provided that the compound is not *N*-(1-(2,5-Difluoro-4-(((3*S*,6*R*)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1*H*-imidazole-1-carboxamide.

In certain embodiments of formula I, m is 0.

In certain embodiments of formula I, m is 1.

In certain embodiments of formula I, n is 0.

In certain embodiments of formula I, n is 1.

In certain embodiments of formula I, p is from 0 to 2.

In certain embodiments of formula I, p is 0 or 1.

In certain embodiments of formula I, p is 0.

In certain embodiments of formula I, p is 1.

In certain embodiments of formula I, p is 2.

In certain embodiments of formula I, p is 3.

In certain embodiments of formula I, q is 0.

In certain embodiments of formula I, q is 1.

In certain embodiments of formula I, q is 2.

In certain embodiments of formula I, q is 0 or 1.

In certain embodiments of formula I, q is 0, 1 or 2.

In certain embodiments of formula I, Het is a five or six membered heteroaryl selected from:

pyrrolyl;
pyrrazolyl;
imidazolyl;
oxazolyl;
thiazolyl;
isoxazolyl;
isothiazolyl;
triazolyl;
oxadiazolyl;
thiadiazolyl;
tetrazolyl;
thiophenyl;
furanyl;
pyridinyl;
pyrimidinyl;
pyridazinyl; or
pyrazinyl.

In certain embodiments of formula I, Het is a five or six membered heteroaryl selected from:

pyrrolyl;
pyrrazolyl;
oxazolyl;
thiazolyl;
isoxazolyl;

isothiazolyl;
triazolyl;
oxadiazolyl;
thiadiazolyl;
tetrazolyl;
thiophenyl;
furanyl;
pyridinyl;
pyrimidinyl;
pyridazinyl; or
pyrazinyl.

In certain embodiments of formula I, Het is a five membered heteroaryl selected from:

pyrrolyl;
pyrrazolyl;
oxazolyl;
thiazolyl;
isoxazolyl;
isothiazolyl;
triazolyl;
oxadiazolyl;
thiadiazolyl;
tetrazolyl; or
thiophenyl.

In certain embodiments of formula I, Het is a five membered heteroaryl selected from: pyrrazolyl; or isoxazolyl.

In certain embodiments of formula I, Het is: oxadiazolyl; or thiadiazolyl; .

In certain embodiments of formula I, Het is imidazolyl.

In certain embodiments of formula I, Het is pyrazolyl.

In certain embodiments of formula I, Het is isoxazolyl.

In certain embodiments of formula I, Het is oxazolyl.

In certain embodiments of formula I, Het is thiazolyl.

In certain embodiments of formula I, Het is oxadiazolyl.

In certain embodiments of formula I, Het is triazolyl.

In certain embodiments of formula I, Het is tetrazolyl.

In certain embodiments of formula I, Het is thiophenyl.

In certain embodiments of formula I, Het is furanyl.

In certain embodiments of formula I, Het is pyridinyl.

In certain embodiments of formula I, Het is pyrimidinyl.

In certain embodiments of formula I, Het is pyridazinyl.

In certain embodiments of formula I, Het is pyrazinyl.

In certain embodiments of formula I, Het is 3H-1,3,4-oxadiazol-2-one-5-yl.

In certain embodiments of formula I, Het is 2-hydroxymethyl-1,3,4-oxadiazol-5-yl.

In certain embodiments of formula I, Het is a five membered heterocyclyl selected from:

pyrrolidinyl;

oxazolidinyl;

dioxolanyl;

imidazolidinyl.

In certain embodiments of formula I, Het is pyrrolidinyl.

In certain embodiments of formula I, Het is oxazolidinyl.

In certain embodiments of formula I, Het is dioxolanyl

In certain embodiments of formula I, Het is imidazolidinyl.

In certain embodiments of formula I, A is -$(CH_2)_r$-C(O)-NH-C_{1-6}alkylene- wherein the C_{1-6}alkenylene may be unsubstituted or substituted once or twice with R^a.

In certain embodiments of formula I, A is -$(CH_2)_r$-C_{1-6}alkenylene-NH-C(O)- wherein the C_{1-6}alkenylene may be unsubstituted or substituted once or twice with R^a.

In certain embodiments of formula I, A is -C(O)-NH-C_{1-6}alkylene- wherein the C_{1-6}alkenylene may be unsubstituted or substituted once or twice with R^a.

In certain embodiments of formula I, A is -C_{1-6}alkenylene-NH-C(O)- wherein the C_{1-6}alkenylene may be unsubstituted or substituted once or twice with R^a.

In certain embodiments of formula I, A is -C(O)-NH-$CH(CH_3)$-.

In certain embodiments of formula I, A is -CH(CH_3)-C(O)-NH-.

In certain embodiments of formula I, r is 0.

In certain embodiments of formula I, r is 1.

In certain embodiments of formula I, W is -CR^bR^c- or -O-.

In certain embodiments of formula I, W is -CR^bR^c-.

In certain embodiments of formula I, W is -O-.

In certain embodiments of formula I, W is –NR^d-.

In certain embodiments of formula I, W is -S-.

In certain embodiments of formula I, W is -SO_2-.

In certain embodiments of formula I, W is -CH_2-.

In certain embodiments of formula I, one or two of X^1, X^2, X^3 and X^4 is N and the others are CR^e.

In certain embodiments of formula I, three of X^1, X^2, X^3 and X^4 are CR^e and the other is N.

In certain embodiments of formula I, X^1, X^2, X^3 and X^4 are CR^e.

In certain embodiments of formula I, X^1 is N and X^2, X^3 and X^4 are CR^e.

In certain embodiments of formula I, X^2 is N and X^1, X^3 and X^4 are CR^e.

In certain embodiments of formula I, X^1 and X^4 are N, and X^2 and X^3 are CR^a.

In certain embodiments of formula I, X^2 and X^3 are N, and X^1 and X^4 are CR^e.

In certain embodiments of formula I, X^1 and X^2 are N, and X^3 and X^4 are CR^e.

In certain embodiments of formula I, R^1 is hydrogen.

In certain embodiments of formula I, R^1 is $C_{1\text{-}6}$alkyl.

In certain embodiments of formula I, R^2 is hydrogen.

In certain embodiments of formula I, R^2 is $C_{1\text{-}6}$alkyl.

In certain embodiments of formula I, R^3 is hydrogen.

In certain embodiments of formula I, R^3 is $C_{1\text{-}6}$alkyl.

In certain embodiments of formula I, R^4 is hydrogen.

In certain embodiments of formula I, R^4 is $C_{1\text{-}6}$alkyl.

In certain embodiments of formula I, R^5 is hydrogen.

In certain embodiments of formula I, R^5 is $C_{1\text{-}6}$alkyl.

In certain embodiments of formula I, R^6 is hydrogen.

In certain embodiments of formula I, R^6 is C_{1-6}alkyl.

In certain embodiments of formula I, R^7 is hydrogen.

In certain embodiments of formula I, R^7 is C_{1-6}alkyl.

In certain embodiments of formula I, R^8 is hydrogen.

In certain embodiments of formula I, R^8 is C_{1-6}alkyl.

In certain embodiments of formula I, R^3 and R^4 together with the atoms to which they are attached form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, R^3 and R^4 together with the atoms to which they are attached form a three, four or five membered saturated ring.

In certain embodiments of formula I, R^5 and R^6 together with the atoms to which they are attached form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, R^5 and R^6 together with the atoms to which they are attached form a three, four or five membered saturated ring.

In certain embodiments of formula I, R^7 and R^8 together with the atoms to which they are attached form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, R^7 and R^8 together with the atoms to which they are attached form a three, four or five membered saturated ring.

In certain embodiments of formula I, one of R^3 and R^4 together with one of R^5 and R^6 and the atoms to which they are attached form a three, four, five, six or seven membered ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, one of R^5 and R^6 together with one of R^7 and R^8 and the atoms to which they are attached form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, each R^9 is independently: C_{1-6}alkyl; halo; or halo-C_{1-6}alkyl.

In certain embodiments of formula I, R^9 is C_{1-6}alkyl.

In certain embodiments of formula I, R^9 is halo.

In certain embodiments of formula I, R^9 is C_{1-6}alkoxy.

In certain embodiments of formula I, R^9 is cyano.

In certain embodiments of formula I, R^9 is halo-C_{1-6}alkyl.

In certain embodiments of formula I, each R^9 is independently: fluoro; chloro; or trifluoromethyl.

In certain embodiments of formula I, R^{10} is: C_{1-6}alkyl; hydroxy; oxo; or hydroxy-C_{1-6}alkyl.

In certain embodiments of formula I, R^{10} is: amino; C_{1-6}alkoxy; or C_{1-6}alkyl.

In certain embodiments of formula I, R^{10} is amino.

In certain embodiments of formula I, R^{10} is C_{1-6}alkoxy.

In certain embodiments of formula I, R^{10} is hydroxy.

In certain embodiments of formula I, R^{10} is oxo.

In certain embodiments of formula I, R^{10} is cyano.

In certain embodiments of formula I, R^{10} is halo.

In certain embodiments of formula I, R^{10} is hydroxy-C_{1-6}alkyl.

In certain embodiments of formula I, R^{10} is C_{1-6}alkoxy-C_{1-6}alkyl.

In certain embodiments of formula I, R^{10} is C_{1-6}alkyl.

In certain embodiments of formula I, R^{10} is halo-C_{1-6}alkyl.

In certain embodiments of formula I, R^{10} is cyano-C_{1-6}alkyl.

In certain embodiments of formula I, R^a is: C_{1-6}alkoxy; C_{3-6}cycloalkyl-C_{1-6}alkyl; C_{3-6}cycloalkyloxy; C_{3-6}cycloalkyl-C_{1-6}alkoxy; heterocylyl-C_{1-6}alkyl; or heterocylyl-C_{1-6}alkoxy; wherein the heterocyclyl moieties are each independently selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, and wherein the heterocycyl moieties and C_{3-6}cycloalkyl each may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is: C_{1-6}alkoxy; heterocylyl-C_{1-6}alkyl; or heterocylyl-C_{1-6}alkoxy; wherein the heterocyclyl moieties are each independently selected from

oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, and wherein the heterocycyl moieties each may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is: C_{1-6}alkoxy; heterocylyl-C_{1-6}alkyl; or heterocylyl-C_{1-6}alkoxy; wherein the heterocyclyl moieties are each independently selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl and azetidinyl.

In certain embodiments of formula I, R^a is C_{1-6}alkoxy.

In certain embodiments of formula I, R^a isC_{1-6}alkoxy-C_{1-6}alkyl.

In certain embodiments of formula I, R^a is hydroxy-C_{1-6}alkyl.

In certain embodiments of formula I, R^a is C_{3-6}cycloalkyl which may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is C_{3-6}cycloalkyl-C_{1-6}alkyl wherein the C_{3-6}cycloalkyl moiety may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is C_{3-6}cycloalkyloxy; C_{3-6}cycloalkyl-C_{1-6}alkoxy; heterocyclyl; heterocylyl-C_{1-6}alkyl; or heterocylyl-C_{1-6}alkoxy; wherein the heterocyclyl moieties are each independently selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, and wherein the heterocycyl moieties and C_{3-6}cycloalkyl each may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is C_{3-6}cycloalkyl-C_{1-6}alkoxy wherein the C_{3-6}cycloalkyl moiety may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is heterocyclyl selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, each of which may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is heterocylyl-C_{1-6}alkyl wherein the heterocyclyl moiety is selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, each of which may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^a is heterocylyl-C_{1-6}alkoxy wherein the heterocyclyl moiety is selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, each of which may be unsubstituted or substituted one or more times with R^f.

In certain embodiments of formula I, R^b is hydrogen.

In certain embodiments of formula I, R^b is C_{1-6}alkyl.

In certain embodiments of formula I, R^c is hydrogen.

In certain embodiments of formula I, R^c is C_{1-6}alkyl.

In certain embodiments of formula I, R^b and R^c together with the atoms to which they are attached form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, one of R^b and R^c together with one of R^7 and R^8 and the atoms to which they are attached form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, one of R^b and R^c together with one of R^5 and R^6 and the atoms to which they are attached form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be optionally substituted one or more times with R^i.

In certain embodiments of formula I, R^d is hydrogen.

In certain embodiments of formula I, R^d is C_{1-6}alkyl.

In certain embodiments of formula I, each R^e is independently: hydrogen; C_{1-6}alkyl; halo; or cyano; wherein the C_{1-6}alkyl moieties may be unsubstituted or substituted one or more times with halo;

In certain embodiments of formula I, each R^e is independently: hydrogen; C_{1-6}alkyl; halo; or halo-C_{1-6}alkyl.

In certain embodiments of formula I, each R^e is independently: hydrogen; C_{1-6}alkyl; or halo.

In certain embodiments of formula I, each R^e is independently: hydrogen; or halo.

In certain embodiments of formula I, each R^e is independently: hydrogen; or fluoro.

In certain embodiments of formula I, R^e is hydrogen.

In certain embodiments of formula I, R^e is C_{1-6}alkyl.

In certain embodiments of formula I, R^e is halo.

In certain embodiments of formula I, R^e is C_{1-6}alkoxy.

In certain embodiments of formula I, R^e is cyano.

In certain embodiments of formula I, R^e is halo-C_{1-6}alkyl.

In certain embodiments of formula I, R^f is: C_{1-6}alkyl; halo; oxo; hydroxy; acetyl; or C_{1-6}alkoxy.

In certain embodiments of formula I, R^f is C_{1-6}alkyl.

In certain embodiments of formula I, R^f is halo.

In certain embodiments of formula I, R^f is C_{1-6}alkoxy.

In certain embodiments of formula I, R^f is halo-C_{1-6}alkyl.

In certain embodiments of formula I, R^f is oxo.

In certain embodiments of formula I, R^f is hydroxy.

In certain embodiments of formula I, R^f is acetyl.

In certain embodiments of formula I, R^g is C_{1-6}alkyl;

In certain embodiments of formula I, R^g is oxo;

In certain embodiments of formula I, R^g is halo;

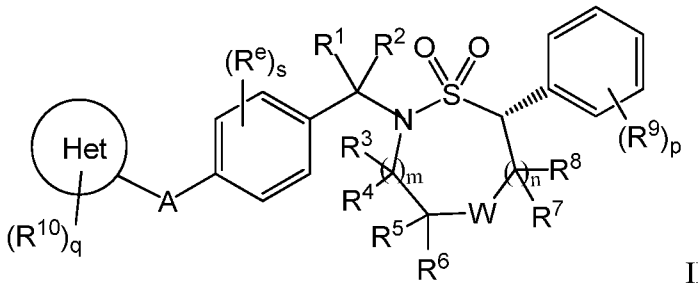
In certain embodiments of formula I, R^g is halo-C_{1-6}alkyl;

In certain embodiments of formula I, R^g is hydroxy-C_{1-6}alkyl;

In certain embodiments of formula I, R^g is C_{1-6}alkoxy-C_{1-6}alkyl; or

In certain embodiments of formula I, R^g is cyano-C_{1-6}alkyl.

In certain embodiments of formula I, the subject compounds may be of formula II:



II;

wherein s is from 0 to 3, and m, n, p, q, Het, A, W, R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} are as defined herein.

In certain embodiments of formula II, R^e is halo.

In certain embodiments of formula II, R^e is fluoro.

In certain embodiments of formula II, s is 0 or 1.

In certain embodiments of formula II, s is 0.

In certain embodiments of formula II, s is 1.

In certain embodiments of formula II, s is 1 or 2.

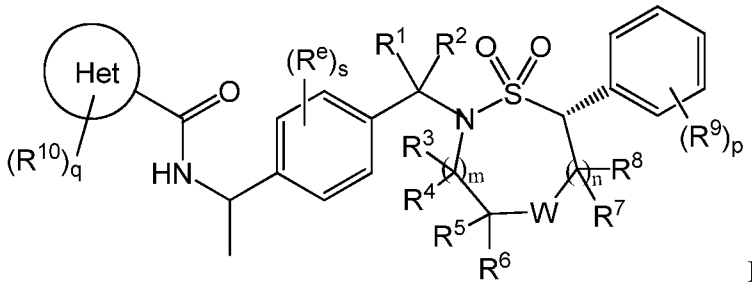
In certain embodiments of formula II, s is 2.

In certain embodiments of formula II, s is 1, 2 or 3.

In certain embodiments of formula II, s is 2 or 3.

In certain embodiments of formula II, s is 3.

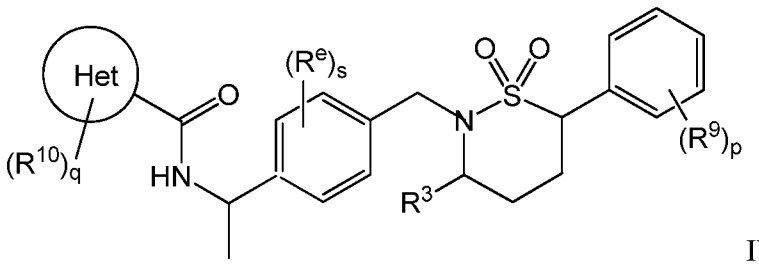
In certain embodiments of formula I, the subject compounds may be of formula III:



III

wherein m, n, p, q, S, Het, W, R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} are as defined herein.

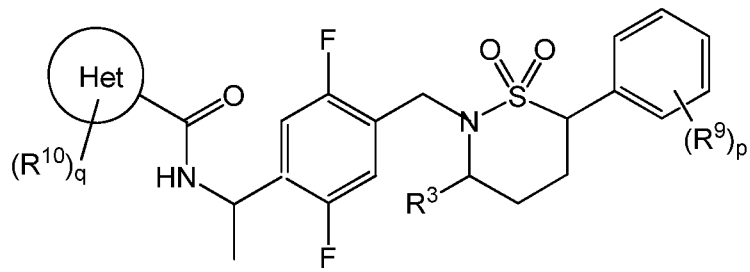
In certain embodiments of formula I, , the subject compounds may be of formula IV:



IV

wherein p, q, s, Het, R^3, R^9, R^{10} and and R^e are as defined herein.

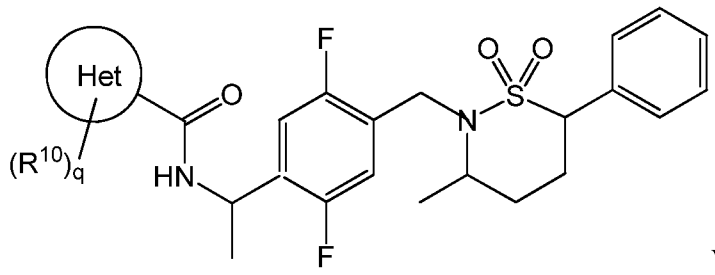
In certain embodiments of formula I, , the subject compounds may be of formula V:



V

wherein p, q, Het, R^3, R^9 and R^{10} are as defined herein.

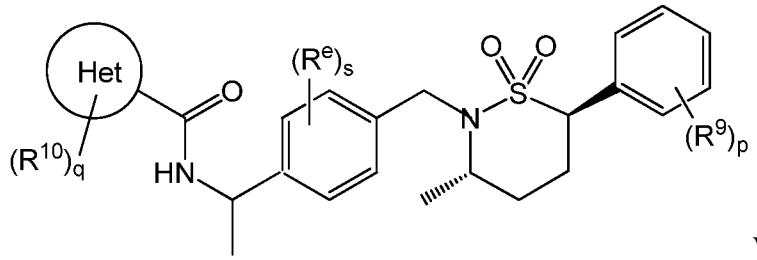
In certain embodiments of formula I, , the subject compounds may be of formula VI:



VI

wherein q, Het, and R^{10} are as defined herein.

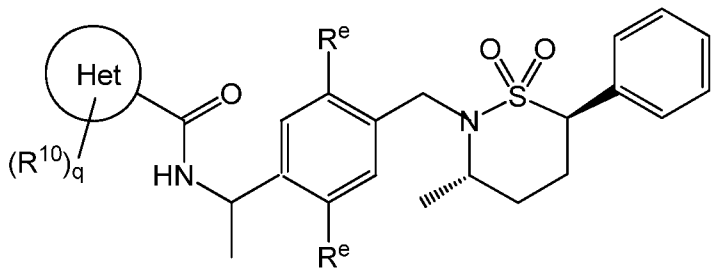
In certain embodiments of formula I, , the subject compounds may be of formula VII:



VII

wherein p, q, s, Het, A, R^3, R^9, R^{10} and R^e are as defined herein.

In certain embodiments of formula I, , the subject compounds may be of formula VIII:



VIII

wherein q, Het, A, R^3, R^{10} and R^e are as defined herein.

Methods

The invention also provides a method for treating a disease or condition mediated by or otherwise associated with the RORc receptor, the method comprising administering to a subject in need thereof an effective amount of a compound of the invention.

The disease may be arthritis such as rheumatoid arthritis or osteoarthritis.

The disease may be asthma or COPD.

The disease may be psoriasis.

The disease may be muscular distrophy.

Representative compounds in accordance with the methods of the invention are shown in the experimental examples below.

Synthesis

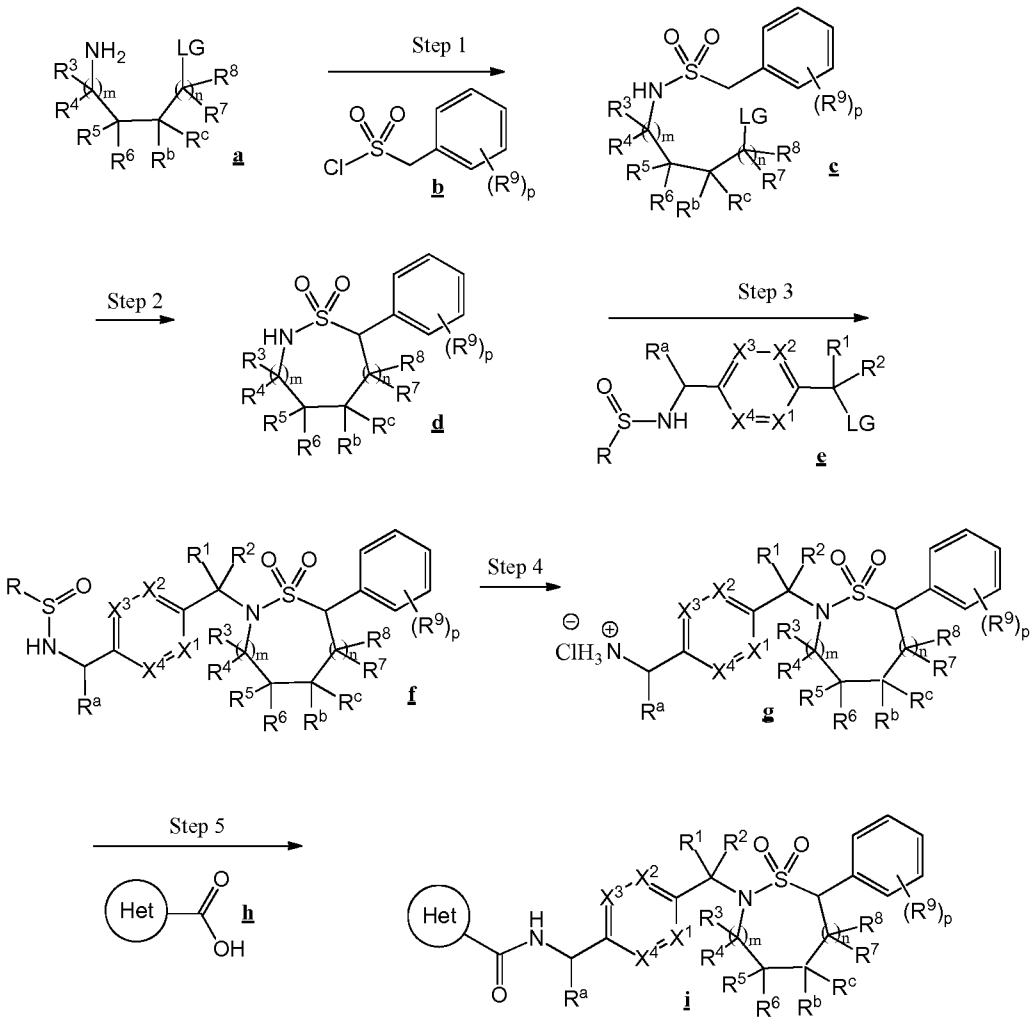
Compounds of the present invention can be made by a variety of methods depicted in the illustrative synthetic reaction schemes shown and described below.

The starting materials and reagents used in preparing these compounds generally are either available from commercial suppliers, such as Aldrich Chemical Co., or are prepared by methods known to those skilled in the art following procedures set forth in references such as *Fieser and Fieser's Reagents for Organic Synthesis*; Wiley & Sons: New York, **1991**, Volumes 1-15; *Rodd's Chemistry of Carbon Compounds*, Elsevier Science Publishers, 1989, Volumes 1-5 and Supplementals; and *Organic Reactions*, Wiley & Sons: New York, **1991**, Volumes 1-40. The following synthetic reaction schemes are merely illustrative of some methods by which the compounds of the present invention can be synthesized, and various modifications to these synthetic reaction schemes can be made and will be suggested to one skilled in the art having referred to the disclosure contained in this Application.

The starting materials and the intermediates of the synthetic reaction schemes can be isolated and purified if desired using conventional techniques, including but not limited to, filtration, distillation, crystallization, chromatography, and the like. Such materials can be characterized using conventional means, including physical constants and spectral data.

Unless specified to the contrary, the reactions described herein may be conducted under an inert atmosphere at atmospheric pressure at a reaction temperature range of from about -78 °C to about 150 °C, for example, from about 0 °C to about 125 °C, or conveniently at about room (or ambient) temperature, e.g., about 20 °C.

Scheme A below illustrates one synthetic procedure usable to prepare specific compounds of formula I, wherein LG is a leaving group such as halo, sulfonate or the like and may be the same or different on each occurrence, R is lower alkyl, and m, n, p, q, X^1, X^2, X^3, X^4, R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^b and R^c are as defined herein.



SCHEME A

In step 1 of Scheme A, alkyl amine a is reacted with benzyl sulfonyl chloride b to form sulfonamide compound c. The reaction of step 1 may be carried out in a polar aprotic solvent such as THF or methylene chloride, and in the presence of a tertiary amine base or weak base such as potassium carbonate. The leaving group of compound a may be bromo in certain embodiments. Similarly, the chloro group of compound b may in certain embodiments be replaced by other halo or leaving group.

A cyclization reaction is carried out in step 2 to afford thiazinane compound d. The cyclization may be achieved in the presence of a strong base such as an alkyl lithium reagent, using polar aprotic solvent under anhydrous conditions.

In step 3, thiazinane compound c is reacted with aryl sulfinamide compound e to yield aralkyl thiazinane f. Sulfinamide compound e may be prepared by treatment of an

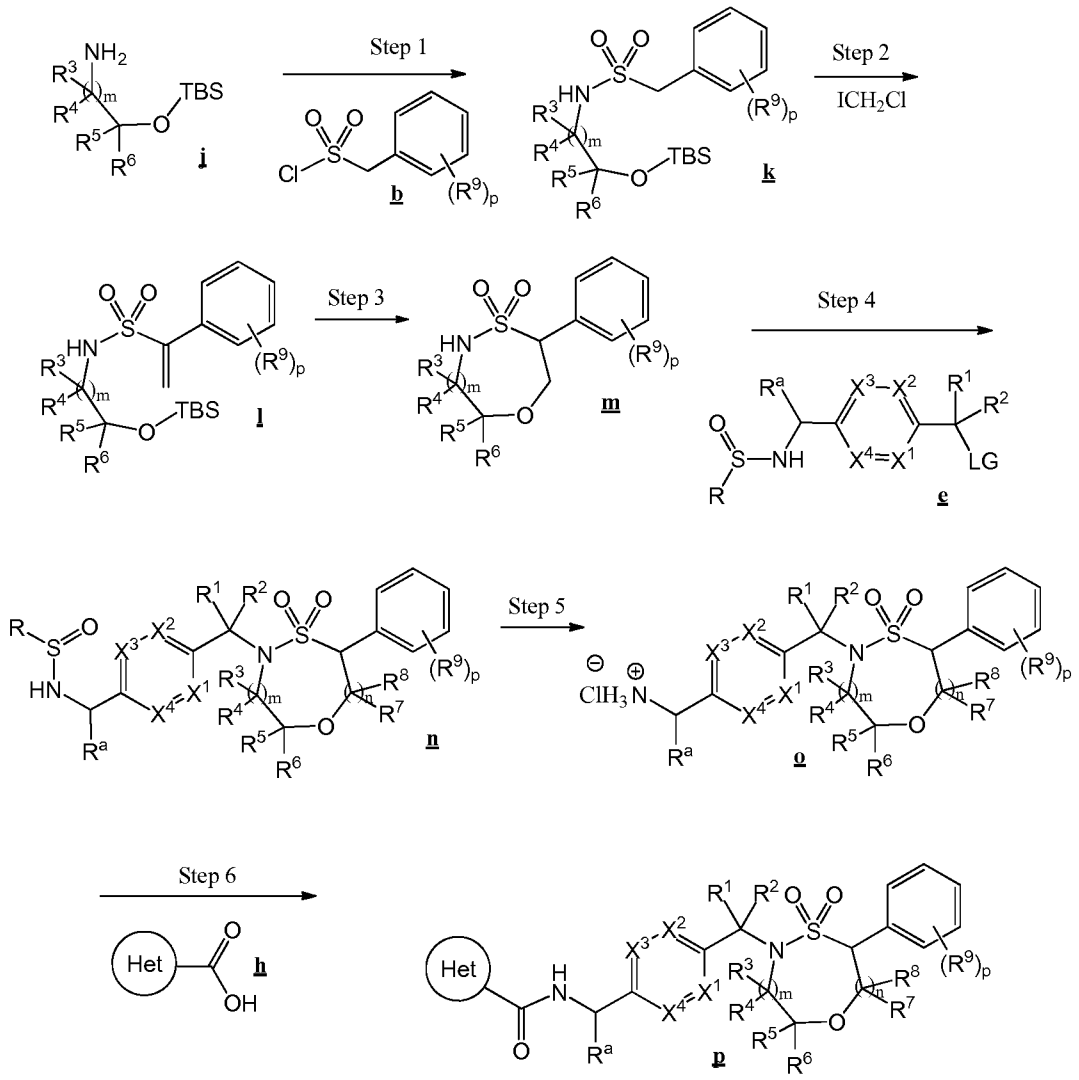
appropriate aryl halide with alkyl lithium reagent followed by (*E*)-*N*-ethylidene-2-methylpropane-2-sulfinamide as described further below in the Examples.

Compound f may then be treated with HCl or other acid acid in step 4 to provide aminium halide compound g.

In step 5, aminium halide compound g is reacted with heteroaryl carboxylic acid h to yield the heteroaryl amide sultam compound I, which is a compound of formula I in accordance with the invention.

Many variations in the above procedure are possible and will suggest themselves to those skilled in the art.

Scheme B below shows another synthetic procedure usable to prepare specific compounds of formula I, wherein TBS is tri-(tert-butyl)-silyl, LG is a leaving group such as halo, R is lower alkyl and m, n, p, q, X^1, X^2, X^3, X^4, Y, R^1, R^2, R^3, R^4, R^5, R^6, R^9 and R^{10} are as defined herein.



SCHEME B

In step 1 of Scheme B, tri-(tert-butyl)-slilyloxy amine j is reacted with benzyl sulfonyl chloride b, as described above with reference to Scheme A, to form sulfonamide compound k. In certain embodiments the tri-(tert-butyl)-slilyloxy group may be replaced with other leaving groups.

In step 2, sulfonamide compound k is reacted with iodochloromethane to provide an alkenylsulfonamide compound l. This reaction may be achieved in the presence of a strong base such as an alkyl lithium reagent, using polar aprotic solvent such as THF under anhydrous conditions. In certain embodiments iodochloromethane may be replaced with other methylene reagents.

In step 3, a cyclization reaction is affected to provide oxathiazepane compound m. The cyclization may be carried out in the presence of an amine base under polar aprotic solvent conditions.

In step 4, thiazinane compound m is reacted with aryl sulfinamide compound e to yield aralkyl thiazinane n as described above for Scheme A. In step 5 compound n istreated with HCl or other acid acid to provide aminium halide compound o, and in step 6 aminium halide compound o is reacted with heteroaryl carboxylic acid h to yield the heteroaryl amide sultam compound p, which is a compound of formula I in accordance with the invention.

Many variations on the procedure Scheme B are possible and will suggest themselves to those skilled in the art. Specific details for producing compounds of the invention are described in the Examples below.

Administration and Pharmaceutical Composition

The invention includes pharmaceutical compositions comprising at least one compound of the present invention, or an individual isomer, racemic or non-racemic mixture of isomers or a pharmaceutically acceptable salt or solvate thereof, together with at least one pharmaceutically acceptable carrier, and optionally other therapeutic and/or prophylactic ingredients.

In general, the compounds of the invention will be administered in a therapeutically effective amount by any of the accepted modes of administration for agents that serve similar utilities. Suitable dosage ranges are typically 1-500 mg daily, for example 1-100 mg daily, and most preferably 1-30 mg daily, depending upon numerous factors such as the severity of the disease to be treated, the age and relative health of the subject, the potency of the compound used, the route and form of administration, the indication towards which the administration is directed, and the preferences and experience of the medical practitioner involved. One of ordinary skill in the art of treating such diseases will be able, without undue experimentation and in reliance upon personal knowledge and the disclosure of this Application, to ascertain a therapeutically effective amount of the compounds of the present invention for a given disease.

Compounds of the invention may be administered as pharmaceutical formulations including those suitable for oral (including buccal and sub-lingual), rectal, nasal, topical, pulmonary, vaginal, or parenteral (including intramuscular, intraarterial, intrathecal, subcutaneous and intravenous) administration or in a form suitable for administration by

inhalation or insufflation. A particular manner of administration is generally oral using a convenient daily dosage regimen which can be adjusted according to the degree of affliction.

A compound or compounds of the invention, together with one or more conventional adjuvants, carriers, or diluents, may be placed into the form of pharmaceutical compositions and unit dosages. The pharmaceutical compositions and unit dosage forms may be comprised of conventional ingredients in conventional proportions, with or without additional active compounds or principles, and the unit dosage forms may contain any suitable effective amount of the active ingredient commensurate with the intended daily dosage range to be employed. The pharmaceutical compositions may be employed as solids, such as tablets or filled capsules, semisolids, powders, sustained release formulations, or liquids such as solutions, suspensions, emulsions, elixirs, or filled capsules for oral use; or in the form of suppositories for rectal or vaginal administration; or in the form of sterile injectable solutions for parenteral use. Formulations containing about one (1) milligram of active ingredient or, more broadly, about 0.01 to about one hundred (100) milligrams, per tablet, are accordingly suitable representative unit dosage forms.

The compounds of the invention may be formulated in a wide variety of oral administration dosage forms. The pharmaceutical compositions and dosage forms may comprise a compound or compounds of the present invention or pharmaceutically acceptable salts thereof as the active component. The pharmaceutically acceptable carriers may be either solid or liquid. Solid form preparations include powders, tablets, pills, capsules, cachets, suppositories, and dispersible granules. A solid carrier may be one or more substances which may also act as diluents, flavouring agents, solubilizers, lubricants, suspending agents, binders, preservatives, tablet disintegrating agents, or an encapsulating material. In powders, the carrier generally is a finely divided solid which is a mixture with the finely divided active component. In tablets, the active component generally is mixed with the carrier having the necessary binding capacity in suitable proportions and compacted in the shape and size desired. The powders and tablets may contain from about one (1) to about seventy (70) percent of the active compound. Suitable carriers include but are not limited to magnesium carbonate, magnesium stearate, talc, sugar, lactose, pectin, dextrin, starch, gelatine, tragacanth, methylcellulose, sodium carboxymethylcellulose, a low melting wax, cocoa butter, and the like. The term “preparation” is intended to include the formulation of the active compound with encapsulating material as

carrier, providing a capsule in which the active component, with or without carriers, is surrounded by a carrier, which is in association with it. Similarly, cachets and lozenges are included. Tablets, powders, capsules, pills, cachets, and lozenges may be as solid forms suitable for oral administration.

Other forms suitable for oral administration include liquid form preparations including emulsions, syrups, elixirs, aqueous solutions, aqueous suspensions, or solid form preparations which are intended to be converted shortly before use to liquid form preparations. Emulsions may be prepared in solutions, for example, in aqueous propylene glycol solutions or may contain emulsifying agents, for example, such as lecithin, sorbitan monooleate, or acacia. Aqueous solutions can be prepared by dissolving the active component in water and adding suitable colorants, flavors, stabilizers, and thickening agents. Aqueous suspensions can be prepared by dispersing the finely divided active component in water with viscous material, such as natural or synthetic gums, resins, methylcellulose, sodium carboxymethylcellulose, and other well known suspending agents. Solid form preparations include solutions, suspensions, and emulsions, and may contain, in addition to the active component, colorants, flavors, stabilizers, buffers, artificial and natural sweeteners, dispersants, thickeners, solubilizing agents, and the like.

The compounds of the invention may be formulated for parenteral administration (e.g., by injection, for example bolus injection or continuous infusion) and may be presented in unit dose form in ampoules, pre-filled syringes, small volume infusion or in multi-dose containers with an added preservative. The compositions may take such forms as suspensions, solutions, or emulsions in oily or aqueous vehicles, for example solutions in aqueous polyethylene glycol. Examples of oily or nonaqueous carriers, diluents, solvents or vehicles include propylene glycol, polyethylene glycol, vegetable oils (e.g., olive oil), and injectable organic esters (e.g., ethyl oleate), and may contain formulatory agents such as preserving, wetting, emulsifying or suspending, stabilizing and/or dispersing agents. Alternatively, the active ingredient may be in powder form, obtained by aseptic isolation of sterile solid or by lyophilization from solution for constitution before use with a suitable vehicle, e.g., sterile, pyrogen-free water.

The compounds of the invention may be formulated for topical administration to the epidermis as ointments, creams or lotions, or as a transdermal patch. Ointments and creams may, for example, be formulated with an aqueous or oily base with the addition of suitable thickening and/or gelling agents. Lotions may be formulated with an aqueous or oily base and

will in general also containing one or more emulsifying agents, stabilizing agents, dispersing agents, suspending agents, thickening agents, or coloring agents. Formulations suitable for topical administration in the mouth include lozenges comprising active agents in a flavored base, usually sucrose and acacia or tragacanth; pastilles comprising the active ingredient in an inert base such as gelatine and glycerine or sucrose and acacia; and mouthwashes comprising the active ingredient in a suitable liquid carrier.

The compounds of the invention may be formulated for administration as suppositories. A low melting wax, such as a mixture of fatty acid glycerides or cocoa butter is first melted and the active component is dispersed homogeneously, for example, by stirring. The molten homogeneous mixture is then poured into convenient sized molds, allowed to cool, and to solidify.

The compounds of the invention may be formulated for vaginal administration. Pessaries, tampons, creams, gels, pastes, foams or sprays containing in addition to the active ingredient such carriers as are known in the art to be appropriate.

The subject compounds may be formulated for nasal administration. The solutions or suspensions are applied directly to the nasal cavity by conventional means, for example, with a dropper, pipette or spray. The formulations may be provided in a single or multidose form. In the latter case of a dropper or pipette, this may be achieved by the patient administering an appropriate, predetermined volume of the solution or suspension. In the case of a spray, this may be achieved for example by means of a metering atomizing spray pump.

The compounds of the invention may be formulated for aerosol administration, particularly to the respiratory tract and including intranasal administration. The compound will generally have a small particle size for example of the order of five (5) microns or less. Such a particle size may be obtained by means known in the art, for example by micronization. The active ingredient is provided in a pressurized pack with a suitable propellant such as a chlorofluorocarbon (CFC), for example, dichlorodifluoromethane, trichlorofluoromethane, or dichlorotetrafluoroethane, or carbon dioxide or other suitable gas. The aerosol may conveniently also contain a surfactant such as lecithin. The dose of drug may be controlled by a metered valve. Alternatively the active ingredients may be provided in a form of a dry powder, for example a powder mix of the compound in a suitable powder base such as lactose, starch, starch derivatives such as hydroxypropylmethyl cellulose and polyvinylpyrrolidine (PVP). The powder

carrier will form a gel in the nasal cavity. The powder composition may be presented in unit dose form for example in capsules or cartridges of e.g., gelatine or blister packs from which the powder may be administered by means of an inhaler.

When desired, formulations can be prepared with enteric coatings adapted for sustained or controlled release administration of the active ingredient. For example, the compounds of the present invention can be formulated in transdermal or subcutaneous drug delivery devices. These delivery systems are advantageous when sustained release of the compound is necessary and when patient compliance with a treatment regimen is crucial. Compounds in transdermal delivery systems are frequently attached to an skin-adhesive solid support. The compound of interest can also be combined with a penetration enhancer, e.g., Azone (1-dodecylazacycloheptan-2-one). Sustained release delivery systems are inserted subcutaneously into the subdermal layer by surgery or injection. The subdermal implants encapsulate the compound in a lipid soluble membrane, e.g., silicone rubber, or a biodegradable polymer, e.g., polylactic acid.

The pharmaceutical preparations may be in unit dosage forms. In such form, the preparation is subdivided into unit doses containing appropriate quantities of the active component. The unit dosage form can be a packaged preparation, the package containing discrete quantities of preparation, such as packeted tablets, capsules, and powders in vials or ampoules. Also, the unit dosage form can be a capsule, tablet, cachet, or lozenge itself, or it can be the appropriate number of any of these in packaged form.

Other suitable pharmaceutical carriers and their formulations are described in *Remington: The Science and Practice of Pharmacy* **1995,** edited by E. W. Martin, Mack Publishing Company, 19th edition, Easton, Pennsylvania. Representative pharmaceutical formulations containing a compound of the present invention are described below.

Utility

The compounds of the invention are useful for treatment of immune disorders generally. The compounds may be used for treatment of arthritis, including rheumatoid arthritis, osteoarthritis, psoriatic arthritis, septic arthritis, spondyloarthropathies, gouty arthritis, systemic lupus erythematosus and juvenile arthritis, osteoarthritis, and other arthritic conditions.

The compounds may be used for treatment of respiratory disorders such as chronic obstructive pulmonary disease (COPD), asthma, bronchospasm, and the like.

The compounds may be used for treatment of gastrointestinal disorder ("GI disorder") such as Irritable Bowel Syndrome (IBS), Inflammatory Bowel Disease (IBD), biliary colic and other biliary disorders, renal colic, diarrhea-dominant IBS, pain associated with GI distension, and the like.

The compounds may be used for treatment of psoriasis, muscular sclerosis, Sjogren's disease, lupus, and pulmonary fibrosis.

GENERAL EXPERIMENTAL

LCMS methods:

High Pressure Liquid Chromatography - Mass Spectrometry (LCMS) experiments to determine retention times (RT) and associated mass ions were performed using one of the following methods:

Method A: Compounds were analysed using the following conditions: Experiments were performed on a Waters ZMD single quadrupole mass spectrometer linked to a Hewlett Packard HP1100 LC system with UV diode array detector and 100 position autosampler. The spectrometer has an electrospray source operating in positive and negative ion mode. This system uses a Phenomenex Luna 3 µm C18(2) 30 x 4.6 mm column at ambient temperature and a 2.0 mL / minute flow rate. The initial solvent system was 95% water containing 0.1% formic acid (solvent A) and 5% acetonitrile containing 0.1% formic acid (solvent B) for the first 0.5 minute followed by a gradient up to 5% solvent A and 95% solvent B over the next 4 minutes. This was maintained for 1 minute before returning to 95% solvent A and 5% solvent B over the next 0.5 minute. Total run time was 6 minutes.

Method B: Compounds were analysed using the following conditions: Experiments were performed on a Waters Micromass ZQ2000 quadrupole mass spectrometer linked to a Waters Acquity UPLC system with a PDA UV detector. The spectrometer has an electrospray source operating in positive and negative ion mode. This system uses an Acquity BEH C18 1.7 µm 100 x 2.1 mm column, maintained at 40 °C or an Acquity BEH Shield RP18 1.7 µm 100 x 2.1 mm column, maintained at 40 °C and a 0.4 mL / minute flow rate. The initial solvent system was 95% water containing 0.1% formic acid (solvent A) and 5% acetonitrile containing 0.1% formic acid (solvent B) for the first 0.4 minute followed by a gradient up to 5% solvent A and 95% solvent B over the next 5.6 minutes. This was maintained for 0.8 minute before returning to 95% solvent A and 5% solvent B over the next 1.2 minutes. Total run time was 8 minutes.

NMR methods:

^{1}H NMR spectra were recorded at ambient temperature or at 80 °C where indicated using one of the following machines: Varian Unity Inova (400 MHz) spectrometer with a triple resonance 5mm probe, Bruker Avance DRX 400 (400 MHz) spectrometer with a triple resonance 5mm probe, a Bruker Avance DPX 300 (300 MHz) equipped with a standard 5mm dual frequency probe for detection of 1H and 13C, Bruker Fourier 300MHz system equipped with a standard 5mm 1H / 13C probe, a Bruker AVIII (400 MHz) using a BBI Broad Band Inverse 5mm probe, or a Bruker AVIII (500 MHz) using a QNP (Quad Nucleus detect) 5mm probe. Chemical shifts are expressed in ppm relative to an internal standard, tetramethylsilane (ppm = 0.00). The following abbreviations have been used: br = broad signal, s = singlet, d = doublet, dd = double doublet, t = triplet, td = triplet doublet, dddd = doublet doublet doublet doublet, q = quartet, m = multiplet, or any combination of.

Microwave reactor:

Microwave reactions were carried out using a Biotage® Initiator® in vials appropriate to the scale of the reaction and at the temperature and time described in the experimental details.

Purification Equipment:

Purifications were carried out using pre-packed silica gel cartridges either on a Teledyne ISCO CombiFlash® or Biotage® Isolera Four® or using compressed air to apply external pressure. Solvents and gradients shown in the experimental details were used.

Reverse Phase High Pressure Liquid Chromatography (HPLC) was used to purify compounds where indicated. Separation using gradient elution on a Phenomenex Gemini C18 column (250 x 21.2 mm, 5 micron) as stationary phase and using mobile phase indicated, operating at a 18 mL/min flow rate using a Gilson UV/Vis -155 dual channel detector and Gilson GX-271 automated liquid handler.

Phase separator cartridges are supplied by Biotage® as Isolute® phase separator cartridges.

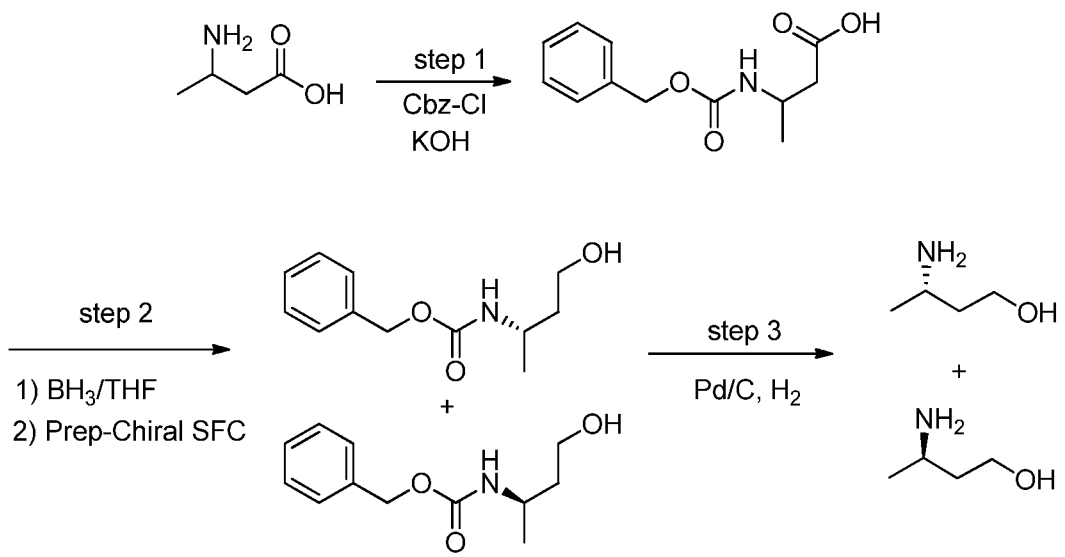
LIST OF ABBREVIATIONS

AcOH	Acetic acid
AIBN	2,2'-Azobis(2-methylpropionitrile)
Atm.	Atmosphere
BOC	*tert*-Butyloxycarbonyl group
$(BOC)_2O$	Di-*tert*-butyl dicarbonate
CrO_3	Chromium (VI) oxide

$CDCl_3$	Deuterated chloroform
DavePhos	2-Dicyclohexylphosphino-2′-(*N*,*N*-dimethylamino)biphenyl
DCM	Dichloromethane / methylene chloride
DMA	*N*,*N*-Dimethylacetamide
DIAD	Diisopropyl azodicarboxylate
DIPEA	DIPEA
DMAP	4-Dimethylaminopyridine
DME	1,2-Dimethoxyethane
DMF	*N*,*N*-Dimethylformamide
DMSO	Dimethyl sulfoxide
DPPF	1,1'-Bis(diphenylphosphino)ferrocene
ES	Electrospray
Et_2O	Diethyl ether
Et_3N	Triethylamine
EtOH	Ethanol/Ethyl alcohol
EtOAc	Ethyl acetate
H_2O	Water
H_2SO_4	Sulfuric acid
HATU	2-(1*H*-7-Azabenzotriazol-1-yl)--1,1,3,3-tetramethyl uronium hexafluorophosphate methanaminium
HBTU	*O*-Benzotriazol-1-yl-*N*,*N*,*N*',*N*'-tetramethyluronium hexafluorophosphate
HCO_2H	Formic acid
HCl	Hydrochloric acid
HOBT	1-Hydroxybenzotriazole
HPLC	High pressure liquid chromatography
RP HPLC	Reverse phase high pressure liquid chromatography
IBX	2-Iodoxybenzoic acid
IMS	Industrial methylated spirit
KOH	Potassium hydroxide
K_2CO_3	Potassium carbonate
LDA	Lithium diisopropylamide
i-PrOH	Isopropanol / isopropyl alcohol / propan-2-ol
LCMS	Liquid Chromatograph / Mass Spectroscopy
LiOH	Lithium hydroxide
$MgSO_4$	Magnesium sulphate
MeOH	Methanol / Methyl alcohol
MW	Microwaves
NaH	Sodium hydride
NaCl	Sodium chloride
NaOH	Sodium hydroxide
Na_2SO_4	Sodium sulfate
Na_2CO_3	Sodium carbonate
$NaHCO_3$	Sodium bicarbonate / Sodium hydrogen carbonate
NBS	*N*-Bromosuccinimide
NH_4Cl	Ammonium chloride
NMP	1-Methyl-2-pyrrolidinone

$POCl_3$	Phosphorus oxychloride
$PhCH_3$	Toluene
$Pd_2(dba)_3$	Tris(dibenzylideneacetone)dipalladium (0)
PSI	Pound per square inch
RT	Room temperature
sat.	Saturated
SCX-2	Pre-packed Isolute® silica-based sorbent with a chemically bonded propylsulfonic acid functional group
SFC	Supercritical fluid chromatography
TBDMS	*tert*-Butyldimethylsilyl
TFA	Trifluoroacetic acid
THF	Tetrahydrofuran
TIPS	Triisopropylsilyl
TLC	Thin layer chromatography
TMSCl	Chlorotrimethylsilane
XantPhos	4,5-Bis(diphenylphosphino)-9,9-dimethylxanthene

Preparations 1 and 2: (3R)-3-Aminobutan-1-ol and (3S)-3-Aminobutan-1-ol



Step 1 3-[[(Benzyloxy)carbonyl]amino]butanoic acid

Into a 2000-mL 4-necked round-bottom flask was placed a solution of 3-aminobutanoic acid (100 g, 969.75 mmol, 1.00 equiv) in water (1000 mL), followed by the addition of potassium hydroxide (136 g, 2.42 mol, 2.50 equiv) in several batches. To this was added benzyl chloroformate (247 g, 1.45 mol, 1.50 equiv) dropwise with stirring at 0-5°C. The resulting solution was stirred at 25°C for 5 h. The reaction progress was monitored by LCMS. The resulting solution was extracted with 3x250 mL of dichloromethane and the aqueous layers were combined. The pH value of the water phase was adjusted to 3 with hydrogen chloride (2

mol/L). The precipitates were collected by filtration and dried to afford 102 g (44%) of 3-[[(benzyloxy)carbonyl]amino]butanoic acid as a white solid.

Step 2: Benzyl *N*-[(2*S*)-4-hydroxybutan-2-yl]carbamate and Benzyl *N*-[(2*R*)-4-hydroxybutan-2-yl]carbamate

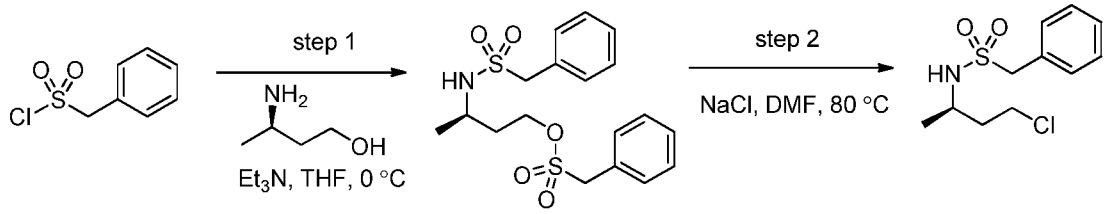
Into a 2000-mL 3-necked round-bottom flask purged and maintained with an inert atmosphere of nitrogen was placed a solution of 3-[[(benzyloxy)carbonyl]amino]butanoic acid (102 g, 429.92 mmol, 1.00 equiv) in THF (300 mL), followed by the addition of BH_3/THF (1N) (645 mL, 1.50 equiv) dropwise with stirring at 0-5°C. The resulting solution was stirred at 40°C for 2 h, quenched by the addition of 200 mL of methanol and concentrated under vacuum. The residue was purified on a silica gel column eluting with ethyl acetate: petroleum ether (1:2). The crude product (70 g) was purified by Prep-SFC with the following conditions (prep SFC): Column, Phenomenex Lux 5u Cellulose-4, 2.12*25,5um; mobile phase, CO_2 (85%), ethanol (15%); Detector, UV 254nm. This resulted in 30 g (31.5%) of benzyl N-[(2R)-4-hydroxybutan-2-yl]carbamate as an off-white solid and 30 g (31.5%) of benzyl N-[(2S)-4-hydroxybutan-2-yl]carbamate as an off-white solid.

Step 3: (3*R*)-3-Aminobutan-1-ol and (3*S*)-3-Aminobutan-1-ol

Into a 1000-mL round-bottom flask was placed a solution of benzyl *N*-[(2*S*)-4-hydroxybutan-2-yl]carbamate (30 g, 134.4 mmol, 1.00 equiv) in methanol (500 mL) and palladium carbon (3 g, 0.10 equiv). The resulting solution was stirred at 25°C for 12 h under an atmosphere of hydrogen. The solids were filtered out and the filtrate was concentrated under vacuum to afford 11.7 g (92%) of (3*S*)-3-aminobutan-1-ol as an oil. ^{1}H NMR (300MHz, DMSO, *ppm*): δ 4.48 (3H, s), 3.47 (2H, s), 2.96 (1H, s), 1.47-1.41 (2H, q), 1.02-0.99 (3H, d); LCMS (ESI), m/z, 90 $[M+H]^+$; measured $[\alpha]_D^{20.2}$ +11.65° (C=1.22g/100mL in EtOH), lit. $[\alpha]_D^{20}$ +16.3° (*c*=4.5 in EtOH) (*J. Org. Chem.* 1996, *61*, 2293–2304.).

Using the above procedure, 12.0 g 12 g (94%) of (3*R*)-3-aminobutan-1-ol was isolated as an oil. ^{1}H NMR (300MHz, DMSO, *ppm*): δ 4.48 (3H, s), 3.47 (2H, s), 2.96 (1H, s), 1.47-1.41 (2H, q), 1.02-0.99 (3H, d); LCMS (ESI), m/z, 90 $[M+H]^+$; measured $[\alpha]_D^{20.2}$ -11.1° (C = 0.32g/100mL in EtOH), lit. $[\alpha]_D^{25}$ -25° (*c*=1.25 in EtOH) (*Tetrahedron: Asymmetry* **1999**, 10, *2213–2224*.).

Preparation 3: (R)-N-(4-Chlorobutan-2-yl)-1-phenylmethanesulfonamide



Step 1: (*R*)-3-(Phenylmethylsulfonamido)butyl phenylmethanesulfonate

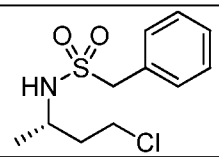
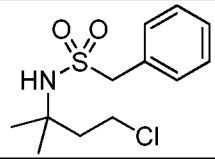
To a solution of (3*R*)-3-aminobutan-1-ol (1.0 g, 11.2 mmol) and triethylamine (3.3 mL, 23.6 mmol) in tetrahydrofuran (37 mL) at 0 °C was slowly added phenylmethanesulfonyl chloride (4.49 g, 23.6 mmol) and the reaction was stirred at room temperature for 16 hours. MTBE (100 mL) was then added and the $Et_3N{\cdot}HCl$ salt was removed by filtration. The filtrate was then concentrated to give crude (R)-3-(phenylmethylsulfonamido)butyl phenylmethanesulfonate which was used without purification. LCMS (ESI), m/z, 398 [M+H] +.

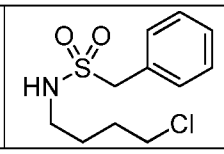
Step 2: (*R*)-*N*-(4-Chlorobutan-2-yl)-1-phenylmethanesulfonamide

To the crude (*R*)-3-(phenylmethylsulfonamido)butyl phenylmethanesulfonate (23.6 mmol) was added sodium chloride (984 mg, 16.8 mmol) and dimethylformamide (37 mL) and the reaction was stirred at 80 °C for 16 hours. The reaction was then diluted with EtOAc, washed with water (x2) and brine, dried with $MgSO_4$, concentrated and purified by silica gel column chromatography (0-50% Acetone in Heptane, 216 nM) to give (*R*)-*N*-(4-chlorobutan-2-yl)-1-phenylmethanesulfonamide (1.71 g, 6.53 mmol, 58% yield over 2 steps). LCMS (ESI), m/z, 261 [M+H] +.

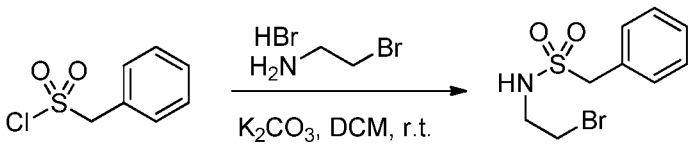
Additional compounds made using the above procedure are shown in Table 1.

Table 1

	Structure	Name	LCMS (ESI), m/z, [M+H]+
4		(S)-N-(4-chlorobutan-2-yl)-1-phenylmethanesulfonamide	261
5		N-(4-chloro-2-methylbutan-2-yl)-1-phenylmethanesulfonamide	275

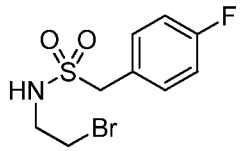
6		N-(4-chlorobutyl)-1-phenylmethanesulfonamide	261

Preparation 7: N-(2-bromoethyl)(phenyl)methanesulfonamide



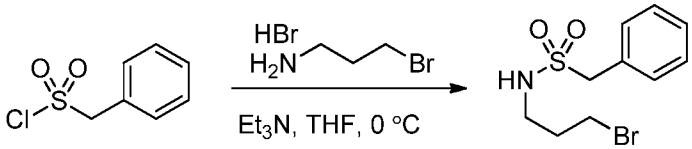
K_2CO_3 (8.7 g, 62 mmol) was added into a mixture of phenylmethanesulfonyl chloride (6 g, 31 mmol) and 2-bromoethanamine hydrobromide (6.4 g, 31 mmol) in DCM (100 mL) at 0°C. And the resulting mixture was stirred at r.t. for 4 hours and left standing overnight. Upon the completion of reaction, water (100 mL) was added in and DCM phase was separated. The aqueous phase was extracted with DCM. The combined organic phase was dried over Na_2SO_4, filetered and concentrated in vacuo to provide a crude which was separated with column chromatography (silica gel with 200 – 300 mesh, 0 to 50% of EtOAc in petroleum ether) to provide compound *N*-(2-bromoethyl)(phenyl)methanesulfonamide (7.0 g, 80%) as a pale yellow solid. ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.40 (m, 5H), 4.58 (m, 1H), 4.29 (s, 2H), 3.34-3.29 (m, 4H). LCMS (ESI), 300, 302 $[M+Na]^+$, Br pattern found.

Preparation 8 *N*-(2-bromoethyl)(4-fluorophenyl)methanesulfonamide



N-(2-bromoethyl)(4-fluorophenyl)methanesulfonamide was also made using the above procedure, replacing phenylmethanesulfonyl chloride with 4-fluoro-phenylmethanesulfonyl chloride. ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.43-7.38 (m, 2H), 7.13-7.07 (m, 2H), 4.62 (br s, 1H), 4.26 (s, 2H), 3.41-3.32 (m, 4H).

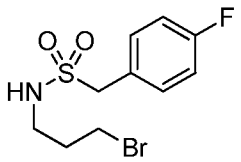
Preparation 9: *N*-(3-bromopropyl)(phenyl)methanesulfonamide



A solution of phenylmethanesulfonyl chloride (2.19 g, 10 mmol) was added into a suspension of 3-bromopropan-1-amine hydrobromide (2.19 g, 10 mmol) and Et_3N (2.02 g, 20

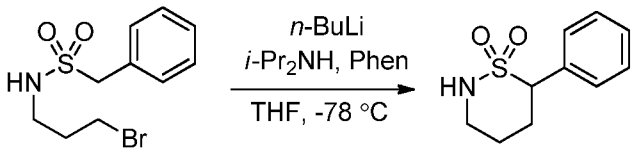
mmol) in THF (50 mL) at 0 °C. The mixture was stirred at 0 °C for 5 min. TLC confirmed the completion of reaction. Solid was filtered out with suction, and the filtrate was concentrated to provide compound N-(3-bromopropyl)(phenyl)methanesulfonamide (2.7 g, quant.) as a pale yellow solid which was used in the next step without further purification. ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.40 (m, 5H), 4.48 (m, 1H), 4.27 (s, 2H), 3.41 (t, J = 6.6 Hz, 2H), 3.16 (q, 2H), 2.01 (m, 2H). LCMS (ESI), m/z, 314 and 316 $[M+Na]^+$, Br pattern found.

Preparation 10: *N*-(3-bromopropyl)(4-fluorophenyl)methanesulfonamide



N-(3-bromopropyl)(4-fluorophenyl)methanesulfonamide was prepared using the above procedure. ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.42-7.37 (m, 2H), 7.13-7.07 (m, 2H), 4.26 (m, 1H), 4.24 (s, 2H), 3.46-3.42 (m, 2H), 3.20-3.16 (m, 2H), 2.05-2.00 (m, 2H).

Preparation 11: 6-Phenyl-1,2-thiazinane 1,1-dioxide

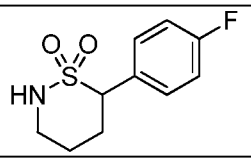
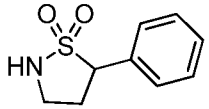
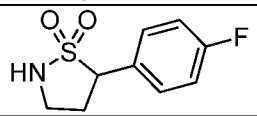
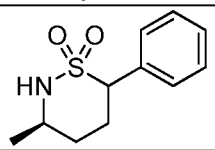
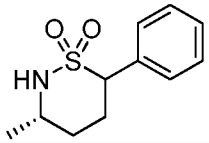
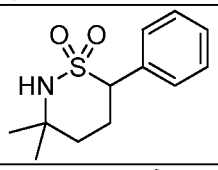
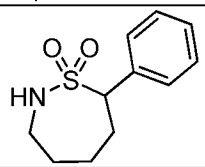


To a solution of *N*-(3-bromopropyl)-1-phenylmethanesulfonamide (2.3 g, 7.9 mmol), diisopropylamine (0.28 mL, 2.0 mmol) and 1,10-phenanthroline (3.6 mg, 0.02 mmol) in tetrahydrofuran (26 mL) at -78 °C was added *n*-BuLi (6.8 mL, 2.5 M in hexanes) dropwise and the reaction was stirred for 16 hours. Saturated NH_4Cl was then added and the reaction was diluted with EtOAc, washed with water and brine, dried with $MgSO_4$, concentrated and purified by silica gel column chromatography (0-50% EtOAc/heptane) to 6-Phenyl-1,2-thiazinane 1,1-dioxide (1.3 g, 80% yield). ^{1}H NMR (300 MHz, DMSO-d_6) δ 7.40-7.35 (m, 5H), 6.98 (m, 1H), 4.12 (dd, 1H), 3.26-3.20 (m, 2H), 2.40-2.30 (m, 1H), 2.16-2.12 (m, 1H), 1.77-1.65 (m, 2H). LCMS (ESI), m/z, 234 $[M+Na]^+$. (Reference: D. Askin, et al. *Org. Lett.* **2003**, 4175.)

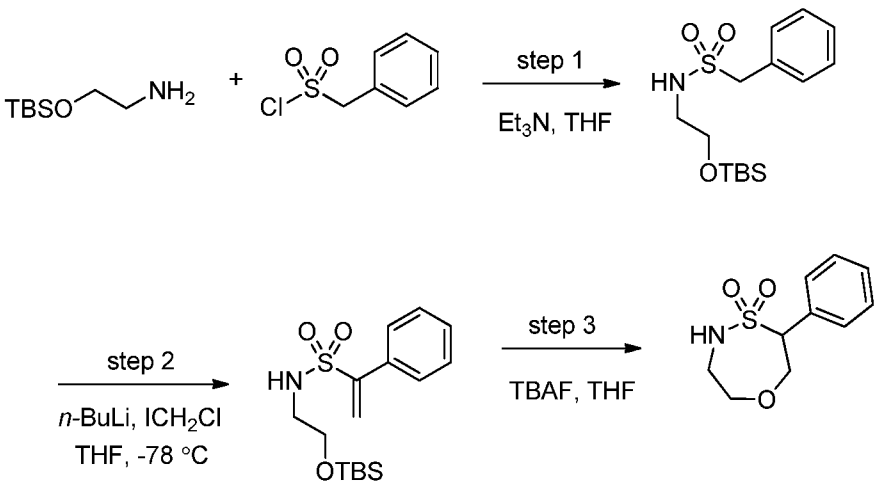
Additional compounds made using the above procedure are shown in Table 2.

Table 2

	Structure	Name	LCMS (ESI), m/z, $[M+H]^+$

12		6-(4-fluorophenyl)-1,2-thiazinane 1,1-dioxide	230
13		5-phenylisothiazolidine 1,1-dioxide	198
14		5-(4-fluorophenyl)isothiazolidine 1,1-dioxide	216
15		(3*R*)-3-methyl-6-phenyl-1,2-thiazinane 1,1-dioxide	226
16		(3*S*)-3-methyl-6-phenyl-1,2-thiazinane 1,1-dioxide	226
17		3,3-dimethyl-6-phenyl-1,2-thiazinane 1,1-dioxide	240
18		7-phenyl-1,2-thiazepane 1,1-dioxide	226

Preparation 19: 3-Phenyl-1,4,5-oxathiazepane 4,4-dioxide



Step 1: *N*-(2-((Tert-butyldimethylsilyl)oxy)ethyl)-1-phenylmethanesulfonamide

To a solution of 2-((tert-butyldimethylsilyl)oxy)ethanamine (11.7 g, 66.6 mmol) and triethylamine (11.2 mL, 79.9 mmol) in tetrahydrofuran (222 mL) at 0 °C was slowly added phenylmethanesulfonyl chloride (12.7 g, 66.6 mmol) portion wise and the reaction was stirred at room temperature for 16 hours. MTBE was then added and the $Et_3N{\cdot}HCl$ salt was removed by filtration. The filtrate was then concentrated and purified by silica gel solumn chromatography (0-30% Acetone in heptane, 216 nM) to *N*-(2-((tert-butyldimethylsilyl)oxy)ethyl)-1-phenylmethanesulfonamide (17.8 g, 81 % yield). LCMS (ESI), m/z, 330. [M+H] +.

Step 2: *N*-(2-((Tert-butyldimethylsilyl)oxy)ethyl)-1-phenylethenesulfonamid

To a solution of *N*-[2-[tert-butyl(dimethyl)silyl]oxyethyl]-1-phenyl-methanesulfonamide (33 g, 100.2 mmol) in tetrahydrofuran (334 mL) at -78 °C was slowly added *n*-BuLi (2.5 M in hexanes) (100 mL, 250 mmol) via cannula and the reaction was stirred at -78 °C was 2 hours. Chloroiodomethane (8.3 mL, 110 mmol) was then slowly added and the reaction was stirred at -78 °C for one hour, then allowed to warm to room temperature and aged for 16 hours. The reaction was then quenched with saturated NH_4Cl and extracted with dichloromethane, dried with $MgSO_4$, concentrated and purified by silica gel column chromatography (0-60% EtOAc in heptane) to give *N*-[2-[tert-butyl(dimethyl)silyl]oxyethyl]-1-phenyl-ethenesulfonamide (24 g, 70 % yield). LCMS (ESI), m/z, 342. [M+H] +.

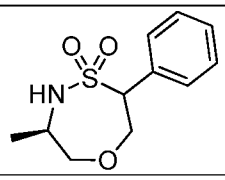
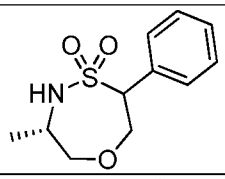
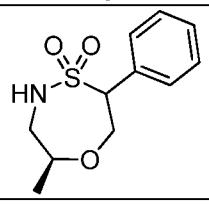
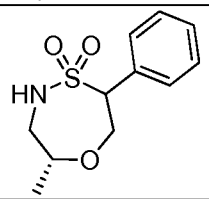
Step 3: 3-Phenyl-1,4,5-oxathiazepane 4,4-dioxide

To a solution of *N*-(2-((Tert-butyldimethylsilyl)oxy)ethyl)-1-phenylethenesulfonamide (717 mg, 2.1 mmol) in tetrahydrofuran (7 mL) at 0 °C was added tetrabutylammonium fluoride (1.0 M in THF) (2.2 mL, 2.2 mmol) dropwise and the reaction was stirred at room temperature for 16 hours. Saturated NH_4Cl was then added and the product was extracted with dichloromethane (x2), dried with $MgSO_4$, concentrated and purified by silica gel column chromatography (0-100% EtOAc in heptane) to give 3-phenyl-1,4,5-oxathiazepane 4,4-dioxide (401 mg, 84 % yield). (24 g, 70 % yield). LCMS (ESI), m/z, 228. [M+H] +. (Reference: P. Hansen, et al. *Org. Lett.* **2008**, 2951).

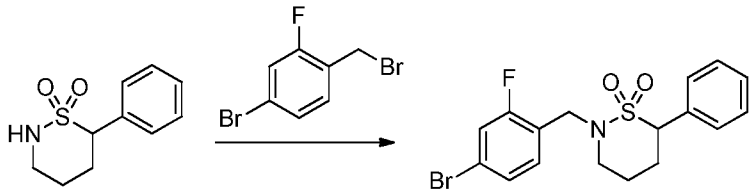
Additional compounds made using the above procedure are shown in Table 3.

Table 3

	Structure	Name	LCMS (ESI), m/z, $[M+H]^+$

20		(6*R*)-6-methyl-3-phenyl-1,4,5-oxathiazepane 4,4-dioxide	242
21		(6*S*)-6-methyl-3-phenyl-1,4,5-oxathiazepane 4,4-dioxide	242
22		(7*S*)-7-methyl-3-phenyl-1,4,5-oxathiazepane 4,4-dioxide	242
23		(7*R*)-7-methyl-3-phenyl-1,4,5-oxathiazepane 4,4-dioxide	242

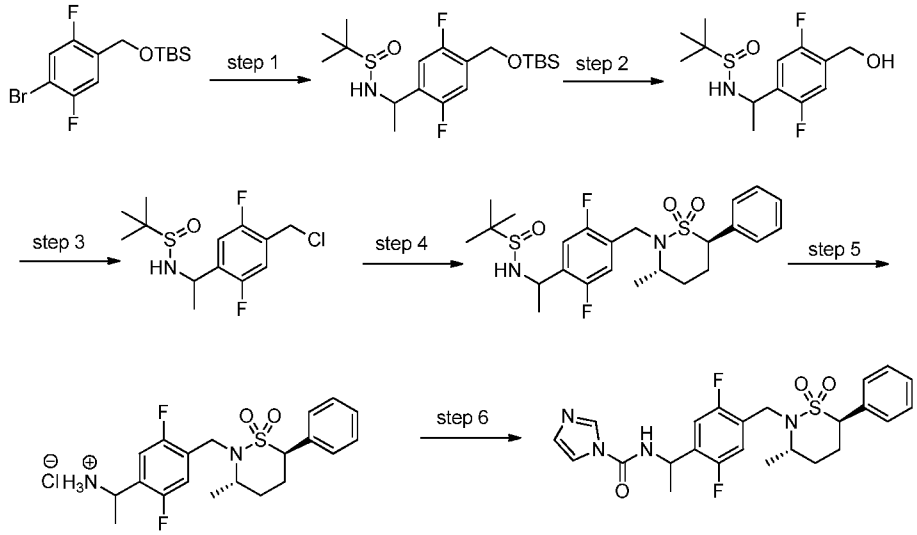
Preparation 24 2-(4-Bromo-2-fluorobenzyl)-6-phenyl-1,2-thiazinane 1,1-dioxide



To a solution of 6-phenyl-1,2-thiazinane 1,1-dioxide (300 mg, 1.42 mmol) and 4-bromo-1-(bromomethyl)-2-fluorobenzene (456 mg, 1.7 mmol) in *N,N*-dimethylacetamide (5 mL) at 0 °C was added sodium hydride (60% in mineral oil) (68 mg, 1.85 mmol) and the reaction was stirred at room temperature for 2 hours. Water was added and the reaction was diluted with EtOAc, washed with brine, dried with $MgSO_4$, filtered and purified by silica gel column chromatography (0-60% EtOAc/heptane) to give 2-(4-bromo-2-fluorobenzyl)-6-phenyl-1,2-thiazinane 1,1-dioxide as a mixture of diastereomers (396 mg, 70% yield). LCMS (ESI), m/z, 398 [M+H] +.

Similarly prepared was (3S)-2-(4-bromo-2-fluorobenzyl)-3-methyl-6-phenyl-1,2-thiazinane 1,1-dioxide.

Example 1: 3-[1-[2,5-Difluoro-4-[[(3*S*,6*R*)-3-methyl-1,1-dioxo-6-phenyl-thiazinan-2-yl]methyl]phenyl]ethyl]-1*H*-imidazol-2-one



Step 1: *N*-(1-(4-(((*tert*-Butyldimethylsilyl)oxy)methyl)-2,5-difluorophenyl)ethyl)-2-methylpropane-2-sulfinamide

To a solution of ((4-bromo-2,5-difluorobenzyl)oxy)(*tert*-butyl)dimethylsilane (10 g, 29.8 mmol) in diethyl ether (200 mL) at -78 °C was added dropwise *n*-butyllithium (2.5 M, 14.2 mL, 35.6 mmol). The resulting mixture was stirred at -78 °C for 1 h, then a solution of (*E*)-*N*-ethylidene-2-methylpropane-2-sulfinamide (5.8 g, 39.4 mmol) in diethyl ether (30 mL) was added dropwise at -78 °C, the reaction mixture was stirred at -78 °C for 30 min. The reaction was quenched with saturated ammonium chloride solution (100 mL), extracted with EtOAc (2 × 100 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The residue was purified by Biotage Flash column (40 g silica, UV254, 0-30% PE/EA) to obtain the title product (10 g, 83% yield) as colorless oil. LCMS (ESI): m/z = 406.2 $[M+H]^+$.

Step 2: *N*-(1-(2,5-Difluoro-4-(hydroxymethyl)phenyl)ethyl)-2-methylpropane-2-sulfinamide

To a solution of the product of step 1 (7.7 g, 19 mmol) in THF (100 mL) was added TBAF (38 mL, 38 mmol), the reaction mixture was stirred at 25 °C for 1 h. The solvent was removed and diluted with EtOAc (100 mL), then washed with water (50 mL × 3), dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The residue was purified by flash chromatography eluting with 0-50% EtOAc in PE to afford the title compound (4.9 g, 76 % yield) as colorless oil. LCMS (ESI): m/z = 292.1 $[M+H]^+$.

Step 3: *N*-(1-(4-(Chloromethyl)-2,5-difluorophenyl)ethyl)-2-methylpropane-2-sulfinamide

To a solution of the product of step 2 (4.9 g, 16.8 mmol) in DCM (100 mL) was added triethylamine (5.1 g, 50.5 mmol) and methanesulfonyl chloride (3.9 g, 33.6 mmol) at 0 °C. The reaction mixture was stirred at 25 °C overnight then quenched with water (50 mL), extracted with DCM (2 × 50 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The residue was purified by Biotage Flash column (40 g silica, UV254, PE/EA=1:0-2:3) to give the title compound (3.4 g, 65% yield) as a white solid. LCMS (ESI): m/z = 310.0 $[M+H]^+$.

Step 4: *N*-(1-(2,5-Difluoro-4-(((3*S*,6*R*)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-2-methylpropane-2-sulfinamide

To a solution of the product of step 3 (3.4 g, 11 mmol) in DMF (50mL) was added (3*S*,6*R*)-3-methyl-6-phenyl-thiazinane 1,1-dioxide (2.9 g, 13 mmol) and cesium carbonate (12.4 g, 38 mmol). The reaction was stirred at 25 °C for 16 h, quenched with saturated NH_4Cl solution (100 mL), extracted with EtOAc (50mL × 3), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The residue was purified by Biotage Flash column (40 g silica, UV254, 0-50% PE/EA) to give the title compound (4.6 g, 84% yield) as light yellow oil. LCMS (ESI): m/z = 499.2 $[M+H]^+$.

Step 5: 1-(2,5-Difluoro-4-(((3*S*,6*R*)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethan-1-aminium chloride

To a solution of the product of step 4 (4.6 g, 9.2 mmol) in MeOH (20 mL) was added dropwise anhydrous HCl in 1,4-dioxane (4 M, 6.9 mL, 27.7 mmol) at 0 °C. The reaction was stirred at 0 °C for 30 min. The solvent was removed *in vacuo* and the crude product was triturated with diethyl ether, filtered, washed with more diethyl ether, dried under a high vacuum system for 1 h to give the title compound (3.8 g, 96% yield) as a white solid.

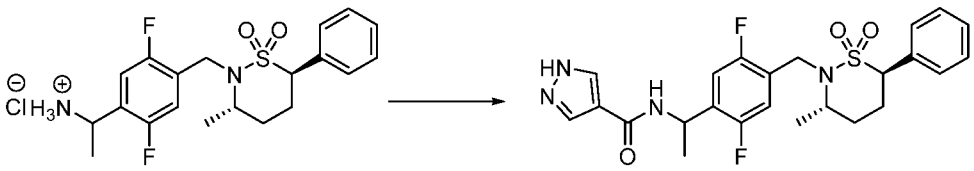
LCMS (ESI): m/z = 395.2 $[M+H]^+$; ^1H NMR (400 MHz, DMSO-d_6) δ 8.46 (s, 3H), 7.54-7.50 (m, 1H), 7.47-7.46 (m, 2H), 7.40-7.31 (m, 4H), 4.61-4.52 (m, 3H), 4.43-4.37 (m, 1H), 4.16-4.10 (m, 1H), 2.47-2.44 (m, 1H), 2.13-2.08 (m, 1H), 1.82-1.79 (m, 1H), 1.69-1.66 (m, 1H), 1.52-1.50 (m, 3H),1.15-1.11 (m, 3H).

Step 6: *N*-(1-(2,5-Difluoro-4-(((3*S*,6*R*)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1*H*-imidazole-1-carboxamide

To a solution of the product of step 5 (150 mg, 0.38 mmol) in THF (10 mL) was added CDI (carbonyldiimidazole, 74 mg, 0.46 mmol). The reaction was stirred at 20 °C for 2 h, then

quenched with water (20 mL), extracted with EA (2×30mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with 0-30% EtOAc in PE to afford the title compound (250 mg, 98% yield) as colorless oil. LCMS (ESI): m/z = 489.1 $[M+H]^+$.

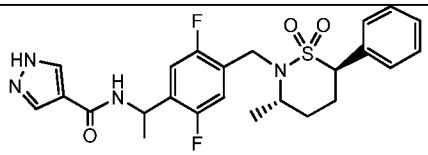
Example 2: *N*-[1-[2,5-Difluoro-4-[[(3*S*,6*R*)-3-methyl-1,1-dioxo-6-phenyl-thiazinan-2-yl]methyl]phenyl]ethyl]-1H-pyrazole-4-carboxamide

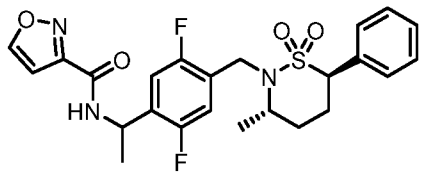
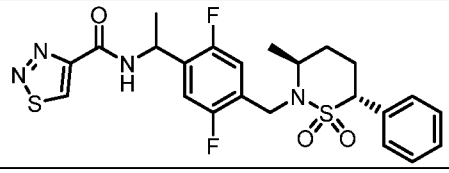
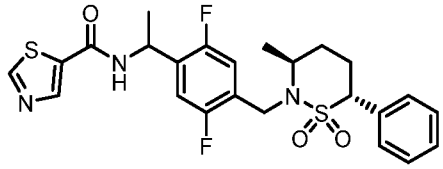
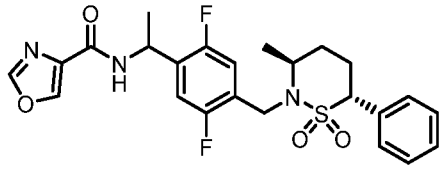
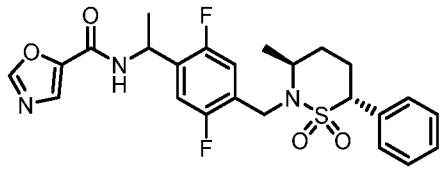
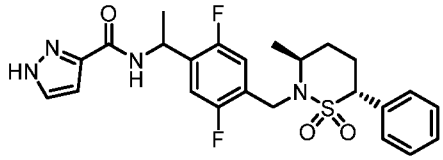
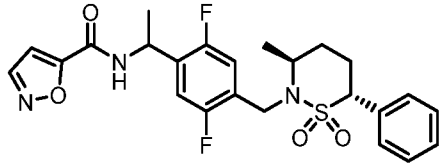
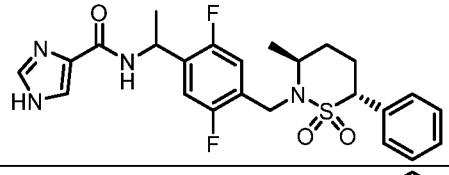
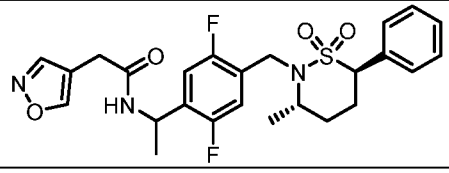


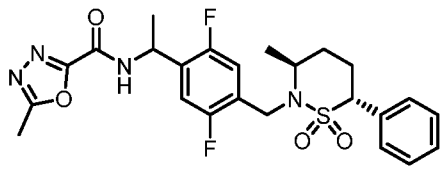
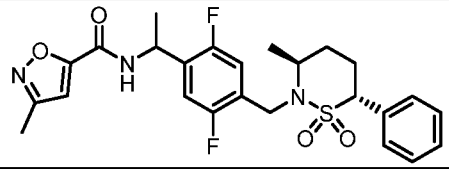
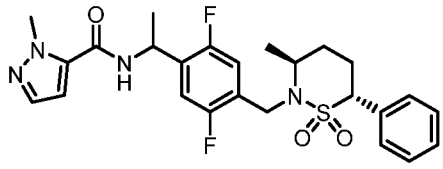
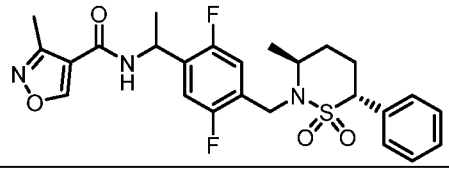
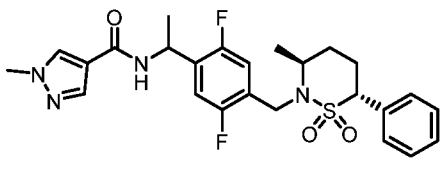
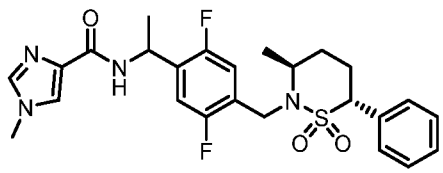
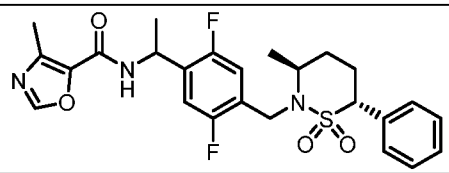
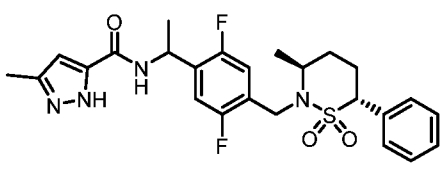
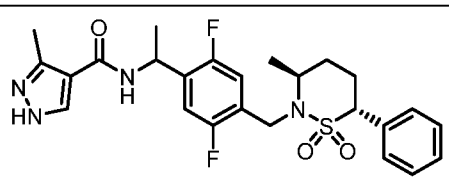
A vial was charged with 1-[2,5-difluoro-4-[[(3*S*,6*R*)-3-methyl-1,1-dioxo-6-phenyl-thiazinan-2-yl]methyl]phenyl]ethanamine hydrochloride (35 mg, 0.081 mmol), 1H-pyrazole-4-carboxylic acid (10.0 mg, 0.089 mmol), *N*,*N*-dimethylformamide (0.5 mL) and triethylamine (0.046 mL, 0.32 mmol) and the suspension was stirred for 2 minutes. HATU (35 mg, 0.089 mmol) was then added and the reaction was stirred at room temperature for 1 hours. DMSO (0.3 mL) was added to obtain a homogeneous solution and the mixture was purified directly by preparative HPLC to give *N*-[1-[2,5-difluoro-4-[[(3*S*,6*R*)-3-methyl-1,1-dioxo-6-phenyl-thiazinan-2-yl]methyl]phenyl]ethyl]-1H-pyrazole-4-carboxamide (8.9 mg, 0.018 mmol, 22% yield) as a white solid. LCMS (ESI): m/z = 489.2 $[M+H]^+$; ^{1}H NMR (400 MHz, DMSO-d6) δ 13.04 (s, 1H), 8.26 (t, *J* = 7.0 Hz, 1H), 8.19 (s, 1H), 7.92 (s, 1H), 7.49 – 7.43 (m, 2H), 7.43 – 7.31 (m, 3H), 7.21 (dd, *J* = 10.7, 6.1 Hz, 2H), 5.37 – 5.23 (m, 1H), 4.58 – 4.42 (m, 2H), 4.35 (dd, *J* = 17.6, 3.4 Hz, 1H), 4.20 – 4.04 (m, 1H), 2.47 – 2.37 (m, 1H), 2.17 – 2.04 (m, 1H), 1.90 – 1.72 (m, 1H), 1.72 – 1.62 (m, 1H), 1.43 (dd, *J* = 7.0, 2.9 Hz, 3H), 1.12 (dd, *J* = 6.9, 3.4 Hz, 3H).

Compounds made using the above procedures are shown in Table 4 below, together with IC_{50} values for RORc.

Table 4

	Structure	Name	IC_{50}
1		N-[1-[2,5-difluoro-4-[[(3S,6R)-3-methyl-1,1-dioxo-6-phenyl-thiazinan-2-yl]methyl]phenyl]ethyl]-1H-pyrazole-4-carboxamide	0.0227

		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)isoxazole-3-carboxamide	0.0068
3		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1,2,3-thiadiazole-4-carboxamide	0.003
4		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)thiazole-5-carboxamide	0.0064
5		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)oxazole-4-carboxamide isomer A	0.17
6		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)oxazole-5-carboxamide isomer B	0.076
7		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1H-pyrazole-3-carboxamide	0.083
8		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)isoxazole-5-carboxamide	0.011
9		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1H-imidazole-4-carboxamide	0.094
10		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-2-(isoxazol-4-yl)acetamide	0.10

11		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-5-methyl-1,3,4-oxadiazole-2-carboxamide	0.0093
12		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methylisoxazole-5-carboxamide	0.0065
13		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-pyrazole-5-carboxamide	0.075
14		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methylisoxazole-4-carboxamide	0.054
15		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-pyrazole-4-carboxamide	0.014
16		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-imidazole-4-carboxamide	0.39
17		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-4-methyloxazole-5-carboxamide	0.23
18		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methyl-1H-pyrazole-5-carboxamide	0.11
19		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methyl-1H-pyrazole-4-carboxamide	0.014

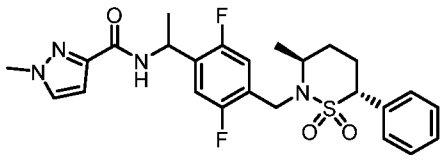
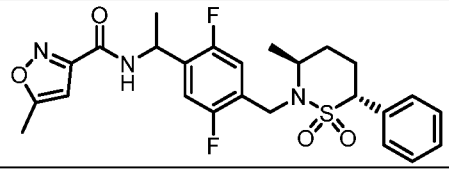
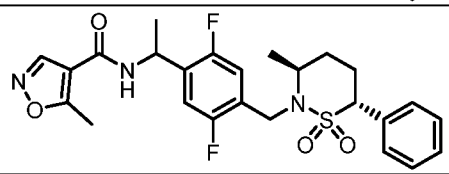
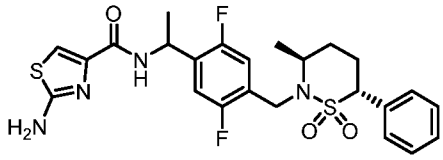
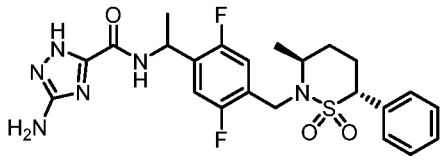
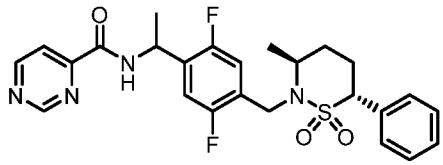
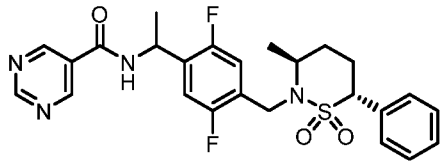
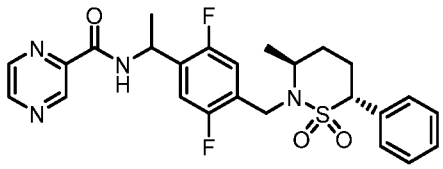
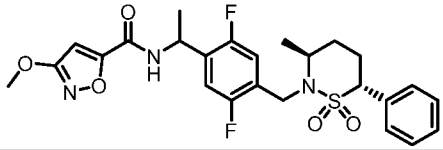
20		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-pyrazole-3-carboxamide	0.25
21		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-5-methylisoxazole-3-carboxamide	0.0071
22		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-5-methylisoxazole-4-carboxamide	0.043
23		2-amino-N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)thiazole-4-carboxamide	0.22
24		3-amino-N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1H-1,2,4-triazole-5-carboxamide	0.048
25		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)pyrimidine-4-carboxamide	0.059
26		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)pyrimidine-5-carboxamide	0.0088
27		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)pyrazine-2-carboxamide	0.15
28		N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methoxyisoxazole-5-carboxamide	0.0073

Table 4

Proton NMR data for selected compounds in Table 4 are shown below, with compound numbers corresponding to those shown in Table 4.

Compound 3: ^{1}H NMR (400 MHz, DMSO-d6) δ 9.67 (d, *J* = 4.5 Hz, 1H), 9.55 (d, *J* = 8.0 Hz, 1H), 7.50 – 7.43 (m, 2H), 7.43 – 7.35 (m, 4H), 7.23 (dd, *J* = 10.6, 6.0 Hz, 1H), 5.45 (t, *J* = 7.4 Hz, 1H), 4.59 – 4.46 (m, 2H), 4.36 (d, *J* = 17.7 Hz, 1H), 4.12 (ddd, *J* = 11.8, 6.7, 2.3 Hz, 1H), 2.48 – 2.41 (m, 1H), 2.14 – 2.08 (m, 1H), 1.78 (t, *J* = 11.9 Hz, 1H), 1.72 – 1.64 (m, 1H), 1.53 (d, *J* = 7.0 Hz, 3H), 1.12 (d, *J* = 6.8 Hz, 3H).

Compound 4: ^{1}H NMR (400 MHz, DMSO-d6) δ 9.23 (dd, *J* = 2.5, 0.6 Hz, 1H), 9.06 (dd, *J* = 7.6, 4.9 Hz, 1H), 8.58 (dd, *J* = 4.9, 0.7 Hz, 1H), 7.49 – 7.43 (m, 2H), 7.43 – 7.35 (m, 3H), 7.25 (ddd, *J* = 16.2, 10.6, 6.0 Hz, 2H), 5.35 – 5.23 (m, 1H), 4.61 – 4.46 (m, 2H), 4.35 (dd, *J* = 17.8, 3.0 Hz, 1H), 4.18 – 4.08 (m, 1H), 2.47 – 2.41 (m, 1H), 2.16 – 2.05 (m, 1H), 1.80 (q, *J* = 12.9, 12.4 Hz, 1H), 1.67 (d, *J* = 14.2 Hz, 1H), 1.47 (dd, *J* = 7.0, 2.7 Hz, 3H), 1.12 (dd, *J* = 6.9, 2.9 Hz, 3H).

Compound 12: ^{1}H NMR (400 MHz, DMSO-d6) δ 9.33 (dd, *J* = 7.9, 4.4 Hz, 1H), 7.46 (dd, *J* = 8.0, 1.7 Hz, 2H), 7.43 – 7.34 (m, 3H), 7.25 (ddd, *J* = 20.7, 10.6, 6.0 Hz, 2H), 6.96 (d, *J* = 4.6 Hz, 1H), 5.31 (td, *J* = 7.4, 4.0 Hz, 1H), 4.61 – 4.46 (m, 2H), 4.40 – 4.32 (m, 1H), 4.12 (ddd, *J* = 11.9, 6.8, 2.0 Hz, 1H), 2.44 (dd, *J* = 13.6, 3.8 Hz, 1H), 2.30 (d, *J* = 1.9 Hz, 3H), 2.15 – 2.05 (m, 1H), 1.87 – 1.73 (m, 1H), 1.66 (d, *J* = 14.1 Hz, 1H), 1.46 (dd, *J* = 7.1, 2.5 Hz, 3H), 1.11 (dd, *J* = 6.9, 3.1 Hz, 3H).

Compound 21: ^{1}H NMR (400 MHz, DMSO-d6) δ 9.21 (dd, *J* = 8.1, 5.6 Hz, 1H), 7.49 – 7.44 (m, 2H), 7.43 – 7.33 (m, 3H), 7.29 (dd, *J* = 10.6, 6.0 Hz, 1H), 7.22 (dd, *J* = 10.6, 6.0 Hz, 1H), 6.53 (dq, *J* = 4.2, 0.8 Hz, 1H), 5.33 (td, *J* = 7.5, 4.1 Hz, 1H), 4.60 – 4.45 (m, 2H), 4.40 – 4.30 (m, 1H), 4.17 – 4.07 (m, 1H), 2.46 (dd, *J* = 2.0, 0.9 Hz, 3H), 2.41 (dd, *J* = 13.0, 3.7 Hz, 1H), 2.14 – 2.05 (m, 1H), 1.80 (q, *J* = 12.9, 12.0 Hz, 1H), 1.66 (d, *J* = 14.3 Hz, 1H), 1.45 (dd, *J* = 7.1, 2.4 Hz, 3H), 1.11 (dd, *J* = 6.9, 2.9 Hz, 3H).

Compound 26: ^{1}H NMR (400 MHz, DMSO-d6) δ 9.32 (d, *J* = 1.9 Hz, 1H), 9.20 (d, *J* = 4.5 Hz, 2H), 7.46 (dq, *J* = 7.1, 1.4 Hz, 2H), 7.42 – 7.35 (m, 3H), 7.32 (ddd, *J* = 10.6, 6.1, 1.7 Hz, 1H), 7.24 (dd, *J* = 10.6, 6.1 Hz, 1H), 5.34 (td, *J* = 7.1, 3.0 Hz, 1H), 4.61 – 4.45 (m, 2H), 4.41 – 4.31 (m, 1H), 4.18 – 4.08 (m, 0H), 2.47 – 2.38 (m, 1H), 2.15 – 2.04 (m, 1H), 1.88 – 1.72 (m, 1H), 1.67 (d, *J* = 14.2 Hz, 1H), 1.49 (dd, *J* = 7.0, 2.5 Hz, 3H), 1.12 (dd, *J* = 6.9, 3.2 Hz, 3H).

Compound 28: ^{1}H NMR (400 MHz, DMSO-d6) δ 9.33 (dd, *J* = 7.8, 4.4 Hz, 1H), 7.50 – 7.43 (m, 2H), 7.43 – 7.35 (m, 3H), 7.25 (ddd, *J* = 18.8, 10.5, 5.9 Hz, 2H), 6.86 (d, *J* = 4.7 Hz, 1H), 5.29 (td, *J* = 7.4, 3.6 Hz, 1H), 4.60 – 4.45 (m, 2H), 4.35 (dd, *J* = 18.5, 1.9 Hz, 1H), 4.17 – 4.08 (m, 1H), 3.94 (d, *J* = 1.6 Hz, 3H), 2.45 (dd, *J* = 13.4, 3.7 Hz, 1H), 2.16 – 2.07 (m, 1H), 1.78 (t, *J* = 12.1 Hz, 1H), 1.71 – 1.63 (m, 1H), 1.46 (dd, *J* = 7.1, 2.5 Hz, 3H), 1.11 (dd, *J* = 6.9, 2.8 Hz, 3H).

Example 3 *In vitro* RORc Ligand Binding Assay

This assay was used to determine a compound's potency in inhibiting activity of RORc by determining, Ki_{app}, IC_{50}, or percent inhibition values. Consumables used in this Example are shown in Table 5 below.

Table 5

Consumable	**Supplier and product code**
GFB Unifilter plates	Perkin Elmer 6005177
3-[(3-Cholamidopropyl)dimethylammonio]-1-propanesulfonate (CHAPS)	Sigma C5070
96-well polypropylene U-bottom assay plate	Nunc 267245
HEPES buffer, 1 M	Sigma H3375
Magnesium chloride ($MgCl_2$)	Sigma M8266
D,L-Dithiothreitol (DTT)	Sigma D0632
Sodium chloride (NaCl)	Sigma 71382
Bovine serum albumin (BSA)	Sigma A7030 [lyophilized powder, ≥98% (agarose gel electrophoresis), Essentially fatty acid free, essentially globulin free]
25-hydroxycholesterol	Sigma H1015
25-[26,27-^{3}H]hydroxycholesterol	Perkin Elmer NET674250UC American Radiolabeled Chemicals ART0766
RORc ligand binding domain	Genentech (e.g., PUR 28048), expressed in *E. coli*
Plate seals	Perkin Elmer 6005185
Microscint 0	Perkin Elmer 6013611

Table 5

Filter Plate Preparation

On day of the assay, 100 uL of 0.05% CHAPS (in deionized H_2O) was added to all wells of the GFB Unifilter plate and allowed soak for 1 h. A wash buffer of 50 mM HEPES (pH 7.4), 150 mM NaCl, and 5 mM $MgCl_2$ was prepared to wash the filter plate. To prepare an

assay buffer, BSA was added to the wash buffer to reach 0.01% and DTT was added to reach 1 mM.

Compounds

For IC_{50} mode, 10 mM compound stocks were serially diluted in DMSO with DMSO to give 20x required final concentration in DMSO (15 uL compound + 30 uL DMSO). The 20x compound stocks were diluted in DMSO with Assay Buffer 4-fold to reach 5x the final test concentration in 25% DMSO (10 uL compound + 30 uL Assay Buffer). Solutions were mixed by aspiration several times with a pipette set on 50 uL volume. For the assay, 10 uL of 5x compound stock solutions in 25% DMSO were added to the assay plate in duplicate.

For two point screening, 10 mM stock compound solutions were diluted in DMSO to obtain 200 uM (20x the high test concentration) and then diluted 10-fold further to reach 20 uM (20x the low test concentration). The 20x stocks were diluted 4-fold with Assay Buffer (10 uL compound + 30 uL Assay Buffer) to reach 5x the test concentrations (50 uM and 5 uM) and 10 uL were added to two assay plates for the duplicate wells. With each concentration tested on 2 plates, each set of 80 compounds used 4 assay plates (1 uM and 10 uM, with n=2).

Nonspecific binding (NSB) samples, Total Binding (TB) samples and No Receptor (No R) samples

25-hydroxycholesterol (1 uM) was used to determine the level of NSB signal is prepared in DMSO as for compounds above, then diluted in Assay Buffer to give a final concentration of 5 uM. For 25-hydroxycholesterol in 25% DMSO/75% Assay Buffer; 10 uL per well was used for NSB samples. Wells for Total Binding and No Receptor sample determination contained 10 uL of 25% DMSO/75% Assay Buffer per well.

Radioligand (25-[^{3}H]hydroxycholesterol) Preparation

25-[^{3}H]hydroxycholesterol was diluted in Assay Buffer to obtain 15 nM and vortex to mix. Add 20 uL to all wells to reach 6 nM final concentration in the assay.

Receptor Preparation

The optimal concentration for RORc receptor was found to be 0.6 ug/mL. Stock receptor solution was diluted in assay buffer to obtain 1.5 ug/mL in Assay Buffer. 20 uL was added to all wells. For No Receptor samples, 20 uL Assay Buffer was substituted for receptor solution.

Sample addition to Plates and Incubation

Assay plates were 96-well polypropylene V-bottom plates. 10 uL of 5x compound in 25% DMSO/75% Assay Buffer was added to Test wells. 10 uL of 25% DMSO/75% Assay Buffer was added to Total Binding or No Receptor wells. 10 uL of 5 uM 25-hydroxycholesterol in 25% DMSO/75% Assay Buffer was added to NSB wells. 20 uL of 15 nM 25-[^{3}H]hydroxycholesterol prepared in Assay Buffer was added to all wells. 20 uL of 1.5 ug/mL RORc receptor was added to wells (or 40 uL Assay Buffer to No R wells). Following addition to the wells, the plates were incubated 3 h at 25°C.

Filtration

Using a Packard Filtermate Harvester, the filter plate were washed 4 times following transfer of the incubated samples. Plates were dry-filtered completely (2 h at 50 °C or overnight at room temperature). 50 uL Microscint 0 was added to all wells and read on Topcount protocol Inverted.

Final concentrations

Final concentrations were as follows: 50 mM HEPES buffer (pH 7.4); 150 mM NaCl; 1 mM DTT; 5 mM $MgCl_2$; 0.01% BSA; 5% DMSO; 0.6 ug/mL RORc receptor; 6 nM 25-[^{3}H]hydroxycholesterol. For NSB wells, 1 uM 25-hydroxycholesterol was also present.

Example 4: RORc Coactivator Peptide Binding Assay

Assays were carried out in 16-microL reaction volumes in black 384 Plus F Proxiplates (Perkin-Elmer 6008269). All assay components except test ligand were mixed in coregulator buffer D (Invitrogen PV4420) containing 5 mM DTT and added to the plate at twice their final concentrations in a volume of 8 microL. Test ligands at 2x the final concentration were then added to the wells in 8 µL of coregulator buffer D containing 5 mM DTT and 4% DMSO. Final incubations contained 1x coregulator buffer D, 5 mM DTT, test ligand, 2% DMSO, 50 nM biotinyl-CPSSHSSLTERKHKILHRLLQEGSPS (American Peptide Company; Vista, CA), 2 nM Europium anti-GST (Cisbio 61GSTKLB), 12.5 nM streptavidin-D2 (Cisbio 610SADAB), 50 mM KF, and 10 nM of bacterially-expressed human RORc ligand binding domain protein containing an *N*-terminal 6xHis-GST-tag and residues 262-507 of Accession NP_005051. Ten test ligand concentrations were tested in duplicate. After the reaction plates were incubated for 3 h in the dark at room temperature (22-23 °C), the plate was read on an EnVision plate reader (PerkinElmer) following the Europium/D2 HTRF protocol (ex 320, em 615 and 665, 100 µs lag time, 100 flashes, 500 µs window). The time-resolved FRET signal at 665 nm was divided by

that at 615 nm to generate the signal ratio of each well. The signal ratio of wells containing RORc and peptide but no test ligand were averaged and set to 0% Effect while the signal ratios of the blank wells containing coactivator peptide but no RORc were averaged and set to -100% Effect. RORc exhibits a basal (constitutive) signal in this assay and test ligands can increase or decrease the signal ratio relative to this basal signal level. RORc agonists increase the signal ratio in this assay and result in a positive % Effect value. Inverse agonists decrease the signal ratio, and result in a negative % Effect value. The EC_{50} value is the concentration of test compound that provides half-maximal effect (increased or decreased assay signal) and is calculated by Genedata Screener® software (Genedata; Basel, Switzerland) using the following equation:

$$\% \text{ Effect} = S_0 + \{(S_{inf} - S_0)/[1+(10^{\log EC_{50}}/10^c)^n]\}$$

where S_0 equals the activity level at zero concentration of test compound, S_{inf} is the activity level at infinite concentration of test compound, EC_{50} is the concentration at which the activity reaches 50% of the maximal effect, c is the concentration in logarithmic units corresponding to the values on the x-axis of the dose-response curve plot, and n is the Hill coefficient (the slope of the curve at the EC_{50}).

Example 5: Arthritis Mouse Model

8 to 10-week old male DBA/1 (DBA/1OlaHsd, Harlan Laboratories) mice are housed in a specific pathogen free (SPF) animal facility. Arthritis is induced by two injections of collagen subcutaneously in the base of the tail. The initial injection (on day 0) uses bovine type II collagen (2 mg/ml from Chondrex, Redmond, Wash.) emulsified in equal volume of CFA containing 4 mg/ml of M. tuberculosis (Chondrex). The CII booster injection on Day 29 is emulsified in incomplete Freund's adjuvant (IFA). Each animal receives 0.1 ml of emulsion by subcutaneous/intradermal injection in the tail 2 to 3 cm from the body of the mouse. The booster injection site is in the vicinity of but different from the initial injection site and closer to the body of the animal. OR-1050 was formulated in HRC-6 as above. On weekdays, the animals receive two doses (a.m. and p.m.) of HRC-6 or 50 mg/kg OR-1050 p.o. (2.5 mls/kg). On weekends, a single dose of 100 mg/kg is administered (5 mls/kg).

The mice are observed daily for clinical symptoms of CIA based on the following qualitative scale. Each paw was examined individually and scored. Grade 0, normal; grade 1, mild but definite redness and swelling of the ankle or wrist, or apparent redness and swelling

limited to individual digits, regardless of the number of affected digits; grade 2, moderate redness and swelling of ankle or wrist; grade 3, severe redness and swelling of the entire paw including digits; grade 4, maximally inflamed limb with involvement of multiple joints. To estimate cumulative disease severity for each animal, an area under the curve score is calculated for each animal by totaling the sum of the daily hind paw measurements betweens days 24 and 48.

Example 6: Muscular Sclerosis Mouse Model I

Experiments are conducted on female mice aged 4-6 weeks belong to the C57BL/6 strain weighing 17-20 g. Experimental autoimmune encephalomyelitis (EAE) is actively induced using 95% pure synthetic myelin oligodendrocyte glycoprotein peptide 35-55 (MOG_{35-55}) (Invitrogen). Each mouse is anesthetized and receives 200 ug of MOG_{35-55} peptide and 15 ug of Saponin extract from Quilija bark emulsified in 100 uL of phosphate-buffered saline. A 25 uL volume is injected subcutaneously over four flank areas. Mice are also intraperitoneally injected with 200 ng of pertussis toxin in 200 uL of PBS. A second, identical injection of pertussis toxin is given after 48 h.

A compound of the invention is administered at selected doses. Control animals receive 25 uL of DMSO. Daily treatment extends from day 26 to day 36 post-immunization. Clinical scores are obtained daily from day 0 post-immunization until day 60. Clinical signs are scored using the following protocol: 0, no detectable signs; 0.5, distal tail limpness, hunched appearance and quiet demeanor; 1, completely limp tail; 1.5, limp tail and hindlimb weakness (unsteady gait and poor grip with hind limbs); 2, unilateral partial hind limb paralysis; 2.5, bilateral hind limb paralysis; 3, complete bilateral hindlimb paralysis; 3.5, complete hindlimb paralysis and unilateral forelimb paralysis; 4, total paralysis of hind limbs and forelimbs (Eugster et al., Eur J Immunol 2001, 31, 2302-2312).

Inflammation and demyelination may be assessed by histology on sections from the CNS of EAE mice. Mice are sacrificed after 30 or 60 days and whole spinal cords are removed and placed in 0.32 M sucrose solution at 4° C. overnight. Tissues are prepared and sectioned. Luxol fast blue stain is used to observe areas of demyelination. Haematoxylin and eosin staining is used to highlight areas of inflammation by darkly staining the nuclei of mononuclear cells. Immune cells stained with H&E are counted in a blinded manner under a light microscope. Sections are separated into gray and white matter and each sector is counted

manually before being combined to give a total for the section. T cells are immunolabeled with anti-CD3+ monoclonal antibody. After washing, sections are incubated with goat anti-rat HRP secondary antibody. Sections are then washed and counterstained with methyl green. Splenocytes isolated from mice at 30 and 60 days post-immunization are treated with lysis buffer to remove red blood cells. Cells are then re-suspended in PBS and counted. Cells at a density of about $3x10^6$ cells/mL are incubated overnight with 20 ug/mL of MOG peptide. Supernatants from stimulated cells are assayed for IFNgamma protein levels using an appropriate mouse IFN-gamma immunoassay system.

Example 7: Muscular Sclerosis Mouse Model II

In this model, female rodents are anesthetized with isoflurane and injected with Freund's Incomplete Adjuvant containing 1 mg/mL neuronal antigen (e.g. myelin basic protein, myelin oligodendrocyte glycoprotein, proteolipid protein) and 4 mg/mL mycobacterium tuberculosis at two sites on the back on day 0 of this study. A compound of interest is then dosed daily in a sub-cutaneous, intra-peritoneally, or oral manner from day 0 until the end of study at an efficacious dose. Daily observations of degree of paralysis are taken as measures of efficacy.

Example 8: Psoriasis Mouse Model I

The severe, combined immunodeficient (SCID) mouse model can be used to evaluate the efficacy of compounds for treating psoriasis in humans (Boehncke, Ernst Schering Res Found Workshop 2005, 50, 213-34; and Bhagavathula et al., J Pharmacol Expt'l Therapeutics 2008, 324(3), 938-947). Briefly, SCID mice are used as tissue recipients. One biopsy for each normal or psoriatic volunteer (human) is transplanted onto the dorsal surface of a recipient mouse. Treatment is initiated 1 to 2 weeks after transplantation. Animals with the human skin transplants are divided into treatment groups. Animals are treated twice daily for 14 days. At the end of treatment, animals are photographed and then euthanized. The transplanted human tissue along with the surrounding mouse skin is surgically removed and fixed in 10% formalin and samples obtained for microscopy. Epidermal thickness is measured. Tissue sections are stained with an antibody to the proliferation-associated antigen Ki-67 and with an anti-human CD3.sup.+ monoclonal antibody to detect human T lymphocytes in the transplanted tissue. Sections are also probed with antibodies to c-myc and beta-catenin. A positive response to treatment is reflected by a reduction in the average epiderma thickness of the psoriatic skin

transplants. A positive response is also associated with reduced expression of Ki-67 in keratinocytes.

Example 9: Psoriasis Mouse Model II

Using the Imidquimod model of skin inflammation (Fits et al, Journal of Immunology, 2009, 182: 5836-5845), 10-12 week old BALB/c, Il17c+/+ or Il17c-/-, or Il17re+/+ or Il17re-/- mice were administered 50 mg Aldara cream (5% Imidquimod in Graceway, 3M) in the shaved back and right ear daily for 5 days. Clinical scoring and ear thickness measurements were performed daily. Scoring was based upon the manifestation of psoriatic symptoms, such as erythema, scaling and thickness: 0, No disease. 1, Very mild erythema with very mild thickening and scaling involving a small area. 2, Mild erythema with mild thickening and scaling involving a small area. 3, Moderate erythema with moderate thickening and scaling (irregular and patchy) involving a small area (<25%). 4, Severe erythema with marked thickening and scaling (irregular and patchy) involving a moderate area (25-50%). 5, Severe erythema with marked thickening and scaling (irregular and patchy) involving a large area (>50%). Ear and back tissue were harvested on day 5 for histological evaluation. Efficacy of compounds is compared in the imiquimod (IMQ) mouse model of psoriasis. Balb/c mice (10 males/group) received daily topical IMQ (5% cream) on shaved back and right ear for 5 days as described above. Animals received oral dose of a representative compound or DMF (45 or 90 mg-eq MMF/kg twice daily) or vehicle from Day -5 to Day +5. Erythema score is the primary outcome measure. The Erythema score values of the compounds tested at an oral dose of 90 mg-eq MMF/kg BID for 10 days in male Balb/C mice are set forth in Table 3, below. The data shows that the compounds of the disclosure are equipotent to DMF.

Example 10: Irritable Bowel Disease Mouse Model I

Effectiveness in treatment of inflammatory bowel disease may be evaluated as described by Jurjus et al., J Pharmacol Toxicol Methods 2004, 50, 81-92; Villegas et al., Int'l Immunopharmacol 2003, 3, 1731-1741; and Murakami et al., Biochemical Pharmacol 2003, 66, 1253-1261. Briefly, female ICR mice are divided into treatment groups which are given either water (control), 5% DSS in tap water is given at the beginning of the experiment to induce colitis, or various concentrations of test compound. After administering test compound for 1 week, 5% DSS in tap water is also administered to the groups receiving test compound for 1 week. At the end of the experiment, all mice are sacrificed and the large intestine is removed.

Colonic mucosa samples are obtained and homogenized. Proinflammatory mediators (e.g., IL-1alpha, IL-1beta, TNFalpha, PGE2, and PGF2alpha.) and protein concentrations are quantified. Each excised large intestine is histologically examined and the damage to the colon scored.

Example 11: Chronic Obstructive Pulmonary Disease Mouse Model

The cigarette smoke model of Martorana et al., Am J Respir Crit Care Med 2005, 172, 848-835; and Cavarra et al., Am J Respir Crit Care Med 2001, 164, 886-890 can be used for assessing efficacy in treating emphysema. Briefly, six-week old C57B1/6J male mice are exposed either to room air or to the smoke of five cigarettes for 20 minutes. For the acute study, mice are divided into three groups of 40 animals each. These groups are then divided into four subgroups of 10 mice each as follows: (1) no treatment/air-exposed; (2) no treatment/smoke-exposed; (3) a first dose of test compound plus smoke-exposed; and (4) a second dose of test compound. In the first group, trolox equivalent antioxidant capacity is assessed at the end of the exposure in bronchoalveolar lavage fluid. In the second group, cytokines and chemokines are determined in bronchoalveolar lavage fluid using a commercial cytokine panel at 4 hours; and in the third group bronchoalveolar lavage fluid cell count is assessed at 24 hours.

In a chronic study, the mice are exposed to either room air or to the smoke of three cigarettes/day, for 5 days/week, for 7 months. Five groups of animals are used: (1) no treatment/air-exposed; (2) a first dose of a test compound plus air-exposed; (3) no treatment/smoke-exposed; (4) a second dose of the test compound plus smoke-exposed; and (5) the first dose of the test compound plus smoke exposed. Seven months after chronic exposure to room air or cigarette smoke, 5 to 12 animals from each group are sacrificed and the lungs fixed intratracheally with formalin. Lung volume is measured by water displacement. Lungs are stained. Assessment of emphysema includes mean linear intercept and internal surface area. The volume density of macrophages, marked immunohistochemically with anti-mouse Mac-3 monoclonal antibodies is determined by point counting. A mouse is considered to have goblet cell metaplasia when at least one or more midsize bronchi/lung showed a positive periodic acid-Schiff staining for the determination of desmosine, fresh lungs are homogenized, processed, and analyzed by high-pressure liquid chromatography.

Example 12: Asthma Mouse Model

A single inhaled allergen challenge can induce an acute increase in airway responsiveness in some individuals and animal models. However, repeated allergen inhalations

have demonstrated more pronounced, consistent, and prolonged increases in airway responsiveness. This mouse model of long-term repeated inhalations of allergen has been used to study the long term effect of allergic diseases in the lung, and to delineate the cells, mechanisms, molecules, and mediators involved in the induction of airway hyperresponsiveness of lung in humans.

Crystalline OVA is obtained from Pierce Chem. Co. (Rockford, Ill.) aluminum potassium sulfate (alum) from Sigma Chem. Co. (St. Louis, Mo.), pyrogen-free distilled water from Baxter, Healthcare Corporation (Deerfield, Ill.), 0.9% sodium chloride (normal saline) from Lymphomed (Deerfield, Ill.) and Trappsol.TM. HPB-L100 (aqueous hydroxypropylbeta cyclodextrin; 45 wt/vol % aqueous solution) from Cyclodextrin Technologies Development, Inc. (Gainesville, Fla.). The OVA (500 ug/ml in normal saline) is mixed with equal volumes of 10% (wt/vol) alum in distilled water. The mixture (pH 6.5 using 10 N NaOH) after incubation for 60 minutes at room temperature is centrifuged at 750 g for 5 minutes; the pellet resuspended to the original volume in distilled water and used within one hour. The selective 5-lipoxtgenase inhibitor, Zileuton (N-[1-benzo[b]thien-2-ylethyl]-N-hydroxyurea; J. Pharmacol Exp Ther. 1991; 256: 929-937) is dissolved in Trappsol.TM. Histatek, Inc. (Seattle, Wash.) to provide the mast cell degranulation inhibitor, f-Met-Leu-Phe-Phe ("HK-X").

Female BALB/c Once (6-8 wk of age) receive an i.p. injection of 0.2 ml (100 ug) of OVA with alum on the different protocols of Standard (J. Exp Med. 1996; 184: 1483-1494). Mice are anesthetized with 0.2 ml i.p. of ketamine (0.44 mg/ml)/xylazine (6.3 mg/ml) in normal saline before receiving an intranasal (i.n.) dose of 100 ug OVA in 0.05 ml normal saline and an i.n. dose of 50 ug OVA in 0.05 ml normal saline separately on different days. Two control groups are used: the first group receives normal saline with alum i.p. and normal saline without alum i.n.; and the second group receives OVA with alum i.p., OVA without alum i.n., and normal saline, alone.

The trachea and left lung (the right lung may be used for bronchoalveolar lavage ("BAL") as described below) are obtained and fixed in 10% neutral formaldehyde solution at room temperature for about 15 h. After being embedded in paraffin, the tissues are cut into 5-um sections and processed with the different staining or immunolabling further. Discombe's eosinophil staining is used for counting the cell numbers with the counterstain of methylene blue. The eosinophil number per unit airway area (2,200 um^2) is determined by morphometry (J.

Pathol. 1992; 166: 395-404; Am Rev Respir Dis. 1993; 147:448-456). Fibrosis is identified with the Masson's trichrome staining. Airway mucus iss identified by the following staining method: methylene blue, hematoxylin and eosin, mucicarmine, alcian blue, and alcian blue/periodic acid-Schiff (PAS) reaction (Troyer, H., "Carbohydrates" in Principles and Techniques of Histochemistry, Little, Brown and Company, Boston, Mass., 1980: 89-121; Sheehan, D. C., et al., "Carbohydrates" in Theory and Practice of Histotechnology, Battle Press, Columbus, Ohio, 1980: 159-179) Mucin is stained with mucicarmine solution; metanil yellow counterstain is employed. Acidic mucin and sulfated mucosubstances are stained with alcian blue, pH 2.5; nuclear fast red counterstain is used. Neutral and acidic mucosubstances are identified by alcian blue, pH 2.5, and PAS reaction. The degree of mucus plugging of the airways (0.5-0.8 mm in diameter) is also assessed by morphometry. The percent occlusion of airway diameter by mucus iss classified on a semiquantitative scale from 0 to 4+. The histologic and morphometric analyses may be performed by individuals blinded to the protocol design.

On day 28, 24 hours after the last i.n. administration of either normal saline or OVA, pulmonary mechanics to intravenous infusion of methacholine may be determined in mice in vivo by a plethysmographic method as previously described (10, 1958; 192: 364-368; J. Appl. Physiol. 1988; 64: 2318-2323; J. Exp. Med. 1996; 184: 1483-1494).

After tying off the left lung at the mainstem bronchus, the right lung may be lavaged three times with 0.4 ml of normal saline. Bronchoalveolar lavage (BAL) fluid cells from a 0.05-ml aliquot of the pooled sample are counted using a hemocytometer and the remaining fluid centrifuged at 4°C. for 10 minutes at 200 g. The supernatant may be stored at 70.degree. C. until eicosanoid analysis is performed. After resuspension of the cell pellet in normal saline containing 10% bovine serum albumin ("BSA"), BAL cell smears are made on glass slides. To stain eosinophils, dried slides are stained with Discombe's diluting fluid (0.05% aqueous eosin and 5% acetone (vol/vol) in distilled water; J. Exp. Med. 1970; 131: 1271-1287) for 5-8 minutes, rinsed with water for 0.5 minutes, and counterstained with 0.07% methylene blue for 2 minutes.

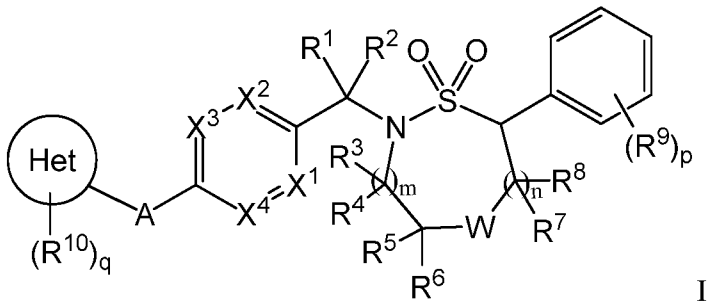
While the present invention has been described with reference to the specific embodiments thereof, it should be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the true spirit and scope of the invention. In addition, many modifications may be made to adapt a particular situation, material, composition of matter, process, process step or steps, to the objective spirit and scope

of the present invention. All such modifications are intended to be within the scope of the claims appended hereto.

CLAIMS

What is claimed is:

1. A compound of formula I



I

or a pharmaceutically acceptable salt thereof,

wherein:

m is 0 or 1;

n is 0 or 1;

p is from 0 to 3;

q is from 0 to 3;

Het is:

a five or six membered heteroaryl selected from:

pyrrolyl;

pyrrazolyl;

imidazolyl;

oxazolyl;

thiazolyl;

isoxazolyl;

isothiazolyl;

triazolyl;

oxadiazolyl;

thiadiazolyl;

tetrazolyl;

thiophenyl;

furanyl;

pyridinyl;

pyrimidinyl;
pyridazinyl; or
pyrazinyl; or
a five membered heterocyclyl selected from:
pyrrolidinyl;
oxazolidinyl;
dioxolanyl; or
imidazolidinyl;

A is:

$-(CH_2)_r-C(O)-NH-C_{1-6}$alkylene; or

C_{1-6}alkenylene-NH-C(O)-$(CH_2)_r$-,

wherein each such C_{1-6}alkenylene may be unsubstituted or substituted once or twice with R^a;

r is: 0 or 1;

W is: $-CR^bR^c-$; -O-; -S-; $-SO_2-$; or $-NR^d-$;

one of X^1, X^2, X^3 and X^4 is N and the others are CR^e; or two of X^1, X^2, X^3 and X^4 are N and the others are CR^e; or three of X^1, X^2, X^3 and X^4 are N and the other is CR^e; or each of X^1, X^2, X^3 and X^4 is CR^e;

R^1, R^2, R^3, R^4, R^5, R^6, R^7 and R^8 each independently is: hydrogen; or C_{1-6}alkyl which may be unsubstituted or substituted one or more times with halo;

or R^3 and R^4 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, $-NR^d-$ or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or R^5 and R^6 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, $-NR^d-$ or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or R^7 and R^8 together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one

or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^3 and R^4 together with one of R^5 and R^6 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^5 and R^6 together with one of R^7 and R^8 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^d- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

each R^9 is independently:

C_{1-6}alkyl;

halo;

C_{1-6}alkoxy; or

cyano;

wherein the C_{1-6}alkyl moieties may be unsubstituted or substituted one or more times with halo;

each R^{10} is independently:

amino;

C_{1-6}alkoxy;

C_{1-6}alkyl;

oxo;

hydroxy

halo;

cyano;

halo-C_{1-6}alkyl;

hydroxy-C_{1-6}alkyl;

C_{1-6}alkoxy-C_{1-6}alkyl; or

cyano-C_{1-6}alkyl;

R^a is:

C_{1-6}alkoxy;

C_{1-6}alkoxy-C_{1-6}alkyl;

hydroxy-C_{1-6}alkyl;

C_{3-6}cycloalkyl;

C_{3-6}cycloalkyl-C_{1-6}alkyl;

C_{3-6}cycloalkyloxy;

C_{3-6}cycloalkyl-C_{1-6}alkoxy;

heterocyclyl;

heterocylyl-C_{1-6}alkyl; or

heterocylyl-C_{1-6}alkoxy;

wherein the heterocyclyl moieties are each independently selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, and wherein the heterocycyl moieties and C_{3-6}cycloalkyl moieties each may be unsubstituted or substituted one or more times with R^f;

R^b, R^c, and R^d each independent is:

hydrogen;

C_{1-6}alkyl; or

halo-C_{1-6}alkyl;

or R^b and R^c together with the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^b and R^c together with one of R^7 and R^8 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

or one of R^b and R^c together with one of R^5 and R^6 and the atoms to which they are attached may form a three, four, five, six or seven membered saturated or partially saturated ring that may optionally include one or two heteroatoms selected from -O-, -NR^a- or -S-, and which may be unsubstituted or substituted one or more times with R^f;

each R^e is independently:

hydrogen;

C_{1-6}alkyl;
halo;
C_{1-6}alkoxy; or
cyano;

wherein the C_{1-6}alkyl moieties may be unsubstituted or substituted one or more times with halo; and

R^f is: C_{1-6}alkyl; halo-C_{1-6}alkyl; halo; oxo; hydroxy; or C_{1-6}alkoxy;

provided that the compound is not *N*-(1-(2,5-Difluoro-4-(((3*S*,6*R*)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1*H*-imidazole-1-carboxamide.

2. The compound of claim 1, wherein n is 0.

3. The compound of claims 1 or 2, wherein R^1, R^2, R^4, R^5, R^6, R^7 and R^8 are hydrogen.

4. The compound of any of claims 1-3, wherein W is -CR^bR^c- and R^b and R^c are hydrogen.

5. The compound of any of claims 1-4, wherein X^1, X^2, X^3 and X^4 are CR^e.

6. The compound of any of claims 1-5, wherein p is 0.

7. The compound of any of claims 1-6, wherein q is 0 or 1.

8. The compound of any of claims 1-7, wherein p is 0.

9. The compound of any of claims 1-8, wherein Het is a five or six membered heteroaryl selected from:

pyrrolyl;
pyrrazolyl;
oxazolyl;
thiazolyl;
isoxazolyl;

isothiazolyl;
triazolyl;
oxadiazolyl;
thiadiazolyl;
tetrazolyl;
thiophenyl;
furanyl;
pyridinyl;
pyrimidinyl;
pyridazinyl; or
pyrazinyl;

10. The compound of any of claims 1-10, wherein r is 0.

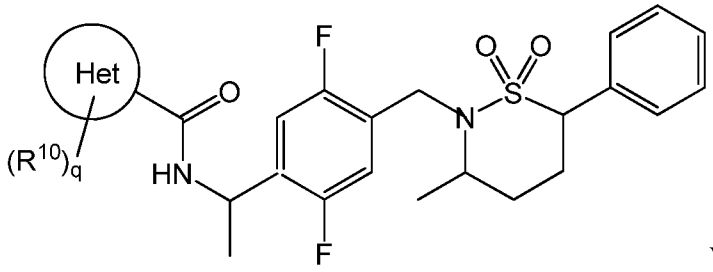
11. The compound of any of claims 1-9, wherein A is A is -C(O)-NH-CH(CH_3)-.

12. The compound of any of claims 1-11, wherein R^3 is C_{1-6}alkyl.

13. The compound of any of claims 1-12, wherein R^{10} is: C_{1-6}alkyl.

14. The compound of any of claims 1-13, wherein R^a is: C_{1-6}alkoxy; heterocylyl-C_{1-6}alkyl; or heterocylyl-C_{1-6}alkoxy; wherein the heterocyclyl moieties are each independently selected from oxetanyl, tetrahydrofuranyl, tetrahydropyranyl, azetidinyl, pyrrolidinyl and piperidinyl, and wherein the heterocycyl moieties each may be unsubstituted or substituted one or more times with R^f.

14. The compound of claim 1, wherein the compound is of formula VI:



VI.

15. The compound of claim 1, wherein the compound is selected from:

N-[1-[2,5-difluoro-4-[[(3S,6R)-3-methyl-1,1-dioxo-6-phenyl-thiazinan-2-yl]methyl]phenyl]ethyl]-1H-pyrazole-4-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)isoxazole-3-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1,2,3-thiadiazole-4-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)thiazole-5-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)oxazole-5-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1H-pyrazole-3-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)isoxazole-5-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1H-imidazole-4-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-2-(isoxazol-4-yl)acetamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-5-methyl-1,3,4-oxadiazole-2-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methylisoxazole-5-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-pyrazole-5-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methylisoxazole-4-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-pyrazole-4-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-imidazole-4-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-4-methyloxazole-5-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methyl-1H-pyrazole-5-carboxamide;

N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methyl-1H-pyrazole-4-carboxamide;
N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1-methyl-1H-pyrazole-3-carboxamide;
N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-5-methylisoxazole-3-carboxamide;
N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-5-methylisoxazole-4-carboxamide;
2-amino-N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)thiazole-4-carboxamide;
3-amino-N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-1H-1,2,4-triazole-5-carboxamide;
N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)pyrimidine-4-carboxamide;
N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)pyrimidine-5-carboxamide;
N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)pyrazine-2-carboxamide; and
N-(1-(2,5-difluoro-4-(((3S,6R)-3-methyl-1,1-dioxido-6-phenyl-1,2-thiazinan-2-yl)methyl)phenyl)ethyl)-3-methoxyisoxazole-5-carboxamide.

16. A composition comprising:

(a) a pharmaceutically acceptable carrier; and

(b) a compound of any of claims 1-15.

17. A compound according to any one of claims 1 to15 for the treatment of a disease selected from rheumatoid arthritis, osteoarthritis, psoriatic arthritis, septic arthritis, spondyloarthropathies, gouty arthritis, juvenile arthritis, chronic obstructive pulmonary disease (COPD), asthma, bronchospasm, Irritable Bowel Syndrome (IBS), Inflammatory Bowel Disease (IBD), psoriasis, biliary colic, renal colic, diarrhea-dominant IBS, muscular sclerosis, Sjogren's disease, lupus, and pulmonary fibrosis.

18. The use of a compound according to any one of claims 1 to15 for the treatment of a disease rheumatoid arthritis, osteoarthritis, psoriatic arthritis, septic arthritis, spondyloarthropathies, gouty arthritis, juvenile arthritis, chronic obstructive pulmonary disease (COPD), asthma, bronchospasm, Irritable Bowel Syndrome (IBS), Inflammatory Bowel Disease (IBD), psoriasis, biliary colic, renal colic, diarrhea-dominant IBS, muscular sclerosis, Sjogren's disease, lupus, and pulmonary fibrosis.

19. The use of a compound according to any one of claims 1 to15 for the preparation of a medicament for the treatment of a disease selected from rheumatoid arthritis, osteoarthritis, psoriatic arthritis, septic arthritis, spondyloarthropathies, gouty arthritis, juvenile arthritis, chronic obstructive pulmonary disease (COPD), asthma, bronchospasm, Irritable Bowel Syndrome (IBS), Inflammatory Bowel Disease (IBD), psoriasis, biliary colic, renal colic, diarrhea-dominant IBS, muscular sclerosis, Sjogren's disease, lupus, and pulmonary fibrosis.

20. A method for treating a disease selected from rheumatoid arthritis, osteoarthritis, psoriatic arthritis, septic arthritis, spondyloarthropathies, gouty arthritis, juvenile arthritis, chronic obstructive pulmonary disease (COPD), asthma, bronchospasm, Irritable Bowel Syndrome (IBS), Inflammatory Bowel Disease (IBD), psoriasis, biliary colic, renal colic, diarrhea-dominant IBS, muscular sclerosis, Sjogren's disease, lupus, and pulmonary fibrosis, the method comprising administering to a subject in need thereof an effective amount of a compound of any of claims 1-15.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2016/080904

Box No. I Nucleotide and/or amino acid sequence(s) (Continuation of item 1.c of the first sheet)

1. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☒ furnished subsequent to the international filing date for the purposes of international search only:

      ☒ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

2. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

3. Additional comments:

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/080904

A. CLASSIFICATION OF SUBJECT MATTER
INV. C07D417/12 A61K31/541 A61P29/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, CHEM ABS Data, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014/202741 A1 (HOFFMANN LA ROCHE [CH]; GENENTECH INC [US]) 24 December 2014 (2014-12-24) page 1, line 7 - line 9; claim 1; examples 3,6-8	1-21
X	US 2015/197529 A1 (FAUBER BENJAMIN [US] ET AL) 16 July 2015 (2015-07-16) paragraph [0002]; claim 1; example 114	1-21
X,P	WO 2016/096936 A1 (HOFFMANN LA ROCHE [CH]; GENENTECH INC [US]) 23 June 2016 (2016-06-23) page 99, line 1 - line 2; examples 25, step 6	1

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 March 2017	15/05/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Seelmann, Ingo

1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/080904

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	WO 2017/005668 A1 (F HOFFMANN-LA ROCHE AG [CH]; GENENTECH INC [US]) 12 January 2017 (2017-01-12) page 1, line 3 - line 4; claim 1; examples 50-79 -----	1

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2016/080904

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

11, 15, 16(completely); 1-10, 12-14, 17-21(partially)

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 11, 15, 16(completely); 1-10, 12-14, 17-21(partially)

   subject-matter relating to compounds with Het-A = Het-C(O)-NH-C1-6alkyl-

   ---

2. claims: 1-10, 12-14, 17-21(all partially)

   subject-matter relating to compounds with Het-A = Het-C1-6alkyl-NH-C(O)-

   ---

3. claims: 1-9, 12-14, 17-21(all partially)

   subject-matter relating to compounds with Het-A = Het-CH2-C(O)-NH-C1-6alkyl- or Het-C1-6alkyl-NH-C(O)-CH2-

   ---

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/080904

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014202741 A1	24-12-2014	CA 2911963 A1	24-12-2014
		CN 105308042 A	03-02-2016
		EP 3010919 A1	27-04-2016
		JP 2016522240 A	28-07-2016
		KR 20160023676 A	03-03-2016
		WO 2014202741 A1	24-12-2014
US 2015197529 A1	16-07-2015	CA 2932888 A1	16-07-2015
		CN 105916852 A	31-08-2016
		EP 3092238 A1	16-11-2016
		JP 2017502065 A	19-01-2017
		KR 20160106708 A	12-09-2016
		TW 201620884 A	16-06-2016
		US 2015197529 A1	16-07-2015
		US 2016168141 A1	16-06-2016
		WO 2015104356 A1	16-07-2015
WO 2016096936 A1	23-06-2016	NONE	
WO 2017005668 A1	12-01-2017	NONE	