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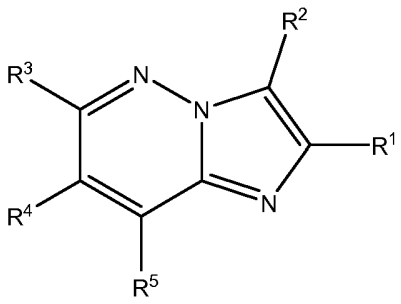
(54) Title: IMIDAZO [1,2-B] PYRIDAZINE COMPOUNDS AS MODULATORS OF LIVER X RECEPTORS



(I)

(57) Abstract: This invention relates generally to imidazo[1,2-b] pyridazine-based modulators of Liver X receptors (LXRs) having formula (I) and related methods: Formula (I) wherein R^2 is C^6-C^{10} aryl or heteroaryl including 5-10 atoms, each of which is: (i) substituted with 1 R^6, and (ii) optionally substituted with from 1-5 R^e; and R^1, R^3, R^4, R^5, R^6 and R^e are defined herein.

IMIDAZO [1,2-B] PYRIDAZINE COMPOUNDS AS MODULATORS OF LIVER X RECEPTORS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of United States Provisional Application No. 61/015,856, filed on December 21, 2007, which is incorporated by reference in its entirety.

TECHNICAL FIELD

This invention relates generally to imidazo[1,2-b] pyridazine-based modulators of Liver X receptors (LXRs) and related methods.

BACKGROUND

Atherosclerosis is among the leading causes of death in developed countries. Some of the independent risk factors associated with atherosclerosis include the presence of relatively high levels of serum LDL cholesterol and relatively low levels of serum HDL cholesterol in affected patients. As such, some anti-atherosclerotic therapy regimens include the administration of agents (e.g., statins) to reduce elevated serum LDL cholesterol levels.

Agents that increase patient HDL cholesterol levels can also be useful in anti-atherosclerotic therapy regimens. HDL cholesterol is believed to play a major role in the transport of cholesterol from peripheral tissues to the liver for metabolism and excretion (this process is sometimes referred to as "reverse cholesterol transport"). ABCA1 is a transporter gene involved in HDL production and reverse cholesterol transport. Upregulation of ABCA1 can therefore result in increased reverse cholesterol transport as well as inhibition of cholesterol absorption in the gut. In addition, HDL is also believed to inhibit the oxidation of LDL cholesterol, reduce the inflammatory response of endothelial cells, inhibit the coagulation pathway, and promote the availability of nitric oxide.

Liver X receptors (LXRs), originally identified in the liver as orphan receptors, are members of the nuclear hormone receptor super family and are believed to be involved in the regulation of cholesterol and lipid metabolism. LXRs are ligand-

activated transcription factors and bind to DNA as obligate heterodimers with retinoid X receptors. While LXRα is generally found in tissues such as liver, kidney, adipose tissue, intestine and macrophages, LXRβ displays a ubiquitous tissue distribution pattern. Activation of LXRs by oxysterols (endogenous ligands) in macrophages results in the expression of several genes involved in lipid metabolism and reverse cholesterol transport including the aforementioned ABCA1; ABCG1; and ApoE. See, e.g., Koldamova, et al., *J. Biol. Chem.* **2003**, *278*, 13244.

Studies have been conducted in LXRα knock-out (k/o), LXRβ k/o and double k/o mice to determine the physiological role of LXRs in lipid homeostasis and atherosclerosis. The data from these studies suggested that in double k/o mice on normal chow diet, increased cholesterol accumulation was observed in macrophages (foam cells) of the spleen, lung and arterial wall. The increased cholesterol accumulation was believed to be associated with the presence of reduced serum HDL cholesterol and increased LDL cholesterol, even though the total cholesterol levels in the mice were about normal. While LXRα k/o mice did not appear to show significant changes in hepatic gene expression, LXRβ k/o mice showed 58% decrease in hepatic ABCA1 expression and 208% increase in SREBP1c expression suggesting that LXRβ may be involved in the regulation of liver SREBP1c expression.

Data obtained from studies employing two different atherosclerotic mouse models (ApoE k/o and LDLR k/o) suggest that agonists of LXRα or β can be relatively effective in upregulating ABCA1 expression in macrophages. For example, inhibition of atherosclerotic lesions could be observed when ApoE k/o and LDLR k/o mice were treated with LXRα or β agonists for 12 weeks. The tested agonists were observed to have variable effects on serum cholesterol and lipoprotein levels and appeared to cause a relatively significant increase in serum HDL cholesterol and triglyceride levels. These *in vivo* data were found to be consistent with *in vitro* data obtained for the same agonists in macrophages.

In addition to the lipid and triglyceride effects described above, it is also believed that activation of LXRs results in the inhibition of inflammation and proinflammatory gene expression. This hypothesis is based on data obtained from studies employing three

different models of inflammation (LPS-induced sepsis, acute contact dermatitis of the ear and chronic atherosclerotic inflammation of the artery wall). These data suggest that LXR modulators can mediate both the removal of cholesterol from the macrophages and the inhibition of vascular inflammation.

For a review of LXR biology and LXR modulators, see, e.g., Goodwin, et al., *Current Topics in Medicinal Chemistry* **2008**, *8*, 781; and Bennett, et al., *Current Medicinal Chemistry* **2008**, *15*, 195.

For studies related to atherosclerosis, see, e.g., Scott, J. *N. Engl. J. Med.* **2007**, *357*, 2195; Joseph, et al., *PNAS* **2002**, *99*, 7604; Tangirala, et. al., *PNAS*, **2002**, *99*, 11896; and Bradley, et al., *Journal of Clinical Investigation* **2007,** 117, 2337-2346.

For studies related to inflammation, see, e.g., Fowler, et al., *Journal of Investigative Dermatology* **2003**, *120*, 246; and US 2004/0259948.

For studies related to Alzheimer's disease, see, e.g., Koldamova, et al., *J. Biol. Chem.* **2005**, *280*, 4079; Sun, et al., *J. Biol. Chem.* **2003**, *278*, 27688; and Riddell, et al., *Mol. Cell Neurosci.* **2007**, *34*, 621.

For studies related to diabetes, see, e.g., Kase, et al., *Diabetologia* **2007**, *50*, 2171; and Liu, et al., *Endocrinology* **2006**, *147*, 5061.

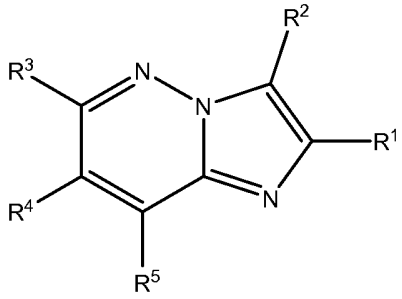
For studies related to skin aging, see, e.g., WO 2004/076418; WO 2004/103320; and US 2008/0070883.

For studies related to arthritis, see, e.g., Chintalacharuvu, et. al., *Arthritis a& Rheumatism* **2007**, *56*, 1365; and WO 2008/036239.

SUMMARY

This invention relates generally to imidazo[1,2-b] pyridazine-based modulators of Liver X receptors (LXRs) and related methods.

In one aspect, this invention features a compound having formula (I):



(I)

in which:

R^1 is:

(i) hydrogen; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-10 R^a; or

(iii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-10 R^b; or

(iv) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, heterocyclyl including 3-10 atoms, heterocycloalkenyl including 3-10 atoms, C_7-C_{11} aralkyl, or heteroaralkyl including 6-11 atoms, each of which is optionally substituted with from 1-10 R^c; or

(v) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-10 R^d;

R^2 is C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is:

(i) substituted with 1 R^6, and

(ii) optionally substituted with from 1-5 R^e;

R^6 is WA, wherein:

W at each occurrence is, independently, a bond; -O-; -NR^7- wherein R^7 is hydrogen or C_1-C_6 alkyl; C_{1-6} alkylene, C_{2-6} alkenylene, or C_{2-6} alkynylene; -W^1(C_{1-6} alkylene)-; or -(C_{1-6} alkylene)W^1-;

W^1 at each occurrence is, independently, -O- or -NR^7-;

A at each occurrence is, independently, C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is:

(i) substituted with 1 R^8, and

(ii) optionally further substituted with from 1-5 R^g;

R^8 at each occurrence is, independently:

(i) -W^2-$S(O)_nR^9$ or -W^2-$S(O)_nNR^{10}R^{11}$; or

(ii) -W^2-$C(O)OR^{12}$; or

(iii) -W^2-$C(O)NR^{10}R^{11}$; or

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with 1 R^h, and

(b) optionally further substituted with from 1-5 R^a; or

(v) -$NR^{13}R^{14}$;

wherein:

W^2 at each occurrence is, independently, a bond; C_{1-6} alkylene; C_{2-6} alkenylene; C_{2-6} alkynylene; C_{3-6} cycloalkylene; -O(C_{1-6} alkylene)-, or -NR^7(C_{1-6} alkylene)-;

n at each occurrence is, independently, 1 or 2;

R^9 at each occurrence is, independently:

(i) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-5 R^a; or

(ii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-5 R^b; or

(iii) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, C_7-C_{11} aralkyl, or heteroaralkyl including 6-11 atoms, each of which is optionally substituted with from 1-5 R^c; or

(iv) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d;

R^{10} and R^{11} are each, independently, hydrogen; R^9; or heterocyclyl including 3-10 atoms or a heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; or

R^{10} and R^{11} together with the nitrogen atom to which they are attached form a heterocyclyl including 3-10 atoms or a heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c;

R^{12} at each occurrence is, independently, hydrogen or R^9;

at each occurrence of $-NR^{13}R^{14}$, one of R^{13} and R^{14} is hydrogen or C_1-C_3 alkyl; and the other of R^{13} and R^{14} is:

(i) $-S(O)_nR^9$; or

(ii) $-C(O)OR^{12}$; or

(iii) $-C(O)NR^{10}R^{11}$; or

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with 1 R^h, and

(b) optionally further substituted with from 1-5 R^a;

each of R^3 and R^4 is, independently:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a;

R^5 is:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano;

R^a at each occurrence is, independently:

(i) NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; C_6-C_{10} aryloxy or heteroaryloxy including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d; C_7-C_{11} aralkoxy, heteroaralkoxy including 6-11 atoms, C_3-C_{11} cycloalkoxy, C_3-C_{11} cycloalkenyloxy, heterocyclyloxy including 3-10 atoms, or heterocycloalkenyloxy including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; cyano; or

(ii) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, heterocyclyl including 3-10 atoms, or heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c;

R^b at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; C_6-C_{10} aryloxy or heteroaryloxy including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d; C_7-C_{11} aralkoxy, heteroaralkoxy including 6-11 atoms, C_3-C_{10} cycloalkoxy, C_3-C_{10} cycloalkenyloxy, heterocyclyloxy including 3-10 atoms, or heterocycloalkenyloxy including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; cyano; or

(ii) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, heterocyclyl including 3-10 atoms, or heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; or

(iii) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d;

R^c at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; or cyano; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-5 R^a; or

(iii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-5 R^b;

R^d at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; or cyano; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-5 R^a; or

(iii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-5 R^b;

R^e at each occurrence is, independently, C_1-C_6 alkyl; C_1-C_6 haloalkyl; halo; hydroxyl; NR^mR^n; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; or cyano;

R^g at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; or cyano; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl;

R^h at each occurrence is, independently, hydroxyl, C_1-C_6 alkoxy, or C_1-C_6 haloalkoxy; C_3-C_{10} cycloalkoxy or C_3-C_{10} cycloalkenyloxy, each of which is optionally substituted with from 1-5 R^c; or C_6-C_{10} aryloxy or heteroaryloxy including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d;

each of R^m and R^n at each occurrence is, independently, hydrogen, C_1-C_6 alkyl, or C_1-C_6 haloalkyl;

or an N-oxide and/or salt (e.g., a pharmaceutically acceptable salt) thereof.

In one aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In one aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 is:

(i) $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$; or

(iii) $-W^2-C(O)NR^{10}R^{11}$; or

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with 1 R^h, and

(b) optionally further substituted with from 1-5 R^a; or

(v) $-NR^{13}R^{14}$; and

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In one aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 is:

(i) $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$.

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In another aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 at each occurrence is, independently:

(i) $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$; or

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with 1 R^h, and

(b) optionally further substituted with from 1-5 R^a; or

(v) $-NR^{13}R^{14}$.

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In one aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 is (ii) $-W^2-C(O)OR^{12}$.

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In another aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 is (iii) $-W^2-C(O)NR^{10}R^{11}$.

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In a further aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 is $-W^2-CN$.

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In one aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 is:

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with 1 R^h, and

(b) optionally further substituted with from 1-5 R^a.

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In another aspect, this invention features a compound having formula (I), in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can each be, independently, as defined anywhere herein, and

R^8 is:

(v) $-NR^{13}R^{14}$.

In certain embodiments:

R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano.

In one aspect, this invention relates to any subgenera of formula (I) described herein.

In one aspect, this invention relates to any of the specific imidazo[1,2-b] pyridazine compounds delineated herein . In some embodiments, the compound of formula (I) can be selected from the title compounds of Examples 7-11; or a pharmaceutically acceptable salt and/or N-oxide thereof.

In one aspect, this invention features a composition (e.g., pharmaceutical composition), which includes a compound of formula (I) (including any subgenera or specific compounds thereof) or a salt (e.g., a pharmaceutically acceptable salt) or a prodrug thereof and a pharmaceutically acceptable adjuvant, carrier or diluent. In some embodiments, the composition can include an effective amount of the compound or the salt thereof. In some embodiments, the composition can further include an additional therapeutic agent.

In one aspect, this invention features a dosage form, which includes from about 0.05 milligrams to about 2,000 milligrams (e.g., from about 0.1 milligrams to about 1,000 milligrams, from about 0.1 milligrams to about 500 milligrams, from about 0.1 milligrams to about 250 milligrams, from about 0.1 milligrams to about 100 milligrams, from about 0.1 milligrams to about 50 milligrams, or from about 0.1 milligrams to about 25 milligrams) of formula (I) (including any subgenera or specific compounds thereof), or a salt (e.g., a pharmaceutically acceptable salt), or an N-oxide, or a prodrug thereof. The dosage form can further include a pharmaceutically acceptable carrier and/or an additional therapeutic agent.

The invention also relates generally to modulating (e.g., activating) LXRs with the imidazo[1,2-b] pyridazine compounds described herein. In some embodiments, the methods can include, e.g., contacting an LXR in a sample (e.g., a tissue, a cell free assay medium, a cell-based assay medium) with a compound of formula (I) (including any subgenera or specific compounds thereof). In other embodiments, the methods can include administering a compound of formula (I) (including any subgenera or specific compounds thereof) to a subject (e.g., a mammal, e.g., a human, e.g., a human having or at risk of having one or more of the diseases or disorders described herein).

In one aspect, this invention also relates generally to methods of treating (e.g., controlling, ameliorating, alleviating, slowing the progression of, delaying the onset of, or

reducing the risk of developing) or preventing one or more LXR-mediated diseases or disorders in a subject (e.g., a subject in need thereof). The methods include administering to the subject an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof. LXR-mediated diseases or disorders can include, e.g., cardiovascular diseases (e.g., acute coronary syndrome, restenosis), atherosclerosis, atherosclerotic lesions, type I diabetes, type II diabetes, Syndrome X, obesity, lipid disorders (e.g., dyslipidemia, hyperlipidemia, hypertriglyceridemia, hypercholesterolemia, low HDL and high LDL), cognitive disorders (e.g., Alzheimer's disease or dementia), inflammatory diseases (e.g., multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease, Crohn's disease, endometriosis, LPS-induced sepsis, acute contact dermatitis of the ear, chronic atherosclerotic inflammation of the artery wall), celiac, thyroiditis, skin aging or connective tissue diseases.

In another aspect, this invention relates to methods of modulating (e.g., increasing) serum HDL cholesterol levels in a subject (e.g., a subject in need thereof), which includes administering to the subject an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In another aspect, this invention relates to methods of modulating (e.g., decreasing) serum LDL cholesterol levels in a subject (e.g., a subject in need thereof), which includes administering to the subject an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In another aspect, this invention relates to methods of modulating (e.g., increasing) reverse cholesterol transport in a subject (e.g., a subject in need thereof), which includes administering to the subject an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In another aspect, this invention relates to methods of modulating (e.g., decreasing or inhibiting) cholesterol absorption in a subject (e.g., a subject in need thereof), which includes administering to the subject an effective amount of a compound

of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In a further aspect, this invention relates to methods of preventing or treating a cardiovascular disease (e.g., acute coronary syndrome, restenosis, or coronary artery disease), which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In one aspect, this invention relates to methods of preventing or treating a atherosclerosis and/or atherosclerotic lesions, which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In another aspect, this invention relates to methods of preventing or treating diabetes (e.g., type I diabetes or type II diabetes), which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In a further aspect, this invention relates to methods of preventing or treating Syndrome X, which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In one aspect, this invention relates to methods of preventing or treating a obesity, which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In another aspect, this invention relates to methods of preventing or treating a lipid disorder (e.g., dyslipidemia, hyperlipidemia, hypertriglyceridemia, hypercholesterolemia, low HDL and/or high LDL), which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In a further aspect, this invention relates to methods of preventing or treating a cognitive disorder (e.g., Alzheimer's disease or dementia), which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In one aspect, this invention relates to methods of preventing or treating dementia, which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In another aspect, this invention relates to methods of preventing or treating Alzheimer's disease, which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In a further aspect, this invention relates to methods of preventing or treating an inflammatory disease (e.g., multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease, Crohn's disease, endometriosis, LPS-induced sepsis, acute contact dermatitis of the ear, chronic atherosclerotic inflammation of the artery wall), which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In another aspect, this invention relates to methods of preventing or treating rheumatoid arthritis, which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In a further aspect, this invention relates to methods of preventing or treating celiac, which includes administering to a subject in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In a further aspect, this invention relates to methods of preventing or treating thyroiditis, which includes administering to a subject in need thereof an effective amount

of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof.

In one aspect, this invention relates to methods of treating a connective tissue disease (e.g., osteoarthritis or tendonitis), which includes administering to a subject (e.g., a mammal, e.g., a human) in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof. In embodiments, the compound of formula (I) inhibits (e.g., reduces or otherwise diminishes) cartilage degradation. In embodiments, the compound of formula (I) induces (e.g., increases or otherwise agments) cartilage regeneration. In embodiments, the compound of formula (I) inhibits (e.g., reduces or otherwise diminishes) cartilage degradation and induces (e.g., increases or otherwise agments) cartilage regeneration. In embodiments, the compound of formula (I) inhibits (e.g., reduces or otherwise diminishes) aggrecanase activity. In embodiments, the compound of formula (I) inhibits (e.g., reduces or otherwise diminishes) elaboration of pro-inflammatory cytokines in osteoarthritic lesions.

In another aspect, this invention relates to methods of treating or preventing skin aging, the method comprising administering (e.g., topically administering) to a subject (e.g., a mammal, e.g., a human) in need thereof an effective amount of a compound of formula (I) (including any subgenera or specific compounds thereof) or a pharmaceutically acceptable salt or prodrug thereof. In embodiments, the skin aging can be derived from chronological aging, photoaging, steroid-induced skin thinning, or a combination thereof.

The term "skin aging" includes conditions derived from intrinsic chronological aging (for example, deepened expression lines, reduction of skin thickness, inelasticity, and/or unblemished smooth surface), those derived from photoaging (for example, deep wrinkles, yellow and leathery surface, hardening of the skin, elastosis, roughness, dyspigmentations (age spots) and/or blotchy skin), and those derived from steroid-induced skin thinning. Accordingly, another aspect is a method of counteracting UV photodamage, which includes contacting a skin cell exposed to UV light with an effective amount of a compound of formula (I).

In some embodiments, the compound of formula (I) (including any subgenera or specific compounds thereof) does not substantially increase serum and/or hepatic triglyceride levels of the subject.

In some embodiments, the administered compound of formula (I) (including any subgenera or specific compounds thereof) can be an LXR agonist (e.g., an LXRα agonist or an LXRβ agonist, e.g., an LXRβ agonist).

In some embodiments, the subject can be a subject in need thereof (e.g., a subject identified as being in need of such treatment). Identifying a subject in need of such treatment can be in the judgment of a subject or a health care professional and can be subjective (e.g. opinion) or objective (e.g. measurable by a test or diagnostic method). In some embodiments, the subject can be a mammal. In certain embodiments, the subject is a human.

In a further aspect, this invention also relates to methods of making compounds described herein. Alternatively, the method includes taking any one of the intermediate compounds described herein and reacting it with one or more chemical reagents in one or more steps to produce a compound described herein.

In one aspect, this invention relates to a packaged product. The packaged product includes a container, one of the aforementioned compounds in the container, and a legend (e.g., a label or an insert) associated with the container and indicating administration of the compound for treatment and control of the diseases or disorders described herein.

In embodiments, any compound, composition, or method can also include any one or more of the features (alone or in combination) delineated in the detailed description and/or in the claims.

R^1 can be hydrogen.

R^1 can be C_1-C_3 alkyl or C_1-C_3 haloalkyl (e.g., CF_3). For example, R^1 can be CH_3 (i.e., methyl), CH_3CH_2 (i.e., ethyl), or $(CH_3)_2CH$ (i.e., isopropyl).

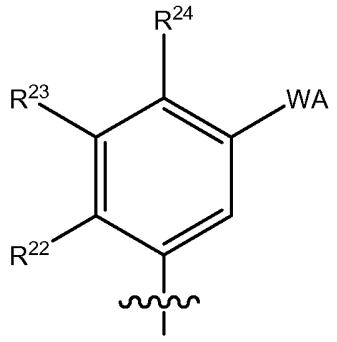
R^1 can be C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, or 1) R^d. For example, R^1 can be phenyl, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, or 1) R^d.

R^1 can be C_7-C_{11} aralkyl, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, or 1) R^c. For example, R^1 can be benzyl, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, or 1) R^c.

R^1 can be C_3-C_8 cycloalkyl or heterocyclyl including 3-8 atoms, each of which is optionally substituted with from 1-3 R^c.

R^2 can be C_6-C_{10} aryl, which is (a) substituted with 1 R^6; and (b) optionally substituted with from 1-2 R^e. In embodiments, R^2 can be phenyl, which is (a) substituted with 1 R^6; and (b) optionally substituted with 1 R^e. In other embodiments, R^2 can be phenyl, which is substituted with 1 R^6.

R^2 can have formula (A-2):



(A-2).

In some embodiments, each of R^{22}, R^{23}, and R^{24} can be, independently, hydrogen or R^e. In these and other embodiments related to formula (A-2), R^e can be as defined anywhere herein.

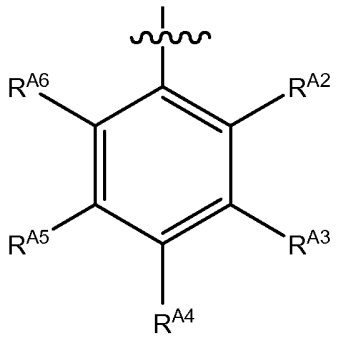
In some embodiments, (i) each of R^{22}, R^{23}, and R^{24} is hydrogen; or (ii) one of R^{22}, R^{23}, and R^{24} is R^e, and the other two are hydrogen.

In certain embodiments, each of R^{22}, R^{23}, and R^{24} can be hydrogen. In other embodiments, one of R^{22}, R^{23}, and R^{24} can be R^e, and the other two are hydrogen. For example, R^{22} can be R^e (e.g., halo, e.g., chloro), and each of R^{23} and R^{24} can be hydrogen.

W can be -O-. W can be a bond. W can be -W^1(C_{1-6} alkylene)-; in embodiments, W^1 can be -O-, and W can be, for example, -OCH_2-.

A can be C_6-C_{10} aryl, which is (a) substituted with 1 R^8; and (b) optionally substituted with from 1-4 R^g. In some embodiments, A can be phenyl, which is (a) substituted with 1 R^8; and (b) optionally substituted with from 1-4 R^g.

A can have formula (B-1):



(B-1)

in which:

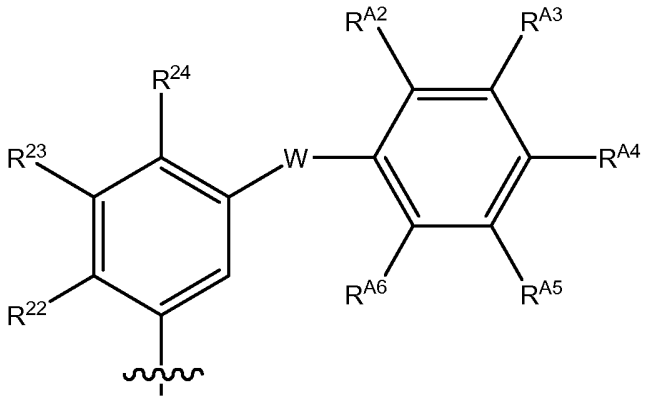
one of R^{A3} and R^{A4} is R^8, the other of R^{A3} and R^{A4} is hydrogen; and

each of R^{A2}, R^{A5}, and R^{A6} is, independently, hydrogen or R^g. In these and other embodiments related to formula (B-1), each of R^8 and R^g can be, independently, as defined anywhere herein.

R^8 can be $-W^2-S(O)_nR^9$. W^2 can be a bond. n can be 2. W^2 can be a bond, and n can be 2. R^9 can be C_1-C_{10} alkyl, optionally substituted with from 1-2 R^a. In embodiments, R^9 can be C_1-C_5 alkyl (e.g., CH_3, CH_3CH_2, or $(CH_3)_2CH$), e.g., CH_3 or CH_3CH_2). R^9 can be C_2-C_8 alkyl substituted with 1 R^a. In embodiments, R^a can be hydroxyl or C_1-C_3 alkoxy.

R^8 can be $-W^2-C(O)OR^{12}$.

R^2 can have formula (C-1):



(C-1) .

In some embodiments:

each of R^{22}, R^{23}, and R^{24} is, independently, hydrogen or R^e;

and

one of R^{A2}, R^{A3}, R^{A4}, R^{A5}, and R^{A6} is R^8, and the others are each, independently, hydrogen or R^g.

In some embodiments:

(i) each of R^{22}, R^{23}, and R^{24} is hydrogen; or

(ii) one of R^{22}, R^{23}, and R^{24} is R^e, and the other two are hydrogen;

and

one of R^{A2}, R^{A3}, R^{A4}, R^{A5}, and R^{A6} is R^8, and the others are each, independently, hydrogen or R^g.

In these and other embodiments related to formula (C-1), each of W, R^8, R^e and R^g can be, independently, as defined anywhere herein.

Embodiments can include, for example, one or more of the following features (and/or any one or more other features described anywhere herein). In some embodiments, each of R^{22}, R^{23}, and R^{24} can be hydrogen. In other embodiments, one of R^{22}, R^{23}, and R^{24} can be R^e, and the other two are hydrogen. For example, R^{22} can be R^e (e.g., halo, e.g., chloro), and each of R^{23} and R^{24} can be hydrogen.

W can be -O-. W can be a bond. W can be $-OCH_2-$.

One of R^{A3} and R^{A4} can be R^8, and the other of R^{A3} and R^{A4} can be hydrogen; and each of R^{A2}, R^{A5}, and R^{A6} can be, independently, hydrogen or R^g.

In certain embodiments, R^{A3} can be $-W^2-S(O)_nR^9$. Each of R^{A2}, R^{A5}, and R^{A6} can be hydrogen. W^2 can be a bond. n can be 2. W^2 can be a bond, and n can be 2. R^9 can be C_1-C_{10} alkyl, optionally substituted with from 1-2 R^a. In embodiments, R^9 can be C_1-C_5 alkyl (e.g., CH_3, CH_3CH_2, or $(CH_3)_2CH$)). R^9 can be C_2-C_8 alkyl substituted with 1 R^a. In embodiments, R^a can be hydroxyl or C_1-C_3 alkoxy. R^{A5} can be hydrogen or R^g, and each of R^{A2} and R^{A6} is hydrogen.

In certain embodiments, R^{A4} can be $-W^2-C(O)OR^{12}$. R^{12} can be hydrogen. R^{12} can be C_1-C_3 alkyl. W^2 can be C_1-C_3 alkylene (e.g., CH_2). W^2 can be a bond. Each of R^{A2}, R^{A5}, and R^{A6} can be hydrogen.

Each of R^3 and R^4 can be, independently: (i) hydrogen; or (ii) halo. Each of R^3 and R^4 can be hydrogen.

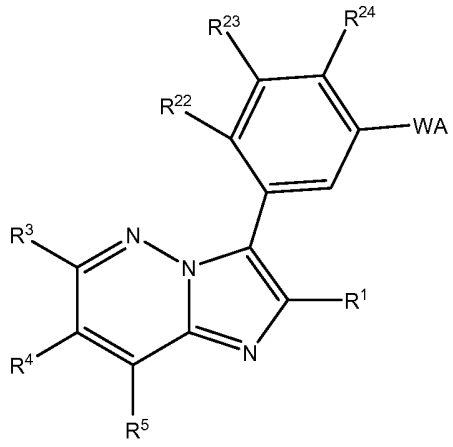
R^5 can be: (ii) halo; or (iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or (iv) cyano.

R^5 can be C_1-C_6 haloalkyl. In certain embodiments, R^5 can be C_1-C_3 perfluoroalkyl (e.g., CF_3).

R^5 can be halo (e.g., chloro).

One or more of R^1, R^3, R^4, and R^5 (e.g., R^1 and/or R^5) can be a substituent other than hydrogen.

The compound can have formula (VI):



(VI)

in which:

R^1 is:

(i) hydrogen; or

(ii) C_1-C_3 alkyl or C_1-C_3 haloalkyl; or

(iii) C_6-C_{10} aryl or heteroaryl including 5-6 atoms, each of which is optionally substituted with from 1-5 R^d; or

(iv) C_7-C_{11} aralkyl, which is optionally substituted with from 1-5 R^c;

each of R^3 and R^4 is, independently:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_3 alkyl or C_1-C_3 haloalkyl, each of which is optionally substituted with from 1-3 R^a;

R^5 is:

(ii) halo; or

(iii) C_1-C_3 alkyl or C_1-C_3 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) cyano; and

each of R^{22}, R^{23}, and R^{24} is, independently, hydrogen or R^e.

Embodiments can include one or more of the following features (and/or any one or more other features described anywhere herein).

R^1 can be hydrogen. R^1 can be CH_3, CH_3CH_2, or $(CH_3)_2CH$. R^1 can be phenyl, which is optionally substituted with from 1-5 R^d. R^1 can be benzyl, which is optionally substituted with from 1-5 R^c.

W can be -O-. W can be a bond. W can be $-OCH_2-$.

A can have formula (B-1), in which one of R^{A3} and R^{A4} is R^8, and the other of R^{A3} and R^{A4} is hydrogen; and each of R^{A2}, R^{A5}, and R^{A6} is, independently, hydrogen or R^g. R^{A3} can be $-W^2-S(O)_nR^9$, in which W^2 can be a bond, and n can be 2. R^9 can be C_1-C_6 alkyl, optionally substituted with from 1-2 R^a. R^9 can be CH_3, CH_2CH_3, or *iso*propyl. R^9 can be C_2-C_8 alkyl substituted with 1 R^a. R^a can be hydroxyl or C_1-C_3 alkoxy. R^{A5} can be hydrogen or R^c, and each of R^{A2} and R^{A6} can be hydrogen. R^{A4} can be $-W^2-C(O)OR^{12}$. R^{12} can be hydrogen or C_1-C_3 alkyl. W^2 can be CH_2. Each of R^{A2}, R^{A5}, and R^{A6} can be hydrogen. Each of R^3 and R^4 can be hydrogen. Each of R^{22}, R^{23}, and R^{24} can be hydrogen. One of R^{22}, R^{23}, and R^{24} can be R^e, and the other two are hydrogen. For example, R^{22} can be R^e (e.g., chloro), and each of R^{23} and R^{24} is hydrogen. R^5 can be CF_3. R^5 can be chloro.

The term "mammal" includes organisms, which include mice, rats, cows, sheep, pigs, rabbits, goats, horses, monkeys, dogs, cats, and humans.

"An effective amount" refers to an amount of a compound that confers a therapeutic effect (e.g., treats, controls, ameliorates, prevents, delays the onset of, or reduces the risk of developing a disease, disorder, or condition or symptoms thereof) on the treated subject. The therapeutic effect may be objective (i.e., measurable by some test or marker) or subjective (i.e., subject gives an indication of or feels an effect). An effective amount of the compound described above may range from about 0.01 mg/Kg to about 1000 mg/Kg, (e.g., from about 0.1 mg/Kg to about 100 mg/Kg, from about 1 mg/Kg to about 100 mg/Kg). Effective doses will also vary depending on route of administration, as well as the possibility of co-usage with other agents.

The term "halo" or "halogen" refers to any radical of fluorine, chlorine, bromine or iodine.

In general, and unless otherwise indicated, substituent (radical) prefix names are derived from the parent hydride by either (i) replacing the "ane" in the parent hydride

with the suffixes "yl," "diyl," "triyl," "tetrayl," etc.; or (ii) replacing the "e" in the parent hydride with the suffixes "yl," "diyl," "triyl," "tetrayl," etc. (here the atom(s) with the free valence, when specified, is (are) given numbers as low as is consistent with any established numbering of the parent hydride). Accepted contracted names, e.g., adamantyl, naphthyl, anthryl, phenanthryl, furyl, pyridyl, isoquinolyl, quinolyl, and piperidyl, and trivial names, e.g., vinyl, allyl, phenyl, and thienyl are also used herein throughout. Conventional numbering/lettering systems are also adhered to for substituent numbering and the nomenclature of fused, bicyclic, tricyclic, polycyclic rings.

The term "alkyl" refers to a saturated hydrocarbon chain that may be a straight chain or branched chain, containing the indicated number of carbon atoms. For example, C_1-C_{20} alkyl indicates that the group may have from 1 to 20 (inclusive) carbon atoms in it. Any atom can be optionally substituted, e.g., by one or more substituents. Examples of alkyl groups include without limitation methyl, ethyl, *n*-propyl, *iso*propyl, and *tert*-butyl.

The term "cycloalkyl" refers to saturated monocyclic, bicyclic, tricyclic, or other polycyclic hydrocarbon groups. Any atom can be optionally substituted, e.g., by one or more substituents. A ring carbon serves as the point of attachment of a cycloalkyl group to another moiety. Cycloalkyl groups can contain fused rings. Fused rings are rings that share a common carbon atom. Cycloalkyl moieties can include, e.g., cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, adamantyl, and norbornyl (bicycle[2.2.1]heptyl).

The terms "alkylene," "alkenylene," "alkynylene," and "cycloalkylene" refer to divalent, straight chain or branched chain alkyl (e.g., -CH_2-), alkenyl (e.g., -CH=CH-), alkynyl (e.g., -C≡C-); or cycloalkyl moieties, respectively.

The term "haloalkyl" refers to an alkyl group, in which at least one hydrogen atom is replaced by halo. In some embodiments, more than one hydrogen atom (2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26,etc. hydrogen atoms) on a alkyl group can be replaced by more than one halogen (e.g., 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, etc. halogen atoms). In these embodiments, the hydrogen atoms can each be replaced by the same halogen (e.g., fluoro) or the hydrogen atoms can be replaced by a combination of different halogens

(e.g., fluoro and chloro). "Haloalkyl" also includes alkyl moieties in which all hydrogens have been replaced by halo (e.g., perhaloalkyl, e.g., perfluoroalkyl, such as trifluoromethyl). Any atom can be optionally substituted, e.g., by one or more substituents.

The term "aralkyl" refers to an alkyl moiety in which an alkyl hydrogen atom is replaced by an aryl group. One of the carbons of the alkyl moiety serves as the point of attachment of the aralkyl group to another moiety. Aralkyl includes groups in which more than one hydrogen atom on an alkyl moiety has been replaced by an aryl group. Any ring or chain atom can be optionally substituted, e.g., by one or more substituents. Non-limiting examples of "aralkyl" include benzyl, 2-phenylethyl, 3-phenylpropyl, benzhydryl (diphenylmethyl), and trityl (triphenylmethyl) groups.

The term "heteroaralkyl" refers to an alkyl moiety in which an alkyl hydrogen atom is replaced by a heteroaryl group. One of the carbons of the alkyl moiety serves as the point of attachment of the aralkyl group to another moiety. Heteroaralkyl includes groups in which more than one hydrogen atom on an alkyl moiety has been replaced by a heteroaryl group. Any ring or chain atom can be optionally substituted, e.g., by one or more substituents. Heteroaralkyl can include, for example, 2-pyridylethyl.

The term "alkenyl" refers to a straight or branched hydrocarbon chain containing 2-20 carbon atoms and having one or more double bonds. Any atom can be optionally substituted, e.g., by one or more substituents. Alkenyl groups can include, e.g., allyl, 1-butenyl, 2-hexenyl and 3-octenyl groups. One of the double bond carbons can optionally be the point of attachment of the alkenyl substituent. The term "alkynyl" refers to a straight or branched hydrocarbon chain containing 2-20 carbon atoms and having one or more triple bonds. Any atom can be optionally substituted, e.g., by one or more substituents. Alkynyl groups can include, e.g., ethynyl, propargyl, and 3-hexynyl. One of the triple bond carbons can optionally be the point of attachment of the alkynyl substituent.

The term "alkoxy" refers to an -O-alkyl radical. The term "mercapto" refers to an SH radical. The term "thioalkoxy" refers to an -S-alkyl radical. The terms "aryloxy" and "heteroaryloxy" refer to an -O-aryl radical and -O-heteroaryl radical, respectively. The

terms "thioaryloxy" and "thioheteroaryloxy" refer to an -S-aryl radical and -S-heteroaryl radical, respectively.

The terms "aralkoxy" and "heteroaralkoxy" refer to an -O-aralkyl radical and -O-heteroaralkyl radical, respectively. The terms "thioaralkoxy" and "thioheteroaralkoxy" refer to an -S-aralkyl radical and -S-heteroaralkyl radical, respectively. The term "cycloalkoxy" refers to an -O-cycloalkyl radical. The terms "cycloalkenyloxy" and "heterocycloalkenyloxy" refer to an -O-cycloalkenyl radical and -O-heterocycloalkenyl radical, respectively. The term "heterocyclyloxy" refers to an -O-heterocyclyl radical. The term "thiocycloalkoxy" refers to an -S-cycloalkyl radical. The terms "thiocycloalkenyloxy" and "thioheterocycloalkenyloxy" refer to an -S-cycloalkenyl radical and -S-heterocycloalkenyl radical, respectively. The term "thioheterocyclyloxy" refers to an -S-heterocyclyl radical.

The term "heterocyclyl" refers to a saturated monocyclic, bicyclic, tricyclic or other polycyclic ring system having 1-4 heteroatoms if monocyclic, 1-8 heteroatoms if bicyclic, or 1-10 heteroatoms if tricyclic, said heteroatoms selected from O, N, or S (and mono and dioxides thereof, e.g., $N\rightarrow O^-$, S(O), SO_2). Thus, a heterocyclyl ring includes carbon atoms and 1-4, 1-8, or 1-10 heteroatoms selected from N, O, or S if monocyclic, bicyclic, or tricyclic, respectively. A ring heteroatom or ring carbon is the point of attachment of the heterocyclyl substituent to another moiety. Any atom can be optionally substituted, e.g., by one or more substituents. The heterocyclyl groups can contain fused rings. Fused rings are rings that share a common carbon or nitrogen atom. Heterocyclyl groups can include, e.g., tetrahydrofuryl, tetrahydropyranyl, piperidyl (piperidino), piperazinyl, morpholinyl (morpholino), pyrrolinyl, and pyrrolidinyl.

The term "cycloalkenyl" refers to partially unsaturated monocyclic, bicyclic, tricyclic, or other polycyclic hydrocarbon groups. A ring carbon (e.g., saturated or unsaturated) is the point of attachment of the cycloalkenyl substituent. Any atom can be optionally substituted, e.g., by one or more substituents. The cycloalkenyl groups can contain fused rings. Fused rings are rings that share a common carbon atom. Cycloalkenyl moieties can include, e.g., cyclohexenyl, cyclohexadienyl, or norbornenyl.

The term "heterocycloalkenyl" refers to partially unsaturated monocyclic, bicyclic, tricyclic, or other polycyclic hydrocarbon groups having 1-4 heteroatoms if

monocyclic, 1-8 heteroatoms if bicyclic, or 1-10 heteroatoms if tricyclic, said heteroatoms selected from O, N, or S (and mono and dioxides thereof, e.g., $N\rightarrow O^-$, S(O), SO_2) (e.g., carbon atoms and 1-4, 1-8, or 1-10 heteroatoms of N, O, or S if monocyclic, bicyclic, or tricyclic, respectively). A ring carbon (e.g., saturated or unsaturated) or heteroatom is the point of attachment of the heterocycloalkenyl substituent. Any atom can be optionally substituted, e.g., by one or more substituents. The heterocycloalkenyl groups can contain fused rings. Fused rings are rings that share a common carbon or nitrogen atom. Heterocycloalkenyl groups can include, e.g., tetrahydropyridyl, dihydropyranyl, 4,5-dihydrooxazolyl, 4,5-dihydro-1H-imidazolyl, 1,2,5,6-tetrahydro-pyrimidinyl, and 5,6-dihydro-2H-[1,3]oxazinyl.

The term "aryl" refers to a fully unsaturated, aromatic monocyclic, bicyclic, or tricyclic, hydrocarbon ring system, wherein any ring atom can be optionally substituted, e.g., by one or more substituents. Aryl groups can contain fused rings. Fused rings are rings that share a common carbon atom. Aryl moieties can include, e.g., phenyl, naphthyl, anthracenyl, and pyrenyl.

The term "heteroaryl" refers to a fully unsaturated, aromatic monocyclic, bicyclic, tricyclic, or other polycyclic hydrocarbon groups having 1-4 heteroatoms if monocyclic, 1-8 heteroatoms if bicyclic, or 1-10 heteroatoms if tricyclic, said heteroatoms independently selected from O, N, or S (and mono and dioxides thereof, e.g., $N\rightarrow O^-$, S(O), SO_2) (e.g., carbon atoms and 1-4, 1-8, or 1-10 heteroatoms of N, O, or S if monocyclic, bicyclic, or tricyclic, respectively). Any atom can be optionally substituted, e.g., by one or more substituents. Heteroaryl groups can contain fused rings. Fused rings are rings that share a common carbon or nitrogen atom. Heteroaryl groups can include, e.g., pyridyl, thienyl, furyl (furanyl), imidazolyl, indolyl, isoquinolyl, quinolyl and pyrrolyl.

The descriptor C(O) refers to a carbon atom that is doubly bonded to oxygen.

The term "substituent" refers to a group "substituted" on, e.g., an alkyl, haloalkyl, cycloalkyl, alkenyl, alkynyl, aralkyl, heteroaralkyl, heterocyclyl, heterocycloalkenyl, cycloalkenyl, aryl, or heteroaryl group at any atom of that group. In one aspect, the substituent(s) (e.g., R^d) on a group are independently any one single, or any combination of two or more of the permissible atoms or groups of atoms delineated for that

substituent. In another aspect, a substituent may itself be substituted with any one of the above substituents.

In general, when a definition for a particular variable includes both hydrogen and non-hydrogen (halo, alkyl, aryl, etc.) possibilities, the term "substituent(s) other than hydrogen" refers collectively to the non-hydrogen possibilities for that particular variable.

Descriptors such as "C_1-C_6 alkyl which is optionally substituted with from 1-2 R^a" (and the like) is intended to include as alternatives both unsubstituted C_1-C_6 alkyl and C_1-C_6 alkyl that is substituted with from 1-2 R^a. The use of a substituent (radical) prefix names such as alkyl without the modifier "optionally substituted" or "substituted" is understood to mean that the particular substituent is unsubstituted. However, the use of "haloalkyl" without the modifier "optionally substituted" or "substituted" is still understood to mean an alkyl group, in which at least one hydrogen atom is replaced by halo.

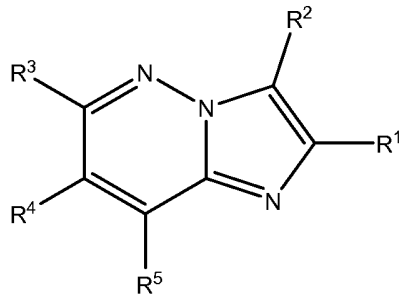
In some embodiments, the compounds have agonist activity for genes involved with HDL production and cholesterol efflux (e.g., ABCA1) and antagonist activity for genes involved with triglyceride synthesis (e.g., SREBP-1c).

The details of one or more embodiments of the invention are set forth in the description below. Other features and advantages of the invention will be apparent from the description and from the claims.

DETAILED DESCRIPTION

This invention relates generally to imidazo[1,2-b] pyridazine-based modulators of Liver X receptors (LXRs) and related methods.

The imidazo[1,2-b] pyridazine-based LXR modulators have the general formula (I):



(I)

in which R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, W, W^1, W^2, A, R^a, R^b, R^c, R^d, R^e, R^g, R^h, R^m, R^n, and n, can be, independently, as defined anywhere herein.

For ease of exposition, it is understood that where in this specification (including the claims), a group is defined by "as defined anywhere herein" (or the like), the definitions for that particular group include the first occurring and broadest generic definition as well as any sub-generic and specific definitions delineated anywhere in this specification.

Variable R^1

In some embodiments, R^1 can be:

(**1-i**) hydrogen; or

(**1-ii**) C_1-C_6 (e.g., C_1-C_3) alkyl or C_1-C_6 (e.g., C_1-C_4 or C_1-C_3) haloalkyl, each of which is optionally substituted with from 1-10 (e.g., 1-5, 1-4, 1-3, 1-2, 1) R^a; or

(**1-iv**) C_3-C_{10} (e.g., C_3-C_8 or C_3-C_6) cycloalkyl, C_3-C_{10} (e.g., C_3-C_8 or C_3-C_6) cycloalkenyl, heterocyclyl including 3-10 (e.g., 3-8 or 3-6) atoms, heterocycloalkenyl including 3-10 (e.g., 3-8 or 3-6) atoms, C_7-C_{11} (e.g., C_7-C_{10}) aralkyl, or heteroaralkyl including 6-11 (e.g., 6-10) atoms, each of which is optionally substituted with from 1-10 (e.g., 1-5, 1-4, 1-3, 1-2, 1) R^c; or

(**1-v**) C_6-C_{10} (e.g., phenyl) aryl or heteroaryl including 5-10 (e.g., 5-6) atoms, each of which is optionally substituted with from 1-10 (e.g., 1-5, 1-4, 1-3, 1-2, 1) R^d.

In some embodiments, R^1 can be:

(**1-i**) hydrogen; or

(**1-ii**) C_1-C_6 (e.g., C_1-C_3) alkyl or C_1-C_6 (e.g., C_1-C_6 or C_1-C_4) haloalkyl, each of which is optionally substituted with from 1-10 (e.g., 1-5, 1-4, 1-3, 1-2, 1) R^a; or

(**1-iv'**) C_7-C_{11} (e.g., C_7-C_{10}) aralkyl, or heteroaralkyl including 6-11 (e.g., 6-10) atoms, each of which is optionally substituted with from 1-10 (e.g., 1-5, 1-4, 1-3, 1-2, 1) R^c; or

(**1-v**) C_6-C_{10} (e.g., phenyl) aryl or heteroaryl including 5-11 (e.g., 5-10, 5-6) atoms, each of which is optionally substituted with from 1-10 (e.g., 1-5, 1-4, 1-3, 1-2, 1) R^d.

In some embodiments, R^1 can be any one of: (**1-i**), (**1-ii**), (**1-iv**), (**1-iv'**), and (**1-v**). In certain embodiments, R^1 can be hydrogen. In other embodiments, R^1 can be a substituent other than hydrogen.

In some embodiments, R^1 can be any two of: (**1-i**), (**1-ii**), (**1-iv**), (**1-iv'**), and (**1-v**). In certain embodiments, R^1 can be hydrogen and any one of (**1-ii**), (**1-iv**), (**1-iv'**), and (**1-v**). In other embodiments, R^1 can be any two of (**1-ii**), (**1-iv**), (**1-iv'**), and (**1-v**), e.g., R^1 can be (**1-ii**) and (**1- iv'**).

In some embodiments, R^1 can be any three of: (**1-i**), (**1-ii**), (**1-iv**), (**1-iv'**), and (**1-v**). In certain embodiments, R^1 can be hydrogen and any two of (**1-ii**), (**1-iv**), (**1-iv'**), and (**1-v**), e.g., R^1 can be (**1-ii**) and (**1- iv'**). In other embodiments, R^1 can be any three of (**1-ii**), (**1-iv**), (**1-iv'**), and (**1-v**), e.g., (**1-ii**), (**1-iv'**), and (**1-v**).

In embodiments, R^1 can be C_1-C_6 (e.g., C_1-C_5 or C_1-C_3) alkyl. For example, R^1 can be methyl (CH_3), ethyl (CH_2CH_3), or isopropyl ($CH(CH_3)_2$).

In embodiments, R^1 can be C_1-C_6 (e.g., C_1-C_4 or C_1-C_3) haloalkyl (e.g., perhaloalkyl). For example, R^1 can be CF_3.

In embodiments, R^1 can be C_7-C_{11} (e.g., C_7-C_{10}) aralkyl, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c. For example, R^1 can be benzyl or 2-

phenylethyl, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c. In certain embodiments, R^1 can be benzyl.

In embodiments, R^1 can be heteroaralkyl including 6-10 atoms, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c. In certain embodiments, the alkyl portion can be C_1-C_2 alkylene, and the heteroaryl portion can be thienyl, furyl, pyrrolyl, or pyridinyl, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c.

In embodiments, R^1 can be C_6-C_{10} aryl, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^d. For example, R^1 can be phenyl, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^d.

In embodiments, R^1 can be heteroaryl including 5-10 (e.g., 5-6) atoms, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^d. For example, R^1 can be thienyl, furyl, pyrrolyl, or pyridinyl, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^d.

Variable R^2

In some embodiments, R^2 can be C_6-C_{10} (e.g., phenyl) aryl, which is (i) substituted with 1 R^6 and (ii) optionally substituted with from 1-5 (e.g., 1-3, 1-2, 1) R^e.

In some embodiments, when R^2 is aryl and substituted with R^e, each R^e can be independently of one another: halo (e.g., chloro); C_1-C_3 alkyl; C_1-C_3 haloalkyl (e.g., C_1-C_3 fluoroalkyl, e.g., 1-5 fluorines can be present; or C_1-C_3 perfluoroalkyl); CN; hydroxyl; NR^mR^n (e.g., NH_2, monoalkylamino, or dialkylamino); C_1-C_3 alkoxy; C_1-C_3 haloalkoxy.

In certain embodiments, when R^2 is substituted with R^e, each R^e can be independently of one another: C_1-C_3 alkyl; C_1-C_3 haloalkyl, e.g., C_1-C_3 perfluoroalkyl; halo (e.g., chloro); or CN.

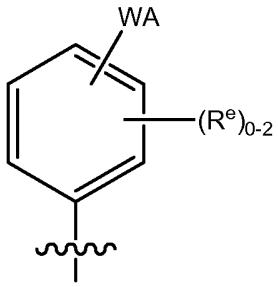
In certain embodiments, when R^2 is substituted with R^e, each R^e can be independently of one another: C_1-C_3 alkyl; C_1-C_3 haloalkyl, e.g., C_1-C_3 perfluoroalkyl; halo (e.g., chloro).

In certain embodiments, when R^2 is substituted with R^e, each R^e can be independently of one another halo (e.g., chloro).

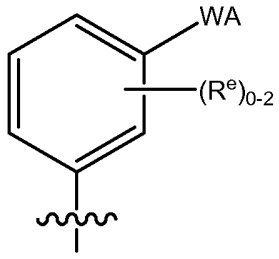
In some embodiments, R^2 can be C_6-C_{10} aryl, which is (i) substituted with 1 R^6 and (ii) optionally substituted with from 1-5 (e.g., 1-3, 1-2, 1) R^e.

In some embodiments, R^2 can be C_6-C_{10} aryl, which is (i) substituted with 1 R^6 and (ii) optionally substituted with 1 or 2 R^e.

In certain embodiments, R^2 can be phenyl, which is (i) substituted with 1 R^6 and (ii) optionally substituted with 1 or 2 (e.g., 1) R^e (e.g., halo, e.g., chloro). In other embodiments, R^2 can be phenyl, which is substituted with 1 R^6. In these embodiments, R^2 can have formula (A), in which R^6 (i.e., the moiety -WA) can be attached to a ring carbon that is *ortho*, *meta*, or *para* (e.g., *meta*) with respect to the ring carbon that connects the phenyl ring to the 3-position of the imidazo[1,2-b]pyridazine ring, and R^e, when present can be connected to ring carbons that are not occupied by WA. For example, R^2 can have formula (A-1), in which R^6 (WA) is attached to the ring carbon that is *meta* with respect to the ring carbon that connects the phenyl ring to the 3-position of the imidazo[1,2-b]pyridazine ring in formula (I).

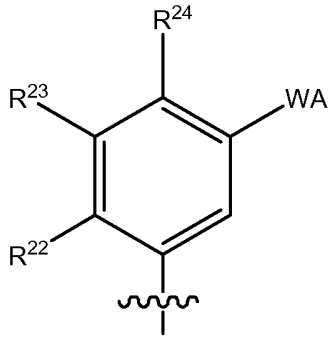


(A)



(A-1)

In certain embodiments, R^2 can have formula (A-2):



(**A-2**).

In some embodiments, each of R^{22}, R^{23}, and R^{24} can be, independently of one another, hydrogen or R^e. In these and other embodiments related to formula (A-2), R^e can be as defined anywhere herein.

In some embodiments, (i) each of R^{22}, R^{23}, and R^{24} is hydrogen; or (ii) one of R^{22}, R^{23}, and R^{24} is R^e, and the other two are hydrogen.

In embodiments, each of R^{22}, R^{23}, and R^{24} can be hydrogen. In other embodiments, each of R^{22}, R^{23}, and R^{24} can be a substituent other than hydrogen. In still other embodiments, one or two of R^{22}, R^{23}, and R^{24} can be R^e, and the other(s) are hydrogen.

In certain embodiments, one of R^{22}, R^{23}, and R^{24} can be R^e, and the other two are hydrogen. In embodiments, R^{22} can be R^e, and each of R^{23} and R^{24} can be hydrogen. In certain embodiments, R^e can be: halo (e.g., chloro); C_1-C_3 alkyl; or C_1-C_3 haloalkyl (e.g., C_1-C_3 fluoroalkyl, e.g., 1-5 fluorines can be present; or C_1-C_3 perfluoroalkyl). In certain embodiments, R^e can be halo (e.g., chloro).

In some embodiments, R^2 can be heteroaryl including 5-10 (e.g., 5-6) atoms, which is (i) substituted with 1 R^6 and (ii) optionally substituted with from 1-5 (e.g., 1-3, 1-2, 1) R^e.

In embodiments, when R^2 is heteroaryl and substituted with R^e, each R^e can be independently as defined anywhere herein. For example, each R^e can be independently of one another: C_1-C_3 alkyl; C_1-C_3 haloalkyl, e.g., C_1-C_3 perfluoroalkyl; halo (e.g., chloro); e.g., each R^e can be halo (e.g., chloro).

In some embodiments, R^2 can be heteroaryl including 5-10 atoms, which is (i) substituted with 1 R^6 and (ii) optionally substituted with from 1-5 (e.g., 1-3, 1-2, 1) R^e.

In some embodiments, R^2 can be heteroaryl including 5-10 atoms, which is (i) substituted with 1 R^6 and (ii) optionally substituted with 1 or 2 R^e.

In some embodiments, R^2 can be heteroaryl including 5-6 atoms, which is (i) substituted with 1 R^6 and (ii) optionally substituted with 1 or 2 R^e.

In some embodiments, R^2 can be heteroaryl including 8-10 atoms, which is (i) substituted with 1 R^6 and (ii) optionally substituted with 1 or 2 R^e.

In certain embodiments, R^2 can be pyridyl, pyrimidinyl, thienyl, furyl, quinolinyl, oxazolyl, thiazolyl, imidazolyl, isoxazolyl, indolyl, benzo[1,3]-dioxolyl, benzo[1,2,5]-oxadiazolyl, isochromenyl-1-one, 3-H-isobenzofuranyl-1-one (e.g., pyridyl, thienyl, or indolyl, e.g., pyridyl or indolyl, e.g., pyridinyl), each of which is (i) substituted with 1 R^6 and (ii) optionally substituted with 1 or 2 R^e. For example, R^2 can be pyridyl substituted with 1 R^6.

In certain embodiments, R^2 is other than optionally substituted thienyl or pyrimidinyl.

Variable W

In some embodiments, W can be -O-.

In some embodiments, W can be a bond.

In other embodiments, W can be $-W^1(C_{1-6}$ alkylene)-. In certain embodiments, W^1 can be -O-. For example, W can be $-O(C_{1-3}$ alkylene)- (e.g., $-OCH_2-$, $-OCH_2CH_2-$, or $-OCH_2CH_2CH_2-$, e.g., $-OCH_2-$).

In some embodiments, W can be $-NR^7-$ (e.g., -NH-).

In some embodiments, W can be $-(C_{1-6}$ alkylene)W^1-. In certain embodiments, W^1 is $-NR^7-$, in which R^7 can be hydrogen; or W^1 can be -O-. In certain embodiments, W can be $-(C_{1-3}$ alkylene)NH- (e.g., $-CH_2NH-$). In certain embodiments, W can be $-(C_{1-3}$ alkylene)O- (e.g., $-CH_2O-$).

In still other embodiments, W can be C_2-C_4 alkenylene (e.g., -CH=CH-); C_2-C_4 alkynylene (e.g., -C≡C-); or C_{1-3} alkylene (e.g., CH_2).

Variable A

In general, A is an aromatic or heteroaromatic ring system that is (a) substituted with one R^8; and (b) optionally substituted with one or more R^g.

In some embodiments, A can be C_6-C_{10} (e.g., phenyl) aryl, which is (a) substituted with 1 R^8; and (b) optionally further substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1, e.g., 1-2) R^g, in which R^g can be as defined anywhere herein.

In embodiments, when A is aryl and substituted with one or more R^g, each R^g can be independently of one another:

(i) halo; C_1-C_6 (e.g., C_1-C_3) alkoxy or C_1-C_6 (e.g., C_1-C_3) haloalkoxy; or cyano; or

(ii) C_1-C_6 (e.g., C_1-C_3) alkyl or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In embodiments, when A is aryl and substituted with one or more R^g, each R^g can be independently of one another:

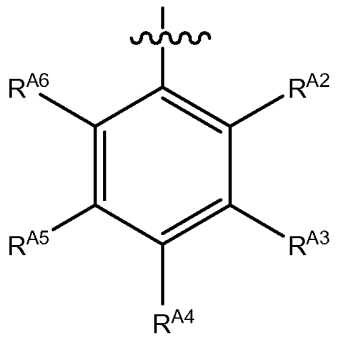
- halo (e.g., chloro or fluoro); or
- C_1-C_6 (e.g., C_1-C_3) haloalkoxy; or
- C_1-C_6 (e.g., C_1-C_3) alkoxy; NR^mR^n; or
- cyano; or
- C_1-C_6 (e.g., C_1-C_3) alkyl or C_1-C_6 (e.g., C_1-C_6, C_1-C_3) haloalkyl.

In some embodiments, A can be C_6-C_{10} aryl, which is (i) substituted with 1 R^8 and (ii) optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1, e.g., 1-2) R^g.

In some embodiments, A can be phenyl, which is (i) substituted with 1 R^8 and (ii) optionally substituted with from 1-4 (e.g., 1-3, 1-2, 1) R^g.

In these embodiments, R^8 can be attached to a ring carbon that is *ortho*, *meta*, or *para* (e.g., *meta* or *para*) with respect to the ring carbon that connects the phenyl ring to W.

In certain embodiments, A can have formula (B-1):



(B-1)

in which one of R^{A3} and R^{A4} is R^8, the other of R^{A3} and R^{A4} and each of R^{A2}, R^{A5}, and R^{A6} is, independently, hydrogen or R^g, in which R^g can be as defined anywhere herein. In these and other embodiments related to formula (B-1), R^8 can be as defined anywhere herein.

In embodiments, one of R^{A3} and R^{A4} can be R^8, the other of R^{A3} and R^{A4} can be hydrogen; and each of R^{A2}, R^{A5}, and R^{A6} can be, independently, hydrogen or R^g.

In certain embodiments, R^{A3} can be R^8. For example, R^{A3} can be R^8, R^{A4} can be hydrogen, and each of R^{A2}, R^{A5}, and R^{A6} can be hydrogen. As another example, R^{A3} can be R^8; R^{A4} can be hydrogen; one of R^{A2}, R^{A5}, and R^{A6} (e.g., R^{A5}) can be R^g (e.g., halo) and the other two of R^{A2}, R^{A5}, and R^{A6} can be hydrogen.

In certain embodiments, R^{A4} can be R^8. For example, R^{A4} can be R^8, R^{A3} can be hydrogen, and each of R^{A2}, R^{A5}, and R^{A6} can be hydrogen. As another example, R^{A3} can be R^8; R^{A4} can be hydrogen; one of R^{A2}, R^{A5}, and R^{A6} can be R^g (e.g., halo) and the other two of R^{A2}, R^{A5}, and R^{A6} can be hydrogen.

In some embodiments, A can be heteroaryl including 5-10 atoms, which is (a) substituted with from 1 R^8; and (b) is optionally substituted with from 1-3 (e.g., 1-2, 1) R^g, in which R^g can be as defined anywhere herein.

In some embodiments, A can be heteroaryl including 5-10 atoms, which is (a) substituted with 1 R^8; and (b) is optionally substituted with from 1-2 (e.g., 1) R^g.

In certain embodiments, A can be pyrrolyl, pyridyl, pyridyl-N-oxide, pyrazolyl, pyrimidinyl, thienyl, furyl, quinolinyl, oxazolyl, thiazolyl, imidazolyl, isoxazolyl, indolyl,

benzo[1,3]-dioxolyl, benzo[1,2,5]-oxadiazolyl, isochromenyl-1-one, 3-H-isobenzofuranyl-1-one (e.g., pyridyl, thienyl, or indolyl, e.g., pyridyl), which is (i) substituted with 1 R^8 and (ii) optionally substituted with 1-3 (e.g., 1-2, 1) R^g.

In certain embodiments, A can be pyrrolyl, pyridyl, pyrimidinyl, pyrazolyl, thienyl, furyl, quinolyl, oxazolyl, thiazolyl, imidazolyl, or isoxazolyl, each of which is (a) substituted with 1 R^8; and (b) is optionally substituted with from 1-3 (e.g., 1-2, 1) R^g.

In certain embodiments, A can be pyridyl, pyrimidinyl, thienyl, furyl, oxazolyl, thiazolyl, imidazolyl, or isoxazolyl, each of which is (a) substituted with 1 R^8; and (b) is optionally substituted with from 1-3 (e.g., 1-2, 1) R^g.

In certain embodiments, A can be pyridyl in which W is attached to the 2- or 3-position of the pyridiyl ring. For example, A can be pyridyl in which W is attached to the 2-position of the pyridyl ring, and R^8 is attached to the 4- or the 6-position of the pyridyl ring. Such rings can be further substituted with 1, 2 or 3 R^g (e.g., halo, e.g., chloro; or NR^gR^h, e.g., NH_2).

Variable R^8

R^8 can be:

(**8-i**) $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$; or

(**8-ii**) $-W^2-C(O)OR^{12}$; or

(**8-iii**) $-W^2-C(O)NR^{10}R^{11}$; or

(**8-iv**) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with from 1 R^h, and

(b) optionally further substituted with from 1-5 R^a;

or

(**8-v**) $-NR^{13}R^{14}$.

In some embodiments, R^8 can be:

- (**8-i'**) $-W^2-S(O)_nR^9$; or
- (**8-ii**), (**8-iii**), (**8-iv**), or (**8-v**).

In some embodiments, R^8 can be any one of: **(8-i)**, **(8-i')**, **(8-ii)**, **(8-iii)**, **(8-iv)**, or **(8-v)**. In certain embodiments, R^8 can be $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$ (e.g., $-W^2-S(O)_nR^9$).

In other embodiments, R^8 can be $-W^2-C(O)OR^{12}$ or $-W^2-C(O)NR^{10}R^{11}$ (e.g., $-W^2-C(O)OR^{12}$).

In still other embodiments, R^8 can be W^2-CN.

In some embodiments, R^8 can be any two of: **(8-i)**, **(8-i')**, **(8-iii)**, or **(8-v)**. In certain embodiments, R^8 can be $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$ (e.g., $-W^2-S(O)_nR^9$) and any one of **(8-iii)** or **(8-v)**.

In some embodiments, R^8 can be any three of: **(8-i)**, **(8-i')**, **(8-iii)**, or **(8-v)**.

In certain embodiments, R^8 can be:

- $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$ (e.g., $-W^2-S(O)_nR^9$); and
- **(8-iii)** or **(8-v)**.

In other embodiments, R^8 can be **(8-iii)** or **(8-v)**.

In some embodiments, R^8 can be $-W^2-S(O)_nR^9$ (e.g., $-W^2-S(O)_2R^9$, in which n is 2). In embodiments, W^2 can be a bond, i.e., R^9 is connected to variable A by the sulfur (S) atom of the sulfinyl or the sulfonyl group.

In some embodiments, R^9 can be C_1-C_6 (e.g., C_1-C_5) alkyl or C_1-C_6 (e.g., C_1-C_5 or C_1-C_3) haloalkyl, optionally substituted with from 1-2 R^a.

In certain embodiments, R^9 can be C_1-C_6 (e.g., C_1-C_5) alkyl, optionally substituted with from 1 R^a.

In certain embodiments, R^9 can be unsubstituted branched or unbranched C_1-C_6 (e.g., C_1-C_5) alkyl. For example, R^9 can be methyl (CH_3). As another example, R^9 can be ethyl (CH_2CH_3). As a further example, R^9 can be *iso*propyl ($CH(CH_3)_2$).

In certain embodiments, R^9 can be branched or unbranched C_2-C_6 (e.g., C_3-C_6, or C_3-C_5) alkyl, which is substituted with 1 R^a. In embodiments, R^a can be: hydroxyl; C_1-

C_6 (e.g., C_1-C_3) alkoxy; C_3-C_7 cycloalkoxy or C_6-C_{10} aryloxy, each of which can be optionally substituted with R^c and R^d, respectively; NR^mR^n; halo; or heterocyclyl including 3-8 atoms, which is optionally substituted with from 1-5 R^c. For example, R^a can be hydroxyl, C_1-C_6 (e.g., C_1-C_3) alkoxy, or NR^mR^n. In certain embodiments, R^a (e.g., hydroxyl) can be attached to a secondary or tertiary carbon atom of the alkyl group or a primary carbon of the alkyl group. In embodiments, R^9 can be hydroxyl substituted C_3-C_6 (e.g., C_3-C_5) alkyl. In other embodiments, R^{10} can be C_3-C_6 (e.g., C_3-C_5) alkyl that is substituted with an amino group (NH_2) or a secondary or tertiary amino group.

In certain embodiments, R^9 can be C_7-C_{11} aralkyl (e.g., benzyl), optionally substituted with from 1-3 (e.g., 1-2, 1) R^c.

In certain embodiments, R^9 can be C_6-C_{10} aryl, optionally substituted with from 1-2 R^d.

In some embodiments, R^8 can be $-W^2$-$S(O)_nNR^{10}R^{11}$ (e.g., $-W^2$-$S(O)_2NR^{10}R^{11}$, in which n is 2). In embodiments, W^2 can be a bond, i.e., R^9 is connected to variable A by the sulfur (S) atom of the sulfinamide or sulfonamide group.

In certain embodiments, one or both of R^{10} and R^{11} can be hydrogen. In certain embodiments, R^8 can be $-S(O)_2NH_2$. In other embodiments, one of R^{10} and R^{11} can be hydrogen, and the other of R^{10} and R^{11} can be:

(i) C_1-C_6 (e.g., C_1-C_3) alkyl or C_1-C_6 (e.g., C_1-C_3) haloalkyl, each of which is optionally substituted with from 1-5 (e.g., 1-5, 1-4, 1-3, 1-2, 1) R^a (e.g., R^a can be: hydroxyl; C_1-C_6 (e.g., C_1-C_3) alkoxy; C_3-C_7 cycloalkoxy or C_6-C_{10} aryloxy, each of which can be optionally substituted with R^c and R^d, respectively; NR^mR^n; or heterocyclyl including 3-8 atoms, which is optionally substituted with from 1-5 R^c); or

(iii) C_7-C_{11} aralkyl, or heteroaralkyl including 6-11 atoms, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c; or

(iv) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^d.

In certain embodiments, R^{10} and R^{11} can each be, independently of one another:

(i) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-5 R^a; or

(ii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-5 R^b; or

(iii) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, heterocyclyl including 3-11 atoms, heterocycloalkenyl including 3-10 atoms, C_7-C_{11} aralkyl, or heteroaralkyl including 6-11 atoms, each of which is optionally substituted with from 1-5 R^c; or

(iv) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d.

In certain embodiments, R^{10} and R^{11} can each be, independently of one another:

(i) C_1-C_6 (e.g., C_1-C_3) alkyl or C_1-C_6 (e.g., C_1-C_3) haloalkyl, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^a (e.g., R^a can be: hydroxyl; C_1-C_6 (e.g., C_1-C_3) alkoxy; C_3-C_7 cycloalkoxy or C_6-C_{10} aryloxy, each of which can be optionally substituted with R^c and R^d, respectively; NR^mR^n; or heterocyclyl including 3-8 atoms, which is optionally substituted with from 1-5 R^c); or

(iii) C_7-C_{11} aralkyl, or heteroaralkyl including 6-11 atoms, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c; or

(iv) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^d.

In certain embodiments, R^{10} and R^{11} together with the nitrogen atom to which they are attached can form a heterocyclyl including 3-10 (e.g., 3-8, or 3-6) atoms or a heterocycloalkenyl including 3-10 (e.g., 3-8, or 3-6) atoms, each of which is optionally substituted with from 1-5 (1-4, 1-3, 1-2, 1) R^c. In some embodiments, the heterocyclyl can further include one or more additional ring heteroatoms (e.g., N, O, or S).

In certain embodiments, R^{10} and R^{11} together with the nitrogen atom to which they are attached can form a heterocyclyl including 3-10 (e.g., 3-8, 3-6, or 5-6) atoms, which is optionally substituted with from 1-5 (1-4, 1-3, 1-2, 1) R^c. For example, R^{10} and R^{11} together with the nitrogen atom to which they are attached can form a morpholinyl,

piperidyl, pyrrolidinyl, or piperazinyl ring, each of which is optionally substituted with from 1-5 (1-4, 1-3, 1-2, 1) R^c.

In some embodiments, R^8 can be $-W^2-C(O)OR^{12}$. In some embodiments, W^2 can be C_1-C_6 alkylene; or a bond. In certain embodiments, W^2 can be C_1-C_6 alkylene. For example, W^2 can be C_1-C_3 alkylene, such as CH_2 or CH_2CH_2. In other embodiments, W^2 can be a bond.

In some embodiments, R^{12} can be:

(i) hydrogen; or

(ii) C_1-C_6 (e.g., C_1-C_5) alkyl, which is optionally substituted with from 1-3 (e.g., 1-2, 1) R^a; or

(iii) C_3-C_7 cycloalkyl or C_7-C_{11} aralkyl, each of which is optionally substituted with from 1-5 R^c; or

(iv) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d.

In certain embodiments, R^{12} can be hydrogen. In other embodiments, R^{12} can be a substituent other than hydrogen.

In some embodiments, R^8 can be $-W^2-C(O)NR^{10}R^{11}$.

Embodiments can include, for example, any one or more of the features described above in conjunction with $-W^2-S(O)_nNR^{10}R^{11}$ and/or $-W^2-C(O)OR^{12}$.

In some embodiments, R^8 can be C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is (a) substituted with from 1 R^h, and (b) optionally further substituted with from 1 or 2 R^a (e.g., R^a can be C_3-C_7 cycloalkyl, which is optionally substituted with from 1-5 R^c).

In certain embodiments, R^h at each occurrence can be, independently, hydroxyl, C_1-C_6 alkoxy, C_1-C_6 haloalkoxy; C_3-C_{10} cycloalkoxy, which is optionally substituted with from 1-5 R^c; or C_6-C_{10} aryloxy or heteroaryloxy including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d.

In certain embodiments, R^8 can have the following formula: $-C(R^{81})(R^{82})(R^h)$, in which each of R^{81} and R^{82} is, independently, C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is optionally further substituted with from 1 or 2 R^a (e.g., R^a can be C_3-C_7 cycloalkyl, which is optionally substituted with from 1-5 R^c); C_3-C_7 cycloalkyl, which is optionally substituted with from 1-5 R^c; or C_6-C_{10} aryl, which is optionally substituted with from 1-10 R^d; and R^h can be as defined anywhere herein.

In some embodiments, R^8 can be $-NR^{13}R^{14}$, one of R^{13} and R^{14} is hydrogen or C_1-C_3 alkyl (e.g., hydrogen); and the other of R^{13} and R^{14} can be:

(i) $-S(O)_nR^9$; or

(ii) $-C(O)OR^{12}$; or

(iii) $-C(O)NR^{10}R^{11}$; or

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with from 1 R^h, and

(b) optionally further substituted with from 1-5 R^a

.

In embodiments, each of n, R^9, R^{10}, R^{11}, R^{12}, R^h, R^a, and R^d can be, independently, as defined anywhere herein. In embodiments, R12 can be a substituent other than hydrogen.

Variables R^3 and R^4

In some embodiments, each of R^3 and R^4 can be, independently:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a.

In certain embodiments, each of R^3 and R^4 can be, independently:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_3 alkyl or C_1-C_3 haloalkyl (e.g., perhaloalkyl, e.g., perfluoroalkyl), each of which is optionally substituted with from 1-3 R^a.

In certain embodiments, each of R^3 and R^4 can be independently hydrogen or halo (e.g., fluoro).

In certain embodiments, each of R^3 and R^4 can be hydrogen.

In certain embodiments, each of R^3 and R^4 can be a substituent other than hydrogen (e.g., halo, e.g., fluoro).

In certain embodiments, one of R^3 and R^4 can be hydrogen, and the other can be:

(ii) halo; or

(iii) C_1-C_6 (e.g., C_1-C_3) alkyl or C_1-C_6 (e.g., C_1-C_3) haloalkyl (e.g., perhaloalkyl, e.g., perfluoroalkyl), each of which is optionally substituted with from 1-3 R^a.

Variable R^5

In some embodiments, R^5 can be:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) cyano.

In some embodiments, R^5 can be halo, cyano, C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be chloro or bromo (e.g., chloro), cyano, C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be halo, C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be chloro or bromo (e.g., chloro), C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be halo (e.g., chloro) or C_1-C_6 (e.g., C_1-C_3) haloalkyl (e.g., CF_3).

In some embodiments, R^5 can be chloro or bromo (e.g., chloro) or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In certain embodiments, R^5 can be chloro, cyano, CH_3, or CF_3. In certain embodiments, R^5 can be chloro, CH_3, or CF_3. In certain embodiments, R^5 can be chloro or CF_3.

In some embodiments, R^5 can be hydrogen.

In some embodiments, R^5 can be hydrogen, halo, cyano, C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be hydrogen, chloro or bromo (e.g., chloro), cyano, C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be hydrogen, halo, C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be hydrogen, chloro or bromo (e.g., chloro), C_1-C_6 (e.g., C_1-C_3) alkyl, or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In some embodiments, R^5 can be hydrogen, halo (e.g., chloro), or C_1-C_6 (e.g., C_1-C_3) haloalkyl (e.g., CF_3).

In some embodiments, R^5 can be hydrogen, chloro or bromo (e.g., chloro), or C_1-C_6 (e.g., C_1-C_3) haloalkyl.

In certain embodiments, R^5 can be hydrogen, chloro, cyano, CH_3, or CF_3. In certain embodiments, R^5 can be hydrogen, chloro, CH_3, or CF_3. In certain embodiments, R^5 can be hydrogen, chloro, or CF_3.

In some embodiments, R^5 can be C_1-C_6 (e.g., C_1-C_3) haloalkyl (e.g., perfluoroalkyl, e.g., CF_3). In certain embodiments, R^5 can be CF_3.

In some embodiments, R^5 can be halo (e.g., chloro).

In some embodiments, R^5 can be C_1-C_6 (e.g., C_1-C_3) alkyl (e.g., CH_3).

In some embodiments, R^5 can be cyano.

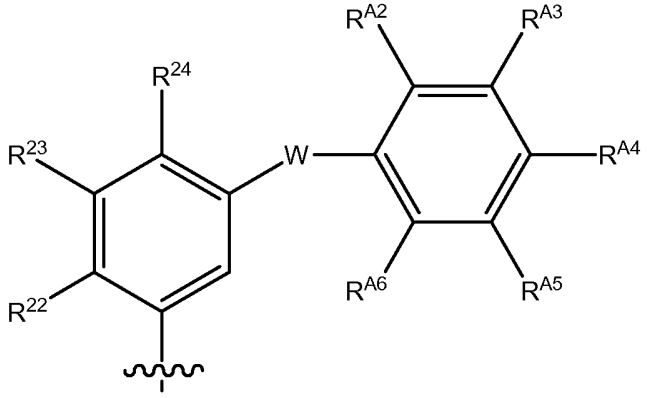
In some embodiments, R^5 can be hydrogen.

In some embodiments, R^5 can be other than C_1-C_6 alkyl (e.g., CH_3).

In some embodiments, when R^8 is $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$, then R^5 can be hydrogen; or hydrogen and any one or more of the permissible, non-hydrogen substitutents delineated above for R^5.

In some embodiments, when R^8 is other than $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$, then R^5 can be other than hydrogen.

A subset of compounds includes those in which R^2 has formula (C-1):



(C-1).

In some embodiments:

each of R^{22}, R^{23}, and R^{24} is, independently, hydrogen or R^e; and

one of R^{A2}, R^{A3}, R^{A4}, R^{A5}, and R^{A6} is R^8, and the others are each, independently, hydrogen or R^g; and

W can be as defined anywhere herein.

In some embodiments:

(i) each of R^{22}, R^{23}, and R^{24} is hydrogen; or

(ii) one of R^{22}, R^{23}, and R^{24} is R^e, and the other two are hydrogen;

one of R^{A2}, R^{A3}, R^{A4}, R^{A5}, and R^{A6} is R^8, and the others are each, independently, hydrogen or R^g; and

W can be as defined anywhere herein.

Embodiments can include, for example, one or more of the following features (and/or any one or more other features described anywhere herein).

W can be -O-, a bond, $-OCH_2-$, or -NH- (e.g., -O-, a bond, or $-OCH_2-$).

R^e, R^8, and R^g can each be, independently, as defined anywhere herein.

Each of R^{22}, R^{23}, and R^{24} can be hydrogen; or each of R^{22}, R^{23}, and R^{24} can be a substituent other than hydrogen; or one or two of R^{22}, R^{23}, and R^{24} can be R^e, and the other(s) can be hydrogen.

One of R^{22}, R^{23}, and R^{24} can be R^e, and the other two can be hydrogen. For example, R^{22} can be R^e, and each of R^{23} and R^{24} can be hydrogen. In embodiments, R^e can be: halo (e.g., chloro); C_1-C_3 alkyl; or C_1-C_3 haloalkyl (e.g., C_1-C_3 fluoroalkyl, e.g., 1-5 fluorines can be present; or C_1-C_3 perfluoroalkyl). In certain embodiments, R^e can be halo (e.g., chloro).

One of R^{A3} and R^{A4} can be R^8, the other of R^{A3} and R^{A4} can be hydrogen; and each of R^{A2}, R^{A5}, and R^{A6} can be, independently, hydrogen or R^g.

R^{A3} can be R^8, R^{A4} can be hydrogen, and each of R^{A2}, R^{A5}, and R^{A6} can be hydrogen; or R^{A3} can be R^8; R^{A4} can be hydrogen; one of R^{A2}, R^{A5}, and R^{A6} (e.g., R^{A5}) can be R^g (e.g., halo, e.g., fluoro) and the other two of R^{A2}, R^{A5}, and R^{A6} can be hydrogen.

R^{A4} can be R^8, R^{A3} can be hydrogen, and each of R^{A2}, R^{A5}, and R^{A6} can be hydrogen. R^{A3} can be R^8; R^{A4} can be hydrogen; one of R^{A2}, R^{A5}, and R^{A6} can be R^g (e.g., halo) and the other two of R^{A2}, R^{A5}, and R^{A6} can be hydrogen.

R^8 can be $-W^2-S(O)_nR^9$, in which n is 2, and each of W^2 and R^9 can be as defined anywhere herein. For example, W^2 can be a bond. As another example, R^9 can be C_1-C_6 alkyl, optionally substituted with from 1-2 R^a. In embodiments, R^9 can be CH_3, CH_2CH_3, or *iso*propyl.

By way of example, R^{A3} can be $-W^2-S(O)_nR^9$. n can be 2. W^2 can be a bond. R^9 can be C_1-C_6 alkyl, optionally substituted with from 1-2 R^a. R^9 can be C_1-C_3 alkyl (e.g., CH_3). R^9 can be C_2-C_8 alkyl substituted with 1 R^a (e.g., R^a can be hydroxyl or C_1-C_3 alkoxy). Each of R^{A2}, R^{A4}, R^{A5}, and R^{A6} can be hydrogen. R^{A5} can be R^g, and each of R^{A2}, R^{A4}, and R^{A6} can be hydrogen.

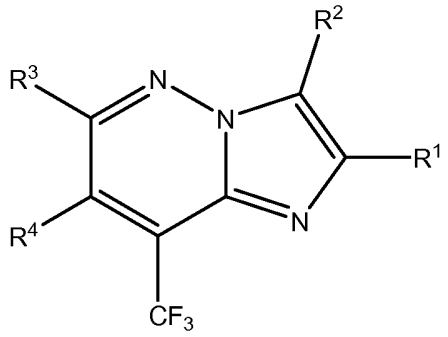
R^8 can be $-W^2-C(O)OR^{12}$. Each of W^2 and R^{12} can be as defined anywhere herein. For example, W^2 can be a bond or C_1-C_6 alkylene. As another example, R^{12} can be hydrogen or C_1-C_6 alkyl.

By way of example, R^{A4} can be $-W^2-C(O)OR^{12}$. W^2 can be a bond or C_1-C_6 alkylene (e.g., CH_2). R^{12} can be hydrogen or C_1-C_3 alkyl. Each of R^{A2}, R^{A3}, R^{A5}, and R^{A6} can be hydrogen.

R^8 can be W^2-CN.

Other embodiments can include one of more other features described herein and present in combination with the features delineated above.

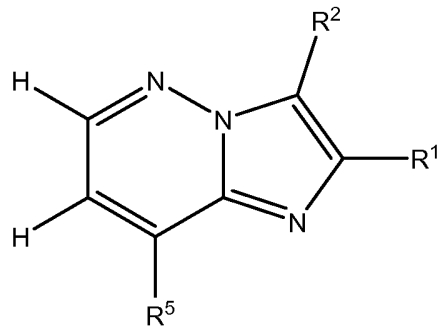
In some embodiments, the compounds can have formula (II):



(II)

in which each of R^1, R^2, R^3, and R^4 can be, independently, as defined anywhere herein (generically, subgenerically, or specifically).

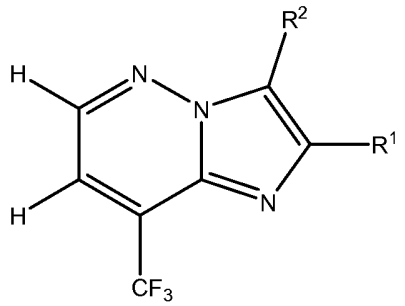
In some embodiments, the compounds can have formula (III):



(III)

in which each of R^1, R^2, and R^5 can be, independently, as defined anywhere herein (generically, subgenerically, or specifically).

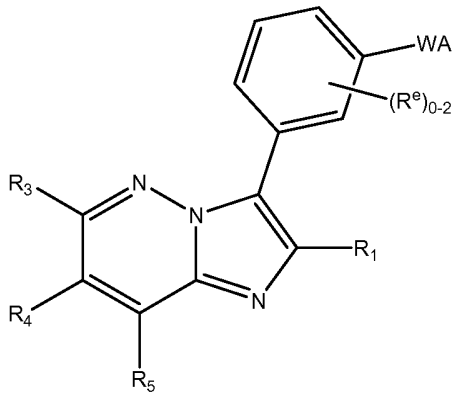
In some embodiments, the compounds can have formula (IV):



(IV)

in which each of R^1 and R^2 can be, independently, as defined anywhere herein (generically, subgenerically, or specifically).

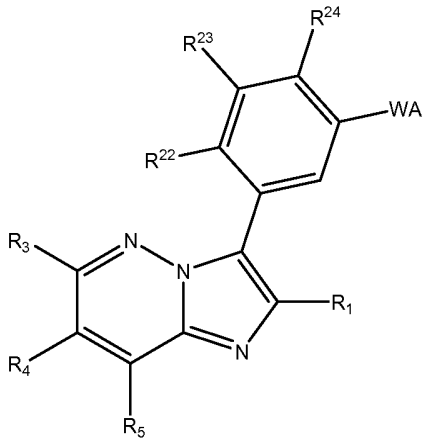
In some embodiments, the compounds can have formula (V):



(V)

in which each of R^1, R^3, R^4, R^5 , R^e, W, and A can be, independently, as defined anywhere herein (generically, subgenerically, or specifically).

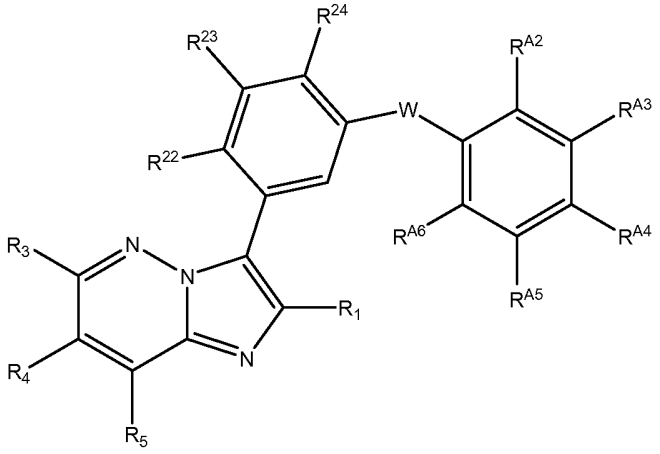
In some embodiments, the compounds can have formula (VI):



(VI)

in which each of R^1, R^3, R^4, R^5, R^{22}, R^{23}, R^{24}, W, and A can be, independently, as defined anywhere herein (generically, subgenerically, or specifically).

In some embodiments, the compounds can have formula (VII):



(VII)

in which each of R^1, R^3, R^4, R^5 , R^{22}, R^{23}, R^{24}, R^{A2}, R^{A3}, R^{A4}, R^{A5}, R^{A6}, W, and A can be, independently, as defined anywhere herein (generically, subgenerically, or specifically).

In embodiments, the compounds of formulas (II), (III), (IV), (V), (VI), and (VII) can include any one or more of the following features.

R^1 can be:

(i) hydrogen; or

(ii) C_1-C_6 (e.g., C_1-C_3 or C_1-C_2) alkyl or C_1-C_6 (e.g., C_1-C_3 or C_1-C_2) haloalkyl; or

(iii) C_6-C_{10} (e.g., phenyl) aryl or heteroaryl including 5-10 (e.g., 5-6 atoms), each of which is optionally substituted with from 1-5 R^d; or (iv) C_7-C_{11} (e.g., C_7-C_{10}) aralkyl, or heteroaralkyl including 6-11 (e.g., 6-10) atoms, each of which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c.

R^1 can be hydrogen.

R^1 can be:

(ii) C_1-C_6 (e.g., C_1-C_3 or C_1-C_2) alkyl or C_1-C_6 (e.g., C_1-C_3 or C_1-C_2) haloalkyl; or

(iii) C_6-C_{10} (e.g., phenyl) aryl, which is optionally substituted with from 1-5 R^d; or

(iv) C_7-C_{11} (e.g., C_7-C_{10}, benzyl) aralkyl, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c.

R^1 can be:

(iii) heteroaryl including 5-10 (e.g., 5-6 atoms), which is optionally substituted with from 1-5 R^d; or

(iv) heteroaralkyl including 6-11 (e.g., 6-10) atoms, which is optionally substituted with from 1-5 (e.g., 1-4, 1-3, 1-2, 1) R^c.

R^1 can be: H; CH_3, CH_2CH_3, or $CH(CH_3)_2$; CF_3; phenyl, which is optionally substituted with from 1-5 R^d; or benzyl, which is optionally substituted with from 1-5 R^c.

R^2 can have formula (A), (A-1), (A-2), or (C-1) as defined anywhere herein.

W can be -O-.

W can be a bond.

W can be $-W^1(C_{1-6}$ alkylene)-. In certain embodiments, W^1 can be -O-. For example, W can be $-O(C_{1-3}$ alkylene)- (e.g., $-OCH_2$-).

W can be $-(C_{1-6}$ alkylene)W^1-. In certain embodiments, W^1 is $-NR^9$-, in which R^9 can be hydrogen; or W^1 can be -O-. In certain embodiments, W can be $-(C_{1-3}$ alkylene)NH- (e.g., $-CH_2NH$-). In certain embodiments, W can be $-(C_{1-3}$ alkylene)O- (e.g., $-CH_2O$-).

W can be $-NR^8$-, (e.g., -NH-).

In some embodiments, A can be phenyl, which is (i) substituted with 1 R^8 and (ii) optionally substituted with from 1-5 (e.g., 1-3, 1-2, 1) R^g, in which R^g can be as defined anywhere herein.

A can have formula (B-1). In embodiments, one of R^{A3} and R^{A4} is R^8, and the other of R^{A3} and R^{A4} is hydrogen; and each of R^{A2}, R^{A5}, and R^{A6} is, independently, hydrogen or R^g, in which R^8 and R^g can be as defined anywhere herein.

A can be heteroaryl including 5-10 atoms, which is (a) substituted with 1 R^8; and (b) is optionally substituted with from 1-3 (e.g., 1-2, 1) R^g, in which R^g can be as defined anywhere herein.

Each of R^e, R^8, and R^g can be, independently, as defined anywhere herein.

R^8 can be $-W^2-S(O)_nR^9$ or $-W^2-S(O)_nNR^{10}R^{11}$ (e.g., $-W^2-S(O)_nR^9$)

.Each of R^9, R^{10}, and R^{11} can be, independently, as defined anywhere herein (e.g., as defined in conjunction with formula (C-1)).

W^2, n, R^{22}, R^{23}, R^{24}, R^{A2}, R^{A3}, R^{A4}, R^{A5}, and R^{A6} can be as defined in conjunction with formula (C-1).

Each of R^3 and R^4 can be hydrogen.

R^5 can be:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) cyano.

R^5 can be halo (e.g., chloro) or C_1-C_6 (e.g., C_1-C_3) haloalkyl (e.g., CF_3).

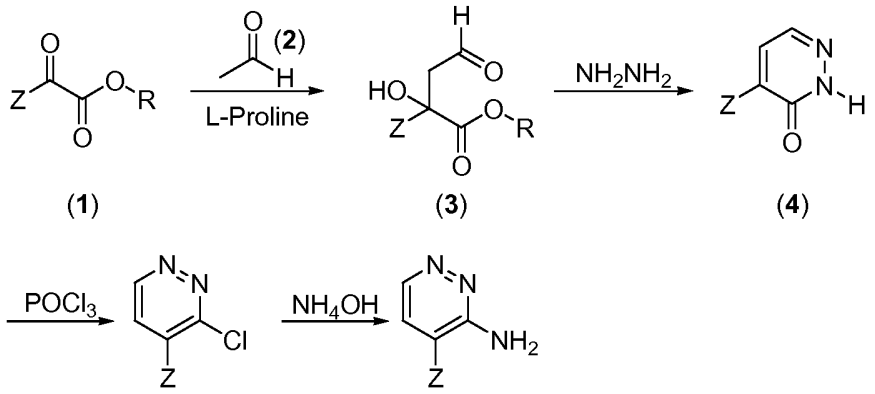
One or more (e.g., 2 or 3) of R^1, R^3, R^4, and R^5 (e.g., R^1 and/or R^5) can be a substituent other than hydrogen.

It is understood that the actual electronic structure of some chemical entities cannot be adequately represented by only one canonical form (*i.e.* Lewis structure). While not wishing to be bound by theory, the actual structure can instead be some hybrid or weighted average of two or more canonical forms, known collectively as resonance forms or structures. Resonance structures are not discrete chemical entities and exist only on paper. They differ from one another only in the placement or "localization" of the bonding and nonbonding electrons for a particular chemical entity. It can be possible for one resonance structure to contribute to a greater extent to the hybrid than the others. Thus, the written and graphical descriptions of the embodiments of the present invention are made in terms of what the art recognizes as the predominant resonance form for a particular species.

The compounds described herein can be synthesized according to methods described herein (or variations thereof) and/or conventional, organic chemical synthesis methods from commercially available starting materials and reagents or from starting materials and reagents that can be prepared according to conventional organic chemical synthesis methods. The compounds described herein can be separated from a reaction mixture and further purified by a method such as column chromatography, high-pressure liquid chromatography, or recrystallization. As can be appreciated by the skilled artisan, further methods of synthesizing the compounds of the formulae herein will be evident to those of ordinary skill in the art. Additionally, the various synthetic steps may be performed in an alternate sequence or order to give the desired compounds. Synthetic chemistry transformations and protecting group methodologies (protection and deprotection) useful in synthesizing the compounds described herein are known in the art and include, for example, those such as described in R. Larock, *Comprehensive Organic Transformations*, VCH Publishers (1989); T.W. Greene and P.G.M. Wuts, *Protective Groups in Organic Synthesis*, 2d. Ed., John Wiley and Sons (1991); L. Fieser and M. Fieser, *Fieser and Fieser's Reagents for Organic Synthesis*, John Wiley and Sons (1994); and L. Paquette, ed., *Encyclopedia of Reagents for Organic Synthesis*, John Wiley and Sons (1995), and subsequent editions thereof.

In some embodiments, the compounds of formula (I) can be prepared from compounds of formula (**6**), which, in turn, can be prepared, e.g., according to Scheme 1.

Scheme 1

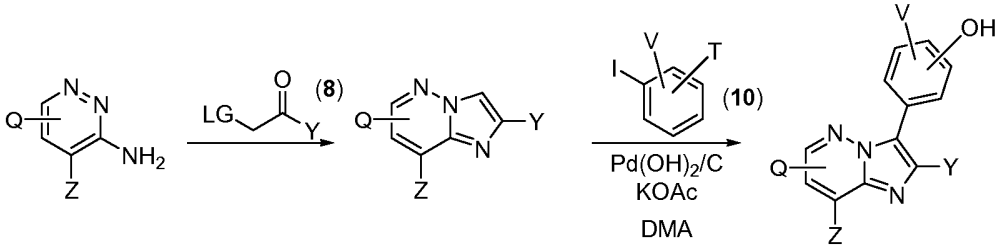


The term "Z" in Scheme 1 corresponds to R^5 in formula (I) or is a substituent precursor thereto.

According to Scheme 1, the compounds of formula (**6**) can be prepared by reacting pyruvates (**1**, Z = H, Me or CF_3) with acetaldehyde (**2**), typically in the presence of an amino acid such as L-proline, in a solvent such as dichloromethane at ambient temperatures to produce the aldol product (**3**). Reaction with hydrazine in a polar solvent such as EtOH or AcOH at elevated temperatures, typically at reflux, gives pyridazinones (**4**). The pyridazinones (**4**) can be converted into the chloropyridazines (**5**) via reaction in refluxing $POCl_3$. Lastly, displacement of the chlorine with a nitrogen source such as ammonium hydroxide, at elevated temperatures in a steel autoclave, provides the desired 3-aminopyridazines (**6**).

In some embodiments, compounds of formula (I) can be prepared according to Scheme 2.

Scheme 2



(7) (**9**) (**11** T = OH)

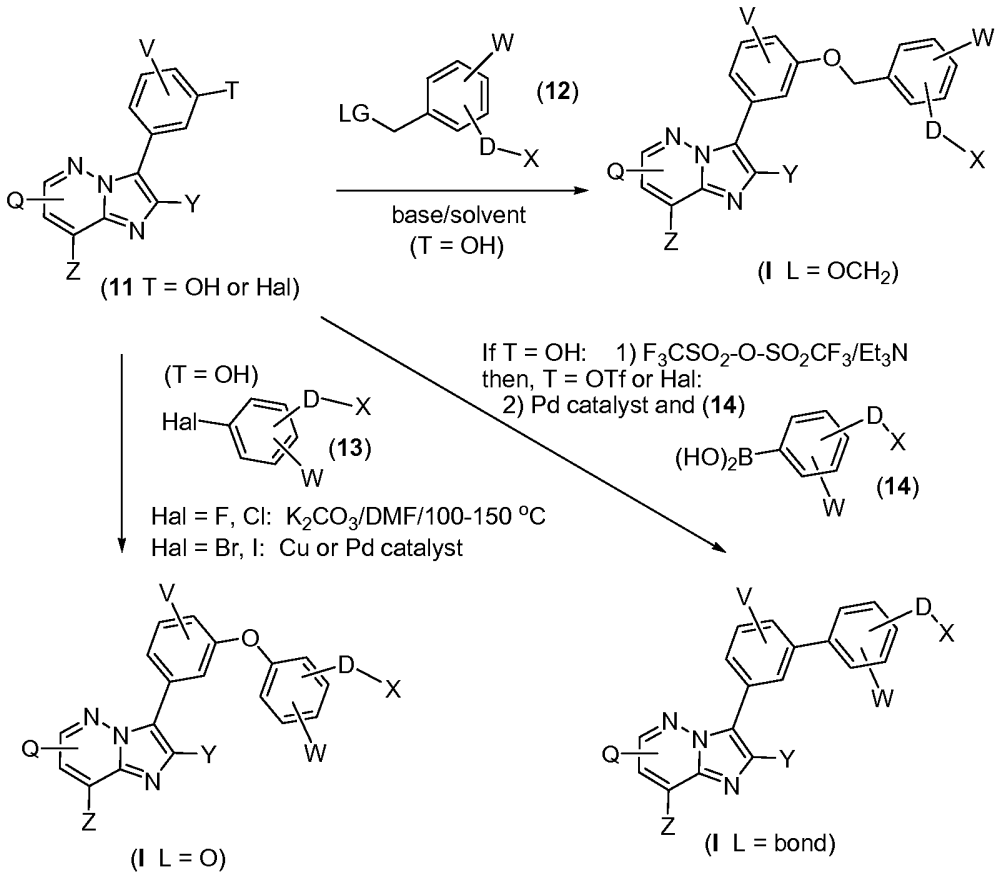
The term "Q" in Scheme 2 corresponds to R^3 and R^4 in formula (I) or is a substituent precursor thereto. The term "Z" in Scheme 2 corresponds to R^5 in formula (I) or is a substituent precursor thereto. The term "Y" in Scheme 1 corresponds to R^1 in formula (I) or is a substituent precursor thereto. The term "V" in Scheme 1 corresponds to hydrogen or R^e in formula (I) or is a substituent precursor thereto. The term "T" in Scheme 1 corresponds to WA in formula (I) or is a substituent precursor thereto.

According to Scheme 2, the compounds of formula (**1**) can be prepared by reacting 3-aminopyridazines (**7**) with alpha-halo-ketone (**8**, where LG = Cl, Br, or can be other leaving groups such as mesylate or tosylate), typically in the presence of a base such as sodium bicarbonate in a solvent such as ethanol at elevated temperatures,

typically 80-90 °C, for 16 to 24 h. Reaction of the resulting imidazo[1,2-b]pyridazine (**9**) with an iodoarene (**10**) in the presence of 20% palladium hydroxide and base such as potassium acetate in a solvent such as dimethylacetamide at elevated temperatures, typically 145 °C, results in compounds (**11**). In compounds **11**, in which T is a protected hydroxyl group such as a methoxy or benzyloxy group, deprotection of the hydroxyl group leads to compounds **11** (T = OH). Typical conditions for deprotection when T is a methoxy include treatment with pyridine hydrochloride at 200 °C for 0.5 – 2 h or treatment with BBr_3 in dichloromethane, or other methods known to those skilled in the art.

In some embodiments, compounds of formula (I) can be prepared according to Scheme 3.

Scheme 3



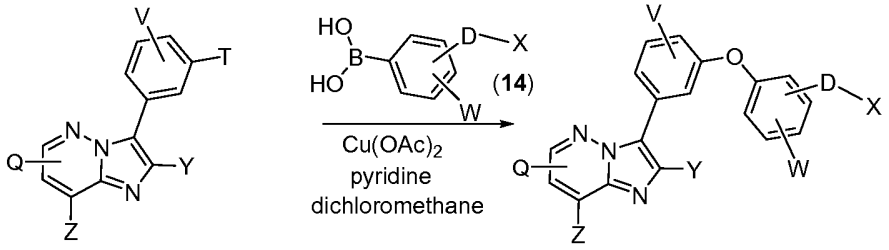
The meanings of "Q," "Z," "V," "T," and "Y" in Scheme 3 are the same as indicated above for Scheme 2. The term "W" in Scheme 3 corresponds to hydrogen or R^g

in formula (I) or is a substituent precursor thereto. The term "D-X" in Scheme 3 corresponds to WA in formula (I) or is a substituent precursor thereto.

According to Scheme 3, compounds of formula **11** in which T = OH, prepared by Scheme 2, can be alkylated with an alkylating agent **12** using potassium, sodium or cesium carbonate as the base providing compounds of formula (**I** W = OCH_2). If the X group of the compound of formula (**I**) is or contains a carboxylic acid ester moiety, this moiety can be transformed to the carboxylic acid upon treatment with aqueous lithium hydroxide, sodium hydroxide or potassium hydroxide in a suitable organic solvent, typically one that is partly miscible with water such as tetrahydrofuran (THF), 1,4-dioxane, or an alcohol such as methanol or ethanol. If the R group of the compound of formula (**I**) contains a CH_2X' where X' is a halogen Br or Cl, then this group can be transformed to CH_2CN upon treatment with sodium cyanide in a suitable organic solvent. Alternatively, compounds of formula (**I**) in which T = OH can be treated with a halogenated aromatic ring-containing compound **13** to provide a biarylether of formula (**I** L = O). If the halogen is a fluorine or chlorine atom, the formation of the biarylether of formula (**I**) is accomplished by treatment with a base such as potassium carbonate, typically in a polar solvent such as dimethylformamide or dimethylsulfoxide, at elevated temperatures, typically 100 °C to 150 °C for several hours. Alternatively, where the halogen is a bromine or iodine, the formation of the biarylether (**I**) is accomplished with a coupling reaction using a metal catalyst such as a copper salt or a palladium salt in the presence of a base and a solvent such as 1,4-dioxane at elevated temperatures, typically at 90-100 °C. Where a compound of formula (**I**) in which a direct bond to the 4-phenyl ring is desired, the phenol of compounds of formula (**11**) in which T = OH is converted into a triflate (**11** where T = OSO_2CF_3) using triflic anhydride and a tertiary amine such as triethylamine. The resulting triflate or bromide or iodide of formula (**11** T = OSO_2CF_3, Br or I) is coupled to an aryl boronic acid of formula (**14**) under catalysis with a palladium catalyst, a reaction known as a Suzuki reaction to those skilled in the art.

In some embodiments, compounds of formula (I) can be prepared according to Scheme 4.

Scheme 4



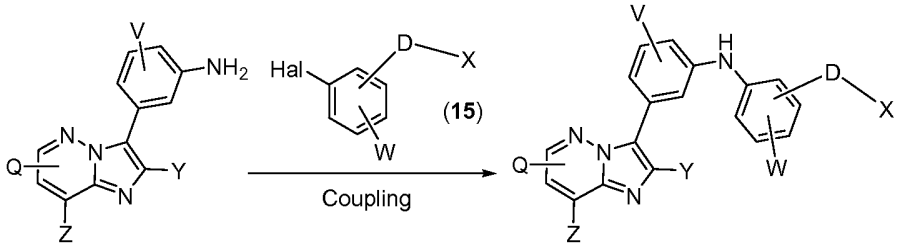
(**11** T = OH) (I L = O)

The meanings of "Q," "Z," "V," "T," "Y," "W," and "D-X" in Scheme 4 are the same as indicated above for Scheme 3.

According to Scheme 4, a compound of formula **11** (T = OH) can be converted to biarylethers of formula (**I**) (W = O), e.g., by $Cu(OAc)_2$ mediated coupling of boronic acid **14** in the presence of base, such as pyridine in a halogenated solvent, such as dichloromethane at ambient temperatures.

In some embodiments, compounds of formula (I) in which W is NR^7 can be prepared according to Scheme 5.

Scheme 5



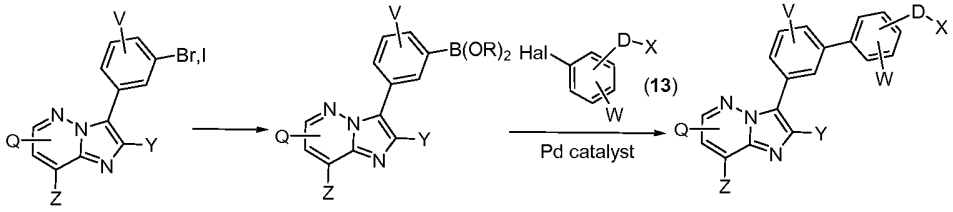
(**11** T = NH_2) (I L = NR)

The meanings of "Q," "Z," "V," "T," "Y," "W," and "D-X" in Scheme 5 are the same as indicated above for Scheme 3.

According to Scheme 5, treatment of the amino compound (**11**) with an aryl halide of formula (**15**) (or the corresponding aryltriflate or arylboronic acid) can provide the corresponding biarylamine of formula (I).

In some embodiments, compounds of formula (I) can be prepared according to Scheme 6.

Scheme 6



(**11**, T = Br, I) (**11**, T = $B(OR)_2$) (I, L = bond)

The meanings of "Q," "Z," "V," "T," "Y," "W," and "D-X" in Scheme 6 are the same as indicated above for Scheme 3.

Referring to Scheme 6, a compound of formula **11** can be converted to a borolane (**11**, T = $B(OR)_2$, R = H or alkyl) under standard Suzuki conditions. Such a borolane can be coupled under conditions described above with an aryl bromide or aryl iodide **13** to afford compounds of formula (**I**) (L = bond).

The compounds of this invention may contain one or more asymmetric centers and thus occur as racemates and racemic mixtures, single enantiomers, individual diastereomers and diastereomeric mixtures. All such isomeric forms of these compounds are expressly included in the present invention. The compounds of this invention may also contain linkages (e.g., carbon-carbon bonds, carbon-nitrogen bonds such as amide bonds) wherein bond rotation is restricted about that particular linkage, e.g. restriction resulting from the presence of a ring or double bond. Accordingly, all *cis/trans* and *E/Z* isomers and rotational isomers are expressly included in the present invention. The compounds of this invention may also be represented in multiple tautomeric forms, in such instances, the invention expressly includes all tautomeric forms of the compounds described herein, even though only a single tautomeric form may be represented (e.g., alkylation of a ring system may result in alkylation at multiple sites, the invention expressly includes all such reaction products). All such isomeric forms of such compounds are expressly included in the present invention.

The compounds of this invention include the compounds themselves, as well as their salts and their prodrugs, if applicable. A salt, for example, can be formed between an anion and a positively charged substituent (e.g., amino) on a compound described

herein. Suitable anions include chloride, bromide, iodide, sulfate, nitrate, phosphate, citrate, methanesulfonate, trifluoroacetate, and acetate. Likewise, a salt can also be formed between a cation and a negatively charged substituent (e.g., carboxylate) on a compound described herein. Suitable cations include sodium ion, potassium ion, magnesium ion, calcium ion, and an ammonium cation such as tetramethylammonium ion. Examples of prodrugs include esters and other pharmaceutically acceptable derivatives, which, upon administration to a subject, are capable of providing active compounds.

Pharmaceutically acceptable salts of the compounds of this invention include those derived from pharmaceutically acceptable inorganic and organic acids and bases. Examples of suitable acid salts include acetate, adipate, alginate, aspartate, benzoate, benzenesulfonate, bisulfate, butyrate, citrate, camphorate, camphorsulfonate, digluconate, dodecylsulfate, ethanesulfonate, formate, fumarate, glucoheptanoate, glycolate, hemisulfate, heptanoate, hexanoate, hydrochloride, hydrobromide, hydroiodide, 2-hydroxyethanesulfonate, lactate, maleate, malonate, methanesulfonate, 2-naphthalenesulfonate, nicotinate, nitrate, palmoate, pectinate, persulfate, 3-phenylpropionate, phosphate, picrate, pivalate, propionate, salicylate, succinate, sulfate, tartrate, thiocyanate, tosylate and undecanoate. Other acids, such as oxalic, while not in themselves pharmaceutically acceptable, may be employed in the preparation of salts useful as intermediates in obtaining the compounds of the invention and their pharmaceutically acceptable acid addition salts. Salts derived from appropriate bases include alkali metal (e.g., sodium), alkaline earth metal (e.g., magnesium), ammonium and N-(alkyl)$_4^+$ salts. This invention also envisions the quaternization of any basic nitrogen-containing groups of the compounds disclosed herein. Water or oil-soluble or dispersible products may be obtained by such quaternization. Salt forms of the compounds of any of the formulae herein can be amino acid salts of carboxy groups (e.g. L-arginine, -lysine, -histidine salts).

The term "pharmaceutically acceptable carrier or adjuvant" refers to a carrier or adjuvant that may be administered to a subject (e.g., a patient), together with a compound of this invention, and which does not destroy the pharmacological activity thereof and is

nontoxic when administered in doses sufficient to deliver a therapeutic amount of the compound.

Pharmaceutically acceptable carriers, adjuvants and vehicles that may be used in the compositions of this invention include, but are not limited to, ion exchangers, alumina, aluminum stearate, lecithin, self-emulsifying drug delivery systems (SEDDS) such as d-α-tocopherol polyethyleneglycol 1000 succinate, surfactants used in pharmaceutical dosage forms such as Tweens or other similar polymeric delivery matrices, serum proteins, such as human serum albumin, buffer substances such as phosphates, glycine, sorbic acid, potassium sorbate, partial glyceride mixtures of saturated vegetable fatty acids, water, salts or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium hydrogen phosphate, sodium chloride, zinc salts, colloidal silica, magnesium trisilicate, polyvinyl pyrrolidone, cellulose-based substances, polyethylene glycol, sodium carboxymethylcellulose, polyacrylates, waxes, polyethylene-polyoxypropylene-block polymers, polyethylene glycol and wool fat. Cyclodextrins such as α-, β-, and γ-cyclodextrin, or chemically modified derivatives such as hydroxyalkylcyclodextrins, including 2- and 3-hydroxypropyl-β-cyclodextrins, or other solubilized derivatives may also be advantageously used to enhance delivery of compounds of the formulae described herein.

In general, the compounds described herein can be used for treating (e.g., controlling, ameliorating, alleviating, slowing the progression of, delaying the onset of, or reducing the risk of developing) or preventing one or more diseases, disorders, conditions or symptoms mediated by LXRs (e.g., cardiovascular diseases (e.g., acute coronary syndrome, restenosis), atherosclerosis, atherosclerotic lesions, type I diabetes, type II diabetes, Syndrome X, obesity, lipid disorders (e.g., dyslipidemia, hyperlipidemia, hypertriglyceridemia, hypercholesterolemia, low HDL and high LDL), cognitive disorders (e.g., Alzheimer's disease, dementia), inflammatory diseases (e.g., multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease, Crohn's disease, endometriosis, LPS-induced sepsis, acute contact dermatitis of the ear, chronic atherosclerotic inflammation of the artery wall), celiac, thyroiditis, skin aging (e.g., skin aging is derived from chronological aging, photoaging, steroid-induced skin thinning, or a combination thereof), or connective tissue disease (e.g., osteoarthritis or tendonitis).

A disorder or physiological condition that is mediated by LXR refers to a disorder or condition wherein LXR can trigger the onset of the condition, or where inhibition of a particular LXR can affect signaling in such a way so as to treat, control, ameliorate, alleviate, prevent, delay the onset of, slow the progression of, or reduce the risk of developing the disorder or condition. Examples of such disorders include, but are not limited to cardiovascular diseases (e.g., acute coronary syndrome, restenosis), atherosclerosis, atherosclerotic lesions, type I diabetes, type II diabetes, Syndrome X, obesity, lipid disorders (e.g., dyslipidemia, hyperlipidemia, hypertriglyceridemia, hypercholesterolemia, low HDL and high LDL), cognitive disorders (e.g., Alzheimer's disease, dementia), inflammatory diseases (e.g., multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease, Crohn's disease, endometriosis, LPS-induced sepsis, acute contact dermatitis of the ear, chronic atherosclerotic inflammation of the artery wall), celiac, thyroiditis, skin aging (e.g., skin aging is derived from chronological aging, photoaging, steroid-induced skin thinning, or a combination thereof), or connective tissue disease (e.g., osteoarthritis or tendonitis).

While not wishing to be bound by theory, it is believed that LXR modulators that activate cholesterol efflux (e.g., upregulate ABCA1), but do not substantially increase SREBP-1c expression and triglyceride synthesis in liver, can both reduce atherosclerotic risk and minimize the likelihood of concommitantly increasing serum and hepatic triglyceride levels. Candidate compounds having differential activity for regulating ABCA1 (ABCG1) vs. SREBP-1c can be can be evaluated using conventional pharmacological test procedures, which measure the affinity of a candidate compound to bind to LXR and to upregulate the gene ABCA1.

In some embodiments, LXR ligands can be identified initially in cell-free LXR beta and LXR alpha competition binding assays. LXR ligands can be further characterized by gene expression profiling for tissue selective gene regulation.

In some embodiments, the compounds described herein have agonist activity for ABCA1 transactivation but do not substantially affect (e.g., inhibit) SREBP-1c gene expression in differentiated THP-1 macrophages. Gene expression analysis in an antagonist mode can be used to further delineate differential regulation of ABCA1 and SREBP-1c gene expression. In certain embodiments, the compounds described herein

preferentially antagonize SREBP-1c activation (a marker for genes involved in cholesterol and fatty acid homeostasis) but do not substantially affect (e.g., have relatively minimal or additive effects) on ABCA1 gene expression or genes known to enhance HDL biogenesis (based on a competition assay with known potent synthetic LXR agonists). Cell type or tissue specificity may be further evaluated in additional cell lines, intestinal, CaCo2 or liver, HepG2 and Huh-7 cells where ABCA1 activity is believed to influence net cholesterol absorption and reverse cholesterol transport. The test procedures performed, and results obtained therefrom are described in the Examples section.

In some embodiments, the compounds described herein have agonist activity for ABCA1 and antagonist activity for SREBP-1c (e.g., as determined by gene specific modulation in cell based assays). In certain embodiments, the compounds described herein (in the agonist mode) have at least about 20% efficacy for ABCA1 activation by LXR and do not substantially agonize SREBP-1c (at most about 25% efficacy relative to a reference compound N-(2,2,2-trifluoro-ethyl)-N-[4-(2,2,2-trifluoro-1-hydroxy-1-trifluoromethyl-ethyl)-phenyl]-benzenesulfonamide (Schultz, Joshua R., Genes & Development (2000), 14(22), 2831-2838)). In certain embodiments, the compounds described herein (in the antagonist mode) do not substantially antagonize ABCA1 gene expression. While not wishing to be bound by theory, it is believed that there may be an additive effect on ABCA1 gene expression relative to the reference compound at their EC_{50} concentration. In certain embodiments, the compounds described herein (in the antagonist mode) inhibited agonist-mediated SREBP-1c gene expression in a dose dependent fashion.

In some embodiments, to study the effect of the compounds of formula (I) on skin aging, for example, in a clinical trial, cells can be isolated and RNA prepared and analyzed for the levels of expression of TIMP1, ABCA12, decorin, TNFα, MMP1, MMP3, and/or IL-8. The levels of gene expression (i.e., a gene expression pattern) can be quantified, for example, by Northern blot analysis or RT-PCR, by measuring the amount of protein produced, or by measuring the levels of activity of TIMP1, ABCA12, decorin, TNFα, MMP1, MMP3, and/or IL-8, all by methods known to those of ordinary skill in the art. In this way, the gene expression pattern can serve as a marker, indicative

of the physiological response of the cells to the compounds of formula (I). Accordingly, this response state may be determined before, and at various points during, treatment of the individual with the compounds of formula (I).

In one embodiment, expression levels of cytokines and metalloproteases described herein can be used to facilitate design and/or identification of compounds that treat skin aging through an LXR-based mechanism. Accordingly, the invention provides methods (also referred to herein as "screening assays") for identifying modulators, i.e., LXR modulators, that have a stimulatory or inhibitory effect on, for example, TIMP1, ABCA12, decorin, TNFα, MMP1, MMP3, and/or IL-8 expression.

An exemplary screening assay is a cell-based assay in which a cell that expresses LXR is contacted with a test compound, and the ability of the test compound to modulate TIMP1, ABCA12, decorin, TNFα, MMP1, MMP3, and/or IL-8 expression through an LXR-based mechanism. Determining the ability of the test compound to modulate TIMP1, ABCA12, decorin, TNFα, MMP1, MMP3, and/or IL-8 expression can be accomplished by monitoring, for example, DNA, mRNA, or protein levels, or by measuring the levels of activity of TIMP1, ABCA12, decorin, TNFα, MMP1, MMP3, and/or IL-8, all by methods known to those of ordinary skill in the art. The cell, for example, can be of mammalian origin, e.g., human.

In some embodiments, to study the effect of the compounds of formula (I) on osteoarthritis, for example, in a clinical trial, cells can be isolated and RNA prepared and analyzed for the levels of expression of ApoD and other genes implicated in osteoarthritis (for example, TNFα). The levels of gene expression (i.e., a gene expression pattern) can be quantified by Northern blot analysis or RT-PCR, by measuring the amount of protein produced, or by measuring the levels of activity of ApoD or other genes, all by methods known to those of ordinary skill in the art. In this way, the gene expression pattern can serve as a marker, indicative of the physiological response of the cells to the LXR modulator. Accordingly, this response state may be determined before, and at various points during, treatment of the individual with the LXR modulator.

An exemplary screening assay is a cell-based assay in which a cell that expresses LXR is contacted with a test compound, and the ability of the test compound to modulate ApoD expression and/or aggrecanase activity and/or cytokine elaboration through an

LXR-based mechanism. Determining the ability of the test compound to modulate ApoD expression and/or aggrecanase activity and/or cytokine elaboration can be accomplished by monitoring, for example, DNA, mRNA, or protein levels, or by measuring the levels of activity of ApoD, aggrecanase, and/or TNFα, all by methods known to those of ordinary skill in the art. The cell, for example, can be of mammalian origin, e.g., human.

In some embodiments, the compounds described herein can be coadministered with one or more other threapeutic agents. In certain embodiments, the additional agents may be administered separately, as part of a multiple dose regimen, from the compounds of this invention (e.g., sequentially, e.g., on different overlapping schedules with the administration of one or more compounds of formula (I) (including any subgenera or specific compounds thereof)). In other embodiments, these agents may be part of a single dosage form, mixed together with the compounds of this invention in a single composition. In still another embodiment, these agents can be given as a separate dose that is administered at about the same time that one or more compounds of formula (I) (including any subgenera or specific compounds thereof) are administered (e.g., simultaneously with the administration of one or more compounds of formula (I) (including any subgenera or specific compounds thereof)). When the compositions of this invention include a combination of a compound of the formulae described herein and one or more additional therapeutic or prophylactic agents, both the compound and the additional agent can be present at dosage levels of between about 1 to 100%, and more preferably between about 5 to 95% of the dosage normally administered in a monotherapy regimen.

The compounds and compositions described herein can, for example, be administered orally, parenterally (e.g., subcutaneously, intracutaneously, intravenously, intramuscularly, intraarticularly, intraarterially, intrasynovially, intrasternally, intrathecally, intralesionally and by intracranial injection or infusion techniques), by inhalation spray, topically, rectally, nasally, buccally, vaginally, via an implanted reservoir, by injection, subdermally, intraperitoneally, transmucosally, or in an ophthalmic preparation, with a dosage ranging from about 0.01 mg/Kg to about 1000 mg/Kg, (e.g., from about 0.01 to about 100 mg/kg, from about 0.1 to about 100 mg/Kg, from about 1 to about 100 mg/Kg, from about 1 to about 10 mg/kg) every 4 to 120 hours,

or according to the requirements of the particular drug. The interrelationship of dosages for animals and humans (based on milligrams per meter squared of body surface) is described by Freireich et al., Cancer Chemother. Rep. 50, 219 (1966). Body surface area may be approximately determined from height and weight of the patient. *See, e.g.*, Scientific Tables, Geigy Pharmaceuticals, Ardsley, New York, 537 (1970). In certain embodiments, the compositions are administered by oral administration or administration by injection. The methods herein contemplate administration of an effective amount of compound or compound composition to achieve the desired or stated effect. Typically, the pharmaceutical compositions of this invention will be administered from about 1 to about 6 times per day or alternatively, as a continuous infusion. Such administration can be used as a chronic or acute therapy. The amount of active ingredient that may be combined with the carrier materials to produce a single dosage form will vary depending upon the host treated and the particular mode of administration. A typical preparation will contain from about 5% to about 95% active compound (w/w). Alternatively, such preparations contain from about 20% to about 80% active compound.

Lower or higher doses than those recited above may be required. Specific dosage and treatment regimens for any particular patient will depend upon a variety of factors, including the activity of the specific compound employed, the age, body weight, general health status, sex, diet, time of administration, rate of excretion, drug combination, the severity and course of the disease, condition or symptoms, the patient's disposition to the disease, condition or symptoms, and the judgment of the treating physician.

Upon improvement of a patient's condition, a maintenance dose of a compound, composition or combination of this invention may be administered, if necessary. Subsequently, the dosage or frequency of administration, or both, may be reduced, as a function of the symptoms, to a level at which the improved condition is retained when the symptoms have been alleviated to the desired level. Patients may, however, require intermittent treatment on a long-term basis upon any recurrence of disease symptoms.

The compositions of this invention may contain any conventional non-toxic pharmaceutically-acceptable carriers, adjuvants or vehicles. In some cases, the pH of the formulation may be adjusted with pharmaceutically acceptable acids, bases or buffers to enhance the stability of the formulated compound or its delivery form.

The compositions may be in the form of a sterile injectable preparation, for example, as a sterile injectable aqueous or oleaginous suspension. This suspension may be formulated according to techniques known in the art using suitable dispersing or wetting agents (such as, for example, Tween 80) and suspending agents. The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles and solvents that may be employed are mannitol, water, Ringer's solution and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose, any bland fixed oil may be employed including synthetic mono- or diglycerides. Fatty acids, such as oleic acid and its glyceride derivatives are useful in the preparation of injectables, as are natural pharmaceutically-acceptable oils, such as olive oil or castor oil, especially in their polyoxyethylated versions. These oil solutions or suspensions may also contain a long-chain alcohol diluent or dispersant, or carboxymethyl cellulose or similar dispersing agents which are commonly used in the formulation of pharmaceutically acceptable dosage forms such as emulsions and or suspensions. Other commonly used surfactants such as Tweens or Spans and/or other similar emulsifying agents or bioavailability enhancers which are commonly used in the manufacture of pharmaceutically acceptable solid, liquid, or other dosage forms may also be used for the purposes of formulation.

The compositions of this invention may be orally administered in any orally acceptable dosage form including, but not limited to, capsules, tablets, emulsions and aqueous suspensions, dispersions and solutions. In the case of tablets for oral use, carriers which are commonly used include lactose and corn starch. Lubricating agents, such as magnesium stearate, are also typically added. For oral administration in a capsule form, useful diluents include lactose and dried corn starch. When aqueous suspensions and/or emulsions are administered orally, the active ingredient may be suspended or dissolved in an oily phase is combined with emulsifying and/or suspending agents. If desired, certain sweetening and/or flavoring and/or coloring agents may be added.

The compositions of this invention may also be administered in the form of suppositories for rectal administration. These compositions can be prepared by mixing a

compound of this invention with a suitable non-irritating excipient which is solid at room temperature but liquid at the rectal temperature and therefore will melt in the rectum to release the active components. Such materials include, but are not limited to, cocoa butter, beeswax and polyethylene glycols.

Topical administration of the compositions of this invention is useful when the desired treatment involves areas or organs readily accessible by topical application. For application topically to the skin, the composition should be formulated with a suitable ointment containing the active components suspended or dissolved in a carrier. Carriers for topical administration of the compounds of this invention include, but are not limited to, mineral oil, liquid petroleum, white petroleum, propylene glycol, polyoxyethylene polyoxypropylene compound, emulsifying wax and water. Alternatively, the composition can be formulated with a suitable lotion or cream containing the active compound suspended or dissolved in a carrier with suitable emulsifying agents. Suitable carriers include, but are not limited to, mineral oil, sorbitan monostearate, polysorbate 60, cetyl esters wax, cetearyl alcohol, 2-octyldodecanol, benzyl alcohol and water. The compositions of this invention may also be topically applied to the lower intestinal tract by rectal suppository formulation or in a suitable enema formulation.

In some embodiments, topical administration of the compounds and compositions described herein may be presented in the form of an aerosol, a semi-solid pharmaceutical composition, a powder, or a solution. By the term "a semi-solid composition" is meant an ointment, cream, salve, jelly, or other pharmaceutical composition of substantially similar consistency suitable for application to the skin. Examples of semi-solid compositions are given in Chapter 17 of The Theory and Practice of Industrial Pharmacy, Lachman, Lieberman and Kanig, published by Lea and Febiger (1970) and in *Remington: The Science and Practice of Pharmacy* by University of the Sciences in Philadelphia (Editor); Publisher: Lippincott Williams & Wilkins; Twenty first Edition (May 1, 2005), which is incorporated herein by reference in its entirety..

Topically-transdermal patches are also included in this invention. Also within the invention is a patch to deliver active chemotherapeutic combinations herein. A patch includes a material layer (e.g., polymeric, cloth, gauze, bandage) and the compound of the formulae herein as delineated herein. One side of the material layer can have a

protective layer adhered to it to resist passage of the compounds or compositions. The patch can additionally include an adhesive to hold the patch in place on a subject. An adhesive is a composition, including those of either natural or synthetic origin, that when contacted with the skin of a subject, temporarily adheres to the skin. It can be water resistant. The adhesive can be placed on the patch to hold it in contact with the skin of the subject for an extended period of time. The adhesive can be made of a tackiness, or adhesive strength, such that it holds the device in place subject to incidental contact, however, upon an affirmative act (e.g., ripping, peeling, or other intentional removal) the adhesive gives way to the external pressure placed on the device or the adhesive itself, and allows for breaking of the adhesion contact. The adhesive can be pressure sensitive, that is, it can allow for positioning of the adhesive (and the device to be adhered to the skin) against the skin by the application of pressure (e.g., pushing, rubbing,) on the adhesive or device.

The compositions of this invention may be administered by nasal aerosol or inhalation. Such compositions are prepared according to techniques well-known in the art of pharmaceutical formulation and may be prepared as solutions in saline, employing benzyl alcohol or other suitable preservatives, absorption promoters to enhance bioavailability, fluorocarbons, and/or other solubilizing or dispersing agents known in the art.

A composition having the compound of the formulae herein and an additional agent (e.g., a therapeutic agent) can be administered using any of the routes of administration described herein. In some embodiments, a composition having the compound of the formulae herein and an additional agent (e.g., a therapeutic agent) can be administered using an implantable device. Implantable devices and related technology are known in the art and are useful as delivery systems where a continuous, or timed-release delivery of compounds or compositions delineated herein is desired. Additionally, the implantable device delivery system is useful for targeting specific points of compound or composition delivery (e.g., localized sites, organs). Negrin et al., Biomaterials, 22(6):563 (2001). Timed-release technology involving alternate delivery methods can also be used in this invention. For example, timed-release formulations based on polymer technologies, sustained-release techniques and encapsulation

techniques (e.g., polymeric, liposomal) can also be used for delivery of the compounds and compositions delineated herein.

The invention will be further described in the following examples. It should be understood that these examples are for illustrative purposes only and are not to be construed as limiting this invention in any manner.

EXAMPLES

The following describes the preparation of representative compounds of this invention. Compounds described as homogeneous are determined to be of 90% or greater purity (exclusive of enantiomers) by analytical reverse phase chromatographic analysis with 254 nM UV detection. Melting points are reported as uncorrected in degrees centigrade. Mass spectral data is reported as the mass-to-charge ratio, *m/z*; and for high resolution mass spectral data, the calculated and experimentally found masses, $[M+H]^+$, for the neutral formulae M are reported. All reactions are stirred and run under a nitrogen atmosphere unless otherwise noted. In the silica gel chromatography conditions, the abbreviations E and H refer to ethyl acetate and hexanes, respectively, and 20:80 E:H denotes a mixture of 20% ethyl acetate and 80% hexane, by volume.

Example 1

Ethyl 2-hydroxy-4-oxo-2-(trifluoromethyl)butanoate

Ethyl 3,3,3-trifluoro-2-oxopropanoate (15.0 g, 88 mmol) and acetaldehyde (4.95 mL, 88 mmol) stirred in dichloromethane (176 mL) were treated with L-proline (5.08 g, 44.1 mmol) in one portion and the reaction was stirred for 2 h. Quench with water and extract with dichloromethane. The combined organics were dried over $MgSO_4$ and concentrated to yield 16.81 g (89%) of the title compound as an orange viscous liquid.

Example 2

4-(trifluoromethyl)pyridazin-3(2H)-one

Ethyl 2-hydroxy-4-oxo-2-(trifluoromethyl)butanoate (16.62 g, 78 mmol) in EtOH (40 mL) was treated with hydrazine hydrate (5.66 mL, 116 mmol) and stirred at room temperature for 1.5 h, then heated at reflux for 1.5 h. The ethanol was removed in vacuo

and the resulting material was partitioned between water and ethyl acetate and the layers were separated. The aqueous layer was extracted with additional ethyl acetate. The combined organic layers were dried over $MgSO_4$ and concentrated in vacuo to yield the title compound as a yellow/orange solid (9.75 g, 77%).

5

Example 3

3-chloro-4-(trifluoromethyl)pyridazine

A mixture of 4-(trifluoromethyl)pyridazin-3(2H)-one (9.3 g, 56.7 mmol) in $POCl_3$ (75 mL) was heated at reflux for 1.5 h. The solvent was removed and the resulting
10 material was carefully neutralized with saturated aqueous $NaHCO_3$ and then with solid K_2CO_3 (using ethyl acetate to reduce foaming). The mixture was extracted with ethyl acetate. The combined organics were washed with brine and dried over $MgSO_4$. The product was purified via silica gel chromatography eluting with a 5:95 to 30:70 E:H gradient to afford the title compound as an orange liquid (3.51 g, 34%).

15

Example 4

4-(trifluoromethyl)pyridazin-3-amine

In a steel high pressure reaction vessel were combined 3-chloro-4-(trifluoromethyl)pyridazine (3.47 g, 19.01 mmol), concentrated NH_4OH (170 mL), and
20 DME (50 mL). The mixture was heated to 180 ^oC overnight. The reaction vessel was cooled and carefully opened. The reaction mixture was extracted several times with ethyl acetate. The combined organics were dried over $MgSO_4$ and concentrated. The product was purified via silica gel chromatography eluting with a 25:75 to 65:35 E:H gradient to afford the title compound as a white solid (1.11 g, 36%).

25

Example 5

2-benzyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine

4-(Trifluoromethyl)pyridazin-3-amine (1.07 g, 6.56 mmol), 1-bromo-3-phenylpropan-2-one (1.677 g, 7.87 mmol), and sodium bicarbonate (1.102 g, 13.12 mmol) in EtOH (20 mL) were heated at reflux overnight. The EtOH was removed in vacuo and the resulting material was partitioned between ethyl acetate and water. The layers were separated and the aqueous layer was extracted with additional ethyl acetate. The combined organics were dried over $MgSO_4$ and concentrated in vacuo. The residue was purified by silica gel chromatography eluting with a 0:100 to 20:80 E:H gradient to afford the title compound as a yellow solid (0.28 g, 15%).

Example 6

3-(2-benzyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl)phenol

A mixture of 2-benzyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine (0.250 g, 0.902 mmol), 3-iodophenol (0.218 g, 0.992 mmol), potassium acetate (0.265 g, 2.71 mmol) and 20% palladium hydroxide on carbon (0.063 g, 0.090 mmol) in dimethylacetamide (10 mL) was heated to 145 ^{o}C overnight. The cooled reaction was filtered through Celite. The mother liquor was partitioned between ethyl acetate and water and the layers were separated. The organic layer was washed several times with water then with a solution of half-saturated brine, then dried over $MgSO_4$ and concentrated. The product was purified via silica gel chromatography eluting with a 0:100 to 30:70 E:H gradient to afford the title compound as a yellow solid (0.214 g, 64%).

Example 7

2-Benzyl-3-{3-[3-(methylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine

A mixture of 3-(2-benzyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl)phenol (0.214 g, 0.579 mmol), 3-(methylsulfonyl)phenylboronic acid (0.348 g, 1.738 mmol), diacetoxycopper (0.210 g, 1.159 mmol), pyridine (0.142 mL, 1.738 mmol) and 4A molecular sieves (0.600 g) in dichloromethane (10 mL) was stirred open to the air for 65 h. The reaction was filtered through Celite and concentrated. The resulting material was purified via silica gel chromatography eluting with a 0:100 to 30:70 E:H gradient to

afford 0.286 g of impure product. Purification with reverse phase chromatography eluting with a 0:100 to 100: 0 acetonitrile:water gradient gave the title compound as a yellow solid (0.214 g, 67%). MS (ES) *m/z* 523.9; HRMS: calcd for $C_{27}H_{20}F_3N_3O_3S$ + H+, 524.12502; found (ESI, [M+H]+ Calc'd), 524.1250.

Example 8

Step 1) *2-ethyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine*

The title intermediate was prepared in a similar manner to Example 5 except using 1-bromo-2-butanone in place of 1-bromo-3-phenylpropan-2-one to afford a yellow solid.

Step 2) *3-(2-ethyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl)phenol*

The title intermediate was prepared in a similar manner to Example 6 except using 2-ethyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine in place of 2-benzyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine to afford a yellow solid.

Step 3) *2-ethyl-3-{3-[3-(methylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine*

A mixture of 3-(2-ethyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl)phenol (0.294 g, 0.957 mmol), 1-bromo-3-(methylsulfonyl)benzene (0.450 g, 1.91 mmol), cesium carbonate (0.935 g, 2.87 mmol) and N,N-dimethylglycine hydrochloride (0.050 g, 0.36 mmol) in 1,4-dioxane (5 mL) was heated at reflux overnight. The reaction was cooled and water was added. The mixture was extracted with ethyl acetate. The combined extracts were dried over $MgSO_4$ and concentrated. Purification by column chromatography using a 0:100 to 40:60 E:H gradient afforded the title compound as a hard, yellow glass (0.278 g, 63%). MS (ES) *m/z* 462.0. HRMS: calcd for $C_{22}H_{18}F_3N_3O_3S$ + H+, 462.10937; found (ESI, [M+H]+ Obs'd), 462.1102.

Example 9

2-Ethyl-3-{3-[3-(ethylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine

The title compound was prepared in a similar manner to Example 8, step 3 except using 1-bromo-3-(ethylsulfonyl)benzene in place of 1-bromo-3-(methylsulfonyl)benzene. MS (ES) *m/z* 476.1. HRMS: calcd for $C_{23}H_{20}F_3N_3O_3S$ + H+, 476.12502; found (ESI, [M+H]+ Obs'd), 476.1254.

Example 10

Step 1) *2-isopropyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine*

The title intermediate was prepared in a similar manner to Example 5 except using 1-bromo-3-methyl-2-butanone in place of 1-bromo-3-phenylpropan-2-one to afford a yellow solid.

Step 2) *3-[2-isopropyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl]phenol*

The title intermediate was prepared in a similar manner to Example 6 except using 2-isopropyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine in place of 2-benzyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine to yield a yellow solid.

Step 3) *2-isopropyl-3-{3-[3-(methylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine*

The title compound was prepared in a similar manner to Example 8, step 3 except using 3-[2-isopropyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl]phenol in place of 3-(2-ethyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl)phenol. MS (ES) m/z 476.0. HRMS: calcd for C23H20F3N3O3S + H+, 476.12502; found (ESI, [M+H]+ Obs'd), 476.1254.

Example 11

3-{3-[3-(ethylsulfonyl)phenoxy]phenyl}-2-isopropyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine

The title compound was prepared in a similar manner to Example 8, step 3 except using 1-bromo-3-(ethylsulfonyl)benzene in place of 1-bromo-3-(methylsulfonyl)benzene and 3-[2-isopropyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl]phenol in place of 3-

(2-ethyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl)phenol. MS (ES) *m/z* 490.0. HRMS: calcd for $C_{24}H_{22}F_3N_3O_3S$ + H+, 490.14067; found (ESI, [M+H]+ Obs'd), 490.1407.

The structures of the title compounds of Examples 1-11 are set forth below.

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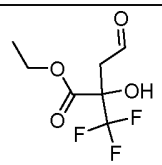
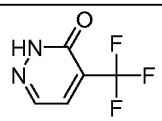
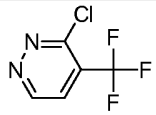
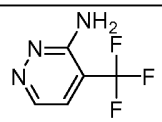
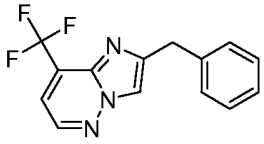
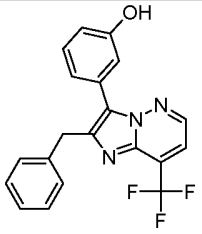
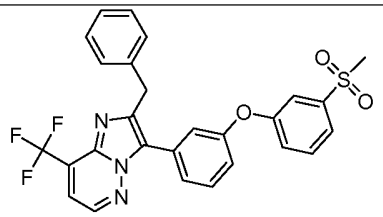
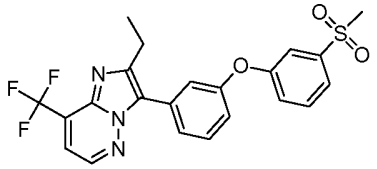
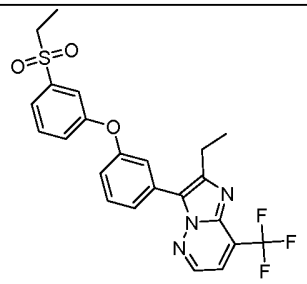
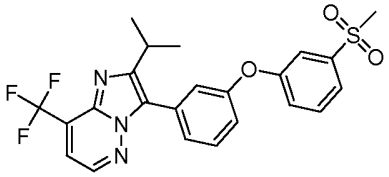
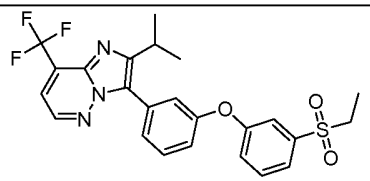
1	
2	
3	
4	
5	
6	

7	
8	
9	
10	
11	

Example 12

Biological testing

Representative compounds of this invention were evaluated in conventional pharmacological test procedures which measured their affinity to bind to LXR and to upregulate the gene ABCA1, which causes cholesterol efflux from atherogenic cells, such as macrophages.

LXR activation can be critical for maintaining cholesterol homeostasis, but its coincident regulation of fatty acid metabolism may lead to increased serum and hepatic

triglyceride levels. Selective LXR modulators that activate cholesterol efflux with minimal impact on SREBP-1c expression and triglyceride synthesis in liver would be expected to reduce atherosclerotic risk with an improved therapeutic index and minimize the potential for deleterious effects on metabolic balance.

The test procedures performed, and results obtained are briefly described in the following sections:

I. Ligand-Binding Test Procedure for Human LXRβ

II. Ligand-Binding Test Procedure for Human LXRα

III. Quantitative Analysis of ABCA1 Gene Regulation in THP-1 Cells

IV. Results

I. Ligand-Binding Test Procedure for Human LXRβ.

Ligand-binding to the human LXRβ was demonstrated for representative compounds of this invention by the following procedure.

Materials and Methods:

Buffer: 100mM KCl, 100mM TRIS (pH 7.4 at +4°C), 8.6%glycerol, 0.1mM PMSF*, 2mM MTG* ,0.2% CHAPS (* not used in wash buffer)

Tracer: ^{3}H T0901317

Receptor source: E.coli extract from cells expressing biotinylated hLXRβ. Extract was made in a similar buffer as above, but with 50mM TRIS.

Day 1

Washed streptavidin and coated flash plates with wash buffer.

Diluted receptor extract to give Bmax ~ 4000 cpm and add to the wells.

Wrapped the plates in aluminum foil and stored them at +4°C over night.

Day 2

Made a dilution series in DMSO of the test ligands.

Made a 5nM solution of the radioactive tracer in buffer.

Mixed 250µl diluted tracer with 5µl of the test ligand from each concentration of the dilution series.

Washed the receptor-coated flash plates.

Added 200µl per well of the ligand/radiolabel mixture to the receptor-coated flash plates.

Wrapped the plates in aluminum foil and incubate at +4°C over night.

Day 3

Aspirated wells, and wash the flashed plates. Sealed the plate.

Measured the remaining radioactivity in the plate.

II. Ligand-Binding Test Procedure for Human LXRα.

Ligand-binding to the human LXRα was demonstrated for representative compounds of this invention by the following procedure.

Materials and Methods:

Buffer: 100mM KCl, 100mM TRIS (pH 7.4 at +4°C), 8.6%glycerol, 0.1mM PMSF*, 2mM MTG* ,0.2% CHAPS (* not used in wash buffer)

Tracer: ^{3}H T0901317

Receptor source: E.coli extract from cells expressing biotinylated hLXRα. Extract was made in a similar buffer as above, but with 50mM TRIS.

Day 1

Washed streptavidin and coated flash plates with wash buffer.

Diluted receptor extract to give Bmax ~ 4000 cpm and add to the wells.

Wrapped the plates in aluminum foil and stored them at +4°C over night.

Day 2

Made a dilution series in DMSO of the test ligands.

Made a 5nM solution of the radioactive tracer in buffer.

Mixed 250µl diluted tracer with 5µl of the test ligand from each concentration of the dilution series.

Washed the receptor-coated flash plates.

Added 200µl per well of the ligand/radiolabel mixture to the receptor-coated flash plates.

Wrapped the plates in aluminum foil and incubate at +4°C over night.

Day 3

Aspirated wells, and wash the flashed plates. Sealed the plate.

Measured the remaining radioactivity in the plate.

III. Quantitative Analysis of ABCA1 Gene Regulation in THP-1 Cells.

The compounds of formula (I) effect on the regulation of the ABCA1 gene was evaluated using the following procedure.

Materials and Methods

Cell culture: The THP-1 monocytic cell line (ATCC # TIB-202) was obtained from American Type Culture Collection (Manassas, VA) and cultured in RPMI 1640 medium (Gibco, Carlsbad, Ca) containing 10% FBS, 2 mM L-glutamine, and 55 uM beta-Mercaptoethanol (BME). Cells were plated in 96-well format at a density of 7.5 X 10^4 in complete medium containing 50-100 ng/ml phorbal 12,13-dibutyrate (Sigma, St.Louis, Mo) for three days to induce differentiation into adherent macrophages. Differentiated THP-1 cells were treated with test compounds or ligands dissolved in DMSO (Sigma, D-8779) in culture medium lacking phorbal ester. Final concentrations of DMSO did not exceed 0.3% of the media volume. Dose response effects were measured in duplicate, in the range of 0.001 to 30 micromolar concentrations and treated cells were incubated for an additional 18 hrs prior to RNA isolation. Unstimulated cells treated with vehicle were included as negative controls on each plate. An LXR agonist reference, N-(2,2,2-trifluoro-ethyl)-N-[4-(2,2,2-trifluoro-1-hydroxy-1-trifluoromethyl-ethyl)-phenyl]-benzenesulfonamide (Schultz, Joshua R., Genes & Development (2000), 14(22), 2831-2838), was dosed at 1.0 uM and served as a positive control. In antagonist mode, the compound under study is analyzed in the presence of 150nM GW3965, trifluoromethyl-benzyl)-(2,2-diphenyl-ethyl)-amino]-propoxy]-phenyl)-acetic acid (Collins, J.L., *J. Med. Chem.* (2000), **45**:1963-1966.). Results of antagonist analysis are expressed as % antagonism and IC50 (in μM).

RNA isolation and quantitation: Total cellular RNA was isolated from treated cells cultured in 96-well plates using PrepStation 6100 (Applied Biosystems, Foster City, Ca), according to the manufacturer's recommendations. RNA was resuspended in ribonuclease-free water and stored at –70°C prior to analysis. RNA concentrations were quantitated with RiboGreen test procedure, #R-11490 (Molecular Probes, Eugene, OR).

Gene expression analysis: Gene-specific mRNA quantitation was performed by real-time PCR with the Perkin Elmer Corp. chemistry on an ABI Prism 7700 Sequence detection system (Applied Biosystems, Foster City, CA) according to the manufacturer's instructions. Samples (50-100 ng) of total RNA were assayed in duplicate or triplicate in 50 ul reactions using one-step RT-PCR and the standard curve method to estimate specific mRNA concentrations. Sequences of gene-specific primer and probe sets were designed with Primer Express Software (Applied Biosystems, Foster City, CA). The human ABCA1 primer and probe sequences are: forward, CAACATGAATGCCATTTTCCAA, reverse, ATAATCCCCTGAACCCAAGGA, and probe, 6FAM-TAAAGCCATGCCCTCTGCAGGAACA-TAMRA. RT and PCR reactions were performed according to PE Applied Biosystem's protocol for Taqman Gold RT-PCR or Qiagen's protocl for Quantitect probe RT-PCR. Relative levels of ABCA1 mRNA are normalized using GAPDH mRNA or 18S rRNA probe/primer sets purchased commercially (Applied Biosystems, Foster City, CA).

Statistics:

Mean, standard deviation and statistical significance of duplicate evaluations of RNA samples were assessed using ANOVA, one-way analysis of variance using SAS analysis.

Reagents:

- GAPDH Probe and Primers - Taqman GAPDH Control Reagents 402869 or 4310884E
18S Ribosomal RNA – Taqman 18S Control Reagents 4308329
10 Pack Taqman PCR Core Reagent Kit 402930
Qiagen Quantitect probe RT-PCR 204443.

IV. Results:

Table I

EX	hLXRβ binding	hLXRα binding
	IC50 (uM)	*IC50 (uM)*
7	0.00196	0.044
8	0.133	2.04
9	0.148	1.57
10	0.099	1.46
11	0.117	1.09

Table II

EX	Gene regulation by LXR (human)	
	EC50 ABCA1 (uM)	*Agonism ABCA1 (%)*
8	1.85	85
10	1.84	81
11	2.05	92

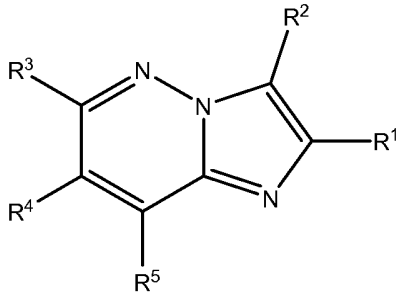
Based on the results obtained in the standard pharmacological test procedures, the compounds of this invention can be useful in treating or inhibiting LXR mediated diseases. In particular, the compounds of this invention can be useful in the treatment and inhibition of atherosclerosis and atherosclerotic lesions, lowering LDL cholesterol levels, increasing HDL cholesterol levels, increasing reverse cholesterol transport, inhibiting cholesterol absorption, treatment or inhibition of cardiovascular diseases (e.g., acute coronary syndrome, restenosis), atherosclerosis, atherosclerotic lesions, type I diabetes, type II diabetes, Syndrome X, obesity, lipid disorders (e.g., dyslipidemia, hyperlipidemia, hypertriglyceridemia, hypercholesterolemia, low HDL and high LDL), cognitive disorders (e.g., Alzheimer's disease, dementia), inflammatory diseases (e.g., multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease, Crohn's disease, endometriosis, LPS-induced sepsis, acute contact dermatitis of the ear, chronic atherosclerotic inflammation of the artery wall), celiac, thyroiditis, skin aging (e.g., skin

aging is derived from chronological aging, photoaging, steroid-induced skin thinning, or a combination thereof), or connective tissue disease (e.g., osteoarthritis or tendonitis).

A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are in the claims.

WHAT IS CLAIMED IS

1. A compound having formula (I):



(I)

wherein:

R^1 is:

(i) hydrogen; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-10 R^a; or

(iii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-10 R^b; or

(iv) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, heterocyclyl including 3-10 atoms, heterocycloalkenyl including 3-10 atoms, C_7-C_{11} aralkyl, or heteroaralkyl including 6-11 atoms, each of which is optionally substituted with from 1-10 R^c; or

(v) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-10 R^d;

R^2 is C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is:

(i) substituted with 1 R^6, and

(ii) optionally substituted with from 1-5 R^e;

R^6 is WA, wherein:

W at each occurrence is, independently, a bond; -O-; -NR^7-; C_{1-6} alkylene, C_{2-6} alkenylene, or C_{2-6} alkynylene; -W^1(C_{1-6} alkylene)-; or -(C_{1-6} alkylene)W^1-;

W^1 at each occurrence is, independently, -O- or -NR^7-;

R^7 is hydrogen or C_1-C_6 alkyl;

A at each occurrence is, independently, C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is:

(i) substituted with 1 R^8, and

(ii) optionally further substituted with from 1-5 R^g;

R^8 at each occurrence is, independently:

(i) -W^2-$S(O)_nR^9$ or -W^2-$S(O)_nNR^{10}R^{11}$; or

(ii) -W^2-$C(O)OR^{12}$; or

(iii) -W^2-$C(O)NR^{10}R^{11}$; or

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with 1 R^h, and

(b) optionally further substituted with from 1-5 R^a; or

(vi) -$NR^{13}R^{14}$;

wherein:

W^2 at each occurrence is, independently, a bond; C_{1-6} alkylene; C_{2-6} alkenylene; C_{2-6} alkynylene; C_{3-6} cycloalkylene; -O(C_{1-6} alkylene)-, or -NR^7(C_{1-6} alkylene)-;

n at each occurrence is, independently, 1 or 2;

R^9 at each occurrence is, independently:

(i) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-5 R^a; or

(ii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-5 R^b; or

(iii) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, C_7-C_{11} aralkyl, or heteroaralkyl including 6-11 atoms, each of which is optionally substituted with from 1-5 R^c; or

(iv) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d;

R^{10} and R^{11} are each, independently, hydrogen; R^9; or heterocyclyl including 3-10 atoms or a heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; or

R^{10} and R^{11} together with the nitrogen atom to which they are attached form a heterocyclyl including 3-10 atoms or a heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c;

R^{12} at each occurrence is, independently, hydrogen or R^9;

at each occurrence of $-NR^{13}R^{14}$, one of R^{13} and R^{14} is hydrogen or C_1-C_3 alkyl; and the other of R^{13} and R^{14} is:

(i) $-S(O)_nR^9$; or

(ii) $-C(O)OR^{12}$; or

(iii) $-C(O)NR^{10}R^{11}$; or

(iv) C_1-C_{12} alkyl or C_1-C_{12} haloalkyl, each of which is:

(a) substituted with 1 R^h, and

(b) optionally further substituted with from 1-5 R^a;

each of R^3 and R^4 is, independently:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a;

R^5 is:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) nitro; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; C_1-C_6 thioalkoxy; C_1-C_6 thiohaloalkoxy; or cyano;

R^a at each occurrence is, independently:

(i) NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; C_6-C_{10} aryloxy or heteroaryloxy including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d; C_7-C_{11} aralkoxy, heteroaralkoxy including 6-11 atoms, C_3-C_{11} cycloalkoxy, C_3-C_{11} cycloalkenyloxy, heterocyclyloxy including 3-10 atoms, or heterocycloalkenyloxy including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; cyano; or

(ii) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, heterocyclyl including 3-10 atoms, or heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c;

R^b at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; C_6-C_{10} aryloxy or heteroaryloxy including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d; C_7-C_{11} aralkoxy, heteroaralkoxy including 6-11 atoms, C_3-C_{10} cycloalkoxy, C_3-C_{10} cycloalkenyloxy, heterocyclyloxy including 3-10 atoms, or heterocycloalkenyloxy including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; cyano; or

(ii) C_3-C_{10} cycloalkyl, C_3-C_{10} cycloalkenyl, heterocyclyl including 3-10 atoms, or heterocycloalkenyl including 3-10 atoms, each of which is optionally substituted with from 1-5 R^c; or

(iii) C_6-C_{10} aryl or heteroaryl including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d;

R^c at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; or cyano; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-5 R^a; or

(iii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-5 R^b;

R^d at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; or cyano; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-5 R^a; or

(iii) C_2-C_6 alkenyl or C_2-C_6 alkynyl, each of which is optionally substituted with from 1-5 R^b;

each of R^e at each occurrence is, independently, C_1-C_6 alkyl; C_1-C_6 haloalkyl; halo; hydroxyl; NR^mR^n; C_1-C_6 alkoxy; C_1-C_6 haloalkoxy; or cyano;

R^g at each occurrence is, independently:

(i) halo; NR^mR^n; hydroxy; C_1-C_6 alkoxy or C_1-C_6 haloalkoxy; cyano; or

(ii) C_1-C_6 alkyl or C_1-C_6 haloalkyl;

R^h at each occurrence is, independently, hydroxyl, C_1-C_6 alkoxy, or C_1-C_6 haloalkoxy; C_3-C_{10} cycloalkoxy or C_3-C_{10} cycloalkenyloxy, each of which is optionally substituted with from 1-5 R^c; or C_6-C_{10} aryloxy or heteroaryloxy including 5-10 atoms, each of which is optionally substituted with from 1-5 R^d;

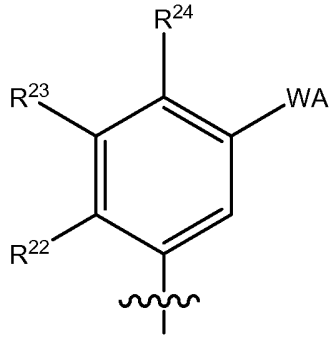
each of R^m and R^n at each occurrence is, independently, hydrogen, C_1-C_6 alkyl, or C_1-C_6 haloalkyl;

or an N-oxide and/or a pharmaceutically acceptable salt thereof.

2. The compound of claim 1, wherein R^2 is C_6-C_{10} aryl, which is (a) substituted with 1 R^6; and (b) optionally substituted with from 1-2 R^e.

3. The compound of claim 1, wherein R^2 is phenyl, which is (a) substituted with 1 R^6; and (b) optionally substituted with 1 R^e.

4. The compound of claim 3, wherein R^2 has formula (A-2):



(A-2),

wherein:

(i) each of R^{22}, R^{23}, and R^{24} is hydrogen; or

(ii) one of R^{22}, R^{23}, and R^{24} is R^e, and the other two are hydrogen.

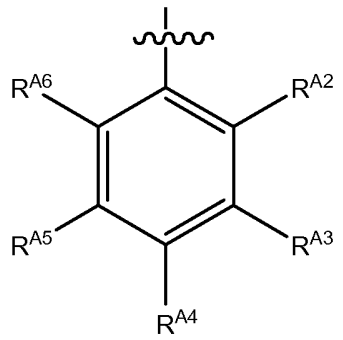
5. The compound of claim 4, wherein each of R^{22}, R^{23}, and R^{24} is hydrogen.

6. The compound of any one of claims 1 to 5, wherein W is -O-.

7. The compound of any one of claims 1 to 6, wherein A is C_6-C_{10} aryl, which is (a) substituted with 1 R^8; and (b) optionally substituted with from 1-4 R^g.

8. The compound of any one of claims 1 to 6, wherein A is phenyl, which is (a) substituted with 1 R^8; and (b) optionally substituted with from 1-4 R^g.

9. The compound of any one of claims 1 to 6, wherein A has formula (B-1):



(B-1)

wherein:

one of R^{A3} and R^{A4} is R^8, the other of R^{A3} and R^{A4} is hydrogen; and

each of R^{A2}, R^{A5}, and R^{A6} is, independently, hydrogen or R^g.

10. The compound of any one of claims 1 to 9, wherein R^8 is $-W^2-S(O)_nR^9$.

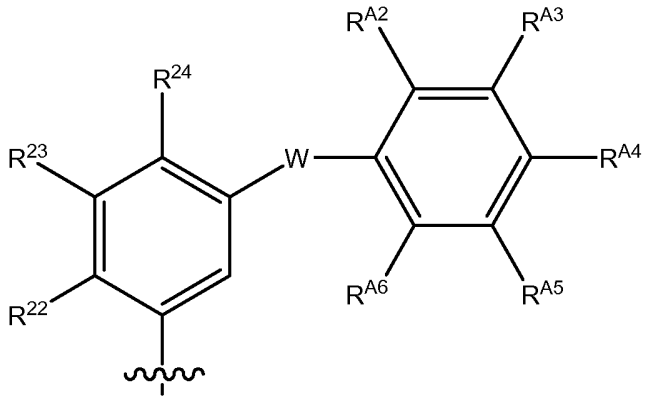
11. The compound of claim 10, wherein W^2 is a bond, and n is 2.

12. The compound of claim 10 or claim 11, wherein R^9 is C_1-C_6 alkyl, optionally substituted with from 1-2 R^a.

13. The compound of claim 10 or claim 11, wherein R^9 is C_1-C_5 alkyl.

14. The compound of claim 13, wherein R^9 is CH_3 or CH_2CH_3.

15. The compound of claim 1, wherein R^2 has formula (C-1):



(C-1)

wherein:

(i) each of R^{22}, R^{23}, and R^{24} is hydrogen; or

(ii) one of R^{22}, R^{23}, and R^{24} is R^e, and the other two are hydrogen;

and

one of R^{A2}, R^{A3}, R^{A4}, R^{A5}, and R^{A6} is R^8, and the others are each, independently, hydrogen or R^g.

16. The compound of claim 15, wherein each of R^{22}, R^{23}, and R^{24} is hydrogen.

17. The compound of claim 15 or claim 16, wherein W is -O-.

18. The compound of any one of claims 15 to 17, wherein one of R^{A3} and R^{A4} is R^8, and the other of R^{A3} and R^{A4} is hydrogen; and each of R^{A2}, R^{A5}, and R^{A6} is, independently, hydrogen or R^g.

19. The compound of any one of claims 15 to 18, wherein R^{A3} is $-W^2-S(O)_nR^9$.

20. The compound of claim 19, wherein W^2 is a bond, and n is 2.

21. The compound of claim 19 or claim 20, wherein R^9 is C_1-C_6 alkyl, optionally substituted with from 1-2 R^a.

22. The compound of claim 19 or claim 20, wherein R^9 is C_1-C_5 alkyl.

23. The compound of claim 22, wherein R^9 is CH_3 or CH_2CH_3.

24. The compound of any one of claims 18 to 23, wherein each of R^{A2}, R^{A5}, and R^{A6} is hydrogen.

25. The compound of any one of claims 1 to 24, wherein R^1 is C_1-C_3 alkyl or C_1-C_3 haloalkyl.

26. The compound of claim 25, wherein R^1 is CH_3CH_2 or $(CH_3)_2CH$.

27. The compound of any one of claims 1 to 24, wherein R^1 is C_7-C_{11} aralkyl, which is optionally substituted with from 1-5 R^c.

28. The compound of claim 27, wherein R^1 is benzyl, which is optionally substituted with from 1-5 R^c.

29. The compound of any one of claims 1 to 28, wherein each of R^3 and R^4 is hydrogen.

30. The compound of any one of claims 1 to 29, wherein R^5 is:

(ii) halo; or

(iii) C_1-C_6 alkyl or C_1-C_6 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

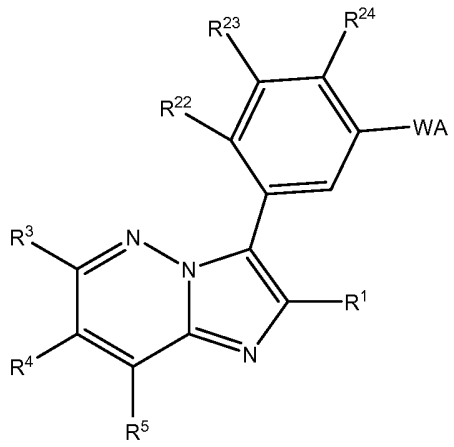
(iv) cyano.

31. The compound of any one of claims 1 to 29, wherein R^5 is C_1-C_6 haloalkyl.

32. The compound of claim 31, wherein R^5 is C_1-C_3 perfluoroalkyl.

33. The compound of claim 32, wherein R^5 is CF_3.

34. The compound of claim 1, wherein the compound has formula (VI):



(VI)

wherein:

R^1 is:

(i) hydrogen; or

(ii) C_1-C_3 alkyl or C_1-C_3 haloalkyl; or

(iii) C_6-C_{10} aryl or heteroaryl including 5-6 atoms, each of which is optionally substituted with from 1-5 R^d; or

(iv) C_7-C_{11} aralkyl, which is optionally substituted with from 1-5 R^c;

each of R^3 and R^4 is, independently:

(i) hydrogen; or

(ii) halo; or

(iii) C_1-C_3 alkyl or C_1-C_3 haloalkyl, each of which is optionally substituted with from 1-3 R^a;

R^5 is:

(ii) halo; or

(iii) C_1-C_3 alkyl or C_1-C_3 haloalkyl, each of which is optionally substituted with from 1-3 R^a; or

(iv) cyano; and

(i) each of R^{22}, R^{23}, and R^{24} is hydrogen; or

(ii) one of R^{22}, R^{23}, and R^{24} is R^e, and the other two are hydrogen.

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

2-Benzyl-3-{3-[3-(methylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine;

2-ethyl-3-{3-[3-(methylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine;

2-Ethyl-3-{3-[3-(ethylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine;

2-isopropyl-3-{3-[3-(methylsulfonyl)phenoxy]phenyl}-8-(trifluoromethyl)imidazo[1,2-b]pyridazine; and

3-{3-[3-(ethylsulfonyl)phenoxy]phenyl}-2-isopropyl-8-(trifluoromethyl)imidazo[1,2-b]pyridazine;

or an N-oxide and/or a pharmaceutically acceptable salt thereof.

36. A composition comprising a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35, and a pharmaceutically acceptable carrier.

37. A method of preventing or treating a Liver X receptor-mediated disease or disorder, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

38. A method of preventing or treating atherosclerosis, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

39. A method of preventing or treating a cardiovascular disease, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

40. The method of claim 39, wherein the cardiovascular disease is acute coronary syndrome or restenosis.

41. The method of claim 39, wherein the cardiovascular disease is coronary artery disease.

42. A method of preventing or treating Syndrome X, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

43. A method of preventing or treating obesity, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

44. A method of preventing or treating one or more lipid disorders selected from dyslipidemia, hyperlipidemia, hypertriglyceridemia, hypercholesterolemia, low HDL and/or high LDL, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

45. A method of preventing or treating Alzheimer's disease, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

46. A method of preventing or treating type I or type II diabetes, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

47. A method of preventing or treating an inflammatory disease, the method comprising administering to a subject in need of such treatment an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

48. The method of claim 47, wherein the inflammatory disease is rheumatoid arthritis.

49. A method of treating a connective tissue disease, the method comprising administering to a mammal in need thereof an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

50. The method of claim 49, wherein the compound of formula (I) inhibits cartilage degradation and induces cartilage regeneration.

51. The method of claim 50, wherein the compound of formula (I) inhibits aggrecanase activity.

52. The method of claim 50, wherein the compound of formula (I) inhibits elaboration of pro-inflammatory cytokines in osteoarthritic lesions.

53. The method of claim 49, wherein the connective tissue disease is osteoarthritis or tendonitis.

54. The method of claim 49, wherein the mammal is a human.

55. A method of treating skin aging, the method comprising administering to a mammal in need thereof an effective amount of a compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35.

56. The method of claim 55, wherein the mammal is a human.

57. The method of claim 55, wherein the compound of formula (I) is topically administered.

58. The method of claim 55, wherein the skin aging is derived from chronological aging, photoaging, steroid-induced skin thinning, or a combination thereof.

59. A compound of formula (I) or an N-oxide and/or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 35 for use in preventing or treating a Liver X receptor-mediated disease or disorder, atherosclerosis, a cardiovascular disease, Syndrome X, obesity, Alzheimer's disease, type I or type II diabetes, an inflammatory disease, or one or more lipid disorders selected from dyslipidemia, hyperlipidemia, hypertriglyceridemia, hypercholesterolemia, low HDL and/or high LDL, in a subject.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/087718

A. CLASSIFICATION OF SUBJECT MATTER
INV. C07D487/04 A61K31/5025 A61P9/00 A61P3/00

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 A61K A61P

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 practical, search terms used)

EPO-Internal, CHEM ABS 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 02/066481 A (ASTRAZENECA AB [SE]; ASTRAZENECA UK LTD [GB]; THOMAS ANDREW PETER [GB]) 29 August 2002 (2002-08-29) in particular page 24 lines 23-28 and page 25 lines 4-11 as well as many examples for instance ex 1-8. -----	1,7-14, 29,36, 38-40, 47,49,59
X	BYTH K F ET AL: "Imidazo[1,2-b]pyridazines: a potent and selective class of CDK inhibitors" BIOORGANIC & MEDICINAL CHEMISTRY LETTERS, PERGAMON, ELSEVIER SCIENCE, GB, vol. 14, 1 January 2004 (2004-01-01), pages 2249-2252, XP002415769 ISSN: 0960-894X tables 1,2 -----	1,7-14, 29,36
	-/--	

[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 document 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
27 April 2009	06/05/2009

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	Gregoire, Ariane

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/087718

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/102194 A (LILLY CO ELI [US]; BARBOSA HEATHER JANELLE [US]; COLLINS ELIZABETH AAR) 28 September 2006 (2006-09-28) claim 1, pages 14-15 and example 67 page 70	1,10-14, 25,29, 30,36, 39,43, 45-54
X	US 2004/067948 A1 (HALLETT DAVID JAMES [GB]) 8 April 2004 (2004-04-08) paragraph [0010]; claims 2,7	1-24,29, 35,36, 43,45
A	US 2006/030612 A1 (STEFFAN ROBERT J [US] ET AL) 9 February 2006 (2006-02-09) the whole document	1-59

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/087718

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. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

Although claims 37-58 are directed to a method of treatment of the human/animal body, the search has been carried out and based on the alleged effects of the compound/composition.

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:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable 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 reportcovers 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.:

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.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2008/087718

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