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**GPR120 receptor agonists and uses thereof**

**GPR120 agonists are provided. These compounds are useful for the treatment of metabolic diseases, including Type II diabetes and diseases associated with poor glycemic control.**
BACKGROUND OF THE INVENTION

[0001]  Diabetes mellitus can be divided into two clinical syndromes, Type I and Type II diabetes mellitus. Type I diabetes, or insulin-dependent diabetes mellitus, is a chronic autoimmune disease characterized by the extensive loss of beta cells in the pancreatic islets of Langerhans (hereinafter referred to as “pancreatic islet cells” or “islet cells”), which produce insulin. As these cells are progressively destroyed, the amount of secreted insulin decreases, eventually leading to hyperglycemia (abnormally high level of glucose in the blood) when the amount secreted drops below the level required for euglycemia (normal blood glucose level). Although the exact trigger for this immune response is not known, patients with Type I diabetes have high levels of antibodies against pancreatic beta cells (hereinafter “beta cells”). However, not all patients with high levels of these antibodies develop Type I diabetes.

[0002]  Type II diabetes, or non-insulin-dependent diabetes mellitus, develops when muscle, fat and liver cells fail to respond normally to insulin. This failure to respond (called insulin resistance) may be due to reduced numbers of insulin receptors on these cells, or a dysfunction of signaling pathways within the cells, or both. The beta cells initially compensate for this insulin resistance by increasing their insulin output. Over time, these cells become unable to produce enough insulin to maintain normal glucose levels, indicating progression to Type II diabetes (Kahn SE, Am J Med 2000) 108 Suppl 6a, 2S-8S).

[0003]  The fasting hyperglycemia that characterizes Type II diabetes occurs as a consequence of the combined lesions of insulin resistance and beta cell dysfunction. The beta cell defect has two components: the first component, an elevation of basal insulin release (occurring in the presence of low, non-stimulatory glucose concentrations), is observed in obese, insulin-resistant pre-diabetic stages as well as in Type II diabetes. The second component is a failure to increase insulin release above the already elevated basal output in response to a hyperglycemic challenge. This lesion is absent in prediabetes and appears to define the transition from normo-glycemic insulin-resistant states to frank diabetes. There is currently no cure for diabetes. Conventional treatments for diabetes are very limited, and focus on attempting to control blood glucose levels in order to minimize or delay complications. Current treatments target either insulin resistance (metformin, thiazolidinediones (“TZDs”)), or insulin release from the beta cell (sulphonylureas, exenatide). Sulphonylureas, and other compounds that act by depolarizing the beta cell, have the side effect of hypoglycemia since they cause insulin secretion independent of circulating glucose levels. One approve drug, Byetta (exenatide) stimulates insulin secretion only in the presence of high glucose, but is not orally available and must be injected. Januvia (sitagliptin) is another recently approved drug that increases blood levels of incretin hormones, which can increase insulin secretion, reduce glucagon secretion and have other less well characterized effects. However, Januvia and other dipeptidyl peptidase IV inhibitors may also influence the tissue levels of other hormones and peptides, and the long-term consequences of this broader effect have not been fully investigated. There is an unmet need for oral drugs that stimulate insulin secretion in a glucose dependent manner.


[0005]  Insulin secretion from the beta cells of pancreatic islets is elicited by increased levels of blood glucose. Glucose is taken up into the beta cell primarily by the beta cell and liver selective transporter GLUT2 (Thorens B, Mol Membr Biol 2001 Oct-Dec;18(4):265-73). Once inside the cell, glucose is phosphorylated by glucokinase, which is the primary glucose sensor in the beta cell since it catalyzes the irreversible rate limiting step for glucose metabolism (Matschinsky FM, Curr Diab Rep 2005 Jun;5(3):171-6). The rate of glucose-6-phosphate production by glucokinase is dependent on the concentration of glucose around the beta cell, and therefore this enzyme allows for a direct relationship between level of glucose in the blood and the overall rate of glucose oxidation by the cell. Mutations in glucokinase produce abnormalities in glucose dependent insulin secretion in humans giving further evidence that this hexokinase family member plays a key role in the islet response to glucose (Gloyn AL, et al., J Biol Chem 2005 Apr 8;280(14):14105-13, Epub 2005 Jan 25). Small molecule activators of glucokinase enhance insulin secretion and may provide a route for therapeutic exploitation of the role of this enzyme (Guertin KR and Grimbsy J, Curr Med Chem 2006;13(15):1839-43; and Matschinsky FM, et al., Diabetes 2006 Jan;55(1):1-12 in diabetes. Glucose metabolism via glycolysis and mitochondrial oxidative phosphorylation ultimately results in ATP production, and the amount of ATP produced in a beta cell
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is directly related to the concentration of glucose to which the beta cell is exposed.

[0006] Glucose dependent insulin secretion from the beta cell is dependent on numerous neurotransmitters and blood-borne hormones, as well as local, intra-islet factors. CNS activation of the vagal innervation of the islet can lead to the release of small molecules such as acetylcholine and peptides such as vasoactive intestinal polypeptide (VIP), gastrin releasing peptide (GRP) and Pituitary Adenylate Cyclase Activating Peptide (PACAP). Acetylcholine activation of phospholipase C through the $\alpha_{1c}$-coupled GPCR M3 muscarinic receptor leads to release of Ca$^{2+}$ from intracellular stores (Gilon P and Henquin JC, Endocr Rev 2001 Oct;22(5):565-604). Cholinergic agonists also lead to a subtle Na$^{+}$-dependent plasma membrane depolarization that can work in concert with glucose-initiated depolarization to enhance insulin release (Gilon P and Henquin JC, Endocr Rev 2001 Oct;22(5):565-604). VIP and PACAP each bind to an overlapping set of $\alpha_{1}$-coupled GPCRs (PAC1, VIPER1, and VIPR2) on the beta cell that lead to stimulation of adenylate cyclase and an increase in intracellular cAMP (Filipsson K, et al., Diabetes 2001 Sep;50(9):1959-69; Yamada H, et al., Regul Pept 2004 Dec 15;123(1-3):147-53; and Qader SS, et al., Am J Physiol Endocrinol Metab 2007 May;292(5):E1447-55).

[0007] Incretin hormones such as Glucagon-Like Peptide 1 (GLP-1) and Glucose-dependent Insulinotropic Polypeptide (GIP, also known as Gastric Inhibitory Polypeptide) also bind to specific $\alpha_{1c}$-coupled GPCRs receptors on the surface of islet cells, including beta cells, and raise intracellular cAMP (Drucker DJ, J Clin Invest 2007 Jan;117(1):143-52. Epub 2006 Dec 21). GIP and GLP-1 are produced and secreted from intestinal K and L cells, respectively, and these peptide hormones are released in response to meals by both direct action of nutrients in the gut lumen and neural stimulation resulting from food ingestion. GIP and GLP-1 have short half-lives in human circulation due to the action of the protease dipeptidyl-peptidase IV (DPPIV), and inhibitors of this protease can lower blood glucose due to their ability to raise the levels of active forms of the incretin peptides. The glucose lowering that can be obtained with DPPIV inhibitors, however, is somewhat limited since these drugs are dependent on the endogenous release of the incretin hormones. Peptides (e.g., exanatide (Byetta)) and peptide-conjugates that bind to the GIP or GLP-1 receptors but are resistant to serum protease cleavage can also lower blood glucose substantially (Gonzalez C, et al., Expert Opin Investig Drugs 2006 Aug;15(8):887-95), but these incretin mimetics must be injected and tend to induce a high rate of nausea and therefore are not ideal therapies for general use in the Type II diabetic population. The clinical success of DPPIV inhibitors and incretin mimetics, though far from ideal, do point to the potential utility of compounds that increase incretin activity in the blood. Some studies have indicated that beta cell responsiveness to GIP is diminished in Type II diabetes (Nauck MA, et al., J Clin Invest 91:301-307 (1993); and Elahi D, et al., Regul Pept 51:63-74 (1994)). Restoration of this responsiveness (Meneilly GS, et al., Diabetes Care 1993 Jan;16(1):110-4) may be a promising way to improve beta cell function in vivo.

[0008] Since increased incretin activity has a positive effect on glucose dependent insulin secretion and perhaps other mechanisms that lead to lower blood glucose, it is also of interest to explore therapeutical approaches to increasing incretin release from intestinal K and L cells. GLP-1 secretion appears to be attenuated in Type II diabetes (Vilsboll T, et al., Diabetes 50:609-613), so improving incretin release may ameliorate this component of metabolic dysregulation. Nutrients such as glucose and fat in the gut lumen prompt incretin secretion by interaction with apical receptors (Vilsboll T, et al., Diabetes 50:609-613). GLP-1 and GIP release can also result from neural stimulation; acetylcholine and GRP can enhance incretin release in a manner perhaps analogous to the effects of these neurotransmitters on the beta cell in regard to insulin secretion (Brubaker P, Ann N Y Acad Sci 2006 Jul;1070:10-26; and Reimann F, et al., Diabetes 2006 Dec;55(Suppl 2):578-585). Somatostatin, leptin and free fatty acids also appear to modulate incretin secretion (Brubaker P, Ann N Y Acad Sci 2006 Jul;1070:10-26; and Reimann F, et al., Diabetes 2006 Dec;55(Suppl 2):S78-S85). To date, however, there does not appear to be a way to selectively impact these pathways to promote incretin secretion for therapeutic benefit. There is a need for oral drugs that stimulate incretin secretion in the treatment of diabetes.

[0009] Incretins can also increase the rate of beta cell proliferation and decrease the apoptotic rates of beta cells in animal models (Farilla L, et al., Endocrinology 2002 Nov;143(11):4397-408) and human islets in vitro (Farilla L, et al., Endocrinology 2003 Dec;144(12):5149-58). The net result of these changes is an increase in beta cell number and islet mass, and this should provide for increased insulin secretory capacity, which is another desired aim of anti-diabetic therapies. GLP-1 has also been shown to protect islets from the destructive effects of agents such as streptozotocin by blocking apoptosis (Li Y, et al., J Biol Chem 2003 Jan 3;278(1):471-8). Cyclic D1, a key regulator of progression through the cell cycle, is up-regulated by GLP-1, and other agents that increase cAMP and PKA activity also have a similar effect (Friedrichsen BN, et al., J Endocrinol 2006 Mar;188(3):481-92; and Kim MJ, et al., J Endocrinol 2006 Mar;188(3):623-33). Increased transcription of the cyclin D1 gene occurs in response to PKA phosphorylation of CREB (cAMP-response element binding) transcription factors (Hussain MA, et al., Mol Cell Biol 2006 Oct;26(20):7747-59). There is a need for oral drugs that increase beta cell number and islet mass in the treatment of diabetes.

[0010] G protein-coupled receptors (GPCRs) are cell-surface receptors that play an important physiological role by transducing and amplifying extra-cellular signals such as hormones, growth factors, neurotransmitters and physiologically active substances. GPCRs are associated with changes in intracellular Ca$^{2+}$ concentration as well as increases in
in intracellular inositol 1, 4, 5-triphosphate (IP3) concentration. These second messengers serve to focus the signal transduction events and stimulate other pathways. Hence, GPCRs are therapeutically important target classes in the pharmaceutical industry.

GRP120 is a GPCR for unsaturated long-chain free fatty acids (FFA) and is highly expressed in lung, intestine, adipocytes and taste cells as well as in the enteronecrine cell lines such as STC-1 and GLUTag (Hirasawa et al., Nature Medicine 2005 Jan; 11: 90-94; and Ikakoubo et al., Endocrinology 2007 Mar; 148(3): 1089-1098; and Katsuma et al., J. Biol. Chem. 2005 May; 280:19507-19515; Matsumura et al., Biomed. Res. 2007 Feb; 28(1):49-55). The stimulation of GPR120 by FFAs increases the release of Ca²⁺ from intracellular stores indicating that GPR120 is a Gq-coupled receptor. GPR120 mediates the effect of unsaturated long-chain free fatty acids in stimulating GLP-1 and cholecystokinin (CCK) secretion, increases plasma insulin, activation of the extracellular signal-regulated kinase (ERK) cascade, proliferation of pancreatic β cells, inhibition of serum deprivation-induced apoptosis and adipogenesis (Katsuma et al., J. Biol. Chem. 2005 May; 280:19507-19515; and Rayasam et al., Expert Opin. Ther. Targets 2007 May; 11(5):661-671; and Tanaka et al., Naunyn Schmiedeberg Arch Pharmacol 2008 Jun; 377(4-6):515-522; and Gotoh et al., Biochem. Biophys. Res. Commun. 2007 Mar; 354(2): 591-597).

Free fatty acids have been demonstrated as ligands for recently identified orphan GPCRs (Rayasam et al., Expert Opin Ther Targets 2007 May;11(5):661-671). GPR120 shares ligand specificity with other fatty acid receptors and there is a need for the development of small molecule agents that are specific modulators for GPR120 function. In particular, GPR120 is a promising target for the treatment of diabetes, obesity and the metabolic syndrome considering the significant role of GLP-1 and CCK in insulin secretion, gastric emptying and appetite feeding control.

BRIEF SUMMARY OF THE INVENTION

Novel GPR120 compound agonists, methods for their preparation, and related synthetic intermediates and compositions are provided. The novel GPR120 agonists are useful in the treatment of diabetes and other related diseases including metabolic syndrome, dyslipidemia, insulin resistance, and complications of diabetes.

Further provided are methods for treating diseases such as Type II diabetes and other diseases and conditions using one or more of these compounds or compositions, as described in further detail below. The invention also provides methods of raising intracellular levels of Ca²⁺ by using one or more of the compounds described herein. Further, the compounds may be used to stimulate insulin production and stimulate secretion of insulin, glucagon-like peptide 1 (GLP1), and glucose dependent insulinotropic polypeptide (GIP) in a mammal, in particular a human. Additionally, the compounds described herein are useful in lowering blood glucose when administered to a mammal in need of treatment to lower blood glucose.

DETAILED DESCRIPTION OF THE INVENTION

The abbreviations used herein are conventional, unless otherwise defined: AcOH: acetic acid; nBuLi: n-butyl-lithium; Cs₂CO₃: cesium carbonate; CH₂Cl₂ or DCM: dichloromethane; CH₃Mgl: methyl magnesium iodide; CuCl₂: copper chloride; DIPEA: (diethylamino)sulfur trifluoride; DEAD: diethyl azodicarboxylate; Dibal: diisobutylaluminum hydride; DIPA: diisopropylethylamine; DMF: dimethylformamide; DMSO: dimethyl sulfoxide; Et₃N: triethylamine; EtOAc: ethyl acetate; EtOH: ethanol; g: gram(s); h: hour; H₂: hydrogen; HBr: hydrogen bromide; HCl: hydrogen chloride; H₂O: water; H₂O₂: hydrogen peroxide; HPLC: high performance liquid chromatography; KCN: potassium cyanide; Lhmds: lithium hexamethyldisilazide; LiAlH₄: lithium aluminum hydride; LiOH: lithium hydroxide; M: molar; MeCN: acetonitrile; Mel: methyl iodide; MeOH: methanol; MgSO₄: magnesium sulfate; MgCO₃: magnesium carbonate; mg: milligram; MsCl: mesyl chloride; mmol: millimoles; mL: milliliter; sodium hydroxide; NaHSO₃: mCPBA: meta-chloroperoxybenzoic acid; N: normality; N₂: nitrogen; Na₂CO₃: sodium carbonate; NaHCO₃: sodium bicarbonate; NaNO₂: sodium nitrite; NaOH: sodium hydroxide; Na₂SO₃: sodium bisulfate; Na₂SO₄: sodium sulfate; NBS: N-bromosuccinimide; NH₂Cl: ammonium chloride; NH₄OAc: ammonium acetate; NMR: nuclear magnetic resonance; Pd/C: palladium on carbon; PPh₃: triphenyl phosphine; iPrOH: isopropyl alcohol; SOCl₂: thionyl chloride; THF: tetrahydrofuran; TLC: thin layer chromatography; μL: microliter.

Unless otherwise stated, the following terms used in the specification and claims have the meanings given below.

"Alkyl" refers to monovalent saturated aliphatic hydrocarbyl groups having from 1 to 10 carbon atoms and, in some embodiments, from 1 to 6 carbon atoms. "Cₚ₋ₚ alkyl" refers to alkyl groups having from u to v carbon atoms. This term includes, by way of example, linear and branched hydrocarbyl groups such as methyl (CH₃), ethyl (CH₂CH₃), n-propyl (CH₃CH₂CH₂), isopropyl (CH₃CH₂CH₂), n-butyl (CH₃CH₂CH₂CH₂), isobutyl ((CH₃)₂CHCH₂), sec-butyl ((CH₃)₂CHCH₂), t-butyl ((CH₃)₃C), n-pentyl (CH₃CH₂CH₂CH₂CH₂), and neopentyl ((CH₃)₂CHCH₂).
onyl, aminocarboxylamino, aminothiocarboxylamino, aminocarboxyloxy, aminosulfonyl, aminosulfonyloxy, aminosulfon-
ylamino, amido, aryl, substituted aryl, arylxoy, substituted aryloxy, arythio, substituted arthyio, azido, carbonyl, car-
boxyl ester, (carboxyl ester)amino, (carboxyl ester)oxy, cyano, cycloalkyl, substituted cycloalkyl, cycloalkyloxy, substi-
tuted cycloalkylthio, cycloalkythio, substituted cycloalkylthio, guanidino, substituted guanidino, halo, hydroxy, hy-
droxynimo, alkoxynimo, hydrazimo, substituted hydrazino, heteroaryl, substituted heteroaryl, heteroaryloxy, substituted heteroarylothio, heterothio, substituted heterothio, heterocyclic, substituted heterocyclic, heterocyclyloxy, substi-
tuted heterocyclylthio, substituted heterocyclylthio, nitro, spirocycloalkyl, SO_3H, substituted sulfonyl, sulfonyloxy, thiaoy, thiocyanato, thiol, alkythio, and substituted alkythio, wherein said substituents are as defined hereina.

[0019] "Alkenyl" refers to a linear or branched hydrocarbyl group having from 2 to 10 carbon atoms and, in some embodiments, from 2 to 6 carbon atoms or 2 to 4 carbon atoms and having at least one site of vinyl unsaturation (\(>\text{C} = \text{C}<\)). "Cu-v alkenyl" refers to alkenyl groups having from u to v carbon atoms and is meant to include for example, ethenyl, propenyl, 1,3-butenediynyl, and the like.

[0020] "Substituted alkenyl" and "substituted Cu-v alkenyl" refers to alkenyl groups having from 1 to 3 substituents and, in some embodiments, 1 to 2 substituents, selected from the group consisting of alkoxy, substituted alkoxy, acyl, acylamino, acyloxy, alkyl, substituted alkyl, alkynyl, substituted alkynyl, amino, substituted amino, aminocarbonyl, aminothiocarbonylaminino, aminothiocarboxylamino, aminocarboxylamino, aminosulfonamido, amido, substituted amido, aryl, substituted aryl, arythio, substituted arthyio, carboxyl, carboxyl ester, (carboxyl ester)amino, (carboxyl ester)oxy, cyano, cycloalkyl, substituted cycloalkyl, cycloalkyloxy, substituted cycloalkylthio, cycloalkythio, substituted cycloalkylthio, guanidino, substituted guanidino, halo, hydroxy, heterothio, substituted heterothio, heterocyclic, substituted heterocyclic, heterocyclyloxy, substituted heterocyclylthio, substituted heterocyclylthio, nitro, SO_3H, substituted sulfonyl, sulfonyloxy, thiaoy, thiol, alkythio, and substituted alkythio, wherein said substituents are defined as herein and with the proviso that any hydroxy or thiol substitution is not attached to an acetylenic carbon atom.

[0021] "Alkynyl" refers to a linear monovalent hydrocarbon radical or a branched monovalent hydrocarbon radical containing at least one triple bond. The term "alkynyl" is also meant to include those hydrocarbyl groups having one triple bond and one double bond. "Cu-v alkynyl" refers to alkynyl groups having from u to v carbon atoms and is meant to include ethynyl, propynyl, and the like.

[0022] "Substituted alkynyl" and "substituted Cu-v alkynyl" refers to alkynyl groups having from 1 to 3 substituents and, in some embodiments, from 1 to 2 substituents, selected from the group consisting of alkoxy, substituted alkoxy, acyl, acylamino, acyloxy, amino, substituted amino, aminocarbonyl, aminothiocarbonylaminino, aminothiocarboxylamino, aminocarboxylamino, aminosulfonamido, amido, substituted amido, aryl, substituted aryl, arythio, substituted arthyio, carboxyl, carboxyl ester, (carboxyl ester)amino, (carboxyl ester)oxy, cyano, cycloalkyl, substituted cycloalkyl, cycloalkyloxy, substituted cycloalkylthio, cycloalkythio, substituted cycloalkylthio, guanidino, substituted guanidino, halo, hydroxy, heterothio, substituted heterothio, heterocyclic, substituted heterocyclic, heterocyclyloxy, substituted heterocyclylthio, substituted heterocyclylthio, nitro, SO_3H, substituted sulfonyl, sulfonyloxy, thiaoy, thiol, alkythio, and substituted alkythio, wherein said substituents are defined as herein and with the proviso that any hydroxy or thiol substitution is not attached to an acetylenic carbon atom.

[0023] "Alkoxy" refers to the group \(-\text{O}-\text{alkyl}\) wherein alkyl is defined herein. Alkoxy includes, by way of example, methoxy, ethoxy, n-propoxy, isopropoxy, n-butoxy, t-butoxy, sec-butoxy, and n-pentoxy. "Cu-v alkoxy" refers to alkoxy groups having from u to v carbon atoms.

[0024] "Substituted alkoxy" and "substituted Cu-v alkoxy" refers to the group \(-\text{O}-(\text{substituted alkyl})\) wherein substituted alkyl is as defined herein.

[0025] "Acyl" refers to the groups H-(C(=O))-, alkyl-(C(=O))-,-substituted alkyl-(C(=O))-,-alkenyl-(C(=O))-,-substituted alkenyl-(C(=O))-,-acycloxy-(C(=O))-,-substituted acyloxy-(C(=O))-,-cycloalkyl-(C(=O))-,-substituted cycloalkyl-(C(=O))-,-aryl-(C(=O))-,-substituted aryl-(C(=O))-,-hydroxy-(C(=O))-,-substituted hydroxy-(C(=O))-,-thio-(C(=O))-,-substituted thio-(C(=O))-,-heterocyclic-(C(=O))-,-substituted heterocyclic-(C(=O))-,-and substituted heterocyclic-(C(=O))-,- wherein alkyl, substituted alkyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, substituted hydroxy, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein. Acyl includes the "acyetyl" group CH_3C(=O)-.

[0026] "Aminocarboxylamino" refers to the groups \(-\text{NR}_2\text{C}(=\text{O})\text{H}\), \(-\text{NR}_2\text{C}(=\text{O})\text{alkyl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{substituted alkyl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{cycloalkyl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{substituted cycloalkyl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{alkenyl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{substituted alkenyl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{aryl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{substituted aryl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{heteroaryl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{substituted heteroaryl}\), \(-\text{NR}_2\text{C}(=\text{O})\text{heterocyclic}\), and \(-\text{NR}_2\text{C}(=\text{O})\text{substituted heterocyclic}\) wherein R^2 is hydrogen or alkyl and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein.
[0027] "Acyloxy" refers to the groups H-C(O)O-, alkyl-C(O)O-, substituted alkyl-C(O)O-, alkenyl-C(O)O-, substituted alkenyl-C(O)O-, alkynyl-C(O)O-, substituted alkynyl-C(O)O-, aryl-C(O)O-, substituted aryl-C(O)O-, cycloalkyl-C(O)O-, substituted cycloalkyl-C(O)O-, heteroaryl-C(O)O-, substituted heteroaryl-C(O)O-, heterocyclic-C(O)O-, and substituted heterocyclic-C(O)O- wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein.

[0028] "Amino" refers to the group -NH2.

[0029] "Substituted amino" refers to the group -NR21R22 where R21 and R22 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and wherein R21 and R22 are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, provided that R21 and R22 are both not hydrogen, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein. When R21 is hydrogen and R22 is alkyl, the substituted amino group is sometimes referred to herein as alkylamino. When R21 and R22 are alkyl, the substituted amino group is sometimes referred to herein as dialkylamino. When referring to a monosubstituted amino, it is meant that either R21 or R22 is hydrogen but not both. When referring to a disubstituted amino, it is meant that neither R21 nor R22 are hydrogen.

[0030] "Hydroxymonoxy" refers to the group -NHOH.

[0031] "Alkoxyamino" refers to the group -NHO-alkyl wherein alkyl is defined herein.

[0032] "Aminocarbonyl" refers to the group -C(O)NR23R24 where R23 and R24 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic, hydroxy, alkoxy, and substituted alkoxy, and where R23 and R24 are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein. When R23 is hydrogen and R24 is alkyl, the substituted amino group is sometimes referred to herein as alkylamino. When R23 and R24 are alkyl, the substituted amino group is sometimes referred to herein as dialkylamino. When referring to a monosubstituted amino, it is meant that either R23 or R24 is hydrogen but not both. When referring to a disubstituted amino, it is meant that neither R23 nor R24 are hydrogen.

[0033] "Aminothiocarbonyl" refers to the group -C(S)NR23R24 where R23 and R24 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and where R23 and R24 are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein. When R23 is hydrogen and R24 is alkyl, the substituted amino group is sometimes referred to herein as alkylamino. When R23 and R24 are alkyl, the substituted amino group is sometimes referred to herein as dialkylamino. When referring to a monosubstituted amino, it is meant that either R23 or R24 is hydrogen but not both. When referring to a disubstituted amino, it is meant that neither R23 nor R24 are hydrogen.

[0034] "Aminocarbonylamino" refers to the group -NR20C(O)NR23R24 where R20 is hydrogen or alkyl and R23 and R24 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkylnyl, substituted alkylnyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and where R23 and R24 are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein. When R20 is hydrogen or alkyl and R23 and R24 are alkyl, the aminoamino group is sometimes referred to herein as alkylamino. When R20 is hydrogen or alkyl and R23 and R24 are alkyl, the aminoamino group is sometimes referred to herein as dialkylamino. When referring to a monosubstituted amino, it is meant that either R23 or R24 is hydrogen but not both. When referring to a disubstituted amino, it is meant that neither R23 nor R24 are hydrogen.

[0035] "Aminothiocarbonylamino" refers to the group -NR20C(S)NR23R24 where R20 is hydrogen or alkyl and R23 and R24 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkylnyl, substituted alkylnyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and where R23 and R24 are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein. When R20 is hydrogen or alkyl and R23 and R24 are alkyl, the aminoamino group is sometimes referred to herein as alkylamino. When R20 is hydrogen or alkyl and R23 and R24 are alkyl, the aminoamino group is sometimes referred to herein as dialkylamino. When referring to a monosubstituted amino, it is meant that either R23 or R24 is hydrogen but not both. When referring to a disubstituted amino, it is meant that neither R23 nor R24 are hydrogen.

[0036] "Aminocarboxyloxy" refers to the group -O-(C)NR23R24 where R23 and R24 are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and where R23 and R24 are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein.

[0037] "Aminosulfonyl" refers to the group -S(O)2R23R24 where R23 and R24 are independently selected from the
group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and where R²³ and R²⁴ are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein.

[0038]"Aminosulfonylamino" refers to the group -NR²⁵S(O)₂R²³R²⁴ where R²³ and R²⁴ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and where R²³ and R²⁴ are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein.

[0039]"Aminosulfonyloxy" refers to the group -O-S(O)₂R²³R²⁴ where R²³ and R²⁴ is hydrogen or alkyl and R²³ and R²⁴ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein.

[0040]"Amidino" refers to the group -C(=NR²⁵)NR²³R²⁴ where R²⁵, R²³, and R²⁴ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, aryl, substituted aryl, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and where R²³ and R²⁴ are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein.

[0041]"Aryl" refers to an aromatic group of from 6 to 14 carbon atoms and no ring heteroatoms and having a single ring (e.g., phenyl) or multiple condensed (fused) rings (e.g., naphthyl or anthryl). For multiple ring systems, including fused, bridged, and spiro ring systems having aromatic and non-aromatic rings that have no ring heteroatoms, the term "Aryl" or "Ar" applies when the point of attachment is at an aromatic carbon atom (e.g., 5,6,7,8-tetrahydronaphthalene-2-yl is an aryl group as its point of attachment is at the 2-position of the aromatic phenyl ring).

[0042]"Substituted aryl" refers to aryl groups which are substituted with 1 to 8 and, in some embodiments, 1 to 5, 1 to 3 or 1 to 2 substituents selected from the group consisting of alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, alkoxy, substituted alkoxy, acyl, acylamino, acyloxy, amino, substituted amino, aminocarbonyl, aminothiocarbonyl, aminocarboxylic acid, aminocarboxylic acid amide, aminosulfonyl, aminosulfonylamido, amidino, aryl, substituted aryl, aryloxy, substituted aryloxy, arylthio, substituted arylthio, azido, carboxyl, carboxyl ester, (carboxyl ester)amino, (carboxyl ester)oxy, cyano, cycloalkyl, substituted cycloalkyl, cycloalkyloxy, substituted cycloalkyloxy, cycloalkyloxythio, substituted cycloalkyloxythio, guanidino, substituted guanidino, halo, hydroy, hydroxymino, alkoxymino, hydrazino, substituted hydrazino, heteroaryl, substituted heteroaryl, heteroaryl oxy, substituted heteroaryl oxy, heteroaryloxy, substituted heteroaryloxy, heteroaryloxythio, substituted heteroaryloxythio, heterocyclic, substituted heterocyclic, heterocyclyloxoy, substituted heterocyclyloxoy, heterocyclyloxythio, substituted heterocyclyloxythio, nitro, SO₃H, substituted sulfonyle, sulfonyleoxy, thioacetyl, thiocyanate, thiol, alkythio, and substituted alkythio, wherein said substituents are defined herein.

[0043]"Arylalkyl" or "Aryl(C₁-C₂)alkyl" refers to the radical -R³⁴-R³ where R³ is an aryl group as defined herein and R⁴ is an alkylene group (having 8 or fewer main chain carbon atoms) and R⁴ is an aryl group as defined herein. Thus, "arylalkyl" refers to groups such as, for example, benzyl and phenylethyl, and the like. Similarly, "arylalkenyl" means a radical -R³⁴-R⁴ where R³ is an aryl group (an alkylene group having 1 or 2 double bonds) and R⁴ is an aryl group as defined herein, e.g., styrenyl, 3-phenyl-2-propenyl, and the like.

[0044]"Aryloxy" refers to the group -O-arylamino, where ary is as defined herein, that includes, by way of example, phenoxy and naphthoxy.

[0045]"Substituted aryloxy" refers to the group -O-(substituted aryl) where substituted ary is as defined herein.

[0046]"Arylthio" refers to the group -S-arylamino, where ary is as defined herein.

[0047]"Substituted arylthio" refers to the group -S-(substituted aryl), where substituted ary is as defined herein.

[0048]"Azido" refers to the group -N₃.

[0049]"Hydrazino" refers to the group -NNH₂.

[0050]"Substituted hydrazino" refers to the group -N²R⁵-N²R⁶R²⁷ where R²⁶, R²⁷, and R²⁸ are independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, aryl, substituted aryl, carboxyl ester, cycloalkyl, substituted cycloalkyl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic.
substituted heterocyclic, and substituted sulfonyl and wherein R27 and R28 are optionally joined, together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, provided that R27 and R28 are both not hydrogen, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, cycloalkenyl, substituted cycloalkenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic, substituted heterocyclic and substituted sulfonyl are as defined herein.

[0051] "Cyano" or "carbonitrile" refers to the group -CN.
[0052] "Carbonyl" refers to the divalent group -C(O)- which is equivalent to -C(=O)-.
[0053] "Carboxy" or "carboxy" refers to -COOH or salts thereof.
[0054] "Carboxyl ester" or "carboxy ester" refers to the groups -C(O)O-alkyl, -C(O)O-substituted alkyl, -C(O)O-alkenyl, -C(O)O-substituted alkenyl, -C(O)O-aryl, -C(O)O-substituted aryl, -C(O)O-cycloalkyl, -C(O)O-substituted cycloalkyl, -C(O)O-heteroaryl, -C(O)O-substituted heteroaryl, and -C(O)O-substituted heterocyclic wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein.

[0055] "(Carboxyl ester)amino" refers to the group -NR20-C(O)O-alkyl, -NR20-C(O)O-substituted alkyl, -NR20-C(O)O-alkenyl, -NR20-C(O)O-substituted alkenyl, -NR20-C(O)O-aryl, -NR20-C(O)O-substituted aryl, -NR20-C(O)O-cycloalkyl, -NR20-C(O)O-substituted cycloalkyl, -NR20-C(O)O-heteroaryl, -NR20-C(O)O-substituted heteroaryl, and -NR20-C(O)O-substituted heterocyclic wherein R20 is alkyl or hydrogen, and wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein.

[0056] "(Carboxyl ester)oxy" refers to the group -O-C(O)O-alkyl, -O-C(O)O-substituted alkyl, -O-C(O)O-alkenyl, -O-C(O)O-substituted alkenyl, -O-C(O)O-aryl, -O-C(O)O-substituted aryl, -O-C(O)O-cycloalkyl, -O-C(O)O-substituted cycloalkyl, -O-C(O)O-heteroaryl, -O-C(O)O-substituted heteroaryl, and -O-C(O)O-heterocyclic, and -O-C(O)O-substituted heterocyclic wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic are as defined herein.

[0057] "Cy cloalkyl" refers to a saturated or partially saturated cyclic group of from 3 to 14 carbon atoms and no ring heteroatoms and having a single ring or multiple rings including fused, bridged, and spiro ring systems. For multiple ring systems having aromatic and non-aromatic rings that have no ring heteroatoms, the term "cy cloalkyl" applies when the point of attachment is at a non-aromatic carbon atom (e.g., 5,6,7,8-tetrahydroanaphthalene-5-yl). The term "cy cloalkyl" includes cy cloalkenyl groups. Examples of cy cloalkenyl groups include, for instance, adamantyl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, and cy clohexenyl. "Cy cloalkyl" refers to cy cloalkyl groups having u to v carbon atoms as ring members. "Cy cloalkyl" refers to cy cloalkenyl groups having u to v carbon atoms as ring members.

[0058] "Cy cloalkenyl" refers to a partially saturated cy cloalkyl ring having at least one site of >C = C< ring unsaturation.

[0059] "Substituted cy cloalkyl" refers to a cy cloalkyl group, as defined herein, having from 1 to 8, or 1 to 5, or, in some embodiments, 1 to 3 substituents selected from the group consisting of oxo, thione, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkyln, substituted alkyln, oxacyclic, acylic, acyloxy, amino, substituted amino, aminocarbonyl, aminothiocarbonyl, aminocarboxylamino, aminothiocarboxylamino, aminocarboxyloxy, amino-sulfonyl, aminosulfonfonylamino, aminosulfonfonylamino, amidino, aryl, substituted aryl, aryloxoy, substituted aryloxoy, arythio, substituted arythio, azido, carbonyl, cy cloalkyl ester, (carboxyl ester)amino, (carboxyl ester)oxy, cyano, cy cloalkyl, substituted cy cloalkyl, cy cloalkoxy, substituted cy cloalkoxy, cy cloalkythio, substituted cy cloalkythio, guanidino, substituted guanidino, halo, hydroxy, hydroxymino, alkoxymino, hydrazino, substituted hydrazino, heteroaryl, substituted heteroaryl, heteroarylthio, substituted heteroarylthio, heterocyclic, substituted heterocyclic, cy clohydroxyloxy, substituted cy clohydroxyloxy, cy clohydrothio, substituted cy clohydrothio, nitro, SO3H, substituted sulfonyl, sulfonyloxy, thiocacyl, thiocyanat, thiol, alkyln, and substituted alkyln, wherein said substituents are as defined herein. The term "substituted cy cloalkyl" includes substituted cy cloalkenyl groups.

[0060] "Cy cloalkoxy" refers to -O-cy cloalkyl wherein cy cloalkyl is as defined herein.
[0061] "Substituted cy cloalkoxy" refers to -O-(substituted cy cloalkyl) wherein substituted cy cloalkyl is as defined herein.
[0062] "Cy cloalkylthio" refers to -S-cy cloalkyl wherein substituted cy cloalkyl is as defined herein.
[0063] "Substituted cy cloalkylthio" refers to -S-(substituted cy cloalkyl) wherein substituted cy cloalkyl is as defined herein.
[0064] "Guanidino" refers to the group -NH2(-N=H)NH2.
[0065] "Substituted guanidino" refers to -NR29(-N=NR29)N(R29)2 where each R29 is independently selected from the group consisting of hydrogen, alkyl, substituted alkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic, and substituted heterocyclic and two R29 groups attached to a common guanidino nitrogen atom are optionally joined together with the nitrogen bound thereto to form a heterocyclic or substituted heterocyclic group, provided that at least
one R² is not hydrogen, and wherein said substituents are as defined herein.

[0066] "Halo" or "halogen" refers to fluoro, chloro, boro and iodo.

[0067] "Haloalkyl" refers to substitution of alkyl groups with 1 to 5 or, in some embodiments, 1 to 3 halo groups, e.g., -CH₂Cl, -CH₂F, -CH₂Br, -CFClBr, -CH₂CH₂Cl, -CH₂CH₂F, -CF₃, -CH₂CF₃, -CH₂CCl₃, and the like, and further includes those alkyl groups such as perfluoroalkyl in which all hydrogen atoms are replaced by fluorine atoms.

[0068] "Haloalkoxy" refers to substitution of alkoxy groups with 1 to 5 or, in some embodiments, 1 to 3 halo groups, e.g., -OCH₂Cl, -OCH₂F, -OCH₂CH₂Br, -OCH₂CH₂Cl, -OCH₂CF₃, and the like.

[0069] "Hydroxy" or "hydroxyl" refers to the group -OH.

[0070] "Heteroaryl" means an alkyl radical as defined herein with 1, 2 or 3 substituents independently selected from cyano, -ORw, -NRxRy, -SRz, -S(O)Rz, and -S(O)₂Rz (where n is 0, 1, or 2), with the understanding that the point of attachment of the heteroaryl radical is through a carbon atom of the heteroaryl radical. R⁰⁰ is hydrogen, alkyl, cycloalkyl, cycloalkyl-alkyl, aryl, alkylaryalkoxy, alkoxybenzyl, carbonamido, or mono- or di-alkylcarbamoyl. R¹ is hydrogen, alkyl, cycloalkyl, cycloalkyl-alkyl, aryl, or arylalkyl. R² is hydrogen, alkyl, cycloalkyl, cycloalkyl-alkyl, aryl, or arylalkyl. R³ is hydrogen, alkyl, cycloalkyl, cycloalkyl-alkyl, aryl, alkylaryalkoxy, arkoxybenzyl, carbonamido, mono- or di-alkylcarbamoyl or alkylosulfonyl. R⁴ is hydrogen, alkyl, cycloalkyl, cycloalkyl-alkyl, aryl, alkylarylalkyn, amino, mono-alkylaminino, di-alkylaminino, or hydroxyalkyn. Representative examples include, for example, 2-hydroxyethyl, 2,3-dihydroxypropyl, 2-methoxyethyl, benzyloxymethyl, 2-cyanoethyl, and 2-ethylhydroxyethyl. For each of the above, R⁰⁰, R¹, R², and R³ can be further substituted by amino, fluorine, alkylamino, di-alkylamino, OH or alkoxy. Additionally, the prefix indicating the number of carbon atoms (e.g., C₁⁰-C₁₂) refers to the total number of carbon atoms in the portion of the heteroaryl group exclusive of the cyano, -ORw, -NRxRy, -SRz, -S(O)Rz, and -S(O)₂Rz portions.

[0071] "Heteroaeryl" refers to an aromatic group of from 1 to 14 carbon atoms and 1 to 6 heteroatoms selected from the group consisting of oxygen, nitrogen, and sulfur, and includes a 5- to 18-member ring or ring system that includes a single ring (e.g., imidazolyl) or multiple rings (e.g., benzimidazol-2-yl and benzimidazol-6-yl). For multiple ring systems, including fused, bridged, and spiro ring systems having aromatic and non-aromatic rings, the term "heteroaeryl" applies if there is at least one ring heteroatom and the point of attachment is at a ring atom of an aromatic ring (e.g., 1,2,3,4-tetrahydroquinolin-6-yl and 5,6,7,8-tetrahydroquinolin-3-yl). In one embodiment, the nitrogen and/or the sulfur ring atom (s) of the heteroaeryl group are optionally oxidized to provide for the N-oxide (N-O), sulfynyl, or sulfonyl moieties. More specifically the term heteroaeryl includes, but is not limited to, pyridyl, furanyl, thiienyl, thiazolyl, isothiazolyl, tetrazolyl, triazolyl, imidazolyl, isoxazolyl, pyrrolyl, pyrazolyl, pyridazinyl, pyrimidinyl, benzofuranyl, tetrahydrobenzofuranyl, iso-benzofuranyl, benzothiazolyl, benzothiazolyl, indolyl, isoindolyl, benzoxazolyl, quinolyl, tetrahydroquinolinyl, isoquinolyl, quinazolinyl, benzimidazolyl, benzisoxazolyl, or benzothienyl.

[0072] "N-linked" refers to nitrogen containing groups in which the point of attachment is to the nitrogen atom of the nitrogen containing group. For example, "N-linked tetrazolyl" is a group in which the point of attachment is to a nitrogen atom of the tetrazolyl group. Similarly, N-linked triazolyl, N-linked imidazolyl, N-linked pyrazolyl and N-linked pyrrolyl are groups in which the point of attachment is to a nitrogen atom of the triazole, imidazole, pyrazole, and pyrrole group, respectively. Similarly, "N-linked imidazolyl" refers to an imidazole in which the point of attachment is to the nitrogen atom.

[0073] "Substituted heteroaeryl" refers to heteroaeryl groups that are substituted with from 1 to 8, or, in some embodiments, 1 to 5, or 1 to 3, or 1 to 2 substituents selected from the group consisting of the substituents defined for substituted aeryl.

[0074] "Heteroaeryloxy" refers to -O-heteroaeryl wherein heteroaeryl is as defined herein.

[0075] "Substituted heteroaeryloxy" refers to the group -O-(substituted heteroaeryl) wherein heteroaeryl is as defined herein.

[0076] "Heteroaerylthio" refers to the group -S-heteroaeryl wherein heteroaeryl is as defined herein.

[0077] "Substituted heteroaerylthio" refers to the group -S-(substituted heteroaeryl) wherein heteroaeryl is as defined herein.

[0078] "Heterocycle" or "heterocyclic" or "heterocyclo" or "heterocycloalkyl" or "heterocyclyl" refers to a saturated or partially saturated cyclic group having from 1 to 14 carbon atoms and from 1 to 6 heteroatoms selected from the group consisting of nitrogen, sulfur, or oxygen and includes single ring and multiple ring systems including fused, bridged, and spiro ring systems. For multiple ring systems having aromatic and/or non-aromatic rings, the term "heterocycle", "heterocyclo", "heterocycloalkyl" or "heterocyclyl" applies when there is at least one ring heteroatom and the point of attachment is at an atom of a non-aromatic ring (e.g., 1,2,3,4-tetrahydroquinoline-3-yl, 5,6,7,8-tetrahydroquinolone-6-yl, and decahydroquinoline-6-yl). In one embodiment, the nitrogen and/or sulfur atom(s) of the heterocycle group are optionally oxidized to provide for the N-oxide, sulfynyl, and sulfonyl moieties. More specifically the heterocycle includes, but is not limited to, tetrahydropranyl, piperidinyl, N-methylpiperidin-3-yl, piperazinyl, N-methylpyrrolidin-3-yl, 3-pyrrolidinyl, 2-pyrridon-1-yl, morpholinyl, and pyrrolidinyl. A prefix indicating the number of carbon atoms (e.g., C₃⁰-C₁⁰) refers to the total number of carbon atoms in the portion of the heterocycle group exclusive of the number of heteroatoms.

[0079] "Substituted heterocycle" or "substituted heterocyclic" or "substituted heterocyclo" or "substituted heterocycloalkyl" or "substituted heterocyclyl" refers to heterocycle groups, as defined herein, that are substituted with from 1 to
5 or, in some embodiments, 1 to 3 of the substituents as defined for substituted cycloalkyl.

[0080] "Heterocyclyloxy" refers to the group -O-heterocyclyl wherein heterocyclyl is as defined herein.

[0081] "Substituted heterocyclyloxy" refers to the group -O-(substituted heterocyclyl) wherein heterocyclyl is as defined herein.

[0082] "Heterocyclythio" refers to the group -S-heterocyclyl wherein heterocyclyl is as defined herein.

[0083] "Substituted heterocyclythio" refers to the group -S-(substituted heterocyclyl) wherein heterocyclyl is as defined herein.

[0084] Examples of heterocycle and heteroaryl groups include, but are not limited to, azetidine, pyrrole, imidazole, pyrazole, pyridine, pyrazine, pyrimidine, pyridazine, indolizine, isoindole, indole, dihydropyridone, indazole, purine, quinoline, isoquinoline, quinoline, phthalazine, naphthyridine, quinoxaline, quinazoline, cinnoline, pteridine, carbazole, carbonile, phenanthridine, acridine, phenanthroline, isothiazole, phenazine, isoxazole, phenoxazine, phenothiazine, imidazolidine, imidazoline, piperidine, piperezine, indoline, phthalimide, 1,2,3,4-tetrahydroisoquinoline, 4,5,6,7-tetrahydrobenzo[b]thiophene, thiazole, thiazolidine, thiophene, benzothiophene, morpholinyl, thiomorpholinyl (also referred to as thiamorpholinyl), 1,1-dioxothiomorpholinyl, piperidinyl, pyrrolidinyl, and tetrahydrofuranyl.

[0085] "Nitro" refers to the group -NO2.

[0086] "Oxo" refers to the atom (=O).

[0087] "Oxide" refers to products resulting from the oxidation of one or more heteroatoms. Examples include N-oxides, sulfoxides, and sulfones.

[0088] "Spirocycloalkyl" refers to a 3- to 10-member cyclic substituent formed by replacement of two hydrogen atoms at a common carbon atom with an alkylene group having 2 to 9 carbon atoms, as exemplified by the following structure wherein the methylene group shown below attached to bonds marked with wavy lines is substituted with a spirocycloalkyl group:

![Spirocycloalkyl Structure](image)

[0089] "Sulfonyl" refers to the divalent group -S(O)2-.

[0090] "Substituted sulfonyl" refers to the group -S(O)2-alkyl, -S(O)2-substituted alkyl, -S(O)2-alkenyl, -S(O)2-substituted alkenyl, -S(O)2-alkynyl, -S(O)2-substituted alkynyl, -S(O)2-cycloalkyl, -S(O)2-substituted cycloalkyl, -S(O)2-aryl, -S(O)2-substituted aryl, -S(O)2-heteroaryl, -S(O)2-substituted heteroaryl, -S(O)2-heterocyclic, wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein. Substituted sulfonyl includes groups such as methyl-S(O)2-, phenyl-S(O)2-, and 4-methylphenyl-S(O)2-.

[0091] "Sulfonyloxy" refers to the group -OS(O)2-alkyl, -OS(O)2-substituted alkyl, -OS(O)2-alkenyl, -OS(O)2-substituted alkenyl, -OS(O)2-alkynyl, -OS(O)2-substituted alkynyl, -OS(O)2-cycloalkyl, -OS(O)2-substituted cycloalkyl, -OS(O)2-aryl, -OS(O)2-substituted aryl, -OS(O)2-heteroaryl, -OS(O)2-substituted heteroaryl, -OS(O)2-heterocyclic, wherein alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein.

[0092] "Thiaocetyl" refers to the groups H-C(S)-, alkyl-C(S)-, substituted alkyl-C(S)-, alkynyl-C(S)-, substituted alkynyl-C(S)-, alkynyl-cycloalkyl-C(S)-, substituted alkynyl-cycloalkyl-C(S)-, alkynyl-aryl-C(S)-, substituted alkynyl-aryl-C(S)-, alkynyl-heteroaryl-C(S)-, substituted alkynyl-heteroaryl-C(S)-, and substituted alkynyl-heterocyclic-C(S)-, wherein alkyl, substituted alkyl, alkynyl, substituted alkynyl, cycloalkyl, substituted cycloalkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, heterocyclic and substituted heterocyclic are as defined herein.

[0093] "Thiol" refers to the group -SH.

[0094] "Alkylthio" refers to the group -S-alkyl wherein alkyl is as defined herein.

[0095] "Substituted alkylthio" refers to the group -S-(substituted alkyl) wherein substituted alkyl is as defined herein.

[0096] "Thiocarbonyl" refers to the divalent group -C(S)- which is equivalent to -C(=S)-.

[0097] "Thione" refers to the atom (=S).

[0098] "Thiocyanate" refers to the group -SCN.

[0099] "Compound" and "compounds" as used herein refers to a compound encompassed by the generic formulae disclosed herein, any subgenus of those generic formulae, and any forms of the compounds specified by the generic and subgeneric formulae, such as a pharmaceutically acceptable salt. Unless specified otherwise, the term further includes the isotoopes, racemates, stereoisomers, and tautomers of the compound or compounds.

[0100] "Isotopes" refer to pharmaceutically acceptable isotopically-labeled compounds wherein one or more atoms are replaced by atoms having the same atomic number, but an atomic mass different from the atomic mass usually
found in nature. Suitable isotopes include isotopes of hydrogen, such as $^2$H and $^3$H. Substitution with heavier isotopes such as deuterium, i.e. $^2$H, may afford certain therapeutic advantages resulting from greater metabolic stability, for example, increased in vivo half-life or reduced dosage requirements, and hence may be preferred in some circumstances.

[0101] "Racemates" refers to a mixture of enantiomers.

[0102] "Solvate" or "solvates" of a compound refer to those compounds, where compounds are as defined herein, that are bound to a stoichiometric or non-stoichiometric amount of a solvent. Solvates of a compound includes solvates of all forms of the compound such as the oxide, ester, prodrug, or pharmaceutically acceptable salt of the disclosed generic and subgeneric formulae. Preferred solvents are volatile, non-toxic, and/or acceptable for administration to humans. The present invention provides solvates of the compounds disclosed herein.

[0103] "Stereoisomer" or "stereoisomers" refer to compounds that differ in the chirality of one or more stereocenters. Stereoisomers include enantiomers and diastereomers. The compounds of this invention may exist in stereoisomeric form if they possess one or more asymmetric centers or a double bond with asymmetric substitution and, therefore, can be produced as individual stereoisomers or as mixtures. Unless otherwise indicated, the description is intended to include individual stereoisomers as well as mixtures. The methods for the determination of stereochemistry and the separation of stereoisomers are well-known in the art (see discussion in Chapter 4 of Advanced Organic Chemistry, 4th ed., J. March, John Wiley and Sons, New York, 1992).

[0104] "Tautomer" refers to alternate forms of a compound that differ in the position of a proton, such as enol-keto and imine-enamine tautomers, or the tautomeric forms of heteroaryl groups containing a ring atom attached to both a ring -NH- moiety and a ring =N-moiety such as pyrazoles, imidazoles, benzimidazoles, triazoles, and tetrazoles.

[0105] "Prodrug" refers to any derivative of a compound of the embodiments that is capable of directly or indirectly providing a compound of the embodiments or an active metabolite or derivative thereof when administered to a patient. Prodrugs of a compound of the present invention are prepared by modifying functional groups present in the compound in such a way that the modifications may be cleaved in vivo to release the parent compound, or an active metabolite. For example, prodrugs include compounds wherein a hydroxy, amino, or sulfhydryl group in a compound is bonded to any group that may be cleaved in vivo to regenerate the free hydroxyl, amino, or sulfhydryl group, respectively. Particularly favored prodrugs and prodrugs are those that increase the bioavailability of the compounds of the embodiments when such compounds are administered to a patient (e.g., by allowing an orally administered compound to be more readily absorbed into the blood) or which enhance delivery of the parent compound to a biological compartment (e.g., the brain or lymphatic system) relative to the parent species. Prodrugs include ester, amide, and carbamate (e.g., N,N-dimethylaminoester, N,N-dimethylaminocarbonyl) forms of hydroxy functional groups of compounds of the invention. Examples of ester prodrugs include formate, acetate, propionate, butyrate, acrylate, and ethylsuccinate derivatives. An general overview of prodrugs is provided in T Higuchi and V Stella, Pro-drugs as Novel Delivery Systems, Vol. 14 of the A.C.S. Symposium Series, and in Edward B. Roche, ed., Bioreversible Carriers in Drug Design, American Pharmaceutical Association and Pergamon Press, 1987.

[0106] "Pharmaceutically acceptable salt" refers to pharmaceutically acceptable salts derived from a variety of organic and inorganic counter ions well known in the art and includes, for example, sodium, potassium, calcium, magnesium, ammonium, and tetraalkylammonium. When the molecule contains a basic functionality, acid addition salts of organic or inorganic acids, such as hydrochloric acid, hydrobromic acid, sulfuric acid, nitric acid, phosphoric acid, and the like; or formed with organic acids such as acetic acid, propionic acid, hexanoic acid, cyclopentanepropionic acid, glycolic acid, pyruvic acid, lactic acid, malic acid, succinic acid, malic acid, maleic acid, tartaric acid, citric acid, benzoic acid, 3-(4-hydroxybenzoyl)benzoic acid, cinnamic acid, mandelic acid, methanesulfonic acid, ethanesulfonic acid, 1,2-ethane-disulfonic acid, 2-hydroxyethanesulfonic acid, benzenesulfonic acid, 4-chlorobenzenesulfonic acid, 2-naphthalenesulfonic acid, oxalic acid, 4-toluenesulfonic acid, camphorsulfonic acid, methanesulfonic acid, 4-methylbicyclo[2.2.2]oct-2-ene-1-carboxylic acid, glucoheptonic acid, 3-phenylpropionic acid, trimethylacetic acid, tertiary butylic acid, lauryl sulfuric acid, gluconic acid, glutamic acid, hydroxynaphthoic acid, salicylic acid, stearic acid, muconic acid, and the like. Salts can also be formed when an acidic proton present in the parent compound is either replaced by a metal ion, e.g., an alkali metal ion, an alkaline earth ion, or an aluminum ion; or coordinates with an organic base such as ethanolamine, diethanolamine, triethanolamine, trimethylamine, N-methylglucamine, and the like. Pharmaceutically acceptable salts are suitable for administration in a patient and possess desirable pharmacological properties. Suitable salts further include those described in P. Heinrich Stahl, Camille G. Wermuth (Eds.), Handbook of Pharmaceutical Salts Properties, Selection, and Use; 2002.

[0107] Unless indicated otherwise, the nomenclature of substituents that are not explicitly defined herein are arrived at by naming the terminal portion of the functionality followed by the adjacent functionality toward the point of attachment. For example, the substituent "aryalkyloxycarbonyl" refers to the group (aryl)-(alkyl)-O-C(O)-.

[0108] It is understood that in all substituted groups defined above, polymers arrived at by defining substituents with further substituents to themselves (e.g., substituted aryl having a substituted aryl group as a substituent which is itself substituted with a substituted aryl group, which is further substituted by a substituted aryl group, etc.) are not intended for inclusion herein. In such cases, the maximum number of such substitutions is three. For example, serial substitutions
Turning next to the compositions of the invention, the term "pharmaceutically acceptable carrier or excipient" means a carrier or excipient that is useful in preparing a pharmaceutical composition that is generally safe, and possesses acceptable toxicities. Acceptable carriers or excipients include those that are acceptable for veterinary use as well as human pharmaceutical use. A "pharmaceutically acceptable carrier or excipient" as used in the specification and claims includes both one and more than one such carrier or excipient.

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The term " optionally" or "optionally" as used throughout the specification means that the subsequently described event or circumstance may but need not occur, and that the description includes instances where the event or circumstance occurs and instances in which it does not. For example, "heterocyclyl group optionally mono- or di-substituted with an alkyl group" means that the alkyl may but need not be present, and the description includes situations where the heterocyclyl group is mono- or disubstituted with an alkyl group and situations where the heterocyclyl group is not substituted with the alkyl group.

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obese. Other types of disorders of glucose homeostasis include impaired glucose tolerance, which is a metabolic stage intermediate between normal glucose homeostasis and diabetes, and gestational diabetes mellitus, which is glucose intolerance in pregnancy in women with no previous history of Type I or Type II diabetes.

The term "metabolic syndrome" refers to a cluster of metabolic abnormalities including abdominal obesity, insulin resistance, glucose intolerance, diabetes, hypertension and dyslipidemia. These abnormalities are known to be associated with an increased risk of vascular events.

The guidelines for diagnosis of Type II diabetes, impaired glucose tolerance, and gestational diabetes have been outlined by the American Diabetes Association (see, e.g., The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, Diabetes Care, (1999) Vol. 2 (Suppl 1):S5-19).

The term "secretagogue" means a substance or compound that stimulates secretion. For example, an insulin secretagogue is a substance or compound that stimulates secretion of insulin.

The term "symptom" of diabetes, includes, but is not limited to, polyuria, polydipsia, and polyphagia, as used herein, incorporating their common usage. For example, "polyuria" means the passage of a large volume of urine during a given period; "polydipsia" means chronic, excessive thirst; and "polyphagia" means excessive eating. Other symptoms of diabetes include, e.g., increased susceptibility to certain infections (especially fungal and staphylococcal infections), nausea, and ketoacidosis (enhanced production of ketone bodies in the blood).

The term "complication" of diabetes includes, but is not limited to, microvascular complications and macrovascular complications. Microvascular complications are those complications that generally result in small blood vessel damage. These complications include, e.g., retinopathy (the impairment or loss of vision due to blood vessel damage in the eyes); neuropathy (nerve damage and foot problems due to blood vessel damage to the nervous system); and nephropathy (kidney disease due to blood vessel damage in the kidneys). Macrovascular complications are those complications that generally result from large blood vessel damage. These complications include, e.g., cardiovascular disease and peripheral vascular disease. Cardiovascular disease refers to diseases of blood vessels of the heart. See, e.g., Kaplan RM, et al., "Cardiovascular diseases" in Health and Human Behavior, pp. 206-242 (McGraw-Hill, New York 1993). Cardiovascular disease is generally one of several forms, including, e.g., hypertension (also referred to as high blood pressure), coronary heart disease, stroke, and rheumatic heart disease. Peripheral vascular disease refers to diseases of any of the blood vessels outside of the heart. It is often a narrowing of the blood vessels that carry blood to leg and arm muscles.

The term "atherosclerosis" encompasses vascular diseases and conditions that are recognized and understood by physicians practicing in the relevant fields of medicine. Atherosclerotic cardiovascular disease, coronary heart disease (also known as coronary artery disease or ischemic heart disease), cerebrovascular disease and peripheral vessel disease are all clinical manifestations of atherosclerosis and are therefore encompassed by the terms "atherosclerosis" and "atherosclerotic disease".

The term "antihyperlipidemic" refers to the lowering of excessive lipid concentrations in blood to desired levels.

The term "modulate" or "modulating" refers to the treating, prevention, suppression, enhancement, or induction of a function or condition. For example, compounds can modulate Type II diabetes by increasing insulin in a human, thereby suppressing hyperglycemia. Compounds can also modulate GPR120 by acting as GPR120 agonists.

The term "triglyceride(s)" ("TGs"), as used herein, incorporates its common usage. TGs consist of three fatty acid molecules esterified to a glycerol molecule. TGs store to serve fatty acids that are used by muscle cells for energy production or are taken up and stored in adipose tissue.

Because cholesterol and TGs are water insoluble, they must be packaged in special molecular complexes known as "lipoproteins" in order to be transported in the plasma. Lipoproteins can accumulate in the plasma due to overproduction and/or deficient removal. There are at least five distinct lipoproteins differing in size, composition, density, and function. In the cells of the small intestine, dietary lipids are packaged into large lipoprotein complexes called "chylomicrons", which have a high TG and low-cholesterol content. In the liver, TG and cholesterol esters are packaged and released into plasma as TG-rich lipoprotein called very low density lipoprotein ("VLDL"), whose primary function is the endogenous transport of TGs made in the liver or released by adipose tissue. Through enzymatic action, VLDL can be either reduced and taken up by the liver, or transformed into intermediate density lipoprotein ("IDL"). IDL, is in turn, either taken up by the liver, or is further modified to form low density lipoprotein ("LDL"). LDL is either taken up and broken down by the liver, or is taken up by extrahepatic tissue. High density lipoprotein ("HDL") helps remove cholesterol from peripheral tissues in a process called reverse cholesterol transport.

The term "dyslipidemia" refers to abnormal levels of lipoproteins in blood plasma including both depressed and/or elevated levels of lipoproteins (e.g., elevated levels of LDL and/or VLDL, and depressed levels of HDL).

The term "hyperlipidemia" includes, but is not limited to, the following:
mimics the effect of an endogenous ligand, a hormone for example, and produces a physiological response similar to molecule involved in many biological processes, including glucose and lipid metabolism. 

peptide hormone produced primarily by K cells. GIP stimulates insulin secretion. GIP also has significant effects on lipid secretion and gastric emptying in the stomach, and decreases food intake by increasing satiety.

Incretins include GLP-1 and GIP. The term "GLP-1" or "glucagon-like peptide" is a peptide hormone primarily produced by L cells. GLP-1 increases receptors in insulin sensitive cells and mediates glucose uptake. Insulin is used to treat Type I diabetes and may be used to treat Type II diabetes.

The term "agonist" refers to a compound that binds to a receptor and triggers a response in a cell. An agonist mimics the effect of an endogenous ligand, a hormone for example, and produces a physiological response similar to

Risk factors for hyperlipidemia include, but are not limited to, the following: (1) disease risk factors, such as a history of Type I diabetes, Type II diabetes, Cushing's syndrome, hypothyroidism and certain types of renal failure; (2) drug risk factors, which include, birth control pills; hormones, such as estrogen, and corticosteroids; certain diuretics; and various β-blockers; (3) dietary risk factors include dietary fat intake per total calories greater than 40%; saturated fat intake per total calories greater than 10%; cholesterol intake greater than 300 mg per day; habitual and excessive alcohol use; and obesity.

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The terms "obese" and "obesity" refers to, according to the World Health Organization, a Body Mass Index ("BMI") greater than 27.8 kg/m² for men and 27.3 kg/m² for women (BMI equals weight (kg)/height (m²)). Obesity is linked to a variety of medical conditions including diabetes and hyperlipidemia. Obesity is also a known risk factor for the development of Type II diabetes (see, e.g., Barrett-Conner E, Epidemiol. Rev. (1989) 11:172-181; and Knowler, et al., Am. J. Clin. Nutr. (1991) 53:1543-1551).

The term "pancreas" refers to a gland organ in the digestive and endocrine system of vertebrates, including mammals. The pancreas secretes both digestive enzymes and hormones such as insulin, GLP-1 and GIP, as well as other hormones.

The term "beta cell" refers to cells found in the islet of Langerhans that secrete insulin, amylin, and other hormones.

The term "endocrine cell" refers to cells that secrete hormones into the blood stream. Endocrine cells are found various glands and organ systems of the body including the pancreas, intestines, and other organs.

The term "L cell" refers to gut endocrine cells that produce GLP-1.

The term "K cell" refers to gut endocrine cells thatproduce GIP.

The term "incretin" refers to a group of hormones that increases insulin secretion in response to food intake. Incretins include GLP-1 and GIP.

The term "insulin" refers to a polypeptide hormone that regulates glucose metabolism. Insulin binds to insulin receptors in insulin sensitive cells and mediates glucose uptake. Insulin is used to treat Type I diabetes and may be used to treat Type II diabetes.

The term "GLP-1" or "glucagon-like peptide" is a peptide hormone primarily produced by L cells. GLP-1 increases insulin secretion, decreases glucagon secretion, increases beta cell mass and insulin gene expression, inhibits acid secretion and gastric emptying in the stomach, and decreases food intake by increasing satiety.

The term "GIP" or "gastric inhibitory peptide" or "glucose dependent insulinotropic polypeptide" refers to a peptide hormone produced primarily by K cells. GIP stimulates insulin secretion. GIP also has significant effects on lipid metabolism.

The term "cAMP" or "cyclic AMP" or "cyclic adenosine monophosphate" refers to an intracellular signaling molecule involved in many biological processes, including glucose and lipid metabolism.

The term "agonist" refers to a compound that binds to a receptor and triggers a response in a cell. An agonist mimics the effect of an endogenous ligand, a hormone for example, and produces a physiological response similar to
that produced by the endogenous ligand.

The term “partial agonist” refers to a compound that binds to a receptor and triggers a partial response in a cell. A partial agonist produces only a partial physiological response of the endogenous ligand.

Accordingly, in one embodiment, provided is a compound of Formula (I)

or a pharmaceutically acceptable salt thereof, wherein:

- $A_1, A_2, A_3,$ and $A_4$ are independently selected from the group consisting of N and C, with the proviso that only 0, 1, or 2 of $A_1, A_2, A_3,$ and $A_4$ is N;
- one of $X$ and $Y$ is a bond or $-\text{CH}_2-, -C_2\text{H}_4-$ and the other of $X$ and $Y$ is selected from the group consisting of $-\text{CH}_2-$, $-\text{C}(\text{O})-$, $-\text{C}(\text{O})\text{NR}_a-$, $-\text{NR}_a-$, $-\text{O}-$, $-\text{S}-$, $-\text{S(O)}-$, and $-\text{S(O)}_2-$;
- $E^1, E^2,$ and $E^3$ are independently selected from the group consisting of C and N;
- one of $W^1, W^2, W^3,$ and $W^4$ is independently selected from the group consisting of a bond, $\text{NR}_a$, $\text{CR}_1\text{R}_2$, $\text{O}$, $\text{S}$, $\text{S(O)}$, and $\text{S(O)}_2$, and the remaining $W^1, W^2, W^3,$ and $W^4$ are all $\text{CR}_1\text{R}_2$;
- $L$ is $-(\text{CR}_4\text{R}_5)_q$ wherein optionally one $-(\text{CR}_4\text{R}_5)_q$ is replaced with $-\text{O}-$ or $-\text{S}$; the subscript $k$ is 0, 1, 2, or 3;
- the subscript $m$ is 0, 1, 2, or 3;
- the subscript $q$ is 0, 1, 2, 3, or 4;
- $G$ is selected from the group consisting of

- $\text{C(O)OZ}_1$
- $\text{C(O)NZ}_2$
- each $Z$ is independently selected from the group consisting of H, alkyl, and substituted alkyl;
- each $R^1$ and $R^2$ is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, oxo, CN,
-OR_a, -NR_aR_b, -C(O)Ra, -C(O)OR_a, -C(O)NR_aR_b, -SR_a, -S(O)Ra, and -S(O)_2Ra, and optionally R_1 and R_2 can cyclize to form a 3-, 4-, 5-, or 6-membered heterocyclyl or cycloalkyl ring;

each R_3 is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, alkoxy, amino, substituted amino, aryloxy, and -CN;

each R_4 and R_5 is independently selected from the group consisting H, fluoro, alkyl, substituted alkyl, and alkoxy, and optionally R_4 and R_5 can cyclize to form a 3-, 4-, 5-, or 6-membered heterocyclyl or cycloalkyl ring;

each R_6 is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, CN, -OR_a, -NR_aR_b, -C(O)Ra, -C(O)OR_a, -C(O)NR_aR_b, -NR_aC(O)R_b, -SR_a, -S(O)Ra, and -S(O)_2Ra;

each of R_a and R_b is independently selected from the group consisting of H, alkyl, substituted alkyl, cycloalkyl, heterocyclyl, substituted heterocyclyl, alkenyl, alkynyl, aryl, substituted aryl, heteroaryl, and substituted heteroaryl.

In some aspects, W_4 is O, W_3 is a bond, and W_1 and W_2 are both CR_1R_2. In further aspects, W_1 is O, W_2 is a bond, and W_3 and W_4 are both CR_1R_2.

In one embodiment, provided is a compound of Formula (II) or Formula (III) or a pharmaceutically acceptable salt thereof, wherein:

A_1, A_2, and A_4 are independently selected from the group consisting of N and C,

with the proviso that only 0, 1, or 2 of A_1, A_2, and A_4 is N;

one of X and Y is a bond or -CH_2-, -C_2H_4- and the other of X and Y is selected from the group consisting of -CH_2-, -C(O)-, -C(O)NR_a, -NR_a-, -O-, -S-, -S(O)-, and -S(O)_2-;

E_1, E_2, and E_3 are independently selected from the group consisting of C and N;

one of W_1, W_2, W_3, and W_4 is independently selected from the group consisting of a bond, NR_a, CR_1R_2, O, S, S(O), and S(O)_2, and the remaining W_1, W_2, W_3, and W_4 are all CR_1R_2;

L is -(CR_4R_5)_q- wherein optionally one -(CR_4R_5)_q- is replaced with -O- or -S-;

the subscript k is 0, 1, 2, or 3;

the subscript m is 0, 1, 2, or 3;

the subscript q is 0, 1, 2, or 3;

G is selected from the group consisting of C(O)OZ.
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C(O)NZ₂.

each Z is independently selected from the group consisting of H, alkyl, and substituted alkyl;
each R¹ and R² is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, oxo, CN, -OR¹, -NR¹R², -C(O)R², -C(O)OR¹, -C(O)NR¹R², -NR¹C(O)R², -S(O)²R², and -S(O)²R²; and optionally R¹ and R² can cyclize to form a 3- 4-, 5-, or 6-membered heterocyclyl or cycloalkyl ring;
each R³ is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, alkoxy, substituted alkoxy, amino, substituted amino, aryloxy, and -CN;
each R⁴ and R⁵ is independently selected from the group consisting of H, fluoro, alkyl, substituted alkyl, and alkoxy, and optionally R⁴ and R⁵ can cyclize to form a 3-, 4-, 5-, or 6-membered heterocyclyl or cycloalkyl ring;
each R⁶ is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, CN, -OR¹, -NR¹R², -C(O)R², -C(O)OR¹, -C(O)NR¹R², -SR¹, -S(O)²R², and -S(O)²R²; each of R¹ and R² is independently selected from the group consisting of H, alkyl, substituted alkyl, alkoxy, substituted alkoxy, amino, substituted amino, aryloxy, and -CN; each R³ is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, alkoxy, substituted alkoxy, amino, substituted amino, aryloxy, and -CN; each R⁴ and R⁵ is independently selected from the group consisting of H, fluoro, alkyl, substituted alkyl, and alkoxy, and optionally R⁴ and R⁵ can cyclize to form a 3-, 4-, 5-, or 6-membered heterocyclyl or cycloalkyl ring; each R⁶ is independently selected from the group consisting of H, halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, CN, -OR¹, -NR¹R², -C(O)R², -C(O)OR¹, -C(O)NR¹R², -SR¹, -S(O)²R², and -S(O)²R²; each of R¹ and R² is independently selected from the group consisting of H, alkyl, substituted alkyl, alkoxy, substituted alkoxy, amino, substituted amino, aryloxy, and substituted heteroaryl.

[0152] In some embodiments, W⁴ is O, W³ is a bond, and W¹ and W² are both CR¹R². In some aspects, G is -C(O) OZ. In some such aspects, Z is H.
[0153] In some embodiments, W¹ is O, W² is a bond, and W³ and W⁴ are both CR¹R². In some aspects, G is -C(O) OZ. In some such aspects, Z is H.
[0154] In some embodiments, each R¹ and R² is independently selected from the group consisting of H, fluoro, -CH₃, and -CF₃.
[0155] In some embodiments, R¹ and R² cyclize to form a 3- to 6-membered heterocyclyl or cycloalkyl ring.
[0156] In some embodiments, E¹, E², and E³ are all C.
[0157] In some embodiments, A¹, A², A³, and A⁴ are all C.
[0158] In some embodiments, A¹, A², and A⁴ are all C.
[0159] In yet another aspect, W⁴ is O; W³ is a bond; and W¹ and W² are both CR¹R²; E¹, E², and E³ are all C; and A¹, A², A³, and A⁴ are all C.
[0160] In some embodiments, X and Y are selected from the group consisting of C and O. In some aspects, X is -CH₂- and Y is O.
[0161] In some embodiments, R⁵ is independently selected from the group consisting of fluoro, chloro, -CH₃, and -CF₃. In some aspects, m is 1.
[0162] In some embodiments, R⁶ is independently selected from the group consisting of fluoro, chloro, -CH₃, and -CF₃. In some aspects, k is 0, 1, or 2.
[0163] In some embodiments, the subscript q is 1 or 2.
[0164] In some embodiments, R⁴ and R⁵ are independently selected from the group consisting of H and CH₃.
[0165] In some embodiments, R⁴ and R⁵ cyclize to form a cyclopropyl ring.
[0166] In one embodiment, provided are esters of the compounds of Formula (I), (II) and (III). In some embodiments, the esters are compounds wherein the carboxylic acid group is derivatized to be an ester, such as when Z in the formulae is alkyl or substituted alkyl.
In some aspects of the compounds of Formula (I), $W_4$ is O; $W_3$ is a bond; and $W_1$ and $W_2$ are both CR$_1R_2$; $E_1$, $E_2$, and $E_3$ are all C; $X$ is -CH$_2$-; $Y$ is -O-; the subscript $q$ is 2; and $G$ is -C(O)OZ.

In some aspects of the compounds of Formula (II) and (III), $W_4$ is O; $W_3$ is a bond; and $W_1$ and $W_2$ are both CR$_1R_2$; $E_1$, $E_2$, and $E_3$ are all C; $A_1$, $A_2$, and $A_4$ are all C; $X$ is -CH$_2$-; $Y$ is -O-; the subscript $q$ is 1; and $G$ is -C(O)OZ.

In one embodiment, provided is a compound of Formula (A)

![Diagram](image)

or a pharmaceutically acceptable salt thereof, wherein:

- the group $J$ is absent or selected from the group consisting

![Diagram](image)

- the ring $Q$ is selected from the group consisting of aryl, heteroaryl,

![Diagram](image)

wherein $Q$ is optionally substituted with (R$_6$)$_k$;

- $A_1$, $A_2$, $A_3$ and $A_4$ are independently selected from the group consisting of N and C, with the proviso that only 0, 1 or 2 of $A_1$, $A_2$, $A_3$ and $A_4$ is N;
- $T_1$, $T_2$, $T_3$ and $T_4$ are independently selected from the group consisting of N, O, CR$_1$ and CR$_1$R$_2$, with the proviso that only 0, 1 or 2 of $T_1$, $T_2$, $T_3$ and $T_4$ is selected from N and O;
- $W_1$, $W_2$, $W_3$ and $W_4$ are independently selected from the group consisting of N, NR$_a$, CR$_1$, CR$_1$R$_2$, O, S, S(O) and S(O)$_2$, with the proviso that ring $J$ is not 1,3-dioxolane;
- $E_1$, $E_2$ and $E_3$ are independently selected from the group consisting of C and N;
- one of $X$ and $Y$ is a bond, -CH$_2$-, -CHD-, or -CD$_2$-, and the other of $X$ and $Y$ is selected from the group consisting of -CH$_2$-, -CHD-, -CD$_2$-, -C(O), -C(O)NR$_a$, -NR$_a$-, -O-, -S-, -S(O)- and -S(O)$_2$-;
- $L$ is -(CR$_4$R$_5$)$_q$ wherein optionally one -(CR$_4$R$_5$)- is replaced with -N-, -O-, -S-, -CR$_4$=CR$_5$- or -phenyl-;
- $G$ is selected from the group consisting of -C(O)OZ and -C(O)NZ$_2$;
- each $Z$ is independently selected from the group consisting of H, alkyl and substituted alkyl;
- each R$_1$ and R$_2$ is independently selected from the group consisting of H, deuterium, halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alky- nyl, oxo, alkoxy, substituted alkoxy, CN, -NR$_a$R$_b$, -C(O)R$_a$, -C(O)OR$_a$, -C(O)NR$_a$R$_b$, -NR$_a$C(O)R$_b$, -SR$_a$, -S(O)R$_a$ and -S(O)$_2$R$_a$, and optionally R$_1$ and R$_2$ can cyclize to form a C$_{3-7}$-heterocyclyl, substituted C$_{3-7}$-heterocyclyl, spiro C$_{3-7}$-heterocyclyl, substituted spiro C$_{3-7}$-heterocyclyl, C$_{3-7}$-cycloalkyl, substituted C$_{3-7}$-cycloalkyl, spiroC$_{3-7}$-cycloalkyl or spiro substituted C$_{3-7}$cycloalkyl;
each $R^3$ is independently selected from the group consisting of H, halo, alkyl,
substituted alkyl, alkoxy, substituted alkoxy, -C(O)NRaRb, -NRaC(O)Rb, aryl, substituted aryl, heteroaryl,
substituted heteroaryl, arylalkoxy, substituted arylalkoxy and -CN;

each $R^4$ and $R^5$ is independently selected from the group consisting of H, deuterium,
fluoro, alkyl, substituted alkyl, alkoxy and substituted alkoxy, and optionally $R^4$ and $R^5$ can cyclize to form a
$C_{3-7}$heterocyclyl, substituted $C_{3-7}$heterocyclyl, spiro $C_{3-7}$heterocyclyl, substituted spiro $C_{3-7}$heterocyclyl,
$C_{3-7}$cycloalkyl, substituted $C_{3-7}$cycloalkyl, spiro$C_{3-7}$cycloalkyl or spiro substituted $C_{3-7}$cycloalkyl;
each $R^6$ is independently selected from the group consisting of H, halo, alkyl, aryl, substituted aryl,
substituted heteroaryl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted
alkynyl, CN, -ORa, -NRaRb, -C(O)Ra, -C(O)ORa, -C(O)NRaRb, -NRaC(O)Rb, -SRa, -S(O)Ra and -S(O)2Ra;
each of $R^a$ and $R^b$ is independently selected from the group consisting of H, alkyl, substituted alkyl, cycloalkyl,
substituted heterocyclyl, alkenyl, alkynyl, aryl, substituted aryl, heteroaryl and substituted heteroaryl.

the subscript $k$ is 0, 1, 2 or 3;
the subscript $m$ is 0, 1, 2 or 3; and
the subscript $q$ is 0, 1, 2, 3 or 4.

In another embodiment, provided is a compound of Formula (B)

or a pharmaceutically acceptable salt thereof wherein $R^1$, $R^2$, $R^3$, $R^6$, $W^1$, $W^3$, $E^1$, $E^2$, $E^3$, $X$, $Y$, $Q$, $L$, $G$, $m$ and $k$ are as defined in Formula (A) provided that $W^1$ and $W^3$ are not both O.

In some embodiments of the compound of Formula (B), $W^1$ and $W^3$ are independently selected from the group consisting of CR$^1$R$^2$ and O.

In some embodiments, provided is a compound of Formula (C):

or a pharmaceutically acceptable salt thereof wherein $R^1$, $R^2$, $R^3$, $R^6$, $E^1$, $E^2$, $E^3$, $X$, $Y$, $L$, $G$, $m$ and $k$ are as defined.

In some embodiments, provided is a compound of Formula (C) wherein $E^1$, $E^2$ and $E^3$ are all C.

In some aspects, $X$ is selected from the group consisting of -CH$_2$-, -CHD- and -CD$_2$-, and $Y$ is O.

In a further aspect, in $L$ the subscript $q$ is 2 or 3. In some aspects, the subscript $q$ is 2.

In a further aspect, $G$ is —C(O)OZ. In some aspects, $Z$ is alkyl or H.

In a further aspect, the subscript $m$ is 1 or 2, and each $R^3$ is independently selected from the group consisting of halo, alkyl, substituted alkyl, alkoxy and substituted alkoxy. In some aspects, each $R^3$ is independently selected from...
the group consisting of F, Cl, -CH₃, -CF₃ and —OCH₃.

[0178] In a further aspect, R¹ and R² are independently selected from the group consisting of C₁₋₃alkyl and -CF₃. In some aspects, R¹ and R² are both —CH₃.

[0179] In a further aspect, the subscript k is 0, 1 or 2.

[0180] In a further aspect, each R⁶ is independently selected from the group consisting of fluoro, chloro, -CH₃, -C₂H₅ and -CF₃.

[0181] In one embodiment of the compound of Formula (A), Q is

[0182] In some aspects, the ring J is absent and each R³ is independently selected from the group consisting of alkoxy, substituted alkoxy and halo.

[0183] In another embodiment, provided is a synthetic intermediate or a compound or a pharmaceutically acceptable salt thereof as described in the Examples.

[0184] In other embodiments provided are compound agonists or a pharmaceutically acceptable salt thereof or synthetic intermediates thereof as exemplified in Chemical Examples section below.

[0185] In some embodiments, the compounds of Formula (I)-(III) and (A)-(C) and pharmaceutically acceptable salts thereof have an EC₅₀ against human GPR120 of 10⁻⁸ M or less. In other aspects, the compounds have an EC₅₀ of greater than 10⁻⁸ M and less than or equal to 10⁻⁶ M. In other aspects the compounds have an EC₅₀ of 1 μM or less.

Preparation of Compounds of the Invention

[0186] The compounds of the present invention can be prepared in a number of ways familiar to one skilled in the art of organic chemistry synthesis. The synthetic route of compounds in the present invention is not limited to the methods outlined herein or as provided in the Examples. Individual compounds may require manipulation of the conditions in order to accommodate various functional groups and may require appropriate use of protecting groups. Purification, if necessary, can be accomplished on a silica gel column eluted with the appropriate organic solvent system. Also, reverse phase HPLC or recrystallization may be employed.

Compositions and Methods of Treatment

[0187] In accordance with the present invention methods of treating a disease or condition selected from the group consisting of Type I diabetes, Type II diabetes and metabolic syndrome are provided. The method comprises administering to a subject in need of such treatment a therapeutically effective amount of a compound of the present invention.

[0188] In another aspect, methods of raising intracellular levels of Ca²⁺ in a cell expressing GPR120 are provided. The method comprises exposing a cell that expresses GPR120 to a compound of the invention. Ca²⁺ levels are determined by the methods disclosed in the Example sections herein.

[0189] In one embodiment, the cell that expresses GPR120 is a pancreatic cell, an islet cell, or a beta cell, an intestinal endocrine cell, an L cell or a K cell.

[0190] Another aspect of the invention provides a method of stimulating insulin production in a mammal, in particular a human. The method comprises administering a therapeutically effective amount of a compound of the invention to the mammal. In response to administration of a compound to the subject, insulin is produced by the beta cells. Biological Example 3 provides detailed methods by which a skilled artisan can measure insulin secretion in laboratory animals in response to administration of a compound of the invention.

[0191] In another aspect, the invention provides a method of stimulating insulin secretion in a mammal, in particular a human. The method comprises administering a therapeutically effective amount of a compound of the invention to the mammal. After administration to the subject, insulin is secreted into the blood stream by the beta cells.

[0192] A further aspect of the invention provides a method of stimulating glucose-dependent insulin secretion in a mammal, in particular a human. The method comprises administering a therapeutically effective amount of a compound of the invention to the mammal. After administration to the subject, insulin is secreted into the blood stream by the beta cells in a glucose-dependent manner. Biological Example 4 provides methods that show the blood glucose lowering effects of the compounds of the invention.

[0193] In another embodiment, the invention provides methods of lowering blood glucose in a mammal, preferably a
human. The method comprises administering a therapeutically effective amount of a compound of the invention to the
mammal. In response to administration of a compound to the subject, blood glucose levels are lowered. The method
further comprises steps to measure blood glucose levels before and after administration of a compound of the invention.
Blood glucose levels are easily measured by numerous commercially available glucose monitoring devices that measure
blood glucose from samples of blood or urine. Blood glucose can also be measured by commercially available glucometers
that do not require blood or urine samples. Biological Examples 3 and 4 provide methods that teach how to measure
improvements in diabetes parameters, including blood glucose monitoring.

Another aspect of the invention provides a method of stimulating incretin production in a mammal, in particular
a human. The method comprises administering a therapeutically effective amount of a compound of the invention to the
mammal. In response to administration of a compound to the subject, glucagon-like peptide 1 and glucose-dependent
insulinotropic polypeptide is produced by the intestinal endocrine cells. Biological Example 5 provides detailed methods
by which a skilled artisan can measure incretin production in laboratory animals in response to administration of a
compound of the invention.

Combination Therapy

As noted above, the compounds of the present invention will, in some instances, be used in combination with
other therapeutic agents to bring about a desired effect. Selection of additional agents will, in large part, depend on the
21:160-178; and DeFronzo R, et al. (eds.), Diabetes Reviews (1997) Vol. 5 No. 4). A number of studies have investigated
Current Therapy in Endocrinology and Metabolism, 6th Ed. (Mosby - Year Book, Inc., St. Louis, MO 1997); Chiasson J,
(12A):3U-17U). These studies indicate that diabetes modulation can be further improved by the addition of a second
agent to the therapeutic regimen. Combination therapy includes administration of a single pharmaceutical dosage
formulation that contains a compound as provided herein and one or more additional active agents, as well as administration
of a compound as provided herein and each active agent in its own separate pharmaceutical dosage formulation. For
example, a compound as provided herein and a DPP4 inhibitor can be administered to the human subject together in
a single oral dosage composition, such as a tablet or capsule, or each agent can be administered in separate oral dosage
formulations. Where separate dosage formulations are used, a compound as provided herein and one or more additional
active agents can be administered at essentially the same time (i.e., concurrently), or at separately staggered times
(i.e., sequentially). Combination therapy is understood to include all these regimens.

Another example of combination therapy can be seen in modulating (preventing the onset of the symptoms or
complications associated with) diabetes (or treating, preventing or reducing the risk of developing diabetes and its related
symptoms, complications, and disorders), wherein a compound as provided herein can be effectively used in combination
with, for example, biguanides (such as metformin); thiazolidinediones (such as ciglitazone, pioglitazone, troglitazone,
and rosiglitazone); dipeptidyl-peptidase-4 ("DPP4") inhibitors (such as vildagliptin and sitagliptin); glucagon-like peptide-
1 ("GLP-1") receptor agonists (such as exanatide) (or GLP-1 mimetics); PPAR gamma agonists or partial agonists; dual
PPAR alpha, PPAR gamma agonists or partial agonists; dual PPAR delta, PPAR gamma agonists or partial agonists;
pan PPAR agonists or partial agonists; dehydroepiandrosterone (also referred to as DHEA or its conjugated sulphate
ester, DHEA-SO4); antiglucocorticoids; TNF-alpha inhibitors; alpha-glucosidase inhibitors (such as acarbose, miglitol,
and voglibose); sulfonlyureas (such as chlorpropamide, tolbutamide, acetohexamide, tolazamide, glyburide, gliclazide,
glumepiride, and glipizide); pramlintide (a synthetic analog of the human hormone amylin); other insulin secretagogues
(such as repaglinide, glicludone, and nateglinide); insulin (or insulin mimetics); glucagon receptor antagonists; gastric
inhibitory peptide ("GIP"); or GIP mimetics; as well as the active agents discussed below for treating obesity, hyperlipi-
demia, atherosclerosis and/or metabolic syndrome.

Another example of combination therapy can be seen in treating obesity or obesity-related disorders, wherein
a compound as provided herein can be effectively used in combination with, for example, phenylpropanolamine,
phenteramine; diethylpropion; mazindol; fenfluramine; dexfenfluramine; phentiramine, beta-3 adrenoceptor agonist agents;
sibutramine; gastrointestinal lipase inhibitors (such as orlistat); and leptins. Other agents used in treating obesity or
obesity-related disorders wherein a compound as provided herein can be effectively used in combination with, for
example, cannabinoid-1 ("CB-1") receptor antagonists (such as rimonabant); PPAR delta agonists or partial agonists;
dual PPAR alpha, PPAR delta agonists or partial agonists; dual PPAR delta, PPAR gamma agonists or partial agonists;
pan PPAR agonists or partial agonists; neuropeptide Y; enterostatin; cholecotokinin; bombesin; amylin; histamine H3
receptors; dopamine D2 receptors; melanocyte stimulating hormone; corticotrophin releasing factor; galanin; and gamma
amino butyric acid (GABA).
Still another example of combination therapy can be seen in modulating hyperlipidemia (treating hyperlipidemia and its related complications), wherein a compound as provided herein can be effectively used in combination with, for example, statins (such as atorvastatin, fluuvastatin, lovastatin, pravastatin, and simvastatin), CETP inhibitors (such as torcetrapib); a cholesterol absorption inhibitor (such as ezetimibe); PPAR alpha agonists or partial agonists; PPAR delta agonists or partial agonists; dual PPAR alpha, PPAR delta agonists or partial agonists; dual PPAR alpha, PPAR gamma agonists or partial agonists; dual PPAR delta, PPAR gamma agonists or partial agonists; pan PPAR agonists or partial agonists; fenofibric acid derivatives (such as gemfibrozil, clofibrate, fenofibrate, and bezafibrate); bile acid-binding resins (such as colestipol or cholestyramine); nicotinic acid; probucol; betacarotene; vitamin E; or vitamin C.

A further example of combination therapy can be seen in modulating atherosclerosis, wherein a compound as provided herein is administered in combination with one or more of the following active agents: an antihyperlipidemic agent; a plasma HDL-raising agent; an antihypercholesterolemic agent, such as a cholesterol biosynthesis inhibitor, and a HMG-CoA reductase inhibitor, such as atorvastatin, lovastatin, fluvastatin, and simvastatin; an HMG-CoA synthase inhibitor; a squalene epoxidase inhibitor; or a squalene synthetase inhibitor; an antihypercholesterolemic agent, such as a cholesterol biosynthesis inhibitor, for example, statins (such as atorvastatin, fluvastatin, lovastatin, pravastatin, and simvastatin) and aspirin, or a compound as provided herein with an HMG-CoA reductase inhibitor (e.g., atorvastatin, fluvastatin, lovastatin, pravastatin, and simvastatin) and aspirin. As noted above, a compound as provided herein can be administered in combination with more than one additional active agent, for example, a combination of a compound as provided herein with an HMG-CoA reductase inhibitor (e.g., atorvastatin, fluvastatin, lovastatin, pravastatin, and simvastatin) and aspirin, or a compound as provided herein with an HMG-CoA reductase inhibitor and a β-blocker.

Additionally, a therapeutically effective amount of a compound as provided herein and a therapeutically effective amount of one or more active agents selected from the group consisting of: an antihyperlipidemic agent; a plasma HDL-raising agent; an antihypercholesterolemic agent, such as a cholesterol biosynthesis inhibitor, for example, an HMG-CoA reductase inhibitor; an HMG-CoA synthase inhibitor; a squalene epoxidase inhibitor, or a squalene synthetase inhibitor (also known as squalene synthase inhibitor); an acyl-coenzyme A cholesterol acyltransferase (ACAT) inhibitor, such as melaminamide; probucol; nicotinic acid and the salts thereof and niacinamide; a cholesterol absorption inhibitor, such as β-sitosterol; a bile acid sequestrant anion exchange resin, such as cholestyramine, colestipol or di-alkylaminooalkyl derivatives of a cross-linked dextran; an LDL receptor inducer; fibrates, such as clofibrate, bezafibrate, fenofibrate, and gemfibrozil; vitamin B₆ (also known as pyridoxine) and the pharmaceutically acceptable salts thereof, such as the HCI salt; vitamin B₁₂ (also known as cyanocobalamin); vitamin B₃ (also known as nicotinic acid and niacinamide); anti-oxidant vitamins, such as vitamin C and E and beta carotene; a β-blocker; an angiotensin II antagonist; an angiotensin converting enzyme inhibitor; PPAR alpha agonists or partial agonists; PPAR delta agonists or partial agonists; PPAR gamma agonists or partial agonists; dual PPAR alpha, PPAR delta agonists or partial agonists; dual PPAR alpha, PPAR delta, PPAR gamma agonists or partial agonists; pan PPAR agonists or partial agonists; and a platelet aggregation inhibitor, such as fibrinogen receptor antagonists (i.e., glycoprotein IIb/IIIa fibrinogen receptor antagonists) and aspirin.

An additional example of combination therapy can be seen in modulating metabolic syndrome (or treating metabolic syndrome and its related symptoms, complications and disorders), wherein a compound as provided herein can be effectively used in combination with, for example, the active agents discussed above for modulating or treating diabetes, obesity, hyperlipidemia, atherosclerosis, and/or their respective related symptoms, complications and disorders.

A further embodiment, a compound of the present invention can be administered in combination with halofenic acid, an ester of halofenic acid, or another prodrug of halofenic acid, preferably with (-)-(4-chlorophenyl)-(3-trifluoromethylphenoxo)-acetic acid 2-acetylaminoethyl ester.

In a further embodiment, a compound of the present invention can be administered in combination with halofenic acid, an ester of halofenic acid, or another prodrug of halofenic acid, preferably with (-)-(4-chlorophenyl)-(3-trifluoromethylphenoxy)-acetic acid 2-acetylaminoethyl ester.

In particular, this invention provides methods of treating a mammal, in particular a human by administering a compound as provided herein and a DPP4 inhibitor.

The DPP4 inhibitors useful in the present invention are sitagliptin (Merck), vildagliptin (Novartis), BMS-477118 (saxagliptin) (Bristol-Myers Squibb), R1438 (amino-methylpyridine) (Roche), NVP DPP728 (Novartis), PSN9301 (Prosidion), P32/98 (isoleucine thiozolidide) (Probiodrug), GSK823093C (Denagliptin) (Glaxo Smithkline), SYR-322 (Aloglipin) (Takeda), NN-7201 (NovoNordisk), ALS-2-0426 (Alantlos). (Green BD, Flatt PR, Bailey CJ, Dipeptidyl peptidase IB
A compound as provided herein and DPP4 inhibitor are administered in a single dosage or in separate dosages. The single dosage is administered once a day or multiple times a day. When a compound as provided herein and DPP4 inhibitor are administered in separate dosages, the dosages can be administered once a day or multiple times a day.

A compound as provided herein and DPP4 inhibitor can be dosed at the same time, within several minutes, or separated by hours. By way of example, a compound as provided herein and DPP4 inhibitor can be dosed together in the morning, with no further dosing for the remainder of the day. Alternatively, in the morning, a compound as provided herein and a DPP4 inhibitor is dosed followed with a second dose of a compound as provided herein and/or a DPP4 inhibitor in the evening or after a meal.

It can be necessary to administer dosages of a compound as provided herein and/or DPP4 inhibitor once a day or more than once a day, or before or after a meal, as will be apparent to those skilled in the art. Further, it is noted that the clinician or treating physician will know how and when to start, interrupt, adjust, or terminate therapy in conjunction with individual patient response.

In one embodiment, when the compound as provided herein and the DPP4 inhibitor are administered in a single dosage, the compound and DPP4 inhibitor are formulated into a single pill, single tablet, or a single capsule. When the compound and DPP4 inhibitor are administered in separate dosages, the compound is formulated into a pill, tablet, or capsule and the DPP4 inhibitor is formulated into a separate pill or capsule.

When a compound as provided herein and DPP4 inhibitor are administered in separate dosages, the compound can be administered first and the DPP4 inhibitor can be administered next, following administration of the compound. Alternatively, the DPP4 inhibitor can be administered first and the compound can be administered next. The time between the first administration and the second administration can be varied by a skilled practitioner. In one embodiment, the first administration (a compound as provided herein or a DPP4 inhibitor), is followed immediately by the second administration (a compound as provided herein or a DPP4 inhibitor). In another embodiment, the second administration is within 2 minutes, 5 minutes, 10 minutes, 15 minutes, 30 minutes, or 60 minutes, 1 hour, 2 hours, 3 hours, 4 hours, 5 hours, 6 hours, 7 hours, 8 hours, 9 hours, 10 hours, 11 hours, or 12 hours following the first administration. Yet another embodiment provides for the administration of a compound as provided herein and/or DPP4 inhibitor in the morning followed by the administration of a compound as provided herein and/or DPP4 inhibitor in the evening.

In addition, the present invention provides for kits with unit doses of a compound as provided herein and/or DPP4 inhibitor, either in oral or injectable doses. In addition to the containers containing the unit doses will be an informational package insert describing the use and attendant benefits of the drugs in treating Type II diabetes, obesity, hyperlipidemia, atherosclerosis and metabolic syndrome, and/or their respective related symptoms, complications and disorders. Preferred compounds and unit doses are those described herein above.

Another aspect of this invention provides methods of lowering blood levels of glucose in a subject by administering a compound as provided herein and a DPP4 inhibitor. The method comprises administering a therapeutically effective amount of the compound and DPP4 inhibitor to the mammal. The method further comprises steps to measure blood glucose levels before and after administration of a compound as provided herein and DPP4 inhibitor. Blood glucose levels are easily measured by numerous commercially available glucose monitoring devices that measure blood glucose from samples of blood or urine, or as taught herein. Blood glucose can also be measured by commercially available glucometers that do not require blood or urine samples.

Another aspect of this invention provides methods of lowering blood levels of insulin in a subject by administering a compound as provided herein and a DPP4 inhibitor. The method comprises administering a therapeutically effective amount of the compound and DPP4 inhibitor to the mammal. The method further comprises steps to measure blood insulin levels before and after administration of the compound and a DPP4 inhibitor. Blood insulin levels are easily measured by well-known insulin monitoring assays that measure insulin from samples of blood or urine, or as taught herein.

In another aspect, this invention provides methods of increasing blood levels of incretins in a subject by administering a compound of this invention and a DPP4 inhibitor. The incretins are GLP-1 and GIP. The method comprises administering a therapeutically effective amount of a compound as provided herein and DPP4 inhibitor to the mammal. The method further comprises steps to measure blood incretin levels before and after administration of a compound as provided herein and a DPP4 inhibitor. Blood incretin levels are easily measured by well-known incretin monitoring assays, or as taught herein.

Yet another aspect of this invention provides methods of lowering blood triglyceride levels in a subject by administering a compound as provided herein and a DPP4 inhibitor. The method comprises administering a therapeutically effective amount of the compound and DPP4 inhibitor to the mammal. The method further comprises steps to measure blood triglyceride levels before and after administration of the compound and DPP4 inhibitor. Blood triglyceride levels are easily measured by numerous commercially available devices that measure blood triglyceride levels from...
samples of blood.

A further aspect of this invention provides methods of lowering gastric emptying in a subject by administering a compound of the invention and a DPP4 inhibitor. The method comprises administering a therapeutically effective amount of a compound as provided herein and DPP4 inhibitor to the mammal.

Another aspect of this invention provides methods of increasing insulin production in the islet cells of a subject by administering a compound as provided herein and a DPP4 inhibitor. The method comprises administering a therapeutically effective amount of a compound as provided herein and DPP4 inhibitor to the mammal. The method further comprises steps to measure insulin production in islet cells or the beta cells of the pancreas before and after administration of the compound and a DPP4 inhibitor. The insulin production of islets and beta cells are easily measured by well-known assays, or as taught herein.

In yet another aspect, this invention provides methods of preserving islet function in a subject by administering a compound as provided herein and a DPP4 inhibitor. The method comprises administering a therapeutically effective amount of a compound as provided herein and DPP4 inhibitor to the mammal. The method further comprises steps to measure the function of islets or beta cell’s ability to produce insulin before and after administration of the compound and a DPP4 inhibitor. The insulin production of islets and beta cells are easily measured by well-known assays, or as taught herein.

The compounds that are used in the methods of the present invention can be incorporated into a variety of formulations and medicaments for therapeutic administration. More particularly, a compound as provided herein can be formulated into pharmaceutical compositions by combination with appropriate, pharmaceutically acceptable carriers or diluents, and can be formulated into preparations in solid, semi-solid, liquid or gaseous forms, such as tablets, capsules, pills, powders, granules, dragees, gels, slurries, ointments, solutions, suspensions, injections, inhalants and aerosols. As such, administration of the compounds can be achieved in various ways, including oral, buccal, rectal, parenteral, intraperitoneal, intradermal, transdermal, and/or intratracheal administration. Moreover, the compound can be administered in a local rather than systemic manner, in a depot or sustained release formulation. In addition, the compounds can be administered in a liposome.

The compounds can be formulated with common excipients, diluents or carriers, and compressed into tablets, or formulated as elixirs or solutions for convenient oral administration, or administrated by the intramuscular or intravenous routes. The compounds can be administered transdermally, and can be formulated as sustained release dosage forms and the like. The compounds can be administrated alone, in combination with each other, or they can be used in combination with other known compounds.

Suitable formulations for use in the present invention are found in Remington’s Pharmaceutical Sciences (Mack Publishing Company (1985) Philadelphia, PA, 17th ed.). Moreover, for a brief review of methods for drug delivery, see, Langer, Science (1990) 249:1527-1533. The pharmaceutical compositions described herein can be manufactured in a manner that is known to those of skill in the art, i.e., by means of conventional mixing, dissolving, granulating, dragee-making, levigating, emulsifying, encapsulating, entrapping or lyophilizing processes. The following methods and excipients are merely exemplary and are in no way limiting.

For injection, the compound and optionally a DPP4 inhibitor can be formulated into preparations by dissolving, suspending or emulsifying them in an aqueous or nonaqueous solvent, such as vegetable or other similar oils, synthetic aliphatic acid glycerides, esters of higher aliphatic acids or propylene glycol; and if desired, with conventional additives such as solubilizers, isotonic agents, suspending agents, emulsifying agents, stabilizers and preservatives. Preferably, the compounds of the present invention can be formulated in aqueous solutions, preferably in physiologically compatible buffers such as Hanks’ solution, Ringer’s solution, or physiological saline buffer. For transmucosal administration, penetrants appropriate to the barrier to be permeated are used in the formulation. Such penetrants are generally known in the art.

For oral administration, the compound and optionally DPP4 inhibitors can be formulated readily by combining with pharmaceutically acceptable carriers that are well known in the art. Such carriers enable the compounds to be formulated as tablets, pills, dragees, capsules, emulsions, lipophilic and hydrophilic suspensions, liquids, gels, syrups, slurries, suspensions and the like, for oral ingestion by a patient to be treated. Pharmaceutical preparations for oral use can be obtained by mixing the compounds with a solid excipient, optionally grinding a resulting mixture, and processing the mixture of granules, after adding suitable auxiliaries, if desired, to obtain tablets or dragee cores. Suitable excipients are, in particular, fillers such as sugars, including lactose, sucrose, mannitol, or sorbitol; cellulose preparations such as, for example, maize starch, wheat starch, rice starch, potato starch, gelatin, gum tragacanth, methyl cellulose, hydroxypropylmethyl-cellulose, sodium carboxymethylcellulose, and/or polyvinylpyrrolidone. If desired, disintegrating agents can be added, such as the cross-linked polyvinyl pyrrolidone, agar, or alginic acid or a salt thereof such as sodium alginate.

Dragee cores are provided with suitable coatings. For this purpose, concentrated sugar solutions can be used, which can optionally contain gum arabic, talc, polyvinyl pyrrolidone, carbopol gel, polyethylene glycol, and/or titanium dioxide, lacquer solutions, and suitable organic solvents or solvent mixtures. Dye stuffs or pigments can be added to the tablets or dragee coatings for identification or to characterize different combinations of active compound doses.
Pharmaceutical preparations that can be used orally include push-fit capsules made of gelatin, as well as soft, sealed capsules made of gelatin and a plasticizer, such as glycerol or sorbitol. The push-fit capsules can contain the active ingredients in admixture with filler such as lactose, binders such as starches, and/or lubricants such as talc or magnesium stearate and, optionally, stabilizers. In soft capsules, the active compounds can be dissolved or suspended in suitable liquids, such as fatty oils, liquid paraffin, or liquid polyethylene glycols. In addition, stabilizers can be added. All formulations for oral administration should be in dosages suitable for such administration.

For buccal administration, the compositions can take the form of tablets or lozenges formulated in a conventional manner.

For administration by inhalation, the compounds for use according to the present invention are conveniently delivered in the form of an aerosol spray presentation from pressurized packs or a nebulizer, with the use of a suitable propellant, e.g., dichlorodifluoromethane, trichlorofluoromethane, dichlorotetrafluoroethane, carbon dioxide or other suitable gas, or from propellant-free, dry-powder inhalers. In the case of a pressurized aerosol the dosage unit can be determined by providing a valve to deliver a metered amount. Capsules and cartridges of, e.g., gelatin for use in an inhaler or insufflator can be formulated containing a powder mix of the compound and a suitable powder base such as lactose or starch.

The compounds can be formulated for parenteral administration by injection, e.g., by bolus injection or continuous infusion. Formulations for injection can be presented in unit dosage form, e.g., in ampoules or in multidose containers, with an added preservative. The compositions can take such forms as suspensions, solutions or emulsions in oily or aqueous vehicles, and can contain formulation agents such as suspending, stabilizing and/or dispersing agents.

Pharmaceutical formulations for parenteral administration include aqueous solutions of the active compounds in water-soluble form. Additionally, suspensions of the active compounds can be prepared as appropriate oily injection suspensions. Suitable lipophilic solvents or vehicles include fatty oils such as sesame oil, or synthetic fatty acid esters, such as ethyl oleate or triglycerides, or liposomes. Aqueous injection suspensions can contain substances that increase the viscosity of the suspension, such as sodium carboxymethyl cellulose, sorbitol, or dextran. Optionally, the suspension can also contain suitable stabilizers or agents that increase the solubility of the compounds to allow for the preparation of highly concentrated solutions. Alternatively, the active ingredient can be in powder form for constitution with a suitable vehicle, e.g., sterile pyrogen-free water, before use.

The compounds can also be formulated in rectal compositions such as suppositories or retention enemas, e.g., containing conventional suppository bases such as cocoa butter, carbowaxes, polyethylene glycols or other glycerides, all of which melt at body temperature, yet are solidified at room temperature.

In addition to the formulations described previously, the compounds can also be formulated as a depot preparation. Such long acting formulations can be administered by implantation (for example, subcutaneously or intramuscularly) or by intramuscular injection. Thus, for example, the compounds can be formulated with suitable polymeric or hydrophobic materials (for example, as an emulsion in an acceptable oil) or ion exchange resins, or as sparingly soluble derivatives, for example, as a sparingly soluble salt.

Alternatively, other delivery systems for hydrophobic pharmaceutical compounds can be employed. Liposomes and emulsions are well known examples of delivery vehicles or carriers for hydrophobic drugs. In a presently preferred embodiment, long-circulating, i.e., stealth liposomes can be employed. Such liposomes are generally described in WO 92/13018.

Certain organic solvents such as dimethylsulfoxide (“DMSO”) also can be employed. Additionally, the compounds can be delivered using a sustained-release system, such as semipermeable matrices of solid hydrophobic polymers containing the therapeutic agent. Various types of sustained-release materials have been established and are well known by those skilled in the art. Sustained-release capsules can, depending on their chemical nature, release the compounds for a few hours up to over 100 days.

The pharmaceutical compositions also can comprise suitable solid or gel phase carriers or excipients. Examples of such carriers or excipients include but are not limited to calcium carbonate, calcium phosphate, various sugars, starches, cellulose derivatives, gelatin, and polymers such as polyethylene glycols.

Pharmaceutical compositions suitable for use in the present invention include compositions wherein the active ingredients are contained in a therapeutically effective amount. The amount of composition administered will, of course, be dependent on the subject being treated, on the subject's weight, the severity of the affliction, the manner of administration and the judgment of the prescribing physician. Determination of an effective amount is well within the capability of those skilled in the art, especially in light of the detailed disclosure provided herein.

For any compound used in the method of the present invention, a therapeutically effective dose can be estimated initially from cell culture assays, animal models, or microdosing of human subjects.

Moreover, toxicity and therapeutic efficacy of the compounds described herein can be determined by standard pharmaceutical procedures in cell cultures or experimental animals, e.g., by determining the LD₅₀, the dose lethal to...
50% of the population) and the ED50 (the dose therapeutically effective in 50% of the population). The dose ratio between toxic and therapeutic effect is the therapeutic index and can be expressed as the ratio between LD50 and ED50. Compounds that exhibit high therapeutic indices are preferred. The data obtained from these cell culture assays and animal studies can be used in formulating a dosage range that is not toxic for use in humans. The dosage of such compounds lies preferably within a range of circulating concentrations that include the ED50 with little or no toxicity. The dosage can vary within this range depending upon the dosage form employed and the route of administration utilized. The exact formulation, route of administration and dosage can be chosen by the individual physician in view of the patient’s condition (see, e.g., Fingl et al., 1975 In: The Pharmacological Basis of Therapeutics, Ch. 1).

The amount of a compound as provided herein that can be combined with a carrier material to produce a single dosage form will vary depending upon the disease treated, the mammalian species, and the particular mode of administration. However, as a general guide, suitable unit doses for the compounds of the present invention can, for example, preferably contain between 0.1 mg to about 1000 mg, between 1 mg to about 500 mg, and between 1 mg to about 300 mg of the active compound. In another example, the unit dose is between 1 mg to about 100 mg. Such unit doses can be administered more than once a day, for example, 2, 3, 4, 5 or 6 times a day, but preferably 1 or 2 times per day, so that the total dosage for a 70 kg adult is in the range of 0.001 to about 15 mg per kg weight of subject per administration. A preferred dosage is 0.01 to about 1.5 mg per kg weight of subject per administration, and such therapy can extend for a number of weeks or months, and in some cases, years. It will be understood, however, that the specific dose level for any particular patient will depend on a variety of factors including the activity of the specific compound employed; the age, body weight, general health, sex and diet of the individual being treated; the time and route of administration; the rate of excretion; other drugs that have previously been administered; and the severity of the particular disease undergoing therapy, as is well understood by those of skill in the area.

A typical dosage can be one 1 mg to about 100 mg tablet or 1 mg to about 300 mg taken once a day, or, multiple times per day, or one time-release capsule or tablet taken once a day and containing a proportionally higher content of active ingredient. The time-release effect can be obtained by capsule materials that dissolve at different pH values, by capsules that release slowly by osmotic pressure, or by any other known means of controlled release.

It can be necessary to use dosages outside these ranges in some cases as will be apparent to those skilled in the art. Further, it is noted that the clinician or treating physician will know how and when to start, interrupt, adjust, or terminate therapy in conjunction with individual patient response.

For the compositions, methods and kits provided above, one of skill in the art will understand that preferred compounds for use in each are those compounds that are noted as preferred above. Still further preferred compounds for the compositions, methods and kits are those compounds provided in the non-limiting Examples below.

CHEMICAL EXAMPLES

General Methods. All operations involving moisture and/or oxygen sensitive materials were conducted under an atmosphere of dry nitrogen in pre-dried glassware. Unless noted otherwise, materials were obtained from commercially available sources and used without further purification.

Flash chromatography was performed on an Isco Combiflash Companion using RediSep RF silica gel cartridges by Teledyne Isco. Thin layer chromatography was performed using precoated plates purchased from E. Merck (silica gel 60 PF254, 0.25 mm) and spots were visualized with long-wave ultraviolet light followed by an appropriate staining reagent.

Nuclear magnetic resonance ("NMR") spectra were recorded on a Varian Inova-400 resonance spectrometer. 1H NMR chemical shifts are given in parts per million (δ) downfield from tetramethylsilane ("TMS") using TMS or the residual solvent signal (CDCl3 = δ 7.24, DMSO = δ 2.50) as internal standard. 1H NMR information is tabulated in the following format: multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet), coupling constant(s) (J) in Hertz, number of protons. The prefix "app" is occasionally applied in cases where the true signal multiplicity was unresolved and the "b" indicates the signal in question was broadened.

The compounds were named using ChemBioDraw Ultra Version 11.0.

LCMS analysis was performed using a PE SCIEX API 2000 mass spectrometer with a Phenomenex Luna 5 micron C18 column.

Preparatory HPLC was performed on a Gilson HPLC 215 liquid handler with a Phenomenex column (Gemini 10 μ, C18, 110A) and a UV/VIS 156 detector.

Microwave reactions were performed in a Biotage Initiator EXP US.

When production of starting materials is not particularly described, the compounds are known or may be prepared analogously to methods known in the art or as disclosed in the preparation of intermediates or examples. One of skill in the art will appreciate that synthetic methodologies described herein are only representative of methods for preparation of the compounds of the present invention, and that other well known methods may similarly be used. The present invention is further exemplified, but not limited, by the following examples that illustrate the preparation of the
Preparation of Intermediates

Intermediate 1 5-chloro-7-(chloromethyl)-2,2-dimethyl-2,3-dihydrobenzofuran (5)

[0249]

**Step A:**
To a solution of methyl 5-chloro-2-hydroxybenzoate (2.5 g, 13.4 mmol) in dimethylformamide (25 mL) was added potassium carbonate (2.22 g, 16.1 mmol) and 3-chloro-2-methylprop-1-ene (1.46 g, 16.1 mmol). The suspension was heated at 70 °C for 18 h, cooled to room temperature, diluted with water (50 mL), and extracted with ethyl acetate (2 x 25 mL). The organic layers were combined, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by chromatography (0-20% EtOAc in hexanes) to provide the desired ester (1).

**Step B:**
To a 20 mL microwave tube was added compound (1) (2.00 g, 8.31 mmol) and N-methylpyrrolidinone (15 mL). The tube was sealed and heated in the microwave at 200 °C for 8 h. The solution was cooled to room temperature, diluted with water (50 mL), and extracted with ethyl acetate (2 x 25 mL). The organic layers were combined, dried over sodium sulfate, filtered and concentrated. The residue was purified by chromatography (0-30% EtOAc in hexanes) to provide the desired ester (2).

**Step C:**
Compound (2) (2.00 g, 8.31 mmol) was dissolved in formic acid (10 mL) and water (1 mL) and refluxed for 18 h. The solution was cooled to room temperature, diluted with water (50 mL), and extracted with ethyl acetate (2 x 25 mL). The organic layers were combined, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by chromatography (0-30% EtOAc in hexanes) to provide the desired ester (3).

**Step D:**
Compound (3) (2.00 g, 8.31 mmol) was dissolved in anhydrous tetrahydrofuran (15 mL) and cooled to 0 °C under nitrogen. Lithium aluminum hydride in tetrahydrofuran (1.0 M, 8.31 mL, 8.31 mmol) was added over a ten minute period. After the addition was complete, the solution was allowed to warm to room temperature and stirred for an additional sixty minutes. The solution was cooled to 0 °C and quenched by the addition of ethyl acetate (10 mL) followed by a saturated sodium sulfate aqueous solution (10 mL). The mixture was diluted with ethyl acetate and filtered through a pad of celite. The combined filtrates were dried over sodium sulfate and concentrated in vacuo. The residue was purified by silica gel chromatography (0-100% EtOAc in hexanes) to provide the desired alcohol (4).

**Step E:**
To a solution of compound (4) (1.00 g, 4.70 mmol) in acetonitrile (20 mL) was added thionyl chloride (0.682 mL, 9.4 mmol). The solution was stirred for 4 h and then concentrated in vacuo. The residue was dissolved in ethyl acetate, washed with water and brine. The organic layer was separated, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by chromatography (0-30% EtOAc in hexanes) to provide compound (5).

Intermediate 2

ethyl 3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoate (9)

[0255]
Step A: A solution of 2,6-difluorophenol (25 g, 192 mmol), hexamethylenetetramine (26 g, 192 mmol) and trifluoroacetic acid (190 mmol) was refluxed overnight. The reaction was cooled and diluted with water (200 mL) and extracted with dichloromethane (3 x 100 mL). The organic layer was washed with 10% aqueous potassium carbonate (2 x 100 mL). The aqueous layer was acidified with concentrated hydrochloric acid and extracted with ethyl acetate. The organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo to yield 3,5-difluoro-4-hydroxybenzaldehyde as a white solid. Upon sitting the desired product began to precipitate from the original aqueous layer that was extracted with dichloromethane. The layer was filtered to provide the product as long white crystals.

Step B: To a mixture of 3,5-difluoro-4-hydroxybenzaldehyde (6) (8.26 g, 52.2 mmol), and potassium carbonate (14.4 g, 104.4 mmol) in dimethylformamide (100 mL) was added benzyl chloride (7.2 mL, 62.7 mmol) and stirred overnight at 50 °C. The reaction was diluted with water and extracted with ethyl acetate (3 x 75 mL). The organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel (0-100% EtOAc in hexanes) to afford 4-(benzyloxy)-3,5-difluorobenzaldehyde (7).

Step C: A solution of 4-(benzyloxy)-3,5-difluorobenzaldehyde (7) (1.32 g, 5.34 mmol) and (1-ethoxycarbonyl-ethylidene)triphenyl phosphorane (2.32 g, 6.41 mmol) in tetrahydrofuran (53 mL) was refluxed for 2 hours. The reaction was concentrated in vacuo and was purified by flash column chromatography (0-100% EtOAc in hexanes) to give (E)-ethyl 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylacrylate (8).

Step D: To a solution (E)-ethyl 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylacrylate (8) (1.4 g, 4.21 mmol) in ethanol (25 mL) was added Pd/C (140 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred under a hydrogen balloon overnight at room temperature, filtered through a pad of celite and concentrated in vacuo to give ethyl 3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoate (9).

Intermediate 3

ethyl 3-(3,5-difluoro-4-hydroxyphenyl)propanoate (11)

Step A: In a 350-mL pressure-glass was added 4-bromo-2,6-difluorophenol (23.82 g, 0.11 mol), triethylamine (55 mL, 0.39 mol), ethyl acrylate (34.27 g, 0.34 mol), DMF (50 mL), palladium (II) acetate (1.29 g, 5.75 mmol), and followed by tri-o-tolyphosphine (2.34 g, 7.6 mmol) under N₂. The mixture in the sealed glass was stirred at 110 °C overnight (21 hours), cooled to room temperature and added EtOAc (150 mL) and stirred for 30 minutes, filtered through celite and rinsed with EtOAc (3 x 100 mL). The filtrate was acidified with 2N HCl to pH -2. The organic layer was separated, and the aqueous layer was extracted with EtOAc (2 x 50 mL). The organic layers were combined and washed with water (2 x 100 mL), brine (100 mL) and dried over sodium sulfate. After filtration, heptane (200 mL) was added and the solution was concentrated in vacuo. The resulting precipitate was filtered, washed with heptane (2 x 50 mL) and dried to afford
the desired product as a light-yellow solid. The mother liquor was concentrated in vacuo to obtain additional desired product (10) as a pale-yellow solid. 1H NMR (400 MHz, CDCl₃) δ: 7.50 (d, J = 15.9 Hz, 1H), 7.09 (d, J = 8.3 Hz, 2H), 6.29 (d, J = 15.9 Hz, 1H), 5.54 (br, 1H), 4.26 (q, J = 7.1 Hz, 2H), 1.33 (t, J = 7.1 Hz, 3H).

[0262] **Step B:** To a solution of (E)-ethyl 3-(3,5-difluoro-4-hydroxyphenyl)acrylate (10) (0.751 g, 3.29 mmol) in ethanol (20 mL) was added Pd/C (81 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred under a hydrogen balloon overnight at room temperature, filtered through a pad of celite and concentrated in vacuo to give ethyl 3-(3,5-difluoro-4-hydroxyphenyl)propanoate (11).

Intermediate 4

ethyl 2-(3,5-difluoro-4-hydroxyphenyl)cyclopropanecarboxylate (12)

[0263]

[0264] **Step A:** In a 350-mL pressure-tube was added 4-bromo-2,6-difluorophenol (23.82 g, 0.11 mol), triethylamine (55 mL, 0.39 mol), ethyl acrylate (34.27 g, 0.34 mol), DMF (50 mL), palladium (II) acetate (1.29 g, 5.75 mmol), and tri-o-tolylphosphine (2.34 g, 7.6 mmol) under N₂. The mixture was sealed in the glass tube and was stirred at 110 °C overnight (21 hours). The reaction was cooled to room temperature and EtOAc (150 mL) was added. The mixture was stirred for 30 minutes, filtered through celite and rinsed with EtOAc (3 x 100 mL). The filtrate was acidified with 2N HCl to pH = 2. The organic layer was separated, and the aqueous layer was extracted with EtOAc (2 x 50 mL). The organic layers were combined and washed with water (2 x 100 mL), brine (100 mL) and dried over sodium sulfate. After filtration, heptane (200 mL) was added and the solution was concentrated in vacuo. The resulting precipitate was filtered, washed with heptane (50 mL × 2) and dried to afford the desired product as a light-yellow solid. The mother liquor was concentrated in vacuo to obtain additional desired product (10) as a pale-yellow solid. 1H NMR (400 MHz, CDCl₃) δ: 7.50 (d, J = 15.9 Hz, 1H), 7.09 (d, J = 8.3 Hz, 2H), 6.29 (d, J = 15.9 Hz, 1H), 5.54 (br, 1H), 4.26 (q, J = 7.1 Hz, 2H), 1.33 (t, J = 7.1 Hz, 3H).

[0265] **Step B:** To a mixture of N-methyl-N'-nitro-N-nitrosoguanidine (TCI-America catalogue # M0527, 10 g on a dry weight basis) in ether (150 mL) at 0 °C was added a cold solution of potassium hydroxide (12.60 g) in water (21 mL). After stirring for 2 minutes, a portion of the yellow ethereal solution of the resulting diazomethane was added to a solution of ethyl 3-(3,5-difluoro-4-hydroxyphenyl)acrylate (10) (2.28 g, 0.010 mol) in ether (100 mL) at 0 °C. A portion of palladium (II) acetate (0.372 g, 1.66 mmol) was added followed by an additional portion of diazomethane solution. This process was continued until all the diazomethane solution and palladium (II) acetate was added. The resulting dark mixture was stirred at 0-5 °C for 4 hours and acetic acid (6 drops) was added to quench any excess reagent. After removal of solvent in vacuo, the residue was purified by chromatography on silica gel (0-30% EtOAc in hexanes) to afford the desired product (12) as a white solid. 1H NMR (400 MHz, CDCl₃) δ: 6.67 (d, J = 8.4 Hz, 2H), 5.05 (br, 1H), 4.20 (q, J = 7.1 Hz, 2H), 2.45 - 2.40 (m, 1H), 1.87 - 1.74 (m, 1H), 1.39 - 1.14 (m, 5H).

Intermediate 5

(2,2-dimethylchroman-8-yl)methanol (16)

[0266]
Step A: To a solution of methyl magnesium chloride (3M in tetrahydrofuran, 60 mL, 180 mmol) was added a solution of coumarin (11.4 mL, 90 mmol) in tetrahydrofuran (20 mL) drop wise over forty minutes. The reaction was stirred for 18 h. The solution was quenched with ice cold water (20 mL) and extracted with ethyl acetate (2 x 25 mL). The organic extracts were combined, dried over sodium sulfate, filtered and concentrated in vacuo to obtain the expected compound (13) as a white powder.

Step B: Alcohol (13) (7.6 g, 42.2 mmol) was dissolved in acetic acid (45 mL) and 20% sulfuric acid was added (17 mL). The solution was heated at 100 °C for 45 minutes. After allowing the solution to cool to room temperature, ice (20 g) was added. The mixture was extracted with ethyl acetate (2 x 25 mL), the organic extracts were combined, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by vacuum distillation (85 °C oil bath, 5 mmHg) to provide (14).

Step C: To a solution of n-butyllithium (26 mL, 2.5 M in hexanes) was added anhydrous diethyl ether (30 mL). A solution of compound (14) (4.2 g, 26 mmol) in 30 mL of anhydrous diethyl ether was added drop wise. After the addition was complete, the reaction was refluxed for 90 minutes. The solution was cooled to room temperature and poured into a flask containing a slurry of dry ice in anhydrous diethyl ether. Water was added (50 mL) and the solution was extracted with ethyl acetate (2 x 50 mL). The organic extracts were combined, dried over sodium sulfate, filtered and concentrated in vacuo to obtain the expected compound (15).

Step D: Compound (15) (0.230 g, 1.12 mmol) was dissolved in anhydrous tetrahydrofuran (5 mL) and cooled to 0 °C under nitrogen. Lithium aluminum hydride in tetrahydrofuran (1.0 M, 1.2 mL, 1.2 mmol) was added over a ten minute period. After the addition was complete, the solution was allowed to warm to room temperature and stirred for an additional sixty minutes. The solution was cooled to 0 °C and quenched by the addition of ethyl acetate (10 mL) followed by a saturated sodium sulfate aqueous solution (10 mL). The mixture was diluted with ethyl acetate and filtered through a pad of celite. The combined filtrates were dried over sodium sulfate and concentrated in vacuo. The residue was purified by flash column chromatography (0-100% EtOAc in hexanes) to provide the desired alcohol (16).

Intermediate 6
ethyl 2-(6-fluoro-5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetate (22)
**Step A:** To a solution of malonic acid (21.5 g, 207 mmol) in pyridine (50 mL) was added 4-fluoro-3-methoxy-benzaldehyde (16 g, 104 mmol) and piperidine (1.5 mL). The reaction was refluxed for 13 h. Water was added (25 mL) followed by concentrated HCl (40 mL). The precipitated product (17) was collected by filtration and washed with water.

**Step B:** To a solution of (17) (25 g, 127 mmol) in ethanol (40 mL) was added Pd/C (2 g, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred under a hydrogen balloon overnight at room temperature, filtered through a pad of celite and concentrated *in vacuo* to provide compound (18).

**Step C:** To a 20 mL microwave tube was added compound (18) (2.00 g, 10.1 mmol) and methylsulfonic acid (15 mL). The tube was sealed and heated at 90 °C for 10 minutes. The resulting solution was poured into an ice bath, neutralized to pH 7 with aqueous NaOH. The resulting precipitate was collected by filtration and washed with water to provide compound (19).

**Step D:** To a solution of ketone (19) (3.56 g, 19.8 mmol) in toluene/tetrahydrofuran (50:1, 40 mL) was added Zn° dust (2.6 g, 39.6 mmol) and copper (I) chloride (0.4 g, 3.96 mmol). The suspension was heated at 90 °C for 30 minutes. After cooling to room temperature, ethylbromoacetate (3.4 mL, 31.6 mmol) was added. The suspension was heated at 100 °C for 4 hours. After cooling to room temperature, an aqueous solution of HCl (50 mL, 2N) was added and the solution was extrated with ethyl acetate (2 x 50 mL). The organic extracts were combined, dried over sodium sulfate, filtered and concentrated *in vacuo* to provide the desired ester (20) as a mixture of isomers.

**Step E:** To a solution of (20) (0.79 g, 3.2 mmol) in ethanol (10 mL) was added Pd/C (0.08 g, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred under a hydrogen balloon overnight at room temperature, filtered through a pad of celite and concentrated *in vacuo* to provide compound (21).

**Step F:** To a solution of ester (21) (1.06 g, 4.2 mmol) in dichloromethane (40 mL) at 0 °C was added boron tribromide (3.96 mL, 41.9 mmol). The solution was stirred for 2 hours and quenched with ethanol (5 mL) followed by a saturated solution of sodium bicarbonate (5 mL). The organic layer was separated, dried over sodium sulfate, filtered and concentrated *in vacuo* to obtain the expected product (22).

**Intermediate 7**

ethyl 2-(2-(3,5-difluoro-4-hydroxyphenyl)cyclopropyl)acetate (506)
**Step A:** In a 350-mL pressure-tube was added 4-bromo-2,6-difluorophenol (23.82 g, 0.11 mol), triethylamine (55 mL, 0.39 mol), ethyl acrylate (34.27 g, 0.34 mol), DMF (50 mL), palladium (II) acetate (1.29 g, 5.75 mmol), and tri-o-tolyphosphine (2.34 g, 7.6 mmol) under N₂. The mixture was sealed in the glass tube and was stirred at 110 °C overnight (21 hours). The reaction was cooled to room temperature and EtOAc (150 mL) was added. The mixture was stirred for 30 minutes, filtered through celite and rinsed with EtOAc (100 mL). The filtrate was acidified with 2N HCl to pH ~2. The organic layer was separated, and the aqueous layer was extracted with EtOAc (50 mL). The organic layers were combined and washed with water (100 mL), brine (100 mL) and dried over sodium sulfate. After filtration, heptane (200 mL) was added and the solution was concentrated in vacuo. The resulting precipitate was filtered, washed with heptane (50 mL) and dried to afford the desired product (10) (17.09 g) as a light-yellow solid. The mother liquor was concentrated to obtain additional desired product (4.29 g) as a pale-yellow solid. 

**1H NMR (400 MHz, CDCl₃) δ:** 7.50 (d, J = 15.9 Hz, 1H), 7.09 (d, J = 8.3 Hz, 2H), 6.29 (d, J = 15.9 Hz, 1H), 5.54 (br, 1H), 4.26 (q, J = 7.1 Hz, 2H), 1.33 (t, J = 7.1 Hz, 3H).

**Step B:** To a mixture of N-methyl-N'-nitro-N-nitrosoguanidine (TCI-America catalogue # M0527, 10 g on a dry weight basis, 0.068 mol) in ether (150 mL) at 0 °C was added a cold solution of KOH (12.60 g) in water (21 mL). After stirring for 2 minutes, a portion of the yellow ethereal solution of the resulting diazomethane was added to a solution of ethyl 3-(3,5-difluoro-4-hydroxyphenyl)acrylate (10) (2.28 g, 0.010 mol) in ether (100 mL) at 0 °C. A portion of palladium (II) acetate (0.372 g, 1.66 mmol) was added followed by an additional portion of diazomethane solution. This process was continued until all the diazomethane solution and palladium (II) acetate was added. The resulting dark mixture was stirred at 0-5 °C for 4 hours and acetic acid (6 drops) was added to quench any excess reagent. After removal of solvent, the residue was purified by chromatography on silica gel (0-30% EtOAc in hexanes) to afford 2.04 g of the desired product as a white solid (12).

**1H NMR (400 MHz, CDCl₃) δ:** 6.67 (d, J = 8.4 Hz, 2H), 5.05 (br, 1H), 4.20 (q, J = 7.1 Hz, 2H), 2.45 - 2.40 (m, 1H), 1.87 - 1.74 (m, 1H), 1.39 - 1.14 (m, 5H).

**Step C:** To a mixture of ethyl 2-(3,5-difluoro-4-hydroxyphenyl)cyclopropanecarboxylate (12) (2.04 g, 8.4 mmol) and potassium carbonate (1.69 g, 12.2 mmol) in DMF (15 mL) was added benzyl bromide (1.88g, 11 mmol). The mixture was stirred at rt overnight and partitioned between ethyl acetate and water. The organic extract was washed with water and brine, dried over sodium sulfate and concentrated in vacuo. Purification by flash chromatography on silica gel (0-20% EtOAc in hexanes) gave 2.76 g of desired product (500) as a white solid.

**1H NMR (400 MHz, CDCl₃) δ:** 7.50 - 7.43 (m, 2H), 7.38 - 7.32 (m, 3H), 6.62 (d, J = 9.0 Hz, 2H), 5.12 (s, 2H), 4.19 - 4.11 (m, 2H), 2.43 - 2.38 (m, 1H), 1.89 - 1.76 (m, 1H), 1.65 - 1.58 (m, 1H), 1.29 - 1.15 (m, 4H).

**Step D:** To a solution of ethyl 2-(4-(benzyloxy)-3,5-difluorophenyl)cyclopropanecarboxylate (500) (2.74 g, 8.24 mmol) in tetrahydrofuran (10 mL) at 0 °C was added a solution of LiAlH₄ (IN in ether, 12.5 mL). After stirring at room temperature for 2 hours, 8 mL of EtOAc was added and the solution was stirred for 10 minutes. Water (10 mL) was added and the mixture was stirred for an additional 10 minutes, filtered through celite and rinsed with EtOAc. Thefiltration
was partitioned between EtOAc and water/brine, washed with water/brine, dried over sodium sulfate and concentrated in vacuo to afford 2.25 g of desired product (501) as a colorless liquid. The product was sufficiently pure to be used directly in subsequent Swern oxidation. \(^1^H\) NMR (400 MHz, CDCl\(_3\)) \(\delta\): 7.49 - 7.39 (m, 2H), 7.39 - 7.33 (m, 3H), 6.59 (d, J= 9.2 Hz, 2H), 5.10 (s, 2H), 3.68 - 3.51 (m, 2H), 1.81 - 1.68 (m, 1H), 1.47 - 1.20 (m, 1H), 1.02 - 0.83 (m, 2H).

[0283] Step E: DMSO (2.5 mL) was added to a solution of oxalyl chloride (2.12 g, 16.7 mmol) in anhydrous dichloromethane (15 mL) at -78° C, and then a solution of (2-(4-(benzyloxy)-3,5-difluorophenyl)-cyclopropyl)methanol (501) (2.25 g, 7.75 mmol) in dichloromethane (5 mL) was added, followed by Et\(_3\)N (5.6 mL). Purification by flash chromatography on silica gel (0-30%) gave 2.07 g of desired product (502) as a colorless liquid. \(^1^H\) NMR (400 MHz, CDCl\(_3\)) \(\delta\): 9.37 (s, 1H), 7.47 - 7.41 (m, 2H), 7.40 - 7.29 (m, 3H), 6.65 (d, J = 7.1 Hz, 2H), 5.13 (s, 2H), 2.59 - 2.45 (m, 1H), 2.19 - 2.10 (m, 1H), 1.78 - 1.65 (m, 1H), 1.51 - 1.36 (m, 1H).

[0284] Steps F, G and H: These reactions were conducted according to the protocol described in US patent (US 2004/0092538, pp 40-41).

[0285] Step I: To a solution of ethyl 2-(2-(4-(benzyloxy)-3,5-difluorophenyl)cyclopropyl) acetate (505) (0.782 g, 2.25 mmol) in EtOAc/EtOH (5 mL/10 mL) was added 159 mg of 10% Pd/C, and the mixture was stirred under a hydrogen balloon overnight. After filtration through celite and washing with EtOH, the filtrate was concentrated in vacuo to afford 0.508 g of desired product (506) as a pale-yellow liquid. The product was sufficiently pure to be used directly in subsequent couplings. \(^1^H\) NMR (400 MHz, CDCl\(_3\)) \(\delta\): 6.67 (d, J= 8.4 Hz, 2H), 4.96 (br, 1H), 4.23 - 4.05 (m, 2H), 2.50 - 2.26 (m, 2H), 1.70 - 1.66 (m, 1H), 1.33 -1.19 (m, 4H), 0.97 - 0.79 (m, 2H).

Intermediate 8 ethyl 2-(4-hydroxyphenylthio)acetate (507)

[0286]

Intermediate 9 7-(chloromethyl)-2-methylbenzo[b]thiophene (511)

[0288]

[0289] Step A: The solution of 7-bromo-2-methylbenzo[b]thiophene (508) (0.908 g, 4.0 mmol) in tetrahydrofuran (16 mL) was cooled to -78 °C under nitrogen. n-butyllithium (2.40 mL, 6.0 mmol, 1.0M in Hexanes) was added dropwise. After the addition was complete, the reaction mixture was stirred at -78 °C for 1h, then poured on to the mixture of dry ice in ethyl ether (30 mL). The reaction was stirred to reach room temperature for 5 hours, followed by washing with 1N HCl, brine and dried over sodium sulfate, filtered, and concentrated in vacuo. The obtained white solid was washed with hexanes to provide 2-methylbenzo[b]thiophene-7-carboxylic acid (509) (0.240 g, 31.2%). LC-MS ESI m/z: found 191.0 [M-H].

[0290] Step B: The carboxylic acid (509) (0.240 g, 1.25 mmol) was dissolved in anhydrous tetrahydrofuran (12 mL) and cooled to 0 °C under nitrogen. BH\(_3\)-tetrahydrofuran complex (3.12 mL, 3.12 mmol, 1.0 M in tetrahydrofuran) was added slowly. After the addition was complete, the solution was allowed to warm to room temperature and stirred for an additional 1 hour. The solution was cooled to 0 °C and quenched by the addition of methanol (5 mL) followed by a saturated sodium sulfate aqueous solution (5 mL). The mixture was diluted with ethyl acetate and washed with brine.
and dried over sodium sulfate, filtered, and concentrated in vacuo to provide (2-methylbenzo[b]thiophen-7-yl)methanol (510) (0.203 g, 91.2%) as a colorless oil.

**[0291]** Step C: Thionyl chloride (0.415 mL, 5.69 mmol) was added slowly to an ice cold solution of the alcohol (510) (0.203 g, 1.14 mmol) in dichloromethane (6.0 mL). The reaction mixture was stirred and warmed to room temperature for 1 h. The resulting solution was quenched slowly with saturated sodium bicarbonate (10 mL) and extracted with dichloromethane, the organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo to provide the intermediate 7-(chloromethyl)-2-methylbenzo[b]thiophene (511) (0.150 g, 67.0%) as a yellow oil.

Intermediate 10 ethyl 2-(6-hydroxy-1,2,3,4-tetrahydronaphthalen-1-yl)acetate (514)

**[0292]**

![Diagram](image)

**[0293]** Step A: Sodium hydride (0.5 g, 12.5 mmol) was added slowly to a mixture of 6-methoxy-1-tetralone (0.881 g, 5.0 mmol) and triethyl phosphonoacetate (2.5 mL, 12.5 mmol) in anhydrous tetrahydrofuran (25 mL) at 0 °C. The reaction was warmed to room temperature and refluxed under nitrogen for 48 hours. The reaction mixture was quenched with water and extracted with ethyl acetate. The organic phase was washed with water, brine, dried with sodium sulfate and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (40% EtOAc in hexanes) to provide ethyl 2-(6-methoxy-3,4-dihydronaphthalen-1(2H)-ylidene)acetate (512) (0.792 g, 64.3%) as a yellow oil.

**[0294]** Step B: To a solution of the alkene (512) (0.792 g, 3.22 mmol) in ethanol (53 mL) was added Pd/C (100 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred under a hydrogen balloon overnight at room temperature, then filtered through a pad of celite and concentrated in vacuo to give ethyl 2-(6-methoxy-1,2,3,4-tetrahydronaphthalen-1-yl)acetate (513) (0.708 g, 88.7%) as a colorless oil.

**[0295]** Step C: To a solution of ethyl 2-(6-methoxy-1,2,3,4-tetrahydronaphthalen-1-yl)acetate (513) (0.708 g, 2.85 mmol) in dichloromethane (28 mL) at 0 °C was added boron tribromide (0.809 mL, 8.09 mmol). The solution was stirred for 2 hours and quenched with ethanol (5 mL) followed by a saturated solution of sodium bicarbonate (5 mL). The organic layer was separated, dried over sodium sulfate, filtered and concentrated in vacuo to obtain the intermediate ethyl 2-(6-hydroxy-1,2,3,4-tetrahydronaphthalen-1-yl)acetate (514) (0.600 g, 90.0%) as an oil residue.

Intermediate 11 ethyl 3-(3-chloro-4-hydroxyphenyl)-2-methylpropanoate (516A)

**[0296]**

![Diagram](image)

**[0297]** Step A: The mixture of 3-chloro-4-hydroxybenzaldehyde (0.783 g, 5 mmol) and ethyl 2-(triphenylphosphora-
nylidene)propionate (2.72 g, 7.5 mmol) in anhydrous tetrahydrofuran (25 mL) was heated at 60 °C under nitrogen for 4 hours. The solvent was removed in vacuo and purified by silica gel chromatography (40% EtOAc in hexanes) to provide ethyl 3-(3-chloro-4-hydroxyphenyl)-2-methylacrylate (515) (1.11 g, 95.2%) as a white solid.

[0298] Step B: To a solution of the alkene (515) (0.481 g, 2.0 mmol) in ethyl acetate (20 mL) was added Pd/C (48 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred overnight under a hydrogen balloon at room temperature, then filtered through a pad of celite and concentrated in vacuo to provide the intermediate ethyl 3-(3-chloro-4-hydroxyphenyl)-2-methylpropanoate (516A) (0.470 g, 96.9%) as a white solid. LC-MS ESI m/z: found 243.2 [M+H]+.

Intermediate 12 5-chloro-7-(chloromethyl)-3H-spiro[benzofuran-2,1'-cyclopentane] (522)

[0299]

[0300] Step A: To a solution of ethyl 2-bromo-4-chlorophenol (10.9 g, 52.5 mmol) in acetone (105 mL) was added potassium carbonate (14.5 g, 105 mmol), followed by 2-chlorocyclopentanone (6.3 mL, 63 mmol). The mixture was refluxed at 100 °C overnight, then filtered through celite, concentrated in vacuo and purified by flash chromatography on silica gel (20% EtOAc in hexanes) to provide 2-(2-bromo-4-chlorophenoxy)cyclopentanone (516B) (10.8 g, 71.0%) as a yellow oil.

[0301] Step B: To the mixture of methyl triphenylphosphonium bromide (16.0 g, 44.8 mmol) in anhydrous tetrahydrofuran (125 mL) at 0 °C under nitrogen was added portion wise the potassium tert-butoxide (5.0 g, 44.8 mmol). After stirring at 0 °C for 30 minutes, the mixture of 2-(2-bromo-4-chlorophenoxy)cyclopentanone (516B) (10.8 g, 37.3 mmol) in tetrahydrofuran (40 mL) was added slowly. The resulting mixture was stirred at room temperature under nitrogen for 3 hours. The reaction mixture was quenched with water and extracted with ethyl acetate. The organic phase was washed with water, brine, dried with sodium sulfate and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (5-10% EtOAc in hexanes) to provide 2-bromo-4-chloro-1-(2-methylenecyclopentyloxy)benzene (517) (6.2 g, 58.2%) as a colorless oil.

[0302] Step C: 2-Bromo-4-chloro-1-(2-methylenecyclopentyl) benzene (517) (6.2 g, 21.7 mmol) was heated at 150 °C for 6 hours. The residue was purified by flash chromatography on silica gel (5-10% EtOAc in hexanes) to provide 2-bromo-4-chloro-6-(cyclopentenylmethyl)phenol (518) (5.7 g, 53.0%) as a yellow oil.

[0303] Step D: The mixture of 2-bromo-4-chloro-6-(cyclopentenylmethyl)phenol (518) (5.7 g, 19.8 mmol) and Amberlyst® 15 ion-exchange resin (5.2 g) in toluene (100 mL) was heated at 80 °C for 3 hours. Subsequently, the Amberlyst 15 resin was filtered off and the filtrate was concentrated in vacuo to give 7-bromo-5-chloro-3H-spiro[benzofuran-2,1'-cyclopentane] (519) (5.4 g, 94.9%) as a yellow oil.

[0304] Step E: Similar manner described for the synthesis of (509) was used to synthesize the 5-chloro-3H-spiro[benzofuran-2,1’-cyclopentane]-7-carboxylic acid (520) (1.0 g, 44.5%) as an off-white solid.

[0305] Step F: Similar manner described for the synthesis of (510) was used to synthesize (5-chloro-3H-spiro[benzofuran-2,1’-cyclopentane]-7-yl)methanol (521) (0.640 g, 67.8%) as a colorless oil.
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[0306] Step G: Similar manner described for the synthesis of (511) was used to synthesize the intermediate 5-chloro-7-(chloromethyl)-3H-spiro[benzofuran-2,1'-cyclopentane] (522) (0.630 g, 91.4%) as a yellow oil.

Intermediate 13 7-(chloromethyl)-5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane] (529)

[0307]

[0308] Similar reaction routes used for the synthesis of (522) was used to synthesize the intermediate 7-(chloromethyl)-5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane] (529)

[0309] Step A: Provided 2-(2-bromo-4-fluorophenoxy)cyclopentanone (523) (13.3 g, 92.7%), as a yellow oil.

[0310] Step B: Provided 2-bromo-4-fluoro-1-(2-methylenecyclopentyloxy)benzene (524) (9.7 g, 73.4%) as a colorless oil.

[0311] Step C: Provided 2-bromo-6-(cyclopentenylmethyl)-4-fluorophenol (525) (8.2 g, 62.2%) as a yellow oil.

[0312] Step D: Provided 7-bromo-5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane] (526) (8.2 g, 100%), yellow oil.

[0313] Step E: Provided 5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-carboxylic acid (527) (1.75 g, 86.6%) as an off-white solid.

[0314] Step F: Provided (5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methanol (528) (0.610 g, 37.0%) as a colorless oil.

[0315] Step G: Provided the intermediate 7-(chloromethyl)-5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane] (529) (0.610 g, 92.3%) as a yellow oil.

Intermediate 14

(S)-ethyl 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetate (533)

[0316]
**Step A:** The chiral base (S)-1-phenylethanimine (4.6 mL, 35.7 mmol) was added slowly into the stirring mixture of 2-(5-methoxy-2,3-dihydro-1H-inden-1-yl)acetic acid (530) (7.0 g, 34.0 mmol) in acetone (170 mL). After the addition was complete, an additional portion of acetone (10 mL) was added and stirring was continued for 1 hour. The precipitate was collected by filtration, washed with acetone and dried under vacuum. The solids were re-suspended in acetone (100 mL) and warmed to reflux until all the solids dissolved. The resulting reaction mixture was slowly cooled down to room temperature overnight, during which time the precipitates formed. The suspension was cooled to 0 °C and the white solid was collected and washed with cold acetone by filtration. The solids were dissolved in 1N HCl and extracted with EtOAc. The organic phase was washed with water, brine, dried with sodium sulfate and concentrated in vacuo to provide (S)-2-(5-methoxy-2,3-dihydro-1H-inden-1-yl)acetic (531) (1.65 g, 23.5%, 99.9% ee) as an oil residue.

**Step B:** The mixture of (S)-2-(5-methoxy-2,3-dihydro-1H-inden-1-yl)acetic (531) (1.65 g, 8.0 mmol) and H2SO4 (0.111 mL, 4.0 mmol) in ethanol (5 mL) was refluxed at 100 °C for 2 hours. The solvent was removed in vacuo. The residue was dissolved in ethyl acetate and washed with water. The organic layer was separated, dried over sodium sulfate, filtered and concentrated in vacuo to provide (S)-ethyl 2-(5-methoxy-2,3-dihydro-1H-inden-1-yl)acetate (532) (1.8 g, 96.0%) as an oil.

**Step C:** Similar manner described for the synthesis of (514) was used to synthesize (S)-ethyl 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetate (533) (1.6 g, 94.5%) as an oil residue.

**Intermediate 15**

(S)-ethyl 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetate (536)

**0320** Similar reaction routes used for the synthesis of (533) was used to synthesize the intermediate (S)-ethyl 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetate (536)

**0321** Similar reaction routes used for the synthesis of (533) was used to synthesize the intermediate (S)-ethyl 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetate (536)

**0322** Step A: Provided (R)-2-(5-methoxy-2,3-dihydro-1H-inden-1-yl)acetic acid (534) (2.67 g, 38.1%, 92.0% ee pure) as an oil residue.

**0323** Step B: Provided (R)-ethyl 2-(5-methoxy-2,3-dihydro-1H-inden-1-yl)acetate (535) (2.9 g, 96.9%) as an oil residue.

**0324** Step C: Provided the intermediate (R)-ethyl 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetate (536) (1.7 g,
61.1%) as an oil residue.

Intermediate 16 ethyl 2-(3-fluoro-4-hydroxyphenyl)cyclopropanecarboxylate (539)

[0325]

Step A: The mixture of 3-fluoro-4-methoxybenzaldehyde (5.1g, 33.0 mmol) and (carbethoxymethylene)triphenylphosphorane (17.2 g, 49.5 mmol) in anhydrous toluene (165 mL) was refluxed at 120 °C under nitrogen for 4 hours. The solvent was removed in vacuo and purified by silica gel chromatography (10-20% EtOAc in hexanes) to provide (E)-ethyl 3-(3-fluoro-4-methoxyphenyl)acrylate (537) (6.5 g, 87.6%) as a white solid.

Step B: To a mixture of N-methyl-N'-nitro-N-nitrosoguanidine (TCI-America catalogue # M0527, 3.7g on a dry weight basis, 25.0 mmol) in ether (50 mL) at 0 °C was added a cold solution of 25% aqueous KOH (20mL). After stirring for 2 minutes, a portion of the yellow ethereal solution of the resulting diazomethane was added to a solution of the alkene (537) (1.1g, 5.0 mmol) in ether (25 mL) at 0 °C. A portion of palladium (II) acetate (0.112 g, 0.50 mmol) was added followed by an additional portion of diazomethane solution. This process was continued until all the diazomethane solution and palladium (II) acetate was added. The resulting mixture was stirred at 0-5 °C for 4 hours and acetic acid (6 drops) was added to quench any excess reagent. The resulting mixture was concentrated in vacuo to provide ethyl 2-(3-fluoro-4-methoxyphenyl)cyclopropane carboxylate (538) (0.990 g, 83.0%) as a yellow oil.

Step C: Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 2-(3-fluoro-4-hydroxyphenyl)cyclopropanecarboxylate (539) (0.850 g, 91.1%) as a colorless oil.

Intermediate 17 ethyl 4-(4-hydroxyphenyl)-3-methylbutanoate (542)

[0329]

Step A: Similar manner described for the synthesis of (537) was used to synthesize ethyl 4-(4-methoxyphenyl)-3-methylbut-2-enoate (540) (4.5 g, 64.3%) as a colorless oil.

Step B: Similar manner described for the synthesis of (513) was used to synthesize ethyl 4-(4-methoxyphenyl)-3-methylbutanoate (541) (2.0 g, 98.4%) as a colorless oil.

Step C: Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 4-(4-hydroxyphenyl)-3-methylbutanoate (542) (0.80 g, 42.5%) as a colorless oil.
Intermediate 18 7-(chloromethyl)-2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran (547)

[0333]

[0334] Step A: Similar manner described for the synthesis of (516B) was used to synthesize 4-(2-methylallyloxy)biphenyl (543) (5.9 g, 89.5%) as a white solid.

[0335] Step B: The mixture of 4-(2-methylallyloxy)biphenyl (543) (5.9 g, 26.4 mmol) in N-methyl-2-pyrrolidone was microwaved at 210 °C for 8 hours. The residue was dissolved in ethyl acetate and washed with water. The organic layer was separated, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by flash chromatography on silica gel (5-10 % EtOAc in hexanes) to provide 2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran (544) (3.6 g, 60.8%) as a white solid.

[0336] Step C: To an ice cold solution of 2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran (544) (2.24 g, 10.0 mmol) in dichloromethane (15 mL) was added slowly titanium tetrachloride (2 mL, 18 mmol). After stirring of 5 minutes, dichloro(methoxy) methane (1 mL, 11mmol) was added slowly. The resulting mixture was stirred at 0 °C for 3 hours, quenched slowly with ice water. The product was extracted with dichloromethane. The organic layer was separated, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by flash chromatography on silica gel (5-10 % EtOAc in hexanes) to provide 2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran-7-carbaldehyde (545).

[0337] Step D: To an ice cold solution of 2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran-7-carbaldehyde (545) (1 g, 3.96mmol) in methanol (20 mL) was added portion wise sodium borohydride (179.9 mg, 4.76mmol). The resulting mixture was stirred at 0 °C for 3 hours, quenched slowly with water. The product was extracted with dichloromethane. The organic layer was separated, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by flash chromatography on silica gel (20 % EtOAc in hexanes) to provide (2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran-7-yl)methanol (546).

[0338] Step E: Similar manner described for the synthesis of (511) was used to synthesize the intermediate 7-(chloromethyl)-2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran (547).

Intermediate 19 6-chloro-4-(chloromethyl)-2,2-dimethyl-2,3-dihydrobenzofuran (552)
**Step A:**
To a mixture of methyl 2-amino-3-methoxybenzoate (10 g, 55 mmol) in DMF (200 mL) was added N-chlorosuccinimide (8.08 g, 60.5 mmol) at room temperature, and the resulting mixture was stirred at 50 °C for 2 hours. The reaction was cooled to room temperature, diluted with water (300 mL), and extracted with ethyl acetate (2 x 100 mL). The organic layers were combined and washed with water (2 x 100 mL), brine (100 mL) and dried over sodium sulfate, filtered and concentrated *in vacuo*. The residue was purified by chromatography to provide the desired product (548).

**Step B:**
To a mixture of methyl 2-amino-5-chloro-3-methoxybenzoate (548) (5.2 g, 24 mmol) in water (25 mL) and concentrated sulfuric acid (2.7 mL) was added the solution of sodium nitrite (1.7 g, 24 mmol) in water (25 mL) at room temperature. The mixture was stirred at room temperature for 30 minutes and added to the mixture of copper bromide (5.2 g, 36 mmol) in concentrated hydrogen bromide (10 mL) and water (20 mL) at room temperature. The mixture was stirred at room temperature overnight, was filtered through a pad of celite and rinsed with EtOAc (3 x 100 mL). The organic layer was separated, and the aqueous layer was extracted with EtOAc (2 x 50 mL). The organic layers were combined and washed with water (2 x 100 mL), brine (100 mL) and dried over Na2SO4, filtered and concentrated *in vacuo*. The residue was purified by chromatography to provide the desired product (549).

**Step C:**
A mixture of methyl 2-bromo-5-chloro-3-methoxybenzoate (549) (1.1 g, 4 mmol), 4,4,5,5-tetramethyl-2-(2-methylprop-1-en-1-yl)-1,3,2-dioxaborolan (0.72 g, 4 mmol), Pd(PPh3)4 (138 mg, 0.12 mmol), 2N aqueous sodium carbonate (8 mL), methanol (10 mL), and toluene (6.0 mL) was heated in a pressure tube at 120 °C overnight. Ethyl acetate and water was added and the layers separated. The aqueous phase was extracted with ethyl acetate and the combined organic layers were dried over sodium sulfate, filtered and concentrated *in vacuo*. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc to afford the desired product (550).

**Step D:**
To solution of methyl 5-chloro-3-methoxy-2-(2-methylprop-1-en-1-yl)benzoate (550) (0.6 g, 2.3 mmol) in dichloromethane (20 mL) at -78 °C was added boron tribromide (0.67 mL, 6.9 mmol). The solution was allowed to warm to room temperature and stirred overnight. The reaction was quenched with methanol (5 mL) followed by a saturated solution of sodium bicarbonate (5 mL). The organic layer was separated, dried over sodium sulfate, filtered and concentrated *in vacuo*. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc to afford the desired product (551).

**Step E:**
Compound (552) was prepared in a similar manner as that described for the synthesis of (4) and (5).
**Step A:** DMSO (5.2 mL, 72.6 mmol) in dichloromethane (14.5 mL) was added to a solution of oxalyl chloride (3.1 mL, 36.3 mmol) in dichloromethane (83 mL) at -70 °C under nitrogen. After stirring for 5 minutes, 2-(4-methoxyphenyl)ethanol (5.0 g, 33.0 mmol) dissolved in dichloromethane (33 mL) was added drop wise (20 min). Stirring was continued for an additional 20 min. and triethyl amine (9.7 mL, 69.3 mmol) was added, and the reaction mixture was stirred and warmed slowly to room temperature for 1 hour. The reaction mixture was diluted with water. The organic layer was separated, dried over sodium sulfate, filtered and concentrated in vacuo to provide 2-(4-methoxyphenyl)acetaldehyde (553) (2.2 g, 44.4%) as an oil residue.

**Step B:** Similar manner described for the synthesis of (537) was used to synthesize (E)-ethyl 4-(4-methoxyphenyl)but-2-enoate (554) (1.1 g, 38.2%) as a colorless oil.

**Step C:** Similar manner described for the synthesis of (538) was used to synthesize ethyl 2-(4-methoxybenzyl)cyclopropanecarboxylate (555) (1.2 g, 99.0%) as a colorless oil.

**Step D:** Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 2-(4-hydroxybenzyl)cyclopropanecarboxylate (556) (0.945 g, 80.1%) as a colorless oil.

Intermediate 21 ethyl 2-(2-(4-hydroxyphenyl)cyclopropyl)acetate (562)

**Step A:** The mixture of (2-carboxyethyl)triphenylphosphonium bromide (20.0 g, 54.0 mmol) and 4-methoxybenzaldehyde (6.5 g, 53.5 mmol) in anhydrous DMSO (64 mL) was added slowly to the suspension of 60% NaH in mineral oil (4.3 g, 107 mmol) in anhydrous tetrahydrofuran (32 mL). The reaction mixture was stirred at 0 °C for 30 minutes then warmed to room temperature over 4 hours. The reaction mixture was quenched with 1N HCl (150 mL) and extracted with ethyl acetate. The organic phase was washed with water, brine, dried with sodium sulfate and concentrated.
under reduced pressure. The residue was purified by flash chromatography on silica gel (50% EtOAc in hexanes) to provide (E)-4-(4-methoxyphenyl)but-3-enoic acid (557) (5.7 g, 55.0%) as a yellow solid.

**[0352]** Step B: To the mixture of carboxylic acid (557) (5.7 g, 29.5 mmol) in DMF (150 mL) was added O-(Benzotriazol-1-yl)-N,N,N',N'-tetramethyluronium tetrafluoroborate (9.5 g, 29.5 mol). After stirring for 5 minutes, N,O-dimethylhydroxylamine. HCl (2.9 g, 29.5 mmol) was added, followed by Et₃N (8.2 mL, 58.9 mmol). The reaction mixture was stirred at room temperature for 3 hours, diluted with water and extracted with ethyl acetate. The organic phase was washed with water, brine, dried over sodium sulfate and concentrated in vacuo. The residue was purified by flash chromatography on silica gel (40% EtOAc in hexanes) to provide (E)-N-methoxy-4-(4-methoxyphenyl)-N-methylbut-3-enamide (558) (2.1 g, 29.6%) as a yellow solid.

**[0353]** Step C: The solution of diethyl zinc in hexanes (1M, 17.4 mL, 17.4 mmol) was added slowly to the mixture of iodomethane (2.5 mL, 34.9 mmol), dimethoxy ethane (1.82 mL) in dichloromethane (25 mL) at -15 °C. After stirring for 20 minutes, the solution of (E)-N-methoxy-4-(4-methoxyphenyl)-N-methylbut-3-enamide (558) (2.0 g, 8.7 mmol) in dichloromethane (10 mL) was added to the reaction mixture. The resulting mixture was allowed to warm to room temperature over 24 hours. The reaction mixture was diluted with water and extracted with dichloromethane. The organic phase was washed with water, brine, dried over sodium sulfate and concentrated in vacuo. The residue was purified by flash chromatography on silica gel (30% EtOAc in hexanes) to provide N-methoxy-2-(2-(4-methoxyphenyl)cyclopropyl)-N-methylacetamide (559) (1.8 g, 85.2%) as a yellow oil.

**[0354]** Step D: The mixture ofN-methoxy-2-(2-(4-methoxyphenyl)cyclopropyl)-N-methylacetamide (559) (1.8 g, 7.4 mmol), 2.5N NaOH (15mL) and EtOH (15 mL) was stirred at 60 °C for 24 hours. The reaction mixture was acidified with HCl and extracted with EtOAc. The organic phase was washed with water, brine, dried over sodium sulfate and concentrated in vacuo to provide 2-(2-(4-methoxyphenyl)cyclopropyl)acetic acid (560) (1.5 g, 96.1%) as a yellow solid.

**[0355]** Step E: Similar manner described for the synthesis of (532) was used to synthesize ethyl 2-(2-(4-methoxyphenyl)cyclopropyl)acetate (561) (1.2 g, 71.3%) as a colorless oil.

**[0356]** Step F: Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 2-(2-(4-hydroxyphenyl)cyclopropyl)acetate (562) (0.488 g, 43.6%) as a colorless oil.

**Intermediate 22**

ethyl 3-(4-hydroxy-2,6-dimethylphenyl)propanoate (564)

**[0357]**

![Diagram](image)

**[0358]** Step A: Similar manner described for the synthesis of (537) was used to synthesize (E)-ethyl 3-(4-hydroxy-2,6-dimethylphenyl)acrylate (563) (3.4 g, 100%) as a white solid.

**[0359]** Step B: Similar manner described for the synthesis of (513) was used to synthesize the intermediate ethyl 3-(4-hydroxy-2,6-dimethylphenyl)propanoate (564) (1.0 g, 97.8%) as a colorless oil.

**Intermediate 23**

ethyl 3-(4-hydroxy-2,5-dimethylphenyl)propanoate (567)

**[0360]**
[0361] Step A: Similar manner described for the synthesis of (537) was used to synthesize (E)-ethyl 3-(4-methoxy-2,5-dimethylphenyl)acrylate (565) (3.2 g, 91.0%) as a white solid.

[0362] Step B: Similar manner described for the synthesis of (513) was used to synthesize ethyl 3-(4-methoxy-2,5-dimethylphenyl)propanoate (566) (1.1 g, 72.7%) as a colorless oil.

[0363] Step C: Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 3-(4-hydroxy-2,5-dimethylphenyl)propanoate (567) (0.970 g, 89.1%) as a colorless oil.

Intermediate 24 ethyl 3-(4-hydroxy-2,6-dimethylphenyl)propanoate (570)

[0364]

[0365] Step A: Similar reaction routes used for the synthesis of (537) was used to synthesize (E)-ethyl 3-(4-methoxy-2,3-dimethylphenyl)acrylate (568) (3.2 g, 90.7%) as a white solid.

[0366] Step B: Similar reaction routes used for the synthesis of (513) was used to synthesize ethyl 3-(4-methoxy-2,3-dimethylphenyl)propanoate (569) (1.3 g, 86.0%) as a white solid.

[0367] Step C: Similar reaction routes used for the synthesis of (514) was used to synthesize the intermediate ethyl 3-(4-hydroxy-2,3-dimethylphenyl)propanoate (570) (1.2 g, 89.3%) as a white solid.

Intermediate 25 ethyl 2-(2-(2-fluoro-4-hydroxyphenyl)cyclopropyl)acetate (576)

[0368]
Similar reaction routes used for the synthesis of (562) was used to synthesize the intermediate ethyl 2-(2-(2-fluoro-4-hydroxyphenyl)cyclopropyl)acetate (576).

**Step A:** Provided (E)-4-(2-fluoro-4-methoxyphenyl)but-3-enoic acid (571) (5.0 g, 47.4%) as a yellow oil.

**Step B:** Provided (E)-4-(2-fluoro-4-methoxyphenyl)-N-methoxy-N-methylbut-3-enamide (572) (3.4 g, 56.7%) as a yellow oil.

**Step C:** Provided 2-(2-(2-fluoro-4-methoxyphenyl)cyclopropyl)-N-methoxy-N-methyl acetamide (573) (3.5 g, 96.7%) as a yellow oil.

**Step D:** Provided 2-(2-(2-fluoro-4-methoxyphenyl)cyclopropyl)-N-methoxy-N-methyl acetate (574) (2.7 g, 92.4%) as a yellow oil.

**Step E:** Provided ethyl 2-(2-(2-fluoro-4-methoxyphenyl)cyclopropyl)acetate (575) (1.9 g, 62.8%), yellow oil.

**Step F:** Provided the intermediate ethyl 2-(2-(2-fluoro-4-hydroxyphenyl)cyclopropyl) acetate (576) (1.4 g, 78.6%), colorless oil.

Intermediate 26

ethyl 3-(5-fluoro-4-hydroxy-2-methylphenyl)propanoate (579)

**Step A:** Similar manner described for the synthesis of (545) was used to synthesize 5-fluoro-4-hydroxy-2-methylbenzaldehyde (577) (0.240 g, 6.5%) as a white solid.

**Step B:** Similar manner described for the synthesis of (537) was used to synthesize (E)-ethyl 3-(5-fluoro-4-hydroxy-2-methylphenyl)acrylate (578) (0.330 g, 94.5%) as a white solid.

**Step C:** Similar manner described for the synthesis of (513) was used to synthesize ethyl 3-(5-fluoro-4-hydroxy-2-methylphenyl)propanoate (579) (0.325 g, 97.6%) as a colorless oil.
Intermediate 27

**ethyl 3-(5-fluoro-4-hydroxy-2-methylphenyl)propanoate (585)**

[0380]

**Step A:** Similar manner described for the synthesis of (517) was used to synthesize 2-fluoro-1-methoxy-3-vinylbenzene (580) (3.5 g, 88.5%) as a colorless oil.

**Step B:** Similar manner described for the synthesis of (513) was used to synthesize 1-ethyl-2-fluoro-3-methoxybenzene (581) (3.2 g, 89.7%) as a colorless oil.

**Step C:** Similar manner described for the synthesis of (545) was used to synthesize 2-ethyl-3-fluoro-4-methoxybenzaldehyde (582) (2.7 g, 73.2%) as a colorless oil.

**Step D:** Similar manner described for the synthesis of (537) was used to synthesize (E)-ethyl 3-(2-ethyl-3-fluoro-4-methoxyphenyl)acrylate (583) (1.3 g, 89.4%) as a white solid.

**Step E:** Similar manner described for the synthesis of (513) was used to synthesize ethyl 3-(2-ethyl-3-fluoro-4-methoxyphenyl)propanoate (584) (1.3 g, 98.5%) as a colorless oil.

**Step F:** Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 3-(5-fluoro-4-hydroxy-2-methylphenyl)propanoate (585) (1.2 g, 98.2%) as a colorless oil.

Intermediate 28

**ethyl 3-(5-fluoro-4-hydroxy-2-methylphenyl)propanoate (588)**

[0387]

**Similar reaction routes used for the synthesis of (567) was used to synthesize the intermediate ethyl 3-(5-fluoro-4-hydroxy-2-methylphenyl)propanoate (588)**

**Step A:** Provided (E)-ethyl 3-(4-methoxy-5,6,7,8-tetrahydronaphthalen-1-yl)acrylate (586) (0.540 g, 78.3%) as a white solid.

**Step B:** Provided ethyl 3-(4-methoxy-5,6,7,8-tetrahydronaphthalen-1-yl)propanoate (587) (0.510 g, 93.7%), as an oil residue.
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[0391] **Step C:** Provided the intermediate ethyl 3-(4-hydroxy-5,6,7,8-tetrahydronaphthalen-1-yl)propanoate (588) (0.243 g, 50.3%) as an oil residue.

**Intermediate 29 ethyl 3-(2-ethyl-5-fluoro-4-hydroxyphenyl)propanoate (594)**

[0392]

[0393] Similar reaction routes used for the synthesis of (585) was used to synthesize the intermediate ethyl 3-(2-ethyl-5-fluoro-4-hydroxyphenyl)propanoate (594).

[0394] **Step A:** Provided 1-fluoro-2-methoxy-4-vinylbenzene (589) (1.5 g, 30.3%) as a colorless oil.

[0395] **Step B:** Provided 4-ethyl-1-fluoro-2-methoxybenzene (590) (1.1 g, 71.7%) as a colorless oil.

[0396] **Step C:** Provided 2-ethyl-5-fluoro-4-methoxybenzaldehyde (591) (0.980 g, 76.1%) as a colorless oil.

[0397] **Step D:** Provided (E)-ethyl 3-(2-ethyl-5-fluoro-4-methoxyphenyl)acrylate (592) (1.3 g, 96.5%) as a colorless oil.

[0398] **Step E:** Provided ethyl 3-(2-ethyl-5-fluoro-4-methoxyphenyl)propanoate (593) (1.3 g, 96.2%) as a colorless oil.

[0399] **Step F:** Provided the intermediate ethyl 3-(2-ethyl-5-fluoro-4-hydroxyphenyl)propanoate (594) (0.617 g, 51.4%) as a colorless oil.

**Intermediate 30 ethyl 3-(3-fluoro-4-hydroxy-2-propylphenyl)propanoate (600)**

[0400]

[0401] Similar reaction routes used for the synthesis of (585) was used to synthesize the intermediate ethyl 3-(3-fluoro-4-hydroxy-2-propylphenyl)propanoate (600).

[0402] **Step A:** Provided (E)-2-fluoro-1-methoxy-3-(prop-1-enyl)benzene (595) (1.4 g, 32.5%) as a colorless oil.

[0403] **Step B:** Provided 2-fluoro-1-methoxy-3-propylbenzene (596) (1.2 g, 83.0%) as a colorless oil.

[0404] **Step C:** Provided 3-fluoro-4-methoxy-2-propylbenzaldehyde (597) (1.0 g, 73.4%) as a colorless oil.

[0405] **Step D:** Provided (E)-ethyl 3-(3-fluoro-4-methoxy-2-propylphenyl)acrylate (598) (1.2 g, 86.8%) as a colorless oil.
[0406] Step E: Provided ethyl 3-(3-fluoro-4-methoxy-2-propylphenyl)propanoate (599) (1.2 g, 95.9%) as a colorless oil.

[0407] Step F: Provided the intermediate ethyl 3-(3-fluoro-4-hydroxy-2-propylphenyl)propanoate (600) (1.1 g, 98.2%) as a colorless oil.

Intermediate 31 ethyl 3-(3-fluoro-4-hydroxy-2-pentylphenyl)propanoate (606)

[0408]

[0409] Similar reaction routes used for the synthesis of (585) was used to synthesize the intermediate ethyl 3-(3-fluoro-4-hydroxy-2-pentylphenyl)propanoate (606)

[0410] Step A: Provided (E)-2-fluoro-1-methoxy-3-(pent-1-enyl)benzene (601) (3.5 g, 69.3%) as a colorless oil.

[0411] Step B: Provided 2-fluoro-1-methoxy-3-pentylbenzene (602) (3.1 g, 88.2%) as a colorless oil.

[0412] Step C: Provided 3-fluoro-4-methoxy-2-pentylbenzaldehyde (603) (2.4 g, 67.9%) as a colorless oil.

[0413] Step D: Provided (E)-ethyl 3-(3-fluoro-4-methoxy-2-pentylphenyl)acrylate (604) (2.9 g, 89.7%) as a white solid.

[0414] Step E: Provided ethyl 3-(3-fluoro-4-methoxy-2-pentylphenyl)propanoate (605) (2.7 g, 94.4%) as a colorless oil.

[0415] Step F: Provided the intermediate ethyl 3-(3-fluoro-4-hydroxy-2-pentylphenyl)propanoate (606) (2.5 g, 98.7%) as a colorless oil.

Intermediate 32 ethyl 3-(2-ethyl-3-fluoro-4-hydroxyphenyl)-2-methylpropanoate (609)

[0416]

[0417] Step A: Similar manner described for the synthesis of (515) was used to synthesize (E)-ethyl 3-(2-ethyl-3-fluoro-4-methoxyphenyl)-2-methylacrylate (607) (1.3 g, 89.4%) as a white solid.

[0418] Step B: Similar manner described for the synthesis of (513) was used to synthesize ethyl 3-(2-ethyl-3-fluoro-4-methoxyphenyl)-2-methylpropanoate (608) (1.3 g, 98.5%) as a colorless oil.
**[0419] Step C:** Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 3-(2-ethyl-3-fluoro-4-hydroxyphenyl)-2-methylpropanoate (609) (1.2 g, 98.2%) as a colorless oil.

Intermediate 33 ethyl 3-(3-fluoro-4-hydroxy-2-isopentylphenyl)propanoate (615)

**[0420]**

**[0421]** Similar reaction routes used for the synthesis of (585) was used to synthesize the intermediate ethyl 3-(3-fluoro-4-hydroxy-2-isopentylphenyl)propanoate (615)

**[0422] Step A:** Provided (E)-2-fluoro-1-methoxy-3-(3-methylbut-1-enyl)benzene (610) (3.5 g, 88.5%) as a colorless oil.

**[0423] Step B:** Provided 2-fluoro-1-isopentyl-3-methoxybenzene (611) (3.2 g, 89.7%) as a colorless oil.

**[0424] Step C:** Provided 3-fluoro-2-isopentyl-4-methoxybenzaldehyde (612) (2.8 g, 73.2%) as a colorless oil.

**[0425] Step D:** Provided (E)-ethyl 3-(3-fluoro-2-isopentyl-4-methoxyphenyl)acrylate (613) (1.3 g, 89.4%) as a white solid.

**[0426] Step E:** Provided ethyl 3-(3-fluoro-2-isopentyl-4-methoxyphenyl)propanoate (614) (1.3 g, 98.5%) as a colorless oil.

**[0427] Step F:** Provided the intermediate ethyl 3-(3-fluoro-4-hydroxy-2-isopentylphenyl) propanoate (615) (1.2 g, 98.2%) as a colorless oil.

Intermediate 34 ethyl 3-(2-butyl-3-fluoro-4-hydroxyphenyl)propanoate (621)

**[0428]**
Similar reaction routes used for the synthesis of (585) was used to synthesize the intermediate ethyl 3-(2-butyl-3-fluoro-4-hydroxyphenyl)propanoate (621).

**Step A:** Provided (E)-1-(but-1-enyl)-2-fluoro-3-methoxybenzene (616) (4.5 g, 96.1%) as a colorless oil.

**Step B:** Provided 1-butyl-2-fluoro-3-methoxybenzene (617) (4.2 g, 92.7%) as a colorless oil.

**Step C:** Provided 2-butyl-3-fluoro-4-methoxybenzaldehyde (618) (3.4 g, 69.2%) as a colorless oil.

**Step D:** Provided (E)-ethyl 3-(2-butyl-3-fluoro-4-methoxyphenyl)acrylate (619) (1.0 g, 76.6%) as a white solid.

**Step E:** Provided ethyl 3-(2-butyl-3-fluoro-4-methoxyphenyl)propanoate (620) (1.0 g, 97.4%) as a colorless oil.

**Step F:** Provided the intermediate ethyl 3-(2-butyl-3-fluoro-4-hydroxyphenyl)propanoate (621) (0.937 g, 97.7%) as a colorless oil.

Intermediate 35 ethyl 3-(3-fluoro-4-hydroxyphenyl))-2,2,3,3-tetradeuteriopropanoate (625)

**Step A:** To the mixture of 3-fluoro-4-methoxybenzaldehyde (0.589 g, 3.0 mmol), potassium carbonate (1.8 g, 13.0 mmol) in methanol (65 mL) at room temperature was added slowly dimethyl 1-diazo-2-oxopropylphosphonate (1.4 g, 7.2 mmol). The resulting mixture was stirred at room temperature for 2 hours, quenched with saturated sodium bicarbonate and extracted with ethyl acetate. The organic phase was washed with water, brine, dried over sodium sulfate and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (10 % EtOAc in hexanes) to provide 4-ethynyl-2-fluoro-1-methoxybenzene (622) (0.750 g, 76.9%) as a colorless oil.

**Step B:** To the mixture of diisopropylamine (0.262 mL, 1.87 mmol) in tetrahydrofuran (5 mL) at -78 °C under nitrogen was added slowly the solution of n-butyllithium (1.17 mL, 1.87 mmol, 1.6M in hexanes). After stirring for 30 minutes, the solution of 4-ethynyl-2-fluoro-1-methoxybenzene (622) (0.180 g, 0.94 mmol) in tetrahydrofuran (1 mL) was added slowly into the reaction mixture. The mixture was allowed to reach 0 °C over 1 hour and ethyl chloroformate (0.134 mL, 0.134 mmol) was added. The resulting mixture was stirred at room temperature for 12 hours, quenched with saturated ammonium chloride and extracted with ethyl ether. The organic phase was washed with water, brine, dried over sodium sulfate and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (5-10 % EtOAc in hexanes) to provide ethyl 3-(3-fluoro-4-methoxyphenyl)propiolate (623) (0.070 g, 6.3%) as a colorless oil.

**Step C:** Similar manner described for the synthesis of (513), (except D2 balloon used), was used to synthesize deuterated ethyl 3-(3-fluoro-4-methoxyphenyl)propanoate (624) (0.050g, 68.9%) as a colorless oil.

**Step D:** Similar manner described for the synthesis of (514) was used to synthesize the intermediate deuterated ethyl 3-(3-fluoro-4-hydroxyphenyl)propanoate (625) (0.043 g, 92.1%) as a colorless oil.

Intermediate 36 ethyl 3-(3-fluoro-4-hydroxy-2-propylphenyl))-2,2,3,3-tetradeuteriopropanoate (629)

[0436]
[0442] **Step A:** To a solution of diisopropylamine (0.841 mL, 6.0 mmol) in tetrahydrofuran (15 mL) at -78 °C under nitrogen was added slowly the solution of n-butyllithium (3.75 mL, 6.0 mmol, 1.6M in hexanes). After stirring for 30 minutes, the solution of TMS-diazomethane (3.0 mL, 6.0 mmol, 2M in hexanes) was added slowly into the reaction mixture. The mixture was stirred for 30 minutes then was added the solution of 3-fluoro-4-methoxy-2-propylbenzaldehyde (597) (0.589 g, 3.0 mmol) in tetrahydrofuran (3 mL). The resulting mixture was stirred at room temperature for 12 hours, quenched with saturated ammonium chloride and extracted with ethyl ether. The organic phase was washed with water, brine, dried over sodium sulfate and concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (10 % EtOAc in hexanes) to provide 1-ethynyl-3-fluoro-4-methoxy-2-propylbenzene (626) (0.180 g, 31.2%) as a colorless oil.

[0443] **Step B:** Similar manner described for the synthesis of (623) was used to synthesize ethyl 3-(3-fluoro-4-methoxy-2-propylphenyl)propiolate (627) (0.140 g, 56.6%) as a colorless oil.

[0444] **Step C:** Similar manner described for the synthesis of (513), (except D₂ balloon was used), was used to synthesize deuterated ethyl 3-(3-fluoro-4-methoxy-2-propylphenyl)propanoate (628) (0.085g, 58.9%) as a colorless oil.

[0445] **Step D:** Similar manner described for the synthesis of (514) was used to synthesize the intermediate deuterated ethyl 3-(3-fluoro-4-hydroxy-2-propylphenyl)propanoate (629) (0.078 g, 96.6%) as a colorless oil.

[0446] Intermediate 37 ethyl 3-(2-ethyl-3-fluoro-4-hydroxyphenyl))-2,2,3,3-tetradeuteriopropanoate (633)

[0447] Similar reaction routes used for the synthesis of (625) was used to synthesize the intermediate (633)

[0448] **Step A:** Similar manner described for the synthesis of (622) was used to synthesize 2-ethyl-1-ethynyl-3-fluoro-4-methoxybenzene (630) (0.390 g, 72.9%) as a colorless oil.

[0449] **Step B:** Provided ethyl 3-(2-ethyl-3-fluoro-4-methoxyphenyl)propionate (631) (0.100 g, 18.3%) as a colorless oil.

[0450] **Step C:** Provided deuterated ethyl 3-(2-ethyl-3-fluoro-4-methoxyphenyl)propanoate (632) (0.080 g, 77.5%) as a colorless oil.

[0451] **Step D:** Provided the intermediate deuterated ethyl 3-(2-ethyl-3-fluoro-4-hydroxyphenyl) propanoate (633) (0.062 g, 82.0%) as a colorless oil.
Intermediate 38 ethyl 3-(3-fluoro-4-hydroxy-2-methylphenyl)propanoate (637)

[0452]

\[
\begin{align*}
\text{Step A:} & \quad \text{Similar manner described for the synthesis of (545) was used to synthesize 3-fluoro-4-methoxy-2-methylbenzaldehyde (634) (0.910 g, 73.1%) as a white powder.} \\
\text{Step B:} & \quad \text{Similar manner described for the synthesis of (537) was used to synthesize (E)-ethyl 3-(3-fluoro-4-methoxy-2-methylphenyl)acrylate (635) (1.2 g, 90.8%) as a white powder.} \\
\text{Step C:} & \quad \text{Similar manner described for the synthesis of (513) was used to synthesize ethyl 3-(3-fluoro-4-methoxy-2-methylphenyl)propanoate (636) (1.2 g, 97.5%) as a colorless oil.} \\
\text{Step D:} & \quad \text{Similar manner described for the synthesis of (514) was used to synthesize the intermediate ethyl 3-(3-fluoro-4-hydroxy-2-methylphenyl)propanoate (637) (1.0 g, 95.1%) as a colorless oil.}
\end{align*}
\]

Intermediate 39 ethyl 3-(3-ethyl-4-hydroxyphenyl)propanoate (641)

[0457]

[0458] Step A: Similar reaction routes used for the synthesis of (545) was used to synthesize 3-ethyl-4-methoxybenzaldehyde (638) (0.690 g, 89.4%) as a yellow oil.
[0459] Step B: Similar reaction routes used for the synthesis of (537) was used to synthesize (E)-ethyl 3-(3-ethyl-4-methoxyphenyl)acrylate (639) (0.440 g, 100%) as a colorless oil.
[0460] Step C: Similar reaction routes used for the synthesis of (513) was used to synthesize ethyl 3-(3-ethyl-4-methoxyphenyl)propanoate (640) (0.360 g, 91.1%) as a colorless oil.
[0461] Step D: Similar reaction routes used for the synthesis of (514) was used to synthesize the intermediate ethyl 3-(3-ethyl-4-hydroxyphenyl)propanoate (641) (0.316 g, 93.6%) as a colorless oil.

Intermediate 40 ethyl 3-(3-ethyl-4-hydroxyphenyl)-2-methylpropanoate (644)

[0462]
Step A: Similar reaction routes used for the synthesis of (515) was used to synthesize (E)-ethyl 3-(3-ethyl-4-methoxyphenyl)-2-methylacrylate (642) (0.460 g, 99.0%) as a white powder.

Step B: Similar reaction routes used for the synthesis of (513) was used to synthesize ethyl 3-(3-ethyl-4-methoxyphenyl)-2-methylpropanoate (643) (0.400 g, 86.3%) as a colorless oil.

Step C: Similar reaction routes used for the synthesis of (514) was used to synthesize the intermediate ethyl 3-(3-ethyl-4-hydroxyphenyl)-2-methyl propanoate (644) (0.343 g, 90.7%) as a colorless oil.

Intermediate 41 ethyl 3-(4-aminophenyl)-2-methylpropanoate (646)

Step A: A solution of 4-nitrobenzaldehyde (2 g, 13.2 mmol) and (1-ethoxy carbonylethylidene)triphenyl phos- phorane (4.80 g, 13.2 mmol) in tetrahydrofuran (130 mL) was refluxed for 24 hours. The reaction was concentrated in vacuo and was purified by flash column chromatography on silica gel with hexanes and EtOAc to give (E)-ethyl 2-methyl-3-(4-nitrophenyl)acrylate (645).

Step B: To a solution of (E)-ethyl2-methyl-3-(4-nitrophenyl)acrylate (645) (2.49 g, 10.6 mmol) in ethanol (100 mL) was added Pd/C (250 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred overnight at room temperature, was filtered through a pad of celite and concentrated in vacuo to give ethyl 3-(4-aminophenyl)-2-methylpropanoate (646).

Intermediate 42 4-(2-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)ethyl)phenol (650)

Step A: A solution of 4-nitrobenzaldehyde (2 g, 13.2 mmol) and (1-ethoxy carbonylethylidene)triphenyl phos- phorane (4.80 g, 13.2 mmol) in tetrahydrofuran (130 mL) was refluxed for 24 hours. The reaction was concentrated in vacuo and was purified by flash column chromatography on silica gel with hexanes and EtOAc to give (E)-ethyl 2-methyl-3-(4-nitrophenyl)acrylate (645).

Step B: To a solution of (E)-ethyl2-methyl-3-(4-nitrophenyl)acrylate (645) (2.49 g, 10.6 mmol) in ethanol (100 mL) was added Pd/C (250 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred overnight at room temperature, was filtered through a pad of celite and concentrated in vacuo to give ethyl 3-(4-aminophenyl)-2-methylpropanoate (646).
[0470] **Step A:** 7-(chloromethyl)-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran (647) (1 g, 4.66 mmol), triphenyl phosphine (1.22 g, 4.66 mmol) and toluene (46 mL) were heated at reflux for 48 hours. The reaction was filtered and the solid was washed with diethyl ether to provide ((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methyl) triphenyl phosphonium chloride (648).

[0471] **Step B:** To a solution of ((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methyl) triphenyl phosphonium chloride (648) (500 mg, 1.09 mmol) in anhydrous tetrahydrofuran at room temperature (10 mL) was added n-butyllithium (0.67 mL, 1.31 mmol, 2 M in hexane). After stirring for 10 min 4-(benzyloxy)benzaldehyde (231 mg, 1.09 mmol) was added and stirred for an additional 3 hours. The reaction was quenched with water and extracted with ethyl acetate. The combined organic phase was dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (20%) to give 7-(4-(benzyloxy)styryl)-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran as a cis/trans mixture (649).

[0472] **Step C:** To a solution 7-(4-(benzyloxy) styryl)-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran (649) (207.7 mg, 0.583 mmol) in ethanol (6 mL) was added Pd/C (20 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred overnight at room temperature, was filtered through a pad of celite and concentrated in vacuo to give 4-(2-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)ethyl)phenol (650).

Intermediate 43 ethyl 3-(5-hydroxy-[1,1’-biphenyl]-2-yl)propanoate (653)

[0473] **Step A:** A mixture of 2-bromo-4-hydroxybenzaldehyde (350 mg, 1.74 mmol), phenyl boronic acid (233.5 mg, 1.92 mmol), Pd(PPh3)4 (60 mg, 0.052 mmol), saturated sodium bicarbonate (6.0 mL), methanol (15 mL), and toluene (6.0 mL) was heated in a pressure tube at 120 °C overnight. Ethyl acetate and water were added and the layers separated.
The aqueous phase was extracted with ethyl acetate and the combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (30%) to afford 5-hydroxy-[1,1'-biphenyl]-2-carbaldehde (651).

**Step B:** A solution of 5-hydroxy-[1,1'-biphenyl]-2-carbaldehyde (651) (292 mg, 1.47 mmol) and (carboxymethylene)-triphenylphosphorane (564.5 mg, 1.62 mmol) in toluene (15 mL) was refluxed for 24 hours. The reaction was concentrated in vacuo and was purified by flash column chromatography on silica gel with hexanes and EtOAc (30%) to give (E)-ethyl 3-(5-hydroxy-[1,1'-biphenyl]-2-yl)acrylate (652).

**Step C:** To a solution of (E)-ethyl 3-(5-hydroxy-[1,1'-biphenyl]-2-yl)acrylate (652) (420 mg, 1.57 mmol) in ethanol (6 mL) was added Pd/C (42 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred overnight at room temperature, was filtered through a pad of celite and concentrated in vacuo to give ethyl 3-(5-hydroxy-[1,1'-biphenyl]-2-yl)propanoate (653).

Intermediate 44 5-chloro-7-(chloromethyl)-2,2-dimethylbenzofuran-3(2H)-one (657)

**Step A:** A solution of 5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylic acid (654) (2.39 g, 10.5 mmol), potassium persulfate (8.55 g, 31.6 mmol), cupric sulfate pentahydrate (2.62 g, 10.5 mmol) and acetonitrile/water (1:1) (90 mL) were heated at reflux for 1 hour. Ethyl acetate and water were added and the layers separated. The aqueous phase was extracted with ethyl acetate and the combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo to provide 5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-carboxylic acid (655) as a yellow solid.

**Step B:** To a solution of 5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-carboxylic acid (655) (2.67 g, 11.1 mmol) in tetrahydrofuran (56 mL) was added BH$_3$ • tetrahydrofuran (11.1 mL, 11.1 mmol) drop wise and stirred overnight. The reaction was quenched with water and methanol and then extracted with ethyl acetate. The organic layer was washed with saturated sodium bicarbonate and then extracted with ethyl acetate. The organic layer was washed with saturated sodium bicarbonate and then dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (50%) to afford 5-chloro-7-(hydroxymethyl)-2,2-dimethylbenzofuran-3(2H)-one (656) (278 mg). The saturated sodium bicarbonate layer was acidified to recover the starting acid (655) (1.68 g).

**Step C:** A solution of 5-chloro-7-(hydroxymethyl)-2,2-dimethylbenzofuran-3(2H)-one (656) (278 mg, 1.23 mmol) in neat thionyl chloride (5 mL) was stirred at room temperature for 48 hours. The reaction was concentrated to obtain 5-chloro-7-(chloromethyl)-2,2-dimethylbenzofuran-3(2H)-one (657) as a brown/grey solid.

Intermediate 45 7-(bromomethyl)-5-fluoro-2,2-dimethylbenzofuran-3(2H)-one (660)

**Step A:** To a solution of 5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylic acid (654) (2.39 g, 10.5 mmol), potassium persulfate (8.55 g, 31.6 mmol), cupric sulfate pentahydrate (2.62 g, 10.5 mmol) and acetonitrile/water (1:1) (90 mL) were heated at reflux for 1 hour. Ethyl acetate and water were added and the layers separated. The aqueous phase was extracted with ethyl acetate and the combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo to provide 5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-carboxylic acid (655) as a yellow solid.
**Step A:** A solution of 4-fluoro-2-methylphenol (10g, 79.28 mmol), ethyl 2-bromoisobutyrate (23.2 mL, 158.6 mmol), potassium carbonate (21.9 g, 158.6 mmol), and DMSO (80 mL) was stirred at room temperature for 72 hours. Water and ethyl acetate were added and the layers were separated. The aqueous phase was extracted with ethyl acetate (3 x 50 mL) and the combined organic layers were washed with brine, dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (20%) to afford ethyl 2-(4-fluoro-2-methylphenoxy)-2-methylpropanoate.

**Step B:** To a solution of ethyl 2-(4-fluoro-2-methylphenoxy)-2-methylpropanoate (13.3 g, 55.44 mmol) in tetrahydrofuran (40 mL) and methanol (10 mL) was added NaOH (6.66 g, 166.32 mmol) in water (14 mL) and stirred overnight. The volatiles were removed in vacuo and acidified with concentrated HCl. The milky white solution was extracted with ethyl acetate, dried over sodium sulfate, filtered and concentrated in vacuo to give 2-(4-fluoro-2-methylphenoxy)-2-methylpropanoic acid as a yellow solid.

**Step C:** To a solution of 2-(4-fluoro-2-methylphenoxy)-2-methylpropanoic acid (5g, 23.6 mmol) in tetrahydrofuran (50 mL) at 0 °C was added cat. DMF and oxalyl chloride (2.5 mL, 28.3 mmol). The reaction was warmed to room temperature, stirred for 1 hour, and concentrated in vacuo. The oil was dissolved in dichloromethane (50 mL), cooled to -78 °C and AlCl₃ (7.6 g, 56.6 mmol) was added. The reaction was allowed to warm to room temperature overnight. Ice water was added and the dichloromethane was removed in vacuo. The aqueous phase was extracted with ethyl acetate (3 x 50 mL) and washed with saturated sodium bicarbonate dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (20%) to provide 5-fluoro-2,2,7-trimethylbenzofuran-3(2H)-one.

**Step D:** A solution of provide 5-fluoro-2,2,7-trimethylbenzofuran-3(2H)-one (100 mg, 0.515 mmol), N-Bromosuccinimide (100.8 mg, 0.567 mmol), benzoyl chloride (1.2 mg, 0.005 mmol) and carbon tetrachloride (2 mL) was heated at reflux overnight. Saturated sodium bicarbonate was added and extracted with ethyl acetate, dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (5%) to give 7-(bromomethyl)-5-fluoro-2,2-dimethylbenzofuran-3(2H)-one.

Intermediate 46 ethyl 3-(5-fluoro-4-hydroxy-2-propylphenyl)propanoate
Step A - F: Compound (666) was prepared in a similar manner as that described for the synthesis of (585).

Intermediate 47 5-bromo-7-(chloromethyl)-2,2-dimethyl-2,3-dihydrobenzofuran (670)

[0486] Step A:
Using a dropping funnel, bromine (0.8 mL, 15.6 mmol) in acetic acid (6 mL) was added to a solution of 2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylic acid (1 g, 5.20 mmol) in acetic acid at 0 °C. The reaction was allowed to warm to room temperature and stirred overnight. A 2M solution of sodium sulfite was added until all of the red color disappeared. The volatiles were removed in vacuo and dichloromethane was added and the layers separated. The organic phase was washed with water and brine, dried over sodium sulfate, filtered and concentrated in vacuo to yield 5-bromo-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylic acid (667).

Step B:
Thionyl chloride (0.6 mL, 8.12 mmol) was added slowly to a solution of 5-bromo-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylic acid (667) (1.1 g, 4.06 mmol) in methanol (41 mL). After refluxing for 3 hours the solvent was removed in vacuo to obtain methyl 5-bromo-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylate (668).

Step C:
To a solution of methyl 5-bromo-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylate (668) (466 mg, 1.63 mmol) in tetrahydrofuran (16 mL) at 0 °C was added LAH (1 mL, 1.96 mmol). The reaction was stirred at 0 °C for 1 hour and quenched with 0.2 mL of water, 0.2 mL of 15% NaOH and 0.6 mL of water. The reaction was warmed to room temperature and diluted with diethyl ether. Magnesium sulfate was added and the solution was filtered, washed with diethyl ether, and the solvent removed in vacuo to provide (5-bromo-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methanol (669).

Step D:
To a solution of (5-bromo-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methanol (669) (390 mg, 1.51 mmol) in dichloromethane (15 mL) was added thionyl chloride (0.56 mL, 7.58 mmol). The reaction was stirred at room temperature for 2 hours and then concentrated to afford 5-bromo-7-(chloromethyl)-2,2-dimethyl-2,3-dihydrobenzofuran (670).
Intermediate 48 ethyl 3-(3-((dimethylamino)methyl)-4-hydroxyphenyl)-2-methylpropanoate (673)

[0492]

\[
\begin{align*}
\text{Step A:} & \quad \text{Compound (671) was prepared in a similar manner as that described for the synthesis of (515)} \\
\text{Step B:} & \quad \text{Compound (672) was prepared in a similar manner as that described for the synthesis of (513)} \\
\text{Step C:} & \quad \text{To a solution of ethyl 3-(4-hydroxyphenyl)-2-methylpropanoate (672) (150 mg, 0.72 mmol), potassium carbonate (149.3 mg, 1.08 mmol) in toluene (7 mL) was added N,N-dimethylmethylideneammonium iodide (173.2 mg, 0.94 mmol) and stirred for 72 hours. Water was added and the reaction was extracted with ethyl acetate and the combined organic layers dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (50%) to give ethyl 3-(3-((dimethylamino)methyl)-4-hydroxyphenyl)-2-methylpropanoate (673).}
\end{align*}
\]

Intermediate 49 (2,2-dimethyl-5-(1H-tetrazol-1-yl)-2,3-dihydrobenzofuran-7-yl)methanol (678)

[0496]

\[
\begin{align*}
\text{Step A:} & \quad \text{To a solution of ethyl 2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylate (1g, 4.54 mmol) in trifluoroacetic acid (7 mL) at 0 °C was slowly added nitric acid (1.36 mL). The reaction was stirred at 0 °C for one hour and then at room temperature for 30 minutes. The reaction was added to ice and the resultant solid was collected by filtration, and washed with water to provide ethyl 2,2-dimethyl-5-nitro-2,3-dihydrobenzofuran-7-carboxylate (674) as a yellow solid (1.02 g, 83%).} \\
\text{Step B:} & \quad \text{To a solution ethyl 2,2-dimethyl-5-nitro-2,3-dihydrobenzofuran-7-carboxylate (674) (1.02 g, 3.84 mmol) }
\end{align*}
\]
in ethanol (40 mL) was added Pd/C (100 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was stirred overnight at room temperature, filtered through a pad of celite and concentrated in vacuo to give ethyl 5-amino-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylate (675) (899 mg, 99%)

[0499]  **Step C:** A solution of ethyl 5-amino-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxylate (675) (300 mg, 1.28 mmol), triethyl orthoformate (0.42 mL, 2.55 mmol), sodium azide (124.8 mg, 1.92 mmol), and acetic acid (12 mL) was heated at 100 °C for 2 hours. The reaction was cooled to room temperature and water was added. The aqueous phase was extracted with ethyl acetate and the combined organic layers dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (50%) to afford ethyl 2,2-dimethyl-5-(1H-tetrazol-1-yl)-2,3-dihydrobenzofuran-7-carboxylate (676) (184 mg, 50%).

[0500]  **Step D:** A solution of ethyl 2,2-dimethyl-5-(1H-tetrazol-1-yl)-2,3-dihydrobenzofuran-7-carboxylate (676) (182 mg, 0.631 mmol), lithium hydroxide (106 mg, 2.53 mmol), methanol (1 mL), tetrahydrofuran (1 mL), and water (4 mL) was added and stirred for 2 hours and at room temperature for an additional 1 hour. The reaction was concentrated in vacuo and water was added. The aqueous phase was extracted with ethyl acetate and the combined organic layers dried over sodium sulfate, filtered and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (60%) to afford (2,2-dimethyl-5-(1H-tetrazol-1-yl)-2,3-dihydrobenzofuran-7-yl) methanol (678) (77.8 mg, 61%).

**Intermediate 50 Ethyl 3-(3,5-difluoro-4-hydroxyphenyl)-2-ethoxypropanoate (681)**

**[0502]**

**[0503]  **Step A:** To a solution of 2-chloro-2-ethoxyacetic acid ethyl ester (10 g, 60 mmol) in chloroform (30 mL) was added triphenylphosphine (15.7 g, 60 mmol) and stirred overnight at room temperature. The solvent was removed in vacuo, and diethyl ether was added. The solvent was again removed and dried on high vacuum to give (1,2-diethoxy-2-oxoethyl)triphenylphosphonium chloride (679) (82% yield) as a foamy solid.

**[0504]  **Step B:** To a solution of (1,2-diethoxy-2-oxoethyl)triphenylphosphonium chloride (679) (1.61 g, 3.76 mmol) in tetrahydrofuran (56 mL) was added DBU (0.67 ml, 4.51 mmol) and the reaction was stirred for 10 minutes at room temperature. 4-(benzyloxy)-3,5-difluorobenzaldehyde (1.40 g, 5.64 mmol) was added in one portion and the reaction was stirred at room temperature for 18 hours. The solvent was removed in vacuo, diethyl ether was added and the solids filtered. The filtrate was concentrated in vacuo and the residue oil was purified by flash column chromatography (0-30% EtOAc in hexanes) to provide (Z)-ethyl 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-ethoxyacrylate (680) (31 g, 82% yield).

**[0505]  **Step C:** To a solution of (Z)-ethyl 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-ethoxyacrylate (680) (1.3 g, 3.59 mmol) in ethanol (25 mL) was added Pd/C (140 mg, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred overnight at room temperature, was filtered through a pad of celite and concentrated in vacuo to give ethyl 3-(3,5-difluoro-4-hydroxyphenyl)-2-ethoxypro-
Intermediate 51 ethyl 2-(4-hydroxy-3-methylphenoxy)acetate (682)

[0506]

\[
\text{HO} \quad \text{Br} \quad \text{EtO} \quad \text{HO} \quad \text{EtO}
\]

\[
\text{K}_2\text{CO}_3 \quad \text{ACN, 80°C}
\]

[0507] A mixture of 2-methylbenzene-1,4-diol (5 g, 40.2 mmol), ethyl 2-bromoacetate (1.1 eq.), and potassium carbonate (2 eq.) in acetonitrile (50 mL) was heated at 80 °C for 18 hours. The reaction was cooled to room temperature, and the acetonitrile was removed in vacuo. Water was added and the crude residue was extracted with ethyl acetate. The organic layer was washed with brine, dried over sodium sulfate, filtered and concentrated in vacuo. The residue was purified by silica gel chromatography (0-100% EtOAc in hexanes) to provide ethyl 2-(4-hydroxy-3-methylphenoxy)acetate (682) as a pink solid.

Intermediate 52 ethyl 2-(4-hydroxy-2-methylphenoxy)acetate (685)

[0508]

\[
\text{OH} \quad \text{Br} \quad \text{EtO} \quad \text{OEt}
\]

[0509] Step A: A mixture of 1-(4-hydroxy-3-methylphenyl)ethanone (5 g, 33.3 mmol), ethyl 2-bromoacetate (1.1 eq.), and cesium carbonate (2 eq.) in acetonitrile (200 mL) was stirred at room temperature overnight. The acetonitrile was removed in vacuo, and the crude oil was dissolved in ethyl acetate (50 mL) and washed with 1M HCl (2 X 50 mL), water (2 X 50 mL), and brine (50 mL). The organic layer was dried over sodium sulfate, filtered and concentrated in vacuo to obtain ethyl 2-(4-acetyl-2-methylphenoxy)acetate (683).

[0510] Step B: A solution of ethyl 2-(4-acetyl-2-methylphenoxy)acetate (683) (8.78 g, 37 mmol), mCPBA (2 eq.), and p-TsOH monohydrate (0.15 eq.) in dichloromethane (160 mL) was heated at 40 °C overnight. The reaction was cooled to room temperature and washed with 1M KI (2 X 200 mL), 5%NaHSO3 (2 X 150 mL), and water (200 mL). The organic layer was dried over sodium sulfate, filtered and concentrated in vacuo. The crude material was purified by silica gel chromatography (0-100% EtOAc in hexanes) to provide ethyl 2-(4-acetoxy-2-methylphenoxy)acetate (684) (72%).

[0511] Step C: To a solution of ethyl 2-(4-acetoxy-2-methylphenoxy)acetate (684) (6.79 g, 27 mmol) in dry methanol (150 mL) was added sodium methoxide (1.1 eq.) and the reaction was stirred at room temperature under N2 for 3 hours. The reaction was quenched with 1M HCl and the volatiles were removed in vacuo. The oil was dissolved in ethyl acetate (100 mL) and washed with water (2 X 100 mL), and brine (100 mL). The organic layer was dried over sodium sulfate, filtered and concentrated in vacuo to afford ethyl 2-(4-hydroxy-2-methylphenoxy)acetate (685) as a white solid (77%).

Intermediate 53 ethyl 2-(4-hydroxyphenoxy)acetate (688)

[0512]
Step A - C: Compound (688) was prepared in a similar manner as that described for the synthesis of (685).

Intermediate 54 5-chloro-7-(chloromethyl)-2,3,3-trimethyl-2,3-dihydrobenzofuran (693)

Step A - E: Compound (693) was prepared in a similar manner as that described for the synthesis of (5).

Intermediate 55 methyl 3-(4-hydroxyphenyl)-4-methylpentanoate (695)

Step A - B: Compound (695) was prepared in a similar manner as that described for the synthesis of (11).

Intermediate 56 methyl 5-hydroxy-2,3-dihydro-1H-indene-2-carboxylate (697)
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**[0519]** Step A: A mixture of methyl 5-methoxy-1-oxo-2,3-dihydro-1H-indene-2-carboxylate (5.5 g, 25 mmol) in acetic acid (0.64 M) and perchloric acid (14.9 M) was suspended in a pressure vessel and was shook under a hydrogen atmosphere (30 psi) for 4 hours. The mixture was filtered through a pad of celite and washed with chloroform. The organic phase was washed with water (5X) until the pH was neutral, followed with a wash with brine. The organic layer was dried over sodium sulfate, filtered and concentrated in vacuo. The crude material was purified by silica gel chromatography (0-100% EtOAc in hexanes) to provide methyl 5-methoxy-2,3-dihydro-1H-indene-2-carboxylate (696) (46%).

**[0520]** Step B: To a solution of methyl 5-methoxy-2,3-dihydro-1H-indene-2-carboxylate (696) (2.35 g, 11.4 mmol) in anhydrous dichloromethane (40 mL) cooled to -78 °C was added boron tribromide (1.5 eq.). The reaction was allowed to stir at -78 °C for 30 minutes, 0 °C for 2 hours, and at room temperature overnight. The reaction mixture was cooled to 0 °C and quenched slowly with methanol. After stirring for 15 minutes a saturated sodium bicarbonate solution was added slowly to the mixture and allowed to stir at 0 °C for 30 minutes. Ethyl acetate was added and the layers were separated. The aqueous layer was extracted with ethyl acetate and the combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo to afford methyl 5-hydroxy-2,3-dihydro-1H-indene-2-carboxylate (697).

**[0521] Intermediate 57 ethyl 3-(4-hydroxy-2-isopropoxyphenyl)propanoate (700)**

**[0522]** Step A: A mixture of 4-(benzyloxy)-2-hydroxybenzaldehyde (1 g, 4.38 mol), 2-iodopropane (1.2 eq.) and potassium carbonate (2.5 eq.) in acetone (40 mL) was refluxed overnight. The reaction was cooled to room temperature and filtered through a celite plug, and concentrated to dryness. The crude material was purified by flash column chromatography with ethyl acetate and hexanes to provide 4-(benzyloxy)-2-isopropoxybenzaldehyde (698).

**[0523]** Step B: A solution of 4-(benzyloxy)-2-isopropoxybenzaldehyde (698) (480 mg, 1.776 mmol) and (carbethoxymethylene)triphenylphosphorane (1.1 eq.) in toluene was heated at 100 °C overnight. The reaction was cooled to room temperature and concentrated in vacuo. The crude material was purified by silica gel chromatography (0-50% EtOAc in hexanes) to afford (E)-ethyl 3-(4-(benzyloxy)-2-isopropoxyphenyl)acrylate (699).

**[0524]** Step C: To (E)-ethyl 3-(4-(benzyloxy)-2-isopropoxyphenyl)acrylate (699) (530 mg, 1.56 mmol) in ethanol (12 mL) was added Pd/C (0.5 eq, 10% Degussa type). A balloon of hydrogen gas was added and the reaction was evacuated and back-filled with hydrogen three times. The reaction was stirred overnight at room temperature, filtered through a pad of celite and concentrated in vacuo to give ethyl 3-(4-hydroxy-2 isopropoxyphenyl) propanoate (700).

**Intermediate 58 5-chloro-7-(chloromethyl)-2-methylbenzofuran (705)**

**[0525]**
Step A - E: Compound (705) was prepared in a similar manner as that described for the synthesis of (5). Intermediate 59 ethyl 3-(4-hydroxynaphthalen-1-yl)propanoate (708)

Step A - C: Compound (708) was prepared in a similar manner as that described for the synthesis of (542). Intermediate 60 ethyl 3-((dimethylamino)methyl)-4-hydroxyphenyl)propanoate (711)

Step A: A mixture of 4-bromo-3-((dimethylamino)methyl)phenol (4 g, 17.4 mmol), benzylbromide (2 eq.), and
potassium carbonate (3 eq.) in DMF (100 mL) was stirred at 80 °C overnight. The reaction mixture was cooled to room temperature, quenched with water and extracted with ethyl acetate. The combined organic layers were washed with brine, dried over sodium sulfate, filtered, and concentrated in vacuo. The crude material was purified by silica gel chromatography (0-50% EtOAc in hexanes) to afford 1-(5-(benzyloxy)-2-bromophenyl)-N,N-dimethylmethanamine (709) (98%).

[0531] Steps B: Compound (710) was prepared in a similar manner as that described for the synthesis of (10).

[0532] Step C: Compound (711) was prepared in a similar manner as that described for the synthesis of (11).

Intermediate 61 ethyl 3-(4-hydroxy-2-methylbenzofuran-7-yl)propanoate (716)

[0533]

[0534] Step A - C: Compound (714) was prepared in a similar manner as that described for the synthesis of (3).

[0535] Step D: Compound (715) was prepared in a similar manner as that described for the synthesis of (537)

[0536] Step E: Compound (716) was prepared in a similar manner as that described for the synthesis of (513)

Intermediate 62 5-chloro-7-(chloromethyl)-3,3-dimethyl-2,3-dihydrobenzofuran (725)

[0537]

[0538] Step A: To a solution of 4-chlorophenol (12.6 g, 0.1 mol) and 3-chloro-2-methyl-propene (10.8 g, 0.12 mol) was added concentrated sulfuric acid (5 g, 0.05 mol) and stirred at 0 °C for 1 hour. The mixture was diluted with cold water and extracted with ether. The ethereal extract was washed with brine, dried over anhydrous sodium sulfate, filtered, and evaporated under reduced pressure. The residue was purified by flash chromatography on silica gel to afford 4-chloro-2-(1-chloro-2-methylpropan-2-yl)phenol (721).
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**[0539]** Step B: To a suspension of NaH (1.44 g, 36 mmol) in anhydrous tetrahydrofuran was added 4-chloro-2-(1-chloro-2-methylpropan-2-yl)phenol (721) (6.6 g, 30.0 mmol) at 0 °C. The reaction mixture was stirred at 0 °C for 1 hour. The reaction was quenched with methanol, diluted with water, and extracted with ether. The ethereal extract was washed with brine, dried over anhydrous sodium sulfate, filtered and evaporated in vacuo. The residue was purified by flash chromatography on silica gel to give 5-chloro-3,3-dimethyl-2,3-dihydrobenzofuran (722).

**[0540]** Step C: Compound (723) was prepared in a similar manner as that described for the synthesis of (545).

**[0541]** Step D: Compound (724) was prepared in a similar manner as that described for the synthesis of (546).

**[0542]** Step E: Compound (725) was prepared in a similar manner as that described for the synthesis of (511).

Intermediate 63 3,3-dideuterio-5-chloro-7-(chloromethyl)-2,2-dimethyl-2,3-dihydrobenzofuran (730)

**[0543]**

Intermediates 63 3,3-dideuterio-5-chloro-7-(chloromethyl)-2,2-dimethyl-2,3-dihydrobenzofuran (730)

**[0544]** Step A: Compound (726) was prepared in a similar manner as that described for the synthesis of (655).

**[0545]** Step B: Lithium aluminum deuteride (0.21 g, 5.0 mmol) in dry ether (10 mL) was stirred for 15 min under nitrogen and aluminum chloride (0.7 g, 5.5 mmol) in dry ether (10 mL) was slowly added. Five minutes after the addition, a mixture of 5-chloro-2,2-dimethylbenzofuran-3(2H)-one (726) (1 g, 5 mmol) and aluminum chloride (0.7 g, 5.5 mmol) in dry ether (20 mL) was added to the solution of mixed metal hydride. The reaction mixture was vigorously stirred for 45 min under nitrogen, and the reaction was quenched with D₂O (5 mL) followed by 6 N sulfuric acid (6 mL). The reaction mixture was further diluted with water (25 mL), and the aqueous layer was extracted with four portions of ether (4 x 30 mL). The combined organic layers were washed with water, 10% sodium bicarbonate solution, and water and dried over sodium sulfate. The solvent was removed in vacuo and the residue was purified by flash chromatography on silica gel to afford 3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran (727).

**[0546]** Step C: Compound (728) was prepared in a similar manner as that described for the synthesis of (545).

**[0547]** Step D: Compound (729) was prepared in a similar manner as that described for the synthesis of (546).

**[0548]** Step E: Compound (730) was prepared in a similar manner as that described for the synthesis of (511).

Intermediate 64 7-(chloromethyl)-5,6-difluoro-2,2-dimethyl-2,3-dihydrobenzofuran (737)

**[0549]**
**Step A:** A mixture of 3,4-difluorophenol (2 g, 15.37 mmol), 3-chloro-2-methylpropene (1.66 mL, 16.91 mmol), and potassium carbonate (3.2 g, 23.06 mmol) in DMF (10 mL) was stirred at 85 °C for 6 h. The mixture was filtered and the filtrate was evaporated to dryness. The residue was purified by flash column chromatography eluting with hexanes-EtOAc (2:1) to provide 1,2-difluoro-4-(2-methylallyloxy)benzene (731) (1.78 g, 63%). $^\text{1}H$ NMR (400 MHz, CDCl₃) δ 7.05 (q, J= 9.5 Hz, 1H) 6.76-6.71 (m, 1H), 6.63-6.60 (m, 1H), 5.07 (s, 1H), 5.00 (s, 1H), 4.38 (s, 2H), 1.82 (s, 3H).

**Step B:** To a 1.4 M solution of sec-butyllithium in cyclohexane (6.7 mL) and anhydrous tetrahydrofuran (15 mL) at -75 °C was added 1,2-difluoro-4-(2-methylallyloxy)benzene (731) (1.6 g, 8.68 mmol). The resulting mixture was stirred at -75 °C for 2.5 hours and was then transferred to a round bottom flask containing dry ice. The resulting mixture was shaken for 5 min, and water (10 mL) was added dropwise. The mixture was acidified to pH 1 with concentrated hydrochloric acid and extracted with EtOAc (80 mL X 3). The organic phase was washed with brine (60 mL X 2), water (60 mL), and dried over anhydrous sodium sulfate, and the solvent removed in vacuo to give an oil 2,3-difluoro-6-(2-methylallyloxy)benzoic acid (732) (1.9 g). The product was used directly in the next step without further purification.

**Step C:** A mixture of 2,3-difluoro-6-(2-methylallyloxy)benzoic acid (732) (1.45 g, 6.35 mmol), 3-chloro-2-methylpropene (0.77 mL, 7.62 mmol), and potassium carbonate (1.76 g, 12.7 mmol) in anhydrous DMF was stirred at 65 °C under N₂ overnight. The mixture was filtered and the filtrate was evaporated to dryness. The residue was purified by flash column chromatography eluting with hexanes-EtOAc (4:1) to provide 2-methylallyl 2,3-difluoro-6-(2-methylallyloxy)benzoate (733) (1.55 g, 87%). $^\text{1}H$ NMR (400 MHz, CDCl₃) δ 7.14 (q, J = 9.5 Hz, 1H), 6.63-6.60 (m, 1H), 5.09 (s, 1H), 5.06 (s, 1H), 4.98 (s, 2H), 4.78 (s, 2H), 4.45 (s, 2H), 1.81 (s, 3H), 1.79 (s, 3H).

**Step D:** A solution of 2-methylallyl 2,3-difluoro-6-(2-methylallyloxy)benzoate (733) (1.53 g, 5.42 mmol) in NMP (3.5 mL) was heated in the microwave at 200 °C for 6 h. The solvent was removed in vacuo to provide 2-methylallyl 2,3-difluoro-6-hydroxy-5-(2-methylallyl)benzoate (734) (1.53 g) which was directly used in the next step reaction without further purification.

**Step E:** A solution of 2-methylallyl 2,3-difluoro-6-hydroxy-5-(2-methylallyl)benzoate (734) (0.75 g, 3.29 mmol) was added 1.0 M of borane tetrahydrofuran complex solution (12 mL) and the mixture was stirred at room temperature overnight. The reaction was cooled to 0 °C, acidified with 5 N HCl to pH 1, and then neutralized to pH 8 with 5 N NaOH. The mixture was extracted with EtOAc (80 mL X 3) and the combined organic phase was washed with water (50 mL), dried over anhydrous sodium sulfate, and the solvent removed in vacuo. The product was purified by prep HPLC to yield (5,6-difluoro-2,2-dimethyl-3H-benzofuran-7-yl)methanol (736) (0.4 g, 57%). $^\text{1}H$ NMR (400 MHz, DMSO-d₆) δ 7.18 (t, J = 9.0 Hz, 1H), 4.38 (s, 2H), 2.97 (s, 2H), 1.40 (s, 6H).

**Step F:** To a solution of (5,6-difluoro-2,2-dimethyl-3H-benzofuran-7-yl)methanol (736) (0.18 g, 0.84 mmol) in
anhydrous dichloromethane (5 mL) was added SOCl₂ dropwise at 0 °C. The mixture was stirred at room temperature for 2 h. The solvent was removed in vacuo, and the residue was dissolved in EtOAc (100 mL). The solution was washed with water (30 mL), dried over anhydrous sodium sulfate, and evaporated in vacuo to give a solid 7-(chloromethyl)-5,6-difluoro-2,2-dimethyl-2,3-dihydrobenzofuran (737) (0.194 g, 99%).

Intermediate 65 ethyl 3-(7-hydroxy-2,3-dihydro-1H-inden-4-yl)propanoate (740)

Step A: Compound (738) was prepared in a similar manner as that described for the synthesis of (545).

Step B: Compound (739) was prepared in a similar manner as that described for the synthesis of (537).

Step C: Compound (740) was prepared in a similar manner as that described for the synthesis of (513).

Intermediate 66 ethyl 3-(2-bromo-4-hydroxy-5-methoxyphenyl)propanoate (742)

Step A: Compound (741) was prepared in a similar manner as that described for the synthesis of (537).

Step B: Compound (742) was prepared in a similar manner as that described for the synthesis of (513).

Intermediate 67 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetic acid (23)

The above intermediate was synthesized by a method as disclosed in WO 2004/011445.
Intermediate 68 2-(5-hydroxy-2,3-dihydro-1H-inden-1-yl)acetic acid (24)

[0566]

The above intermediate was synthesized by a method as disclosed in EP 234872.

Intermediate 69 methyl 2,2-dimethyl-2,3-dihydrobenzofuran-4-carboxylate (25)

[0568]

The above intermediate was synthesized by a method as disclosed in WO 2007/030061.

Intermediates 70 & 71

[0570] The following intermediates were purchased from commercial sources and used to synthesize one or more of the representative compounds of the invention.

Intermediate 72 (2-methylbenzo[d]oxazol-7-yl)methanol (744)

[0571]

[0572] Step A: A solution of 3-amino-2-hydroxybenzoic acid (1 g, 6.53 mmol), triethylorthoacetate (4 mL), and P-toluenesulfonic acid (40 mg) was heated at 100 °C for 18 hours. The reaction was concentrated in vacuo and the crude product was purified by flash column chromatography on silica gel with hexanes and EtOAc (30%) to afford ethyl 2-methylbenzo[d]oxazole-7-carboxylate (743) (1.27 g, 95%).

[0573] Step B: To a solution of ethyl 2-methylbenzo[d]oxazole-7-carboxylate (743) (1.27 g, 6.19 mmol) in tetrahydrofuran (61 mL) at 0 °C was added lithium aluminum hydride (7.43 mL, 7.43 mmol, 1M in tetrahydrofuran). The reaction was stirred at 0 °C for 1 hour and quenched with 0.6 mL of water, 0.6 mL of 15% NaOH and 1.8 mL of water. The reaction was warmed to room temperature and diluted with diethyl ether. Magnesium sulfate was added and the solution was
filtered, washed with diethyl ether, and the solvent was removed in vacuo to provide (2-methylbenzo[d]oxazol-7-yl) methanol (744) (0.687 g, 68%).

Intermediate 73 methyl 2-(6-methoxybenzofuran-3-yl)acetate (745)

[0574]

[0575] Step A: To a solution of 2-(6-methoxybenzofuran-3-yl)acetic acid (0.6 g, 2.9 mmol) in anhydrous dichloromethane (20 mL) at -78 °C was added boron tribromide (1.5 eq.) The reaction was stirred at -78 °C for 30 minutes, 0 °C for 2 hours, and at room temperature overnight. The reaction mixture was cooled to 0 °C and quenched slowly with methanol. After stirring for 15 minutes a saturated sodium bicarbonate solution was added slowly to the mixture and allowed to stir at 0 °C for 30 minutes. Ethyl acetate was added and the layers were separated. The aqueous layer was extracted with ethyl acetate and the combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo to give methyl 2-(6-methoxybenzofuran-3-yl)acetate (745) (67%).

Intermediate 74 (R)-4-benzyl-3-((R)-3-(4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (748)

[0576]

[0577] Step A: To a solution of 4-(benzylxoy)phenyl)methanol (21.4 g, 100 mmol) in diethyl ether (250 mL) at 0 °C was added phosphorous tribromide (10.8 g, 40 mmol) and stirred at 0 °C for 30 minutes and at room temperature for 3 hours. The reaction was quenched with water and the layers were separated. The organic layer was washed with water (2 x 400 mL), saturated sodium bicarbonate (2 x 400 mL), and brine. The ether layer was dried over sodium sulfate, filtered and concentrated in vacuo to afford 1-(benzyloxy)-4-(bromomethyl)benzene (746).

[0578] Step B: To a solution of (R)-4-benzyl-3-propionyloxazolidin-2-one (17.0 g, 72.8 mmol) in tetrahydrofuran (200 mL) at -78 °C was added sodium bis(trimethylsilyl)amide (80 mL, 79.4 mmol) and stirred for 1 hour. A solution of 1-(benzyloxy)-4-(bromomethyl) benzene (746) (20.0 g, 72.2 mmol) in tetrahydrofuran (50 mL) was added slowly to the oxazolidinone solution at -78 °C and allowed to warm to room temperature overnight. The solvent was removed in vacuo and the residue was dissolved with ethyl acetate. The organic layer was washed with water, brine, dried over sodium sulfate, filtered, and concentrated in vacuo. The crude compound was purified by flash column chromatography on silica gel with hexanes and EtOAc (20%) to afford (R)-4-benzyl-3-((R)-3-(4-(benzylxoy)phenyl)-2-methylpropanoyl)oxazolidin-2-one (747).

[0579] Step C: Compound (748) was prepared in a similar manner as that described for the synthesis of (513).
Intermediate 75 (S)-4-benzyl-3-((S)-3-(4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (751)

[0580]

Step A:
The synthesis of intermediate (749) was previously described in intermediate 75.

Step B:
Compound (750) was prepared in a similar manner as that described for the synthesis of (747).

Step C:
Compound (751) was prepared in a similar manner as that described for the synthesis of (513).

Intermediate 76 & Intermediate 77 (R)-4-benzyl-3-((S)-3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (754) and (R)-4-benzyl-3-((R)-3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (755)

[0584]

Step A: To a mixture of ethyl 3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoate (9) (930 mg, 3.81 mmol) and potassium carbonate (1.05 g, 7.62 mmol) in DMF (8 mL) was added benzyl chloride (0.53 mL, 4.57 mmol) and stirred overnight at 50 °C. The reaction was diluted with water and extracted with ethyl acetate (3 x 25 mL). The organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel with hexanes and EtOAc to afford ethyl 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoate (752).

Step B: To a mixture of 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoate (752) (1.09 g, 3.26 mmol) in tetrahydrofuran (10 mL), water (10 mL), and methanol (20 mL) was added lithium hydroxide (547 mg, 13.04 mmol) and the solution was stirred overnight at 80 °C. The reaction was concentrated, acidified with 1N hydrochloric acid, and extracted with ethyl acetate. The organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo to yield 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoic acid (753).

[0585]  Step A: To a mixture of ethyl 3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoate (9) (930 mg, 3.81 mmol) and potassium carbonate (1.05 g, 7.62 mmol) in DMF (8 mL) was added benzyl chloride (0.53 mL, 4.57 mmol) and stirred overnight at 50 °C. The reaction was diluted with water and extracted with ethyl acetate (3 x 25 mL). The organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel with hexanes and EtOAc to afford ethyl 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoate (752).

[0586]  Step B: To a mixture of 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoate (752) (1.09 g, 3.26 mmol) in tetrahydrofuran (10 mL), water (10 mL), and methanol (20 mL) was added lithium hydroxide (547 mg, 13.04 mmol) and the solution was stirred overnight at 80 °C. The reaction was concentrated, acidified with 1N hydrochloric acid, and extracted with ethyl acetate. The organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo to yield 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoic acid (753).
Step C: To a solution of 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoic acid (753) (0.99 g, 3.23 mmol) in tetrahydrofuran (2.5 mL) at 0 °C was added triethylamine (0.50 mL, 3.57 mmol) and pivaloyl chloride (0.44 mL, 3.57 mmol) and the reaction was stirred for 30 minutes. In a separate flask (R)-4-benzyloxazolidin-2-one (0.48 g, 2.69 mmol) was dissolved in tetrahydrofuran (4 mL) and cooled to -78 °C. n-butyllithium (1.77 mL, 2.69 mmol, 1.52 M in hexanes) was added and the reaction was stirred for 30 minutes. The solution of 3-(4-(benzyloxy)-3,5-difluorophenyl)-2-methylpropanoic acid was added to the (R)-4-benzyloxazolidin-2-one solution and stirred at -78 °C for 3 hours and at room temperature for 30 minutes. The reaction was quenched with saturated ammonium chloride and extracted with ethyl acetate. The organic layer was dried over sodium sulfate, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography on silica gel with hexanes and EtOAc to afford the two diastereomers (R)-4-benzyl-3-((S)-3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one and (R)-4-benzyl-3-((R)-3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one. The benzyl group was removed with Pd/C under a hydrogen atmosphere as previously described for the synthesis of compound (9) to provide (R)-4-benzyl-3-((S)-3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (754) and (R)-4-benzyl-3-((R)-3-(3,5-difluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (755).

Intermediate 78 & Intermediate 79 (R)-4-benzyl-3-((S)-3-(3-fluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (759) and (R)-4-benzyl-3-((R)-3-(3-fluoro-4-hydroxyphenyl)-2-methylpropanoyl)oxazolidin-2-one (760)

Step A: Compound (757) was prepared in a similar manner as that described for the synthesis of (752).

Step B: Compound (758) was prepared in a similar manner as that described for the synthesis of (753).

Step C: Compounds (759) and (760) were prepared in a similar manner as that described for the synthesis of (754) and (755).

Intermediate 80 & Intermediate 81 (R)-4-benzyl-3-((S)-3-(4-hydroxy-3-(trifluoromethyl)phenyl)-2-methylpropanoyl)oxazolidin-2-one (764) and (R)-4-benzyl-3-((R)-3-(4-hydroxy-3-(trifluoromethyl)phenyl)-2-methylpropanoyl)oxazolidin-2-one (765)
Step A: Compound (762) was prepared in a similar manner as that described for the synthesis of (752).

Step B: Compound (763) was prepared in a similar manner as that described for the synthesis of (753).

Step C: Compounds (764) and (765) were prepared in a similar manner as that described for the synthesis of (754) and (755).

Intermediate 82 (7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methanol (779)

Step A: Compound (776) was prepared in a similar manner as that described for the synthesis of (1).

Step B: Compound (777) was prepared in a similar manner as that described for the synthesis of (2).

Step C: Compounds (778) were prepared in a similar manner as that described for the synthesis of (3).

Step D: Compound (779) was prepared in a similar manner as that described for the synthesis of (4).

Intermediate 83 (6-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methanol (783)
Step A: Compound (780) was prepared in a similar manner as that described for the synthesis of (1). Two regioisomers were obtained during the sigmatropic rearrangement and were separated by flash column chromatography.

Step C: Compounds (782) were prepared in a similar manner as that described for the synthesis of (3). The acid obtained after the cyclization was esterified by adding 20 equivalents of thionyl chloride to a solution of the acid in methanol.

Step D: Compound (783) was prepared in a similar manner as that described for the synthesis of (4).

Intermediate 84 (5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methanol (787)
Step A: Compound (788) was prepared in a similar manner as that described for the synthesis of (1).

Step B: Compound (789) was prepared in a similar manner as that described for the synthesis of (2). Two regioisomers were obtained during the sigmatropic rearrangement and were separated by flash column chromatography.

Step C: Compounds (790) were prepared in a similar manner as that described for the synthesis of (3). The acid obtained after the cyclization was esterified by adding 20 equivalents of thionyl chloride to a solution of the acid in methanol.

Step D: Compound (791) was prepared in a similar manner as that described for the synthesis of (4).

Intermediate 86 dideuterio(5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methanol (792)

Step A: Compound (792) was prepared in a similar manner as that described for the synthesis of (510).

Intermediate 87 ethyl 2,3-dideuterio-3-(4-hydroxyphenyl)propanoate (794)

Step A: Compound (793) is prepared in a similar manner as that described for the synthesis of (537).

Step B: Compound (794) is prepared in a similar manner as that described for the synthesis of (513) (except D₂ balloon is used).

Intermediate 88 deuterio(5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methanol (796)
Step A: A solution of (3) in toluene is cooled to -78 °C and diisobutylaluminum hydride is added under dry nitrogen. The solution is kept at -78 °C before saturated sodium bisulfite is added. The solution is allowed to warm to room temperature and the layers are separated. The toluene layer is extracted with portions of bisulfite which is combined with the aqueous layer, basified with 2 M sodium hydroxide to pH 8-9 (with cooling) and extracted with ether. The ether is washed with water, dried, and evaporated to give (795).

Step B: Compound (796) is prepared in a similar manner as that described for the synthesis of (4).

Intermediate 89 (3-deuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methanol (800)

Step A: Compound (797) is prepared in a similar manner as that described for the synthesis of (4).

Step B: To a solution of 3-deuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-3-ol (797), triethylsilane and dichloromethane at 0 °C is added boron trifluoride diethyl etherate and stirred at room temperature. The reaction is quenched with saturated sodium bicarbonate and extracted with ethyl. The organic layer is dried over sodium sulfate, filtered, and concentrated in vacuo to give 3-deuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran (798).

Step C: Compound (799) is prepared in a similar manner as that described for the synthesis of (545).

Step D: Compound (800) is prepared in a similar manner as that described for the synthesis of (546).

Intermediate 90 7-(chloromethyl)-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran
Preparation of GPR120 Agonists

Example 1: 2-(5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-6-fluoro-2,3-dihydro-1H-inden-1-yl)acetic acid (29)

[0630] Step A: Compound (801) was prepared in a similar manner as that described for the synthesis of (1).

[0631] Step B: Compound (802A) and (802B) were prepared in a similar manner as that described for the synthesis of (2). The two compounds were carried on to the next step as a mixture.

[0632] Step C: Compounds (803) were prepared in a similar manner as that described for the synthesis of (3).

[0633] Step D: Compound (804) was prepared in a similar manner as that described for the synthesis of (510).

Step E: Compound (647) was prepared in a similar manner as that described for the synthesis of (5).

[0634] Preparation of Compound (647) was prepared in a similar manner as that described for the synthesis of (5).

[0635] Step A: To a solution of intermediate (5) (0.100 g, 0.43 mmol) in acetonitrile (3 mL) was added intermediate 22 (0.103 g, 0.43 mmol) and cesium carbonate (0.169 g, 0.52 mmol). The resulting suspension was stirred at 75 °C for 5 h. The reaction was cooled to room temperature and filtered through a pad of celite. The filtrate was concentrated in vacuo and the residue was purified by silica gel chromatography (0-20 % EtOAc in hexanes) to yield intermediate (28).

[0636] Step B: To a solution of intermediate (28) (0.100 g, 0.231 mmol) in tetrahydrofuran (1 mL) and methanol (1 mL) was added a solution of lithium hydroxide (1.0 M, 1.0 mL). The reaction was stirred at room temperature for 4 h. The mixture was acidified with 1M HCl and diluted with ethyl acetate (5 mL). The organic layer was washed with brine (5 mL), dried over sodium sulfate and filtered. The filtrate was concentrated in vacuo and the residue was purified by silica gel chromatography (0-100 % EtOAc in hexanes) to isolate the title compound (29). 1H NMR (400 MHz, CDCl₃): δ: 7.05 (s, 1H), 6.94-6.90 (m, 3H), 5.03 (s, 2H), 3.54-3.51 (m, 1H), 3.00 (s, 2H), 2.86-2.72 (m, 3H), 2.50-2.40 (m, 2H),
Example 2 3-(4-((2,2-dimethylchroman-8-yl) methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (31)

\[ \text{Step A:} \]
To a solution of intermediate (16) (0.140 g, 0.73 mmol) in tetrahydrofuran (3 mL) was added intermediate 9 (0.178 g, 0.73 mmol), polymer supported triphenylphosphine (3 mmol/g, 0.36 g, 1.1 mmol) and diisopropylazodicarboxylate (0.214 mL, 1.1 mmol). The resulting suspension was stirred for 18 h. The reaction was diluted with ethyl acetate and filtered through a pad of celite. The filtrate was concentrated in vacuo and the residual was purified by silica gel chromatography (0-20 % EtOAc in hexanes) to yield the intermediate (30).

\[ \text{Step B:} \]
To a solution of intermediate (30) (0.100 g, 0.256 mmol) in tetrahydrofuran (1 mL) and methanol (1 mL) was added a solution of lithium hydroxide (1.0 M, 1.0 mL). The reaction was stirred at room temperature for 4 h. The mixture was acidified with 1M HCl and diluted with ethyl acetate (5 mL). The organic layer was washed with brine (5 mL), dried over sodium sulfate and filtered. The filtrate was concentrated in vacuo and the residue was purified by silica gel chromatography (0-100 % EtOAc in hexanes) to isolate the title compound (31).

\[ \text{1H NMR (400 MHz, CDCl}_3\text{:} \delta: 7.28 (d, 1H), 7.03 (d, 1H), 6.82 (t, 1H), 5.15 (s, 2H), 3.00-2.95 (m, 1H), 2.77 (t, 2H), 2.73-2.70 (m, 1H), 1.77 (t, 2H), 1.19 (d, J=6.8 Hz, 3H). \]

Example 21 3-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (50)

\[ \text{1H NMR (400 MHz, CDCl}_3\text{:} \delta: 7.08 (t, J=8.0 Hz, 1H), 6.84 (d, J=8.0 Hz, 1H), 6.76-6.68 (m, 3H), 3.11 (s, 2H), 2.96 (dd, J=13.6, 7.4 Hz, 1H), 2.74-2.66 (m, 1H), 2.59 (dd, J=13.6, 7.4 Hz, 1H), 1.48 (s, 6H), 1.18 (d, J=6.8 Hz, 3H). \]

Example 22 2-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-3,5-difluorophenyl)cyclopropanecarboxylic acid (51)
[0644] ¹H NMR (400 MHz, CDCl₃) δ: 7.08 (t, J = 7.8 Hz, 1H), 6.83 (d, J= 7.2 Hz, 1H), 6.71 (d, J= 8 Hz, 1H), 6.63 (d, J= 8.8 Hz, 2 H), 5.04 (s, 2H), 3.11 (s, 2H), 2.52-2.46 (m, 1H), 1.88-1.8 (m, 1H), 1.68-1.62 (m, 1H), 1.48 (s, 6H), 1.34-1.3 (m, 1H).

Reference Example 25 3-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)propanoic acid (54)

[0645]

[0646] ¹H NMR (400 MHz, DMSO-d₆) δ 12.14 (s, 1H), 7.14-7.09 (m, 2H), 6.96 (s, 1H), 6.93 (br s, 1H), 6.76 (t, J = 7.5 Hz, 1H), 5.00 (s, 2H), 2.95 (s, 2H), 2.73 (t, J = 7.6 Hz, 2H), 2.49 (m, 2H), 1.31 (s, 6H).

Example 36 2-(5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (65)

[0647]

[0648] ¹H NMR (400 MHz, CDCl₃) δ 7.24 (s, 1H), 7.09 (d, J= 8.3 Hz, 1H), 7.04 (s, 1H), 6.87 (s, 1H), 6.81 (d, J= 8.3 Hz, 1H), 4.96 (s, 2H), 3.61-3.45 (m, 1H), 3.00 (s, 2H), 2.95-2.77 (m, 3H), 2.50-2.38 (m, 2H), 1.82-1.75 (m, 1H), 1.46 (s, 6H).

Example 37 2-(5-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (66)

[0649]

[0650] ¹H NMR (400 MHz, CDCl₃) δ 7.08 (m, 1H), 7.02 - 6.93 (m, 1H), 6.87 (s, 1H), 6.80 (m, 2H), 4.97 (s, 2H), 3.61 - 3.45 (m, 1H), 2.99 (s, 2H), 2.92 - 2.74 (m, 3H), 2.50 - 2.35 (m, 2H), 1.77 (m, 1H), 1.48 (s, 6H).
Example 40 3-(4-((2,3-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (69)

[0651]

Example 45 3-(4-((6-fluoro-4H-benzo[d][1,3]dioxin-8-yl)methoxy)phenyl)-2-methylpropanoic acid (74)

[0652] \[\text{LC-MS ESI m/z: found 375.1 [M-H]}\]

Example 60 (E)-3-(2-ethyl-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acrylic acid (89)

[0655]

Example 63 3-(7-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-4-yl)propanoic acid (92)

[0657]
Example 64

3-(7-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-4-yl)propanoic acid (93)

Example 68

3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxamido)phenyl)-2-methylpropanoic acid (97)

Example 70

2-(4-(2-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)ethyl)phenoxy)acetic acid (99)
A solution of 4-(2-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)ethyl)phenol (650) (164.1 mg, 0.573 mmol), ethyl bromoacetate (95.7 mg, 0.573 mmol), cesium carbonate (265 mg, 0.688 mmol) and acetonitrile (5 mL) was heated at 50 °C for 18 hours. The reaction was concentrated in vacuo and then purified by flash column chromatography with hexanes and EtOAc (30%). The ester was dissolved in tetrahydrofuran (1.0 mL), methanol (1.0 mL) and water (3 mL). Lithium hydroxide was added and the reaction was stirred at room temperature for 24 hours. The mixture was acidified with 1M HCl and diluted with EtOAc (3 mL). The organic layer was washed with brine (3 mL), dried over sodium sulfate and filtered. The filtrate was concentrated in vacuo to yield 2-(4-(2-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)ethyl)phenoxy)acetic acid (99).

Example 75

3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-2-ethyl-3-fluorophenyl)propanoic acid (104)

Example 76

3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-2-propylphenyl)propanoic acid (105)

Example 77

3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-2-phenylpropanoic acid (106)

1H NMR (400 MHz, DMSO-d6) δ 12.11 (br, 1H), 7.85 (s, 1H), 7.67 (s, 1H), 7.05 (m, 1H), 6.80 (m, 2H), 5.07 (s, 2H), 2.73 (m, 2H), 2.41 (m, 4H), 1.50 (m, 2H), 1.40 (s, 6H), 0.89 (t, J= 8.0 Hz, 3H). LC-MS ESI m/z: found 415.1 [M-H]−.
Example 77

3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (106)

\[ \delta 12.12 (\text{br}, 1\text{H}), 7.86 (\text{s}, 1\text{H}), 7.70 (\text{s}, 1\text{H}), 7.20 - 7.16 (\text{m}, 1\text{H}), 7.04 (d, J = 12.0 \text{ Hz}, 1\text{H}), 6.93 (d, J = 8.0 \text{ Hz}, 1\text{H}), 5.16 (s, 2\text{H}), 2.78 (m, 1\text{H}), 2.56 (m, 2\text{H}), 1.39 (s, 6\text{H}), 1.00 (d, J = 4.0 \text{ Hz}, 3\text{H}). \]

LC-MS ESI m/z: found 405.3 [M-H]-.

Example 78

3-(3-fluoro-4-((5-fluoro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (107)

\[ \delta 12.14 (\text{br}, 1\text{H}), 7.73 (\text{dd}, J = 8.0, 4.0 \text{ Hz}, 1\text{H}), 7.48 (\text{dd}, J = 8.0, 4.0 \text{ Hz}, 1\text{H}), 7.19 (t, J = 8.0 \text{ Hz}, 1\text{H}), 7.02 (d, J = 12.0 \text{ Hz}, 1\text{H}), 6.93 (d, J = 8.0 \text{ Hz}, 1\text{H}), 5.16 (s, 2\text{H}), 2.79 - 2.75 (m, 1\text{H}), 2.56 - 2.51 (m, 2\text{H}), 1.39 (s, 6\text{H}), 1.00 (d, J = 6.3 \text{ Hz}, 3\text{H}). \]

LC-MS ESI m/z: found 389.1 [M-H]-.

Example 79

3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (108)

\[ \delta 7.77 (\text{s}, 1\text{H}), 7.58 (\text{s}, 1\text{H}), 7.43 (\text{s}, 1\text{H}), 7.32 (d, J = 8.4 \text{ Hz}, 1\text{H}), 7.04 (d, J = 8.4 \text{ Hz}, 1\text{H}), 5.19 (s, 2\text{H}), 3.09 - 2.97 (m, 1\text{H}), 2.76 - 2.68 (m, 2\text{H}), 1.48 (s, 6\text{H}), 1.20 (d, J = 6.7 \text{ Hz}, 3\text{H}). \]

LC-MS ESI m/z: found 455.0 [M-H]-.
Example 80

3-(4-((5-chloro-3-hydroxy-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (109)

[0675] To a solution of 3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (106) (80 mg, 0.197 mmol) in tetrahydrofuran/methanol (2:1, 2 mL) was added sodium borohydride (15 mg, 0.393 mmol). After the reaction was stirred at room temperature for 1.5 hours water was added and the solution was extracted with ethyl acetate, dried over sodium sulfate and filtered. The filtrate was concentrated in vacuo to yield 3-(4-((5-chloro-3-hydroxy-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (109). 1H NMR (400 MHz, CDCl3) δ 7.40 (s, 1H), 7.31 (s, 1H), 6.92 (m, 2H), 6.82 (d, J = 12.0 Hz, 1H), 5.04 (s, 2H), 4.75 (s, 1H), 2.93 (m, 1H), 2.71 (m, 1H), 2.64 (m, 1H), 1.49 (s, 3H), 1.34 (s, 3H), 1.18 (d, J = 6.9 Hz, 3H). LC-MS ESI m/z: found 407.3 [M-H].

Example 91

3-(4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (120)

[0677] 1H NMR (400 MHz, CDCl3) δ 7.10 (d, 2H), 6.92 (m, 1H), 6.87 (d, 2H), 6.79 (m, 1H), 4.89 (s, 2H), 3.07 (s, 2H), 3.00 (m, 1H), 2.76-2.61 (m, 3H), 1.51 (s, 6H), 1.17 (d, 3H).

Example 92

3-(3,5-difluoro-4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (121)

[0679] 1H NMR (400 MHz, CDCl3) δ 6.86 (t, 1H), 6.76-6.70 (m, 3H), 4.99 (s, 2H), 3.16 (s, 2H), 2.95 (m, 1H), 2.71 (m, 1H), 2.59 (m, 1H), 1.52 (s, 6H), 1.18 (d, 3H).

[0680] 1H NMR (400 MHz, CDCl3) δ 6.86 (t, 1H), 6.76-6.70 (m, 3H), 4.99 (s, 2H), 3.16 (s, 2H), 2.95 (m, 1H), 2.71 (m, 1H), 2.59 (m, 1H), 1.52 (s, 6H), 1.18 (d, 3H).
Example 93
2-(3,5-difluoro-4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)cyclopropanecarboxylic acid (122)

[0681]

1H NMR (400 MHz, CDCl₃) δ 6.86 (t, 1H), 6.75-6.72 (m, 1H), 6.62 (d, 2H), 4.99 (s, 2H), 3.15 (s, 2H), 2.49 (m, 1H), 1.83 (m, 1H), 1.64 (m, 1H), 1.52 (s, 6H), 1.31 (m, 1H).

Example 94
2-(5-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (123)

[0683]

1H NMR (400 MHz, CDCl₃) δ 7.11 (d, 1H), 6.92 (t, 1H), 6.83-6.76 (m, 3H), 4.89 (s, 2H), 3.54 (m, 1H), 3.08 (s, 2H), 2.92-2.77 (m, 3H), 2.51-2.41 (m, 2H), 1.83-1.74 (m, 1H), 1.52 (s, 6H).

Example 95
3-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (124)

[0685]

1H NMR (400 MHz, CDCl₃) δ 6.80-6.70 (m, 3H), 6.63-6.60 (m, 1H), 5.10 (s, 2H), 3.12 (s, 2H), 2.96 (m, 1H), 2.72 (m, 1H), 2.60 (m, 1H), 1.46 (s, 6H), 1.19 (d, 3H).

Example 96
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (125)

[0687]
Example 97

(R)-3-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy) phenyl)-2-methylpropanoic acid (126)

Example 99

2-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)cyclopropanecarboxylic acid (128)

Example 100

3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (129)
Example 101

3-(3,5-difluoro-4-((6-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (130)

Example 102

3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (131)

Example 109

3-(4-((5-chloro-2,3,3-trimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (138)
Example 112

5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-indene-2-carboxylic acid (141)

\[ \text{[0701]} \]

\[ \text{[0702]} \]

$^1$H NMR (400MHz, CDCl$_3$) $\delta$: 7.25 (s, 1H), 7.09 (d, 1H), 7.03 (s, 1H), 6.86 (s, 1H), 6.80 (d, 1H), 4.95 (s, 2H), 3.40-3.36 (m, 1H), 3.28-3.15 (m, 4H), 2.99 (s, 2H), 1.47 (s, 6H). LC-MS ESI m/z: found 371.0 [M - H]$^-$. 

Example 113

5-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-indene-2-carboxylic acid (142)

\[ \text{[0703]} \]

\[ \text{[0704]} \]

$^1$H NMR (400MHz, CDCl$_3$) $\delta$: 7.08 (d, 1H), 6.97 (d, 1H), 6.85 (s, 1H), 6.81-6.77 (m, 2H), 4.97 (s, 2H), 3.98-3.34 (m, 1H), 3.28-3.14 (m, 4H), 2.99 (s, 2H), 1.48 (s, 6H). LC-MS ESI m/z: found 355.2 [M - H]$^-$. 

Example 114

6-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-naphthoic acid (143)

\[ \text{[0705]} \]

\[ \text{[0706]} \]

$^1$H NMR (400MHz, DMSO-$d_6$) $\delta$: 12.88 (br, 1H), 8.50 (s, 1H), 8.00 (d, 1H), 7.91-7.83 (m, 2H), 7.49 (s, 1H), 7.27 (d, 1H), 7.04 (m, 2H), 5.07 (s, 2H), 3.03 (s, 2H), 1.43 (s, 6H). LC-MS ESI m/z: found 365.0 [M - H]$^-$. 

Example 119

3-(4-((5-chloro-2-methylbenzofuran-7-yl)methoxy)-2-ethylphenyl)propanoic acid (148)

\[ \text{[0707]} \]
[0708] ¹H NMR (400MHz, CDCl₃) δ: 7.38 (s, 1H), 7.32 (s, 1H), 7.09 (d, 1H), 6.88 (s, 1H), 6.80 (d, 1H), 6.35 (s, 1H), 5.28 (s, 2H), 2.93 (m, 2H), 2.67-2.60 (m, 4H), 2.46 (s, 3H), 1.23 (m, 3H). LC-MS ESI m/z: found 370.9 [M - H]⁻.

Example 120

3-(4-((5-chloro-2-methylbenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (149)

[0709]

[0710] ¹H NMR (400MHz, CDCl₃) δ: 7.38 (s, 1H), 7.31 (s, 1H), 6.99-6.93 (m, 2H), 6.85 (d, 1H), 6.34 (s, 1H), 5.34 (s, 2H), 3.02-2.96 (m, 1H), 2.73-2.71 (m, 1H), 2.65-2.59 (m, 1H), 2.45 (s, 3H), 1.18 (m, 3H). LC-MS ESI m/z: found 375.2 [M - H]⁻.

Example 121

3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)naphthalen-1-yl)propanoic acid (150)

[0711]

[0712] ¹H NMR (400MHz, DMSO-d₆) δ: 8.41 (d, 1H), 7.95 (d, 1H), 7.58-7.49 (m, 2H), 7.25 (m, 1H), 7.09 (d, 1H), 6.86-6.81 (m, 2H), 5.17 (s, 2H), 3.36 (m, 2H), 3.02 (s, 2H), 2.79 (m, 2H), 1.48 (s, 6H). LC-MS ESI m/z: found 393.4 [M - H]⁻.

Example 125

3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylbenzofuran-7-yl)propanoic acid (154)

[0713]
Example 126

2-acetamidoethyl 3-(4-(((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoate (155)

A solution of 3-(4-(((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (38) (50 mg, 0.113 mmol), O-(benzotriazol-1-yl)-N,N,N',N'-tetramethyluronium tetrafluoroborate (54.3 mg, 0.169 mmol), and diisopropylethylamine (39.3 µL, 0.225 mmol) in DMF (1.5 mL) was stirred at room temperature for 30 min, then N-acetylethanolamine (23 mg, 0.226 mmol) was added. The reaction mixture was stirred at room temperature overnight. After evaporation of solvent in vacuo, the residue was purified by preparative HPLC to afford 2-acetamidoethyl 3-(4-(((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoate (155) (45 mg, 70%). 1H NMR (400 MHz, CDCl₃) δ: 7.39 (s, 1H), 7.04 (m, 2H), 7.05 - 7.00 (m, 2H), 5.47 (br, 1H), 5.06 (s, 2H), 4.10 (m, 2H), 3.44 - 3.37 (m, 3H), 3.05 (s, 2H), 2.96 - 2.91 (m, 1H), 2.76 - 2.66 (m, 2H), 1.93 (s, 3H), 1.49 (s, 6H), 1.19 (d, J = 6.8 Hz, 3H). LC-MS ESI m/z: found 528.0 [M-H]-.

Example 127

3-(4-(((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methyl)amino)phenyl) propanoic acid (156)

Example 128

3-(4-(((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methyl)amino)phenyl) propanoic acid (157)
[0720] 1H NMR (400 MHz, CDCl₃) δ 7.00 (d, J = 7.8 Hz, 2H), 6.81 (d, J = 8.5 Hz, 1H), 6.73 (d, J = 8.5 Hz, 1H), 6.59 (d, J = 7.8 Hz, 2H), 4.22 (s, 2H), 2.98 (s, 2H), 2.83 (t, J = 7.7 Hz, 2H), 2.61 (t, J = 7.7 Hz, 2H), 1.47 (s, 6H).

Example 129

3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (158)

[0721]

[0722] 1H NMR (400 MHz, CDCl₃) δ 7.76 (d, J = 2.1 Hz, 1H), 7.58 (d, J = 2.2 Hz, 1H), 7.13 (d, J = 8.6 Hz, 2H), 6.94 (d, J = 8.6 Hz, 2H), 5.10 (s, 2H), 3.01 (dd, J = 13.4, 6.5 Hz, 1H), 2.76 - 2.60 (m, 2H), 1.48 (s, 6H), 1.18 (d, J = 6.9 Hz, 3H).

Example 130

3-(4-((5-chloro-3-hydroxy-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (159)

[0723]

[0724] Compound (159) was prepared in a similar manner as that described for the synthesis of 109. 1H NMR (400 MHz, CDCl₃) δ 7.38 (d, J = 1.8 Hz, 1H), 7.29 (d, J = 1.8 Hz, 1H), 7.08 (d, J = 8.4 Hz, 2H), 6.89 (d, J = 8.5 Hz, 2H), 4.96 (s, 2H), 4.74 (s, 1H), 2.97 (dd, J = 13.4, 6.6 Hz, 1H), 2.75 - 2.58 (m, 2H), 1.48 (s, 3H), 1.34 (s, 3H), 1.16 (d, J = 6.8 Hz, 3H).

Example 133

2-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acetic acid (162)

[0725]
Example 140

3-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2-ethylphenyl)propanoic acid (169)

[0726] ¹H NMR (400 MHz, CDCl₃) δ 7.17 (d, J= 7.7 Hz, 2H), 6.94 (m, 3H), 6.79 (d, J= 7.8 Hz, 1H), 4.98 (s, 2H), 3.57 (s, 2H), 2.99 (s, 2H), 1.47 (s, 6H).

Example 145

3-(4-((3,3-dideuterio-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (174)

[0729] ¹H NMR (400 MHz, CDCl₃) δ 7.09 (d, J= 8.4 Hz, 2H), 6.97 (d, J= 9 Hz, 1H), 6.91 (d, J= 8.6 Hz, 2H), 6.78 (d, J= 9 Hz, 1H), 4.97 (s, 2H), 3.13 - 2.93 (m, 1H), 2.81 - 2.55 (m, 2H), 1.47 (s, 6H), 1.17 (d, J= 6.9 Hz, 3H).

Example 146

3-(4-((3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (175)

[0731] ¹H NMR (400 MHz, CDCl₃) δ 7.09 (d, J= 8.4 Hz, 2H), 6.97 (d, J= 9 Hz, 1H), 6.91 (d, J= 8.6 Hz, 2H), 6.78 (d, J= 9 Hz, 1H), 4.97 (s, 2H), 3.13 - 2.93 (m, 1H), 2.81 - 2.55 (m, 2H), 1.47 (s, 6H), 1.17 (d, J= 6.9 Hz, 3H).
Example 147

3-(4-((3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (176)

\[ \text{δ} 7.26 (s, 1H), 7.04 (s, 1H), 6.98 - 6.88 (m, 2H), 6.82 (d, J= 8.4 Hz, 1H), 5.03 (s, 2H), 2.98 (dd, J= 13.6, 6.6 Hz, 1H), 2.76 - 2.65 (m, 1H), 2.60 (dd, J= 13.5, 7.7 Hz, 1H), 1.47 (s, 6H), 1.17 (d, J= 6.9 Hz, 3H). \]

Example 148

3-(4-((5-chloro-3,3-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (177)

\[ \text{δ} 7.40 (s, 1H), 7.3 - 7.24 (m, 2H), 7.10 - 6.97 (m, 2H), 5.08 (s, 2H), 3.03 (dd, J= 13.4, 6.3 Hz, 1H), 2.8 - 2.62 (m, 2H), 1.49 (s, 6H), 1.20 (d, J= 6.7 Hz, 3H). \]

Example 149

3-(4-((5-chloro-3,3-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (178)

\[ \text{δ} 7.26 (s, 1H), 7.00 (s, 1H), 6.97 - 6.90 (m, 2H), 6.84 (d, J= 7.7 Hz, 1H), 5.04 (s, 2H), 4.28 (s, 2H), 2.98 (dd, J= 13.4, 6.6 Hz, 1H), 2.76 - 2.65 (m, 1H), 2.61 (dd, J= 13.5, 7.8 Hz, 1H), 1.33 (s, 6H), 1.18 (d, J= 6.8 Hz, 3H). \]
Example 150

3-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dimethylphenyl)propanoic acid (179)

[0739]

\[ \text{[1H NMR (400 MHz, CDCl}_3\text{)} \delta 7.13 (t, J= 7.8 Hz, 1H), 6.98 (d, J= 8.4 Hz, 1H), 6.92 (d, J= 7.5 Hz, 1H), 6.75 - 6.70 (m, 2H), 4.93 (s, 2H), 3.03 (s, 2H), 2.94 (t, J= 8.0 Hz, 2H), 2.60 (t, J=8.0 Hz, 2H), 2.24 (s, 3H), 2.20 (s, 3H), 1.48 (s, 6H).] \]

Example 151

3-(3,5-difluoro-4-((2-methylbenzo[b]thiophen-7-yl)methoxy)phenyl)-2-methylpropanoic acid (180)

[0741]

\[ \text{[1H NMR (400 MHz, CDCl}_3\text{)} \delta 7.63 (d, J= 7.6 Hz, 1H), 7.37 - 7.28 (m, 2H), 7.01 (s, 1H), 6.74 (d, J = 8.7 Hz, 2H), 5.32 (s, 2H), 3.01 - 2.93 (m, 1H), 2.75 - 2.69 (m, 1H), 2.64 - 2.56 (m, 4H), 1.19 (d, J= 6.9 Hz, 3H). LC-MS ESI m/z: found 375.0 [M-H]-.} \]

Example 152

2-(5-((2-methylbenzo[b]thiophen-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (181)

[0743]

\[ \text{[1H NMR (400 MHz, CDCl}_3\text{)} \delta 7.67 - 7.58 (m, 1H), 7.32 (d, J= 4.8 Hz, 2H), 7.11 (d, J = 8.3 Hz, 1H), 7.02 (s, 1H), 6.92 (s, 1H), 6.86 (d, J = 8.2 Hz, 1H), 5.25 (s, 2H), 3.62 - 3.47 (m, 1H), 2.96 - 2.77 (m, 3H), 2.60 (s, 3H), 2.51 - 2.38 (m, 2H), 1.84 - 1.72 (m, 1H).} \]

Example 153

2-(6-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-1,2,3,4-tetrahyronaphthalen-1-yl)acetic acid (182)

[0745]
Example 154

2-(6-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-1,2,3,4-tetrahydronaphthalen-1-yl)acetic acid (183)

Example 175

(S)-2-(5-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (204)

Example 176

(S)-2-(5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (205)
Example 178

(R)-2-(5-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (207)

Example 179

(R)-2-(5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (208)

Example 187

2-(5-((2,2-dimethyl-5-phenyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (216)
**Example 188**

(R)-2-(5-((6-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (217)

**Example 218**

3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-5,6,7,8-tetrahydronaphthalen-1-yl)propanoic acid (247)

**Example 219**

3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-5,6,7,8-tetrahydronaphthalen-1-yl)propanoic acid (248)
Example 250

3-(2-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (279)

Example 257

2-(5-((5-chloro-2-isopropoxybenzyl)oxy)-6-fluoro-2,3-dihydro-1H-inden-1-yl)acetic acid (286)

Example 258

2-(5-((5-chloro-2-isopropoxybenzyl)oxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (287)
Example 259
2-(5-((2-isopropoxypyridin-3-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (288)

Example 260
3-(4-((1H-indazol-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (289)

Example 261
3-(3,5-difluoro-4-((2-methylbenzo[d]oxazol-7-yl)methoxy)phenyl)-2-methylpropanoic acid (290)
Example 262

2-(6-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)benzofuran-3-yl)acetic acid (291)

[0777]

\[ \text{1H NMR (400MHz, DMSO-}d_6\text{)} \delta: 12.46 \text{ (br, 1H), 7.76 (s, 1H), 7.45 (d, 1H), 7.24 (s, 1H), 7.04-7.00 (m, 2H), 6.93 (d, 1H), 4.99 (s, 2H), 3.63 (s, 2H), 3.04 (s, 2H), 2.50 (s, 3H), 1.45 (s, 6H). LC-MS ESI m/z: found 369.0 [M - H]^-} \]

Example 263

2-(7-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-oxo-2H-chromen-4-yl)acetic acid (292)

[0779]

\[ \text{1H NMR (400MHz, CDCl}_3\text{)} \delta: 6.93 (d, 3H), 6.82 (m, 1H), 6.64 (m, 1H), 6.34 (s, 1H), 5.06 (d, 2H), 3.15 (m, 1H), 3.08-3.01 (m, 2H), 2.95 (m, 2H), 1.51-1.44 (m, 6H). LC-MS ESI m/z: found 398.8 [M + H]^+. \]

Example 264

3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-N-hydroxy-2-methylpropanamide (293)

[0781]

\[ \text{1H NMR (400 MHz, CDCl}_3\text{)} \delta: 7.03 (d, J= 8.1 Hz, 2H), 6.95 (d, J= 10.4 Hz, 1H), 6.89 (d, J= 8.1 Hz, 2H), 6.79 (d, J= 7.8 Hz, 1H), 4.96 (s, 2H), 2.99 (s, 2H), 2.91 - 2.84 (m, 1H), 2.79 (s, 1H), 2.67 - 2.58 (m, 1H), 2.41 - 2.29 (m, 1H), 1.47 (s, 6H), 1.19 (d, J = 6.7 Hz, 3H). LC-MS ESI m/z: found 372.4 (M-H)^-} \]
Example 265

3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-N-hydroxypropanamide (294)

[0783]

\[
\begin{align*}
\text{H NMR (400 MHz, CDCl}_3) \delta & \quad 7.07 (d, J= 7.8 \text{ Hz}, 2\text{H}), 6.98 - 6.88 (m, 3\text{H}), 6.79 (d, J= 8.0 \text{ Hz}, 1\text{H}), 4.97 (s, 2\text{H}), \\
& \quad 2.99 (s, 2\text{H}), 2.91 (t, J= 7.5 \text{ Hz}, 2\text{H}), 2.80 (s, 1\text{H}), 2.41 (t, J= 10.4 \text{ Hz}, 2\text{H}), 1.47 (s, 6\text{H}). \\
\text{LC-MS ESI m/z: found 358.4 (M-H)}.
\end{align*}
\]

Example 267

3-(4-((6-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dimethylphenyl)propanoic acid (296)

[0785]

\[
\begin{align*}
\text{H NMR (400 MHz, CDCl}_3) \delta & \quad 6.97 (d, J= 8.1 \text{ Hz}, 1\text{H}), 6.92 (s, 1\text{H}), 6.70 - 6.66 (m, 2\text{H}), 4.87 (s, 2\text{H}), 2.99 - 2.88 \\
& \quad (m, 4\text{H}), 2.60 (t, J= 8.4 \text{ Hz}, 2\text{H}), 2.23 (s, 3\text{H}), 2.20 (s, 3\text{H}), 1.47 (s, 6\text{H}).
\end{align*}
\]

BIOLOGICAL EXAMPLES

Biological Example 1

GPR120 stable cell line

[0787] Human GPR120 stable cell line was purchased from Multispan Inc (26219 Eden Landing Road, Hayward, CA94545). This GPR120 cell line was generated in HEK293 cells co-expressing Gqi5. In this cell line, the Flag epitope tag (DYKDDDDK) was fused to the amino terminus of human GPR120 protein.

Assay

[0788] The concentration of intracellular Ca\(^{2+}\) was measured as described below. Human GPR120 cells were plated in 96 well plates (Poly-D-Lysine coated black/clear Plate, Greiner Bio-One) at 70,000 cells per well and cultured overnight in conditions of 37°C and 5% CO\(_2\). A Ca\(^{2+}\) assay dye stock solution was prepared by adding 10 mL of assay buffer (HBSS/20mM HEPES, pH 7.4) to FLIPR Calcium 4 Assay Bulk Kit (Molecular Devices). The 10 mL of Ca\(^{2+}\) assay dye solution was prepared by further diluting 0.5 mL of Ca\(^{2+}\) assay dye stock solution with 10 mL of assay buffer. The medium of the cells was removed and immediately 100 µL of the Ca\(^{2+}\) assay dye solution was dispensed into each well followed by incubation at 37°C and 5% CO\(_2\) for 50 minutes to incorporate the Ca\(^{2+}\) dye into the cells. The cell plate was then placed in the Flexstation (Molecular Devices) for 20 minutes at 37°C. Compounds were dissolved in 100% DMSO and diluted to desired concentrations with assay buffer and placed in the Flexstation simultaneously with the cell plate for 20 minute incubation at 37°C prior to reading. Fluorescence intensity was measured immediately following compound addition (25 µL/well) on the Flexstation at an excitation wavelength of 485 nm and an emission wavelength of 525 with 515 nm auto cutoff. The resulting increase in fluorescence intensities corresponds to increases in intracellular Ca\(^{2+}\) levels.
Determination of activity of compounds

Compounds were dissolved in 100% DMSO to a concentration of 20 mM to provide stock solutions. To determine activity against human GPR120, compounds were added with human GPR120 stably expressing cells (described above), at eight desired concentrations ranging from 0.00001 to 20 μM, in 96 well plates and fluorescence intensities were measured for 90 seconds with 2-second intervals. An EC50 value (concentration of the GPR120 agonist where 50% of the agonist’s maximal activity is observed) was calculated using the changes (Max-Min) of fluorescence intensity.

To determine percent activity for a tested compound, the fluorescence intensity value obtained at a particular concentration were compared to the maximal fluorescence intensity value obtained for reference compound GW9508 (4-[[3-phenoxyphenyl]methyl]amino)benzene propanoic acid; British Journal of Pharmacology 2006 148, 619-628) or the compound of Example 25. When GW9508 was used as the reference compound, the maximal activity of GW9508 at 6.7 μM was designated as 100% activity. When the compound of Example 25 was used as the reference compound, the maximal activity of the compound of Example 25 at 2.5 μM was designated as 100% activity. Typically, the GW9508 activity reached a maximum at a concentration of approximately 6.7 μM and typically the compound of Example 25 reached a maximum activity at approximately 2.5μM. Activities of compounds that were tested according to this method are shown in Table 1 below. Table 1 shows the activity expressed as % activity at 5 μM compared to the maximal activity of GW9508 at 6.7 μM or % activity at 2.5 μM compared to the maximal activity of the reference compound of Example 25.

<table>
<thead>
<tr>
<th>Ex.</th>
<th>%Activity (GW9508 Reference Compound)</th>
<th>Ex.</th>
<th>%Activity (Ex. 25 Reference Compound)</th>
<th>Ex.</th>
<th>%Activity (Ex. 25 Reference Compound)</th>
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Compounds of Examples 1-2, 21-22, 36-37, 70, 75-79, 92-97, 99-102, 109, 112-114, 119-121, 127-129, 140, 145-154, 175-176, 178-179, 187-188, 218-219, and 257-265 were found to have an EC50 of less than or equal to 1μM. Compounds of Examples 60, 63-64, 80, 125-126, 130 and 133 were found to have an EC50 of greater than 1μM and less than or equal to 10 μM. Compounds of Examples 40, 45, 68, and 250 were found to have an EC50 of greater than 10 μM.

Biological Example 2 Glucose uptake in 3T3-L1 adipocytes

3T3-L1 fibroblasts are plated into growth medium (DMEM supplemented with 10% FBS, 1% Penicillin-Streptomycin) and grown to confluence for 7 days, with media changes every 2 to 3 days. Differentiation into adipocytes is induced by incubating the cells in DMEM supplemented with 10% FBS, 1% Penicillin-Streptomycin, 698 nM Bovine Insulin, 518 μM IBMX and 248 nM Dexamethasone. Glucose uptake activity is determined by measuring the uptake of 2-deoxy-D-[3H] glucose. Briefly, 3T3-L1 adipocytes are washed twice with PBS, once with Fat Cell Buffer (FCB: 125mM NaCl, 5mM KCl, 1.8mM CaCl2, 2.6mM MgSO4, 25mM Hepes, 2mM pyruvate and 2% BSA, 0.2 μm sterile filtered).
and are incubated with GPR120 agonists in FCB at 37°C for 30 minutes. Insulin is prepared at the indicated concentrations in FCB, added to the cells and incubated for 20 minutes at 37°C. Glucose uptake is initiated by the addition of 2-deoxy-D-[3H] glucose (0.083 Ci/mL and 1.1 mM 2-deoxy-D-glucose in FCB) and incubated for 10 minutes at 37°C. Glucose uptake is terminated by removing the contents of the wells and washing the cells three times with cold PBS. The cells are lysed with scintillation solution and 2-deoxy-D-[3H] glucose retained by the cells is counted (MicroBeta TriLux 1450 - Perkin Elmer). Cell viability is assessed independently with the CellTiter-Glo Luminescent Cell Viability Assay Kit (Promega) as per manufacturer's instructions. Glucose uptake is quantified by normalizing the glucose uptake measurement for each compound treatment to the corresponding cell viability value. The fold induction of glucose uptake is calculated by normalizing all values against the average value of the basal value (taken as 1-fold).

Biological Example 3 Insulin Secretion (Islet Perifusion)

[0793] To determine the effect of GPR120 agonists on insulin secretion from islets, islets from Sprague Dawley rats are isolated and incubated in vitro with GPR120 agonists in the presence of low and high glucose. 200–250g Sprague Dawley rats are obtained from Charles River laboratories and maintained on regular chow (Purina 5001). Before the procedure, rats are anesthetized with intraperitoneal injection of pentobarbital at 200 mg/kg. The bile duct is clamped where it enters the duodenum, then a catheter is placed in the bile duct between the liver and the pancreas. The pancreas is infused through the catheter with a solution of 0.75mg/mL collagenase P (Roche) in HBSS buffer (Biowhitaker) supplemented with 0.1 % glucose and 0.02% BSA. The pancreas is then excised from the rat and placed in 5mL of the collagenase P solution in a 37°C waterbath for 8 minutes. After 8 minutes the digested pancreas is shaken vigorously by hand for 30 seconds. The resulting digest is washed four times in the HBSS buffer, then applied to a discontinuous ficoll gradient. To make the gradient, the digest is re-suspended in 7.5mL of ficoll DL400 solution (Sigma) density 1.108, in a 15mL tube. Three 2mL layers of ficoll solution of decreasing density (1.096, 1.069, 1.037) are then added to the tube to create a density gradient. The gradient is centrifuged at 1500 rpm for 15 minutes after which islets are picked from the top two layers. Islets are washed four times in HBSS buffer, then cultured in RPMI 1640 media (Gibco) supplemented with 1% fetal bovine serum. The following day, 25 size-matched islets are placed in a perifusion chamber and exposed to Krebs Ringer Buffer (KRB;119mM NaCl, 4.7mM KCl, 25mM NaHCO3, 2.5mM CaCl2, 1.2 mM MgSO4, 1.2mM KH2PO4) at a rate of 1mL/minute, using a Cellex Acu-Sys S perifusion culture system. The islets are exposed to KRB containing glucose at 2mM for 30 minutes, followed with buffer containing 16mM glucose for 30 minutes, then returned to 2mM glucose for a further 30 minutes, in the presence of 0.1-100uM of the GPR120 agonist or vehicle (DMSO). Perifusate is collected at 1 minute intervals using a fraction collector, and assayed for insulin using an ELISA kit (Mercodia Ultrasensitive Rat Insulin ELISA Kit, ALPCO). Insulin secretion rate in response to glucose is plotted against time, and the AUC of the curve determined in order to quantify the insulin secretory response to 16mM glucose during the 30 minute perifusion. Statistical significance of differences in AUC between treated and untreated islets are determined by paired Students t test.

Biological Example 4 Oral Glucose Tolerance

[0794] 8-10 week old male C57BL/6J mice (Harlan) were maintained on regular chow diet from Harlan (2018 Teklad Global). On the day of the experiment mice were fasted for 6 hours, then randomized into groups (n=10-15) to receive the tested GPR120 agonist at doses ranging from 100mg/kg or the vehicle (1% CMC, 2% TWEEN 80). Compounds were delivered orally via gavage at 10mL/kg. Blood glucose levels were measured by glucometer (Ascensia Elite XL, Bayer) at time -30 minutes before administration of compound. Blood glucose was measured again after 30 minutes (at time 0), and then the mice were dosed orally with 3g/kg glucose at 10mL/kg. Blood glucose measurements were taken 20, 40, 60, 90 and 120 minutes after glucose administration, by glucometer (Ascensia Elite XL, Bayer).

[0795] Glucose levels were plotted against time, and the incremental area under the curve (AUC) of the glucose excursion was determined from time 0 using Graphpad Prism 5.01. Outliers were excluded using Tukey’s box plot outlier test, and statistical significance of differences in AUC of compound treatment compared to vehicle was determined by non-parametric Kruskal-Wallis test with Dunn’s post test.

[0796] Table 2 below shows the mean percentage inhibition of the glucose excursion for the fifteen animals tested in each group. The compounds were tested at 100 mg/kg and the levels of blood glucose were determined in the presence and absence of the tested compounds. The percentage of glucose reduction is reported. The tested compounds were selected as examples from the exemplified compounds. These results demonstrate that the GPR120 agonists can lower blood glucose in response to an oral glucose challenge.
Biological Example 5 Incretin and enteroendocrine hormone measurement

The effect of GPR120 agonists on the secretion of insulin, Glucagon-like peptide-1 (GLP-1), glucose dependent insulinotropic peptide (GIP), Cholecystokinin (CCK) and Peptide YY (PYY) in C57BL/6J mice are determined as follows.

8-10 week old male C57BL/6J mice (Harlan) are maintained on a regular chow diet from Harlan (2018 Teklad Global). On the day of the experiment, mice are fasted for 6 hours then randomized into treatment groups (n=15). All groups are treated with the DPPIV inhibitor sitagliptin at 1 mg/kg to prevent degradation of active GLP-1. GPR120 agonist compounds are dosed at concentrations ranging from 3-100mg/kg in 1% CMC, 2% TWEEN 80 either by oral gavage or intraperitoneal injection (i.p.) at -30 minutes. Sitagliptin is administered in the same dosing solution. Oral glucose at 3g/kg is administered at 0 minutes. At 3 minutes after glucose administration, animals are anesthetized with pentobarbital (40mg/mL in 10% ethanol) and at 4 minutes blood collected by heart puncture in microtainer tubes (BD) with potassium EDTA. For Glucose-independent incretin studies the same procedure is used but in the absence of oral glucose administration. Dosing of GPR120 agonist compounds and blood collection are as described above. For the GLP-1 assay, the collection tubes also contain a DPP-IV inhibitor provided in the GLP-1 assay kit.

Insulin is measured using the Mercodia mouse Insulin ELISA Kit (ALPCO) according to the manufacturer’s instructions. Bioactive GLP-1 is measured using Glucagon-like peptide-1 (active) ELISA assay kit (Linco) according to the manufacturer’s instructions. Total GIP (bioactive plus inactive) is measured using rat/mouse total GIP ELISA assay kit (Linco), according to the manufacturer’s instructions. CCK (Nonsulfated Cholecystokinin Octapeptide, 26-33) is measured using human, rat, mouse CCK ELISA assay kit (Phoenix Pharmaceuticals), according to the manufacturer’s instructions. PYY is measured using canine, mouse, porcine, rat PYY ELISA assay kit (Peninsula Laboratories), according to the manufacturer’s instructions.

Biological Example 6

Gastric emptying

To evaluate the effects of GPR120 agonists on gastric emptying, 8-10 week old male C57BL/6J mice (Harlan) are fasted for 16-18 hours, then treated orally or by intraperitoneal injection with either GPR120 agonists (1-100 mg/kg) or vehicle (1% CMC, 2% TWEEN 80) 30 minutes prior to initiation of the gastric emptying study. Phenol red (0.05% PR in deionized water) is administered either in an aqueous or glucose solution (0.05% in 20% glucose). Immediately after phenol red (PR) administration (0 min), control group animals are sacrificed by cervical dislocation and the average amount of phenol red recovered is measured as 100% phenol red retention. The remainder of the animals from each group are sacrificed at various time-points following phenol red administration. The stomachs are isolated after clamping at both the pyloric and the cardiac ends. Clamped stomachs are transferred to a 50 mL conical tube containing 5 mL deionized water. Clamps are removed and each stomach is cut into fine pieces with scissors and stomach content is extracted by centrifugation at 3000 rpm for 10 minutes and supernatant is filtered to remove particulates. 1mL of 1N NAOH is added to each 2 mL of filtered supernatant for color development. The concentration of phenol red is determined by measuring the absorbance of the extracted material at a wavelength of 558 nm and then converted to concentration by using the extinction coefficient of phenol red in aqueous solution.

The gastric emptying is calculated by the formula:

\[
\text{% Gastric emptying} = \left( \frac{A - B}{A} \right) \times 100,
\]

where A is the average amount (absorbance) of phenol red recovered immediately after ingestion (the 100% retained group) and B is the amount (absorbance) of phenol red remaining in the stomach at a given time after ingestion.
Biological Example 7

Improvement of diabetes parameters in animal models of diabetes

[0802] Female ZDF rats (Charles River laboratories) are obtained at 6 weeks of age and acclimatized for 1 week before being placed on a high fat diet (RD 13004, Research Diets). GPR120 compounds are administered to the rats by daily gavage at concentrations ranging from 0.3-300 mg/kg in 1% CMC, 2% TWEEN 80. Body weight and food intake is monitored daily. After 14 days of dosing, blood samples are taken from overnight fasted animals to measure glucose and insulin. Glucose is measured using a glucometer (Ascensia Elite XL, Bayer) and insulin is measured using rat insulin ELISA kit (ALPCO). Insulin and glucose levels are compared to those of vehicle treated animals to determine efficacy.

[0803] Male high-fat diet-fed mice (Jackson), that have been placed on a high fat Diet D12492 (Research diets, 60 kcal% fat) at the age of 4-weeks are obtained at 10 weeks of age and acclimatized for 1 week. GPR120 compounds are administered by daily gavage at concentrations ranging from 0.3-300 mg/kg in 1% CMC, 2% TWEEN 80. Body weight and food intake is monitored daily. After 14 days of dosing, blood samples are taken from overnight fasted animals to measure glucose and insulin. Glucose is measured using a glucometer (Ascensia Elite XL, Bayer), insulin is measured using mouse insulin ELISA kit (ALPCO). Insulin and glucose levels are compared to those of vehicle treated animals to determine efficacy.

[0804] The ob/ob mice (Jackson) are obtained at 6 weeks of age and acclimatized for 1 - 2 week. GPR120 compounds are administered by daily gavage at concentrations ranging from 0.3-300 mg/kg in 1% CMC, 2% TWEEN 80. Body weight and food intake is monitored daily. After 14 days of dosing, blood samples are taken from overnight fasted animals to measure glucose and insulin. Glucose is measured using a glucometer (Ascensia Elite XL, Bayer), insulin is measured using mouse insulin ELISA kit (ALPCO). Insulin and glucose levels are compared to those of vehicle treated animals to determine efficacy.

Biological Example 8

Intra peritoneal glucose tolerance test.

[0805] 8-10 week old male C57BL/6J mice (Harlan) were maintained on regular chow diet from Harlan (2018 Teklad Global). On the day before the experiment mice were fasted overnight, then randomized into groups (n=10-15) to receive the tested GPR120 agonist at doses ranging from 100mg/kg or the vehicle (1% CMC, 2% TWEEN 80). Compounds were delivered orally via gavage at 10mL/kg. Blood glucose levels were measured by glucometer (Ascensia Elite XL, Bayer) at time -30 minutes before administration of compound. Blood glucose was measured again after 30 minutes (at time 0), and then the mice were dosed intra peritoneally with 2g/kg glucose at 10mL/kg. Blood glucose measurements were taken 20, 40, 60, 90 and 120 minutes after glucose administration, by glucometer (Ascensia Elite XL, Bayer).

[0806] Glucose levels were plotted against time, and the incremental area under the curve (AUC) of the glucose excursion was determined from time 0 using Graphpad Prism 5.01. Outliers were excluded using Tukey’s box plot outlier test, and statistical significance of differences in AUC of compound treatment compared to vehicle was determined by non-parametric Kruskal-Wallis test with Dunn’s post test.

[0807] Table 3 below shows the mean percentage inhibition of the glucose excursion for the ten animals tested in each group. The compounds were tested at 30 mg/kg and the levels of blood glucose were determined in the presence and absence of the tested compounds. The percentage of glucose reduction is reported. The tested compounds were selected as Examples from the exemplified compounds. These results demonstrate that the GPR120 agonists can lower blood glucose in response to an IP glucose challenge.

<table>
<thead>
<tr>
<th>Example</th>
<th>% reduction IPGTT at 30mg/kg</th>
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<tr>
<td>Example 77</td>
<td>10.4</td>
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<tr>
<td>Example 64</td>
<td>24.9</td>
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<td>Example 178</td>
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EMBODIMENTS

[0808]
Embodiment 1: A compound of Formula (A)

or a pharmaceutically acceptable salt thereof, wherein: the group J is absent or selected from the group consisting

the ring Q is selected from the group consisting of aryl, heteroaryl,

wherein Q is optionally substituted with \((R^6)\);

A¹, A², A³ and A⁴ are independently selected from the group consisting of N and C,

T¹, T², T³ and T⁴ are independently selected from the group consisting of N, O, CR¹

W¹, W², W³ and W⁴ are independently selected from the group consisting of N, NRa,

E¹, E² and E³ are independently selected from the group consisting of C and N;

one of X and Y is a bond, -CH₂-, -CHD-, or -CD₂-, and the other of X and Y is selected from the group consisting of -CH₂-, -CHD-, -CD₂-, -C(O), -C(O)NRa, -NRa-, -O-, -S-, -S(O) and -S(O)₂;

L is -(CR⁴R⁵)₉, wherein optionally one -(CR⁴R⁵)₉ is replaced with —N-, —O-, —S-, —CR⁴=CR⁵-, or -phenyl—;

G is selected from the group consisting of —C(O)OZ and -C(O)NZ₂;

each Z is independently selected from the group consisting of H, alkyl and substituted alkyl; each R¹ and R² is independently selected from the group consisting of H, deuterium, halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, oxo, alkoxy, substituted alkoxy, CN, -NRaRb, -C(O)R², -C(O)ORa, -C(O)NRaRb, -NRaC(O)Rb, -SRa, -S(O)Ra and -S(O)₂Ra, and optionally R¹ and R² can cyclize to form a C₃-7heterocyclyl, substituted C₃-7heterocyclyl, spiro C₃-7heterocyclyl, substituted spiro C₃-7heterocyclyl, C₃-7cycloalkyl, substituted C₃-7cycloalkyl, spiroC₃-7cycloalkyl or spiro substituted C₃-7cycloalkyl;

each R³ is independently selected from the group consisting of H, halo, substituted alkyl, alkoxy, substituted alkoxy, -C(O)NRaRb, -NRaC(O)Rb, -NRaRb, aryloxy, substituted aryl, heteroaryl, substituted heteroaryl, aryloxy, substituted aryloxy and -CN;

each R⁴ and R⁵ is independently selected from the group consisting of H, deuterium,

fluoro, alkyl, substituted alkyl, alkoxy and substituted alkoxy, and optionally R⁴ and R⁵ can cyclize to form a C₃-7heterocyclyl, substituted C₃-7heterocyclyl, spiro C₃-7heterocyclyl, substituted spiro C₃-7heterocyclyl, C₃-7cycloalkyl, substituted C₃-7cycloalkyl, spiroC₃-7cycloalkyl or spiro substituted C₃-7cycloalkyl;

each R⁶ is independently selected from the group consisting of H, halo, alkyl,
substituted alkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, CN, -OR, -NRaRb, -C(O)Ra, -C(O)ORa, -C(O)NRaRb, -NRaC(O)Rb, -SRa, -S(O)Ra and -S(O)2Ra;

each of Ra and Rb is independently selected from the group consisting of H, alkyl, substituted alkyl, cycloalkyl, heterocyclyl, substituted heterocyclyl, alkenyl, alkynyl, aryl, substituted aryl, heteroaryl and substituted heteroaryl.

the subscript k is 0, 1, 2 or 3;
the subscript m is 0, 1, 2 or 3; and
the subscript q is 0, 1, 2, 3 or 4.

Embodiment 2: A compound of Embodiment 1 of Formula (B):

or a pharmaceutically acceptable salt thereof, provided that W1 and W3 are not both O.

Embodiment 3: The compound of Embodiment 2 wherein W1 and W3 are independently selected from the group consisting of CR1R2 and O.

Embodiment 4: The compound of Embodiment 3 of Formula (C):

or a pharmaceutically acceptable salt thereof.

Embodiment 5: The compound of Embodiment 4, wherein E1, E2 and E3 are all C.

Embodiment 6: The compound of Embodiment 5, wherein X is selected from the group consisting of -CH2-, -CHD- and -CD2-, and Y is O.

Embodiment 7: The compound of Embodiment Error! Reference source not found., wherein in L the subscript q is 2 or 3.

Embodiment 8: The compound of Embodiment Error! Reference source not found., wherein the subscript q is 2.

Embodiment 9: The compound of Embodiment 6, wherein G is -C(O)OZ.
Embodiment 10: The compound of Embodiment Error! Reference source not found., wherein Z is H.

Embodiment 11: The compound of Embodiment 7, wherein the subscript m is 1 or 2, and each R3 is independently selected from the group consisting of halo, alkyl, substituted alkyl, alkoxy and substituted alkoxy.

Embodiment 12: The compound of Embodiment 11, wherein, each R3 is independently selected from the group consisting of F, Cl, -CH3, -CF3 and -OCH3.

Embodiment 13: The compound of Embodiment 8, wherein R1 and R2 are independently selected from the group consisting of C1-3alkyl and -CF3.

Embodiment 14: The compound of Embodiment Error! Reference source not found., wherein R1 and R2 are both -CH3.

Embodiment 15: The compound of Embodiment 9, wherein the subscript k is 0, 1 or 2.

Embodiment 16: The compound of Embodiment Error! Reference source not found., wherein each R6 is independently selected from the group consisting of fluoro, chloro, -CH3, -C2H5 and -CF3.

Embodiment 17: The compound of Embodiment 1, wherein, the ring Q is

Embodiment 18: A compound of Embodiment 17, wherein ring J is absent and each R3 is independently selected from the group consisting of alkoxy, substituted alkoxy and halo.

Embodiment 19: A compound of Embodiment 1 or a pharmaceutically acceptable salt thereof selected from the group consisting of

1. 2-(5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-6-fluoro-2,3-dihydro-1H-inden-1-yl)acetic acid (29);
2. 3-(4-((2,2-dimethylchroman-8-yl) methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (31);
3. 3-(4-((2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (32);
4. 2-methyl-3-(4-((2,2,5-trimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (33);
5. 3-(3,5-difluoro-4-((2,2,5-trimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)2-methylpropanoic acid (34);
6. 3-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-methylphenyl)-2-methylpropanoic acid (35);
7. 3-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-methoxyphenyl)-2-methylpropanoic acid (36);
8. 3-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl) phenyl)-2-methylpropanoic acid (37);
9. 3-(3-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (38);
10. 3-(3-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (39);
11. 3-(3-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-methylphenyl)-2-methylpropanoic acid (40);
12. 3-(3-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-methylphenyl)-2-methylpropanoic acid (41);
13. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (42);
14. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (43);
15. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (44);
16. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (45);
17. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (46);
18. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (47);
19. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (48);
20. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (49);
21. 3-(3,5-dichloro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (50);
22. 2-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-3,5-difluorophenyl) cyclopropanecarboxylic acid (51);
23. 3-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)2-methylpropanoic acid (52);
2-(4-(2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl) cyclopropanecarboxylic acid (53);
3-(4-(2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)propanoic acid (54);
2-(3,5-difluoro-4-((4-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)cyclopropanecarboxylic acid (56);
3-(3,5-difluoro-4-((4-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (57);
3-(3-fluoro-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (58);
2-(4-((5,6-difluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylphenyl)propanoic acid (68);
2-(2-bromo-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-5-methoxyphenyl)propanoic acid (81);
2-(2-bromo-4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-5-methoxyphenyl)propanoic acid (82);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methoxyphenyl)propanoic acid (83);
3-(2-bromo-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-5-methoxyphenyl)acetic acid (84);
2-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)thio)-acetic acid (87);
2-((4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)thio)-acetic acid (88);
(E)-3-(2-ethyl-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acrylic acid (89);
3-(2-fluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (90);
3-(2-bromo-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-5-methoxyphenyl)propanoic acid (91);
3-(2-fluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-5-methoxyphenyl)propanoic acid (92);
2-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)thio)-acetic acid (93);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)thio)-acetic acid (94);
3-((4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)thio)-acetic acid (95);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acetic acid (96);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acetic acid (97);
3-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acetic acid (98);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acetic acid (99);
3-(2-fluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (100);
3-(2-fluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (101);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (102);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (103);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (104).
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-2-propylphenyl)propanoic acid (105);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (106);
3-(3-fluoro-4-((5-fluoro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (107);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (108);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylpropanoic acid (109);
3-(4-((5-bromo-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (110);
3-(4-((5-(4-chlorophenyl)-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (111);
3-(4-(2,2-dimethyl-5-(3-(trifluoromethyl)phenyl)-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (112);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-((dimethylamino)methyl)phenyl)-2-methylpropanoic acid (113);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (114);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-((dimethylamino)methyl)phenyl)-2-methylpropanoic acid (115);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methoxyphenyl)-2-methylpropanoic acid (116);
3-(4-(2,2-dimethyl-5-(3-(trifluoromethyl)phenyl)-2,3-dihydrobenzofuran-7-yl)methoxy)-3-((dimethylamino)methyl)phenyl)-2-methylpropanoic acid (117);
3-(4-(2,2-dimethyl-5-(1H-tetrazol-1-yl)-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (118);
3-(4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (119);
2-(3,5-difluoro-4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)cyclopropanecarboxylic acid (120);
2-(5-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (121);
2-(3,5-difluoro-4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)cyclopropanecarboxylic acid (122);
3-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (123);
2-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (124);
(R)-3-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (125);
3-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (126);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methoxypropyl)propanoic acid (127);
2-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)cyclopropanecarboxylic acid (128);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-((dimethylamino)methyl)phenyl)-2-methylpropanoic acid (129);
3-(3,5-difluoro-4-((6-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (130);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (131);
2-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-methoxyphenoxycarboxylic acid (132);
2-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylpropanoic acid (133);
3-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (134);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)butanoic acid (135);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)butanoic acid (136);
3-(4-((5-methoxy-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (137);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (138);
3-(4-((5-ethoxy-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (139);
3-(4-((5-benzzyloxy)-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (140);
5-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-indene-2-carboxylic acid (141);
5-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-indene-2-carboxylic acid (142);
6-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-naphthoic acid (143);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-isopropoxyphenyl)propanoic acid (144);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-isopropoxyphenyl)propanoic acid (145);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-ethoxyphenyl)propanoic acid (146);
2-ethoxy-4-((5-methoxy-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-propanoic acid (147);
3-(4-((5-chloro-2-methylbenzofuran-7-yl)methoxy)-2-ethylphenyl)propanoic acid (148);
3-(4-((5-chloro-2-methylbenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (149);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)naphthalen-1-yl)propanoic acid (150);
3-(2-((dimethylamino)methyl)-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (151);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (152);
3-(4-((2,2-dimethyl-5-(trifluoromethyl)phenyl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (153);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylbenzofuran-7-yl)propanoic acid (154);
2-acetamidooethyl 3-(4-((5-chloro-2,2-dimethyl-3,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (155);
3-(4-((5-chloro-2-methylbenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (156);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dimethylphenyl)propanoic acid (157);
2-(5-((2-methylbenzo[b]thiophen-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (158);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-isopropylphenyl)propanoic acid (159);
3-(2-ethyl-4-((5-fluoro-2,2-dimethyl-3,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (160);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-isopropylphenyl)propanoic acid (161);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acetic acid (162);
2-(5-((5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (163);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-(trifluoromethyl)phenyl)propanoic acid (164);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-(trifluoromethyl)phenyl)propanoic acid (165);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-isopropylphenyl)propanoic acid (166);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-ethylphenyl)propanoic acid (167);
3-(2-ethyl-4-((5-fluoro-2,2-dimethyl-3,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (168);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (169);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (170);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (171);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (172);
3-(4-((3,3-dideuterio-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (173);
3-(4-((3,3-dideuterio-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (174);
3-(4-((3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (175);
3-(4-((3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (176);
3-(4-((3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (177);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (178);
3-(3,5-difluoro-4-((2-methylbenzo[b]thiophen-7-yl)methoxy)phenyl)propanoic acid (179);
2-(5-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (180);
2-(6-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-1,2,3,4-tetrahydronapthalen-1-yl)acetic acid (181);
2-(5-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,4-tetrahydro-1H-inden-1-yl)acetic acid (182);
2-(5-((5-chloro-2,2-dimethyl-3,3-dihydrobenzofuran-7-yl)methoxy)-3,4-tetrahydro-1H-inden-1-yl)acetic acid (183);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylpropanoic acid (184);
3-(4-((5-chloro-2,2-dimethyl-3,3-dihydrobenzofuran-7-yl)methoxy)-2-methylpropanoic acid (185);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylpropanoic acid (186);
3-methyl-3-((2,2,5-trimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)butanoic acid (187);
3-(4-((5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methoxy)phenyl)propanoic acid (188);
2-(6-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-1,2,3,4-tetrahydronapthalen-1-yl)acetic acid (189);
3-(3-fluoro-4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (190);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylpropanoic acid (191);
2-(5-(5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (192);
2-(5-(5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (193);
2-(5-(5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (194);
3-(4-((5-chloro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methoxy)phenyl)propanoic acid (195);
(S)-2-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid
(R)-2-((5-Fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid
(S)-2-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid

3-(4-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid
4-(4-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)butanoic acid
(R)-2-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid

2-(3-Fluoro-4-((5-Fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)cyclopropanecarboxylic acid
2-(4-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-Fluorophenyl)-2-Methylbutanoic acid
2-(4-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-Difluorophenyl)cyclopropanecarboxylic acid
3-(4-((5-Chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-Methoxyphenyl)propanoic acid
3-(4-((5-Fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-Propylphenyl)propanoic acid
3-(2-Chloro-4-((5-Chloro-3H-spiro[benzofuran-2,1'-cyclopentane]-7-yl)methoxy)phenyl)propanoic acid
3-(2-ethyl-5-fluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (249);
3-(4-(5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-ethyl-5-fluorophenyl)propanoic acid (250);
3-(3-fluoro-4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-propylphenyl)propanoic acid (251);
3-(4-(5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluoro-2-propylphenyl)propanoic acid (252);
3-(3-fluoro-4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-pentylphenyl)propanoic acid (253);
3-(4-(5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluoro-2-pentylphenyl)propanoic acid (254);
3-(2-ethyl-3-fluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (255);
3-(4-(5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-propylphenyl)propanoic acid (256);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluoro-2-ethylphenyl)propanoic acid (257);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluoro-2-propylphenyl)propanoic acid (258);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (259);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (260);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (261);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (262);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluoro-2-ethylphenyl)propanoic acid (263);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluoro-2-propylphenyl)propanoic acid (264);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2,2,3,3-tetradeuteriopropanoic acid (265);
3-(4-(dideuterio(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2,2,3,3-tetradeuteriopropanoic acid (266);
3-(4-(2-butyl-3-fluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (267);
3-(4-(5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (268);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (269);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2,2,3,3-tetradeuteriopropanoic acid (270);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-propylphenyl)propanoic acid (271);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,2,3,3-tetradeuteriopropanoic acid (272);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,2,3,3-tetradeuteriopropanoic acid (273);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,2,3,3-tetradeuteriopropanoic acid (274);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (275);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (276);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (277);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (278);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (279);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (280);
3-(4-(2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (281);
3-(4-(2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (282);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (283);
3-(4-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (284);
3-(4-(5-fluoro-3H-spiro[benzofuran-2,1'-cyclopentan]-7-yl)methoxy)-2,3,5-trimethylphenyl)propanoic acid (285);
2-(5-(5-chloro-2-isopropoxybenzyl)oxy)-6-fluoro-2,3-dihydro-1H-inden-1-yl)acetic acid (286);
2-(5-(5-chloro-2-isopropoxybenzyl)oxy)-6-fluoro-2,3-dihydro-1H-inden-1-yl)acetic acid (287);
2-(5-(2-isopropoxyphenylidin-3-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (288);
2-(5-(2-isopropoxyphenylidin-3-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (289);
3-(5,5-difluoro-4-(2-methylbenzo[d]oxazol-7-yl)methoxy)phenyl)-2-methylpropanoic acid (290);
2-(7-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-oxo-2H-chromen-4-yl)acetic acid (291);
2-(7-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-oxo-2H-chromen-4-yl)acetic acid (292);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-N-hydroxy-2-methylpropanamide (293); 3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-N-hydroxypropanamide (294); 3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-4-methylpentanoic acid (295); 3-(4-((6-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dimethylphenyl)propanoic acid (296); and 3-(2-ethoxy-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (297).

Embodiment 20: A composition comprising a compound of any one of Embodiments 1 to 19 and a pharmaceutically acceptable carrier.

Embodiment 21: Use of a compound of any one of Embodiments 1 to 19 in the manufacture of a medicament for treating a disease or condition selected from the group consisting of Type I diabetes, Type II diabetes and metabolic syndrome.

Embodiment 22: The use of Embodiment 21, wherein said disease is Type II diabetes.

Embodiment 23: Use of a compound of any one of Embodiments 1 to 19 in the manufacture of a medicament for lowering blood glucose.

Embodiment 24: Use of a compound of any one of Embodiments 1 to 19 in the manufacture of a medicament for modulating GPR120 activity in a cell.

Claims

1. A compound of Formula (A)

or a pharmaceutically acceptable salt thereof, wherein:
the ring J is absent or selected from the group consisting

\[
\begin{align*}
W^2 &- W^3 \\
W^1 & & W^2 \quad \text{and} \quad W^1 & \quad W^2 \\
\end{align*}
\]

the ring Q is selected from the group consisting of aryl, heteroaryl,
wherein Q is optionally substituted with (R₆)ₖ;
A¹, A², A³ and A⁴ are independently selected from the group consisting of N and C,
with the proviso that only 0, 1 or 2 of A¹, A², A³ and A⁴ is N;
T¹, T², T³ and T⁴ are independently selected from the group consisting of N, O, CR¹
and CR¹R², with the proviso that only 0, 1 or 2 of T¹, T², T³ and T⁴ is selected from N and O;
W¹, W², W³ and W⁴ are independently selected from the group consisting of N, NR³,
CR¹, CR¹R², O, S(O) and S(O)₂, with the proviso that ring J is not 1,3-dioxolane;
E¹, E² and E³ are independently selected from the group consisting of C and N;
one of X and Y is a bond, -CH₂-, -CHD-, or -CD₂-, and the other of X and Y is
selected from the group consisting of -CH₂-, -CD₂-, -C(O), -C(O)NR³, -NR³, -O-, -S-, -S(O) and -S(O)₂;
L is -(CR₄R₅)q wherein optionally one -(CR₄R₅)- is replaced with -N-, -O-, -S-, -CR₄=CR₅-, or -phenyl-;
G is selected from the group consisting of -C(O)OZ, -C(O)NZ-OZ and -C(O)NZ₂;
each Z is independently selected from the group consisting of H, alkyl and
substituted alkyl;
each R¹ and R² is independently selected from the group consisting of H, deuterium,
halo, alkyl, substituted alkyl, cycloalkyl, substituted cycloalkyl, alkenyl, substituted alkenyl,
alkynyl, oxo, alkoxy, substituted alkoxy, CN, -NR³R⁵, -C(O)R⁴, -C(O)OR⁴, -C(O)NR³R⁵, -NR³C(O)R⁵, -SR³, -S(O)R³
and -S(O)₂R³, and optionally R¹ and R² can cyclize to form a C₃₋₇-heterocyclyl, substituted C₃₋₇-heterocyclyl, spiro
C₃₋₇-heterocyclyl, substituted spiro C₃₋₇-heterocyclyl, C₃₋₇-cycloalkyl, substituted C₃₋₇-cycloalkyl, spiroC₃₋₇-cycloalkyl
or spiro substituted C₃₋₇-cycloalkyl;
each R³ is independently selected from the group consisting of H, halo, alkyl,
substituted alkyl, alkoxy, substituted alkoxy, -C(O)NR³R⁵, -NR³C(O)R⁵, -NR³, aryl, substituted aryl, heteroaryl,
substituted heteroaryl, arylxy, substituted arylxy and -CN;
each R⁴ and R⁵ is independently selected from the group consisting H, deuterium,
fluoro, alkyl, substituted alkyl, alkoxy and substituted alkoxy, and optionally R⁴ and R⁵ can cyclize to form a
C₃₋₇-heterocyclyl, substituted C₃₋₇-heterocyclyl, spiro C₃₋₇-heterocyclyl, substituted spiro C₃₋₇-heterocyclyl,
C₃₋₇-cycloalkyl, substituted C₃₋₇-cycloalkyl, spiroC₃₋₇-cycloalkyl or spiro substituted C₃₋₇-cycloalkyl;
each R⁶ is independently selected from the group consisting of H, halo, alkyl,
substituted alkyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, cycloalkyl, substituted cycloalkyl, alkenyl,
substituted alkenyl, alkynyl, substituted alkynyl, CN, -OR³, -NR³R⁵, -C(O)R⁴, -C(O)OR⁴, -C(O)NR³R⁵, -NR³C(O)
R⁵, -SR³, -S(O)R³ and -S(O)₂R³;
each of R³ and R⁵ is independently selected from the group consisting of H, alkyl,
substituted alkyl, cycloalkyl, heterocyclyl, substituted heterocyclyl, alkynyl, alkynyl, aryl, substituted aryl, heteroaryl
and substituted heteroaryl.
the subscript k is 0, 1, 2 or 3;
the subscript m is 0, 1, 2 or 3; and
the subscript q is 0, 1, 2, 3 or 4 provided that:
when ring J is

the subscript q is 0, 1, or 4.

2. A compound of claim 1 of Formula (B):
or a pharmaceutically acceptable salt thereof, provided that W₁ and W₃ are not both O.

3. The compound of claim 2 wherein W₁ and W₃ are independently selected from the group consisting of CR₁R₂ and O.

4. The compound of claim 3 of Formula (C):

or a pharmaceutically acceptable salt thereof.

5. The compound of claim 4, wherein E¹, E² and E³ are all C, X is selected from the group consisting of -CH₂-, -CHD- and -CD₂-, and Y is O.

6. The compound of claim 5, wherein the subscript q is 1, 2, or 3 and G is -C(O)OZ.

7. The compound of claim 6, wherein Z is H, the subscript m is 1 or 2, and each R³ is independently selected from the group consisting of halo, alkyl, substituted alkyl, alkoxy and substituted alkoxy.

8. The compound of claim 7, wherein, R¹ and R² are independently selected from the group consisting of C₁₊₃alkyl and -CF₃ and each R³ is independently selected from the group consisting of F, Cl, -CH₃, -CF₃ and -OCH₃.

9. The compound of claim 8, wherein R¹ and R² are both -CH₃ and the subscript k is 0, 1 or 2, and each R⁶ is independently selected from the group consisting of fluoro, chloro, -CH₃, -C₂H₅ and -CF₃.

10. The compound of claim 1, wherein, the ring Q is

11. The compound of claim 10, wherein ring J is absent and each R³ is independently selected from the group consisting...
of alkoxy, substituted alkoxy and halo.

12. The compound of claim 1 or a pharmaceutically acceptable salt thereof selected from the group consisting of 2-(5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-6-fluoro-2,3-dihydro-1H-inden-1-yl)acetic acid (29);
3-(4-((2,2-dimethylchroman-8-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (31);
2-(4-((2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-3,5-difluorophenyl) cyclopropane carboxylic acid (50);
2-(5-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (65);
2-(5-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (66);
3-(4-((2,3-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (69);
3-(4-((6-fluoro-4H-benzo[d][1,3]dioxin-8-yl)methoxy)phenyl)-2-methylpropanoic acid (74);
(4-S)-2-ethyl-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acrylic acid (89);
3-(7-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-4-yl)propanoic acid (92);
3-(7-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-4-yl)propanoic acid (93);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-carboxamido)phenyl)-2-methylpropanoic acid (97);
2-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)ethyl)phenoxo)acetic acid (99);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-2-ethyl-3-fluorophenyl)propanoic acid (104);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-2-propylphenyl)propanoic acid (105);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (106);
2-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)acrylic acid (107);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (108);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)acrylic acid (109);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (110);
2-(3,5-difluoro-4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl) cyclopropane carboxylic acid (112);
2-(5-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (123);
3-(3,5-difluoro-4-((7-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-2-methylpropanoic acid (121);
2-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)cyclopropane carboxylic acid (122);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (125);
2-(3,5-difluoro-4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-y1)methoxy)phenyl)cyclopropane carboxylic acid (126);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (129);
3-(3,5-difluoro-4-((6-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (130);
3-(4-((5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-4-yl)methoxy)phenyl)-2-methylpropanoic acid (131);
3-(4-((5-chloro-2,3,3-trimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (138);
5-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-indene-2-carboxylic acid (141);
5-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-indene-2-carboxylic acid (142);
6-(5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-naphthoic acid (143);
3-(4-((5-fluoro-2,2-dimethylbenzofuran-7-yl)methoxy)-2-(ethylphenyl)propanoic acid (148);
3-(4-((5-fluoro-2,2-dimethylbenzofuran-7-yl)methoxy)-3-fluorophenyl)propanoic acid (149);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)naphthalen-1-yl)propanoic acid (150);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-2-methylbenzofuran-7-yl)propanoic acid (154);
2-acetamidoethyl 3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2- methylpropanoate (155);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methylamino)phenyl) propanoic acid (156);
3-(4-((5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methylamino)phenyl) propanoic acid (157);
3-(4-((5-chloro-2,2-dimethyl-3-oxo-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (158);
3-(4-((5-chloro-3-hydroxy-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (159);
2-(4-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)phenyl)acetic acid (162);
3-(4-((2,2-dimethyl-3-dihydrobenzofuran-4-y)methoxy)-2-ethylphenyl)propanoic acid (169);
3-(4-((3,3-dideuterio-5-fluoro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (174);
3-(4-((3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (175);
3-(4-((3,3-dideuterio-5-chloro-2,2-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-(trifluoromethyl)phenyl)-2-methylpropanoic acid (176);
3-(4-((5-chloro-3,3-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)phenyl)-2-methylpropanoic acid (177);
3-(4-((5-chloro-3,3-dimethyl-2,3-dihydrobenzofuran-7-yl)methoxy)-3-fluorophenyl)-2-methylpropanoic acid (178);
2-(5-((2-methylbenzo[b]thiophen-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (180);
2-(6-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-1,2,3,4-tetrahydronaphthalen-1-yl)acetic acid (182);
2-(6-((5-chloro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-1,2,3,4-tetrahydronaphthalen-1-yl)acetic acid (183);
(S)-2-(5-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (204);
(S)-2-(5-((5-chloro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (205);
(R)-2-(5-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (207);
(R)-2-(5-((5-chloro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (208);
2-(5-((2,2-dimethyl-5-phenyl-2,3-dihydro-1H-inden-1-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (216);
2-(5-((6-fluoro-2,2-dimethyl-3-dihydrobenzofuran-4-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (217);
3-(4-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-5,6,7,8-tetrahydronaphthalen-1-yl)propanoic acid (247);
3-(4-((5-chloro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-5,6,7,8-tetrahydronaphthalen-1-yl)propanoic acid (248);
3-(2-((5-chloro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)phenyl)propanoic acid (279);
2-(5-((5-chloro-2-isopropoxybenzyl)oxy)-6-fluoro-2,3-dihydro-1H-inden-1-yl)acetic acid (286);
2-(5-((5-chloro-2-isoproxybenzyl)oxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (287);
2-(5-((2-isoproxypyridin-3-yl)methoxy)-2,3-dihydro-1H-inden-1-yl)acetic acid (288);
3-(4-((1H-indazol-7-yl)methoxy)-3,5-difluorophenyl)-2-methylpropanoic acid (289);
3-(3,5-difluoro-4-((2-methylbenzo[d]oxazol-7-yl)methoxy)phenyl)-2-methylpropanoic acid (290);
2-((6-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)benzofuran-3-y)l)acetic acid (291);
2-((7-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)-2-oxo-2H-chromen-4-yl)acetic acid (292);
3-(4-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)phenyl)-N-hydroxy-2-methylpropanamide (293);
3-(4-((5-fluoro-2,2-dimethyl-3-dihydrobenzofuran-7-yl)methoxy)phenyl)-N-hydroxypropanamide (294); and
3-(4-((6-chloro-2,2-dimethyl-3-dihydrobenzofuran-4-yl)methoxy)-2,3-dimethylphenyl)propanoic acid (296).

13. A composition comprising a compound of any one of claims 1 to 12 and a pharmaceutically acceptable carrier.

14. A compound of any one of claims 1 to 12 for use in treating a disease or condition selected from the group consisting of Type I diabetes, Type II diabetes and metabolic syndrome.

15. The compound for use of claim 14, wherein said disease is Type II diabetes.

16. A compound of any one of claims 1 to 12 for use in lowering blood glucose.

17. A compound of any one of claims 1 to 12 for use in modulating GPR120 activity in a cell.
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The present search report has been drawn up for all claims.

Place of search: Munich
Date of completion of the search: 17 September 2012
Examiner: Usuelli, Ambrogio

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