



- (51) **International Patent Classification:**
C07D 401/04 (2006.01) *A61K 31/4523* (2006.01)
C07D 401/14 (2006.01) *A61P 3/10* (2006.01)
C07D 405/14 (2006.01)
- (21) **International Application Number:**
PCT/US2012/020281
- (22) **International Filing Date:**
5 January 2012 (05.01.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
61/430,013 5 January 2011 (05.01.2011) US
61/449,020 3 March 2011 (03.03.2011) US
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- (81) **Designated States (unless otherwise indicated, for every
kind of national protection available):** AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,
HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD,
SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR,
TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States (unless otherwise indicated, for every
kind of regional protection available):** ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ,
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).
- Published:**
— without international search report and to be republished
upon receipt of that report (Rule 48.2(g))



WO 2012/094462 A2

(54) **Title:** HETEROCYCLIC COMPOUNDS FOR THE INHIBITION OF PASK

(57) **Abstract:** Disclosed herein are new heterocyclic compounds and compositions and their application as pharmaceuticals for the treatment of disease. Methods of inhibiting PAS Kinase (PASK) activity in a human or animal subject are also provided for the treatment of diseases such as diabetes mellitus.

HETEROCYCLIC COMPOUNDS FOR THE INHIBITION OF PASK

[001] This application claims the benefit of priority of United States Provisional Applications No. 61/430,013, filed January 5, 2011 and No. 61/449,020, filed March 3, 2011, the disclosures of which are hereby incorporated by reference as if written herein in their entireties.

[002] Disclosed herein are new heterocyclic compounds and compositions and their application as pharmaceuticals for the treatment of disease. Methods of inhibiting PAS Kinase (PASK) activity in a human or animal subject are also provided for the treatment of diseases such as diabetes mellitus.

[003] The regulation of glycogen metabolism is critical for the maintenance of glucose and energy homeostasis in mammals. Glycogen, a large branched polymer of glucose, acts as a reserve of carbon and energy in a variety of organisms. In mammals, the most important stores are found in the liver and skeletal muscle (1). Liver glycogen is required to efficiently buffer blood glucose levels during fasting, whereas muscle glycogen is primarily used locally as a fuel for muscle contraction (2). Dysregulation of glycogen metabolism has been implicated in the development of many diseases, including Type 2 diabetes mellitus (3, 4).

[004] The synthesis of glycogen is primarily controlled through regulation of the enzyme glycogen synthase (GYS, various isoforms), which catalyzes bulk glycogen synthesis (5, 6, 7). The muscle isoform of glycogen synthase (GYS1) is inactivated by reversible phosphorylation that occurs at nine distinct sites within the enzyme (8, 9, 10). In the best characterized form of glycogen synthase, the phosphorylation sites are clustered at the N and C termini (14). Glycogen synthase kinase-3 (GSK-3), an insulin-dependent kinase which has long been implicated in the stepwise phosphorylation of four key sites in the C terminus of glycogen synthase including Ser-640 (one of the most important endogenous regulatory phosphorylation sites in mammalian glycogen synthase (15, 32) and Ser-644 (10, 11-13, 24, 25). GSK-3, however, is not the sole kinase that phosphorylates C-terminal regulatory sites; GSK-3-independent mechanisms also exist, since serine-to-alanine substitutions at Ser-7 and Ser-10 block GSK-3-mediated phosphorylation of the important regulatory sites Ser-640 and Ser-644, and phosphorylation at these sites still occurs.

[005] PASK (purine-analog sensitive kinase, PAS kinase) is a PAS domain-containing serine/threonine kinase, and genetic experiments in *S. cerevisiae* yeast have implicated PASK as a physiological regulator of glycogen synthase and glycogen accumulation (16, 17). As with the

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entire glycogen synthase regulatory system, PASK is highly conserved from yeast to man. Human PASK (hPASK) phosphorylates glycogen synthase primarily at Ser-640, causing near complete inactivation. It is interesting to note that the exact site of PASK-dependent phosphorylation is similar but not identical in yeast and mammalian glycogen synthase (18, 19); yeast PASK phosphorylates glycogen synthase at the site analogous to Ser-644, four residues C-terminal (18). It appears that the hPASK mid region (residues 444–955) is required for efficient phosphorylation of glycogen synthase *in vitro* and for interaction with glycogen synthase in cells: an hPASK mutant (Δ 955) lacking the noncatalytic N terminus was unable to efficiently phosphorylate glycogen synthase. Since this region is not required for the phosphorylation of generic, nonphysiological substrates, such as histones and synthetic peptides, it has been proposed that the mid region of hPASK is essential for substrate-targeting. A similar substrate region has been discovered in many protein kinases (26-29). Unlike GSK-3, the activity of hPASK has been shown to be independent of insulin and probably regulated instead by a more direct metabolic signal (23).

[006] Genetic and proteomic screens using yeast PASK identified a number of substrates and implicated this kinase in the regulation of carbohydrate metabolism and translation (18). It has previously been shown that yeast PASK phosphorylates glycogen synthase *in vitro* and that strains lacking the PASK genes (*PSK1* and *PSK2*) had elevated glycogen synthase activity and an approximately 5- to 10-fold accumulation of glycogen relative to wild-type strains, consistent with impaired ability to phosphorylate glycogen synthase *in vivo* (18). Because glycogen synthesis and translation are two processes tightly regulated in response to nutrient availability and because PAS domains are frequently involved in metabolic sensing, a role for PASK in the cellular response to metabolic status has been proposed. Indeed, it was recently demonstrated that mammalian PASK plays a role in the cellular response to nutrients. The catalytic activity of PASK in pancreatic islet β -cells is rapidly increased in response to glucose addition, and PASK is required for the glucose-responsive expression of some β -cell genes, including preproinsulin (23).

[007] PASK catalytic activity is not responsive to glucose alone, however. The interaction between the hPASK midregion and glycogen synthase is regulated by at least two factors. First, the PAS domain of PAS kinase plays a negative role in regulating this interaction. If the PAS domain is deleted or disrupted, hPASK associates more stably with glycogen synthase. PAS domain function is usually controlled by the metabolic status of the host cell, as has been suggested for the PASK PAS domain (23). This observation raises the intriguing possibility that the hPASK–glycogen synthase interaction is regulated by the metabolic status of the cell, thereby enabling an additional layer of metabolic regulation of glycogen synthesis. Second, glycogen

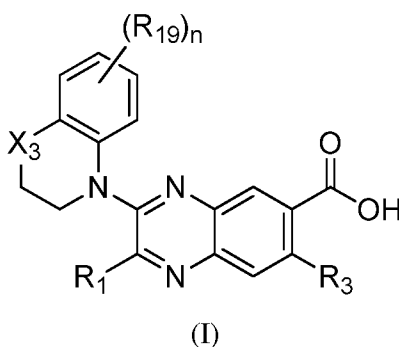
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negatively regulates the hPASK–glycogen synthase interaction, which would initially seem counterintuitive, since glycogen would thereby stimulate its own continued synthesis. It is possible, however, that this mechanism exists to spatially coordinate the synthesis of glycogen. It is becoming increasingly apparent that glycogen is synthesized in cells in a highly organized spatial pattern (30). Perhaps one function of hPASK is to maintain free, unlocalized glycogen synthase in a phosphorylated, inactive form until it is properly localized to an existing, properly organized glycogen particle. These data strongly suggest that the hPASK midregion plays an important role in targeting hPASK catalytic activity to specific substrates within the cell.

[008] Since hPASK has been recently implicated in glucose-sensing and glucose-responsive transcription, it appears likely that glucose signaling by means of hPASK affects glycogen metabolism *in vivo*. It is well established that derangement in glycogen metabolism is one of the hallmarks of both Type 1 and Type 2 diabetes (20) and related conditions (21), including a panoply of life-threatening cardiovascular conditions (22). Using PASK1 mice, it has further been demonstrated that PASK is indeed required for normal insulin secretion by pancreatic β cells, and that PASK deletion results in nearly complete resistance to the phenotypes caused by a high-fat diet, including obesity, insulin resistance and hepatic fat accumulation. Therefore, PASK inhibition would comprise a system for the metabolic control of glucose utilization and storage in mammalian cells, and offer a new method to treat metabolic diseases including but not limited to diabetes and its complications, the metabolic syndrome, insulin resistance, and various cardiovascular conditions.

[009] Novel compounds and pharmaceutical compositions, certain of which have been found to inhibit PASK have been discovered, together with methods of synthesizing and using the compounds including methods for the treatment of PASK-mediated diseases in a patient by administering the compounds.

[010] In certain embodiments of the present invention, a compound has structural Formula I:



or a pharmaceutically acceptable salt, ester, or prodrug thereof, wherein:

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R₁ is chosen from aryl and heteroaryl, either of which may be optionally substituted with one or more substituents chosen from hydrogen, halo, alkyl, alkenyl, alkynyl, cycloalkyl, haloalkyl, aryl, aralkyl, heterocyclyl, heteroaryl, heterarylalkyl, CN, alkoxy, alkylamino, dialkylamino, NHSO₂R₁₂, NHSO₂NHR₁₂, NHCOR₁₂, NHCONHR₁₂, CONHR₁₂, CONR_{12a}R_{12b}, hydroxy, CF₃, CHF₂, CH₂F, SO₂R₁₂, SO₂NHR₁₂, OCF₃, OCHF₂, and OCH₂F;

R₃ is chosen from hydrogen and hydroxyl;

R₁₂, R_{12a} and R_{12b} are independently chosen from hydrogen, C₁-C₆ alkyl, aryl, heteroaryl, aralkyl and heteroaralkyl, or taken together, R_{12a} and R_{12b} may form a heterocycloalkyl or heteroaryl, any of which may be optionally substituted;

R₁₉ is chosen from hydrogen, lower alkyl, alkenyl, alkynyl, hydroxy, alkoxy, CF₃, CHF₂, CH₂F, -COOH, OCF₃, OCHF₂, OCH₂F halo, alkylsulfonyl, cyano, nitro, alkylamino, dialkylamino, NHSO₂R₁₂, NHSO₂NHR₁₂, NHCOR₁₂, NHCONHR₁₂, CONHR₁₂, CONR_{12a}R_{12b}, SO₂NR_{12a}R_{12b}, aryl, and heteroaryl;

X₃ is chosen from CH₂, NR₁₂, and O; and

n is an integer from 0 - 4.

[011] Certain compounds disclosed herein may possess useful PASK modulating activity, and may be used in the treatment or prophylaxis of a disease or condition in which PASK plays an active role. Thus, in broad aspect, certain embodiments also provide pharmaceutical compositions comprising one or more compounds disclosed herein together with a pharmaceutically acceptable carrier, as well as methods of making and using the compounds and compositions. Certain embodiments provide methods for modulating PASK. Other embodiments provide methods for treating a PASK-mediated disorder in a patient in need of such treatment, comprising administering to said patient a therapeutically effective amount of a compound or composition according to the present invention. Also provided is the use of certain compounds disclosed herein for use in the manufacture of a medicament for the treatment of a disease or condition ameliorated by the inhibition of PASK.

[012] In an embodiment, compounds of Formula I are provided wherein n is an integer from 0-2.

[013] In an embodiment, compounds of Formula I are provided wherein R₁ is phenyl.

[014] In an embodiment, compounds of Formula I are provided wherein R₁ is substituted with one or more halo substituents.

[015] In an embodiment, compounds of Formula I are provided wherein said halo substituent is fluoro.

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- [016] In an embodiment, compounds of Formula I are provided wherein R₁ is 4-fluorophenyl.
- [017] In an embodiment, compounds of Formula I are provided wherein R₃ is hydrogen.
- [018] In an embodiment, compounds of Formula I are provided wherein X₃ is CH₂.
- [019] Further provided is a compound as disclosed above for use as a medicament.
- [020] Further provided is a compound as disclosed above for use in the manufacture of a medicament for the prevention or treatment of a disease or condition ameliorated by the inhibition of PASK.
- [021] Further provided is a pharmaceutical composition comprising a compound as recited above together with a pharmaceutically acceptable carrier.
- [022] Further provided is a method of inhibiting PASK comprising contacting PASK with a compound as disclosed above.
- [023] Further provided is a method of treatment of a disease comprising the administration of a therapeutically effective amount of a compound as disclosed above to a patient in need thereof.
- [024] Further provided is the method as recited above wherein said disease is chosen from cancer and a metabolic disease.
- [025] Further provided is the method as recited above wherein said disease is a metabolic disease.
- [026] Further provided is the method as recited above wherein said metabolic disease is chosen from metabolic syndrome, diabetes, dyslipidemia, fatty liver disease, non-alcoholic steatohepatitis, obesity, and insulin resistance.
- [027] Further provided is the method disclosed above wherein said diabetes is Type II diabetes.
- [028] Further provided is the method as disclosed above wherein said dyslipidemia is hyperlipidemia.
- [029] Further provided is a method for achieving an effect in a patient comprising the administration of a therapeutically effective amount of a compound as disclosed above to a patient, wherein the effect is selected from the group consisting of reduction of triglycerides, reduction of cholesterol, and reduction of hemoglobin A1c.
- [030] Further provided is the method as disclosed above wherein said cholesterol is chosen from LDL and VLDL cholesterol.
- [031] Further provided is the method as disclosed above wherein said triglycerides are chosen from plasma triglycerides and liver triglycerides.

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[032] Further provided is a method of treatment of a PASK-mediated disease comprising the administration of:

- a. a therapeutically effective amount of a compound as disclosed above; and
- b. another therapeutic agent.

[033] As used herein, the terms below have the meanings indicated.

[034] When ranges of values are disclosed, and the notation “from n_1 ... to n_2 ” is used, where n_1 and n_2 are the numbers, then unless otherwise specified, this notation is intended to include the numbers themselves and the range between them. This range may be integral or continuous between and including the end values. By way of example, the range “from 2 to 6 carbons” is intended to include two, three, four, five, and six carbons, since carbons come in integer units. Compare, by way of example, the range “from 1 to 3 μM (micromolar),” which is intended to include 1 μM , 3 μM , and everything in between to any number of significant figures (e.g., 1.255 μM , 2.1 μM , 2.9999 μM , etc.).

[035] The term “about,” as used herein, is intended to qualify the numerical values which it modifies, denoting such a value as variable within a margin of error. When no particular margin of error, such as a standard deviation to a mean value given in a chart or table of data, is recited, the term “about” should be understood to mean that range which would encompass the recited value and the range which would be included by rounding up or down to that figure as well, taking into account significant figures.

[036] The term “acyl,” as used herein, alone or in combination, refers to a carbonyl attached to an alkenyl, alkyl, aryl, cycloalkyl, heteroaryl, heterocycle, or any other moiety were the atom attached to the carbonyl is carbon. An “acetyl” group refers to a $-\text{C}(\text{O})\text{CH}_3$ group. An “alkylcarbonyl” or “alkanoyl” group refers to an alkyl group attached to the parent molecular moiety through a carbonyl group. Examples of such groups include methylcarbonyl and ethylcarbonyl. Examples of acyl groups include formyl, alkanoyl and aroyl.

[037] The term “alkenyl,” as used herein, alone or in combination, refers to a straight-chain or branched-chain hydrocarbon radical having one or more double bonds and containing from 2 to 20 carbon atoms. In certain embodiments, said alkenyl will comprise from 2 to 6 carbon atoms. The term “alkenylene” refers to a carbon-carbon double bond system attached at two or more positions such as ethenylene [$(-\text{CH}=\text{CH}-)$, $(-\text{C}::\text{C}-)$]. Examples of suitable alkenyl radicals include ethenyl, propenyl, 2-methylpropenyl, 1,4-butadienyl and the like. Unless otherwise specified, the term “alkenyl” may include “alkenylene” groups.

[038] The term “alkoxy,” as used herein, alone or in combination, refers to an alkyl ether radical, wherein the term alkyl is as defined below. Examples of suitable alkyl ether radicals

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include methoxy, ethoxy, n-propoxy, isopropoxy, *n*-butoxy, *iso*-butoxy, *sec*-butoxy, *tert*-butoxy, and the like.

[039] The term “alkyl,” as used herein, alone or in combination, refers to a straight-chain or branched-chain alkyl radical containing from 1 to 20 carbon atoms. In certain embodiments, said alkyl will comprise from 1 to 10 carbon atoms. In further embodiments, said alkyl will comprise from 1 to 6 carbon atoms. Alkyl groups may be optionally substituted as defined herein.

Examples of alkyl radicals include methyl, ethyl, *n*-propyl, isopropyl, *n*-butyl, isobutyl, *sec*-butyl, *tert*-butyl, pentyl, *iso*-amyl, hexyl, octyl, noyl and the like. The term “alkylene,” as used herein, alone or in combination, refers to a saturated aliphatic group derived from a straight or branched chain saturated hydrocarbon attached at two or more positions, such as methylene ($-\text{CH}_2-$).

Unless otherwise specified, the term “alkyl” may include “alkylene” groups.

[040] The term “alkylamino,” as used herein, alone or in combination, refers to an alkyl group attached to the parent molecular moiety through an amino group. Suitable alkylamino groups may be mono- or dialkylated, forming groups such as, for example, *N*-methylamino, *N*-ethylamino, *N,N*-dimethylamino, *N,N*-ethylmethylamino and the like.

[041] The term “alkylidene,” as used herein, alone or in combination, refers to an alkenyl group in which one carbon atom of the carbon-carbon double bond belongs to the moiety to which the alkenyl group is attached.

[042] The term “alkylthio,” as used herein, alone or in combination, refers to an alkyl thioether ($\text{R}-\text{S}-$) radical wherein the term alkyl is as defined above and wherein the sulfur may be singly or doubly oxidized. Examples of suitable alkyl thioether radicals include methylthio, ethylthio, *n*-propylthio, isopropylthio, *n*-butylthio, *iso*-butylthio, *sec*-butylthio, *tert*-butylthio, methanesulfonyl, ethanesulfinyl, and the like.

[043] The term “alkynyl,” as used herein, alone or in combination, refers to a straight-chain or branched chain hydrocarbon radical having one or more triple bonds and containing from 2 to 20 carbon atoms. In certain embodiments, said alkynyl comprises from 2 to 6 carbon atoms. In further embodiments, said alkynyl comprises from 2 to 4 carbon atoms. The term “alkynylene” refers to a carbon-carbon triple bond attached at two positions such as ethynylene ($-\text{C}::\text{C}-$, $-\text{C}\equiv\text{C}-$). Examples of alkynyl radicals include ethynyl, propynyl, hydroxypropynyl, butyn-1-yl, butyn-2-yl, pentyn-1-yl, 3-methylbutyn-1-yl, hexyn-2-yl, and the like. Unless otherwise specified, the term “alkynyl” may include “alkynylene” groups.

[044] The terms “amido” and “carbamoyl,” as used herein, alone or in combination, refer to an amino group as described below attached to the parent molecular moiety through a carbonyl group, or vice versa. The term “C-amido” as used herein, alone or in combination, refers to a $-\text{C}(=\text{O})-\text{NR}_2$ group with R as defined herein. The term “N-amido” as used herein, alone or in

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combination, refers to a $RC(=O)NH-$ group, with R as defined herein. The term "acylamino" as used herein, alone or in combination, embraces an acyl group attached to the parent moiety through an amino group. An example of an "acylamino" group is acetylamino ($CH_3C(O)NH-$).

[045] The term "amino," as used herein, alone or in combination, refers to $-NRR'$, wherein R and R' are independently chosen from hydrogen, alkyl, acyl, heteroalkyl, aryl, cycloalkyl, heteroaryl, and heterocycloalkyl, any of which may themselves be optionally substituted. Additionally, R and R' may combine to form heterocycloalkyl, either of which may be optionally substituted.

[046] The term "aryl," as used herein, alone or in combination, means a carbocyclic aromatic system containing one, two or three rings wherein such polycyclic ring systems are fused together. The term "aryl" embraces aromatic groups such as phenyl, naphthyl, anthracenyl, and phenanthryl.

[047] The term "aryllalkenyl" or "aralkenyl," as used herein, alone or in combination, refers to an aryl group attached to the parent molecular moiety through an alkenyl group.

[048] The term "aryllalkoxy" or "aralkoxy," as used herein, alone or in combination, refers to an aryl group attached to the parent molecular moiety through an alkoxy group.

[049] The term "aryllalkyl" or "aralkyl," as used herein, alone or in combination, refers to an aryl group attached to the parent molecular moiety through an alkyl group.

[050] The term "aryllalkynyl" or "aralkynyl," as used herein, alone or in combination, refers to an aryl group attached to the parent molecular moiety through an alkynyl group.

[051] The term "aryllalkanoyl" or "aralkanoyl" or "aroyl," as used herein, alone or in combination, refers to an acyl radical derived from an aryl-substituted alkanecarboxylic acid such as benzoyl, naphthoyl, phenylacetyl, 3-phenylpropionyl (hydrocinnamoyl), 4-phenylbutyryl, (2-naphthyl)acetyl, 4-chlorohydrocinnamoyl, and the like.

[052] The term aryloxy as used herein, alone or in combination, refers to an aryl group attached to the parent molecular moiety through an oxy.

[053] The terms "benzo" and "benz," as used herein, alone or in combination, refer to the divalent radical $C_6H_4=$ derived from benzene. Examples include benzothiophene and benzimidazole.

[054] The term "carbamate," as used herein, alone or in combination, refers to an ester of carbamic acid ($-NHCOO-$) which may be attached to the parent molecular moiety from either the nitrogen or acid end, and which may be optionally substituted as defined herein.

[055] The term "O-carbamyl" as used herein, alone or in combination, refers to a $-OC(O)NRR'$ group-with R and R' as defined herein.

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[056] The term “N-carbamyl” as used herein, alone or in combination, refers to a ROC(O)NR'- group, with R and R' as defined herein.

[057] The term “carbonyl,” as used herein, when alone includes formyl [-C(O)H] and in combination is a -C(O)- group.

[058] The term “carboxyl” or “carboxy,” as used herein, refers to -C(O)OH or the corresponding “carboxylate” anion, such as is in a carboxylic acid salt. An “O-carboxy” group refers to a RC(O)O- group, where R is as defined herein. A “C-carboxy” group refers to a -C(O)OR groups where R is as defined herein.

[059] The term “cyano,” as used herein, alone or in combination, refers to -CN.

[060] The term “cycloalkyl,” or, alternatively, “carbocycle,” as used herein, alone or in combination, refers to a saturated or partially saturated monocyclic, bicyclic or tricyclic alkyl group wherein each cyclic moiety contains from 3 to 12 carbon atom ring members and which may optionally be a benzo fused ring system which is optionally substituted as defined herein. In certain embodiments, said cycloalkyl will comprise from 3 to 7 carbon atoms. Examples of such cycloalkyl groups include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, tetrahydronaphthyl, indanyl, octahydronaphthyl, 2,3-dihydro-1H-indenyl, adamantyl and the like. “Bicyclic” and “tricyclic” as used herein are intended to include both fused ring systems, such as decahydronaphthalene, octahydronaphthalene as well as the multicyclic (multicentered) saturated or partially unsaturated type. The latter type of isomer is exemplified in general by, bicyclo[1,1,1]pentane, camphor, adamantane, and bicyclo[3,2,1]octane.

[061] The term “ester,” as used herein, alone or in combination, refers to a carboxy group bridging two moieties linked at carbon atoms.

[062] The term “ether,” as used herein, alone or in combination, refers to an oxy group bridging two moieties linked at carbon atoms.

[063] The term “halo,” or “halogen,” as used herein, alone or in combination, refers to fluorine, chlorine, bromine, or iodine.

[064] The term “haloalkoxy,” as used herein, alone or in combination, refers to a haloalkyl group attached to the parent molecular moiety through an oxygen atom.

[065] The term “haloalkyl,” as used herein, alone or in combination, refers to an alkyl radical having the meaning as defined above wherein one or more hydrogens are replaced with a halogen. Specifically embraced are monohaloalkyl, dihaloalkyl and polyhaloalkyl radicals. A monohaloalkyl radical, for one example, may have an iodo, bromo, chloro or fluoro atom within the radical. Dihalo and polyhaloalkyl radicals may have two or more of the same halo atoms or a combination of different halo radicals. Examples of haloalkyl radicals include fluoromethyl, difluoromethyl, trifluoromethyl, chloromethyl, dichloromethyl, trichloromethyl,

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pentafluoroethyl, heptafluoropropyl, difluorochloromethyl, dichlorofluoromethyl, difluoroethyl, difluoropropyl, dichloroethyl and dichloropropyl. "Haloalkylene" refers to a haloalkyl group attached at two or more positions. Examples include fluoromethylene (-CFH-), difluoromethylene (-CF₂-), chloromethylene (-CHCl-) and the like.

[066] The term "heteroalkyl," as used herein, alone or in combination, refers to a stable straight or branched chain hydrocarbon radical, or combinations thereof, fully saturated or containing from 1 to 3 degrees of unsaturation, consisting of the stated number of carbon atoms and from one to three heteroatoms chosen from O, N, and S, and wherein the nitrogen and sulfur atoms may optionally be oxidized and the nitrogen heteroatom may optionally be substituted or quaternized. The heteroatom(s) O, N and S may be placed at any interior position of the heteroalkyl group. Up to two heteroatoms may be consecutive, such as, for example, -CH₂-NH-OCH₃.

[067] The term "heteroaryl," as used herein, alone or in combination, refers to a 3 to 7 membered unsaturated heteromonocyclic ring, or a fused monocyclic, bicyclic, or tricyclic ring system in which at least one of the fused rings is aromatic, which contains at least one atom chosen from O, S, and N. In certain embodiments, said heteroaryl will comprise from 5 to 7 carbon atoms. The term also embraces fused polycyclic groups wherein heterocyclic rings are fused with aryl rings, wherein heteroaryl rings are fused with other heteroaryl rings, wherein heteroaryl rings are fused with heterocycloalkyl rings, or wherein heteroaryl rings are fused with cycloalkyl rings. Examples of heteroaryl groups include pyrrolyl, pyrrolinyl, imidazolyl, pyrazolyl, pyridyl, pyrimidinyl, pyrazinyl, pyridazinyl, triazolyl, pyranyl, furyl, thienyl, oxazolyl, isoxazolyl, oxadiazolyl, thiazolyl, thiadiazolyl, isothiazolyl, indolyl, isoindolyl, indoliziny, benzimidazolyl, quinolyl, isoquinolyl, quinoxaliny, quinazoliny, indazolyl, benzotriazolyl, benzodioxolyl, benzopyranyl, benzoxazolyl, benzoxadiazolyl, benzothiazolyl, benzothiadiazolyl, benzofuryl, benzothienyl, chromonyl, coumariny, benzopyranyl, tetrahydroquinoliny, tetrazolopyridazinyl, tetrahydroisoquinoliny, thienopyridiny, furopyridiny, pyrrolopyridiny and the like. Exemplary tricyclic heterocyclic groups include carbazolyl, benzidolyl, phenanthroliny, dibenzofurany, acridiny, phenanthridiny, xanthenyl and the like.

[068] The terms "heterocycloalkyl" and, interchangeably, "heterocycle," as used herein, alone or in combination, each refer to a saturated, partially unsaturated, or fully unsaturated monocyclic, bicyclic, or tricyclic heterocyclic group containing at least one heteroatom as a ring member, wherein each said heteroatom may be independently chosen from nitrogen, oxygen, and sulfur. In certain embodiments, said heterocycloalkyl will comprise from 1 to 4 heteroatoms as ring members. In further embodiments, said heterocycloalkyl will comprise from 1 to 2 heteroatoms as ring members. In certain embodiments, said heterocycloalkyl will comprise from

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3 to 8 ring members in each ring. In further embodiments, said heterocycloalkyl will comprise from 3 to 7 ring members in each ring. In yet further embodiments, said heterocycloalkyl will comprise from 5 to 6 ring members in each ring. "Heterocycloalkyl" and "heterocycle" are intended to include sulfones, sulfoxides, N-oxides of tertiary nitrogen ring members, and carbocyclic fused and benzo fused ring systems; additionally, both terms also include systems where a heterocycle ring is fused to an aryl group, as defined herein, or an additional heterocycle group. Examples of heterocycle groups include aziridinyl, azetidiny, 1,3-benzodioxolyl, dihydroisoindolyl, dihydroisoquinoliny, dihydrocinnoliny, dihydrobenzodioxiny, dihydro[1,3]oxazolo[4,5-b]pyridiny, benzothiazolyl, dihydroindolyl, dihydrodropyridiny, 1,3-dioxanyl, 1,4-dioxanyl, 1,3-dioxolanyl, isoindoliny, morpholiny, piperaziny, pyrrolidiny, tetrahydropyridiny, piperidiny, thiomorpholiny, 3,4-methylenedioxyphenyl and the like. The heterocycle groups may be optionally substituted unless specifically prohibited.

[069] The term "hydraziny" as used herein, alone or in combination, refers to two amino groups joined by a single bond, i.e., -N-N- and not embodied in a ring.

[070] The term "hydroxy," as used herein, alone or in combination, refers to -OH.

[071] The term "hydroxyalkyl," as used herein, alone or in combination, refers to a hydroxy group attached to the parent molecular moiety through an alkyl group.

[072] The term "imino," as used herein, alone or in combination, refers to =N-.

[073] The term "iminohydroxy," as used herein, alone or in combination, refers to =N(OH) and =N-O-.

[074] The phrase "in the main chain" refers to the longest contiguous or adjacent chain of carbon atoms starting at the point of attachment of a group to the compounds of any one of the formulas disclosed herein.

[075] The term "isocyanato" refers to a -NCO group.

[076] The term "isothiocyanato" refers to a -NCS group.

[077] The phrase "linear chain of atoms" refers to the longest straight chain of atoms independently selected from carbon, nitrogen, oxygen and sulfur.

[078] The term "lower," as used herein, alone or in a combination, where not otherwise specifically defined, means containing from 1 to and including 6 carbon atoms.

[079] The term "lower aryl," as used herein, alone or in combination, means phenyl or naphthyl, which may be optionally substituted as provided.

[080] The term "lower heteroaryl," as used herein, alone or in combination, means either 1) monocyclic heteroaryl comprising five or six ring members, of which between one and four said members may be heteroatoms chosen from O, S, and N, or 2) bicyclic heteroaryl, wherein each

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of the fused rings comprises five or six ring members, comprising between them one to four heteroatoms chosen from O, S, and N.

[081] The term “lower cycloalkyl,” as used herein, alone or in combination, means a monocyclic cycloalkyl having between three and six ring members. Lower cycloalkyls may be unsaturated. Examples of lower cycloalkyl include cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl.

[082] The term “lower heterocycloalkyl,” as used herein, alone or in combination, means a monocyclic heterocycloalkyl having between three and six ring members, of which between one and four may be heteroatoms chosen from O, S, and N. Examples of lower heterocycloalkyls include pyrrolidinyl, imidazolidinyl, pyrazolidinyl, piperidinyl, piperazinyl, and morpholinyl. Lower heterocycloalkyls may be unsaturated.

[083] The term “lower amino,” as used herein, alone or in combination, refers to $\text{—NRR}'$, wherein R and R' are independently chosen from hydrogen, lower alkyl, and lower heteroalkyl, any of which may be optionally substituted. Additionally, the R and R' of a lower amino group may combine to form a five- or six-membered heterocycloalkyl, either of which may be optionally substituted.

[084] The term “mercaptyl” as used herein, alone or in combination, refers to an RS— group, where R is as defined herein.

[085] The term “nitro,” as used herein, alone or in combination, refers to —NO_2 .

[086] The terms “oxy” or “oxa,” as used herein, alone or in combination, refer to —O— .

[087] The term “oxo,” as used herein, alone or in combination, refers to =O .

[088] The term “perhaloalkoxy” refers to an alkoxy group where all of the hydrogen atoms are replaced by halogen atoms.

[089] The term “perhaloalkyl” as used herein, alone or in combination, refers to an alkyl group where all of the hydrogen atoms are replaced by halogen atoms.

[090] The terms “sulfonate,” “sulfonic acid,” and “sulfonic,” as used herein, alone or in combination, refer the $\text{—SO}_3\text{H}$ group and its anion as the sulfonic acid is used in salt formation.

[091] The term “sulfanyl,” as used herein, alone or in combination, refers to —S— .

[092] The term “sulfinyl,” as used herein, alone or in combination, refers to —S(O)— .

[093] The term “sulfonyl,” as used herein, alone or in combination, refers to $\text{—S(O)}_2\text{—}$.

[094] The term “N-sulfonamido” refers to a $\text{RS(=O)}_2\text{NR}'$ - group with R and R' as defined herein.

[095] The term “S-sulfonamido” refers to a $\text{—S(=O)}_2\text{NRR}'$, group, with R and R' as defined herein.

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[096] The terms “thia” and “thio,” as used herein, alone or in combination, refer to a –S– group or an ether wherein the oxygen is replaced with sulfur. The oxidized derivatives of the thio group, namely sulfinyl and sulfonyl, are included in the definition of thia and thio.

[097] The term “thiol,” as used herein, alone or in combination, refers to an –SH group.

[098] The term “thiocarbonyl,” as used herein, when alone includes thioformyl –C(S)H and in combination is a –C(S)– group.

[099] The term “N-thiocarbamyl” refers to an ROC(S)NR’– group, with R and R’ as defined herein.

[0100] The term “O-thiocarbamyl” refers to a –OC(S)NRR’, group with R and R’ as defined herein.

[0101] The term “thiocyanato” refers to a –CNS group.

[0102] The term “trihalomethoxy” refers to a X₃CO– group where X is a halogen.

[0103] Any definition herein may be used in combination with any other definition to describe a composite structural group. By convention, the trailing element of any such definition is that which attaches to the parent moiety. For example, the composite group alkylamido would represent an alkyl group attached to the parent molecule through an amido group, and the term alkoxyalkyl would represent an alkoxy group attached to the parent molecule through an alkyl group.

[0104] When a group is defined to be “null,” what is meant is that said group is absent.

[0105] The term “optionally substituted” means the antecedent group may be substituted or unsubstituted. When substituted, the substituents of an “optionally substituted” group may include, without limitation, one or more substituents independently selected from the following groups or a particular designated set of groups, alone or in combination: lower alkyl, lower alkenyl, lower alkynyl, lower alkanoyl, lower heteroalkyl, lower heterocycloalkyl, lower haloalkyl, lower haloalkenyl, lower haloalkynyl, lower perhaloalkyl, lower perhaloalkoxy, lower cycloalkyl, phenyl, aryl, aralkyl, aryloxy, lower alkoxy, lower haloalkoxy, oxo, lower acyloxy, carbonyl, carboxyl, lower alkylcarbonyl, lower carboxyester, lower carboxamido, cyano, hydrogen, halogen, hydroxy, amino, lower alkylamino, arylamino, amido, nitro, thiol, lower alkylthio, lower haloalkylthio, lower perhaloalkylthio, arylthio, sulfonate, sulfonic acid, trisubstituted silyl, N₃, SH, SCH₃, C(O)CH₃, CO₂CH₃, CO₂H, pyridinyl, thiophene, furanyl, lower carbamate, and lower urea. Two substituents may be joined together to form a fused five-, six-, or seven-membered carbocyclic or heterocyclic ring consisting of zero to three heteroatoms, for example forming methylenedioxy or ethylenedioxy. An optionally substituted group may be unsubstituted (e.g., –CH₂CH₃), fully substituted (e.g., –CF₂CF₃), monosubstituted (e.g., –CH₂CH₂F) or substituted at a level anywhere in-between fully substituted and monosubstituted

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(e.g., $-\text{CH}_2\text{CF}_3$). Where substituents are recited without qualification as to substitution, both substituted and unsubstituted forms are encompassed. Where a substituent is qualified as “substituted,” the substituted form is specifically intended. Additionally, different sets of optional substituents to a particular moiety may be defined as needed; in these cases, the optional substitution will be as defined, often immediately following the phrase, “optionally substituted with.”

[0106] The term R or the term R', appearing by itself and without a number designation, unless otherwise defined, refers to a moiety chosen from hydrogen, alkyl, cycloalkyl, heteroalkyl, aryl, heteroaryl and heterocycloalkyl, any of which may be optionally substituted. Such R and R' groups should be understood to be optionally substituted as defined herein. Whether an R group has a number designation or not, every R group, including R, R' and Rⁿ where n=(1, 2, 3, ...n), every substituent, and every term should be understood to be independent of every other in terms of selection from a group. Should any variable, substituent, or term (e.g. aryl, heterocycle, R, etc.) occur more than one time in a formula or generic structure, its definition at each occurrence is independent of the definition at every other occurrence. Those of skill in the art will further recognize that certain groups may be attached to a parent molecule or may occupy a position in a chain of elements from either end as written. Thus, by way of example only, an unsymmetrical group such as $-\text{C}(\text{O})\text{N}(\text{R})-$ may be attached to the parent moiety at either the carbon or the nitrogen.

[0107] Asymmetric centers exist in the compounds disclosed herein. These centers are designated by the symbols “R” or “S,” depending on the configuration of substituents around the chiral carbon atom. It should be understood that the invention encompasses all stereochemical isomeric forms, including diastereomeric, enantiomeric, and epimeric forms, as well as d-isomers and l-isomers, and mixtures thereof. Individual stereoisomers of compounds can be prepared synthetically from commercially available starting materials which contain chiral centers or by preparation of mixtures of enantiomeric products followed by separation such as conversion to a mixture of diastereomers followed by separation or recrystallization, chromatographic techniques, direct separation of enantiomers on chiral chromatographic columns, or any other appropriate method known in the art. Starting compounds of particular stereochemistry are either commercially available or can be made and resolved by techniques known in the art. Additionally, the compounds disclosed herein may exist as geometric isomers. The present invention includes all cis, trans, syn, anti, entgegen (E), and zusammen (Z) isomers as well as the appropriate mixtures thereof. Additionally, compounds may exist as tautomers; all tautomeric isomers are provided by this invention. Additionally, the compounds disclosed herein can exist in unsolvated as well as solvated forms with pharmaceutically acceptable solvents such as water,

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ethanol, and the like. In general, the solvated forms are considered equivalent to the unsolvated forms.

[0108] The term “bond” refers to a covalent linkage between two atoms, or two moieties when the atoms joined by the bond are considered to be part of larger substructure. A bond may be single, double, or triple unless otherwise specified. A dashed line between two atoms in a drawing of a molecule indicates that an additional bond may be present or absent at that position.

[0109] The term “disease” as used herein is intended to be generally synonymous, and is used interchangeably with, the terms “disorder” and “condition” (as in medical condition), in that all reflect an abnormal condition of the human or animal body or of one of its parts that impairs normal functioning, is typically manifested by distinguishing signs and symptoms, and causes the human or animal to have a reduced duration or quality of life.

[0110] The term "combination therapy" means the administration of two or more therapeutic agents to treat a therapeutic condition or disorder described in the present disclosure. Such administration encompasses co-administration of these therapeutic agents in a substantially simultaneous manner, such as in a single capsule having a fixed ratio of active ingredients or in multiple, separate capsules for each active ingredient. In addition, such administration also encompasses use of each type of therapeutic agent in a sequential manner. In either case, the treatment regimen will provide beneficial effects of the drug combination in treating the conditions or disorders described herein.

[0111] “PASK inhibitor ” as used herein refers to a compound that exhibits an (IC_{50}/EC_{50}) with respect to PASK activity of no more than about 100 μ M and more typically not more than about 50 μ M, as measured in the PASK assay described generally hereinbelow. IC_{50} is that concentration of inhibitors which reduces the activity of PASK to half-maximal level. Certain compounds disclosed herein have been discovered to exhibit inhibition against PASK.

[0112] The phrase "therapeutically effective" is intended to qualify the amount of active ingredients used in the treatment of a disease or disorder. This amount will achieve the goal of reducing or eliminating the said disease or disorder.

[0113] The term “therapeutically acceptable” refers to those compounds (or salts, prodrugs, tautomers, zwitterionic forms, etc.) which are suitable for use in contact with the tissues of patients without undue toxicity, irritation, and allergic response, are commensurate with a reasonable benefit/risk ratio, and are effective for their intended use.

[0114] As used herein, reference to "treatment" of a patient is intended to include prophylaxis. The term “patient” means all mammals including humans. Examples of patients include humans, cows, dogs, cats, goats, sheep, pigs, and rabbits. Preferably, the patient is a human.

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[0115] The term "prodrug" refers to a compound that is made more active in vivo. Certain compounds disclosed herein may also exist as prodrugs, as described in *Hydrolysis in Drug and Prodrug Metabolism : Chemistry, Biochemistry, and Enzymology* (Testa, Bernard and Mayer, Joachim M. Wiley-VHCA, Zurich, Switzerland 2003). Prodrugs of the compounds described herein are structurally modified forms of the compound that readily undergo chemical changes under physiological conditions to provide the compound. Additionally, prodrugs can be converted to the compound by chemical or biochemical methods in an ex vivo environment. For example, prodrugs can be slowly converted to a compound when placed in a transdermal patch reservoir with a suitable enzyme or chemical reagent. Prodrugs are often useful because, in some situations, they may be easier to administer than the compound, or parent drug. They may, for instance, be bioavailable by oral administration whereas the parent drug is not. The prodrug may also have improved solubility in pharmaceutical compositions over the parent drug. A wide variety of prodrug derivatives are known in the art, such as those that rely on hydrolytic cleavage or oxidative activation of the prodrug. An example, without limitation, of a prodrug would be a compound which is administered as an ester (the "prodrug"), but then is metabolically hydrolyzed to the carboxylic acid, the active entity. Additional examples include peptidyl derivatives of a compound.

[0116] The compounds disclosed herein can exist as therapeutically acceptable salts. The present invention includes compounds listed above in the form of salts, including acid addition salts. Suitable salts include those formed with both organic and inorganic acids. Such acid addition salts will normally be pharmaceutically acceptable. However, salts of non-pharmaceutically acceptable salts may be of utility in the preparation and purification of the compound in question. Basic addition salts may also be formed and be pharmaceutically acceptable. For a more complete discussion of the preparation and selection of salts, refer to *Pharmaceutical Salts: Properties, Selection, and Use* (Stahl, P. Heinrich. Wiley-VCHA, Zurich, Switzerland, 2002).

[0117] The term "therapeutically acceptable salt," as used herein, represents salts or zwitterionic forms of the compounds disclosed herein which are water or oil-soluble or dispersible and therapeutically acceptable as defined herein. The salts can be prepared during the final isolation and purification of the compounds or separately by reacting the appropriate compound in the form of the free base with a suitable acid. Representative acid addition salts include acetate, adipate, alginate, L-ascorbate, aspartate, benzoate, benzenesulfonate (besylate), bisulfate, butyrate, camphorate, camphorsulfonate, citrate, digluconate, formate, fumarate, gentisate, glutarate, glycerophosphate, glycolate, hemisulfate, heptanoate, hexanoate, hippurate, hydrochloride, hydrobromide, hydroiodide, 2-hydroxyethansulfonate (isethionate), lactate,

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maleate, malonate, DL-mandelate, mesitylenesulfonate, methanesulfonate, naphthylenesulfonate, nicotinate, 2-naphthalenesulfonate, oxalate, pamoate, pectinate, persulfate, 3-phenylpropionate, phosphonate, picrate, pivalate, propionate, pyroglutamate, succinate, sulfonate, tartrate, L-tartrate, trichloroacetate, trifluoroacetate, phosphate, glutamate, bicarbonate, para-toluenesulfonate (p-tosylate), and undecanoate. Also, basic groups in the compounds disclosed herein can be quaternized with methyl, ethyl, propyl, and butyl chlorides, bromides, and iodides; dimethyl, diethyl, dibutyl, and diamyl sulfates; decyl, lauryl, myristyl, and steryl chlorides, bromides, and iodides; and benzyl and phenethyl bromides. Examples of acids which can be employed to form therapeutically acceptable addition salts include inorganic acids such as hydrochloric, hydrobromic, sulfuric, and phosphoric, and organic acids such as oxalic, maleic, succinic, and citric. Salts can also be formed by coordination of the compounds with an alkali metal or alkaline earth ion. Hence, the present invention contemplates sodium, potassium, magnesium, and calcium salts of the compounds disclosed herein, and the like.

[0118] Basic addition salts can be prepared during the final isolation and purification of the compounds by reacting a carboxy group with a suitable base such as the hydroxide, carbonate, or bicarbonate of a metal cation or with ammonia or an organic primary, secondary, or tertiary amine. The cations of therapeutically acceptable salts include lithium, sodium, potassium, calcium, magnesium, and aluminum, as well as nontoxic quaternary amine cations such as ammonium, tetramethylammonium, tetraethylammonium, methylamine, dimethylamine, trimethylamine, triethylamine, diethylamine, ethylamine, tributylamine, pyridine, *N,N*-dimethylaniline, *N*-methylpiperidine, *N*-methylmorpholine, dicyclohexylamine, procaine, dibenzylamine, *N,N*-dibenzylphenethylamine, 1-phenamine, and *N,N'*-dibenzylethylenediamine. Other representative organic amines useful for the formation of base addition salts include ethylenediamine, ethanolamine, diethanolamine, piperidine, and piperazine.

[0119] While it may be possible for the compounds of the subject invention to be administered as the raw chemical, it is also possible to present them as a pharmaceutical formulation. Accordingly, provided herein are pharmaceutical formulations which comprise one or more of certain compounds disclosed herein, or one or more pharmaceutically acceptable salts, esters, prodrugs, amides, or solvates thereof, together with one or more pharmaceutically acceptable carriers thereof and optionally one or more other therapeutic ingredients. The carrier(s) must be "acceptable" in the sense of being compatible with the other ingredients of the formulation and not deleterious to the recipient thereof. Proper formulation is dependent upon the route of administration chosen. Any of the well-known techniques, carriers, and excipients may be used as suitable and as understood in the art; *e.g.*, in Remington's Pharmaceutical Sciences. The pharmaceutical compositions disclosed herein may be manufactured in any

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manner known in the art, *e.g.*, by means of conventional mixing, dissolving, granulating, dragee-making, levigating, emulsifying, encapsulating, entrapping or compression processes.

[0120] The formulations include those suitable for oral, parenteral (including subcutaneous, intradermal, intramuscular, intravenous, intraarticular, and intramedullary), intraperitoneal, transmucosal, transdermal, rectal and topical (including dermal, buccal, sublingual and intraocular) administration although the most suitable route may depend upon for example the condition and disorder of the recipient. The formulations may conveniently be presented in unit dosage form and may be prepared by any of the methods well known in the art of pharmacy. Typically, these methods include the step of bringing into association a compound of the subject invention or a pharmaceutically acceptable salt, ester, amide, prodrug or solvate thereof ("active ingredient") with the carrier which constitutes one or more accessory ingredients. In general, the formulations are prepared by uniformly and intimately bringing into association the active ingredient with liquid carriers or finely divided solid carriers or both and then, if necessary, shaping the product into the desired formulation.

[0121] Formulations of the compounds disclosed herein suitable for oral administration may be presented as discrete units such as capsules, cachets or tablets each containing a predetermined amount of the active ingredient; as a powder or granules; as a solution or a suspension in an aqueous liquid or a non-aqueous liquid; or as an oil-in-water liquid emulsion or a water-in-oil liquid emulsion. The active ingredient may also be presented as a bolus, electuary or paste.

[0122] Pharmaceutical preparations which can be used orally include tablets, push-fit capsules made of gelatin, as well as soft, sealed capsules made of gelatin and a plasticizer, such as glycerol or sorbitol. Tablets may be made by compression or molding, optionally with one or more accessory ingredients. Compressed tablets may be prepared by compressing in a suitable machine the active ingredient in a free-flowing form such as a powder or granules, optionally mixed with binders, inert diluents, or lubricating, surface active or dispersing agents. Molded tablets may be made by molding in a suitable machine a mixture of the powdered compound moistened with an inert liquid diluent. The tablets may optionally be coated or scored and may be formulated so as to provide slow or controlled release of the active ingredient therein. All formulations for oral administration should be in dosages suitable for such administration. 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 may be dissolved or suspended in suitable liquids, such as fatty oils, liquid paraffin, or liquid polyethylene glycols. In addition, stabilizers may be added. Dragee cores are provided with suitable coatings. For this purpose, concentrated

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sugar solutions may be used, which may optionally contain gum arabic, talc, polyvinyl pyrrolidone, carbopol gel, polyethylene glycol, and/or titanium dioxide, lacquer solutions, and suitable organic solvents or solvent mixtures. Dyestuffs or pigments may be added to the tablets or dragee coatings for identification or to characterize different combinations of active compound doses.

[0123] The compounds may be formulated for parenteral administration by injection, *e.g.*, by bolus injection or continuous infusion. Formulations for injection may be presented in unit dosage form, *e.g.*, in ampoules or in multi-dose containers, with an added preservative. The compositions may take such forms as suspensions, solutions or emulsions in oily or aqueous vehicles, and may contain formulatory agents such as suspending, stabilizing and/or dispersing agents. The formulations may be presented in unit-dose or multi-dose containers, for example sealed ampoules and vials, and may be stored in powder form or in a freeze-dried (lyophilized) condition requiring only the addition of the sterile liquid carrier, for example, saline or sterile pyrogen-free water, immediately prior to use. Extemporaneous injection solutions and suspensions may be prepared from sterile powders, granules and tablets of the kind previously described.

[0124] Formulations for parenteral administration include aqueous and non-aqueous (oily) sterile injection solutions of the active compounds which may contain antioxidants, buffers, bacteriostats and solutes which render the formulation isotonic with the blood of the intended recipient; and aqueous and non-aqueous sterile suspensions which may include suspending agents and thickening agents. 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 may contain substances which increase the viscosity of the suspension, such as sodium carboxymethyl cellulose, sorbitol, or dextran. Optionally, the suspension may also contain suitable stabilizers or agents which increase the solubility of the compounds to allow for the preparation of highly concentrated solutions.

[0125] In addition to the formulations described previously, the compounds may also be formulated as a depot preparation. Such long acting formulations may be administered by implantation (for example subcutaneously or intramuscularly) or by intramuscular injection. Thus, for example, the compounds may 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.

[0126] For buccal or sublingual administration, the compositions may take the form of tablets, lozenges, pastilles, or gels formulated in conventional manner. Such compositions may comprise the active ingredient in a flavored basis such as sucrose and acacia or tragacanth.

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[0127] The compounds may also be formulated in rectal compositions such as suppositories or retention enemas, *e.g.*, containing conventional suppository bases such as cocoa butter, polyethylene glycol, or other glycerides.

[0128] Certain compounds disclosed herein may be administered topically, that is by non-systemic administration. This includes the application of a compound disclosed herein externally to the epidermis or the buccal cavity and the instillation of such a compound into the ear, eye and nose, such that the compound does not significantly enter the blood stream. In contrast, systemic administration refers to oral, intravenous, intraperitoneal and intramuscular administration.

[0129] Formulations suitable for topical administration include liquid or semi-liquid preparations suitable for penetration through the skin to the site of inflammation such as gels, liniments, lotions, creams, ointments or pastes, and drops suitable for administration to the eye, ear or nose. The active ingredient for topical administration may comprise, for example, from 0.001% to 10% w/w (by weight) of the formulation. In certain embodiments, the active ingredient may comprise as much as 10% w/w. In other embodiments, it may comprise less than 5% w/w. In certain embodiments, the active ingredient may comprise from 2% w/w to 5% w/w. In other embodiments, it may comprise from 0.1% to 1% w/w of the formulation.

[0130] For administration by inhalation, compounds may be conveniently delivered from an insufflator, nebulizer pressurized packs or other convenient means of delivering an aerosol spray. Pressurized packs may comprise a suitable propellant such as dichlorodifluoromethane, trichlorofluoromethane, dichlorotetrafluoroethane, carbon dioxide or other suitable gas. In the case of a pressurized aerosol, the dosage unit may be determined by providing a valve to deliver a metered amount. Alternatively, for administration by inhalation or insufflation, the compounds according to the invention may take the form of a dry powder composition, for example a powder mix of the compound and a suitable powder base such as lactose or starch. The powder composition may be presented in unit dosage form, in for example, capsules, cartridges, gelatin or blister packs from which the powder may be administered with the aid of an inhalator or insufflator.

[0131] Preferred unit dosage formulations are those containing an effective dose, as herein below recited, or an appropriate fraction thereof, of the active ingredient.

[0132] It should be understood that in addition to the ingredients particularly mentioned above, the formulations described above may include other agents conventional in the art having regard to the type of formulation in question, for example those suitable for oral administration may include flavoring agents.

[0133] Compounds may be administered orally or via injection at a dose of from 0.1 to 500 mg/kg per day. The dose range for adult humans is generally from 5 mg to 2 g/day. Tablets or

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other forms of presentation provided in discrete units may conveniently contain an amount of one or more compounds which is effective at such dosage or as a multiple of the same, for instance, units containing 5 mg to 500 mg, usually around 10 mg to 200 mg.

[0134] The amount of active ingredient that may be combined with the carrier materials to produce a single dosage form will vary depending upon the host treated and the particular mode of administration.

[0135] The compounds can be administered in various modes, *e.g.* orally, topically, or by injection. The precise amount of compound administered to a patient will be the responsibility of the attendant physician. The specific dose level for any particular patient will depend upon a variety of factors including the activity of the specific compound employed, the age, body weight, general health, sex, diets, time of administration, route of administration, rate of excretion, drug combination, the precise disorder being treated, and the severity of the indication or condition being treated. Also, the route of administration may vary depending on the condition and its severity.

[0136] In certain instances, it may be appropriate to administer at least one of the compounds described herein (or a pharmaceutically acceptable salt, ester, or prodrug thereof) in combination with another therapeutic agent. By way of example only, if one of the side effects experienced by a patient upon receiving one of the compounds herein is hypertension, then it may be appropriate to administer an anti-hypertensive agent in combination with the initial therapeutic agent. Or, by way of example only, the therapeutic effectiveness of one of the compounds described herein may be enhanced by administration of an adjuvant (*i.e.*, by itself the adjuvant may only have minimal therapeutic benefit, but in combination with another therapeutic agent, the overall therapeutic benefit to the patient is enhanced). Or, by way of example only, the benefit of experienced by a patient may be increased by administering one of the compounds described herein with another therapeutic agent (which also includes a therapeutic regimen) that also has therapeutic benefit. By way of example only, in a treatment for diabetes involving administration of one of the compounds described herein, increased therapeutic benefit may result by also providing the patient with another therapeutic agent for diabetes. In any case, regardless of the disease, disorder or condition being treated, the overall benefit experienced by the patient may simply be additive of the two therapeutic agents or the patient may experience a synergistic benefit.

[0137] Specific, non-limiting examples of possible combination therapies include use of a compound as disclosed herein, and at least one other agent selected from the group comprising:

a) anti-diabetic agents such as insulin, insulin derivatives and mimetics; insulin secretagogues such as the sulfonylureas, *e.g.*, Glipizide, glyburide and Amaryl; insulinotropic

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sulfonylurea receptor ligands such as meglitinides, e.g., nateglinide and repaglinide; insulin sensitizer such as protein tyrosine phosphatase-1B (PTP-1B) inhibitors such as PTP-112; GSK3 (glycogen synthase kinase-3) inhibitors such as SB-517955, SB-4195052, SB-216763, NN-57-05441 and NN-57-05445; RXR ligands such as GW-0791 and AGN-194204; sodium-dependent glucose co-transporter inhibitors such as T-1095; glycogen phosphorylase A inhibitors such as BAY R3401; biguanides such as metformin; alpha-glucosidase inhibitors such as acarbose; GLP-1 (glucagon like peptide-1), GLP-1 analogs such as Exendin-4 and GLP-1 mimetics; DPPIV (dipeptidyl peptidase IV) inhibitors such as DPP728, LAF237 (vildagliptin - Example 1 of WO 00/34241), MK-0431, saxagliptin, GSK23A ; an AGE breaker; a thiazolidinedione derivative (glitazone) such as pioglitazone or rosiglitazone; and a non-glitazone type PPAR δ agonist e.g. GI-262570;

b) hypolipidemic agents such as 3-hydroxy-3-methyl-glutaryl coenzyme A (HMG-CoA) reductase inhibitors, e.g., lovastatin, pitavastatin, simvastatin, pravastatin, cerivastatin, mevastatin, velostatin, fluvastatin, dalvastatin, atorvastatin, rosuvastatin and rivastatin; squalene synthase inhibitors; FXR (farnesoid X receptor) and LXR (liver X receptor) ligands; cholestyramine; fibrates; nicotinic acid and aspirin;

c) an anti-obesity agent or appetite regulating agent such as phentermine, leptin, bromocriptine, dexamphetamine, amphetamine, fenfluramine, dexfenfluramine, sibutramine, orlistat, dexfenfluramine, mazindol, phentermine, phendimetrazine, diethylpropion, fluoxetine, bupropion, topiramate, diethylpropion, benzphetamine, phenylpropanolamine or ecopipam, ephedrine, pseudoephedrine or cannabinoid receptor antagonists;

d) anti-hypertensive agents, e.g., loop diuretics such as ethacrynic acid, furosemide and torsemide; diuretics such as thiazide derivatives, chlorothiazide, hydrochlorothiazide, amiloride; angiotensin converting enzyme (ACE) inhibitors such as benazepril, captopril, enalapril, fosinopril, lisinopril, moexipril, perinodopril, quinapril, ramipril andtrandolapril; inhibitors of the Na-K-ATPase membrane pump such as digoxin; neutral endopeptidase (NEP) inhibitors e.g. thiorphan, tertio-thiorphan, SQ29072; ECE inhibitors e.g. SLV306; ACE/NEP inhibitors such as omapatrilat, sampatrilat and fasidotril; angiotensin n antagonists such as candesartan, eprosartan, irbesartan, losartan, tehnisartan and valsartan, in particular valsartan; renin inhibitors such as aliskiren, terlakiren, ditekiren, RO 66-1132, RO-66-1168; β -adrenergic receptor blockers such as acebutolol, atenolol, betaxolol, bisoprolol, metoprolol, nadolol, propranolol, sotalol and timolol; inotropic agents such as digoxin, dobutamine and milrinone; calcium channel blockers such as amlodipine, bepridil, diltiazem, felodipine, nicardipine, nimodipine, nifedipine, nisoldipine and verapamil; aldosterone receptor antagonists; and aldosterone synthase inhibitors;

e) an HDL increasing compound;

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- f) cholesterol absorption modulator such as etizimibe and KT6-971;
- g) Apo-AI analogues and mimetics;
- h) thrombin inhibitors such as Ximelagatran;
- i) aldosterone inhibitors such as anastrozole, fadrazole, and eplerenone;
- j) inhibitors of platelet aggregation such as aspirin, and clopidogrel bisulfate;
- k) estrogen, testosterone, a selective estrogen receptor modulator, and a selective androgen receptor modulator;
- l) a chemotherapeutic agent such as aromatase inhibitors e.g. femara, anti-estrogens, topoisomerase I inhibitors, topoisomerase II inhibitors, microtubule active agents, alkylating agents, antineoplastic antimetabolites, platin compounds, and compounds decreasing the protein kinase activity such as a PDGF receptor tyrosine kinase inhibitor such as imatinib; and
- m) an agent interacting with a 5-HT₃ receptor and/or an agent interacting with 5-HT₄ receptor such as tegaserod described in the US patent No. 5510353 as example 13, tegaserod hydrogen maleate, cisapride, and cilansetron.

[0138] In any case, the multiple therapeutic agents (at least one of which is a compound disclosed herein) may be administered in any order or even simultaneously. If simultaneously, the multiple therapeutic agents may be provided in a single, unified form, or in multiple forms (by way of example only, either as a single pill or as two separate pills). One of the therapeutic agents may be given in multiple doses, or both may be given as multiple doses. If not simultaneous, the timing between the multiple doses may be any duration of time ranging from a few minutes to four weeks.

[0139] Thus, in another aspect, certain embodiments provide methods for treating PASK-mediated disorders in a human or animal subject in need of such treatment comprising administering to said subject an amount of a compound disclosed herein effective to reduce or prevent said disorder in the subject, optionally in combination with at least one additional agent that is known in the art. In a related aspect, certain embodiments provide therapeutic compositions comprising at least one compound disclosed herein in combination with one or more additional agents for the treatment of PASK-mediated disorders.

[0140] Recent studies have found that elevated medium glucose concentrations caused post-translational activation of PASK. It has also been demonstrated that PASK activity is required for glucose-stimulated insulin expression, as shown by studies in PASK1 mice. It has also been demonstrated that PASK deletion results in nearly complete resistance to the phenotypes caused by a high-fat diet, including obesity, insulin resistance and hepatic fat accumulation. It has been postulated that this protection may be due to an increase in AMPK expression in each of the relevant tissues. PASK deletion abrogates nearly all of the maladaptive phenotype associated

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with a high-fat diet, possibly in part via maintenance of AMPK expression. Increasing AMPK signaling is a proven therapeutic strategy, as illustrated by Metformin, which acts by increasing the phosphorylation and activation of AMPK. Inhibition of PASK signaling elicits similar beneficial effects, but through a distinct mechanism. This complementary therapeutic strategy, either alone or in combination, can be efficacious in the treatment of metabolic diseases. In any case, it appears that PASK inhibition can provide an effective therapeutic strategy for the treatment of diseases, for example Type 2 diabetes, insulin resistance in general, and the metabolic syndrome.

[0141] Metabolic syndrome (also known as metabolic syndrome X) is characterized by having at least three of the following symptoms: insulin resistance; abdominal fat - in men this is defined as a 40 inch waist or larger, in women 35 inches or larger; high blood sugar levels - at least 110 milligrams per deciliter (mg/dL) after fasting; high triglycerides - at least 150 mg/dL in the blood stream; low HDL- less than 40 mg/dL; pro-thrombotic state (e.g. high fibrinogen or plasminogen activator inhibitor in the blood); or blood pressure of 130/85 mmHg or higher. A connection has been found between metabolic syndrome and other conditions such as obesity, high blood pressure and high levels of LDL cholesterol, all of which are risk factors for cardiovascular diseases. For example, an increased link between metabolic syndrome and atherosclerosis has been shown. People with metabolic syndrome are also more prone to developing Type 2 diabetes, as well as PCOS (polycystic ovarian syndrome) in women and prostate cancer in men.

[0142] As described above, insulin resistance can be manifested in several ways, including Type 2 diabetes. Type 2 diabetes is the condition most obviously linked to insulin resistance. Compensatory hyperinsulinemia helps maintain normal glucose levels - often for decades, before overt diabetes develops. Eventually the beta cells of the pancreas are unable to overcome insulin resistance through hypersecretion. Glucose levels rise, and a diagnosis of diabetes can be made. Patients with Type 2 diabetes remain hyperinsulinemic until they are in an advanced stage of disease. As described above, insulin resistance can also correlate with hypertension. One half of patients with essential hypertension are insulin resistant and hyperinsulinemic, and there is evidence that blood pressure is linked to the degree of insulin resistance. Hyperlipidemia, too, is associated with insulin resistance. The lipid profile of patients with Type 2 diabetes includes increased serum very-low-density lipoprotein cholesterol and triglyceride levels and, sometimes, a decreased low-density lipoprotein cholesterol level. Insulin resistance has been found in persons with low levels of high-density lipoprotein. Insulin levels have also been linked to very-low-density lipoprotein synthesis and plasma triglyceride levels.

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[0143] Accordingly, also disclosed are methods of treating insulin resistance in a subject comprising selecting a subject in need of treatment for insulin resistance; and administering to the subject an effective amount of a compound that inhibits PASK.

[0144] Specific diseases to be treated by the compounds, compositions, and methods disclosed herein are those mediated at least in part by PASK. Accordingly, disclosed herein are methods: for reducing glycogen accumulation in a subject; for raising HDL or HDLc, lowering LDL or LDLc, shifting LDL particle size from small dense to normal LDL, lowering VLDL, lowering triglycerides, or inhibiting cholesterol absorption in a subject; for reducing insulin resistance, enhancing glucose utilization or lowering blood pressure in a subject; for reducing visceral fat in a subject; for reducing serum transaminases in a subject; or for treating disease; all comprising the administration of a therapeutic amount of a compound as described herein, to a patient in need thereof. In further embodiments, the disease to be treated may be a metabolic disease. In further embodiment, the metabolic disease may be chosen from: obesity, diabetes melitus, especially Type 2 diabetes, hyperinsulinemia, glucose intolerance, metabolic syndrome X, dyslipidemia, hypertriglyceridemia, hypercholesterolemia, and hepatic steatosis. In other embodiments, the disease to be treated may be chosen from: cardiovascular diseases including vascular disease, atherosclerosis, coronary heart disease, cerebrovascular disease, heart failure and peripheral vessel disease. In preferred embodiments, the methods above do not result in the induction or maintenance of a hypoglycemic state.

[0145] Additionally, the PASK modulators disclosed herein may be used to treat proliferative disorders such as cancers. Hematological and non-hematological cancers which may be treated or prevented include but are not limited to multiple myeloma, acute and chronic leukemias including Acute Lymphocytic Leukemia (ALL), Chronic Lymphocytic Leukemia (CLL), and Chronic Myelogenous Leukemia (CLL), lymphomas, including Hodgkin's lymphoma and non-Hodgkin's lymphoma (low, intermediate, and high grade), malignancies of the brain, head and neck, breast, lung, reproductive tract, upper digestive tract, pancreas, liver, renal, bladder, prostate and colon/rectum.

[0146] Besides being useful for human treatment, certain compounds and formulations disclosed herein may also be useful for veterinary treatment of companion animals, exotic animals and farm animals, including mammals, rodents, and the like. More preferred animals include horses, dogs, and cats.

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References Cited

[0147] The following is a list of references cited herein which, while not necessarily comprehensive, is provided for the convenience of the reader. All references, patents, and patent applications cited herein are hereby incorporated by reference as if written herein in their entireties. When the teachings of these references contradict the teachings presented expressly herein, the present disclosure controls.

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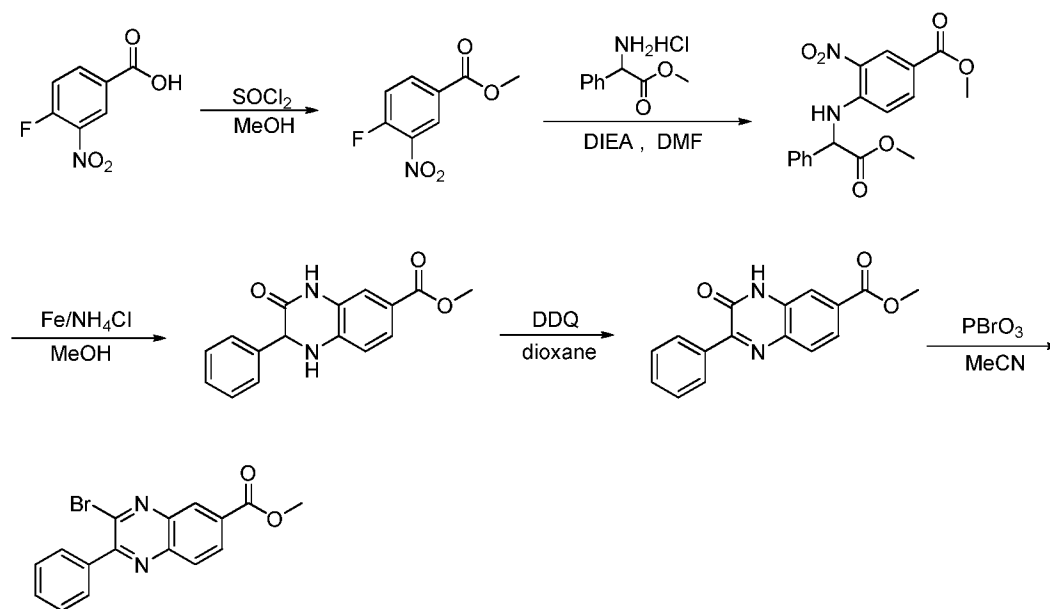
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General Synthetic Methods for Preparing Compounds

[0148] The following schemes can generally be used to practice the present invention.

Scheme I

[0149] **Step 1. Synthesis of methyl 4-fluoro-3-nitrobenzoate.** Thionyl chloride (6.5 g, 54.62 mmol, 1.01 equiv) was added dropwise, with stirring at 0°C, to a methanolic solution (60 mL) of 4-fluoro-3-nitrobenzoic acid (10 g, 54.05 mmol, 1.00 equiv) in a 250-mL round-bottom flask, then stirred for 3 hr at reflux in an oil bath. The resulting mixture was concentrated under vacuum, diluted with 100 mL of EtOAc, and the pH of the solution adjusted to 7-8 with aqueous NaHCO₃ (saturated). The solution was then extracted with 6x50 mL of ethyl acetate, the organic layers combined and dried over anhydrous sodium sulfate, and concentrated under vacuum, affording 12.42 g (crude) of methyl 4-fluoro-3-nitrobenzoate as a white solid.

[0150] **Step 2. Synthesis of methyl 4-(2-methoxy-2-oxo-1-phenylethylamino)-3-nitrobenzoate.** A solution of methyl 2-amino-2-phenylacetate hydrochloride (2.5 g, 12.38 mmol, 1.00 equiv) in DMF (30 mL), methyl 4-fluoro-3-nitrobenzoate (5 g, 25.13 mmol, 2.00 equiv), and DIEA (5 g, 38.76 mmol, 3.13 equiv) was reacted overnight at 30°C in a 100-mL round-bottom flask. The reaction was then quenched by the addition of 200 mL of water, and the solids were collected by filtration. Purification via silica gel column (petroleum ether /EtOAc (50:1)) yielded 3.82 g (90%) of methyl 4-(2-methoxy-2-oxo-1-phenylethylamino)-3-nitrobenzoate as a yellow solid. LC-MS (ES, *m/z*): 345 [M+H]⁺.

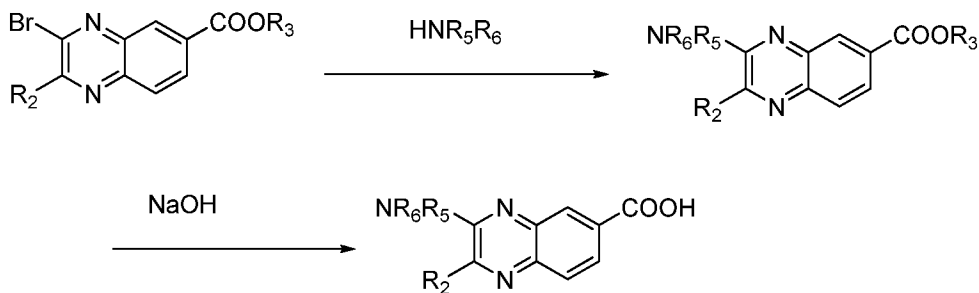
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[0151] **Step 3. Synthesis of methyl 3-oxo-2-phenyl-1,2,3,4-tetrahydroquinoxaline-6-carboxylate.** Iron (34.89 g, 623.04 mmol, 5.00 equiv) was added portionwise to a stirred solution of methyl 4-(2-methoxy-2-oxo-1-phenylethylamino)-3-nitrobenzoate (42.87 g, 124.62 mmol, 1.00 equiv) and aqueous NH₄Cl (32.1 g, 600.00 mmol, 5.00 equiv, 80 mL) in methanol (300 mL). The resulting solution was heated under reflux for 5 h. Upon cooling, the solids were filtered out. The resulting filtrate was concentrated under vacuum, affording 19.81 g (56%) of methyl 3-oxo-2-phenyl-1,2,3,4-tetrahydroquinoxaline-6-carboxylate as a yellow solid. LC-MS (ES, *m/z*): 283 [M+H]⁺.

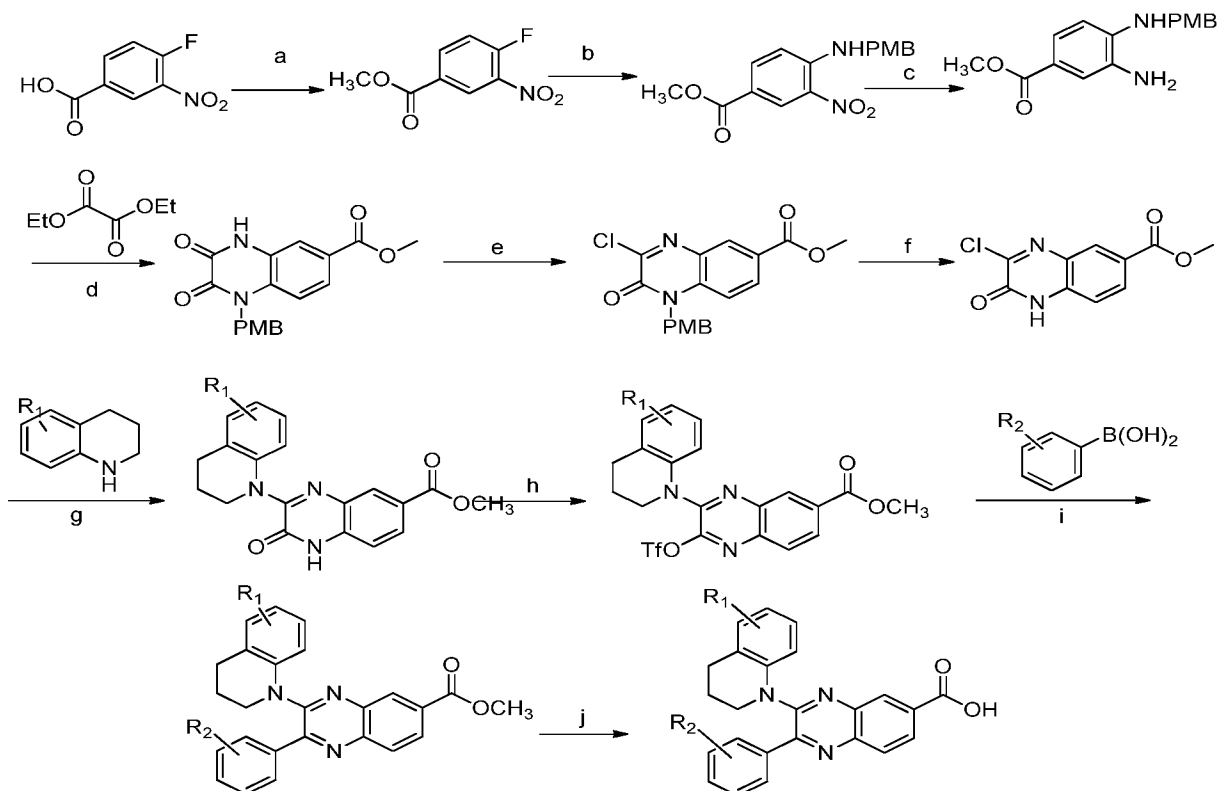
[0152] **Step 4. Synthesis of methyl 3-oxo-2-phenyl-3,4-dihydroquinoxaline-6-carboxylate.** DDQ (21.25 g, 93.6 mmol, 2.62 equiv) was added to a stirred solution of methyl 3-oxo-2-phenyl-1,2,3,4-tetrahydroquinoxaline-6-carboxylate (10.07 g, 35.7 mmol, 1.00 equiv) in dioxane (750 mL) and allowed to react, with stirring, overnight at room temperature. The solids were collected by filtration. The filter cake was washed with 2x500 mL of aqueous K₂CO₃ (saturated). This resulted in 7.29 g (crude) of methyl 3-oxo-2-phenyl-3,4-dihydroquinoxaline-6-carboxylate as an off-white solid. LC-MS (ES, *m/z*): 281 [M+H]⁺.

[0153] **Step 5. Synthesis of methyl 3-bromo-2-phenylquinoxaline-6-carboxylate.** A solution of methyl 3-oxo-2-phenyl-3,4-dihydroquinoxaline-6-carboxylate (2.1 g, 7.50 mmol, 1.00 equiv) and POBr₃ (21.5 g, 74.91 mmol, 10.00 equiv) in CH₃CN (120 mL) in a 1000-mL round-bottom flask was heated under reflux overnight in an oil bath. The resulting mixture was concentrated under vacuum; the pH value was adjusted to 7-8 with aqueous sodium bicarbonate (saturated), and the solution extracted with 4x100 mL of dichloromethane. The organic layers were combined, dried over anhydrous sodium sulfate and concentrated under vacuum, giving 2 g (78%) of methyl 3-bromo-2-phenylquinoxaline-6-carboxylate as a white solid. LC-MS (ES, *m/z*): 343 [M+H]⁺. ¹H-NMR (300 MHz, DMSO-*d*₆) 8.620-8.615 (d, *J*=1.5Hz, 1H), 8.38-8.35 (q, *J*=3.3Hz, 1H), 8.28-8.25 (d, *J*=8.7Hz, 1H), 7.85-7.82 (q, *J*=6Hz, 2H), 7.60-7.58 (t, *J*=2.4Hz, 3H), 3.99 (s, 3H).

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Scheme II

wherein R_5 and R_6 and R_2 are each independently chosen from alkyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl, and amino any of which may be optionally substituted; and R_3 is chosen from hydrogen and optionally substituted alkyl.

Scheme III

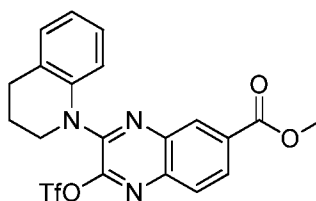
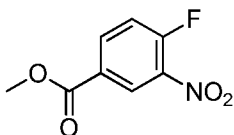
Reagents and conditions; (a) SOCl_2 , MeOH, reflux, 3h, 93%; (b) PMBNH_2 , DIEA, DMF, rt, 3h, 78%; (c) Pd/C, H_2 , MeOH, rt, 0.5h, 73%; (d) reflux, 3h, 74%; (e) POCl_3 , N,N-dimethylaniline, toluene, reflux, overnight, 72%; (f) $\text{H}_2\text{SO}_4(\text{conc})$, rt, 10mins; (g) 150°C , 3h, 42.6%; (h) Tf_2O , pyridine, DCM, rt, overnight; (i) K_3PO_4 , $\text{Pd}(\text{PPh}_3)_4$, dioxane, 90°C , 40 min; (j) NaOH , H_2O , MeOH, rt, overnight.

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[0154] The invention is further illustrated by the following examples, which can be made by the methods described herein or by one skilled in the art without undue experimentation, or can be purchased from commercial sources. Throughout the experimental protocols, the following abbreviations may be used. The list below is provided for convenience and is not intended to be inclusive.

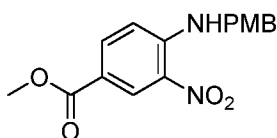
Abbreviation/Acronym	Meaning
Ar	Aryl
Pd ₂ (dba) ₃	Tris(dibenzylideneacetone)dipalladium(0)
BINAP	2,2'-bis(diphenylphosphino)-1,1'-binaphthyl
NaOt-Bu	Sodium t-Butoxide
PE	Petroleum Ether
EA	Ethyl Acetate
DCM	Dichloromethane
TFA	Trifluoroacetic Acid
AcOH	Acetic Acid
DMF	N,N-Dimethylformamide
DIEA	N,N-Diisopropylethylamine
MeOH	Methanol
THF	Tetrahydrofuran
BOC	N-t-butoxycarbonyl
Tol	Toluene
DMSO	Dimethyl Sulfoxide
PCy3	Tricyclohexylphosphine
TLC	Thin Layer Chromatography
X-Phos	2-Dicyclohexylphosphino-2',4',6'-triisopropylbiphenyl
DDQ	2,3-dichloro-5,6-dicyanobenzoquinone

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Intermediate 1.**Methyl 3-(3, 4-dihydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate****Step 1. Methyl 4-fluoro-3-nitrobenzoate**

Thionyl chloride (191.4 g, 1.61 mol) was added to a solution of 4-fluoro-3-nitrobenzoic acid (150.0 g, 810.81 mmol) in methanol (500 ml) at 0°C. The resulting solution was heated to reflux overnight, concentrated *in vacuo*, the product was precipitated by the addition of petroleum ether (200 ml), and the solids were collected by filtration to afford methyl 4-fluoro-3-nitrobenzoate as a light yellow solid (150 g, 93%).

¹H-NMR (300 MHz, CDCl₃) δ 8.74 - 8.77 (m, 1H), 8.31 - 8.37 (m, 1H), 7.37 - 7.43 (m, 1H), 3.99 (s, 3H).

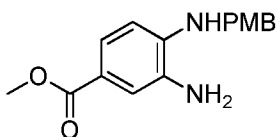
Step 2. Methyl 4-(4-methoxybenzylamino)-3-nitrobenzoate

DIEA (389.0 g, 3.02 mol) was added to a solution of methyl 4-fluoro-3-nitrobenzoate (200.0 g, 1.00 mol) in N,N-dimethylformamide (2 L) at room temperature. Then (4-methoxyphenyl)methanamine (275 g, 2.00 mol) was added dropwise. After 2 h, the reaction was diluted with water (5 L), the solids were collected by filtration to afford methyl 4-(4-methoxybenzylamino)-3-nitrobenzoate as a yellow solid (250 g, 78 %).

¹H-NMR (300 MHz, CDCl₃) δ 8.91 (d, *J* = 1.8 Hz, 1H), 8.64 (b, 1H), 8.02 - 8.06 (m, 1H), 7.26 - 7.30 (m, 2H), 6.88 - 6.95 (m, 3H), 4.53 (d, *J* = 5.4 Hz, 1H), 3.91 (s, 3H), 3.83 (s, 3H).

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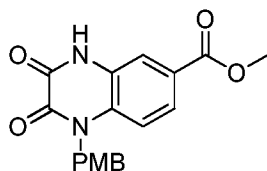
Step 3. Methyl 3-amino-4-(4-methoxybenzylamino)benzoate



A mixture of methyl 4-(4-methoxybenzylamino)-3-nitrobenzoate (35.0 g, 110.65 mmol) and palladium on carbon (5 g) in methanol (3 L) was hydrogenated 30 mins at room temperature. The catalyst was removed by filtration and the filtrate was concentrated *in vacuo* to afford methyl 3-amino-4-(4-methoxybenzylamino) benzoate as a white solid (23.1 g, 76 %).

$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 7.57 - 7.60 (m, 1H), 7.44 (d, $J = 1.8$ Hz, 1H), 7.28 - 7.33 (m, 2H), 6.90 - 6.94 (m, 2H), 6.63 (d, $J = 8.1$ Hz, 1H), 4.33 (s, 2H), 3.86 (s, 3H), 3.83 (s, 3H).

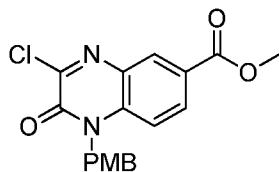
Step 4. Methyl 1-(4-methoxybenzyl)-2,3-dioxo-1,2,3,4-tetrahydroquinoxaline-6-carboxylate



A mixture of methyl 3-amino-4-(4-methoxybenzylamino)benzoate (3 g, 10.48 mmol) and diethyl oxalate (100 ml) was stirred for 3h at reflux and then cooled with a water/ice bath, and diluted with ether (500 ml). The product was collected by filtration to afford methyl 1-(4-methoxybenzyl)-2,3-dioxo-1,2,3,4-tetrahydroquinoxaline-6-carboxylate as a green solid (2.64 g, 74 %).

$^1\text{H-NMR}$ (300 MHz, DMSO) δ 12.22 (s, 1H), 7.80 (s, 1H), 7.61 - 7.62 (d, $J = 1.8$ Hz, 1H), 7.25 - 7.33 (m, 3H), 6.86 - 6.89 (d, $J = 8.7$ Hz, 1H), 5.31 (s, 2H), 3.83 (s, 3H), 3.70 (s, 3H).

Step 5. Methyl 3-chloro-1-(4-methoxybenzyl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

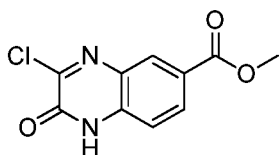


POCl_3 (2 g, 13.25 mmol) and *N,N*-dimethylbenzenamine (2.13 g, 17.60 mmol,) were added to a solution of methyl 1-(4-methoxybenzyl)-2,3-dioxo-1,2,3,4-tetrahydroquinoxaline-6-carboxylate (3 g, 8.81 mmol) in toluene (100 ml). The resulting reaction was stirred overnight at 110°C and concentrated *in vacuo*. The residue was triturated with methanol (50 ml) and collected by filtration to afford methyl 3-chloro-1-(4-methoxybenzyl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a green solid (2.27 g, 72 %).

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$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.25 (d, $J = 1.8$ Hz, 1H), 8.07 - 8.11 (m, 1H), 7.61 (d, $J = 9.0$ Hz, 1H), 7.27 - 7.30 (d, $J = 8.7$ Hz, 2H), 6.86 - 6.90 (m, 2H), 5.46 (s, 2H), 3.83 (s, 3H), 3.71 (s, 3H).

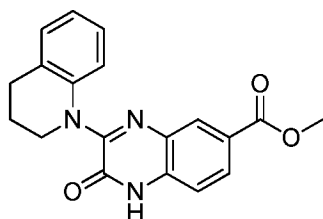
Step 6. 3-Chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate



Methyl 3-chloro-1-(4-methoxybenzyl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (13 g, 36.31 mmol) was added to sulfuric acid (conc, 15 ml) in several batches with stirring at room temperature and then stirred an additional 10 mins. The resulting solution was quenched with ice-water (100 ml), adjusted to $\text{pH}=7$ with aqueous sodium hydroxide (10 N), and extracted with 1-butanol (3 x 200 ml). The organic layers were combined, dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to afford methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a yellow solid (12.4 g, crude).

$^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 13.20 (b, 1H), 8.21 (d, $J = 1.8$ Hz, 1H), 8.10 - 8.12 (m, 1H), 7.43 (d, $J = 8.7$ Hz, 1H), 3.88 (s, 3H).

Step 7. Methyl 3-(3, 4-dihydroquinolin-1(2H)-yl)-2-oxo-1, 2-dihydroquinoxaline-6-carboxylate



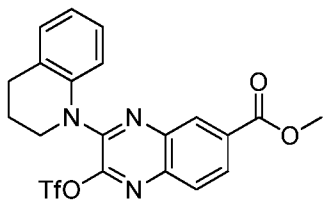
Methyl 3-chloro-2-oxo-1, 2-dihydroquinoxaline-6-carboxylate (300 mg, 1.26 mmol) was added to 8 mL of 1, 2, 3, 4-tetrahydroquinoline and stirred for 3 h at 150°C . The reaction mixture was cooled to room temperature, the product was precipitated by the addition ethyl acetate, and the solids were collected by filtration to afford 3-(3, 4-dihydroquinolin-1(2H)-yl)-2-oxo-1, 2-dihydroquinoxaline-6-carboxylate as a light yellow solid (180 mg, 42.6%).

Calculated for $\text{C}_{19}\text{H}_{17}\text{N}_3\text{O}_3$: 335.13. (ES, m/z): $[\text{M}+\text{H}]^+$ 336.0.

$^1\text{H-NMR}$ (300 MHz, DMSO): δ 12.49 (s, 1H), 7.99 (d, $J = 1.8$ Hz, 1H), 7.84 - 7.88 (m, 1H), 7.30 (d, $J = 8.4$ Hz, 1H), 7.13 - 7.16 (m, 1H), 6.89 - 7.04 (m, 3H), 3.88 - 3.93 (t, $J = 6.3$ Hz, 2H), 3.85 (s, 3H), 2.73 - 2.78 (t, $J = 6.6$ Hz, 2H), 1.91 - 1.99 (m, 2H).

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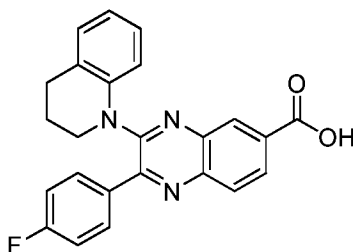
Step 8. Methyl 3-(3, 4-dihydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate



Trifluoromethanesulfonic anhydride (315.6 mg, 1.12 mmol) was added to a solution of methyl 3-(3, 4-dihydroquinolin-1(2H)-yl)-2-oxo-1, 2-dihydroquinoxaline-6-carboxylate (200.0 mg, crude) and pyridine (176.8 mg, 2.24 mmol) in dichloromethane (50 ml). After stirring overnight at room temperature, the reaction was quenched with water (50 ml) and extracted with dichloromethane (3 x 80 ml). Then the organic layers were combined dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to afford methyl 3-(3, 4-dihydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate as red oil (300 mg, crude), which was used directly in the next step.

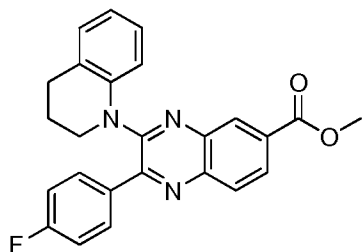
EXAMPLE 1

3-(1,2,3,4-Tetrahydroquinolin-1(2H)-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



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Step 1. Methyl 3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(4-fluorophenyl) quinoxaline-6-carboxylate

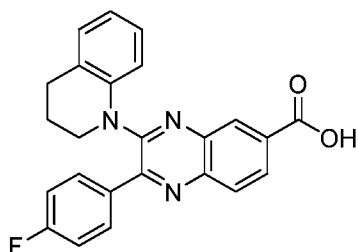


4-fluorophenylboronic acid (188.8 mg, 1.35 mmol), K_3PO_4 (284.8 mg, 1.35 mmol) and $Pd(PPh_3)_4$ (25.9 mg, 0.02 mmol) were added to a solution of methyl 3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy) quinoxaline-6-carboxylate (Intermediate 1, 210 mg, 0.45 mmol) in dioxane (5.0 mL) and three drops of water. The reaction was stirred for 1 h at 95°C while under an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated *in vacuo* and purified by flash column chromatography with 2 % ethyl acetate in petroleum to afford methyl 3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a red solid (70 mg, 36 %).

Calculated for $C_{25}H_{20}FN_3O_2$: 413.15. (ES, m/z): $[M+H]^+$ 414.0

1H -NMR (300 MHz, $CDCl_3$): δ 8.74 (s, 1H), 8.21 - 8.24 (dd, $J_1 = J_2 = 1.5$ Hz, 1H), 8.12 (d, $J = 8.4$ Hz, 1H), 7.72 - 7.76 (m, 2H), 6.93 - 7.02 (m, 3H), 6.79 - 6.83 (m, 2H), 6.62 (s, 1H), 4.02 (s, 3H), 3.93 - 3.97 (t, $J = 6.0$ Hz, 2H), 2.79 - 2.84 (t, $J = 6.3$ Hz, 2H), 2.09 - 2.14 (t, $J = 6.3$ Hz, 2H)

Step 2. 3-(1,2,3,4-Tetrahydroquinolin-1(2H)-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



To a solution of methyl 3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (70 mg, 0.17 mmol) in water (1 mL) and tetrahydrofuran (15 mL) was added sodium hydroxide (27 mg, 0.68 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (30 mL), adjusted to pH 4 with hydrogen chloride (3 N) to give the precipitation, which was collected by filtration to afford 3-

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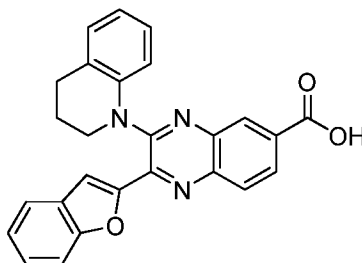
(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a light yellow solid (50 mg, 70%).

Calculated for C₂₄H₁₈FN₃O₂: 399.14 (ES, *m/z*): [M+H]⁺ 400.0

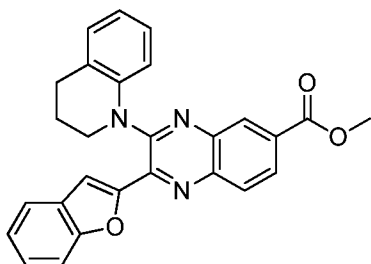
¹H-NMR (300 MHz, DMSO): δ 8.36 (s, 1H), 8.09 (d, *J* = 2.10 Hz, 2H), 7.72 - 7.78 (m, 2H), 7.06 - 7.12 (t, *J* = 9.0 Hz, 2H), 6.98 - 7.00 (m, 1H), 6.69 - 6.73 (m, 2H), 6.57 - 6.59 (m, 1H), 3.81 - 3.85 (t, *J* = 6.3 Hz, 2H), 2.70 - 2.81 (t, *J* = 6.3 Hz, 2H), 1.98 - 2.02 (t, *J* = 6.3 Hz, 2H)

EXAMPLE 2

2-(Benzofuran-2-yl)-3-(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)quinoxaline-6-carboxylic acid



Step 1. Methyl 2-(benzofuran-2-yl)-3-(3,4-dihydroquinolin-1(2*H*)-yl)quinoxaline-6-carboxylate



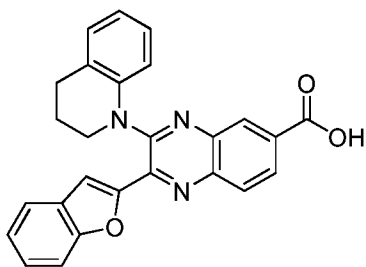
Benzofuran-2-ylboronic acid (217.2 mg, 1.35 mmol), K₃PO₄ (284.8 mg, 1.35 mmol), Pd(PPh₃)₄ (25.9 mg, 0.02 mmol) and water (3 drops) were added to a solution of methyl 3-(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate (Intermediate 1, 210 mg, crudel) in dioxane (5.0 mL) and the reaction was stirred for 1 h at 95°C under an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated *in vacuo* and purified by silica gel column chromatography with 2 % ethyl acetate in petroleum to afford methyl 2-(benzofuran-2-yl)-3-(1,2,3,4-Tetrahydroquinolin-1(2*H*)-yl) quinoxaline-6-carboxylate as a red solid (60 mg).

Calculated for C₂₇H₂₁N₃O₃: 435.16. (ES, *m/z*): [M+H]⁺ 436.0

¹H-NMR (300 MHz, CDCl₃): δ 8.75 (s, 1H), 8.18 - 8.28 (m, 2H), 7.35 - 7.42 (m, 2H), 7.17 - 7.20 (m, 1H), 7.04 - 7.07 (m, 2H), 6.74 - 6.76 (t, *J* = 4.5 Hz, 2H), 6.57 (s, 1H), 4.11 - 4.18 (m, 5H), 3.00 - 3.03 (t, *J* = 6.6 Hz, 2H), 2.22 - 2.26 (t, *J* = 6.0 Hz, 2H)

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Step 2. 2-(Benzofuran-2-yl)-3-(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)quinoxaline-6-carboxylic acid



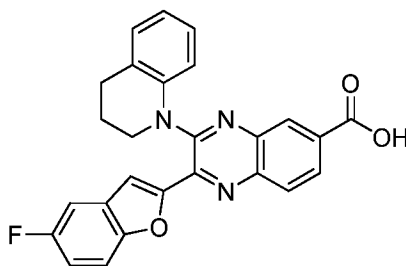
To a solution of methyl 2-(benzofuran-2-yl)-3-(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl) quinoxaline-6-carboxylate (60 mg, 0.14 mmol) in methanol (25 mL) and water (1 mL) was added sodium hydroxide (22 mg, 0.55 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (30 mL), adjusted to pH 4 with hydrogen chloride (3 N) to give the precipitation, which was collected by filtration to afford 2-(benzofuran-2-yl)-3-(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)quinoxaline-6-carboxylic acid as a red solid (45 mg, 74 %).

Calculated for $C_{26}H_{19}N_3O_3$: 421.14. (ES, m/z): $[M+H]^+$ 422.0

1H -NMR (300 MHz, DMSO) δ 8.36 (s, 1H), 8.16 - 8.20 (dd, $J_1 = J_2 = 1.8$ Hz, 1H), 8.11(d, $J = 8.7$ Hz, 1H), 7.53 - 7.66 (m, 3H), 7.33 - 7.38 (m, 1H), 7.20 - 7.25 (m, 1H), 7.06 - 7.09 (m, 1H), 6.66 - 6.73 (m, 2H), 6.50 - 6.53 (dd, $J_1 = J_2 = 0.9$ Hz, 1H), 3.87 - 3.92 (t, $J = 6.0$ Hz, 2H), 2.90 - 3.00 (t, $J = 6.3$ Hz, 2H), 2.08 - 2.17 (m, 2H)

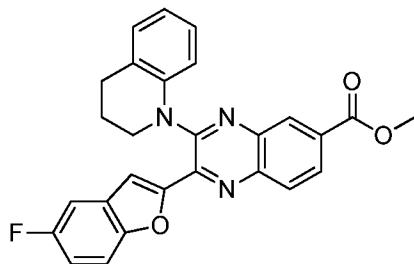
EXAMPLE 3

3-(1,2,3,4-Tetrahydroquinolin-1(2*H*)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylic acid



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Step 1. Methyl 2-(benzofuran-2-yl)-3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)methyl 3-(3, 4-dihydroquinolin-1(2H)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylate

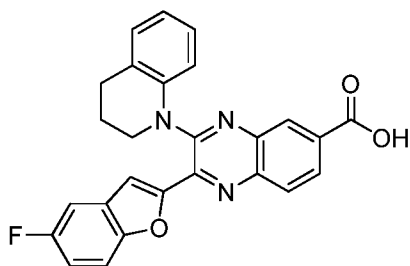


5-Fluorobenzofuran-2-ylboronic acid (242.8 mg, 1.35 mmol), K_3PO_4 (284.8 mg, 1.35 mmol), $Pd(PPh_3)_4$ (25.9 mg, 0.02 mmol) and water (3 drops) were added to a solution of methyl 3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate (Intermediate 1, 210 mg, 0.45 mmol,) in dioxane (5.0 mL). The reaction was stirred for 1 h at $95^\circ C$ under an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated *in vacuo* and purified by a silica gel column chromatography with 2 % ethyl acetate in petroleum ether to afford methyl 3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylate as a red solid (70 mg, 33 %).

Calculated for $C_{27}H_{20}FN_3O_3$: 453.15. (ES, m/z): $[M+H]^+$ 454.0

1H -NMR (300 MHz, $CDCl_3$): δ 8.65 (d, $J = 1.5$ Hz, 1H), 8.19 - 8.27 (m, 2H), 7.50 - 7.56 (m, 3H), 7.34 - 7.37 (m, 1H), 7.19 - 7.25 (m, 1H), 7.09 - 7.13 (m, 1H), 6.75 - 6.80 (m, 2H), 6.59 - 6.61 (m, 1H), 4.02 (s, 3H), 3.96 - 3.98 (t, $J = 6.0$ Hz, 2H), 3.00 - 3.04 (t, $J = 6.6$ Hz, 2H), 2.19 - 2.24 (t, $J = 6.0$ Hz, 2H)

Step 2. 3-(1,2,3,4-Tetrahydroquinolin-1(2H)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylic acid



Sodium hydroxide (24.7 mg, 0.62 mmol) was added to a solution of methyl 3-(1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylate (70 mg, 0.15 mmol) in methanol (25 mL) and water (1 mL). The reaction was stirred overnight at room temperature. The reaction mixture was concentrated *in vacuo*, dissolved in water (30 mL), adjusted to pH 4 with hydrogen chloride (3 N) to give the precipitate, which was collected by

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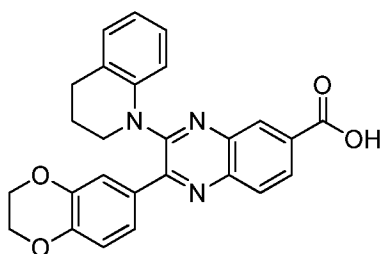
filtration to afford 3-(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylic acid as a red solid (50 mg, 70 %).

Calculated for C₂₆H₁₈FN₃O₃: 439.13. (ES, *m/z*): [M+H]⁺ 440.0

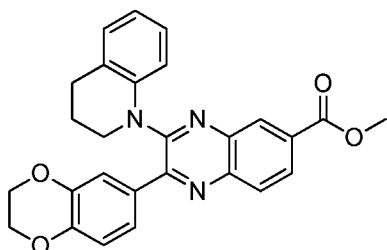
¹H-NMR (300 MHz, DMSO) δ 12.40 (s, 1H), 8.36 (s, 1H), 8.15 (s, 2H), 7.44 - 7.59 (m, 3H), 7.17 - 7.22 (t, *J* = 6.9 Hz, 1H), 7.06 (d, *J* = 5.4 Hz, 1H), 6.57 - 6.69 (m, 3H), 3.85 - 3.92 (m, 2H), 2.85 - 2.93 (m, 2H), 212 - 2.22 (m, 2H)

EXAMPLE 4

2-(2, 3-Dihydro-1,4-benzodioxin-6-yl)-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



Step 1. Methyl 2-(2, 3-dihydro-1,4-benzodioxin-6-yl)-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate



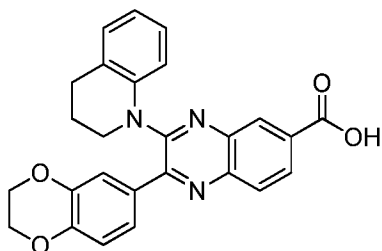
A mixture of methyl 3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (Intermediate 1, 300 mg, crude), (2, 3-dihydro-1, 4-benzodioxin-6-yl)boronic acid (231.0 mg, 1.29 mmol), Pd(PPh₃)₄ (37.0 mg, 0.03 mmol) and K₃PO₄ (405.1 mg, 1.92 mmol) in dioxane (5.0 ml) and water (3 drops) was stirred for 40 min at 90°C under atmosphere of nitrogen. The reaction mixture was concentrated *in vacuo* and purified by silica gel column chromatography with 1 % ethyl acetate in petroleum ether to afford methyl 2-(2, 3-dihydro-1, 4-benzodioxin-6-yl)-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a light yellow solid (65 mg, crude).

Calculated for C₂₇H₂₃N₃O₄: 453.17. (ES, *m/z*): [M+H]⁺ 454.0

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$^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 8.70 (s, 1H), 8.14 - 8.22 (m, 2H), 7.29 - 7.34 (m, 2H), 7.05 - 7.25 (m, 2H), 6.83 - 6.86 (m, 2H), 6.76 (d, $J = 8.4$ Hz, 1H), 4.21 - 4.25 (m, 4H), 4.01 (s, 3H), 3.87 - 3.91 (t, $J = 6.3$ Hz, 2H), 2.82 - 2.86 (t, $J = 6.6$ Hz, 2H), 2.07 - 2.11 (t, $J = 6.0$ Hz, 2H)

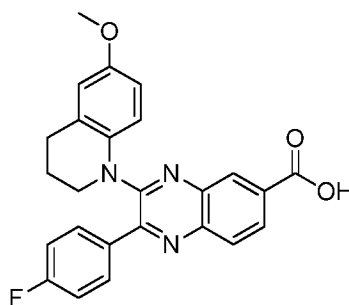
Step 2. 2-(2, 3-dihydro-1,4-benzodioxin-6-yl)-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



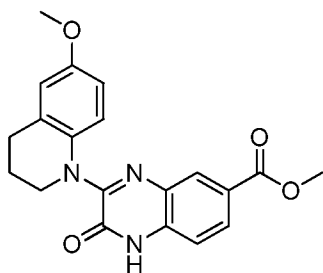
Sodium hydroxide (21.6 mg, 0.54 mmol) was added to a solution of methyl 2-(2, 3-dihydro-1, 4-benzodioxin-6-yl)-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (65 mg, crude) in methanol (5 ml) and water (1 ml) and the reaction was stirred overnight at room temperature. The reaction mixture was concentrated *in vacuo*, the residue was dissolved in water (30 ml), adjusted to pH=5 with hydrochloric acid (3 N), and the precipitate was collected by filtration to afford 2-(2, 3-dihydro-1, 4-benzodioxin-6-yl)-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid as a light yellow solid (31.8 mg).

Calculated for $\text{C}_{26}\text{H}_{21}\text{N}_3\text{O}_4$: 439.15. (ES, m/z): $[\text{M}+\text{H}]^+$ 440.0

$^1\text{H-NMR}$ (300 MHz, DMSO): δ 13.25 (b, 1H), 8.31 (d, $J = 1.2$ Hz, 1H), 8.03 - 8.11 (m, 2H), 7.25 - 7.30 (m, 2H), 7.02 - 7.05 (t, $J = 3.6$ Hz, 1H), 6.75 - 6.79 (m, 3H), 6.61 - 6.64 (m, 1H), 4.19 (d, $J = 2.1$ Hz, 4H), 3.70 - 3.74 (t, $J = 6.0$ Hz, 2H), 2.73 - 2.77 (t, $J = 6.3$ Hz, 2H), 1.94 - 1.98 (t, $J = 6.0$ Hz, 2H)

EXAMPLE 5**2-(4-Fluorophenyl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid**

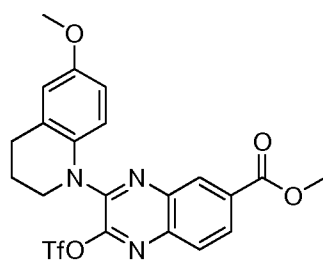
Step 1. Methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate



To a solution of methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (700 mg, crude) in NMP (2 mL) was added 6-methoxy-1,2,3,4-tetrahydroquinoline (1.0 g, 6.13 mmol) with stirring for 3 h at 150°C. The reaction mixture was cooled to room temperature. The product was precipitated by the addition ethyl acetate and the solids were collected by filtration to afford methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a light yellow solid (450mg), which was used to the next step without further purification.

(ES, m/z): $[M+H]^+$ 366.0

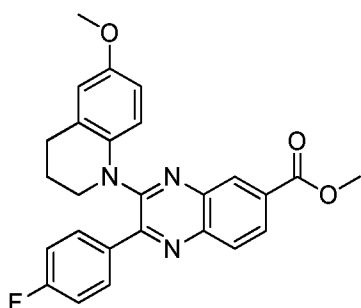
Step 2. Methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate



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To a solution of methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (250 mg, 0.68 mmol) in dichloromethane (50 mL) was added pyridine (161.88 mg, 2.05 mmol) and Tf₂O (288.91 mg, 1.02 mmol) with stirring overnight maintained with an inert atmosphere of nitrogen at room temperature. The reaction was then quenched with water (20 mL), extracted with dichloromethane (3 x 20 mL), the organic layers combined and dried over anhydrous magnesium sulfate, concentrated under vacuum to afford methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as red oil (350 mg, crude), which was used to the next step directly.

Step 3. Methyl 2-(4-fluorophenyl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate



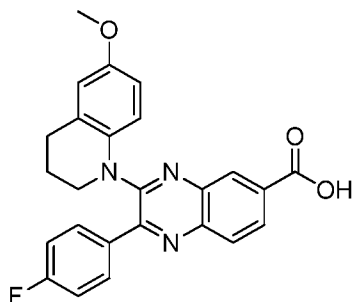
To a solution of methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (350 mg, crude) in dioxane (5.0 mL) and water (three drops) was added 4-fluorophenyl boronic acid (140.85 mg, 1.01 mmol), K₃PO₄ (318.4 mg, 1.51 mmol) and Pd(PPh₃)₄ (29.02 mg, 0.03 mmol) with stirring for 1 h at 90°C maintained with an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated under vacuum to give a residue, which was purified by a silica gel column with 2% ethyl acetate in petroleum to afford methyl 2-(4-fluorophenyl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a red solid (80 mg).

LC/MS (ES, *m/z*): [M+H]⁺ 444.0

¹H-NMR (300 MHz, CDCl₃) δ 8.76 (d, *J* = 1.8 Hz, 1H), 8.17 - 8.21 (dd, *J*₁ = *J*₂ = 1.8 Hz, 1H), 8.08 (d, *J* = 8.4 Hz, 1H), 7.68 - 7.73 (m, 2H), 6.93 - 6.99 (t, *J* = 8.7 Hz, 2H), 6.56 - 6.60 (m, 2H), 6.35 - 6.39 (m, 1H), 4.01 (s, 3H), 3.93 - 3.97 (t, *J* = 6.0 Hz, 2H), 2.75 - 2.79 (t, *J* = 6.6 Hz, 2H), 2.06 - 2.12 (m, 2H)

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Step 4. 2-(4-Fluorophenyl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



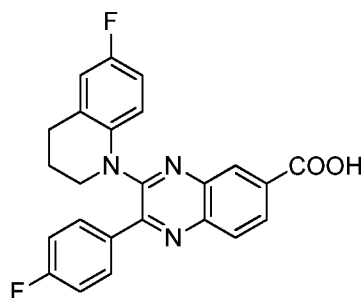
To a solution of methyl 2-(4-fluorophenyl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (80 mg, 0.18 mmol) in water (1 mL) and MeOH (15 mL) was added sodium hydroxide (29 mg, 0.72 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (30 mL), adjusted to pH 5 with hydrogen chloride (3 N) to give the precipitation, which was collected by filtration to afford 2-(4-fluorophenyl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid as a light yellow solid (50 mg, 64.6 %).

LC/MS (ES, m/z): $[M+H]^+$ 430.0

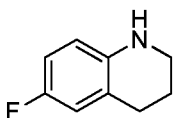
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.31 (s, 1H), 8.04 (s, 2H), 7.71 - 7.76 (m, 2H), 7.07 - 7.13 (t, $J = 8.7$ Hz, 2H), 6.57 - 6.62 (m, 2H), 6.30 - 6.33 (m, 2H), 3.74 - 3.79 (t, $J = 6.6$ Hz, 2H), 3.61 (s, 3H), 2.68 - 2.73 (t, $J = 6.3$ Hz, 2H), 1.94 - 1.99 (t, $J = 6.3$ Hz, 2H)

EXAMPLE 6

3-(6-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



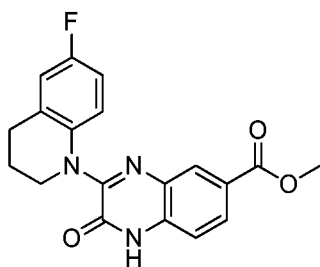
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Step 1. 6-Fluoro-1,2,3,4-tetrahydroquinoline

Sodium cyanoborohydride (6.45 g, 103 mmol) was added gradually to the solution of 6-fluoroquinoline (5 g, 34 mmol) in glacial acetic acid (100 ml) at ambient temperature. After stirring for 12 h the reaction mixture was quenched in water and extracted with EtOAc (3 x 50 mL). The combined organic layers were washed with water, brine and dried over sodium sulfate, filtered and evaporated *in vacuo*, the residue was purified by a silica gel column with 1% to 5% ethyl acetate in petroleum ether to afford 6-fluoro-1,2,3,4-tetrahydroquinoline as a light yellow liquid (3.65 g, 71.6 %).

LC/MS (ES, m/z): $[M+H]^+$ 152.0

$^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 6.68 - 6.74 (m, 2H), 6.43 - 6.48 (m, 1H), 3.27 - 3.31 (m, 2H), 2.74 - 2.79 (t, $J = 6.6$ Hz, 2H), 1.91 - 1.99 (m, 2H)

Step 2. Methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

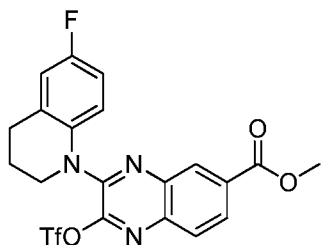
To a solution of methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (500.0 mg, 2.10 mmol) in 6-fluoro-1,2,3,4-tetrahydroquinoline (1.5 g, 9.9 mmol) with stirring for 1 h at 150°C. The reaction mixture was cooled to room temperature. The product was precipitated by the addition ethyl acetate and the solids were collected by filtration to afford methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (369.0 mg, 50%).

LC/MS (ES, m/z): $[M+H]^+$ 354.0

$^1\text{H-NMR}$ (300 MHz, DMSO) δ 12.50 (s, 1H), 7.98 (d, $J = 1.5$ Hz, 1H), 7.83 - 7.87 (m, 1H), 7.31 (d, $J = 8.7$ Hz, 1H), 6.95 - 7.03 (m, 2H), 6.83 - 6.89 (m, 1H), 3.85 - 3.93 (m, 5H), 2.73 - 2.77 (t, $J = 6.6$ Hz, 2H), 1.91 - 1.95 (t, $J = 6.3$ Hz, 2H)

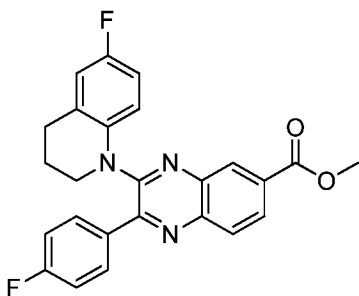
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Step 3. Methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate



To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (200 mg, 0.54 mmol) in dichloromethane (40 mL) was added pyridine (180 mg, 2.28 mmol) and Tf_2O (321 mg, 1.14 mmol) with stirring overnight maintained with an inert atmosphere of nitrogen at room temperature. The reaction was then quenched with water (50 mL), extracted with dichloromethane (3 x 50 mL), the organic layers combined and dried over anhydrous magnesium sulfate, concentrated under vacuum to afford methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate (274 mg, crude), which was used to the next step directly.

Step 4. Methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate



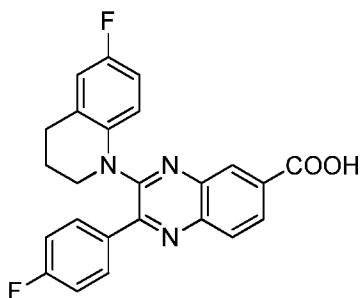
To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate (274 mg, crude) in dioxane (5.0 mL) and water (3 drops) was added 4-fluorophenylboronic acid (200 mg, 1.43 mmol), K_3PO_4 (360 mg, 1.71 mmol) and $\text{Pd}(\text{PPh}_3)_4$ (33 mg, 0.03 mmol) with stirring for 1 h at 90°C maintained with an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated under vacuum to give a residue, which was purified by a silica gel column with 1% to 2% ethyl acetate in petroleum ether to afford methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a yellow solid (88 mg).

LC/MS (ES, m/z): $[\text{M}+\text{H}]^+$ 432.0

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$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 8.67 (s, 1H), 8.19 - 8.23 (m, 1H), 8.10 (d, $J = 8.7$ Hz, 1H), 7.72 - 7.77 (m, 2H), 6.96 - 7.14 (m, 2H), 6.74 - 6.78 (m, 1H), 6.49 - 6.60 (m, 2H), 4.02 (s, 3H), 3.86 - 3.90 (t, $J = 6.0$ Hz, 2H), 2.77 - 2.81 (t, $J = 6.3$ Hz, 2H), 2.07 - 2.11 (t, $J = 6.9$ Hz, 2H)

Step 5. 3-(6-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid

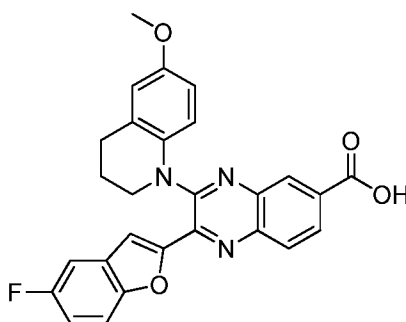


To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (88 mg, 0.18 mmol) in methanol (25 mL) and water (1 mL) was added sodium hydroxide (24.5 mg, 0.61 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (10 mL), adjusted to pH 4 with hydrochloric acid (3 N) to give the precipitation, which was collected by filtration to afford 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a yellow solid (63 mg, 79%).

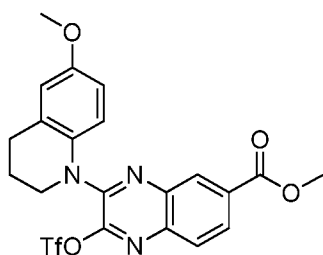
LC/MS (ES, m/z): $[\text{M}+\text{H}]^+$ 418.0

$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.34 (d, $J = 1.2$ Hz, 1H), 8.05 - 8.11 (m, 2H), 7.72 - 7.77 (m, 2H), 7.09 - 7.16 (m, 2H), 6.85 - 6.89 (m, 1H), 6.64 - 6.69 (m, 1H), 6.51 - 6.57 (m, 1H), 3.77 - 3.82 (t, $J = 6.3$ Hz, 2H), 2.71 - 2.76 (t, $J = 6.6$ Hz, 2H), 1.95 - 2.00 (t, $J = 6.3$ Hz, 2H)

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EXAMPLE 7**2-(5-Fluoro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid**

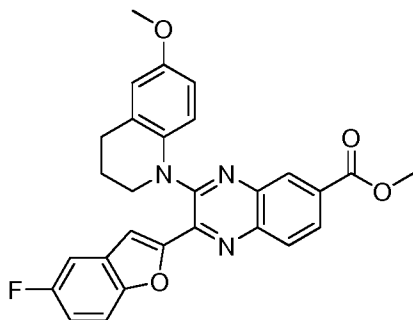
Step 1. Methyl 3-(1,2,3,4-tetrahydroquinolin-1(2*H*)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate



To a solution of methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (100 mg, 0.27 mmol) in dichloromethane (50 mL) was added pyridine (64.8 mg, 0.82 mmol) and Tf₂O (115.6 mg, 0.41 mmol) with stirring overnight maintained with an inert atmosphere of nitrogen at room temperature. The reaction was then quenched with water (20 mL), extracted with dichloromethane (3 x 15 mL), the organic layers combined and dried over anhydrous magnesium sulfate, concentrated under vacuum to afford methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as red oil (150mg, crude), which was used to the next step directly.

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Step 2. Methyl 2-(5-fluoro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate

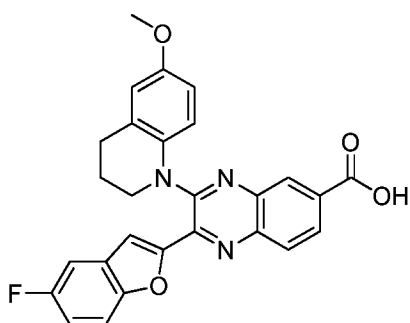


To a solution of methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[[trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (150 mg, crude) in dioxane (5.0 mL) and water (three drops) was added (5-fluoro-1-benzofuran-2-yl)boronic acid (94 mg, 0.52 mmol), K_3PO_4 (165.8 g, 781.08 mmol) and $Pd(PPh_3)_4$ (15.3 mg, 13.08 mmol) with stirring for 1 h at 90°C maintained with an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated under vacuum to give the residue, which was purified by a silica gel column with 2% ethyl acetate in petroleum to afford methyl 2-(5-fluoro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a red solid (40 mg).

(ES, m/z): $[M+H]^+$ 484.0

1H -NMR (300 MHz, $CDCl_3$) δ 8.61 (d, $J = 1.8$ Hz, 1H), 8.13 - 8.22 (m, 2H), 7.36 - 7.42 (m, 2H), 7.17 - 7.21 (m, 1H), 7.01 - 7.08 (m, 1H), 6.65 (d, $J = 2.7$ Hz, 1H), 6.56 (d, $J = 8.7$ Hz, 1H), 6.33 - 6.37 (m, 1H), 4.01 (s, 3H), 3.95 - 3.99 (t, $J = 6.3$ Hz, 2H), 3.63 (s, 3H), 2.93 - 2.98 (t, $J = 6.6$ Hz, 2H), 2.13 - 2.21 (m, 2H)

Step 3. 2-(5-Fluoro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



To a solution of methyl 2-(5-fluoro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (40 mg, 0.083 mmol) in methanol (20 mL) and water (three

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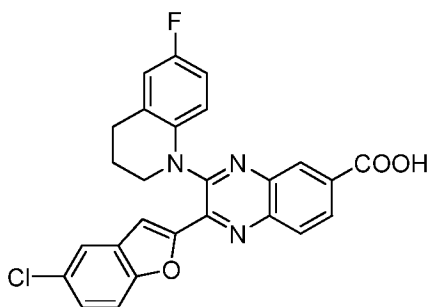
drops) was added sodium hydroxide (16.5 mg, 0.41 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (30 mL), adjusted to pH 5 with hydrogen chloride (3 N) to give the precipitation, which was collected by filtration to afford 2-(5-fluoro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid as a light yellow solid (23 mg, 44 %).

LC/MS (ES, m/z): $[M+H]^+$ 470.0

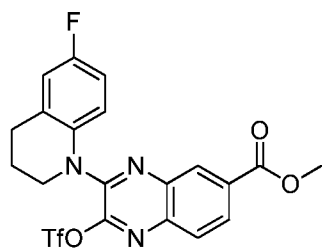
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 13.38 (s, 1H), 8.30 (s, 1H), 8.07 - 8.13 (t, $J = 8.7$ Hz, 2H), 7.55 - 7.59 (m, 1H), 7.42 - 7.46 (m, 2H), 7.16 - 7.23 (m, 1H), 6.67 (d, $J = 2.7$ Hz, 1H), 6.59 (d, $J = 8.7$ Hz, 1H), 6.30 - 6.34 (m, 1H), 3.84 - 3.88 (t, $J = 6.3$ Hz, 2H), 3.53 (s, 3H), 2.87 - 2.91 (t, $J = 6.3$ Hz, 2H), 2.01 - 2.09 (m, 2H)

EXAMPLE 8

2-(5-Chloro-1-benzofuran-2-yl)-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



Step 1. Methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate

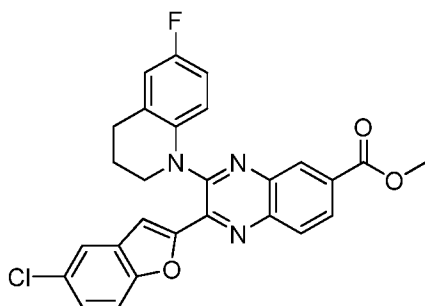


To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (150 mg, 0.43 mmol) in dichloromethane (40 mL) was added pyridine (136 mg, 1.72 mmol) and Tf_2O (242 mg, 0.86 mmol) with stirring overnight maintained with an inert atmosphere of nitrogen at room temperature. The reaction was then quenched with

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water (50 mL), extracted with dichloromethane (3 x 10 mL), the organic layers combined and dried over anhydrous magnesium sulfate, concentrated under vacuum to afford methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate (274 mg, crude), which was used to the next step directly.

Step 2. Methyl 2-(5-chloro-1-benzofuran-2-yl)-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate



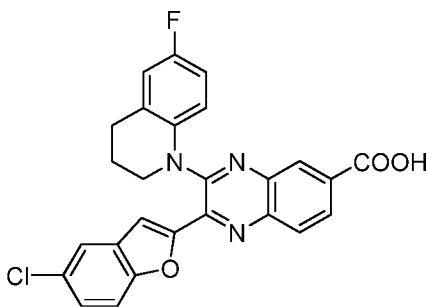
To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (274 mg, crude) in dioxane (5.0 mL) and water (0.5 mL) was added (5-chloro-1-benzofuran-2-yl)boronic acid (210 mg, 1.07 mmol), K_3PO_4 (272 mg, 1.29 mmol) and $Pd(PPh_3)_4$ (25 mg, 0.02 mmol) with stirring for 1 h at $90^\circ C$ maintained with an inert atmosphere of nitrogen. The reaction mixture was concentrated under vacuum to give the residue, which was purified by a silica gel column with 1% to 5% ethyl acetate in petroleum ether to afford methyl 2-(5-chloro-1-benzofuran-2-yl)-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a light red solid (53 mg).

(ES, m/z): $[M+H]^+$ 488.0

1H -NMR (300 MHz, DMSO) δ 8.63 (d, $J = 1.5$ Hz, 1H), 8.18 - 8.26 (m, 2H), 7.53 (d, $J = 2.1$ Hz, 1H), 7.37 - 7.41 (t, $J = 4.2$ Hz, 2H), 7.30 (d, $J = 2.1$ Hz, 1H), 6.81 - 6.85 (m, 1H), 6.46 - 6.58 (m, 2H), 4.02 (s, 3H), 3.96 - 4.00 (m, 2H), 2.96 - 3.00 (t, $J = 6.6$ Hz, 2H), 2.15 - 2.24 (m, 2H)

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Step 3. 2-(5-Chloro-1-benzofuran-2-yl)-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



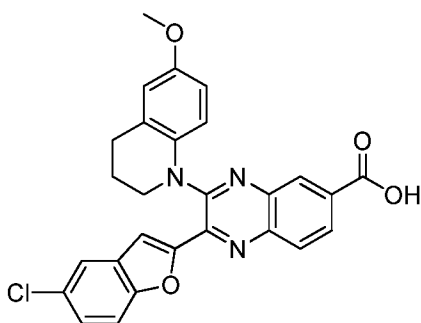
To a solution of methyl 2-(5-chloro-1-benzofuran-2-yl)-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (53 mg, 0.11 mmol) in methanol (25 mL) and water (1 mL) was added sodium hydroxide (12.0 mg, 0.30 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (10 mL), adjusted pH to 5 with hydrogen chloride (3 N) to give the precipitation, which was collected by filtration to afford 2-(5-chloro-1-benzofuran-2-yl)-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid (37.5 mg, 73 %).

(ES, m/z): $[M+H]^+$ 374.0

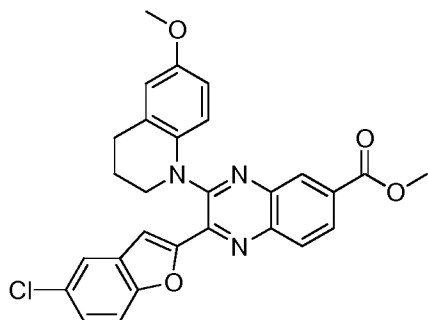
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.30 (d, $J = 1.5$ Hz, 1H), 8.07 - 8.17 (m, 2H), 7.75 (d, $J = 2.1$ Hz, 1H), 7.61 (d, $J = 9.0$ Hz, 1H), 7.49 (s, 1H), 7.36 - 7.39 (m, 1H), 6.91 - 6.96 (m, 1H), 6.52 - 6.68 (m, 1H), 3.85 - 3.89 (t, $J = 6.0$ Hz, 2H), 2.90 - 2.95 (t, $J = 6.6$ Hz, 2H), 2.05 - 2.10 (t, $J = 6.0$ Hz, 2H)

EXAMPLE 9

2-(5-Chloro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



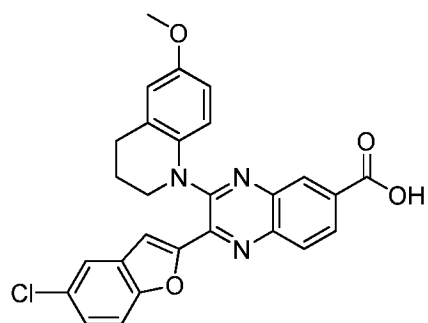
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Step 1. Methyl 2-(5-chloro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate

To a solution of methyl 3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (From Ex. 5, step 2, 130 mg, crude) in dioxane (5.0 mL) and water (three drops) was added (5-chloro-1-benzofuran-2-yl)boronic acid (103 mg, 0.52 mmol, K_3PO_4 (165.8 mg, 0.78 mmol) and $Pd(PPh_3)_4$ (15.2 mg, 0.01 mmol) with stirring for 1 h at 90°C maintained with an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated under vacuum to give the residue, which was purified by a silica gel column with 2% ethyl acetate in petroleum ether to afford methyl 2-(5-chloro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a red solid (40 mg).

(ES, m/z): $[M+H]^+$ 500.0

1H -NMR (300 MHz, $CDCl_3$) δ 8.61 (d, $J = 1.5$ Hz, 1H), 8.13 - 8.22 (m, 2H), 7.51 (d, $J = 2.1$ Hz, 1H), 7.25 - 7.40 (m, 3H), 6.65 (d, $J = 2.7$ Hz, 1H), 6.56 (d, $J = 8.7$ Hz, 1H), 6.32 - 6.36 (m, 1H), 4.01 (s, 3H), 3.96 - 3.99 (t, $J = 6.3$ Hz, 2H), 2.93 - 2.98 (t, $J = 6.6$ Hz, 2H), 2.13 - 2.21 (m, 2H)

Step 2. 2-(5-Chloro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid

To a solution of methyl 2-(5-chloro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (40 mg, 0.08 mmol) in methanol (25 mL) and water (1 mL) was added sodium hydroxide (12.6 mg, 0.32 mmol) with stirring overnight at room

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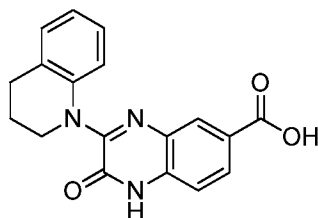
temperature. The reaction mixture was concentrated under vacuum, dissolved in water (5 mL), adjusted to pH 5 with hydrochloric acid (3 N) to give the precipitation, which was collected by filtration to afford 2-(5-fluoro-1-benzofuran-2-yl)-3-(6-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid as a light yellow solid (30.0 mg, 77 %).

LC/MS (ES, m/z): $[M+H]^+$ 486.0

$^1\text{H-NMR}$ (300 MHz, DMSO) δ 13.35 (s, 1H), 8.30 (d, $J = 1.2$ Hz, 1H), 8.09 (s, 1H), 7.71 (d, $J = 2.1$ Hz, 1H), 7.56 (d, $J = 8.7$ Hz, 1H), 7.42 (s, 1H), 7.34 - 7.38 (m, 1H), 6.67 (d, $J = 2.7$ Hz, 1H), 6.59 (d, $J = 8.7$ Hz, 1H), 6.29 - 6.33 (m, 1H), 3.84 - 3.88 (t, $J = 6.3$ Hz, 2H), 3.53 (s, 3H), 2.86 - 2.90 (t, $J = 6.30$ Hz, 2H), 2.03 - 2.09 (m, 2H).

EXAMPLE 10

2-Oxo-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)-1,2-dihydroquinoxaline-6-carboxylic acid



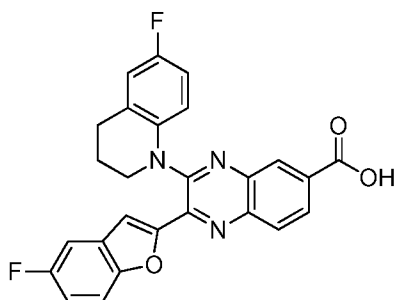
2-oxo-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)-1, 2-dihydroquinoxaline-6-carboxylic acid

To a solution of methyl 2-oxo-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)-1, 2-dihydroquinoxaline-6-carboxylate (50 mg, 0.15 mmol) in methanol (30 mL) was added potassium hydroxide (33.33 mg, 0.60 mmol) and water (1 mL) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (30 mL), adjusted to pH 4 with HCl (3 N) to give the precipitate, which was collected by filtration to afford 2-oxo-3-(1, 2, 3, 4-tetrahydroquinolin-1-yl)-1, 2-dihydroquinoxaline-6-carboxylic acid as a light yellow solid (40.0 mg, 79 %).

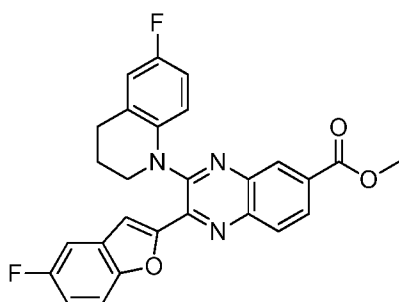
(ES, m/z): $[M+H]^+$ 322.0

$^1\text{H-NMR}$ (300 MHz, DMSO) 7.98 (d, $J = 1.5$ Hz, 1H), 7.83 - 7.86 (dd, $J_1 = J_2 = 1.80$ Hz, 1H), 7.31 (d, $J = 8.4$ Hz, 1H), 7.13 - 7.15 (dd, $J_1 = J_2 = 1.5$ Hz, 1H), 6.87 - 7.04 (m, 3H), 3.88 - 3.92 (t, $J = 6.3$ Hz, 2H), 2.73 - 2.78 (t, $J = 6.6$ Hz, 2H), 1.91 - 1.99 (s, 2H)

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EXAMPLE 11**3-(6-Fluoro-3,4-dihydroquinolin-1(2H)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylic acid**

Step 1. Methyl 2-(5-fluoro-1*H*-inden-2-yl)-3-(6-fluoro-3,4-dihydroquinolin-1(2*H*)-yl)quinoxaline-6-carboxylate

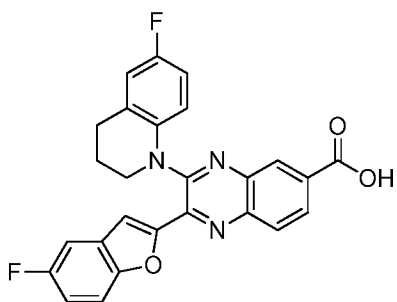


To a solution of methyl 3-(6-fluoro-3,4-dihydroquinolin-1(2*H*)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate (From Ex. 6, step 3, 200 mg, crude) in dioxane (5.0 mL) and three drops of water was added 5-fluorobenzofuran-2-ylboronic acid (210 mg, 1.07 mmol), K₃PO₄ (272 mg, 1.29 mmol) and Pd(PPh₃)₄ (25 mg, 0.02 mmol). The reaction was stirred for 1 h at 90°C under an inert atmosphere of nitrogen in an oil bath. The reaction mixture was concentrated under vacuum to give the residue, which was purified by a silica gel column with 1 % to 5 % ethyl acetate in petroleum to afford methyl 2-(5-fluoro-1*H*-inden-2-yl)-3-(6-fluoro-3,4-dihydroquinolin-1(2*H*)-yl)quinoxaline-6-carboxylate as a light red solid (59 mg). LC/MS (ES, *m/z*): [M+H]⁺ 472.0

¹H-NMR (300 MHz, CDCl₃) δ 8.65 (d, *J* = 1.5 Hz, 1H), 8.16 - 8.27 (m, 2H), 7.37 - 7.43 (m, 2H), 7.19 - 7.23 (m, 1H), 7.03 - 7.10 (m, 1H), 6.80 - 6.84 (m, 1H), 6.47 - 6.59 (m, 2H), 4.02 (s, 3H), 3.98 - 4.00 (m, 2H), 2.96 - 3.01 (t, *J* = 6.6 Hz, 2H), 2.15 - 2.24 (m, 2H)

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Step 2. 3-(6-Fluoro-3,4-dihydroquinolin-1(2H)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylic acid



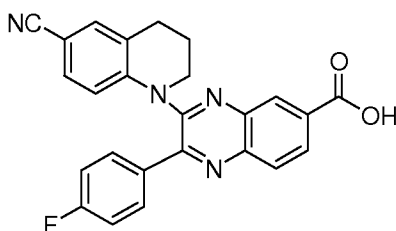
Sodium hydroxide (15.6 mg, 0.39 mmol) was added to a solution of methyl 2-(5-fluoro-1H-inden-2-yl)-3-(6-fluoro-3,4-dihydroquinolin-1(2H)-yl)quinoxaline-6-carboxylate (59 mg, 0.13 mmol) in methanol (25 mL) and tetrahydrofuran (5 mL). The reaction was stirred overnight at room temperature, concentrated in vacuo, dissolved in water (30 mL), and adjusted to pH 5 with hydrogen chloride (3 N). The precipitate was collected by filtration to afford 3-(6-fluoro-3,4-dihydroquinolin-1(2H)-yl)-2-(5-fluorobenzofuran-2-yl)quinoxaline-6-carboxylic acid (32.5 mg, 57 %).

LC/MS (ES, m/z): $[M+H]^+$ 458.0

$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.33 (s, 1H), 8.10 - 8.17 (m, 2H), 7.57 - 7.62 (m, 1H), 7.52 (s, 1H), 7.45 - 7.49 (m, 1H), 7.17 - 7.25 (m, 1H), 6.92 - 6.96 (m, 1H), 6.66 - 6.71 (m, 1H), 6.53 - 6.59 (m, 1H), 3.85 - 3.90 (t, $J = 6.0$ Hz, 2H), 2.90 - 2.95 (t, $J = 6.6$ Hz, 2H), 2.06 - 2.09 (m, 2H)

EXAMPLE 12

3-(6-Cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



To a solution of methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (From Ex 14, step 5, 50 mg, 0.11 mmol) in methanol (20 mL) and water (1 mL) was added lithium hydroxide (10 mg, 0.40 mmol) with stirring overnight at room temperature. The resulting mixture was concentrated under vacuum, dissolved

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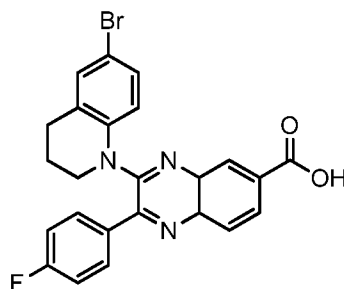
in water (10 mL) and adjusted to 7 with AcOH, collected by filtration to give 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a yellow solid (14.7 mg, 30 %).

$[M+H]^+$ 425.1

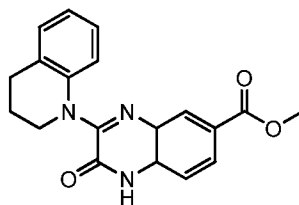
$^1\text{H-NMR}$ (300 MHz, CD_3OD) δ 8.56 (d, $J = 1.2$ Hz, 1H), 8.30 - 8.33 (m, 1H), 8.07 (d, $J = 8.7$ Hz, 1H), 7.77 - 7.82 (m, 2H), 7.33 (d, $J = 1.8$ Hz, 1H), 7.06 - 7.12 (m, 3H), 6.52 (d, $J = 8.4$ Hz, 1H), 3.92 - 3.96 (t, $J = 6.0$ Hz, 2H), 2.84 - 2.88 (t, $J = 6.6$ Hz, 2H), 2.08 - 2.12 (t, $J = 6.0$ Hz, 2H)

EXAMPLE 13

7-(6-Bromo-1,2,3,4-tetrahydroquinolin-1-yl)-6-(4-fluorophenyl)naphthalene-2-carboxylic acid



Step 1. Methyl 2-oxo-3-(1,2,3,4-tetrahydroquinolin-1-yl)-1,2-dihydroquinoxaline-6-carboxylate



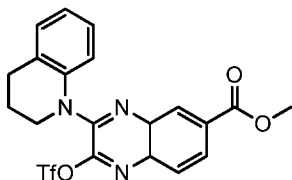
To a solution of 1,2,3,4-tetrahydroquinoline (1.0 g, 7.51 mmol) in NMP (20 ml) was added methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (670 mg, 2.81 mmol) with stirring 3h at 130°C in an oil bath. The product was precipitated with water (80 ml), collected by filtration to afford methyl 2-oxo-3-(1,2,3,4-tetrahydroquinolin-1-yl)-1,2-dihydroquinoxaline-6-carboxylate as a yellow solid (700 mg, 28 %).

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LC/MS (ES, m/z): $[M+H]^+$ 338.0

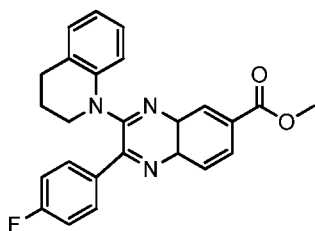
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 10.67 (s, 1H), 8.41 (d, $J = 2.1$ Hz, 1H), 7.93 - 7.96 (m, 1H), 7.14 (d, $J = 2.1$ Hz, 1H), 7.02 - 7.09 (m, 3H), 6.88 - 6.93 (m, 1H), 4.10 - 4.14 (m, 2H), 3.96 (s, 3H), 2.84 - 2.89 (t, $J = 6.6$ Hz, 2H), 1.99 - 2.15 (m, 2H).

Step 2. Methyl 3-(1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate



To a solution of methyl 2-oxo-3-(1,2,3,4-tetrahydroquinolin-1-yl)-1,2-dihydroquinoxaline-6-carboxylate (700 mg, 2.09 mmol) in dichloromethane (40 ml) was added pyridine (660 mg, 8.34 mmol) and then Tf_2O (1179 mg, 4.18 mmol) was added dropwise at 0°C under an atmosphere of nitrogen. The reaction was stirred overnight at room temperature and then quenched by the addition of ice-water (300 ml). The organic layers was separated and the aqueous layers was extracted with dichloromethane (3 x 50 ml) and the organic layers combined, dried over anhydrous magnesium sulfate and concentrated in vacuo at low temperature to afford methyl 3-(1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as a yellow solid (1.33 g, crude), which was used directly in the next step.

Step 3. Methyl 2-(4-fluorophenyl)-3-(1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate



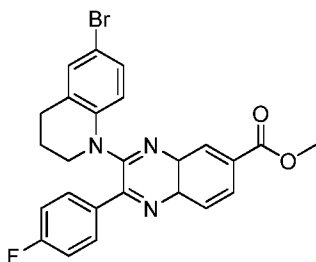
To a solution of methyl 3-(1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (1.33 g, crude in 1,4-dioxane (20 ml) and water (1 ml) was added (4-fluorophenyl)boronic acid (1.19 g, 8.55 mmol), K_3PO_4 (1.20 g, 5.65 mmol) and $\text{Pd}(\text{PPh}_3)_4$ (164 mg, 0.14 mmol) with stirring for 1 h at 90°C under atmosphere of nitrogen. The reaction mixture was concentrated to give a residue, which was purified by a silica gel column with 2% ethyl acetate in petroleum ether to afford methyl 2-(4-fluorophenyl)-3-(1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a yellow solid (560 mg, 48% 2 steps).

LC/MS (ES, m/z): $[M+H]^+$ 416

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$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 8.66 (d, $J = 1.5$ Hz, 1H), 8.19 - 8.23 (m, 1H), 8.08 (d, $J = 8.7$ Hz, 1H), 7.72 - 7.79 (m, 2H), 7.02 - 7.05 (m, 3H), 6.76 - 6.82 (m, 2H), 6.59 - 6.63 (m, 1H), 4.02 (s, 3H), 3.86 - 3.90 (m, 2H), 2.79 - 2.84 (t, $J = 6.3$ Hz, 2H), 2.08 - 2.12 (t, $J = 6.3$ Hz, 2H)

Step 4. Methyl 3-(6-bromo-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate

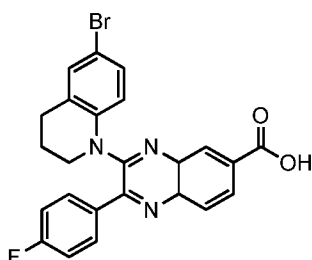


To a solution of methyl 2-(4-fluorophenyl)-3-(1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (300 mg, 0.73 mmol) in *N,N*-dimethylformamide (20 ml) was added NBS (193 mg, 1.08 mmol) under an inert atmosphere of nitrogen. The resulting solution was stirred for 1.5 h at 10°C . Then water (150 ml) was added and the reaction was extracted with ethyl acetate (3 x 50 ml). The organic layers were combined, dried over anhydrous magnesium sulfate and concentrated in vacuo to give a residue, which was purified by silica gel chromatography eluting with 1% - 2% ethyl acetate in petroleum ether to afford methyl 3-(6-bromo-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a yellow solid (200 mg, 56%).

LC/MS(ES, m/z): $[\text{M}+\text{H}]^+$ 495

$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 8.64 (d, $J = 1.8$ Hz, 1H), 8.22 - 8.25 (m, 1H), 8.09 (d, $J = 8.7$ Hz, 1H), 7.76 - 7.81 (m, 2H), 7.18 (s, 1H), 7.00 - 7.05 (m, 2H), 6.92 - 6.95 (m, 1H), 6.51 (d, $J = 8.7$ Hz, 1H), 4.01 (s, 3H), 3.77 - 3.81 (t, $J = 6.3$ Hz, 2H), 2.78 - 2.79 (t, $J = 6.6$ Hz, 2H), 2.05 - 2.10 (m, 2H)

Step 5. 7-(6-Bromo-1,2,3,4-tetrahydroquinolin-1-yl)-6-(4-fluorophenyl)naphthalene-2-carboxylic acid



Sodium hydroxide (39 mg, 0.97 mmol) was added to a solution of methyl 7-(6-bromo-1,2,3,4-tetrahydroquinolin-1-yl)-6-(4-fluorophenyl)naphthalene-2-carboxylate (120 mg, 0.24 mmol) in methanol (30 ml) and water (2 ml). The resulting solution was stirred overnight at room

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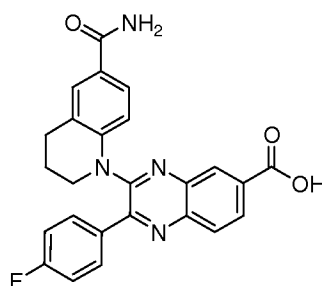
temperature and concentrated in vacuo. The residue was dissolved in water (20 ml) and adjusted to pH 4 with hydrochloric acid (3 N) to give the precipitation, which was collected by filtration to afford 7-(6-bromo-1,2,3,4-tetrahydroquinolin-1-yl)-6-(4-fluorophenyl)naphthalene-2-carboxylic acid as a yellow solid (80 mg, 69 %).

LC/MS (ES, m/z): $[M+H]^+$ 480.0

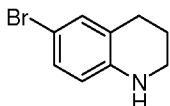
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.37 (s, 1H), 8.07 - 8.36 (m, 2H), 7.75 - 7.80 (m, 2H), 7.13 - 7.20 (m, 3H), 6.85 - 6.89 (m, 1H), 6.58 (d, $J = 8.7$ Hz, 1H), 3.76 - 3.80 (t, $J = 6.0$ Hz, 2H), 2.73 - 2.77 (t, $J = 6.3$ Hz, 2H), 1.95 - 1.99 (t, $J = 6.0$ Hz, 2H)

EXAMPLE 14

3-(6-Carbamoyl-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



Step 1. 6-Bromo-1,2,3,4-tetrahydroquinoline

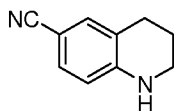


NBS (28 g, 158 mmol) was added to a solution of 1,2,3,4-tetrahydroquinoline (20 g, 150.16 mmol) in carbon tetrachloride (200 mL). The resulting solution was stirred for 3 h at 0°C, extracted with dichloromethane (3 x 50 mL) and concentrated in vacuo to give a residue, which was applied onto a silica gel column with 1 % ethyl acetate in petroleum ether to give 6-bromo-1,2,3,4-tetrahydroquinoline as a yellow solid (11 g, 35%).

LC/MS(ES, m/z): $[M+H]^+$ 212.1

$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 7.03 - 7.07 (m, 2H), 6.35 - 6.38 (m, 1H), 3.51 - 3.55 (m, 2H), 2.73 - 2.80 (m, 2H), 1.89 - 1.99 (m, 2H)

Step 2. 1,2,3,4-Tetrahydroquinoline-6-carbonitrile



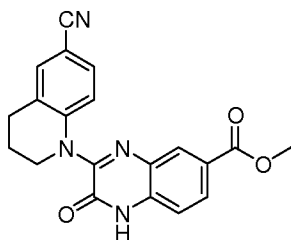
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To a solution of 6-bromo-1,2,3,4-tetrahydroquinoline (10 g, 47.15 mmol) in N,N-dimethylformamide (80 mL) was added Pd(PPh₃)₄ (2.8 g, 2.42 mmol), and zincdicyantrile (6.4 g, 54.49 mmol) and the reaction was stirred for 2 h at 120°C in an oil bath. The reaction was quenched by the addition of water (400 mL) and extracted with dichloromethane(3 x 50 mL), and concentrated in vacuo to give a residue, which was purified by a silica gel chromatography with 1% - 20% ethyl acetate in petroleum ether to give 1,2,3,4-tetrahydroquinoline-6-carbonitrile as a yellow solid (6 g, 80%).

LC/MS (ES, m/z): [M+H]⁺ 159.1

¹H-NMR (300 MHz, CDCl₃) δ 7.20 - 7.23 (m, 2H), 6.40 (d, *J* = 8.1 Hz, 1H), 3.36 - 3.40 (t, *J* = 5.7 Hz, 2H), 2.72 - 2.77 (t, *J* = 6.3 Hz, 2H), 1.90 - 1.97 (m, 2H)

Step 3. Methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

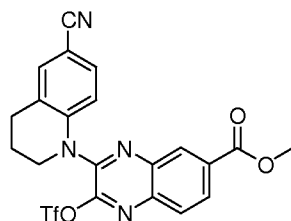


To a solution of methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (300 mg, 1.26 mmol) in NMP (0.5 mL) was added 1,2,3,4-tetrahydroquinoline-6-carbonitrile (597 mg, 3.77 mmol) with stirring for 1 h at 150°C in an oil bath. The resulting solution was diluted with water (100 mL) and the solids were collected by filtration to afford methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a yellow solid (200 mg, 44%).

LC/MS(ES, m/z): [M+H]⁺ 361.1

¹H-NMR (300 MHz, DMSO) δ 12.67 (s, 1H), 8.07 (d, *J* = 1.8 Hz, 1H), 7.92 - 7.96 (m, 1H), 7.60 (d, *J* = 1.8 Hz, 1H), 7.35 - 7.43 (m, 2H), 7.04 (d, *J* = 8.7 Hz, 1H), 3.89 - 3.94 (m, 2H), 3.87 (s, 3H), 2.80 - 2.83 (t, *J* = 6.6 Hz, 2H), 1.95 - 1.99 (t, *J* = 6.9 Hz, 1H)

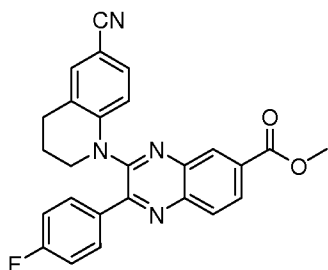
Step 4. Methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate



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To a solution of methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (350 mg, 0.97 mmol) in dichloromethane (20 mL) was added pyridine (547 mg, 6.92 mmol) and then (trifluoromethane)sulfonyl trifluoromethanesulfonate (307 mg, 1.09 mmol) and the reaction was stirred for 2 h at room temperature. The resulting mixture was concentrated in vacuo to provide a residue, which was purified by silica gel chromatography with 1 % - 6 % ethyl acetate in petroleum ether to give methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as a yellow solid (440 mg, crude).

Step 5. Methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate



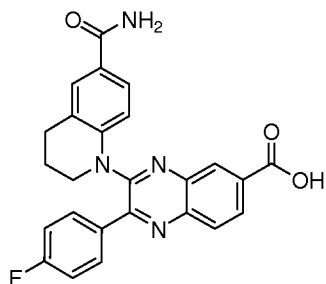
To a solution of methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy] quinoxaline-6-carboxylate (440mg, crude) in 1,4-dioxane (8 mL), was added (4-fluorophenyl)boronic acid (251 mg, 1.79 mmol), Pd(PPh₃)₄ (51 mg, 0.04 mmol), K₃PO₄ (377 mg, 1.79 mmol) with stirring for 2 h at 90°C in an oil bath. The reaction was then quenched by the addition water (30 mL), extracted with chloromethane (3 x 20 mL) and concentrated under vacuum to give methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a yellow solid (200 mg, 47 % 2 steps).

LC/MS(ES, m/z): [M+H]⁺ 439.1

¹H-NMR (300 MHz, CDCl₃) δ 8.67 (d, *J* = 1.8 Hz, 1H), 8.30 - 8.33 (m, 1H), 8.15 (d, *J* = 8.7 Hz, 1H), 7.78 - 7.82 (m, 2H), 7.33 (s, 1H), 6.93 - 7.14 (m, 3H), 6.60 (d, *J* = 8.4 Hz, 1H), 4.13 (s, 3H), 3.78 - 3.82 (t, *J* = 6.0 Hz, 2H), 2.84 - 2.88 (t, *J* = 6.6 Hz, 2H), 2.03 - 2.11 (m, 2H)

Step 6. 3-(6-Carbamoyl-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid

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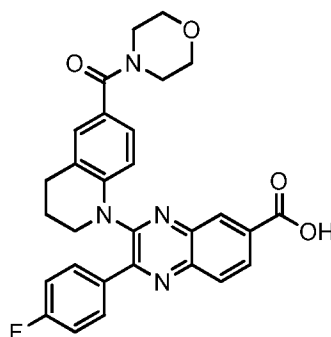
To a solution of methyl 3-(6-cyano-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (150 mg, 0.34 mmol) in DMSO (1.6 mL) and EtOH (6.4 mL) was added H₂O₂ (1.2 mL, 40%), NaOH (0.4 mL, 1M) with stirring overnight at room temperature. The resulting mixture was concentrated under vacuum, diluted with water (15 mL), adjusted pH to 7 with AcOH. The solids were collected by filtration to give 3-(6-carbamoyl-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a solid (131 mg, 87 %).

(ES, m/z): [M+H]⁺ 443.1

¹H-NMR (300 MHz, DMSO) δ 8.40 (d, *J* = 1.2 Hz, 1H), 8.11 - 8.19 (m, 2H), 7.79 - 7.83 (m, 2H), 7.66 (s, 1H), 7.55 (d, *J* = 1.2 Hz, 1H), 7.27 - 7.30 (m, 1H), 7.12 - 7.18 (m, 2H), 7.03 (s, 1H), 6.61 (d, *J* = 8.4 Hz, 1H), 3.80 - 3.84 (t, *J* = 6.0 Hz, 2H), 2.74 - 2.81 (m, *J* = 6.6 Hz, 2H), 1.99 - 2.03 (m, *J* = 6.60 Hz, 2H)

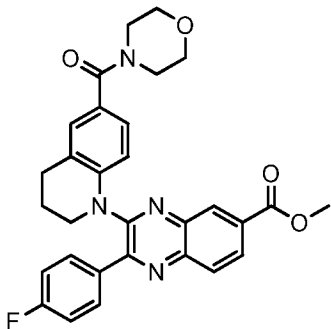
EXAMPLE 15

2-(4-Fluorophenyl)-3-[6-[(morpholin-4-yl)carbonyl]-1,2,3,4-tetrahydroquinolin-1-yl]quinoxaline-6-carboxylic acid



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Step 1. Methyl 2-(4-fluorophenyl)-3-[6-[(morpholin-4-yl)carbonyl]-1,2,3,4-tetrahydroquinolin-1-yl]quinoxaline-6-carboxylate

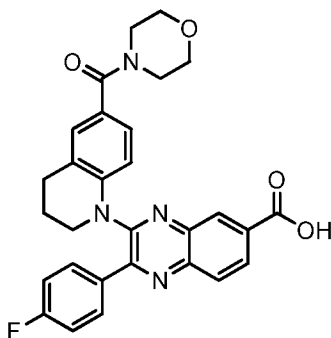


To a solution of methyl 3-(6-bromo-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (130 mg, 0.26 mmol) in dioxane (25 ml) was added morpholine (35 mg, 0.40 mmol) and Pd(dppf)₂Cl₂ (6.7 mg, 0.05 mmol) with stirring overnight maintained with atmosphere of CO(g) at 100°C under 5Atm. The reaction mixture was concentrated under vacuum to give a residue, which was applied onto a silica gel column with 1 % methanol in dichloromethane to afford methyl 2-(4-fluorophenyl)-3-[6-[(morpholin-4-yl)carbonyl]-1,2,3,4-tetrahydroquinolin-1-yl]quinoxaline-6-carboxylate as a yellow solid (107 mg, 77 %).

(ES, m/z): [M+H]⁺ 527.0

¹H-NMR (300 MHz, DMSO): δ 8.43 (s, 1H), 8.13 (s, 2H), 7.68 - 7.73 (m, 2H), 7.04 - 7.12 (m, 3H), 6.69 (d, *J* = 8.4 Hz, 1H), 6.57 (d, *J* = 8.1 Hz, 1H), 3.96 (s, 5H), 3.57 (s, 4H), 2.74 - 2.78 (t, *J* = 6.6 Hz, 2H), 2.02 - 2.06 (t, *J* = 5.7 Hz, 2H)

Step 2. 2-(4-Fluorophenyl)-3-[6-[(morpholin-4-yl)carbonyl]-1,2,3,4-tetrahydroquinolin-1-yl]quinoxaline-6-carboxylic acid



To a solution of methyl 2-(4-fluorophenyl)-3-[6-[(morpholin-4-yl)carbonyl]-1,2,3,4-tetrahydroquinolin-1-yl]quinoxaline-6-carboxylate (107 mg, 0.20 mmol) in methanol (30 ml) and water (2.0 ml) was added sodium hydroxide (32 mg, 0.8 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (20 ml) and adjusted to pH 4 with hydrogen chloride (3 N). The solids were collected by filtration to

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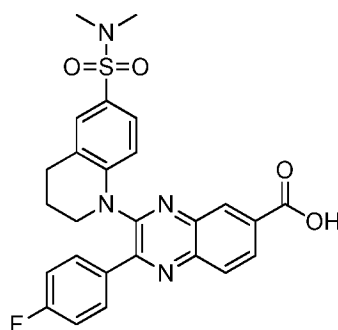
afford 2-(4-fluorophenyl)-3-[6-[(morpholin-4-yl)carbonyl]-1,2,3,4-tetrahydroquinolin-1-yl]quinoxaline-6-carboxylic acid as a light yellow solid (90 mg, 86 %).

(ES, m/z): [M+H]⁺ 513.2

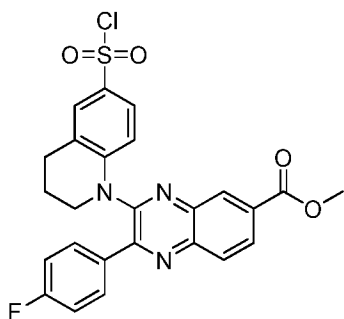
¹H-NMR (300 MHz, DMSO): δ 8.41 (s, 1H), 8.12 (s, 2H), 7.66 - 7.71 (m, 2H), 7.02 - 7.10 (m, 3H), 6.68 (d, *J* = 6.6 Hz, 1H), 6.53 (d, *J* = 8.4 Hz, 1H), 3.93 - 3.97 (t, *J* = 6.3 Hz, 2H), 3.56 (s, 4H), 3.38 (s, 3H), 2.73 - 2.77 (m, 2H), 2.01 - 2.05 (m, 2H)

EXAMPLE 16

3-[6-(Dimethylsulfamoyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



Step 1. Methyl 3-[6-(chlorosulfonyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate



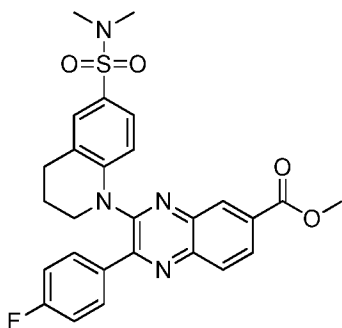
To a solution of methyl 2-(4-fluorophenyl)-3-(1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (300 mg, 0.73 mmol) in chloroform (50 mL) was added sulfuric acid (213.6 mg, 2.18 mmol) and thionyl chloride (514 mg, 4.36 mmol) dropwise with stirring at 85°C for 3 h in an oil bath. The reaction was then quenched by the addition of ice-water, extracted with dichloromethane (3 x 80 mL). The organic layers combined and dried over magnesium sulfate, concentrated under vacuum to give the residue, which was applied onto a silica gel column with 2 % ethyl acetate in petroleum to afford methyl 3-[6-(chlorosulfonyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a yellow solid (260 mg, 70 %).

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(ES, m/z): $[M+H]^+$ 512.0

$^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 8.70 (d, $J = 1.5$ Hz, 1H), 8.35 - 8.38 (m, 1H), 8.18 (d, $J = 4.2$ Hz, 1H), 7.77 - 7.82 (m, 2H), 7.71 (d, $J = 2.1$ Hz, 1H), 7.48 - 7.52 (m, 1H), 7.11 - 7.16 (m, 2H), 6.67 (d, $J = 9.0$ Hz, 1H), 4.04 (s, 3H), 3.76 - 3.80 (t, $J = 6.0$ Hz, 2H), 2.92 - 2.96 (t, $J = 6.3$ Hz, 2H), 2.07 - 2.12 (m, 2H)

Step 2. Methyl 3-[6-(dimethylsulfamoyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate



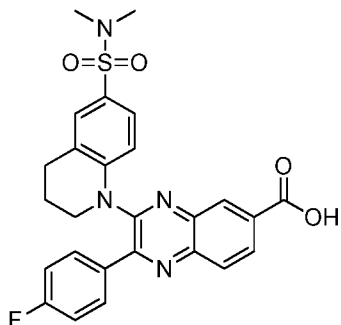
To a solution of dimethylamine hydrochloride (49.66 mg, 0.61 mmol) in dichloromethane (50 mL) was added triethylamine (102 mg, 1.01 mmol) and stirred for 10 min. Then methyl 3-[6-(chlorosulfonyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate (260 mg, 0.51 mmol) in dichloromethane (20 mL) was added dropwise with stirring for 30 min at room temperature. The reaction mixture was concentrated under vacuum to give the residue, which was applied onto a silica gel column with 2% - 5% ethyl acetate in petroleum ether to afford methyl 3-[6-(dimethylsulfamoyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a yellow solid (240 mg, 91%).

(ES, m/z): $[M+H]^+$ 521.0

$^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 8.68 (d, $J = 1.5$ Hz, 1H), 8.28 - 8.31 (m, 1H), 8.14 (d, $J = 5.7$ Hz, 1H), 7.72 - 7.78 (m, 2H), 7.43 (d, $J = 2.1$ Hz, 1H), 7.15 - 7.19 (m, 1H), 6.96 - 7.02 (m, 2H), 6.57 (d, $J = 8.4$ Hz, 1H), 4.04 (s, 3H), 3.95 - 3.99 (t, $J = 6.0$ Hz, 2H), 2.87 - 2.91 (t, $J = 6.9$ Hz, 2H), 2.61 (s, 6H), 2.09 - 2.18 (m, 2H)

Step 3. 3-[6-(Dimethylsulfamoyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid

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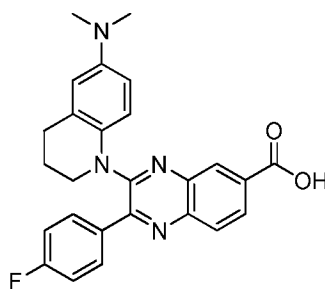
To a solution of methyl 3-[6-(dimethylsulfamoyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate (120 mg, 0.23 mmol) in methanol (30 mL) and water (2 mL) was added sodium hydroxide (36.9 mg, 0.92 mmol) with stirring overnight at room temperature. The reaction mixture was concentrated under vacuum, dissolved in water (30 mL) and adjusted to pH 5 with hydrogen chloride (3 N). The solids were collected by filtration to afford 3-[6-(dimethylsulfamoyl)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a light yellow solid (43.5 mg, 37 %).

(ES, m/z): $[M+H]^+$ 507.1

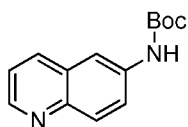
$^1\text{H-NMR}$ (300 MHz, DMSO): δ 8.43 (s, 1H), 8.22 - 8.25 (m, 1H), 8.04 (d, $J = 8.4$ Hz, 1H), 7.70 - 7.75 (m, 2H), 7.30 (d, $J = 2.1$ Hz, 1H), 7.08 - 7.14 (t, $J = 9.0$ Hz, 2H), 6.97 - 7.01 (m, 1H), 6.62 (d, $J = 8.4$ Hz, 1H), 3.99 - 4.03 (t, $J = 6.0$ Hz, 2H), 2.82 - 2.86 (t, $J = 6.0$ Hz, 2H), 2.51 (s, 6H), 2.04 - 2.18 (m, 2H)

EXAMPLE 17

3-[6-(Dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



Step 1. *tert*-Butyl N-(quinolin-6-yl)carbamate



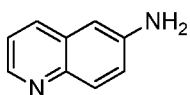
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To a solution of quinoline-6-carboxylic acid (5 g, 28.87 mmol) in toluene (250 ml) was added triethylamine (14.6 g, 144.28 mmol), DPPA (15.9 g, 57.78 mmol,) with stirring for 1 h at 0°C in water/ice bath. Then 2-methylpropan-2-ol (6.4 g, 86.34 mmol) was added with stirring overnight at 90°C in an oil bath and then diluted with water (300 ml), extracted with dichloromethane (3 x 100 ml), dried over anhydrous magnesium sulfate and concentrated under vacuum to give a residue, which was purified by a silica gel column with 1% - 5% ethyl acetate in petroleum ether to afford *tert*-butyl N-(quinolin-6-yl)carbamate as a yellow solid (1.3 g, 18%).

(ES, m/z):[M+H]⁺ 245.1

¹H-NMR (300 MHz, CDCl₃) δ 8.80 - 8.82 (m, 1H), 8.01 - 8.14 (m, 2H), 7.47 - 7.51 (m, 1H), 7.30 - 7.38 (m, 1H), 6.90 - 7.10 (m, 1H), 1.56 (s, 9H)

Step 2. Quinolin-6-amine

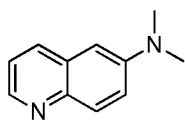


To a solution of *tert*-butyl N-(quinolin-6-yl)carbamate (1.3 g, 5.32 mmol) in DCM (40 ml) was added TFA(10 ml) with stirring overnight at room temperature. The resulting mixture was concentrated under vacuum, diluted with water (30 ml), adjusted pH to 8 with NaHCO₃ solution, extracted with dichloromethane (2 x 20 ml), dried over magnesium sulfate and concentrated *in vacuo* to give quinolin-6-amine as a yellow solid (666 mg, 87%).

LC/MS (ES, m/z):[M+H]⁺ 145.1

¹H-NMR (300 MHz, CDCl₃) δ 8.67 - 8.69(m, 1H), 7.91 - 7.95(m, 2H), 7.28 - 7.31(m, 1H), 7.16 - 7.20(m, 1H), 6.92 (s, 1H), 3.96 (s, 2H)

Step 3. *N,N*-Dimethylquinolin-6-amine

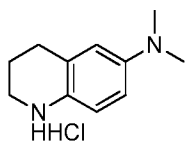


To a solution of quinolin-6-amine (666 mg, 4.62 mmol) in CH₃OH(15 ml) was added 40% aqueous formaldehyde (1 ml), NaBH₃CN (400 mg, 6.37 mmol) with stirring for 3 days at room temperature and diluted with water (150 ml), extracted with ethyl acetate(3 x 30 ml), dried over magnesium sulfate and concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 5% - 20% ethyl acetate in petroleum ether to give *N,N*-dimethylquinolin-6-amine as a solid (400 mg, 50%).

LC/MS (ES, m/z):[M+H]⁺ 173.1

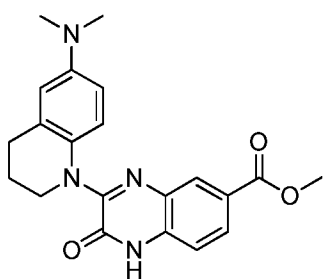
¹H-NMR (300 MHz, CDCl₃) δ 8.59 - 8.61 (m, 1H), 7.94 - 8.00 (m, 2H), 7.37 - 7.41 (m, 1H), 7.27 - 7.32 (m, 1H), 6.81 (d, $J = 2.7$ Hz, 1H), 3.07 (s, 6H)

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Step 4. *N,N*-Dimethyl-1,2,3,4-tetrahydroquinolin-6-amine hydrochloride

To a solution of *N,N*-dimethylquinolin-6-amine (400 mg, 2.32 mmol) in methanol (20 ml), was added PtO₂ (10 mg) and HCl (conc, 1 drop) under hydrogen and the reaction was stirred overnight at room temperature. The reaction was filtered and concentrated *in vacuo* to give *N,N*-dimethyl-1,2,3,4-tetrahydroquinolin-6-amine hydrochloride as a red oil (400 mg, crude).

LC/MS (ES, *m/z*):[M+H]⁺ 177.1

Step 5. Methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

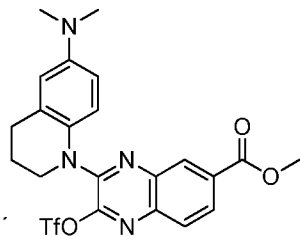
To a solution of methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (420 mg, 1.76 mmol,) in NMP (3 mL) was added DIEA (343 mg, 2.65 mmol), *N,N*-dimethyl-1,2,3,4-tetrahydroquinolin-6-amine hydrochloride (400 mg, crude) and the reaction was stirred for 2 h at 130°C in an oil bath. The resulting solution was diluted with water (100 mL), and the solids were collected by filtration to give methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a red solid (260 mg, 39 %).

LC/MS(ES, *m/z*):[M+H]⁺ 378.1

¹H-NMR (300 MHz, CDCl₃) δ 10.29 (s,1H), 8.28 (d, *J* = 1.5 Hz, 1H), 7.84 - 7.91 (m, 1H), 7.02 - 7.07 (m, 1H), 6.85 (d, *J* = 8.7 Hz, 1H), 6.62 (s, 2H), 4.06 - 4.16 (m, 2H), 3.95 (s, 3H), 2.98 (s,6H), 2.81 - 2.91 (m, 2H), 2.38 - 2.41 (m, 2H)

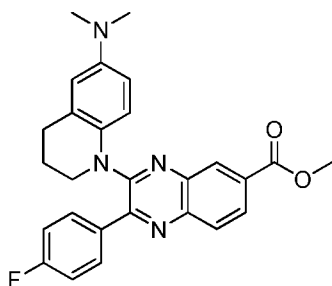
Step 6. Methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-[(trifluoromethane)sulfonyloxy] quinoxaline-6-carboxylate

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To a solution of methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (260 mg, 0.69 mmol) in dichloromethane (50 ml) was added pyridine (270 mg, 3.41 mmol) and (trifluoromethane)sulfonyl trifluoromethanesulfonate (390 mg, 1.38 mmol) and the reaction was stirred for 2 h at room temperature and then washed with water (100 ml), dried over anhydrous magnesium sulfate and concentrated *in vacuo* to give methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as a red solid (400 mg, crude).

Step 7. Methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate



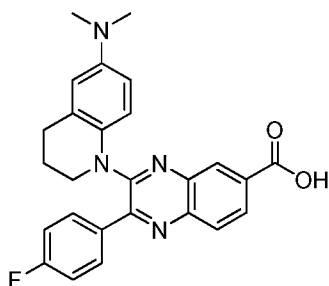
To a solution of methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (400 mg, 0.78 mmol) in 1,4-dioxane (3 ml) was added K_3PO_4 (331 mg, 1.56 mmol), $Pd(PPh_3)_4$ (45 mg, 0.04 mmol), and (4-fluorophenyl)boronic acid (214 mg, 1.53 mmol) and the reaction was stirred for 2 h at 90°C in a oil bath. The resulting solution was concentrated *in vacuo* to give a residue, which was purified by silica gel column chromatography with 1 % - 20 % ethyl acetate in petroleum ether to afford methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a red solid (30 mg, 8 %).

LC/MS (ES, m/z): $[M+H]^+$ 456.1

1H -NMR (300 MHz, $CDCl_3$): δ 8.56 (s, 1H), 8.13 - 8.20 (m, 1H), 8.02 - 8.05 (m, 1H), 7.73 - 7.85 (m, 2H), 6.91 - 6.99 (m, 3H), 6.75 - 6.85 (m, 1H), 6.30 - 6.40 (m, 2H), 4.01 - 4.03 (s, 3H), 3.75 - 3.80 (m, 2H), 2.86 (s, 6H), 2.75 - 2.79 (m, 2H), 2.02 - 2.06 (m, 2H)

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Step 8. 3-[6-(Dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



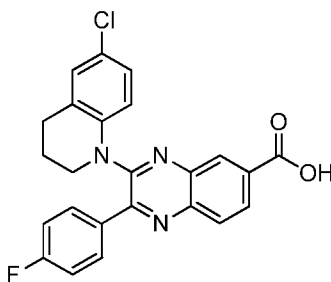
To a solution of methyl 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate (30 mg, 0.07 mmol) in methanol (20 ml) and water (2 ml) was added sodium hydroxide (10 mg, 0.25 mmol) and the reaction was stirred overnight at room temperature. The resulting solution was diluted with water (100 ml), adjusted pH to 5 with AcOH, extracted with ethyl acetate (3 x 20 ml), dried over anhydrous magnesium sulfate and concentrated *in vacuo* to give 3-[6-(dimethylamino)-1,2,3,4-tetrahydroquinolin-1-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a red solid (3 mg, 10 %).

LCMS (ES, m/z):[M+H]⁺ 443.1

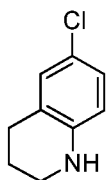
¹H-NMR (300 MHz, CD₃OD): δ 8.48 (s, 1H), 8.11 - 8.15 (m, 1H), 7.96 (d, $J = 8.4$ Hz, 1H), 7.67 - 7.71 (m, 2H), 6.91 - 6.97 (t, $J = 9.0$ Hz, 2H), 6.20 - 6.60 (m, 3H), 3.85 - 4.05 (m, 2H), 2.60 - 2.90 (m, 8H), 2.07 - 2.11 (t, $J = 6.6$ Hz, 2H)

EXAMPLE 18

3-(6-Chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



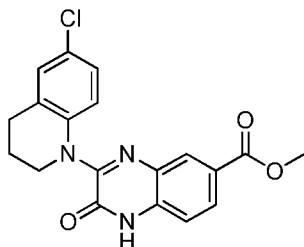
Attorney Docket No. BIOE0009-401-PC

Step 1. 6-Chloro-1,2,3,4-tetrahydroquinoline

To a solution of 6-chloroquinoline (1.5 g, 9.17 mmol) in C₂H₅OH (50 ml) was added PtO₂ (41.5 mg, 0.18 mmol) and concentrated HCl (0.1 ml) under an atmosphere of hydrogen gas. The reaction was stirred overnight at room temperature, then concentrated *in vacuo*, diluted with water (100 ml), adjusted to pH 8 with aqueous sodium bicarbonate. The resulting solution was extracted with dichloromethane (3 x 80 ml) and the organic layers were combined, dried over anhydrous magnesium sulfate, concentrated *in vacuo* to afford 6-chloro-1,2,3,4-tetrahydroquinoline as a colorless oil (1.2 g, 78 %).

LC/MS (ES, *m/z*): [M+H]⁺ 168.0

¹H-NMR (300 MHz, CDCl₃) δ 6.90 - 6.98 (m, 2H), 6.39 - 6.42 (t, *J* = 1.2 Hz, 1H), 3.23 - 3.35 (m, 2H), 2.73 - 2.81 (m, 2H), 1.91 - 1.96 (m, 2H)

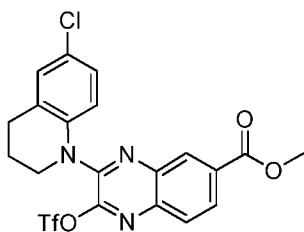
Step 2. Methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

To a solution of methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (1.0 g, 4.19 mmol) in NMP (10.0 ml) was added 6-chloro-1,2,3,4-tetrahydroquinoline (1.20 g, 7.16 mmol) and the reaction was stirred for 1 h at 150°C in an oil bath. The reaction mixture was cooled down to room temperature, precipitated with water (100 ml). The solids were collected by filtration and dried in an oven under reduced pressure to afford methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a gray solid (1.0 g, crude).

LC/MS (ES, *m/z*): [M+H]⁺ 370.0

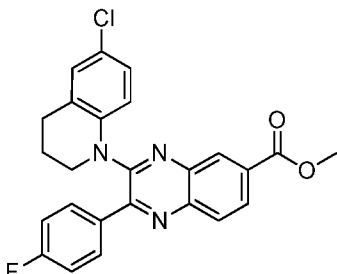
Attorney Docket No. BIOE0009-401-PC

Step 3. Methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate



To a solution of methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (1.0 g, crude) in dichloromethane (80 ml) was added pyridine (850 mg, 10.75 mmol) and Tf_2O (1.50 g, 5.32 mmol) with stirring overnight under an atmosphere of nitrogen at room temperature. Then reaction mixture was quenched with water (100 ml), extracted with dichloromethane (3 x 20 ml), and the organic layers were combined and dried over anhydrous magnesium sulfate. The organics were concentrated *in vacuo* to afford methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as a yellow solid (1.0 g, crude), which was used to the next step directly.

Step 4. Methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate



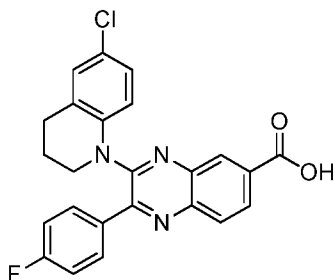
To a solution of methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy] quinoxaline-6-carboxylate (400 mg, crude) in DME (5.0 ml) and water (1 ml) was added (4-fluorophenyl)boronic acid (134 mg, 0.96 mmol), $\text{Pd}(\text{PPh}_3)_4$ (45.5 mg, 0.04 mmol), Na_2CO_3 (251 mg, 2.37 mmol) with stirring for 1h at 95°C under an atmosphere of nitrogen. The reaction mixture was concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 1 % ethyl acetate in petroleum ether to afford methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a light yellow solid (125 mg).

LC/MS(ES, m/z): $[\text{M}+\text{H}]^+$ 448.0

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$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.39 (s, 1H), 8.12 (d, $J = 1.2$ Hz, 2H), 7.75 - 7.80 (m, 2H), 7.07 - 7.18 (m, 3H), 6.65 - 6.77 (m, 2H), 3.95 (s, 3H), 3.79 - 3.92 (m, 2H), 2.72 - 2.77 (t, $J = 6.6$ Hz, 2H), 1.94 - 2.02 (m, 2H)

Step 5. 3-(6-Chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



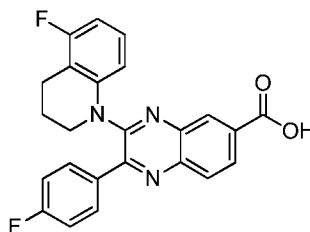
To a solution of methyl 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (125 mg, 0.28 mmol) in methanol (30 ml) and water (1.0 ml) was added sodium hydroxide (44.6 mg, 1.11 mmol). The reaction was stirred overnight at room temperature. Then the reaction mixture was concentrated *in vacuo*, dissolved in water (30 ml), adjusted to pH 5 with aqueous hydrochloric acid (3 N) to give a precipitate, which was collected by filtration to afford 3-(6-chloro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a light yellow solid (90 mg, 74 %).

LC/MS (ES, m/z): $[\text{M}+\text{H}]^+$ 434.0

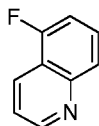
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.37 (s, 1H), 8.05 - 8.16 (m, 2H), 7.75 - 7.79 (m, 2H), 7.07 - 7.19 (m, 3H), 6.62 - 6.70 (m, 1H), 6.73 - 6.77 (m, 1H), 3.77 - 3.81 (t, $J = 6.0$ Hz, 2H), 2.72 - 2.77 (t, $J = 6.3$ Hz, 2H), 1.95 - 2.01 (m, 2H)

EXAMPLE 19

3-(7-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid

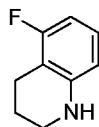


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Step 1. 5-Fluoroquinoline

To a suspension of 5-aminoquinoline (10.0g, 0.069 mol) in 48% HBF_4 (40 mL) at 0°C was added portionwise sodium nitrite. This was stirred for 1 hour and then poured into 1:1 ethyl acetate/diethyl ether (50 mL). The resulting suspension was filtered and the solid dried. This solid was added portionwise to refluxing xylene (80 mL) and stirred for 2 hours then allowed to cool. The xylene was decanted off and the residue was dissolved in 1N aqueous hydrochloric acid (100 mL). After neutralization with sodium carbonate, the mixture was extracted with ethyl acetate (3 x 80 mL). The extracts were dried over sodium sulfate, filtered and the volatiles were removed *in vacuo*. The residue was purified by silica gel column chromatography, eluting with 2% ethyl acetate in petroleum ether to afford 5-fluoroquinoline as a colorless oil (2.5 g, 24.5%).

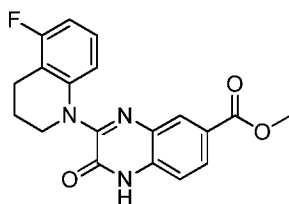
$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 8.93 - 8.98 (m, 1H), 8.43 - 8.46 (m, H), 7.92 (d, $J = 8.4$ Hz, 1H), 7.62 - 7.78 (m, 1H), 7.41 - 7.49 (m, 1H), 7.22 - 7.26 (m, 1H)

Step 2. 5-Fluoro-1,2,3,4-tetrahydroquinoline

Palladium on carbon (10%, 1.25 g) was added to a solution of 5-fluoroquinoline (2.5 g, 16.99 mmol) in methanol and the reaction was overnight at room temperature under an atmosphere of hydrogen. The reaction mixture was filtered through Celite and concentrated *in vacuo* to afford 5-fluoro-1,2,3,4-tetrahydroquinoline as a colorless oil (1.80 g, 70 %).

LC/MS (ES, m/z): $[\text{M}+\text{H}]^+$ 152.0

$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 6.87 - 6.95 (m, 2H), 6.26 - 6.40 (m, 2H), 3.28 - 3.31 (m, 2H), 2.72 - 2.77 (t, $J = 6.60$ Hz, 2H), 1.92 - 1.98 (m, 2H)

Step 3. Methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

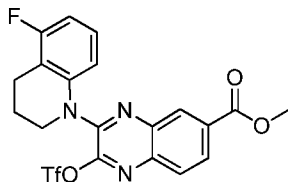
To a solution of methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (1.0 g, 4.19 mmol) in NMP (10.0 mL) was added 5-fluoro-1,2,3,4-tetrahydroquinoline (1.5 g, 9.92 mmol) with

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stirring for 1 h at 150°C in an oil bath. The reaction mixture was cooled to room temperature, precipitated with water (100 mL). The solids were collected by filtration and dried in an oven under reduced pressure to afford methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a gray solid (1.0 g, crude).

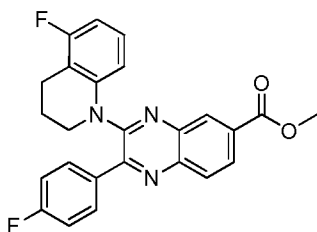
LC/MS (ES, m/z): $[M+H]^+$ 354.0

Step 4. Methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate



To a solution of methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (1.0 g, crude) in dichloromethane (80 mL) was added pyridine (890 mg, 11.25 mmol) and Tf_2O (1.58 g, 5.60 mmol) and the reaction was stirred overnight under an atmosphere of nitrogen at room temperature. The reaction mixture was then quenched with water (50 mL), extracted with dichloromethane (3 x 80 mL). Then the organic layers were combined and dried over anhydrous magnesium sulfate, concentrated *in vacuo* to afford methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as a yellow solid (1.0 g), which was used directly in the next step.

Step 5. Methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate



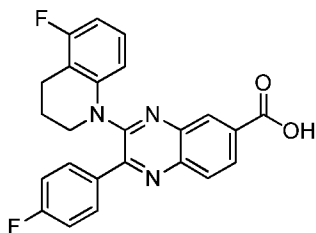
To a solution of methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (200 mg, 0.41 mmol) in dioxane (5.0 mL) and water (3 drops) was added (4-fluorophenyl)boronic acid (173 mg, 1.24 mmol), $Pd(PPh_3)_4$ (23.77 mg, 0.02 mmol), and K_3PO_4 (262 mg, 1.23 mmol). The reaction was stirred for 1h at 95°C under an atmosphere of nitrogen. The reaction mixture was concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 1 % ethyl acetate in petroleum ether to afford methyl 3-(5-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a light yellow solid (140 mg, 78 %).

LC/MS (ES, m/z): $[M+H]^+$ 432.0

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$^1\text{H-NMR}$ (300 MHz, CDCl_3) δ 8.63 (d, $J = 1.8$ Hz, 1H), 8.22 - 8.26 (m, 1H), 8.09 (d, $J = 2.7$ Hz, 1H), 7.82 - 7.88 (m, 2H), 7.01 - 7.09 (m, 2H), 6.76 - 6.84 (m, 1H), 6.45 - 6.58 (m, 2H), 4.01 (s, 3H), 3.71 - 3.77 (m, 2H), 2.81 - 2.85 (t, $J = 6.9$ Hz, 2H), 2.02 - 2.10 (m, 2H)

Step 6. 3-(7-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



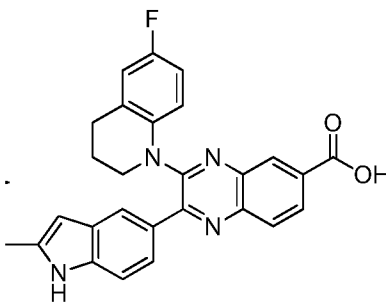
Sodium hydroxide (52.0 mg, 1.30 mmol) was added to a solution of methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (140 mg, 0.32 mmol) in methanol (30 mL) and water (1.0 mL). The reaction was stirred overnight at room temperature and then concentrated *in vacuo*, dissolved in water (30 mL), and adjusted to pH 5 with aqueous hydrochloric acid (3 N) to give a precipitate, which was collected by filtration to afford 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a light yellow solid (100 mg, 74%).

LC/MS(ES, m/z): $[\text{M}+\text{H}]^+$ 418.1

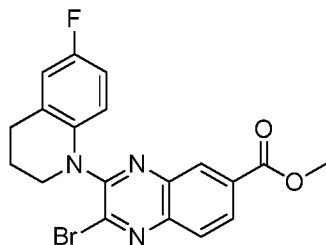
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 8.54 (s, 1H), 8.09 - 8.38 (m, 2H), 7.81 - 7.90 (m, 2H), 7.16 - 7.22 (m, 2H), 6.73 - 6.80 (m, 1H), 6.46 - 6.59 (m, 2H), 3.73 - 3.76 (t, $J = 6.0$ Hz, 2H), 2.71 - 2.75 (t, $J = 6.6$ Hz, 2H), 1.97 - 2.06 (m, 2H)

EXAMPLE 20

3-(6-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(2-methyl-1H-indol-5-yl)quinoxaline-6-carboxylic acid



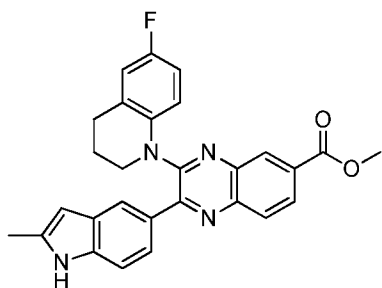
Attorney Docket No. BIOE0009-401-PC

Step 1. Methyl 2-bromo-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate

To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (1.0, 2.06 mmol) in toluene (30 mL) was added Bu_4NBr (1.33 g, 4.12 mmol). The reaction was stirred for 5 h at 120°C under an inert atmosphere of nitrogen. The reaction mixture was concentrated *in vacuo* to give a residue, which was purified by a silica gel column with 1 % ethyl acetate in petroleum ether to afford methyl 2-bromo-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a yellow solid (540 mg, 63%).

LC/MS(ES, m/z): $[\text{M}+\text{H}]^+$ 417.0

$^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 8.60 (d, $J = 1.5$ Hz, 1H), 8.20 - 8.23 (m, 1H), 7.99 (d, $J = 8.7$ Hz, 1H), 6.93-6.98 (m, 1H), 6.78 - 6.85 (m, 1H), 6.57 (d, $J = 4.8$ Hz, 1H), 4.02(s, 3H), 3.92 - 3.96 (m, 2H), 2.87 - 2.92 (m, 2H), 2.13 - 2.17 (m, 2H)

Step 2. Methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(2-methyl-1H-indol-5-yl)quinoxaline-6-carboxylate

To a solution of methyl 2-bromo-3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (200 mg, 0.48 mmol) in ethylene glycol dimethyl ether (7 ml) was added 2-methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1H-indole (124 mg, 0.48 mmol), sodium carbonate (101.8 mg, 0.96 mmol) and $\text{Pd}(\text{PPh}_3)_4$ (28 mg, 0.02 mmol) and water (3 ml). The reaction was stirred for 40 min at 90°C . Then it was extracted with ethyl acetate (3 x 50 ml) and the organic layers were combined, dried over anhydrous magnesium sulfate and concentrated *in vacuo* to provide a residue, which was purified by a silica gel column chromatography with 2 % ethyl

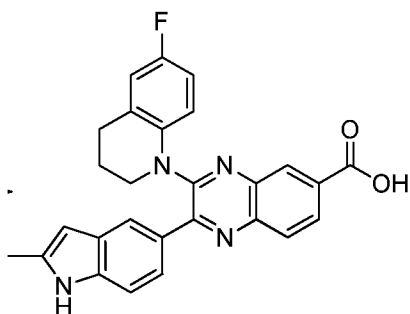
Attorney Docket No. BIOE0009-401-PC

acetate in petroleum ether to afford methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(2-methyl-1*H*-indol-5-yl)quinoxaline-6-carboxylate as a light red solid (118 mg, 53 %).

LC/MS (ES, *m/z*): [M+H]⁺ 467.0

¹H-NMR (300 MHz, CDCl₃): δ 8.62 (d, *J* = 1.5 Hz, 1H), 8.20 - 8.26 (m, 2H), 7.99 - 8.02 (m, 2H), 7.60 (d, *J* = 9.0 Hz, 1H), 7.22 (d, *J* = 6.6 Hz, 1H), 6.79 - 6.83 (m, 1H), 6.72 - 6.75 (m, 1H), 6.57 - 6.71 (m, 1H), 6.23 (s, 1H), 4.01 (s, 3H), 3.68 - 3.72 (m, 2H), 2.72 - 2.83 (m, 2H), 2.46 (s, 3H), 1.98 - 2.02 (m, 2H)

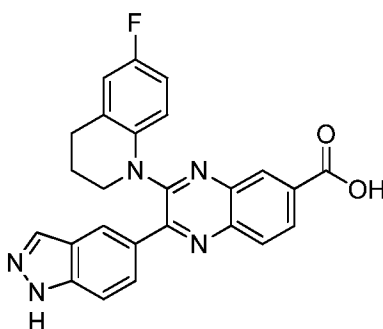
Step 3. 3-(6-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(2-methyl-1*H*-indol-5-yl)quinoxaline-6-carboxylic acid



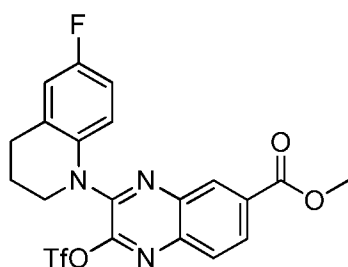
To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(2-methyl-1*H*-indol-5-yl)quinoxaline-6-carboxylate (118 mg, 0.25 mmol) in methanol (20 ml) and water (1.0 ml) was added sodium hydroxide (40 mg, 1.00 mmol). The reaction was stirred overnight at room temperature. The reaction mixture was concentrated *in vacuo*, dissolved in water (20 mL) and adjusted to pH 4 with hydrogen chloride (3 N). The solids were collected by filtration to afford 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(2-methyl-1*H*-indol-5-yl)quinoxaline-6-carboxylic acid as a light yellow solid (81 mg, 71%).

LC/MS (ES, *m/z*): [M+H]⁺ 453.1

¹H-NMR (300 MHz, DMSO): δ 10.99 (s, 1H), 8.24 (s, 1H), 8.09 - 8.12 (m, 1H), 7.91 - 7.95 (m, 2H), 7.51 (d, *J* = 1.5 Hz, 1H), 7.48 (d, *J* = 1.5 Hz, 1H), 6.81 - 6.85 (m, 1H), 6.71 - 6.75 (m, 1H), 6.56 - 6.62 (m, 1H), 6.15 (s, 1H), 3.61 - 3.68 (m, 2H), 2.74 - 2.81 (m, 2H), 2.49 (s, 3H), 1.92 - 1.95 (m, 2H)

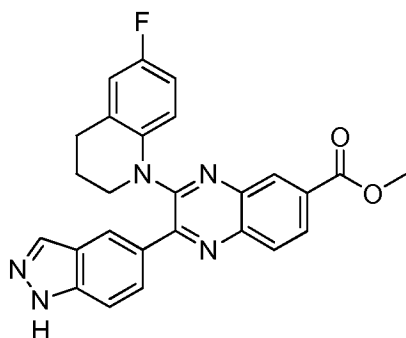
EXAMPLE 21**3-(6-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(1H-indazol-5-yl)quinoxaline-6-carboxylic acid**

Step 1. Methyl 3-(6-fluoro-3,4-dihydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate



To a solution of methyl 3-(6-fluoro-3,4-dihydroquinolin-1(2H)-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (150 mg, 0.43 mmol) in dichloromethane (30 mL) was added pyridine (136 mg, 1.72 mmol) and then Tf_2O (243 mg, 0.86 mmol) was added dropwise with stirring at 0°C . The resulting solution was stirred for 4 h at room temperature and then washed with water (3 x 50 mL), dried over anhydrous sodium sulfate and concentrated *in vacuo* to afford methyl 3-(6-fluoro-3,4-dihydroquinolin-1(2H)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate as red oil (200 mg, crude).

Step 2. Methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(1H-indazol-5-yl)quinoxaline-6-carboxylate



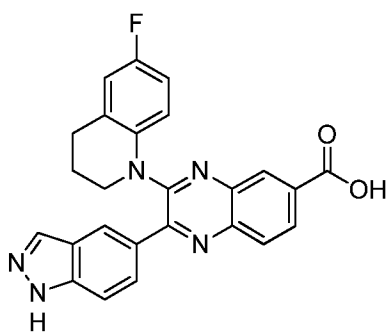
Attorney Docket No. BIOE0009-401-PC

To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (200 mg, crude) in ethylene glycol dimethyl ether (5 mL) was added *tert*-butyl 5-(tetramethyl-1,3,2-dioxaborolan-2-yl)-1*H*-indazole-1-carboxylate (282 mg, 0.82 mmol), Pd(PPh₃)₄ (24 mg, 0.02 mmol), sodium carbonate (109 mg, 1.03 mmol) and water (2 mL). The resulting solution was stirred for 1 h at 90°C and then quenched by the addition of CH₂Cl₂ (20 mL), washed with water (3 x 50 mL), dried over anhydrous sodium sulfate and concentrated *in vacuo* to give a residue, which was purified by silica gel column chromatography with 5 % ethyl acetate in petroleum ether to afford methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(1*H*-indazol-5-yl)quinoxaline-6-carboxylate as a yellow solid (60 mg).

LC/MS (ES, *m/z*):[M+H]⁺ 454.0

¹H-NMR (300 MHz, CDCl₃): δ 8.61 (d, *J* = 1.8 Hz, 1H), 8.19 - 8.26 (m, 2H), 8.08 - 8.18 (m, 2H), 7.87 - 7.95 (m, 1H), 7.43 - 7.49 (m, 1H), 6.66 - 6.71 (m, 2H), 6.47 - 6.53 (m, 1H), 4.02 (s, 3H), 3.76 - 3.80 (t, *J* = 6.0 Hz, 2H), 2.78 - 2.82 (t, *J* = 6.3 Hz, 2H), 2.01 - 2.09 (m, 2H)

Step 3. 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(1*H*-indazol-5-yl)quinoxaline-6-carboxylic acid



To a solution of methyl 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(1*H*-indazol-5-yl)quinoxaline-6-carboxylate (60 mg, 0.13 mmol) in methanol (20 mL) was added sodium hydroxide (15.8 mg, 0.40 mmol) and water (1 mL). The resulting solution was stirred for 3 h at room temperature and concentrated *in vacuo*. The residue was dissolved in water (20 mL) and adjusted to pH 5 with hydrochloric acid (3 N). The solids were collected by filtration to afford 3-(6-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(1*H*-indazol-5-yl)quinoxaline-6-carboxylic acid as a yellow solid (27 mg, 47 %).

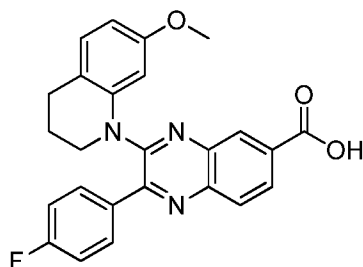
LC/MS (ES, *m/z*): [M+H]⁺ 440.1

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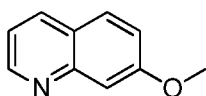
$^1\text{H-NMR}$ (300 MHz, DMSO) δ 13.11(s, 1H), 8.33 (s, 1H), 8.20 (s, 1H), 8.05 - 8.10 (m, 3H), 7.74 - 7.77 (m, 1H), 7.46 (d, $J = 8.7$ Hz, 1H), 6.72 - 6.81 (m, 2H), 6.49 - 6.56 (m, 1H), 3.71 - 3.75 (t, $J = 6.0$ Hz, 2H), 2.74 - 2.78 (t, $J = 6.3$ Hz, 2H), 1.93 - 1.97 (t, $J = 6.3$ Hz, 2H)

EXAMPLE 22

2-(4-Fluorophenyl)-3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



Step 1. 7-Methoxyquinoline

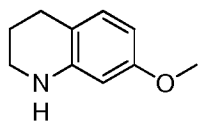


To a solution of sodium hydride (5.5 g, 137.50 mmol, 60%) in N,N-dimethylformamide (150 ml) was added quinolin-7-ol (8 g, 55.11 mmol). The reaction was stirred for 1 h at 0°C in a water/ice bath. Then CH_3I (7.84 g, 55.23 mmol) was added and the solution was stirred for an additional 1 h at room temperature. The reaction was then quenched by the addition of water/ice (700 ml) and extracted with ethyl acetate (3 x 200 ml). The organic layers were combined, dried over anhydrous sodium sulfate, and concentrated in vacuo to give a residue, which was purified by a silica gel column with 6 % ethyl acetate in petroleum ether to afford 7-methoxyquinoline as a red oil (5.5 g, 63%).

LC/MS (ES, m/z): $[\text{M}+\text{H}]^+$ 160.0

$^1\text{H-NMR}$ (300 MHz, CDCl_3): δ 8.84 - 8.86 (m, 1H), 8.07 - 8.11 (m, 1H), 7.70 - 7.73 (t, $J = 5.1$ Hz, 1H), 7.44 (d, $J = 2.4$ Hz, 1H), 7.20 - 7.30 (m, 2H), 3.95 (s, 3H)

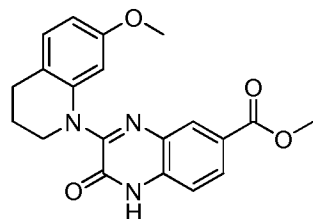
Attorney Docket No. BIOE0009-401-PC

Step 2. 7-Methoxy-1,2,3,4-tetrahydroquinoline

To a solution of 7-methoxyquinoline (2.0 g, 12.56 mmol) in methanol (60 ml) was added PtO₂ (180 mg, 0.79 mmol). H₂ (g) was introduced into above solution and the reaction was stirred overnight at room temperature and then the solids were filtered off. The organics were concentrated *in vacuo* to give a residue, which was purified by silica gel column chromatography with 3 % ethyl acetate in petroleum ether to afford 7-methoxy-1,2,3,4-tetrahydroquinoline as a light yellow oil (1.5 g, 73%).

LC/MS (ES, m/z): [M+H]⁺ 164.0

¹H-NMR (300 MHz, CD₃OD): δ 6.76 (d, *J* = 8.4 Hz, 1H), 6.09 - 6.17 (m, 2H), 3.69 (s, 1H), 3.19 - 3.23 (m, 2H), 2.64 - 2.69 (t, *J* = 6.6 Hz, 2H), 1.85 - 1.93 (m, 2H)

Step 3. Methyl 3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

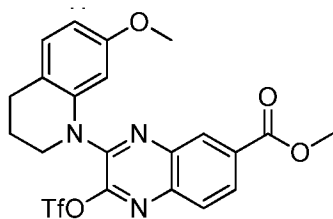
To a solution of 7-methoxy-1,2,3,4-tetrahydroquinoline (1.34 g, 8.21 mmol) in NMP (5 ml) was added methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (1.1 g, 4.61 mmol). The resulting solution was stirred for 1 h at 150°C in an oil bath and then diluted with water (300 ml). The solids were collected by filtration to afford methyl 3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a red solid (844 mg, 28%).

LC/MS (ES, m/z): [M+H]⁺ 366.1

¹H-NMR (300 MHz, CD₃OD): δ 8.21 (d, *J* = 1.8 Hz, 1H), 7.93 - 7.96 (m, 1H), 7.28 (d, *J* = 8.4 Hz, 1H), 7.05 (d, *J* = 8.4 Hz, 1H), 6.60 - 6.63 (m, 1H), 6.43 (d, *J* = 2.4 Hz, 1H), 3.92 - 4.02 (m, 1H), 3.88 (s, 3H), 3.69 (s, 3H), 2.76 - 2.81 (t, *J* = 6.6 Hz, 2H), 1.99 - 2.09 (m, 2H)

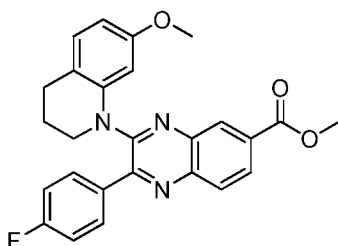
Step 4. Methyl 3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate

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To a solution of methyl 3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (690 mg, 1.89 mmol) in dichloromethane (80 ml) was added DIEA (1.5 g, 11.61 mmol). Then Tf_2O (1.4 g, 4.96 mmol) was added dropwise. The resulting solution was stirred overnight at room temperature and then quenched by the addition of water/ice (100 ml), extracted with dichloromethane (3 x 20 ml). Then the organic layers were combined, dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 2 % ethyl acetate in petroleum ether to afford methyl 3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as a red oil (870 mg, 93%).

Step 5. Methyl 2-(4-fluorophenyl)-3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate



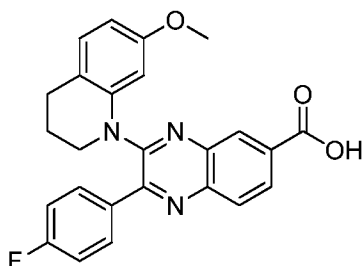
To a solution of methyl 3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy] quinoxaline -6-carboxylate (400 mg, 0.80 mmol) in 1,4-dioxane (3 ml) was added K_3PO_4 (338 mg, 1.59 mmol), $\text{Pd}(\text{PPh}_3)_4$ (47 mg, 0.04 mmol), and (4-fluorophenyl)boronic acid (224 mg, 1.60 mmol). The resulting solution was stirred for 1 h at 90°C in an oil bath and then quenched by the addition of water (80 ml), extracted with dichloromethane (3 x 30 ml), the organic layers were combined and dried over anhydrous magnesium sulfate and concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 5 % ethyl acetate in petroleum ether to afford methyl 2-(4-fluorophenyl)-3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate as a yellow solid (100 mg, 28%).

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LC/MS(ES, m/z): [M+H]⁺ 444.0

¹H-NMR (300 MHz, CD₃OD): δ 8.64 (d, *J* = 1.8 Hz, 1H), 8.19 - 8.23 (m, 1H), 8.08 (d, *J* = 2.1 Hz, 1H), 7.72 - 7.80 (m, 2H), 6.92 - 7.02 (m, 3H), 6.35 - 6.39 (m, 1H), 6.13 (d, *J* = 2.4 Hz, 1H), 4.02 (s, 3H), 3.77 - 3.90 (m, 2H), 3.59 (s, 3H), 2.74 - 2.78 (t, *J* = 6.6 Hz, 2H), 2.02 - 2.11 (m, 2H)

Step 6. 2-(4-Fluorophenyl)-3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid



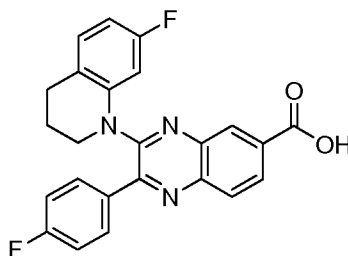
To a solution of methyl 2-(4-fluorophenyl)-3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylate (88 mg, 0.20 mmol) in methanol (30 ml) was added sodium hydroxide (32 mg, 0.80 mmol) and water (2 ml). The reaction was stirred for 2 days at room temperature. The resulting solution was diluted with water (15 ml), adjusted to pH 5 with AcOH, extracted with ethyl acetate (2 x 20 ml) and the organic layers were combined and concentrated *in vacuo* to afford 2-(4-fluorophenyl)-3-(7-methoxy-1,2,3,4-tetrahydroquinolin-1-yl)quinoxaline-6-carboxylic acid as a yellow solid (59 mg, 69%).

LC/MS (ES, m/z): [M+H]⁺ 430.1

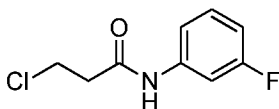
¹H-NMR (300 MHz, DMSO): δ 8.37 (s, 1H), 8.10 (s, 1H), 7.73 - 7.78 (m, 2H), 7.08 - 7.14 (m, 2H), 6.87 (d, *J* = 8.4 Hz, 1H), 6.28 - 6.31 (m, 1H), 6.13 (d, *J* = 2.4 Hz, 1H), 3.80 - 3.85 (m, 2H), 3.47 (s, 3H), 2.65 - 2.71 (m, 2H), 1.90 - 2.10 (m, 2H)

EXAMPLE 23

3-(7-Fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



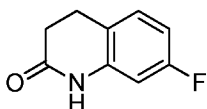
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Step 1. 3-Chloro-*N*-(3-fluorophenyl)propanamide

To a solution of 3-fluoroaniline (10 g, 90.00 mmol) in acetone (40 ml) was added pyridine (18 g, 227.56 mmol) and 3-chloropropanoyl chloride (13.73 g, 108.14 mmol) and the reaction was stirred for 3 h at 55°C. The resulting solution was extracted with ethyl acetate (3 x 50 ml) and the organic layers were combined, dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to afford 3-chloro-*N*-(3-fluorophenyl)propanamide as a yellow solid (13.21 g, 73 %).

LC/MS (ES, *m/z*): [M+H]⁺ 202.0

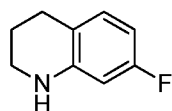
¹H-NMR (300 MHz, CDCl₃): δ 7.51 - 7.62 (m, 1H), 7.31 - 7.41 (m, 1H), 7.16 (d, *J* = 8.1 Hz, 1H), 6.83 - 6.89 (m, 1H), 3.89 - 3.93 (m, 2H), 2.82 - 2.87 (m, 2H)

Step 2. 7-Fluoro-1,2,3,4-tetrahydroquinolin-2-one

To the solid of 3-chloro-*N*-(3-fluorophenyl)propanamide (3 g, 14.88 mmol) was added AlCl₃ (6.3 g, 0.047 mmol) and maintained with an inert atmosphere of nitrogen with stirring for 5h at 120°C. The reaction was then quenched with ice-water, extracted with ethyl acetate (3 x 50 ml) and the organic layers were combined, dried over anhydrous magnesium sulfate and concentrated *in vacuo*. The residue was purified by silica gel column chromatography with 4 % ethyl acetate in petroleum ether to afford 7-fluoro-1,2,3,4-tetrahydroquinolin-2-one as a white solid (1.5 g, 61 %).

LCMS (ES, *m/z*): [M+H]⁺ 166.0

¹H-NMR (300 MHz, CDCl₃): δ 8.73 (s, 1H), 7.10 - 7.19 (m, 1H), 6.71 - 6.79 (m, 1H), 6.56 - 6.70 (m, 1H), 2.98 - 3.05 (m, 2H), 2.64 - 2.69 (m, 2H)

Step 3. 7-Fluoro-1,2,3,4-tetrahydroquinoline

To a solution of 7-fluoro-1,2,3,4-tetrahydroquinolin-2-one (1.5 g, 9.08 mmol) in tetrahydrofuran (50 ml) was dropwise BH₃ in THF (1M, 90 ml), the solution was stirred for 24 h at 60°C. The reaction mixture was cooled and then quenched by the addition of methanol (15 ml) and HCl (conc) (5ml), then stirred for 1 h at 60°C. The reaction mixture was cooled to room temperature and adjusted to pH 12 with sodium hydroxide (4 mol/L), extracted with (3 x 15 ml) of ethyl acetate and the organic layers were combined and dried over anhydrous magnesium sulfate,

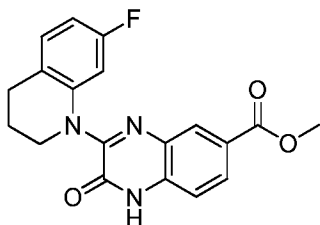
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concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 3 % ethyl acetate in petroleum ether to afford 7-fluoro-1,2,3,4-tetrahydroquinoline as a yellow solid (0.9 g, 66%).

LC/MS (ES, m/z): [M+H]⁺ 152.0

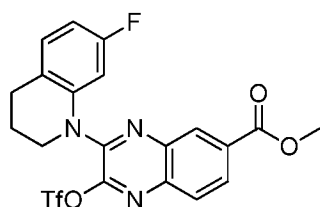
¹H-NMR (300 MHz, CDCl₃): δ 6.86 - 6.94 (m, 1H), 6.15 - 6.26 (m, 1H), 6.27 - 6.35 (m, 1H), 3.92 (s, 1H), 3.29 - 3.33 (m, 2H), 2.72 - 2.78 (m, 2H), 1.91 - 2.00 (m, 2H)

Step 4. Methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate



To a solution of 7-fluoro-1,2,3,4-tetrahydroquinoline (1 g, 6.61 mmol) in NMP (30 ml) was added methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (900 mg, 3.77 mmol) and then stirred for 2 h at 150°C. The resulting solution was diluted with water ((900 ml). The solids were collected by filtration to afford methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a brown solid (900 mg, 39 %).

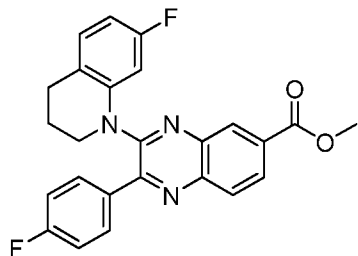
Step 5. Methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate



To a solution of methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (900 mg, 2.55 mmol) in dichloromethane (50 ml) was added pyridine (802 mg, 10.14 mmol) the reaction was cooled to 0°C. Then Tf₂O (2149 mg, 7.62 mmol) was added dropwise and the reaction was stirred overnight at room temperature. Then the mixture was washed with water (100 ml), dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to afford a residue, which was purified by silica gel column chromatography with 1 % - 2 % ethyl acetate in petroleum ether to afford 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate as a yellow solid (819 mg, 66 %).

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Step 6. Methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate

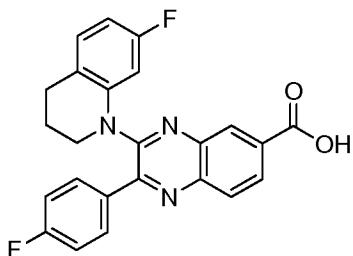


A solution of K_3PO_4 (682 mg, 3.21 mmol) in water (2 ml) was added to a solution of methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (500 mg, 1.03 mmol) (4-fluorophenyl)boronic acid (173 mg, 1.24 mmol), and in dioxane (25 ml). Then $Pd(PPh_3)_4$ (60 mg, 0.05 mmol) was added and the reaction was stirred for 20 min at $90^\circ C$. The resulting mixture was concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 1 % - 3 % ethyl acetate in petroleum ether to afford methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl) quinoxaline-6-carboxylate as a yellow solid (200 mg, 45 %).

LC/MS (ES, m/z): $[M+H]^+$ 432.0

1H -NMR (300 MHz, $CDCl_3$): δ 8.67 (d, $J = 1.8$ Hz, 1H), 8.23 - 8.27 (m, 1H), 8.12 (d, $J = 8.7$ Hz, 1H), 7.76 - 7.81 (m, 2H), 6.93 - 7.05 (m, 2H), 6.46 - 6.53 (m, 1H), 6.28 - 6.33 (m, 1H), 4.03 (s, 3H), 3.81 - 3.85 (m, 2H), 2.76 - 2.81 (m, 2H), 2.03 - 2.11 (m, 2H)

Step 7. 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



To a solution of methyl 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate (120 mg, 0.28 mmol) in methanol (20 ml) was added a solution of sodium hydroxide (44 mg, 1.10 mmol) in water (3 ml). The reaction was stirred overnight at room temperature. The resulting mixture was concentrated *in vacuo* to give a residue, which was dissolved in water (20 ml) and adjusted to pH 4 with hydrogen chloride (3 N). The solids were collected by filtration to afford 3-(7-fluoro-1,2,3,4-tetrahydroquinolin-1-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a yellow solid (101 mg, 87 %).

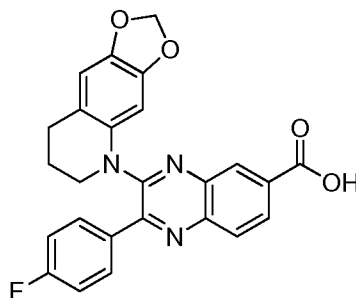
LC/MS (ES, m/z): $[M+H]^+$ 418.1

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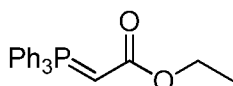
¹H-NMR (300 MHz, DMSO): δ 8.39 (d, *J* = 1.2 Hz, 1H), 8.09 - 8.17 (m, 2H), 7.76 - 7.81 (m, 2H), 7.14 - 7.20 (m, 2H), 6.98 - 7.03 (m, 1H), 6.49 - 6.54 (m, 2H), 6.75 - 6.79 (m, 2H), 2.70 - 2.74 (m, 2H), 1.94 - 1.98 (m, 2H)

EXAMPLE 24

3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]Dioxolo[4,5-*g*]quinolin-5-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid

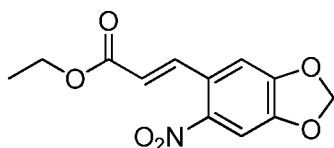


Step 1. Ethyl 2-(triphenyl-[5]-phosphanylidene)acetate



PPh₃ (57 g, 217.32 mmol) was added to a solution of ethyl 2-bromoacetate (30 g, 179.64 mmol) in CH₃CN (200 ml). The reaction was stirred overnight at 120°C. Then it was concentrated *in vacuo* and the residue was dissolved in water (200 ml) and adjusted to pH 8 with sodium bicarbonate (aq), extracted with ethyl acetate (3 x 150 ml), the organic layers were combined and concentrated *in vacuo* to afford ethyl 2-(triphenyl-[5]-phosphanylidene)acetate as a light yellow solid (41 g, crude).

Step 2. (*E*)-Ethyl 3-(6-nitrobenzo[d][1,3]dioxol-5-yl)acrylate



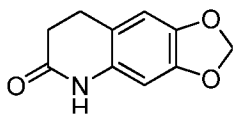
To a solution of 6-nitro-2*H*-1,3-benzodioxole-5-carbaldehyde (10 g, 51.25 mmol) in benzene (100 ml) was added ethyl 2-(triphenyl-[5]-phosphanylidene)acetate (36 g, 103.34 mmol) and the reaction was stirred for 6 h at reflux. The reaction mixture was concentrated *in vacuo* to provide a residue which was purified by silica gel column chromatography with 1% ethyl acetate in petroleum ether to afford (*E*)-ethyl 3-(6-nitrobenzo[d][1,3]dioxol-5-yl)acrylate as a yellow solid (7.5 g, 55 %).

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LC/MS (ES, m/z): [M+H]⁺ 266.0

¹H-NMR (300 MHz, CDCl₃): δ 8.10 (d, *J* = 15.9 Hz, 1H), 7.57 (s, 1H), 7.01 (s, 1H), 6.25 (d, *J* = 15.6 Hz, 1H), 6.15 (d, *J* = 8.7 Hz, 2H), 4.27 - 4.34 (m, 2H), 1.34 - 1.39 (t, *J* = 7.2 Hz, 3H)

Step 3. 2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]Dioxolo[4,5-*g*]quinolin-6-one

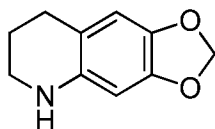


Palladium on carbon (340 mg) was added to a solution of (*E*)-ethyl 3-(6-nitrobenzo[d][1,3]dioxol-5-yl)acrylate (500 mg, 1.89 mmol) in AcOH (60 ml). Then H₂ (g) was introduced at 5 Atm and the reaction was stirred overnight at 70°C. The reaction mixture was adjusted to pH 8 with saturated aqueous NaHCO₃ and extracted with ethyl acetate (3 x 80 ml). The organic layers were combined, dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to afford 2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-*g*]quinolin-6-one as a brown solid (316 mg, crude).

LC/MS (ES, m/z): [M+H]⁺ 192.0

¹H-NMR (300 MHz, CD₃OD): δ 6.69 (s, 1H), 6.45 (d, *J* = 5.4 Hz, 1H), 5.90 (s, 2H), 2.83 - 2.88 (m, 2H), 2.49 - 2.55 (m, 2H)

Step 4. 5,6,7,8-Tetrahydro-[1,3]dioxolo[4,5-*g*]quinoline



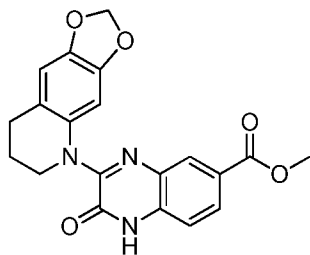
To a solution of 2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-*g*]quinolin-6-one (250 mg, crude) in tetrahydrofuran (50 ml) was dropwise BH₃ in THF (1 N, 26 ml). The reaction was stirred at 60°C overnight. Then the reaction mixture was quenched with hydrogen chloride (3 N), adjusted to pH 8 with sodium bicarbonate, extracted with ethyl acetate (3 x 50 ml). The organic layers were combined, dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to afford 5,6,7,8-tetrahydro-[1,3]dioxolo[4,5-*g*]quinoline as a solid (180 mg).

LC/MS (ES, m/z): [M+H]⁺ 178.0

¹H-NMR (300 MHz, CDCl₃): δ 6.48 (s, 1H), 6.12 (s, 1H), 5.82 (s, 2H), 3.24 - 3.27 (m, 2H), 2.68 - 2.72 (t, *J* = 6.3 Hz, 2H), 1.88 - 1.96 (m, 2H)

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Step 5. Methyl 3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-*g*]quinolin-5-yl]-2-oxo-1,2-dihydroquinoxaline-6-carboxylate

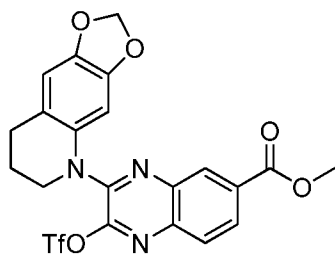


To a solution of methyl 3-chloro-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (161 mg, 0.67 mmol) in NMP (5 ml) was added the 2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-*g*]quinoline (180 mg, 1.02 mmol) and the reaction was stirred for 1h at 140°C. The reaction mixture was cooled to room temperature, and the product was precipitated by the addition of water and filtered off to afford methyl 3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-*g*]quinolin-5-yl]-2-oxo-1,2-dihydroquinoxaline-6-carboxylate as a brown solid (140 mg, 55 %).

LC/MS (ES, *m/z*): [M+H]⁺ 380.0

¹H-NMR (300 MHz, CDCl₃): δ10.31 (s, 1H), 8.30 - 8.36 (m, 1H), 7.92 - 9.95 (m, 1H), 7.06 (d, *J* = 8.7 Hz, 1H), 6.68 (d, *J* = 9.0 Hz, 1H), 6.50 (d, *J* = 7.5 Hz, 1H), 5.92 (s, 2H), 4.02 - 4.08 (m, 2H), 3.96 (s, 3H), 2.75 - 2.79 (t, *J* = 6.3 Hz, 2H), 2.00 - 2.08 (m, 2H)

Step 6. Methyl 3-(7,8-dihydro-[1,3]dioxolo[4,5-*g*]quinolin-5(6*H*)-yl)-2-(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate

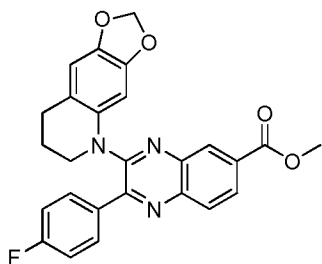


To a solution of methyl 3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-*g*]quinolin-5-yl]-2-oxo-1,2-dihydroquinoxaline-6-carboxylate (140 mg, 0.37 mmol) in dichloromethane (80 ml) was added pyridine (175 mg, 2.21 mmol) and Tf₂O (510 mg, 1.81 mmol). The reaction was stirred overnight under atmosphere of nitrogen at room temperature. Then the reaction mixture was quenched with water (200 ml), extracted with dichloromethane (3 x 20 ml), the organic layers were combined, dried over anhydrous magnesium sulfate, and concentrated *in vacuo* to afford methyl 3-(7,8-dihydro-[1,3]dioxolo[4,5-*g*]quinolin-5(6*H*)-yl)-2-

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(trifluoromethylsulfonyloxy)quinoxaline-6-carboxylate as a red oil (150mg, crude), which was used directly in the next step.

Step 7. Methyl 3-(7,8-dihydro-[1,3]dioxolo[4,5-g]quinolin-5(6*H*)-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate

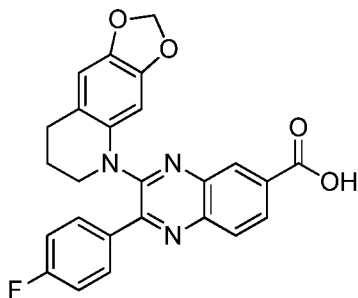


To a solution of methyl 3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-g]quinolin-5-yl]-2-[(trifluoromethane)sulfonyloxy]quinoxaline-6-carboxylate (150 mg, crude) in dioxane (5.0 ml) and water (3 drops) was added (4-fluorophenyl)boronic acid (124 mg, 0.89 mmol), Pd(PPh₃)₄ (17 mg, 0.01 mmol), K₃PO₄ (186 mg, 0.88 mmol). The reaction was stirred for 40 min at 90°C under atmosphere of nitrogen. Then the reaction mixture was concentrated *in vacuo* to give a residue, which was purified by a silica gel column chromatography with 1% ethyl acetate in petroleum ether to afford methyl 3-(7,8-dihydro-[1,3]dioxolo[4,5-g]quinolin-5(6*H*)-yl)-2-(4-fluorophenyl)quinoxaline-6-carboxylate as a light yellow solid (100mg).

LC/MS (ES, m/z): [M+H]⁺ 458.0

¹H-NMR (300 MHz, CDCl₃): δ 8.69 (d, *J* = 1.5 Hz, 1H), 8.17 - 8.21 (m, 1H), 8.07 (d, *J* = 8.7 Hz, 1H), 7.72 - 7.76 (m, 2H), 6.98 - 7.04 (m, 2H), 6.53 (s, 1H), 6.19 (s, 1H), 5.80 (s, 2H), 4.02 (s, 3H), 3.80 - 3.85 (t, *J* = 6.6 Hz, 2H), 2.68 - 2.73 (t, *J* = 6.3 Hz, 2H), 2.02 - 2.06 (t, *J* = 6.6 Hz, 2H)

Step 8. 3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-g]quinolin-5-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid



Sodium hydroxide (35 mg, 0.88 mmol) was added to a solution of methyl 3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-g]quinolin-5-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylate (100 mg, 0.22 mmol) in methanol (30 ml) and water (1.0 ml) and the reaction was stirred overnight at room

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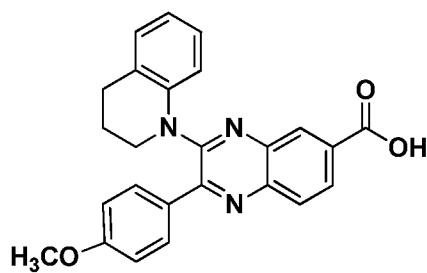
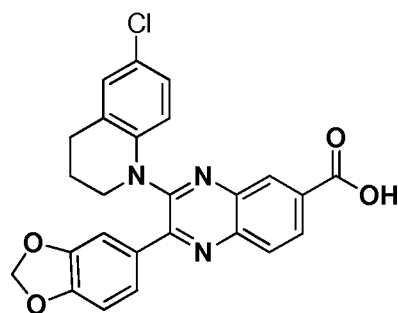
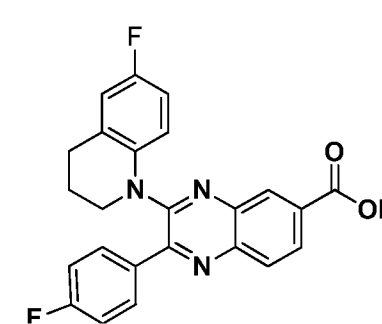
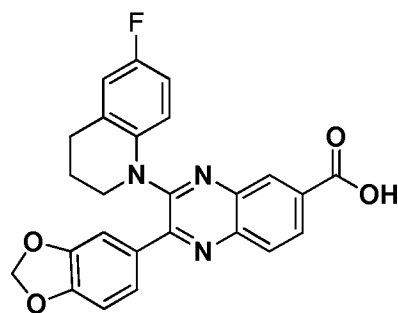
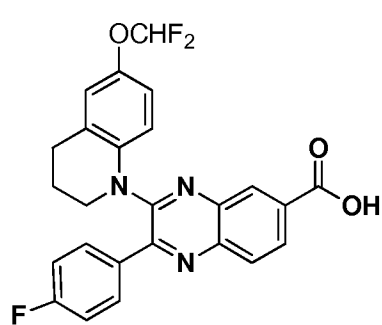
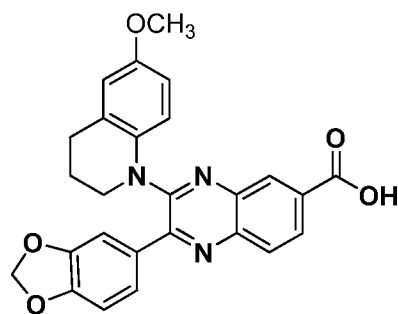
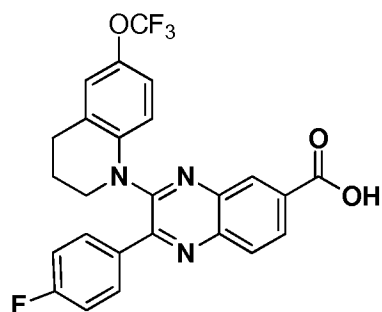
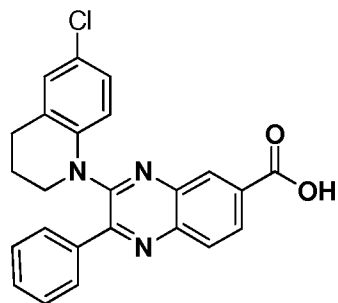
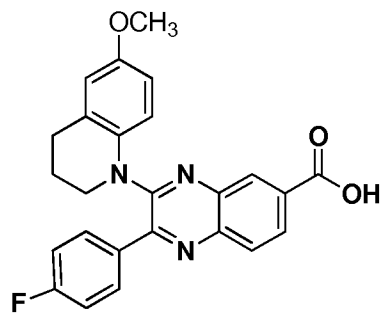
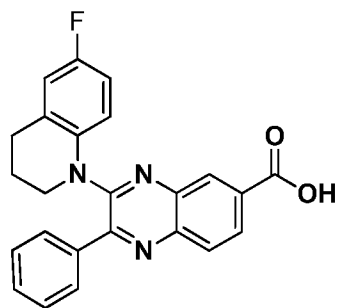
temperature. The reaction mixture was concentrated *in vacuo*, dissolved in water (30 ml), and adjusted to pH 5 with hydrochloric acid (3 N) to give a precipitate which was collected by filtration to afford 3-[2*H*,5*H*,6*H*,7*H*,8*H*-[1,3]dioxolo[4,5-*g*]quinolin-5-yl]-2-(4-fluorophenyl)quinoxaline-6-carboxylic acid as a light yellow solid (70.0 mg, 72 %).

LC/MS (ES, m/z): [M+H]⁺ 444.1

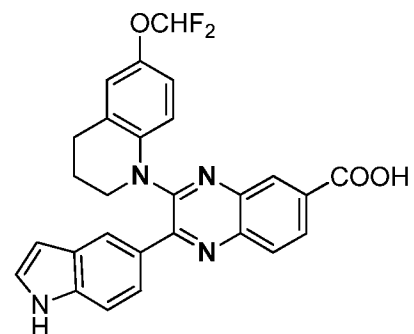
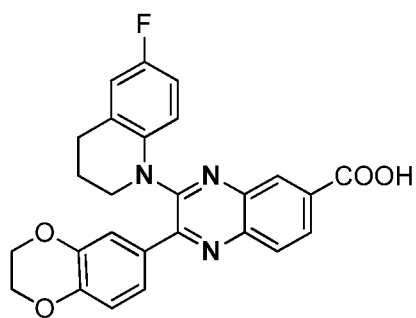
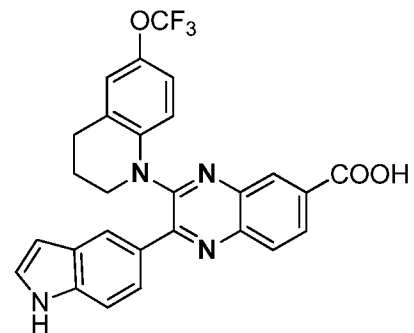
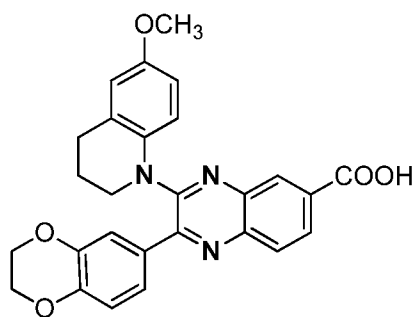
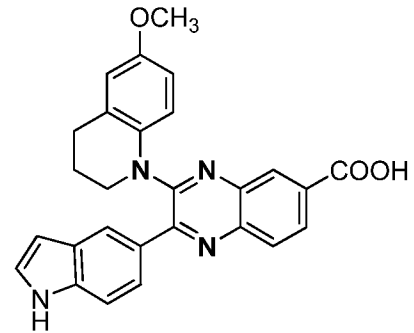
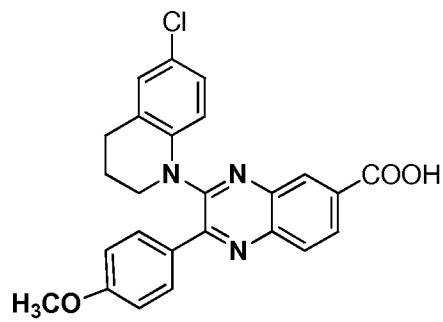
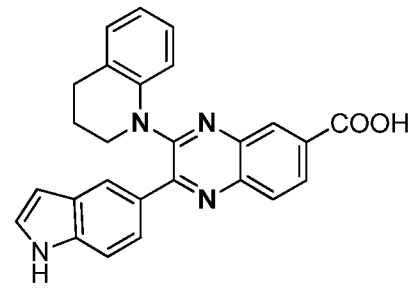
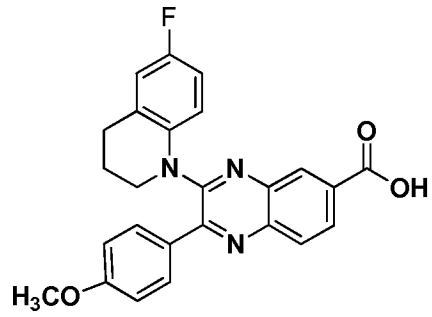
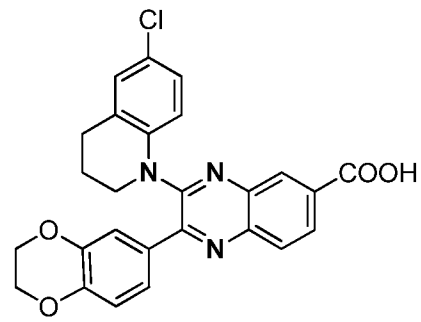
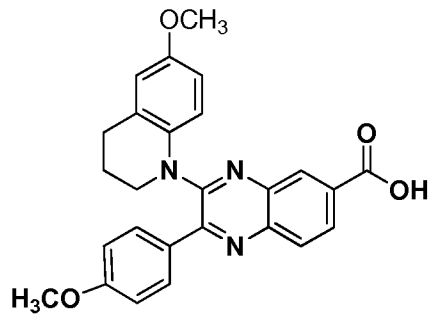
¹H-NMR (300 MHz, DMSO): δ 8.30 (s, 1H), 8.08 (d, *J* = 8.71 Hz, 1H), 7.98 (d, *J* = 8.4 Hz, 1H), 7.73 - 7.77 (m, 2H), 7.13 - 7.19 (m, 2H), 6.61 (s, 1H), 6.39 (s, 1H), 5.79 (s, 2H), 3.62 - 3.66 (t, *J* = 6.3 Hz, 2H), 2.61 - 2.66 (t, *J* = 6.3 Hz, 2H), 1.87 - 1.91 (t, *J* = 6.3 Hz, 2H)

[0155] The following compounds can generally be made using the methods known in the art and described above. It is expected that these compounds when made will have activity similar to those that have been made in the examples above.

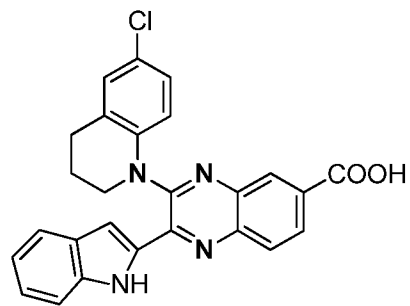
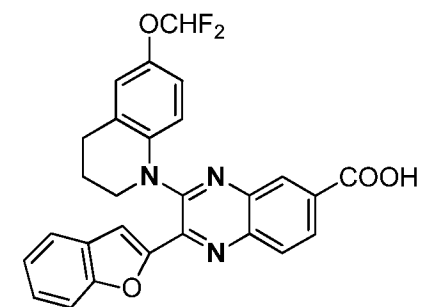
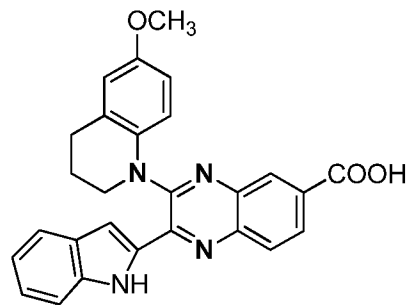
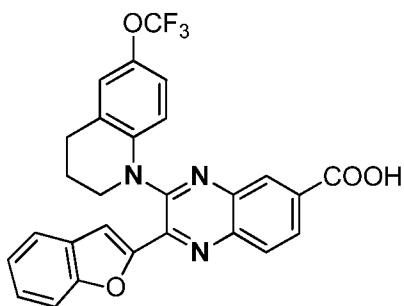
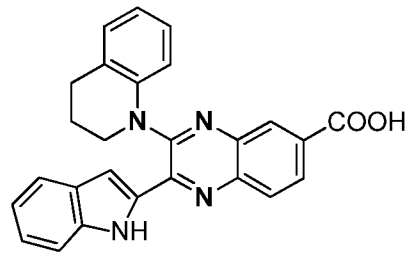
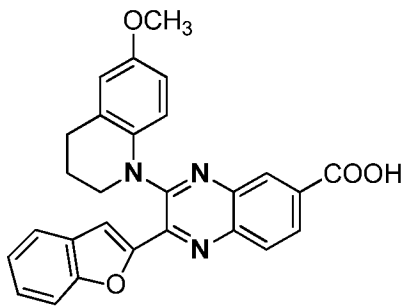
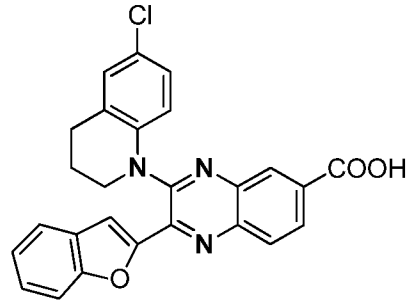
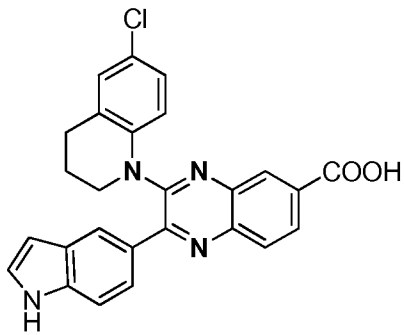
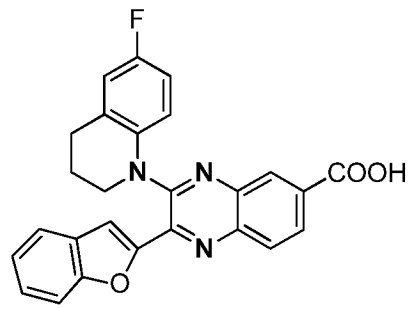
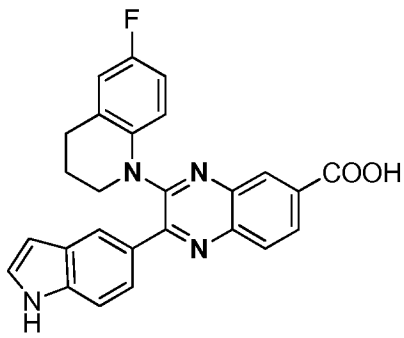
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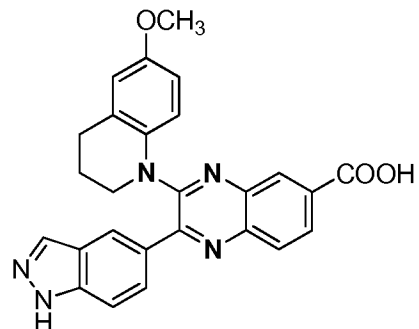
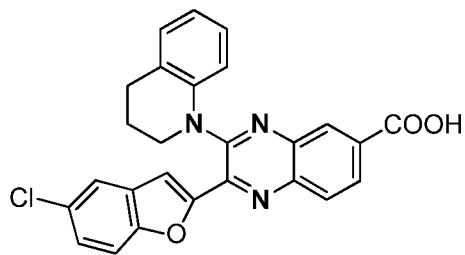
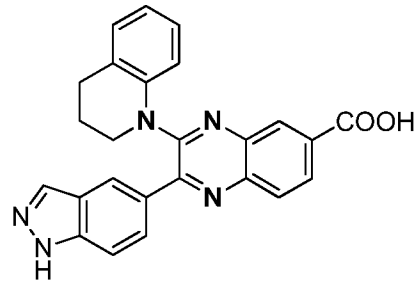
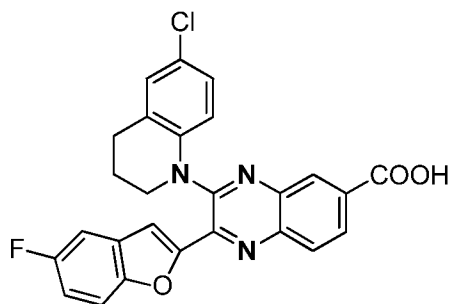
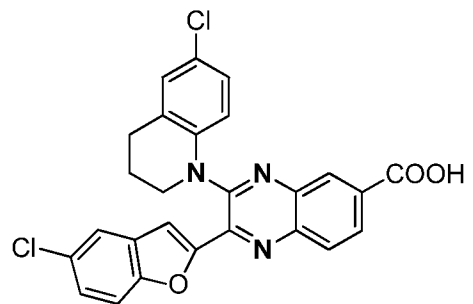
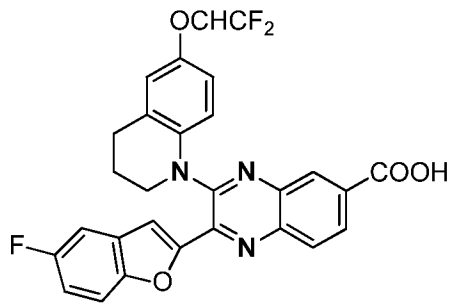
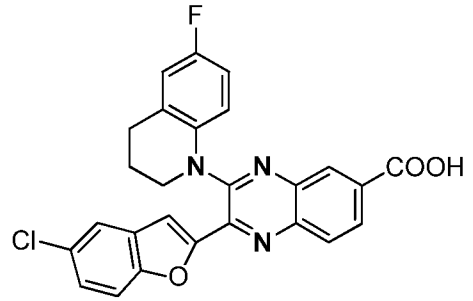
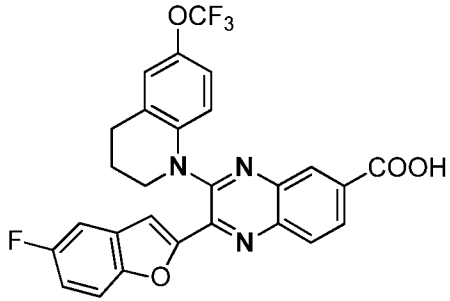
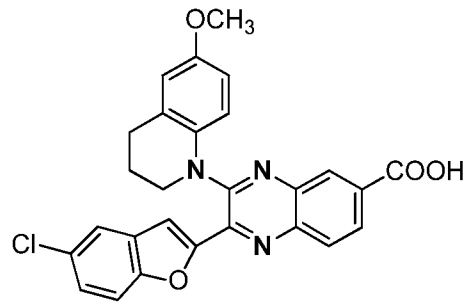
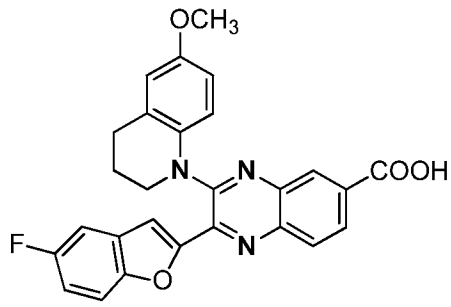
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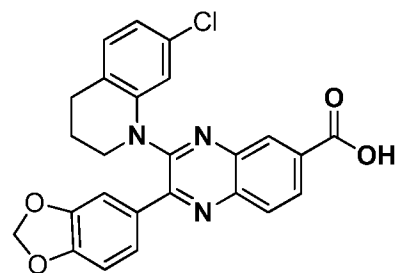
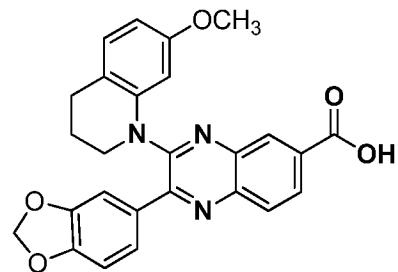
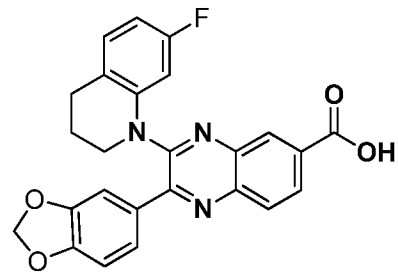
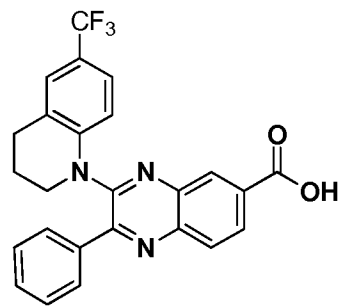
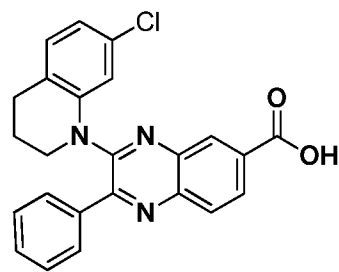
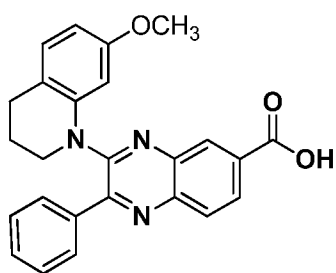
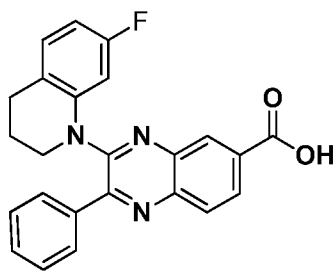
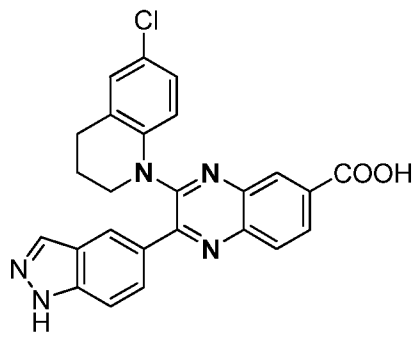
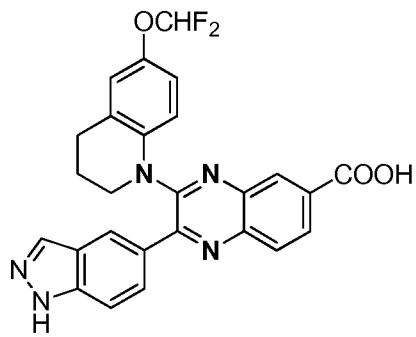
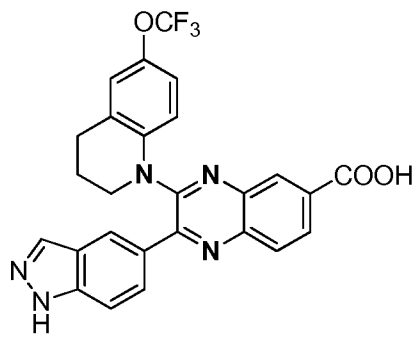
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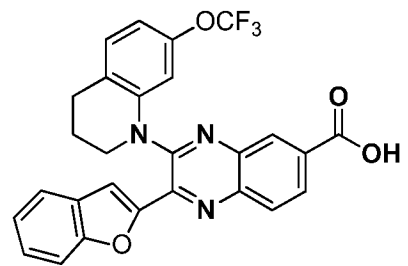
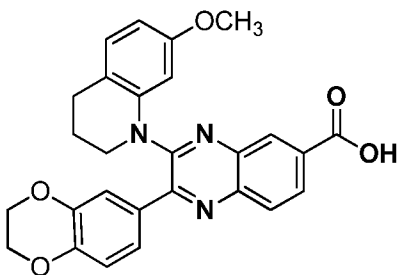
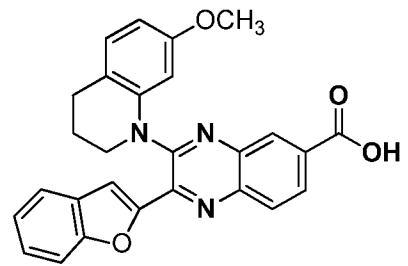
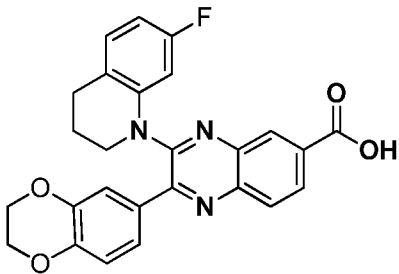
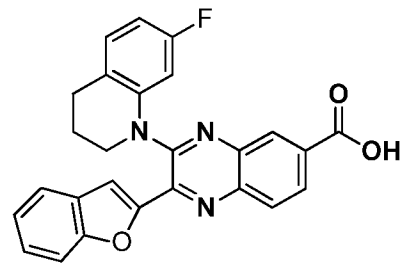
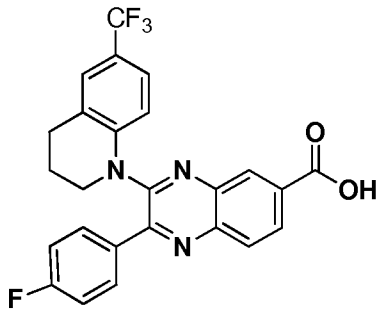
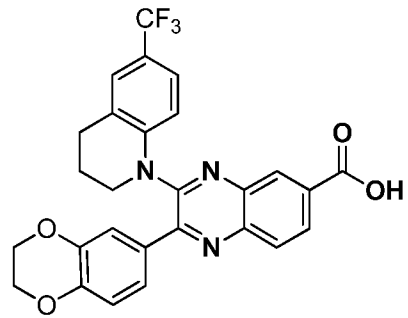
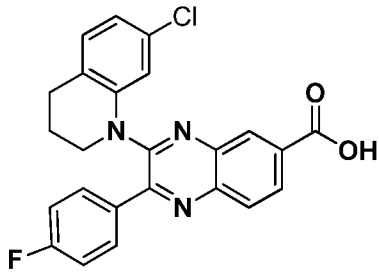
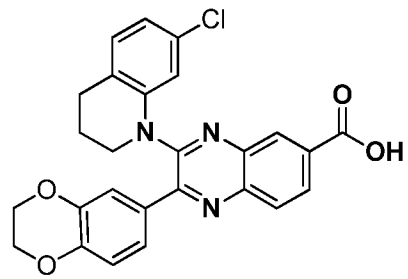
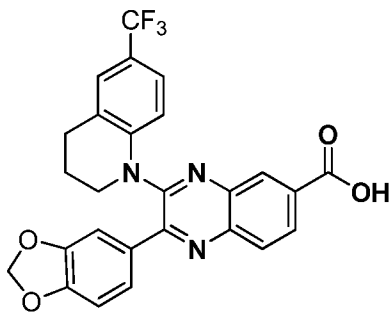
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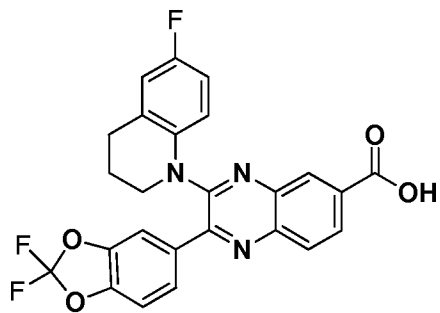
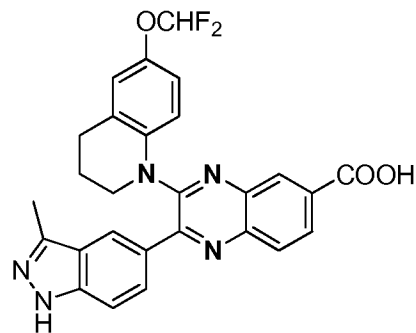
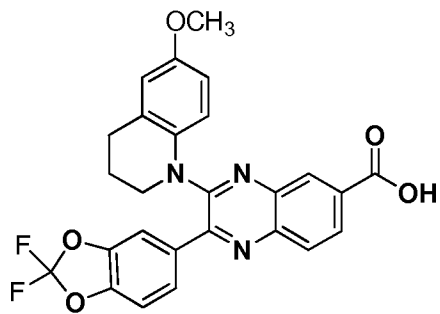
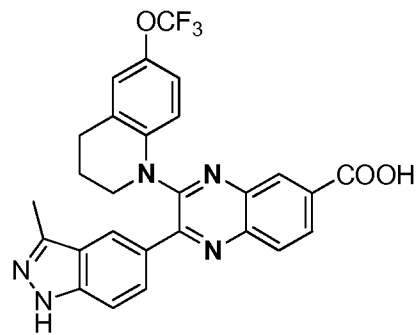
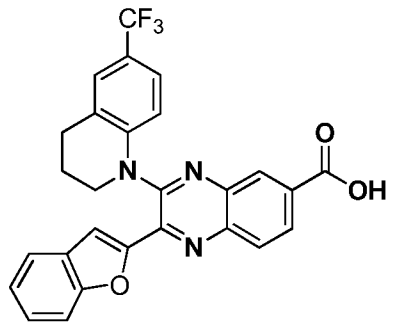
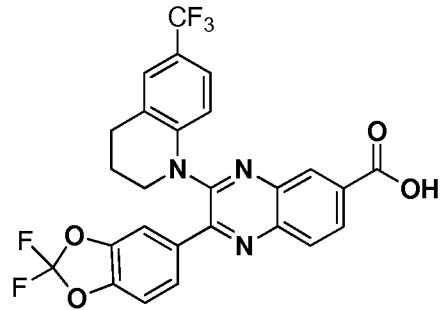
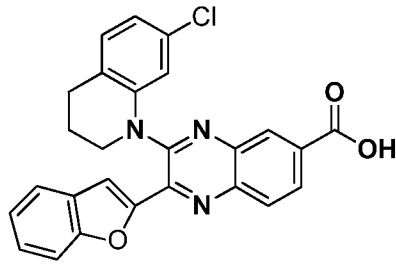
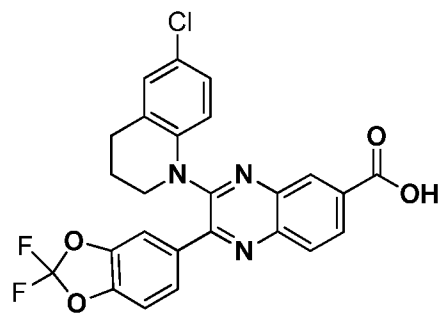
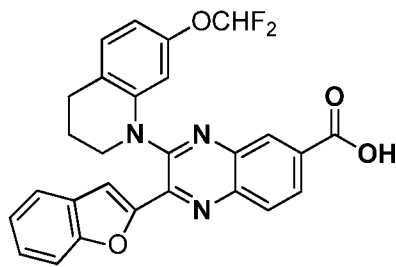
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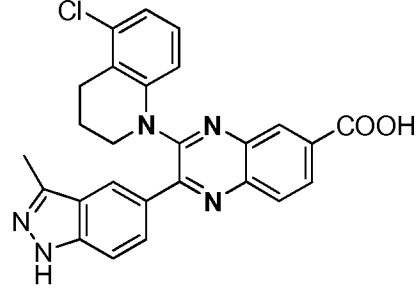
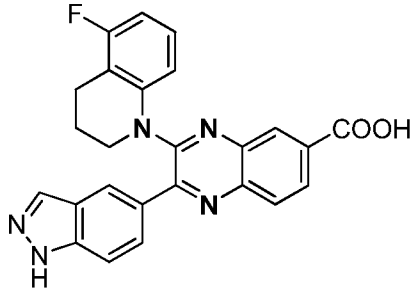
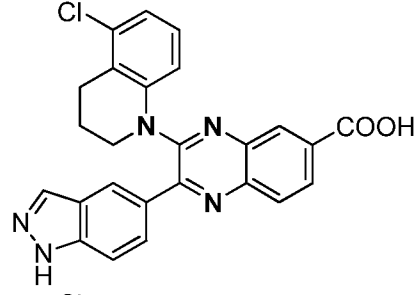
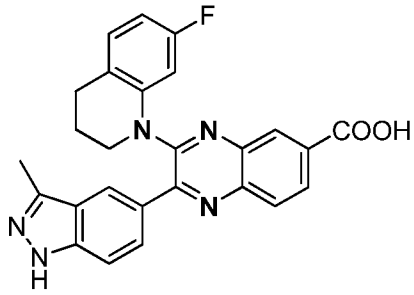
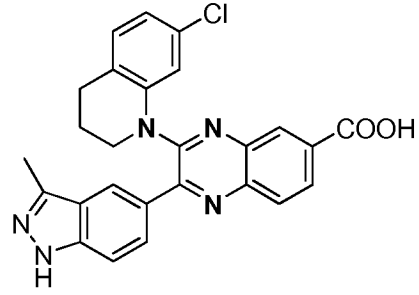
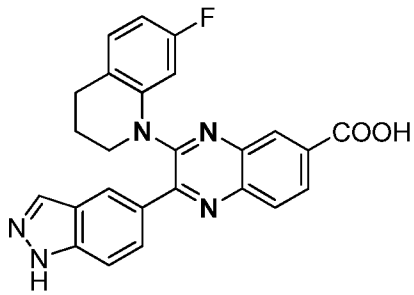
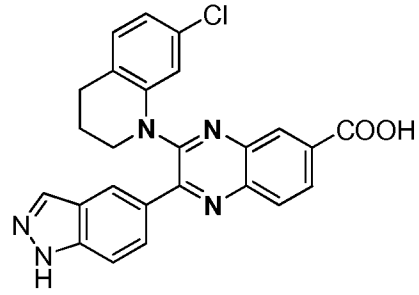
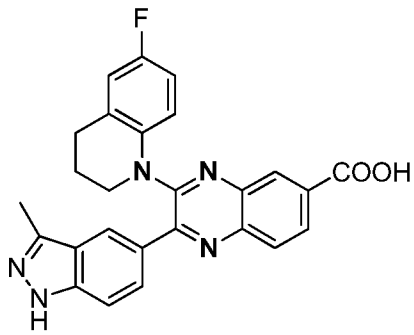
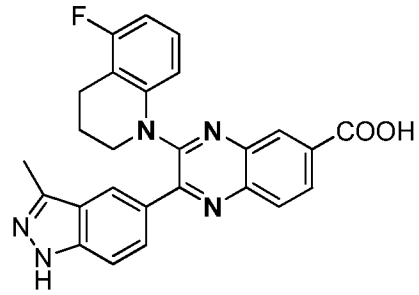
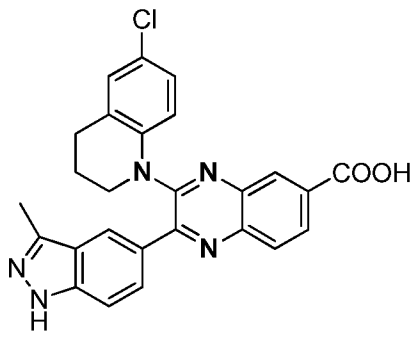
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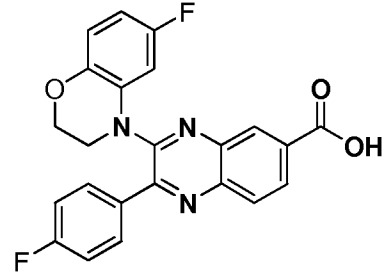
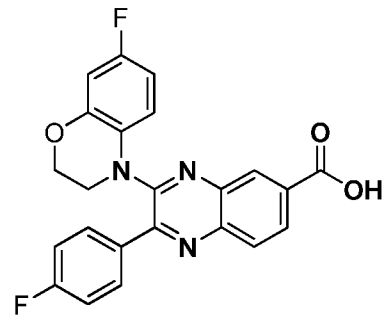
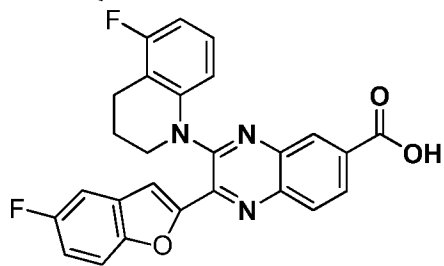
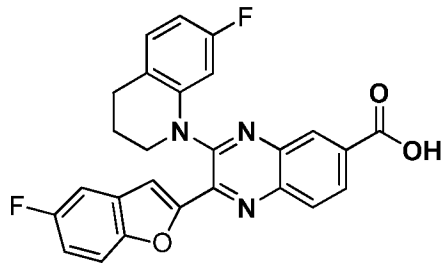
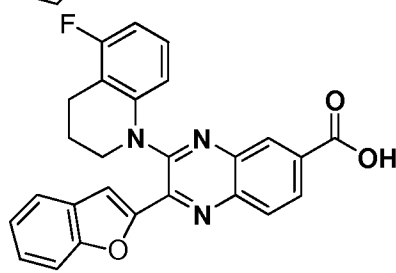
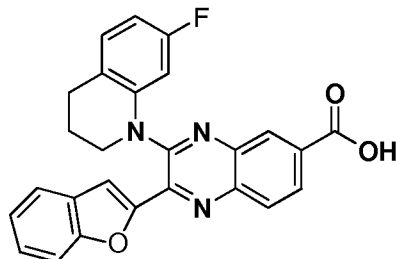
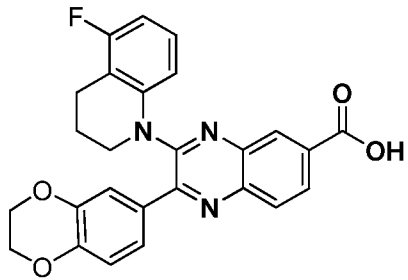
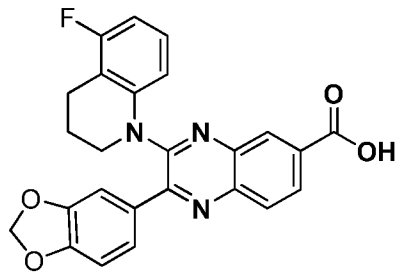
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[0156] The activity of the compounds in Examples 1- 24 as PASK modulators is illustrated in the following assays. The other compounds listed above, which have not yet been made and/or tested, are predicted to have activity in these assays as well. Compounds with activity in the following assay are expected to also have activity in other *in vitro* and *in vivo* assays as indicated in WO 2011/028947, the disclosure of which is hereby incorporated by reference.

Biochemical Assay for hPASK Activity

PAS Kinase FRET Assay

[0157] The aim of the FRET assay is to determine the inhibition potential of test compounds on targeted kinase. This assay platform provides a homogenous screening method for measuring kinase activity by quantitating the amount of phospho-substrate in solution following a kinase reaction.

[0158] In the presence of kinase and ATP, the *Ulight*-peptide is phosphorylated and captured by an anti-phospho-substrate antibody, which brings the Eu chelate donor and *Ulight* acceptor dyes into close proximity. Upon excitation at 340 nm, the Eu chelate transfers its energy to the *Ulight* dye, resulting in a fluorescent light emission at 665 nm.

[0159] Titration of kinase at 1 mM ATP was achieved via the following protocol. After making serial three-fold dilutions of PASK (Invitrogen) in reaction buffer across the plate; 5 μ l of kinase dilution and 5 μ l substrate/ATP mix were added to the wells of the white Optiplate-384 (PerkinElmer). The contents of the plate were and incubated at RT for 1 h. The reaction was stopped by adding 5 μ l of stop solution to each test well followed by mixing and incubation at RT for 10 minutes. 5 μ l of detection mix (detection antibody diluted in detection buffer) was added; the contents of the plate were mixed and then incubated in the dark for 1 hour at RT. The signal was recorded at TR-FRET mode (665nm/615nm). The results were graphed to calculate the EC₅₀.

[0160] Titration of ATP at the EC₅₀ concentration of kinase to determine ATP Km,app. was performed using the following method. After making serial dilutions of ATP (Invitrogen), 5 μ l of ATP dilution and 5 μ l substrate/kinase mix were added to the wells of the white Optiplate-384 (PerkinElmer). The contents of the plate were and incubated at RT for 1 h. The reaction was stopped by adding 5 μ l of stop solution to each test well followed by mixing and incubation at RT for 10 minutes. 5 μ l of detection mix (detection antibody diluted in detection buffer) was added; the contents of the plate were mixed and then incubated in the dark for 1 hour at RT. The

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signal was recorded at TR-FRET mode (665nm/615nm). The results were graphed to calculate the EC₅₀ as the ATP K_{m,app}.

[0161] Compound screening was done via the following method. 10 mM stock solution of test compound in DMSO was prepared by dissolving test compound in DMSO at RT for 1 hour, and then sonicating at 100% output for 8 minutes. If compound is not soluble under this condition, it was diluted to 3 mM. Kinase reaction buffer was prepared containing 10 mM MgCl₂, 50 mM HEPES, 1 mM EGTA, 0.01% TWEEN-20, 2 mM DTT. Serial dilutions of the test compounds were prepared at 4 × final assay concentrations using *Freedom EVO200*® dispensing system as follows: 12×10⁻⁵ M, 4×10⁻⁵ M, 1.33×10⁻⁵ M, 4.44×10⁻⁶ M, 1.48×10⁻⁶ M, 4.92×10⁻⁷ M, 1.65×10⁻⁷ M, 5.48×10⁻⁷ M, 1.82×10⁻⁸ M, 6.09×10⁻⁹, 2.03×10⁻⁹ M. Test compounds (2.5 μl at 4 × the final assay concentration) was added to wells using *Freedom EVO200*® dispensing system. As a positive control, 2.5 μl of positive compound was added to assay wells, and 2.5 μl of DMSO to assay wells as vehicle control. Kinase solution was prepared in reaction buffer at 2 × final assay concentration. Kinase solution (5 μl) was added to each well of the assay plate. The substrate and ATP solution was prepared in kinase reaction buffer at 4 × final assay concentration. The kinase reaction was started by adding 2.5 μl of substrate + ATP mix solution to each well of the assay plate. The plate is mixed on a plate shaker; then covered and allowed to react for 2 hours in the dark at 25°C without shaking. The reaction was stopped by adding 5 μl of stop solution to each test well followed by mixing and incubation at RT for 10 minutes in the dark. 5 μl of detection mix (detection antibody diluted in detection buffer) was added; the contents of the plate were mixed and then incubated in the dark for 1 hour at RT. The signal was recorded at TR-FRET mode (665nm/615nm).

[0162] Results are shown below in Table 1.

Table 1.

Example #	IC ₅₀ Kinase Domain
	+ indicates ≤ 10 um - indicates > 10 um
1	+
2	+
3	+
4	+
5	+
6	+
7	+
8	+
9	+
10	-
12	+
13	+
14	+
15	+
16	+
17	+
18	+
19	+
20	+
21	+
22	+
23	+
24	+

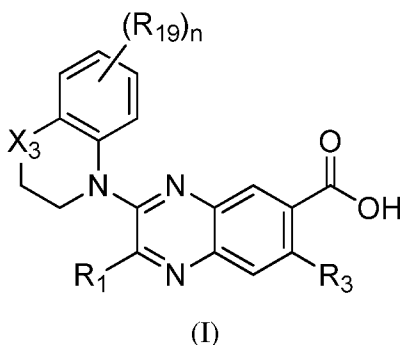
[0163] From the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions.

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CLAIMS

What is claimed is:

1. A compound of structural Formula I:



or a pharmaceutically acceptable salt, ester, or prodrug thereof, wherein:

R₁ is chosen from aryl and heteroaryl, either of which may be optionally substituted with one or more substituents chosen from hydrogen, halo, alkyl, alkenyl, alkynyl, cycloalkyl, haloalkyl, aryl, aralkyl, heterocyclyl, heteroaryl, heterarylalkyl, CN, alkoxy, alkylamino, dialkylamino, NHSO₂R₁₂, NHSO₂NHR₁₂, NHCOR₁₂, NHCONHR₁₂, CONHR₁₂, CONR_{12a}R_{12b}, hydroxy, and CF₃, CHF₂, CH₂F, SO₂R₁₂, SO₂NHR₁₂, OCF₃, OCHF₂, and OCH₂F;

R₃ is chosen from hydrogen and hydroxyl;

R₁₂, R_{12a} and R_{12b} are independently chosen from hydrogen, C₁-C₆ alkyl, aryl, heteroaryl, aralkyl and heteroaralkyl, or taken together, R_{12a} and R_{12b} may form a heterocycloalkyl or heteroaryl, any of which may be optionally substituted;

R₁₉ is chosen from hydrogen, lower alkyl, alkenyl, alkynyl, hydroxy, alkoxy, CF₃, CHF₂, CH₂F, COOH, OCF₃, OCHF₂, OCH₂F, halo, alkylsulfonyl, cyano, nitro, alkylamino, dialkylamino, NHSO₂R₁₂, NHSO₂NHR₁₂, NHCOR₁₂, NHCONHR₁₂, CONHR₁₂, CONR_{12a}R_{12b}, SO₂NR_{12a}R_{12b}, aryl, and heteroaryl;

X₃ is chosen from CH₂, NR₁₂, and O;

n is an integer from 0 – 4; and

with the proviso that the compound is not chosen from

3-(6-methoxy-3,4-dihydroquinolin-1(2H)-yl)-2-phenylquinoxaline-6-carboxylic acid,

2-(benzo[d][1,3]dioxol-5-yl)-3-(3,4-dihydroquinolin-1(2H)-yl)quinoxaline-6-carboxylic acid, and

3-(3,4-dihydroquinolin-1(2H)-yl)-2-phenylquinoxaline-6-carboxylic acid.

2. The compound as recited in Claim 1, wherein n is an integer from 0 – 2.

3. The compound as recited in Claim 1, wherein R₁ is phenyl.

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4. The compound as recited in Claim 3, wherein R₁ is substituted with one or more halo substituents.
5. The compound as recited in Claim 4, wherein said halo substituent is fluoro.
6. The compound as recited in Claim 5, wherein R₁ is 4-fluorophenyl.
7. The compound as recited in Claim 1, wherein R₃ is hydrogen.
8. The compound as recited in Claim 1, wherein X₃ is CH₂.
9. A compound as recited in Claim 1 for use in the manufacture of a medicament for the prevention or treatment of a disease or condition ameliorated by the inhibition of PASK.
10. A pharmaceutical composition comprising a compound as recited in Claim 1 together with a pharmaceutically acceptable carrier.
11. A method of inhibiting PASK comprising contacting PASK with a compound as recited in Claim 1.
12. A method of treatment of a disease comprising the administration of a therapeutically effective amount of a compound as recited in Claim 1 to a patient in need thereof.
13. The method as recited in Claim 12 wherein said disease is chosen from cancer and a metabolic disease.
14. The method as recited in Claim 12 wherein said disease is a metabolic disease.
15. The method as recited in claim 14 wherein said metabolic disease is chosen from metabolic syndrome, diabetes, dyslipidemia, fatty liver disease, non-alcoholic steatohepatitis, obesity, and insulin resistance.
16. The method of claim 15 wherein said diabetes is Type II diabetes.
17. The method of claim 15 wherein said dyslipidemia is hyperlipidemia.
18. A method for achieving an effect in a patient comprising the administration of a therapeutically effective amount of a compound as recited in any of Claim 1 to a patient, wherein the effect is selected from the group consisting of reduction of triglycerides, reduction of cholesterol, and reduction of hemoglobin A1c.
19. The method of claim 18 wherein said cholesterol is chosen from LDL and VLDL cholesterol.
20. The method of claim 18 wherein said triglycerides are chosen from plasma triglycerides and liver triglycerides.
21. A method of treatment of a PASK-mediated disease comprising the administration of:
 - a. a therapeutically effective amount of a compound as recited in Claim 1; and
 - b. another therapeutic agent.