



(51) International Patent Classification:

A61K 31/5025 (2006.01) C07D 401/14 (2006.01)

C07D 487/04 (2006.01) A61P 35/00 (2006.01)

C07D 401/04 (2006.01)

(21) International Application Number:

PCT/US2021/063567

(22) International Filing Date:

15 December 2021 (15.12.2021)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/125,654 15 December 2020 (15.12.2020) 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, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO,

NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

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

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: MULTI-CYCLIC IRAK AND FLT3 INHIBITING COMPOUNDS AND USES THEREOF

(57) Abstract: Some embodiments of the disclosure include inventive compounds (e.g., compounds of Formula (I)) and compositions (e.g., pharmaceutical compositions) which inhibit IRAK and/or FLT3 and which can be used for treating, for example, certain diseases. Some embodiments include methods of using the inventive compound (e.g., in compositions or in pharmaceutical compositions) for administering and treating (e.g., diseases such as hematopoietic cancers, myelodysplastic syndromes (MDS), acute myeloid leukemia (AML), etc.). Additional embodiments provide disease treatment using combinations of the inventive IRAK and/or FLT3 inhibiting compounds with other therapies, such as cancer therapies.



MULTI-CYCLIC IRAK AND FLT3 INHIBITING COMPOUNDS AND USES THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is an International Application which claims priority to U.S. Provisional Application No. 63/125,654, filed December 15, 2020, the entirety of which is incorporated herein by reference.

FIELD OF THE DISCLOSURE

[0002] The present disclosure generally relates to compounds and compositions which are kinase inhibitors and the use of the same in treating diseases and disorders, including cancers.

BACKGROUND

[0003] Myelodysplastic syndromes (MDS) are malignant, potentially fatal blood diseases that arise from a defective hematopoietic stem/progenitor cell, confer a predisposition to acute myeloid leukemia (AML) (Corey et al., 2007; Nimer, 2008), and often progress to chemotherapy-resistant secondary acute myeloid leukemia (sAML). A majority of patients having MDS die of marrow failure, immune dysfunction, and/or transformation to overt leukemia.

[0004] MDS are heterogeneous diseases with few treatment options, as there is a lack of effective medicines capable of providing a durable response. Current treatment options for MDS are limited but include allogeneic HSC transplantation, demethylating agents, and immunomodulatory therapies (Ebert, 2010). While hemopoietic stem cell (HSC) transplantation can be used as a curative treatment for MDS, this option is unavailable to many older patients, who instead receive supportive care and transfusions to ameliorate disease complications. Unfortunately, MDS clones can persist in the marrow even after HSC transplantation, and the disease invariably advances (Tehranchi et al., 2010). For advanced disease or high-risk MDS, patients may also receive immunosuppressive therapy, epigenetic modifying drugs, and/or chemotherapy (Greenberg, 2010). Despite recent progress, most MDS patients exhibit treatment-related toxicities or relapse (Sekeres, 2010a). Overall, the efficacy of these treatments is variable, and generally life expectancies are only slightly improved as compared to supportive care. The

complexity and heterogeneity of MDS, and the lack of human xenograft models are obstacles which are challenging for identifying and evaluating novel molecular targets for this disease.

[0005] Approximately 30% of MDS patients also develop aggressive AML due to acquisition of additional mutations in the defective hematopoietic stem/progenitor cell (HSPC) (Greenberg et al., 1997). AML is a cancer of the myeloid line of blood cells, characterized by the rapid growth of abnormal white blood cells that accumulate in the bone marrow and interfere with the production of normal blood cells. AML is the most common acute leukemia affecting adults, and its incidence increases with age. Although AML is a relatively rare disease, accounting for approximately 1.2% of cancer deaths in the United States, its incidence is expected to increase as the population ages. Several risk factors and chromosomal abnormalities have been identified, but the specific cause is not clear. As an acute leukemia, AML progresses rapidly and is typically fatal within weeks or months if left untreated. The prognosis for AML that arises from MDS is worse as compared to other types of AML.

[0006] Several compounds are known to treat blood disorders and cancers (e.g. MDS, AML), but do so inadequately. While some known compounds, such as Quizartinib, Gilteritinib, and Crenolanib, can be used to treat AML, some of these treatments do not result in complete remission or partial remission. In some instances, for example, treatment can result in adaptive resistance or selecting mutations that are resistant to inhibitors, as with Quizartinib, in particular, where repeated administration can lead to desensitization in tumor cell suppression of proliferation (Melgar et al., 2019).

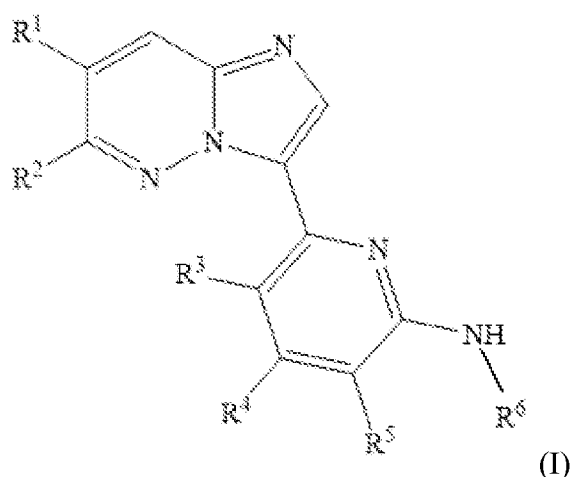
[0007] In treating MDS and/or AML, there is a need to develop therapies capable of inhibiting the adaptive resistance mechanism, to improve survival in the context of AML and MDS. There is also an unmet need in AML for drugs that increase overall survival, decrease the length of hospital stay as well as hospital readmission rates, overcome acquired resistance to other treatments, and increase the success rate for hematopoietic stem cell transplant. There is additionally a need for drugs for treating MDS which can slow the conversion rate to AML, and decrease transfusion dependence.

[0008] It is therefore necessary to develop treatments and methods of effectively treating MDS and/or AML, and/or other conditions or disorders characterized by dysregulated (e.g., hyperactive) IRAK (e.g., IRAK 1 and/or 4). Additionally, in doing so, it will be important

to determine whether a patient is likely to be responsive to a particular treatment or method of treatment. Certain embodiments of the disclosure can address one or more of these issues.

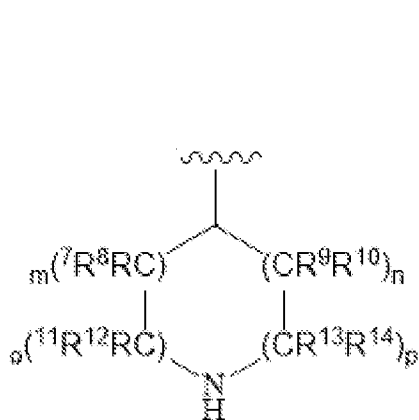
SUMMARY OF THE DISCLOSURE

[0009] In one aspect, the present disclosure relates to a compound of Formula (I)

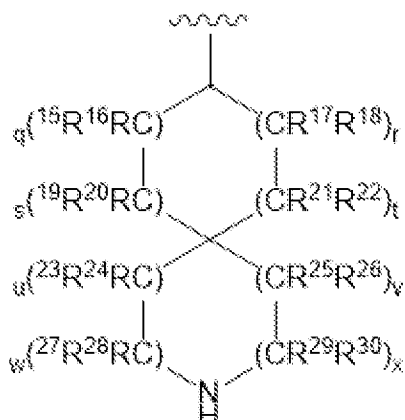


or a salt, ester, solvate, optical isomer, geometric isomer, salt of an isomer, prodrug, or derivative thereof, wherein: R^1 is selected from H, halogen, hydroxy, oxo, -CN, amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl; R^2 is selected from H, halogen, hydroxy, oxo, -CN, amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with

one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, fused ring aryl, heteroaryl, fused ring heteroaryl, or C₁-C₇ alkyl which is substituted with cycloalkyl; R³, R⁴, and R⁵ are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl; R⁶ is



(Ia), or

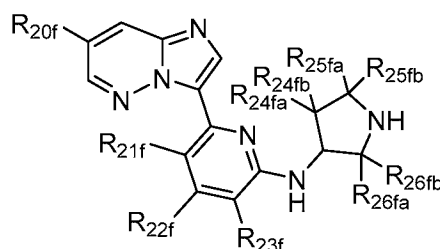


(Ib);

R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, R¹⁴ are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen; R¹⁵, R¹⁶, R¹⁷, R¹⁸, R¹⁹, R²⁰, R²¹, R²²,

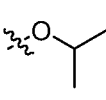
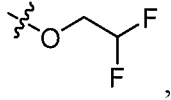
R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , R^{29} , and R^{30} are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen; and m, n, o, p, q, r, s, t, u, v, w, and x are each independently selected from 0, 1, 2, 3, 4, or 5, where q+r+s+t is at least 1, and where u+v+w+x is at least 1.

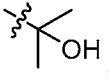
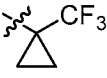
[0010] In one embodiment, the compound of Formula (I) is a compound of Formula (II_f)



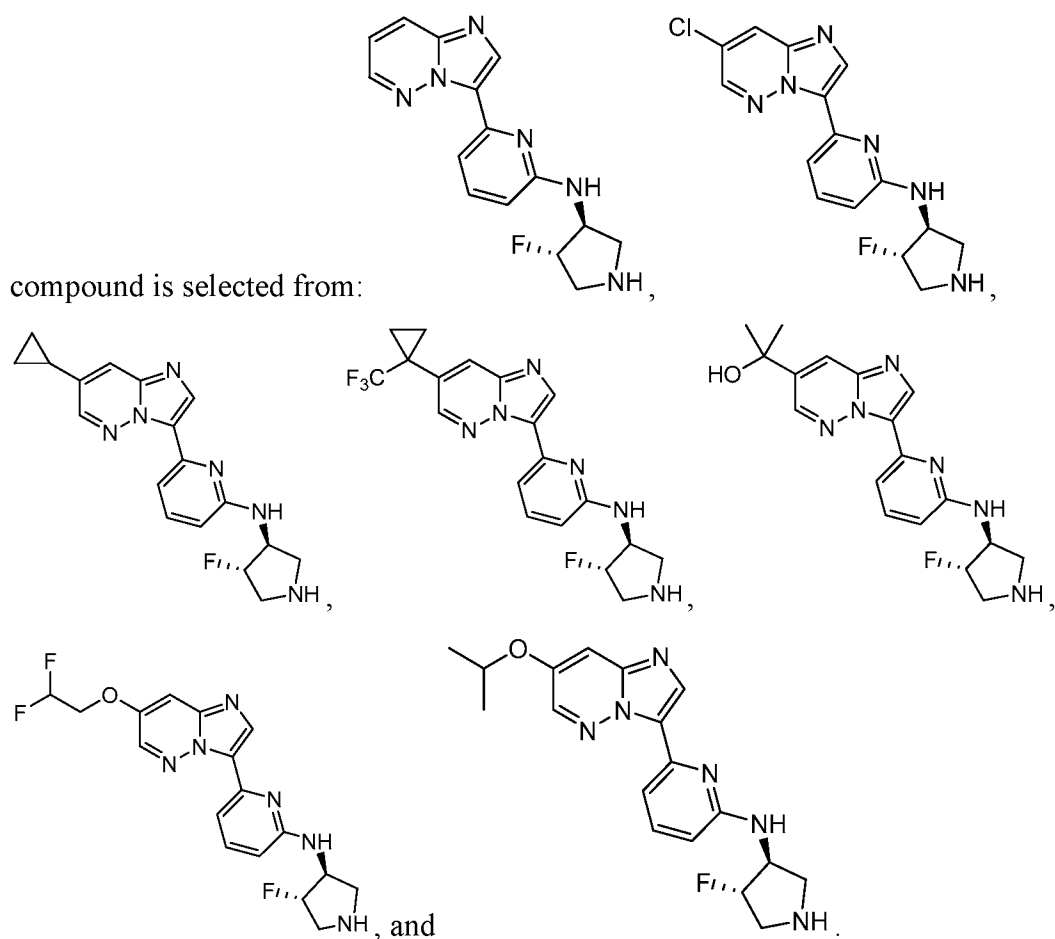
Formula (II_f),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein: R_{20f} is selected from H, halogen, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and -O-(C₃-C₆ cycloalkyl), wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, and C₃-C₆ cycloalkyl and -O-(C₃-C₆ cycloalkyl) are each optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen; R_{21f} , R_{22f} , and R_{23f} are each independently selected from H and halogen; and R_{24fa} , R_{24fb} , R_{25fa} , R_{25fb} , R_{26fa} , and R_{26fb} are each independently selected from H, halogen, -OH, C₁-C₆ alkyl, and C₁-C₆ alkoxy, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more halogen atoms. In one embodiment, one or more of R_{24fa} , R_{24fb} , R_{25fa} , R_{25fb} , R_{26fa} , and R_{26fb} is independently selected from halogen, -OH, optionally substituted C₁-C₆ alkyl, and optionally substituted C₁-C₆ alkoxy. In one embodiment, R_{20f} is H. In one

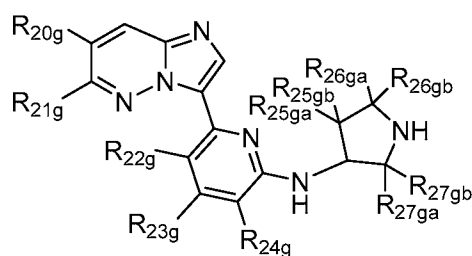
embodiment, at least one of (i)-(iii) applies: (i) R_{20f} is selected from Cl, , ,

, unsubstituted C₃ cycloalkyl, and ; (ii) R_{21f} , R_{22f} , and R_{23f} are each H; (iii)

R_{25fa} , R_{25fb} , R_{26fa} , and R_{26fb} are each H and R_{24fa} and/or R_{24fb} is F. In one embodiment, the



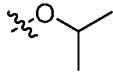
[0011] In one embodiment, the compound of Formula (I) is a compound of Formula (IIg)

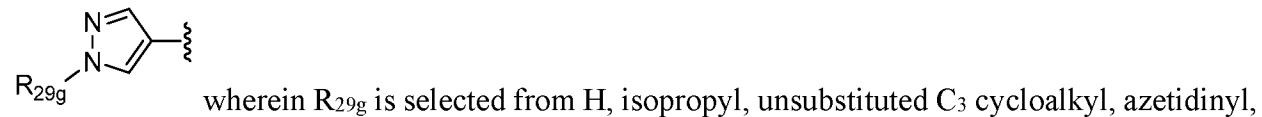
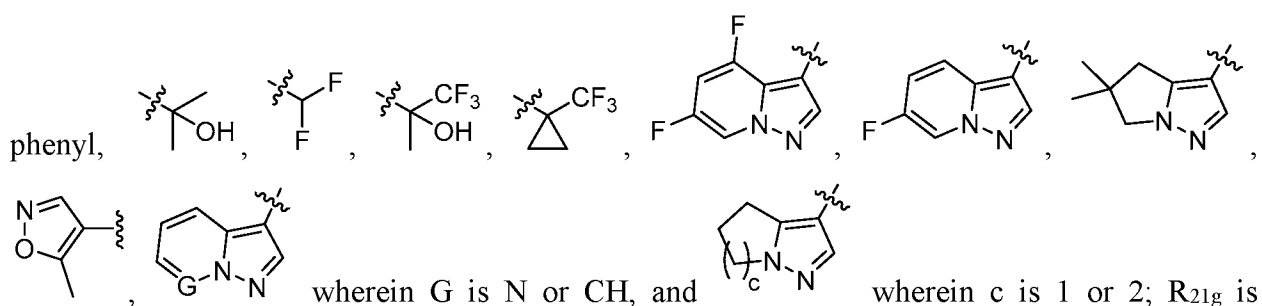


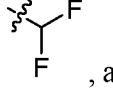
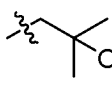
formula (IIg),

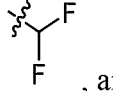
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein: R_{20g} is selected from H and C_1 - C_6 alkoxy; R_{21g} is selected from halogen, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_3 - C_6 cycloalkyl, $-O-(C_6-C_{12}$ aryl), C_3 - C_9 heterocyclyl, and $-NR_{28ga}R_{28gb}$, wherein C_1 - C_6 alkyl and C_1 - C_6 alkoxy are each optionally substituted with one or more substituents selected from $-OH$ and halogen, C_3 - C_6 cycloalkyl is optionally substituted with one or more substituents selected from C_1 - C_6 alkyl and halogen, and C_3 - C_9 heterocyclyl is optionally substituted with one or more substituents selected from C_1 - C_6 alkyl, C_3 - C_6 -cycloalkyl, C_3 - C_9 -heterocyclyl, $-OH$, and halogen; R_{22g} , R_{23g} ,

and R_{24g} are each independently selected from H and halogen; R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} are each independently selected from H, halogen, -OH, C₁-C₆ alkyl, and C₁-C₆ alkoxy, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more halogen atoms; and R_{28ga} and R_{28gb} are each independently selected from H, C₁-C₆ alkyl, and C₃-C₆ cycloalkyl. In one embodiment, one or more of R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} is independently selected from halogen, -OH, optionally substituted C₁-C₆ alkyl, and optionally substituted C₁-C₆ alkoxy. In one embodiment, R_{20g} is H. In one embodiment, at least one of (i)-

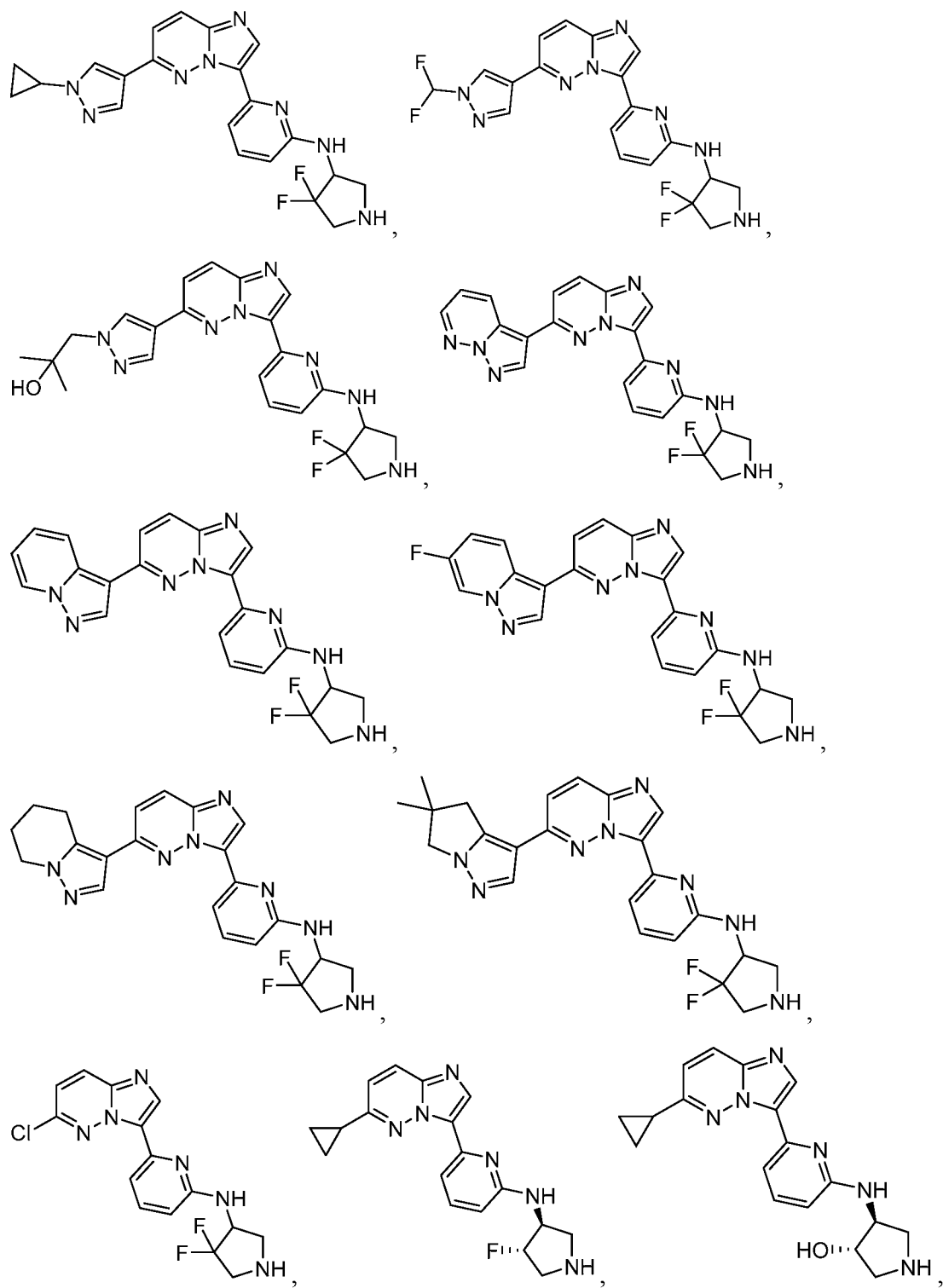
(ix) applies: (i) R_{20g} is selected from -OCH₃ and ; (ii) R_{21g} is selected from t-butyl, unsubstituted C₃ cycloalkyl, morpholinyl, azetidynyl, piperdiny, isoxazoly, Cl, -CF₃, -OCH₃, -O-

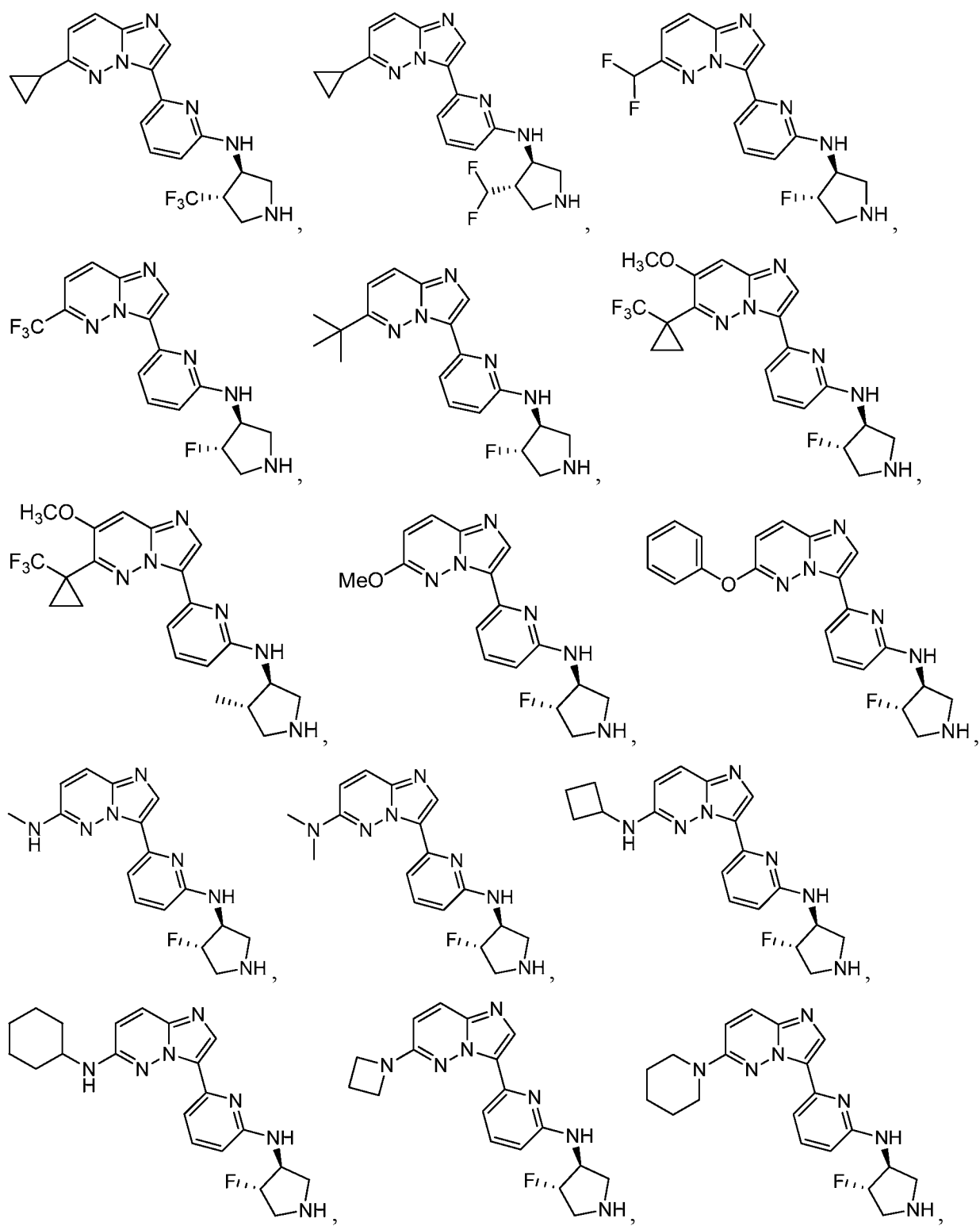


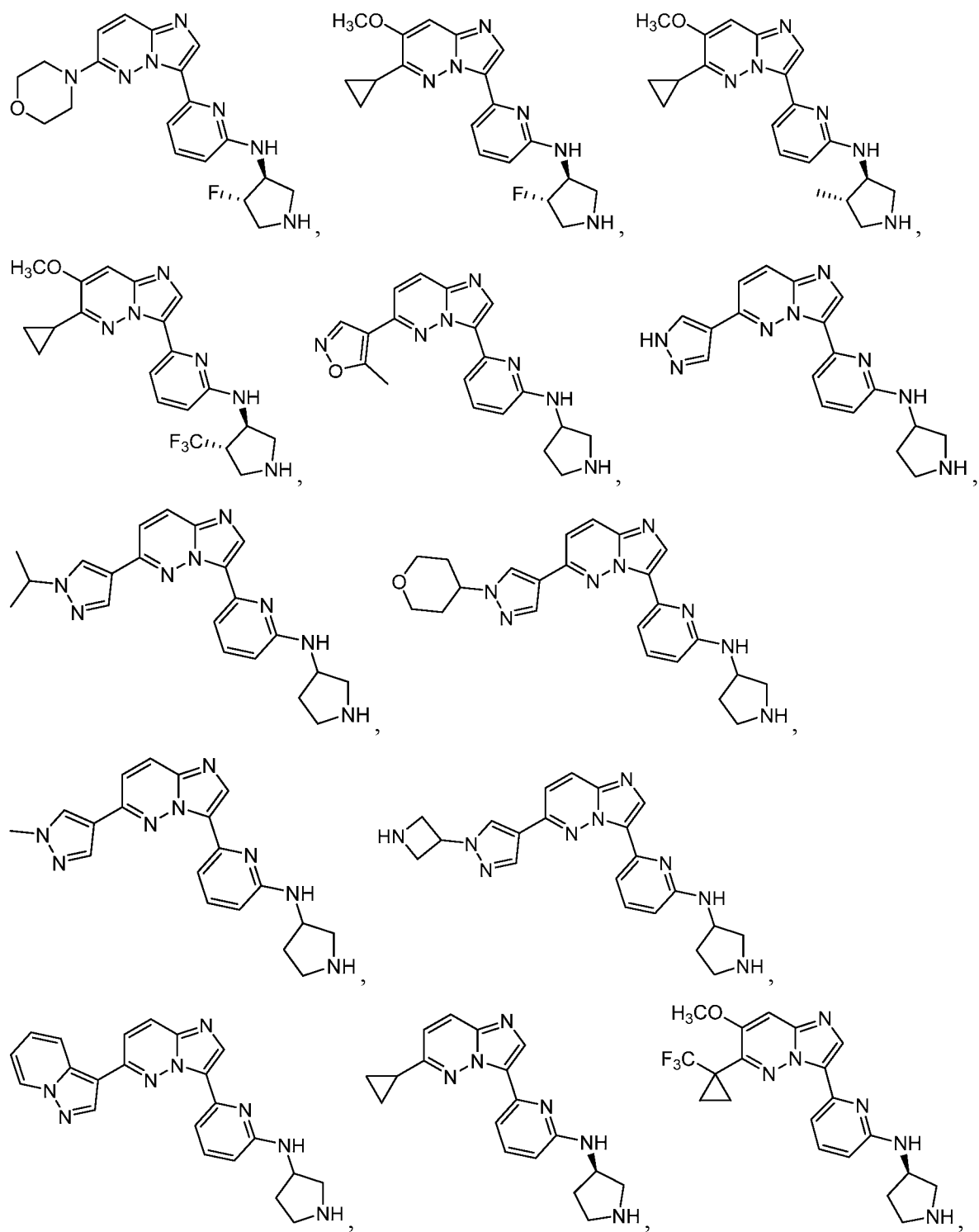
tetrahydropyranyl -CH₃, , and ; (iv) R_{21g} -NR_{28ga}R_{28gb} wherein R_{28ga} is H and R_{28gb} is selected from -CH₃, cyclobutyl, and cyclohexyl or wherein R_{28ga} and R_{28gb} are each -CH₃; (v) R_{22g}, R_{23g}, and R_{24g} are each H; (vi) R_{22g} and R_{24g} are each F and R_{23g} is H; (vii) R_{22g} and R_{24g} are each H and R_{23g} is F; (viii) R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} are each H; (ix) R_{26ga}, R_{26gb},

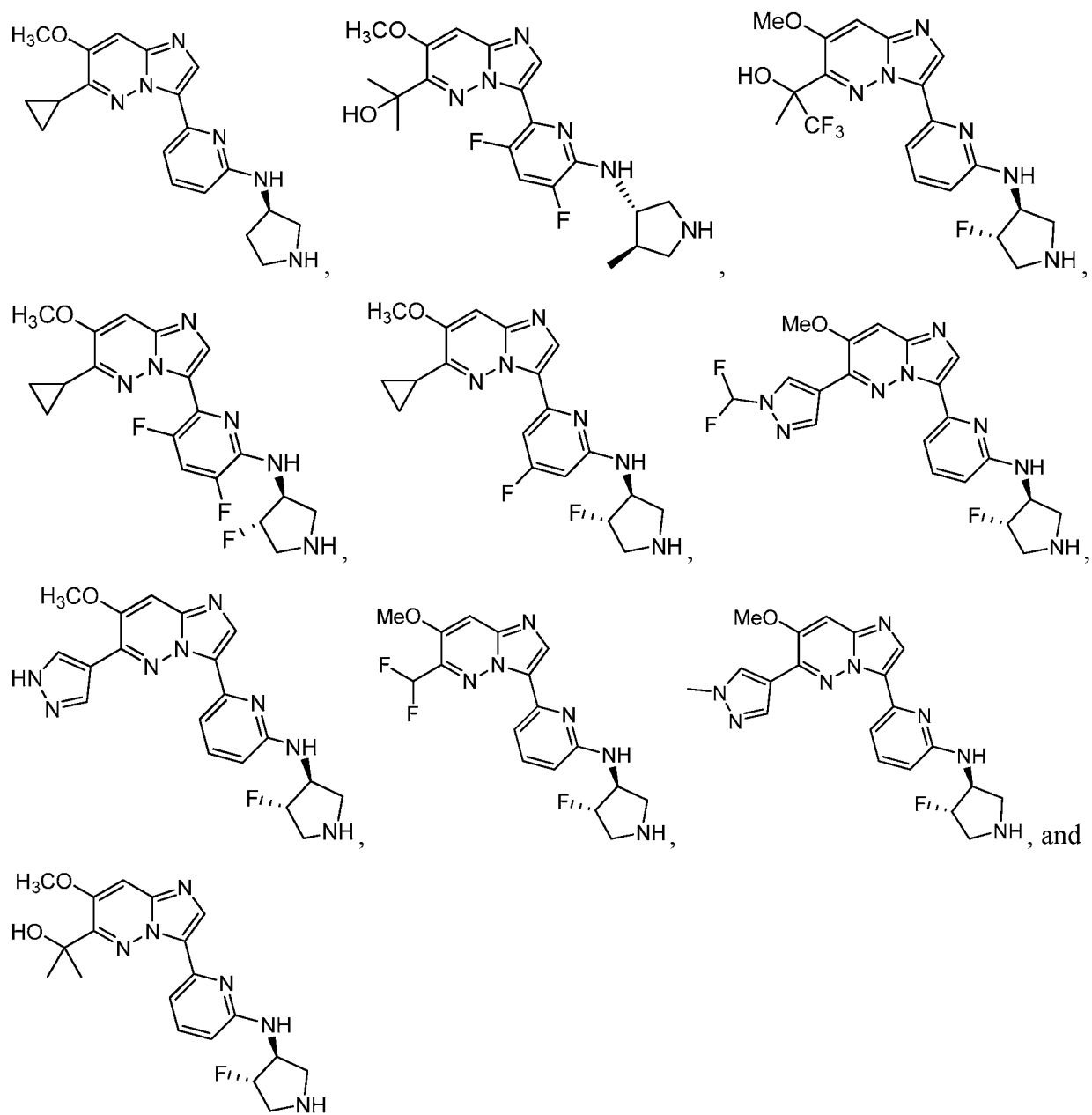
R_{27ga}, and R_{27gb} are each H and R_{25ga} and/or R_{25gb} are selected from F, -CH₃, -OH, -CF₃, , and -OCH₃. In one embodiment, the compound is selected from:



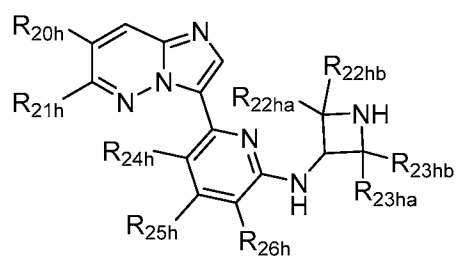






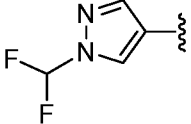


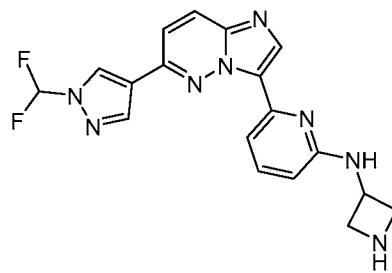
[0012] In one embodiment, the compound of Formula (I) is a compound of Formula (IIh)



Formula (IIh),

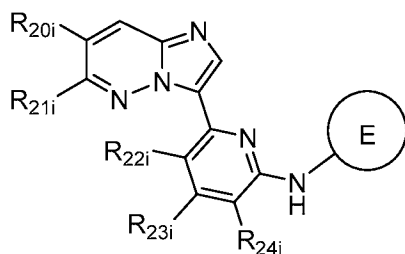
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein: R_{20h} is selected from H and C₁-C₆ alkoxy; R_{21h} is selected from C₁-C₆ alkyl, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl is optionally substituted with one or more substituents selected from -OH and halogen and C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl are each optionally substituted with one or more substituents selected from C₁-C₆ alkyl, -OH, and halogen; R_{22ha}, R_{22hb}, R_{23ha}, and R_{23hb} are each independently selected from H and C₁-C₆ alkyl, wherein C₁-C₆ alkyl is optionally substituted with one or more halogen atoms; and R_{24h}, R_{25h}, and R_{26h} are each independently selected from H and halogen. In one embodiment, at least one of (i)-(iv) applies:

(i) R_{20h} is H; (ii) R_{21h} is ; (iii) R_{22ha}, R_{22hb}, R_{23ha}, and R_{23hb} are each H; (iii) R_{24h}, R_{25h},



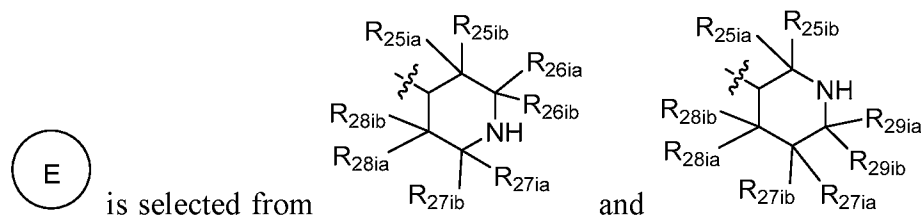
and R_{26h} are each H. In one embodiment, the compound is

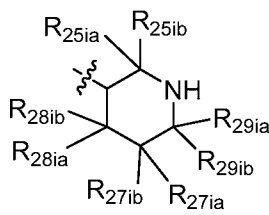
[0013] In one embodiment, the compound of Formula (I) is a compound of Formula (IIi)



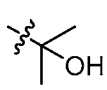
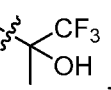
Formula (IIi),

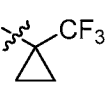
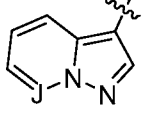
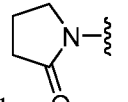
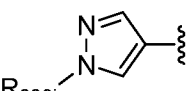
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

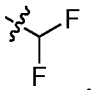
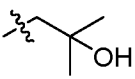


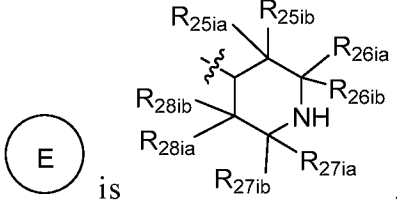
is selected from  and ; R_{20i} is selected from H, and C₁-C₆ alkoxy; R_{21i} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or

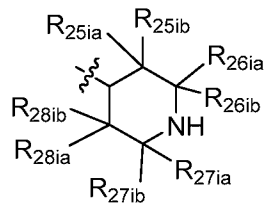
more substituents selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, -OH, -C=O, and halogen; R_{22i}, R_{23i}, and R_{24i} are each independently selected from H and halogen; and R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} are each independently selected from H, halogen, -OH, or C₁-C₆ alkyl. In one embodiment, one or more of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is independently selected from halogen, -OH, and C₁-C₆ alkyl. In one embodiment, each of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is H. In one embodiment, at least one of (i)-(xi) applies: (i) R_{20i} is

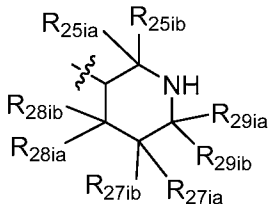
selected from H and -OCH₃; (ii) R_{21i} is selected from , , , unsubstituted C₃

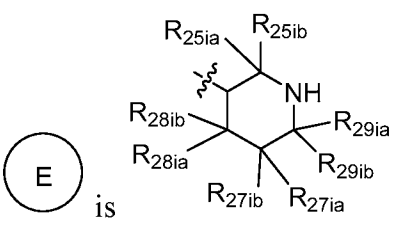
cycloalkyl, ,  wherein J is N or CH, and ; (iii) R_{21i} is R_{220i}-

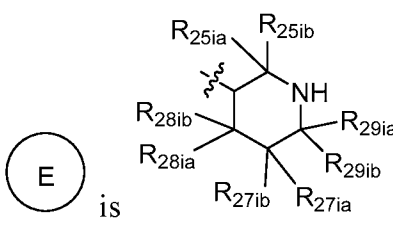
wherein R_{220i} is selected from H, -CH₃, , , and unsubstituted C₃ cycloalkyl; (iv) R_{22i}, R_{23i}, and R_{24i} are each H; (v) R_{22i} and R_{24i} are each F and R_{23i} is H; (vi) R_{22i} and R_{24i} are each

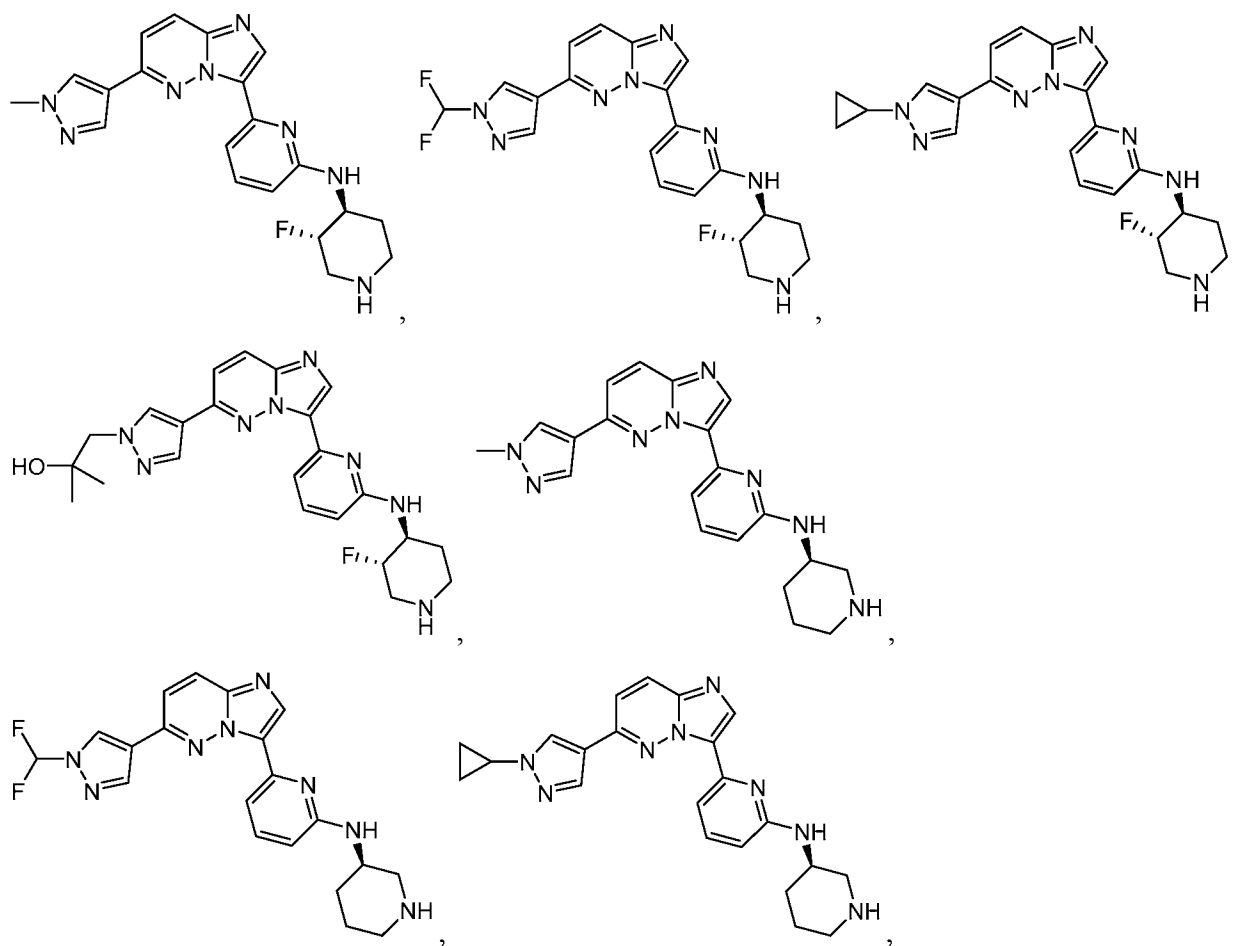
H and R_{23i} is F; (vii)  is , each of R_{25ia}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia},

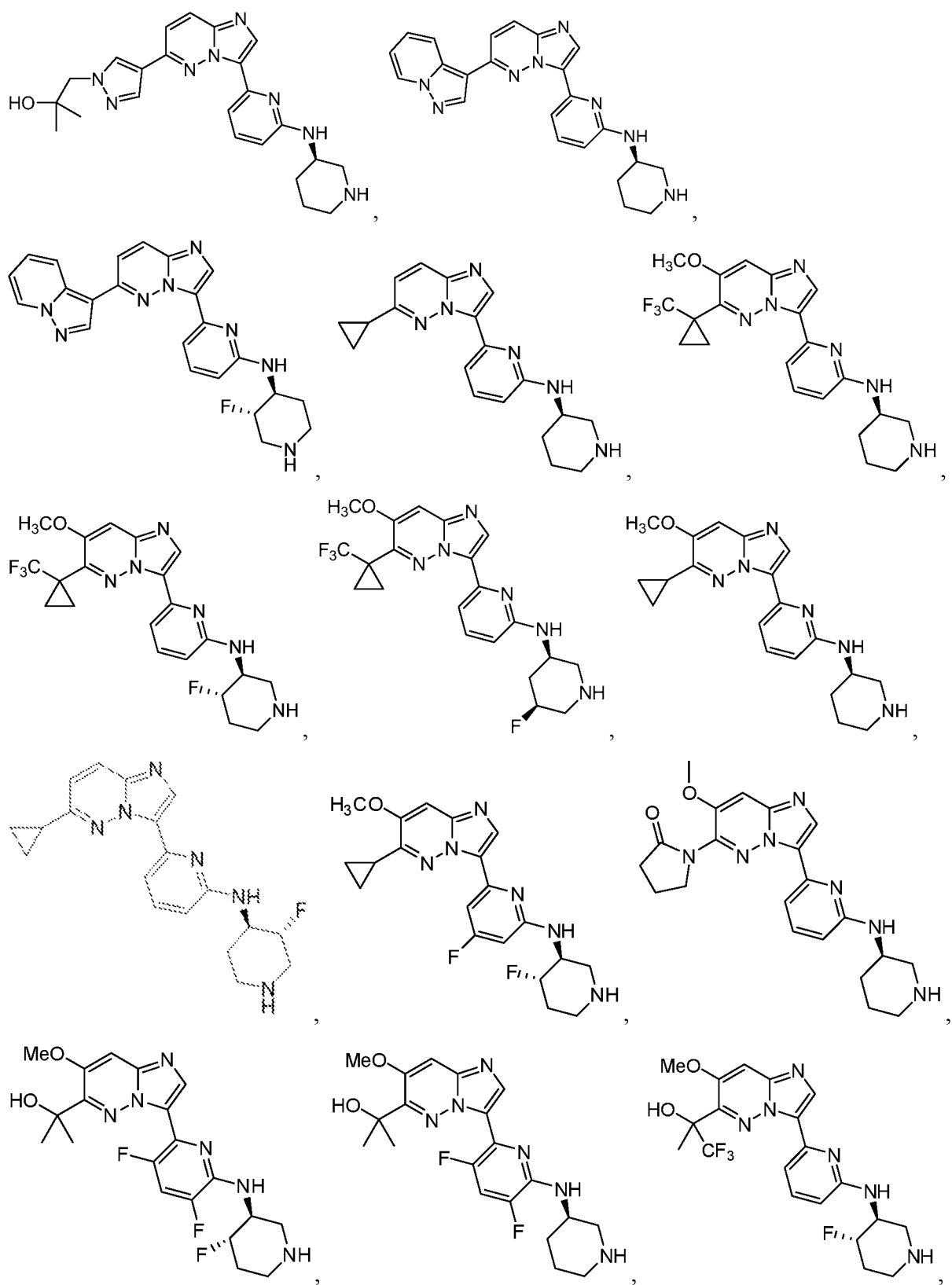
and R_{28ib} is H and R_{25ib} is F; (viii)  is , each of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib},

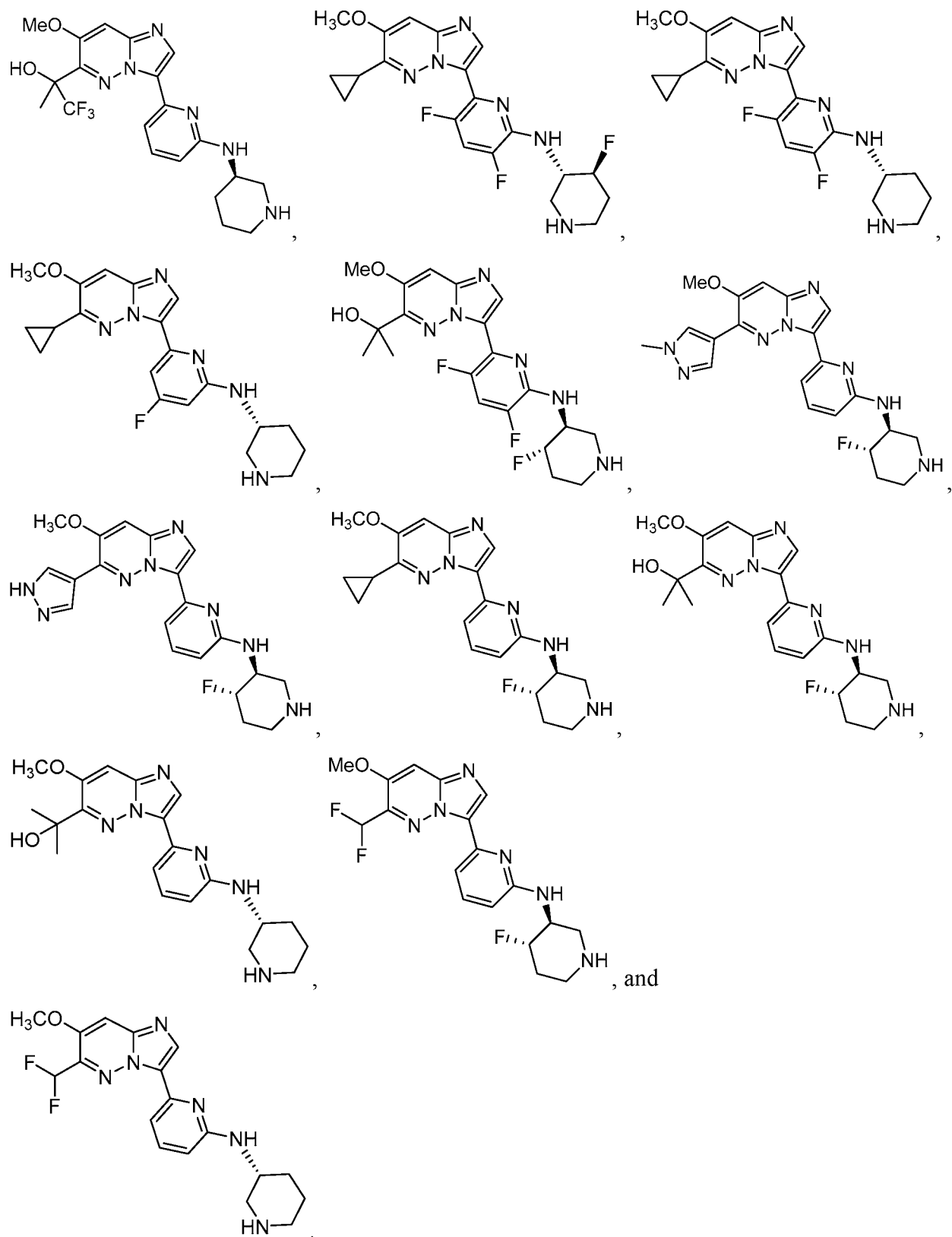
R_{27ia}, R_{27ib}, R_{28ia}, and R_{28ib} is H; (ix)  is , each of R_{25ia}, R_{25ib}, R_{27ia},

R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is H; (x)  is , each of R_{25ia}, R_{25ib}, R_{27ia},

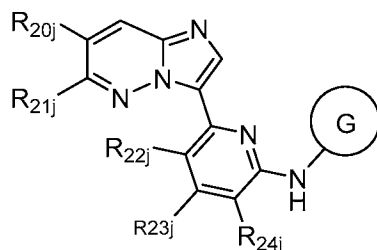
R_{27ib}, R_{28ia}, R_{29ia}, and R_{29ib} is H and R_{28ib} is F; (xi)  is , each of R_{25ia}, R_{25ib}, R_{27ia}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is H and R_{27ib} is F. In one embodiment, the compound is selected from:





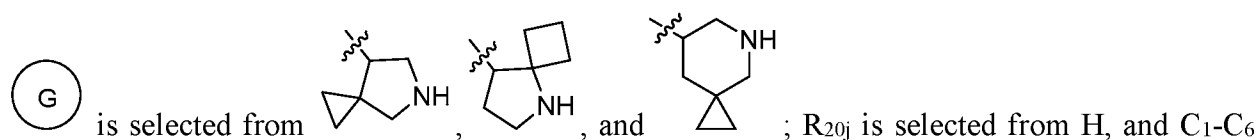


[0014] In one embodiment, the compound of Formula (I) is a compound of Formula (IIj)



Formula (IIj),

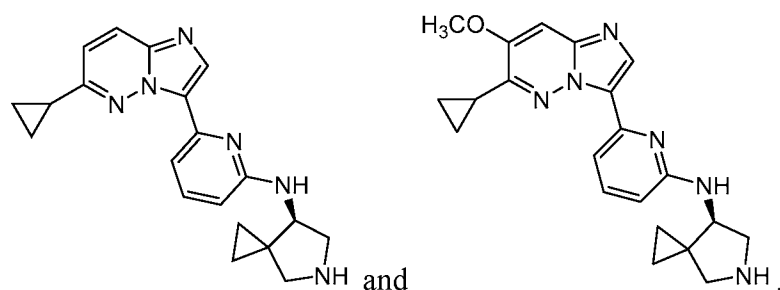
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:



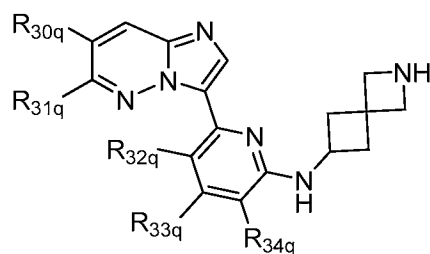
alkoxy; R_{21j} is selected from H, C₁-C₆ alkyl, C₁-C₆ alkoxy, and C₃-C₆ cycloalkyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from halogen and -OH, and C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen; and R_{22j}, R_{23j}, and R_{24j} are each independently selected from H and halogen. In one embodiment, at least one of (i)-(iv) applies: (i) R_{20j} is selected from

H and -OCH₃; (ii) R_{21j} is unsubstituted C₃ cycloalkyl; (iii) R_{22j}, R_{23j}, and R_{24j} are each H; (iv)

is . In one embodiment, the compound is selected from:

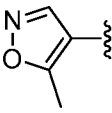
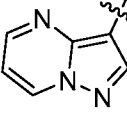
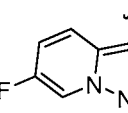
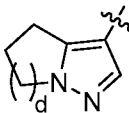
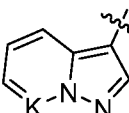
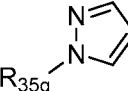


[0015] In one embodiment, the compound of Formula (I) is a compound of Formula (IIIq)

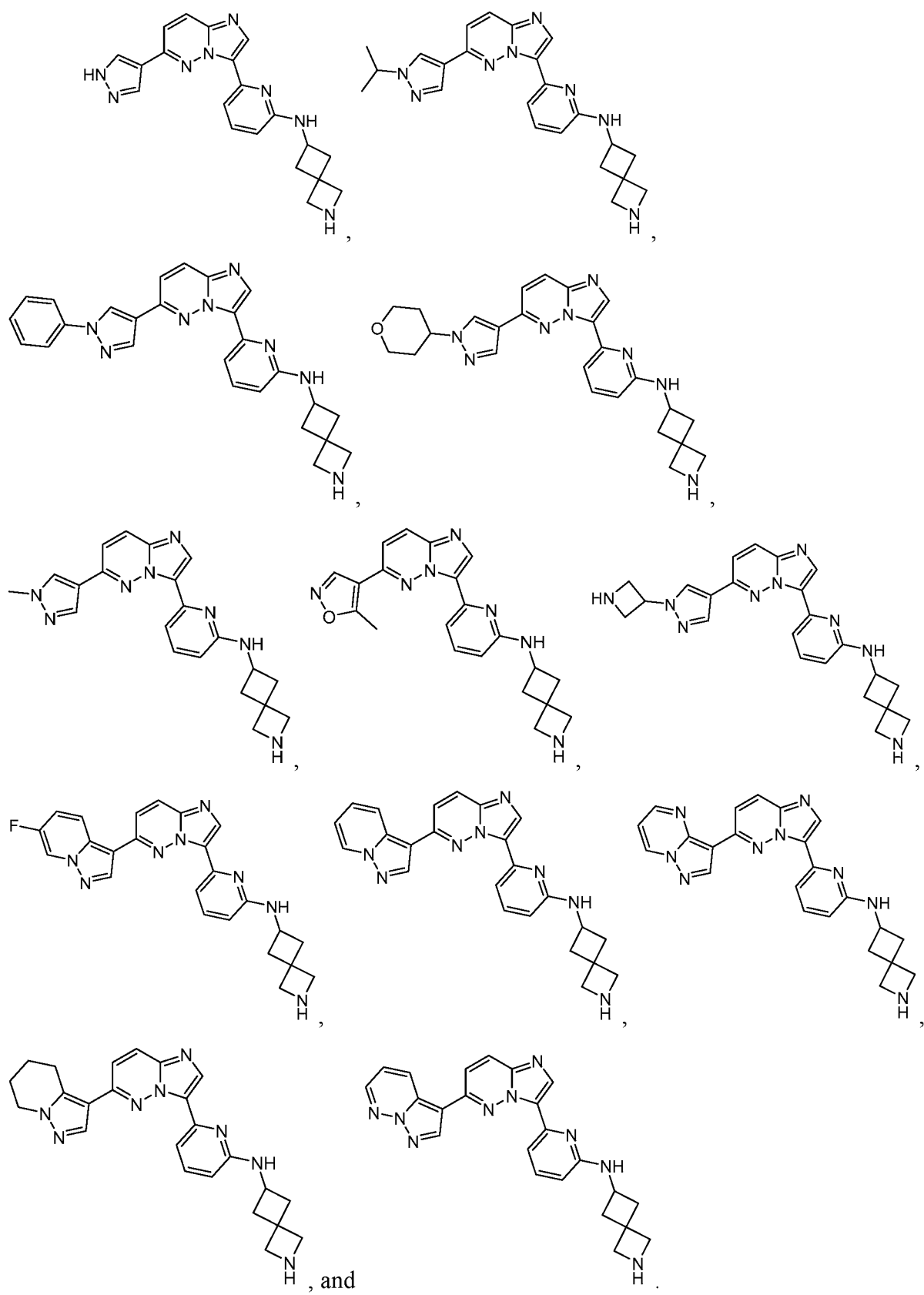


Formula (IIIq),

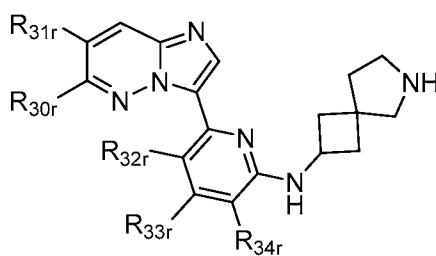
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein: R_{30q} is selected from H and C₁-C₆ alkoxy; R_{31q} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; and R_{32q} , R_{33q} , and R_{34q} are each independently selected from H and halogen. In one embodiment, at least one of

(i)-(iv) applies: (i) R_{30q} is H; (ii) R_{31q} is selected from , , ,  wherein d is 1 or 2, and  wherein K is N or CH; (iii) R_{31q} is  wherein R_{35q}

wherein R_{35q} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyranyl; (iv) R_{32q} , R_{33q} , and R_{34q} are each H. In one embodiment, the compound is selected from:

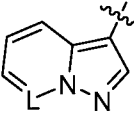
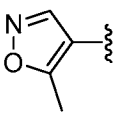


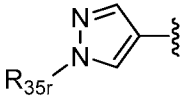
[0016] In one embodiment, the compound of Formula (I) is a compound of Formula (IIIr)

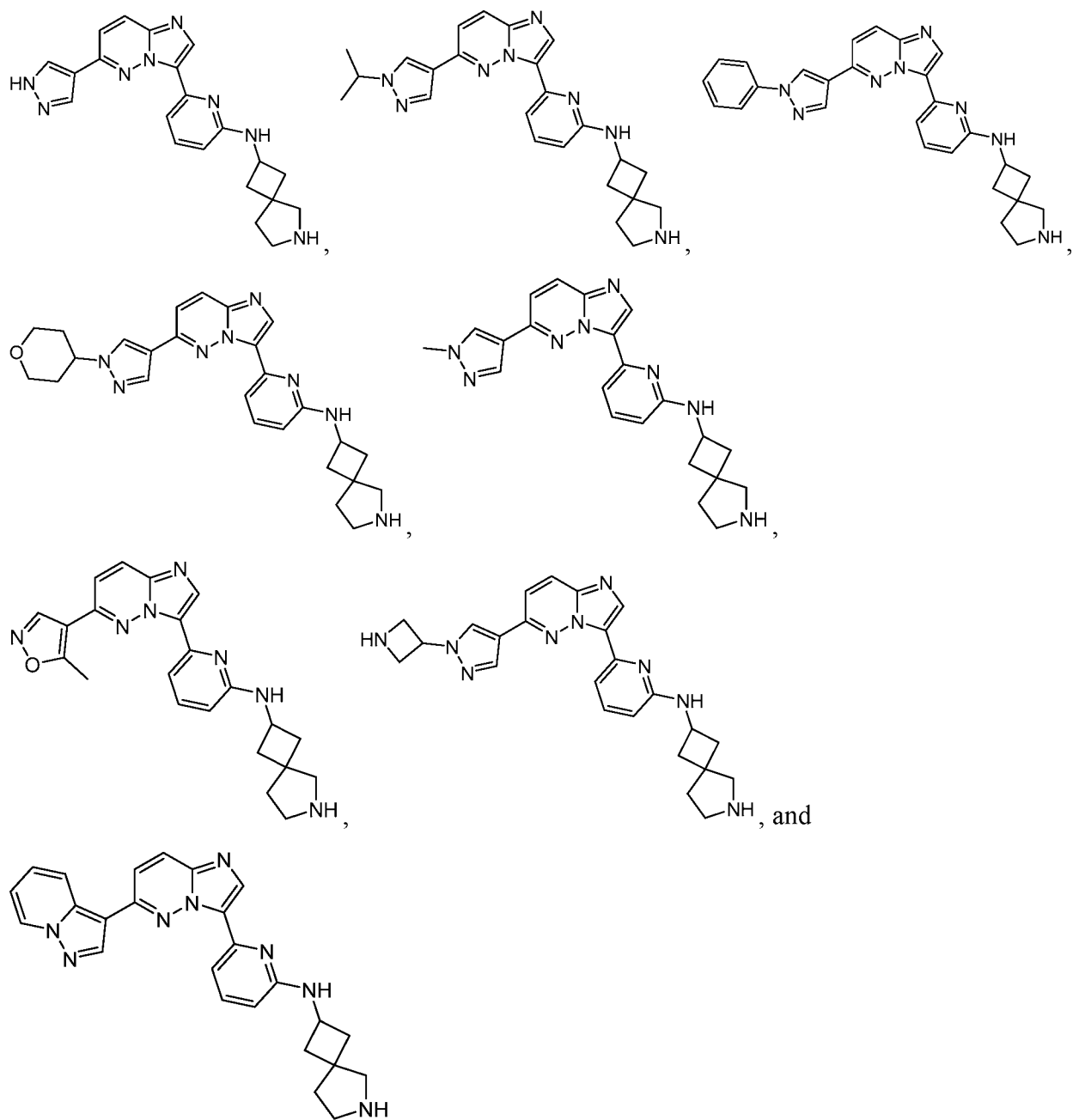


Formula (IIIr),

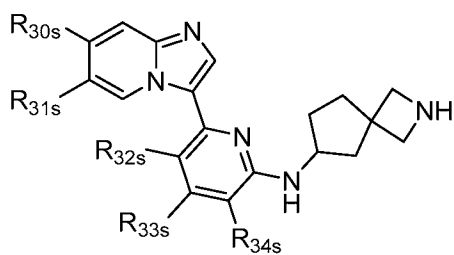
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein: R_{30r} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; R_{31r} is selected from H and C₁-C₆ alkoxy; and R_{32r}, R_{33r}, and R_{34r} are each independently selected from H and halogen. In one embodiment, at least one of (i)-(iv)

applies: (i) R_{30r} is selected from  wherein L is N or CH and ; (ii) R_{30r} is

 wherein R_{35r} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyranyl; (iii) R_{31r} is H; (iv) R_{32r}, R_{33r}, and R_{34r} are each H. In one embodiment, the compound is selected from:

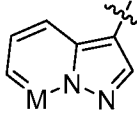
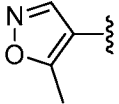
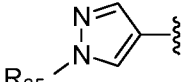


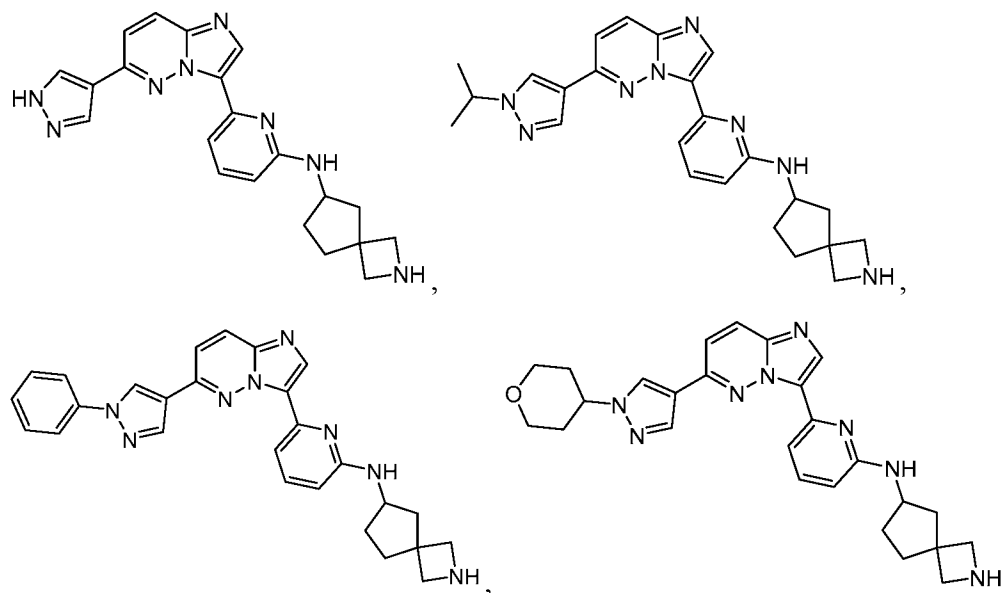
[0017] In one embodiment, the compound of Formula (I) is a compound of Formula (IIIs)

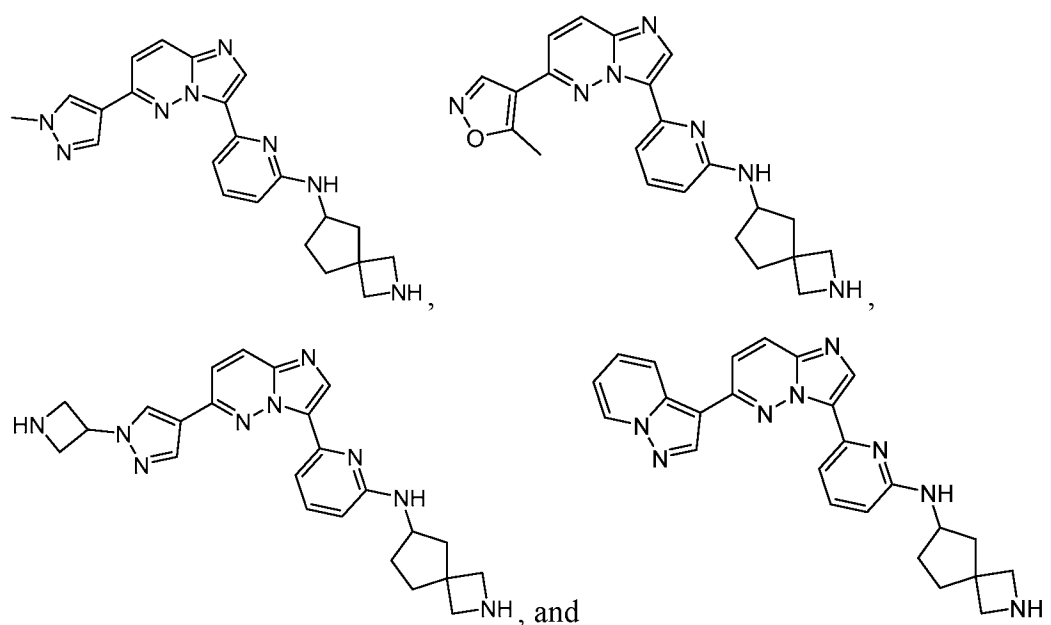


Formula (IIIs),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein: R_{30s} is selected from H and C₁-C₆ alkoxy; R_{31s} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; and R_{32s} , R_{33s} , and R_{34s} are each independently selected from H and halogen. In one embodiment, at least one of

(i)-(iv) applies: (i) R_{30s} is H; (ii) R_{31s} is selected from  wherein M is N or CH and ; (iii) R_{31s} is  wherein R_{35s} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyranyl; (iv) R_{32s} , R_{33s} , and R_{34s} are each H. In one embodiment, the compound is selected from:





[0018] In another aspect, the present disclosure relates to a compound of any of the formula disclosed herein, wherein the compound is an inhibitor of at least one of IRAK1, IRAK4, and FLT3. In one embodiment, the compound is an inhibitor of at least two of IRAK1, IRAK4, and FLT3. In one embodiment, the compound is an inhibitor of IRAK1 and IRAK4. In one embodiment, the compound is an inhibitor of IRAK1, IRAK4, and FLT3. In one embodiment, FLT3 is selected from WT FLT3, activated FLT3, and mutated FLT3. In one embodiment, the mutated FLT3 is D835Y mutated FLT3 or F691L mutated FLT3.

[0019] In another aspect, the present disclosure relates to a composition comprising a compound of any one of formula disclosed herein, wherein the composition further comprises a formulary ingredient, an adjuvant, or a carrier. In one embodiment, the composition is used in combination with one or more of: a chemotherapy agent, a BCL2 inhibitor, an immune modulator, a BTK inhibitor, a DNA methyltransferase inhibitor/hypomethylating agent, an anthracycline, a histone deacetylase (HDAC) inhibitor, a purine nucleoside analogue (antimetabolite), an isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, an antibody-drug conjugate, an mAbs/immunotherapy, a Plk inhibitor, a MEK inhibitor, a CDK inhibitor, a CDK9 inhibitor, a CDK8 inhibitor, a retinoic acid receptor agonist, a TP53 activator, a CELMoD, a smoothened receptor antagonist, an ERK inhibitor including an ERK2/MAPK1 or ERK1/MAPK3 inhibitor, a PI3K inhibitor, an mTOR inhibitor, a steroid or glucocorticoid receptor modulator, an EZH2 inhibitor, a hedgehog (Hh) inhibitor, a Topoisomerase I inhibitor, a Topoisomerase II inhibitor, an

aminopeptidase/Leukotriene A4 hydrolase inhibitor, a FLT3/Axl/ALK inhibitor, a FLT3/KIT/PDGFR, PKC, and/or KDR inhibitor, a Syk inhibitor, an E-selectin inhibitor, an NEDD8-activator, an MDM2 inhibitor, a PLK1 inhibitor, an Aurora A inhibitor, an aurora kinase inhibitor, an EGFR inhibitor, an AuroraB/C/VEGFR1/2/3/FLT3/CSF-1R/Kit/PDGFR/AB inhibitor, an AKT 1, 2, and/or 3 inhibitor, a ABL1/2/SRC/EPHA2/LCK/YES1/KIT/PDGFRB/FYN inhibitor, a farnesyltransferase inhibitor, a BRAF/MAP2K1/MAP2K2 inhibitor, a Menin-KMT2A/MLL inhibitor, and a multikinase inhibitor. In one embodiment, the composition is used in combination with a BCL2 inhibitor. In one embodiment, the BCL2 inhibitor is venetoclax or a pharmaceutically acceptable salt thereof.

[0020] In another aspect, the present disclosure relates to a method of treating a disease or disorder in a subject, the method comprising administering to the subject a therapeutically effective amount of a compound of any of the formula disclosed herein or a composition comprising a compound of any of the formula disclosed herein. In one embodiment, the method comprises administering to the subject a composition comprising the therapeutically effective amount of the compound of Formula (I) and a formulary ingredient, an adjuvant, or a carrier. In one embodiment, the disease or disorder is responsive to at least one of interleukin-1 receptor-associated kinase (IRAK) inhibition and fms-like tyrosine kinase 3 (FLT3) inhibition. In one embodiment, the administration comprises parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration. In one embodiment, the compound is administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 1,000 mg /kg subject body weight. In one embodiment, the disease or disorder comprises a hematopoietic cancer. In one embodiment, the disease or disorder comprises myelodysplastic syndrome (MDS) and/or acute myeloid leukemia (AML). In one embodiment, the disease or disorder comprises lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL with MYD88 mutation, follicular lymphoma, or marginal zone lymphoma. In one embodiment, the disease or disorder comprises at least one cancer selected from glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney

cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, or one or more inflammatory diseases or autoimmune disease characterized by overactive IRAK1 and/or IRAK4, or combinations thereof. In one embodiment, the disease or disorder comprises one or more inflammatory diseases or autoimmune disease selected from chronic inflammation, sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, or combinations thereof. In one embodiment, the disease or disorder comprises: (i) MDS, MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2; or (ii) AML with a splicing factor mutation, AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the AML is not driven by FLT3 mutations but expresses IRAK4-Long. In one embodiment, the MDS with a splicing factor mutation comprises MDS with a splicing factor mutation in U2AF1 or SF3B1 and the AML splicing factor mutation comprises AML with a splicing factor mutation in U2AF1 or SF3B1. In one embodiment, the disease or disorder comprises DLBCL, and wherein the DLBCL comprises a L265P MYD88 mutant (ABC) subtype of DLBCL or a S219C MYD88 mutant (GCB) subtype of DLBCL. In one embodiment, the method further comprises administering to the subject one or more additional therapies selected from: a chemotherapy agent, a BCL2 inhibitor, an immune modulator, a BTK inhibitor, a DNA methyltransferase inhibitor/hypomethylating agent, an anthracycline, a histone deacetylase (HDAC) inhibitor, a purine nucleoside analogue (antimetabolite), an isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, an antibody-drug conjugate, an mAbs/immunotherapy, a Plk inhibitor, a MEK inhibitor, a CDK inhibitor, a CDK9 inhibitor, a CDK8 inhibitor, a retinoic acid receptor agonist, a TP53 activator, a CELMoD, a smoothened receptor antagonist, an ERK inhibitor including an ERK2/MAPK1 or ERK1/MAPK3 inhibitor, a PI3K inhibitor, an mTOR inhibitor, a steroid or glucocorticoid receptor modulator, an EZH2 inhibitor, a hedgehog (Hh) inhibitor, a Topoisomerase I inhibitor, a Topoisomerase II inhibitor, an aminopeptidase/Leukotriene A4 hydrolase inhibitor, a FLT3/Axl/ALK inhibitor, a FLT3/KIT/PDGFR, PKC, and/or KDR inhibitor, a Syk inhibitor, an E-selectin inhibitor, an

NEDD8-activator, an MDM2 inhibitor, a PLK1 inhibitor, an Aurora A inhibitor, an aurora kinase inhibitor, an EGFR inhibitor, an AuroraB/C/VEGFR1/2/3/FLT3/CSF-1R/Kit/PDGFRB/B inhibitor, an AKT 1, 2, and/or 3 inhibitor, a ABL1/2/SRC/EPHA2/LCK/YES1/KIT/PDGFRB/FYN inhibitor, a farnesyltransferase inhibitor, a BRAF/MAP2K1/MAP2K2 inhibitor, a Menin-KMT2A/MLL inhibitor, and a multikinase inhibitor. In one embodiment, the method further comprises administering a BCL2 inhibitor to the subject. In one embodiment, the BCL2 inhibitor is venetoclax or a pharmaceutically acceptable salt thereof. In one embodiment, the disease or disorder is a BCL2 inhibitor resistant disease or disorder. In one embodiment, the disease or disorder is a venetoclax resistant disease or disorder. In one embodiment, the disease or disorder is a FLT3 inhibitor resistant disease or disorder. In one embodiment, the disease or disorder is BCL2 inhibitor resistant acute myeloid leukemia (AML). In one embodiment, the disease or disorder is venetoclax resistant acute myeloid leukemia (AML). In one embodiment, the disease or disorder is FLT3 inhibitor resistant acute myeloid leukemia (AML). In one embodiment, the disease or disorder is BCL2 inhibitor resistant refractory acute myeloid leukemia (AML). In one embodiment, the disease or disorder is venetoclax resistant refractory acute myeloid leukemia (AML). In one embodiment, the disease or disorder is FLT3 inhibitor resistant refractory acute myeloid leukemia (AML). In one embodiment, the disease or disorder is BCL2 inhibitor resistant relapsed acute myeloid leukemia (AML). In one embodiment, the disease or disorder is venetoclax resistant relapsed acute myeloid leukemia (AML). In one embodiment, the disease or disorder is FLT3 inhibitor resistant relapsed acute myeloid leukemia (AML). In one embodiment, the compound of any one of the formula disclosed herein or the composition comprising a compound of any one of the formula disclosed herein and the one or more additional therapies are administered together in one administration or composition. In one embodiment, the compound of any of the formula disclosed herein or the composition comprising a compound of any of the formula disclosed herein and the one or more additional therapies are administered separately in more than one administration or more than one composition. In one embodiment, the disease or disorder is alleviated by inhibiting at least one of IRAK1, IRAK4, and FLT3 in the subject. In one embodiment, the disease or disorder is alleviated by inhibiting at least two of IRAK1, IRAK4, and FLT3 in the subject. In one embodiment, the disease or disorder is alleviated by inhibiting IRAK1 and IRAK4 in the subject. In one embodiment, the disease or disorder is alleviated by inhibiting IRAK1, IRAK4, and FLT3 in the

subject. In one embodiment, FLT3 is selected from WT FLT3, activated FLT3, and mutated FLT3. In one embodiment, the mutated FLT3 is D835Y mutated FLT3 or F691L mutated FLT3.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIGS. 1A-1B depict the concentration (nM) response of Compound 106 and Venetoclax for inhibition of cell viability, measured at 48 hours. The numbers in each cell represent the % of viable cells (FIG. 1A) or the excess HSA scores (FIG. 1B) at each given concentration combination. FIG. 1A: A 10 x 10 combination of Venetoclax with Compound 106 in MOLM14 (D835Y) cells. The numbers in each cell represent the % response at each given concentration combination. FIG. 1B: A 10 x 10 combination of Venetoclax with Compound 106 in MOLM14 (D835Y) cells. The numbers in each cell represent the excess HSA score at each given concentration combination. A negative excess HSA score illustrates that the drug combination is better than either drug alone, and greater synergy is observed at larger negative values of the excess HSA score.

[0022] FIGS. 2A-2B depict the concentration (nM) response of Compound 108 and Venetoclax for inhibition of cell viability, measured at 48 hours. The numbers in each cell represent the % of viable cells (FIG. 2A) or the excess HSA scores (FIG. 2B) at each given concentration combination. FIG. 2A: A 10 x 10 combination of Venetoclax with Compound 108 in MOLM14 (D835Y) cells. The numbers in each cell represent the % response at each given concentration combination. FIG. 2B: A 10 x 10 combination of Venetoclax with Compound 108 in MOLM14 (D835Y) cells. The numbers in each cell represent the excess HSA scores at each given concentration combination. A negative excess HSA score illustrates that the drug combination is better than either drug alone, and greater synergy is observed at larger negative values of the excess HSA score.

[0023] FIGS. 3A-3B depict the relative potency for various compounds to synergize with Venetoclax in a 10 x 10 combination in MOLM14 (D835Y) cells. Here, relative potency is expressed as the concentration of compound required to fully potentiate a 7.8 nM concentration of Venetoclax to <5% of the maximum response in the cell viability experiment. The numbers in each cell represent the % response at each given concentration combination. FIG. 3A: Compound 106 (see structure below the chart) fully potentiates the 7.8 nM Venetoclax response at 3.1 nM, whereas the FLT3/BTK inhibitor CG-806 (see structure to the right of the

chart) requires substantially higher concentrations to reach a similar level of potentiation with the same 7.8 nM Venetoclax concentration. FIG. 3B: Other FLT3 inhibitors Gilteritinib hemifumarate (see structure below the chart), Quizartinib (see structure to the right of the chart), and CA-4948 (see structure to the right of the chart) also require substantially higher concentrations to reach a similar level of potentiation as Compound 106 with the same 7.8 nM Venetoclax concentration.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0024] The following related applications are incorporated by reference herein in their entirety, and for all purposes: U.S. Patent Application No. 62/414,058, Overexpression of U2AF1 as a Genetic Predictor of Activated IRAK, filed October 28, 2016; U.S. Patent Application No. 62/429,289, Overexpression of U2AF1 as a Genetic Predictor of Activated IRAK, filed December 2, 2016; PCT Patent Publication No. WO 2018081738, TREATMENT OF DISEASES ASSOCIATED WITH ACTIVATED IRAK, filed October 30, 2017; U.S. Patent Application No. 16/339,692, TREATMENT OF DISEASES ASSOCIATED WITH ACTIVATED IRAK, filed April 4, 2019; U.S. Patent Application No. 61/826,211, Combination Therapy for MDS, filed May 22, 2013; PCT Patent Publication No. WO 2014190163, Combination Therapy for MDS, filed May 22, 2014; U.S. Patent No. 9,168,257, Combination Therapy for MDS, issued October 27, 2015; U.S. Patent No. 9,504,706, Combination Therapy for MDS, issued November 29, 2016; U.S. Patent No. 9,855,273, Combination Therapy for MDS, issued January 2, 2018; U.S. Patent No. 10,487,329, Methods and Compositions for the Treatment of Head and Neck Cancer, issued November 26, 2019; U.S. Patent Application No. 62/375,965, Compounds, Compositions, Methods for Treating Diseases, and Methods for Preparing Compounds, filed August 17, 2016; PCT Patent Publication No. WO 2018038988, Compounds, Compositions, Methods for Treating Diseases, and Methods for Preparing Compounds, filed August 16, 2017; U.S. Patent Application No. 16/326,571, COMPOUNDS, COMPOSITIONS, METHODS FOR TREATING DISEASES, AND METHODS FOR PREPARING COMPOUNDS, filed February 19, 2019; U.S. Patent Application No. 16/804,518, COMPOUNDS, COMPOSITIONS, METHODS FOR TREATING DISEASES, AND METHODS FOR PREPARING COMPOUNDS, filed February 28, 2020; U.S. Patent Application No. 62/812,948, COMPOUNDS, COMPOSITIONS, METHODS FOR TREATING DISEASES, AND METHODS FOR PREPARING COMPOUNDS, filed March 1, 2019; U.S. Patent Application No. 63/059,815, Multi-Cyclic IRAK and FLT3 Inhibiting

Compounds and Uses Thereof, filed July 31, 2020; International Patent Application No. PCT/US2021/044089, Multi-Cyclic IRAK and FLT3 Inhibiting Compounds and Uses Thereof, filed July 31, 2021; U.S. Patent Application No. 63/129,895, Multi-Cyclic IRAK and FLT3 Inhibiting Compounds and Uses Thereof, filed December 23, 2020; and U.S. Patent Application No. 63/285,663, IRAK Inhibitors Combination Therapies, filed December 3, 2021.

[0025] While embodiments encompassing the general inventive concepts may take diverse forms, various embodiments will be described herein, with the understanding that the present disclosure is to be considered merely exemplary, and the general inventive concepts are not intended to be limited to the disclosed embodiments.

[0026] Some embodiments of the invention include inventive compounds (e.g., compounds of Formula (I)). Other embodiments include compositions (e.g., pharmaceutical compositions) comprising the inventive compound. Still other embodiments of the invention include compositions for treating, for example, certain diseases using the inventive compounds. Some embodiments include methods of using the inventive compound (e.g., in compositions or in pharmaceutical compositions) for administering and treating. Further embodiments include methods for making the inventive compound. Yet further embodiments include methods for determining whether a particular patient is likely to be responsive to such treatment with the inventive compounds and compositions.

[0027] Unless otherwise noted, terms are to be understood according to conventional usage by those of ordinary skill in the relevant art.

[0028] The abbreviations used herein have their conventional meaning within the chemical and biological arts. The chemical structures and formulae set forth herein are constructed according to the standard rules of chemical valency known in the chemical arts.

[0029] Where substituent groups are specified by their conventional chemical formulae, written from left to right, they equally encompass the chemically identical substituents that would result from writing the structure from right to left, e.g., $-\text{CH}_2\text{O}-$ is equivalent to $-\text{OCH}_2-$.

[0030] As used herein, in relation to compounds of Formulae (I), (II), (III), etc., the term “attached” signifies a stable covalent bond, certain preferred points of attachment being apparent to those of ordinary skill in the art.

[0031] As used herein (unless otherwise specified), the term “alkyl” means a monovalent, straight or branched hydrocarbon chain, which can be fully saturated, mono- or

polyunsaturated and can include di- and multivalent radicals, having the number of carbon atoms designated (i.e., C₁-C₁₀ means one to ten carbons). For example, the terms “C₁-C₇ alkyl” or “C₁-C₄ alkyl” refer to straight- or branched-chain saturated hydrocarbon groups having from 1 to 7 (e.g., 1, 2, 3, 4, 5, 6, or 7), or 1 to 4 (e.g., 1, 2, 3, or 4), carbon atoms, respectively. Examples of C₁-C₇ alkyl groups include, but are not limited to, methyl, ethyl, n-propyl, i-propyl, n-butyl, s-butyl, t-butyl, n-pentyl, s-pentyl, n-hexyl, and n-heptyl. Examples of C₁-C₄ alkyl groups include, but are not limited to, methyl, ethyl, n-propyl, i-propyl, n-butyl, s-butyl, and t-butyl.

[0032] As used herein (unless otherwise specified), the term “alkenyl” means a monovalent, straight or branched hydrocarbon chain that includes one or more (e.g., 1, 2, 3, or 4) double bonds. Double bonds can occur in any stable point along the chain and the carbon-carbon double bonds can have either the *cis* or *trans* configuration. For example, this definition shall include but is not limited to ethenyl, propenyl, butenyl, pentenyl, hexenyl, heptenyl, octenyl, nonenyl, decenyl, undecenyl, 1,5-octadienyl, 1,4,7-nonatrienyl, cyclopentenyl, cyclohexenyl, cycloheptenyl, cyclooctenyl, ethylcyclohexenyl, butenylcyclopentyl, 1-pentenyl-3-cyclohexenyl, and the like. Similarly, “heteroalkenyl” refers to heteroalkyl having one or more double bonds. Further examples of alkenyl groups include, but are not limited to, vinyl, allyl, 1-propenyl, 2-propenyl, 1-butenyl, 2-butenyl, 3-butenyl, 1-pentenyl, 2-pentenyl, 3-pentenyl, 4-pentenyl, 1-hexenyl, 2-hexenyl, 3-hexenyl, 4-hexenyl, and 5-hexenyl.

[0033] As used herein (unless otherwise specified), the term “alkynyl” means a monovalent, straight or branched hydrocarbon chain that includes one or more (e.g., 1, 2, 3, or 4) triple bonds and that also may optionally include one or more (e.g. 1, 2, 3, or 4) double bonds in the chain. Examples of alkynyl groups include, but are not limited to, ethynyl, 1-propynyl, 2-propynyl, 1-butyne, 2-butyne, 3-butyne, 1-pentyne, 2-pentyne, 3-pentyne, 4-pentyne, 1-hexynyl, 2-hexynyl, 3-hexynyl, 4-hexynyl, and 5-hexynyl.

[0034] As used herein (unless otherwise specified), the term “alkoxy” means any of the above alkyl, alkenyl, or alkynyl groups which is attached to the remainder of the molecule by an oxygen atom (alkyl-O-). Examples of alkoxy groups include, but are not limited to, methoxy (sometimes shown as MeO-), ethoxy, isopropoxy, propoxy, and butyloxy.

[0035] The term “alkylene,” by itself or as part of another substituent, means, unless otherwise stated, a divalent radical derived from an alkyl, alkenyl, or alkynyl group, as exemplified, but not limited by, -CH₂CH₂CH₂CH₂-. Typically, an alkyl (or alkylene) group will

have from 1 to 24 carbon atoms, with those groups having 10 or fewer carbon atoms being preferred in the compounds disclosed herein. A “lower alkyl” or “lower alkylene” is a shorter chain alkyl or alkylene group, generally having eight or fewer carbon atoms.

[0036] As used herein (unless otherwise specified), the term “cycloalkyl” means a monovalent, monocyclic or bicyclic, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12 membered hydrocarbon group. The rings can be saturated or partially unsaturated. Examples of cycloalkyl groups include, but are not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, and bicycloalkyls (e.g., bicyclooctanes such as [2.2.2]bicyclooctane or [3.3.0]bicyclooctane, bicyclononanes such as [4.3.0]bicyclononane, and bicyclodecanes such as [4.4.0]bicyclodecane (decalin), or spiro compounds). For a monocyclic cycloalkyl, the ring is not aromatic. For a bicyclic cycloalkyl, if one ring is aromatic, then the other is not aromatic. For a bicyclic cycloalkyl, one or both rings can be substituted.

[0037] The term “heteroalkyl,” by itself or in combination with another term, means, unless otherwise stated, a stable straight or branched chain, or combinations thereof, consisting of at least one carbon atom and at least one heteroatom selected from the group consisting of O, N, P, Si, and S, and wherein the nitrogen and sulfur atoms can optionally be oxidized, and the nitrogen heteroatom can optionally be quaternized. The heteroatom(s) O, N, P, S, and Si can be placed at any interior position of the heteroalkyl group or at the position at which the alkyl group is attached to the remainder of the molecule. Examples include, but are not limited to: $-\text{CH}_2-\text{CH}_2-\text{O}-\text{CH}_3$, $-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_3$, $-\text{CH}_2-\text{CH}_2-\text{N}(\text{CH}_3)-\text{CH}_3$, $-\text{CH}_2-\text{S}-\text{CH}_2-\text{CH}_3$, $-\text{CH}_2-\text{CH}_2-\text{S}(\text{O})-\text{CH}_3$, $-\text{CH}_2-\text{CH}_2-\text{S}(\text{O})_2-\text{CH}_3$, $-\text{CH}=\text{CH}-\text{O}-\text{CH}_3$, $-\text{Si}(\text{CH}_3)_3$, $-\text{CH}_2-\text{CH}=\text{N}-\text{OCH}_3$, $-\text{CH}=\text{CH}-\text{N}(\text{CH}_3)-\text{CH}_3$, $-\text{O}-\text{CH}_3$, $-\text{O}-\text{CH}_2-\text{CH}_3$, and $-\text{CN}$. Up to two heteroatoms can be consecutive, such as, for example, $-\text{CH}_2-\text{NH}-\text{OCH}_3$.

[0038] Similarly, the term “heteroalkylene,” by itself or as part of another substituent, means, unless otherwise stated, a divalent radical derived from heteroalkyl, as exemplified, but not limited by, $-\text{CH}_2-\text{CH}_2-\text{S}-\text{CH}_2-\text{CH}_2-$ and $-\text{CH}_2-\text{S}-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_2-$. For heteroalkylene groups, heteroatoms can also occupy either or both of the chain termini (e.g., alkyleneoxy, alkylenedioxy, alkyleneamino, alkylenediamino, and the like). Still further, for alkylene and heteroalkylene linking groups, no orientation of the linking group is implied by the direction in which the formula of the linking group is written. For example, the formula $-\text{C}(\text{O})_2\text{R}'-$ represents both $-\text{C}(\text{O})_2\text{R}'-$ and $-\text{R}'\text{C}(\text{O})_2-$. As described above, heteroalkyl

groups, as used herein, include those groups that are attached to the remainder of the molecule through a heteroatom, such as -C(O)R', -C(O)NR', -NR'R", -OR', -SR', and/or -SO₂R'. Where "heteroalkyl" is recited, followed by recitations of specific heteroalkyl groups, such as -NR'R" or the like, it will be understood that the terms heteroalkyl and -NR'R" are not redundant or mutually exclusive. Rather, the specific heteroalkyl groups are recited to add clarity. Thus, the term "heteroalkyl" should not be interpreted herein as excluding specific heteroalkyl groups, such as -NR'R" or the like.

[0039] As used herein (unless otherwise specified), the term "halogen" or "halo" means monovalent Cl, F, Br, or I. Additionally, terms such as "haloalkyl" are meant to include monohaloalkyl and polyhaloalkyl. For example, the term "halo(C₁-C₄)alkyl" includes, but is not limited to, fluoromethyl, difluoromethyl, trifluoromethyl, 2,2,2-trifluoroethyl, 4-chlorobutyl, 3-bromopropyl, and the like.

[0040] As used herein (unless otherwise specified), the term "aryl" means a monovalent, monocyclic or bicyclic, 5, 6, 7, 8, 9, 10, 11, or 12 member aromatic hydrocarbon group and also means polyunsaturated, aromatic, hydrocarbon substituent, which can be a single ring or multiple rings (preferably from 1 to 3 rings) that are fused together (i.e., a fused ring aryl) or linked covalently. A fused ring aryl refers to multiple rings fused together wherein at least one of the fused rings is an aryl ring. Examples of aryl groups include, but are not limited to, phenyl, naphthyl, tolyl, and xylyl. For an aryl that is bicyclic, one or both rings can be substituted.

[0041] As used herein (unless otherwise specified), the term "heteroaryl" means a monovalent, monocyclic or bicyclic, 5, 6, 7, 8, 9, 10, 11, or 12 membered, hydrocarbon group, where 1, 2, 3, 4, 5, or 6 carbon atoms are replaced by a hetero atom independently selected from nitrogen, oxygen, or sulfur atom, and the monocyclic or bicyclic ring system is aromatic. Heteroaryl groups (or rings) can contain from one to four heteroatoms selected from N, O, and S, wherein the nitrogen and sulfur atoms are optionally oxidized, and the nitrogen atom(s) are optionally quaternized. Thus, the term "heteroaryl" includes fused ring heteroaryl groups (i.e., multiple rings fused together wherein at least one of the fused rings is a heteroaromatic ring). A 5,6-fused ring heteroarylene refers to two rings fused together, wherein one ring has 5 members and the other ring has 6 members, and wherein at least one ring is a heteroaryl ring. Likewise, a 6,6-fused ring heteroarylene refers to two rings fused together, wherein one ring has 6 members and the other ring has 6 members, and wherein at least one ring is a heteroaryl ring. And a 6,5-

fused ring heteroarylene refers to two rings fused together, wherein one ring has 6 members and the other ring has 5 members, and wherein at least one ring is a heteroaryl ring. A heteroaryl group can be attached to the remainder of the molecule through a carbon or heteroatom. Examples of heteroaryl groups include, but are not limited to, thienyl (or thiophenyl), furyl, indolyl, pyrrolyl, pyridinyl, pyrazinyl, oxazolyl, thiazolyl, quinolinyl, pyrimidinyl, imidazolyl, triazolyl, tetrazolyl, 1H-pyrazol-4-yl, 1-Me-pyrazol-4-yl, pyridin-3-yl, pyridin-4-yl, 3,5-dimethylisoxazolyl, 1H-pyrrol-3-yl, 3,5-di-Me-pyrazolyl, and 1H-pyrazol-4-yl. For a bicyclic heteroaryl, if one ring is aryl, then the other is heteroaryl. For a bicyclic heteroaryl, one or both rings can have one or more hetero atoms. For a bicyclic heteroaryl, one or both rings can be substituted.

[0042] An “arylene” and a “heteroarylene,” alone or as part of another substituent, mean a divalent radical derived from an aryl and heteroaryl, respectively. Accordingly, the term “aryl” can represent an unsubstituted, mono-, di- or trisubstituted monocyclic, polycyclic, biaryl and heterocyclic aromatic groups covalently attached at any ring position capable of forming a stable covalent bond, certain preferred points of attachment being apparent to those skilled in the art (e. g. 3-indolyl, 4-imidazolyl). The aryl substituents are independently selected from the group consisting of halo, nitro, cyano, trihalomethyl, C₁₋₁₆alkyl, arylC₁₋₁₆alkyl, C₀₋₁₆alkyloxyC₀₋₁₆alkyl, arylC₀₋₁₆alkyloxyC₀₋₁₆alkyl, C₀₋₁₆alkylthioC₀₋₁₆alkyl, arylC₀₋₁₆alkylthioC₀₋₁₆alkyl, C₀₋₁₆alkylaminoC₀₋₁₆alkyl, arylC₀₋₁₆alkylaminoC₀₋₁₆alkyl, di(arylC₁₋₁₆alkyl)aminoC₀₋₁₆alkyl, C₁₋₁₆alkylcarbonylC₀₋₁₆alkyl, arylC₁₋₁₆alkylcarbonylC₀₋₁₆alkyl, C₁₋₁₆alkylcarboxyC₀₋₁₆alkyl, arylC₁₋₁₆alkylcarboxyC₀₋₁₆alkyl, C₁₋₁₆alkylcarbonylaminoC₀₋₁₆alkyl, arylC₁₋₁₆alkylcarbonylaminoC₀₋₁₆alkyl, -C₀₋₁₆alkylCOOR₄, -C₀₋₁₆alkylCONR₅R₆ wherein R₄, R₅ and R₆ are independently selected from hydrogen, C₁-C₁₁alkyl, arylC₀-C₁₁alkyl, or R₅ and R₆ are taken together with the nitrogen to which they are attached forming a cyclic system containing 3 to 8 carbon atoms with or without one C₁₋₁₆alkyl, arylC₀-C₁₆alkyl, or C₀-C₁₆alkylaryl substituent. Aryl includes but is not limited to pyrazolyl and triazolyl.

[0043] For brevity, the term “aryl” when used in combination with other terms (e.g., aryloxy, arylthioxy, arylalkyl) includes both aryl and heteroaryl rings as defined above. Thus, the terms “arylalkyl,” “aralkyl” and the like are meant to include those radicals in which an aryl group is attached to an alkyl group (e.g., benzyl, phenethyl, pyridylmethyl, and the like) including those alkyl groups in which a carbon atom (e.g., a methylene group) has been replaced by, for example, an oxygen atom (e.g., phenoxymethyl, 2-pyridyloxymethyl, 3-(1-naphthyloxy)propyl,

and the like), or a sulfur atom. Accordingly, the terms "arylalkyl" and the like (e.g. (4-hydroxyphenyl)ethyl, (2-aminonaphthyl)hexyl, pyridylcyclopentyl) represents an aryl group as defined above attached through an alkyl group as defined above having the indicated number of carbon atoms.

[0044] The terms "cycloalkyl" and "heterocycloalkyl", also referred to as "heterocyclyl", by themselves or in combination with other terms, mean, unless otherwise stated, cyclic versions of "alkyl" and "heteroalkyl," respectively. Examples of cycloalkyl include, but are not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, 1-cyclohexenyl, 3-cyclohexenyl, cycloheptyl, and the like. As used herein (unless otherwise specified), the term "heterocycloalkyl" or "heterocyclyl" means a monovalent, monocyclic or bicyclic, 5, 6, 7, 8, 9, 10, 11, or 12 membered, hydrocarbon, where 1, 2, 3, 4, 5, or 6 carbon atoms are replaced by a hetero atom independently selected from nitrogen atom, oxygen atom, or sulfur atom, and the monocyclic or bicyclic ring system is not aromatic. Additionally, for heterocycloalkyl, a heteroatom can occupy the position at which the heterocycle is attached to the remainder of the molecule. Examples of heterocycloalkyl include, but are not limited to, 1-(1,2,5,6-tetrahydropyridyl), 1-piperidinyl, 2-piperidinyl, 3-piperidinyl, 4-morpholinyl, 3-morpholinyl, tetrahydrofuran-2-yl, tetrahydrofuran-3-yl, tetrahydrothien-2-yl, tetrahydrothien-3-yl, 1-piperazinyl, 2-piperazinyl, tetrahydropyran, pyrrolidinyl (e.g., pyrrolidin-1-yl, pyrrolidin-2-yl, pyrrolidin-3-yl, or pyrrolidin-4-yl), piperazinyl (e.g., piperazin-1-yl, piperazin-2-yl, piperazin-3-yl, or piperazin-4-yl), piperidinyl (e.g., piperadin-1-yl, piperadin-2-yl, piperadin-3-yl, or piperadin-4-yl), and morpholinyl (e.g., morpholin-1-yl, morpholin-2-yl, morpholin-3-yl, or morpholin-4-yl,). For a bicyclic heterocyclyl, if one ring is aromatic (e.g., monocyclic aryl or heteroaryl), then the other ring is not aromatic. For a bicyclic heterocyclyl, one or both rings can have one or more hetero atoms. For a bicyclic heterocyclyl, one or both rings can be substituted and the like. A "cycloalkylene" and a "heterocycloalkylene," alone or as part of another substituent, means a divalent radical derived from a cycloalkyl and heterocycloalkyl, respectively.

[0045] As used herein (unless otherwise specified), the term "hetero atom" means an atom selected from nitrogen atom, oxygen atom, or sulfur atom.

[0046] As used herein (unless otherwise specified), the terms "hydroxy" or "hydroxyl" means a monovalent -OH group.

[0047] The term “acyl” means, unless otherwise stated, $-C(O)R$ where R is a substituted or unsubstituted alkyl, substituted or unsubstituted cycloalkyl, substituted or unsubstituted heteroalkyl, substituted or unsubstituted heterocycloalkyl, substituted or unsubstituted aryl, or substituted or unsubstituted heteroaryl.

[0048] The term “oxo,” as used herein, means an oxygen that is double bonded to a carbon atom.

[0049] The term “alkylsulfonyl,” as used herein, means a moiety having the formula $-S(O_2)-R'$, where R' is an alkyl group as defined above. R' can have a specified number of carbons (e.g., “C₁-C₄ alkylsulfonyl”).

[0050] The term “carbonyloxy” represents a carbonyl group attached through an oxygen bridge.

[0051] In the above definitions, the terms “alkyl” and “alkenyl” can be used interchangeably in so far as a stable chemical entity is formed, as would be apparent to those skilled in the art.

[0052] The term “linker” refers to attachment groups interposed between substituents. In some embodiments, the linker includes amido ($-CONH-R^n$ or $-NHCO-R^n$), thioamido ($-CSNH-R^n$ or $-NHCS-R^n$), carboxyl ($-CO_2-R^n$ or $-OCOR^n$), carbonyl ($-CO-R^n$), urea ($-NHCONH-R^n$), thiourea ($-NHCSNH-R^n$), sulfonamido ($-NHSO_2-R^n$ or $-SO_2NH-R^n$), ether ($-O-R^n$), sulfonyl ($-SO_2-R^n$), sulfoxyl ($-SO-R^n$), carbamoyl ($-NHCO_2-R^n$ or $-OCONH-R^n$), or amino ($-NHR^n$) linking moieties.

[0053] Each of the above terms (e.g., “alkyl,” “heteroalkyl,” “aryl,” and “heteroaryl,” and so forth) includes both substituted and unsubstituted forms of the indicated radical. Preferred substituents for each type of radical are provided herein.

[0054] As used herein (unless otherwise specified), the term “substituted” (e.g., as in substituted alkyl) means that one or more hydrogen atoms of a chemical group (with one or more hydrogen atoms) can be replaced by one or more non-hydrogen substituents selected from the specified options. The replacement can occur at one or more positions. The term “optionally substituted” means that one or more hydrogen atoms of a chemical group (with one or more hydrogen atoms) can be, but is not required to be substituted.

[0055] A “substituent group,” as used herein, means a non-hydrogen substituent group that may be, and preferably is, a group selected from the following moieties:

(A) -NH₂, -SH, -CN, -CF₃, -NO₂, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -N(CH₃)₂, ethynyl (-CCH), propynyl, sulfo (-SO₃H), -CONH₂, -CONHCH₃, -CON(CH₃)₂, unsubstituted C₁-C₇ alkyl, unsubstituted C₁-C₇ heteroalkyl, unsubstituted C₁-C₇ perfluorinated alkyl, unsubstituted C₁-C₇ alkoxy, unsubstituted C₁-C₇ haloalkoxy, unsubstituted cycloalkyl, unsubstituted heterocycloalkyl, unsubstituted aryl, unsubstituted heteroaryl, and

(B) C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, cycloalkyl, heterocycloalkyl, aryl, and heteroaryl, substituted with at least one substituent selected from:

(i) -NH₂, -SH, -CN, -CF₃, -NO₂, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -N(CH₃)₂, ethynyl (-CCH), propynyl, sulfo (-SO₃H), CONH₂, -CONHCH₃, -CON(CH₃)₂, unsubstituted C₁-C₇ alkyl, unsubstituted C₁-C₇ heteroalkyl, unsubstituted C₁-C₇ perfluorinated alkyl, unsubstituted C₁-C₇ alkoxy, unsubstituted C₁-C₇ haloalkoxy, unsubstituted cycloalkyl, unsubstituted heterocycloalkyl, unsubstituted aryl, unsubstituted heteroaryl, and

(ii) C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, cycloalkyl, heterocycloalkyl, aryl, and heteroaryl, substituted with at least one substituent selected from:

(a) -NH₂, -SH, -CN, -CF₃, -NO₂, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -N(CH₃)₂, ethynyl (-CCH), propynyl, sulfo (-SO₃H), CONH₂, -CONHCH₃, -CON(CH₃)₂, unsubstituted C₁-C₇ alkyl, unsubstituted C₁-C₇ heteroalkyl, unsubstituted C₁-C₇ perfluorinated alkyl, unsubstituted C₁-C₇ alkoxy, unsubstituted C₁-C₇ haloalkoxy, unsubstituted cycloalkyl, unsubstituted heterocycloalkyl, unsubstituted aryl, unsubstituted heteroaryl, and

(b) C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, cycloalkyl, heterocycloalkyl, aryl, and heteroaryl, substituted with at least one substituent selected from: -NH₂, -SH, -CN, -CF₃, -NO₂, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -N(CH₃)₂, ethynyl (-CCH), propynyl, sulfo (-SO₃H), CONH₂, -CONHCH₃, -CON(CH₃)₂, unsubstituted C₁-C₇ alkyl, unsubstituted C₁-C₇ heteroalkyl,

unsubstituted C₁-C₇ perfluorinated alkyl, unsubstituted C₁-C₇ alkoxy, unsubstituted C₁-C₇ haloalkoxy, unsubstituted cycloalkyl, unsubstituted heterocycloalkyl, unsubstituted aryl, unsubstituted heteroaryl.

[0056] A “size-limited substituent” or “size-limited substituent group,” as used herein, means a group, e.g., selected from all of the substituents described above for a “substituent group,” wherein each substituted or unsubstituted alkyl is a substituted or unsubstituted C₁-C₂₀ alkyl, each substituted or unsubstituted heteroalkyl is a substituted or unsubstituted 2-20-membered heteroalkyl, each substituted or unsubstituted cycloalkyl is a substituted or unsubstituted C₄-C₈ cycloalkyl, and each substituted or unsubstituted heterocycloalkyl is a substituted or unsubstituted 4-8-membered heterocycloalkyl.

[0057] A “lower substituent” or “lower substituent group,” as used herein, means a group, e.g., selected from all of the substituents described above for a “substituent group,” wherein each substituted or unsubstituted alkyl is a substituted or unsubstituted C₁-C₈ alkyl, each substituted or unsubstituted heteroalkyl is a substituted or unsubstituted 2-8-membered heteroalkyl, each substituted or unsubstituted cycloalkyl is a substituted or unsubstituted C₅-C₇ cycloalkyl, and each substituted or unsubstituted heterocycloalkyl is a substituted or unsubstituted 5-7-membered heterocycloalkyl.

[0058] The term “about” used in the context of a numeric value indicates a range of +/- 10% of the numeric value, unless expressly indicated otherwise.

[0059] Some compounds of the invention can have one or more chiral centers and can exist in and be isolated in optically active and racemic forms, for any of the one or more chiral centers. Some compounds can exhibit polymorphism. The compounds of the present invention (e.g., Formula I) encompass any optically active, racemate, stereoisomer form, polymorphism, or mixtures thereof. If a chiral center does not provide an indication of its configuration (i.e., R or S) in a chemical structure, it should be considered to represent R, S or a racemate.

[0060] As used herein, the term “sample” encompasses a sample obtained from a subject or patient. The sample can be of any biological tissue or fluid. Such samples include, but are not limited to, sputum, saliva, buccal sample, oral sample, blood, serum, mucus, plasma, urine, blood cells (e.g., white cells), circulating cells (e.g. stem cells or endothelial cells in the blood), tissue, core or fine needle biopsy samples, cell-containing body fluids, free floating nucleic acids, urine, stool, peritoneal fluid, and pleural fluid, tear fluid, or cells therefrom. Samples can also

include sections of tissues such as frozen or fixed sections taken for histological purposes or microdissected cells or extracellular parts thereof. A sample to be analyzed can be tissue material from a tissue biopsy obtained by aspiration or punch, excision or by any other surgical method leading to biopsy or resected cellular material. Such a sample can comprise cells obtained from a subject or patient. In some embodiments, the sample is a body fluid that include, for example, blood fluids, serum, mucus, plasma, lymph, ascitic fluids, gynecological fluids, or urine but not limited to these fluids. In some embodiments, the sample can be a non-invasive sample, such as, for example, a saline swish, a buccal scrape, a buccal swab, and the like.

[0061] As used herein, “blood” can include, for example, plasma, serum, whole blood, blood lysates, and the like.

[0062] As used herein, the term “assessing” includes any form of measurement, and includes determining if an element is present or not. The terms “determining,” “measuring,” “evaluating,” “assessing,” “analyzing,” and “assaying” can be used interchangeably and can include quantitative and/or qualitative determinations.

[0063] As used herein, the term “monitoring” with reference to a type of cancer refers to a method or process of determining the severity or degree of the type of cancer or stratifying the type of cancer based on risk and/or probability of mortality. In some embodiments, monitoring relates to a method or process of determining the therapeutic efficacy of a treatment being administered to a patient.

[0064] As used herein, “outcome” can refer to an outcome studied. In some embodiments, “outcome” can refer to survival / mortality over a given time horizon. For example, “outcome” can refer to survival / mortality over 1 month, 3 months, 6 months, 1 year, 5 years, or 10 years or longer. In some embodiments, an increased risk for a poor outcome indicates that a therapy has had a poor efficacy, and a reduced risk for a poor outcome indicates that a therapy has had a good efficacy.

[0065] As used herein, the term “high risk clinical trial” refers to one in which the test agent has “more than minimal risk” (as defined by the terminology used by institutional review boards, or IRBs). In some embodiments, a high risk clinical trial is a drug trial.

[0066] As used herein, the term “low risk clinical trial” refers to one in which the test agent has “minimal risk” (as defined by the terminology used by IRBs). In some embodiments, a low risk clinical trial is one that is not a drug trial. In some embodiments, a low risk clinical trial

is one that involves the use of a monitor or clinical practice process. In some embodiments, a low risk clinical trial is an observational clinical trial.

[0067] As used herein, the terms “modulated” or “modulation,” or “regulated” or “regulation” and “differentially regulated” can refer to both up regulation (*i.e.*, activation or stimulation, *e.g.*, by agonizing or potentiating) and down regulation (*i.e.*, inhibition or suppression, *e.g.*, by antagonizing, decreasing or inhibiting), unless otherwise specified or clear from the context of a specific usage.

[0068] As used herein, the term “subject” refers to any suitable (*e.g.*, treatable) member of the animal kingdom. In the methods, the subject is preferably a mammal. In the methods, the subject is preferably a human patient. In the methods, the subject may be a mammalian pediatric patient. In the methods, the pediatric patient is a mammalian (*e.g.*, preferably human) patient under 18 years of age, while an adult patient is 18 or older.

[0069] As used herein, the term “treating” (and its variations, such as “treatment” “treating,” “treat,” and the like) is, unless stated otherwise, to be considered in its broadest context and refers to obtaining a desired pharmacologic and/or physiologic effect. In particular, for example, the term “treating” may not necessarily imply or require that an animal is treated until total recovery. Accordingly, “treating” includes amelioration of the symptoms, relief from the symptoms or effects associated with a condition, decrease in severity of a condition, or preventing, preventively ameliorating symptoms, or otherwise reducing the risk of developing a particular condition. In some aspects, “treating” may not require or include prevention. As used herein, reference to “treating” an animal includes but is not limited to prophylactic treatment and therapeutic treatment. The effect can be prophylactic in terms of completely or partially preventing a disease or symptom thereof and/or can be therapeutic in terms of a partial or complete cure for a disease and/or adverse effect attributable to the disease. “Treatment,” as used herein, covers any treatment of a disease in a subject, preferably in a mammal (*e.g.*, in a human), and may include one or more of: (a) preventing the disease from occurring in a subject which may be predisposed to the disease but has not yet been diagnosed as having it; (b) inhibiting the disease, *i.e.*, arresting its development; and (c) relieving the disease, *i.e.*, causing regression or elimination of the disease and/or relieving one or more disease symptoms. In particular aspects of the methods, such as conditions or disorders characterized by dysregulated IRAK expression or dysregulated (*e.g.*, hyperactive) IRAK-mediated signaling pathway(s), treatment may be or include reducing such

expression or signaling. “Treatment” can also encompass delivery of an agent or administration of a therapy in order to provide for a pharmacologic effect, even in the absence of a disease or condition. Any of the compositions (e.g., pharmaceutical compositions) described herein can be used to treat a suitable subject.

[0070] “Therapeutically effective amount” means an amount effective to achieve a desired and/or beneficial effect. An effective amount can be administered in one or more administrations. In the methods, a therapeutically effective amount is an amount appropriate to treat an indication. By treating an indication is meant achieving any desirable effect, such as one or more of palliate, ameliorate, stabilize, reverse, slow, or delay disease progression, increase the quality of life, or to prolong life. Such achievement can be measured by any suitable method, such as measurement of tumor size or blood cell count, or any other suitable measurement.

[0071] As used herein, the term “marker” or “biomarker” refers to a biological molecule, such as, for example, a nucleic acid, peptide, protein, hormone, and the like, whose presence or concentration can be detected and correlated with a known condition, such as a disease state. It can also be used to refer to a differentially expressed gene whose expression pattern can be utilized as part of a predictive, prognostic or diagnostic process in healthy conditions or a disease state, or which, alternatively, can be used in methods for identifying a useful treatment or prevention therapy.

[0072] As used herein, an mRNA “isoform” is an alternative transcript for a specific mRNA or gene. This term includes pre-mRNA, immature mRNA, mature mRNA, cleaved or otherwise truncated, shortened, or aberrant mRNA, modified mRNA (e.g. containing any residue modifications, capping variants, polyadenylation variants, etc.), and the like.

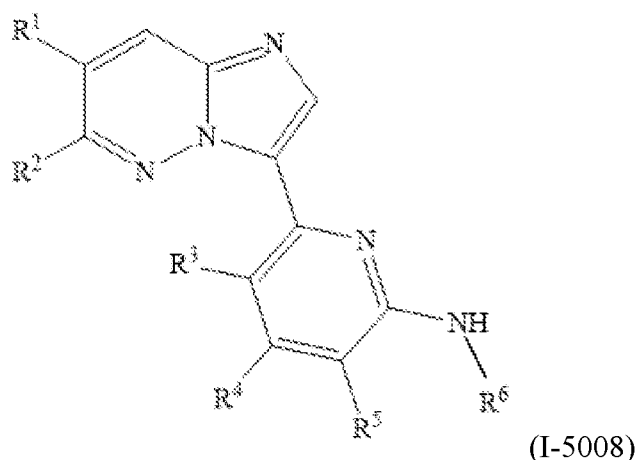
[0073] “Antibody” or “antibody peptide(s)” refer to an intact antibody, or a binding fragment thereof that competes with the intact antibody for specific binding; this definition also encompasses monoclonal and polyclonal antibodies. Binding fragments are produced by recombinant DNA techniques, or by enzymatic or chemical cleavage of intact antibodies. Binding fragments include Fab, Fab', F(ab')₂, Fv, and single-chain antibodies. An antibody other than a “bispecific” or “bifunctional” antibody is understood to have each of its binding sites identical. An antibody, for example, substantially inhibits adhesion of a receptor to a counterreceptor when an excess of antibody reduces the quantity of receptor bound to counterreceptor by at least about 20%,

40%, 60% or 80%, and more usually greater than about 85% (as measured in an in vitro competitive binding assay).

[0074] Embodiments of the invention set forth herein include inventive compounds (e.g., compounds of Formula (I), such as compounds of Formula (II) and Formula (III)). Other embodiments include compositions (e.g., pharmaceutical compositions) comprising the inventive compound. Still other embodiments of the invention include compositions (e.g., pharmaceutical compositions) for treating, for example, certain diseases using the inventive compounds. Some embodiments include methods of using the inventive compound (e.g., in compositions or in pharmaceutical compositions) for administering and treating (e.g., diseases such as cancer or blood disorders). Some embodiments include methods of determining whether a patient is suitable for, or likely to respond favorably to, a particular treatment. Further embodiments include methods for making the inventive compounds. Additional embodiments of the invention are also discussed herein.

Compounds and Compositions, Including Pharmaceutical Compositions

[0075] Some embodiments of the invention include compounds having a structure according to Formula (I-5008):



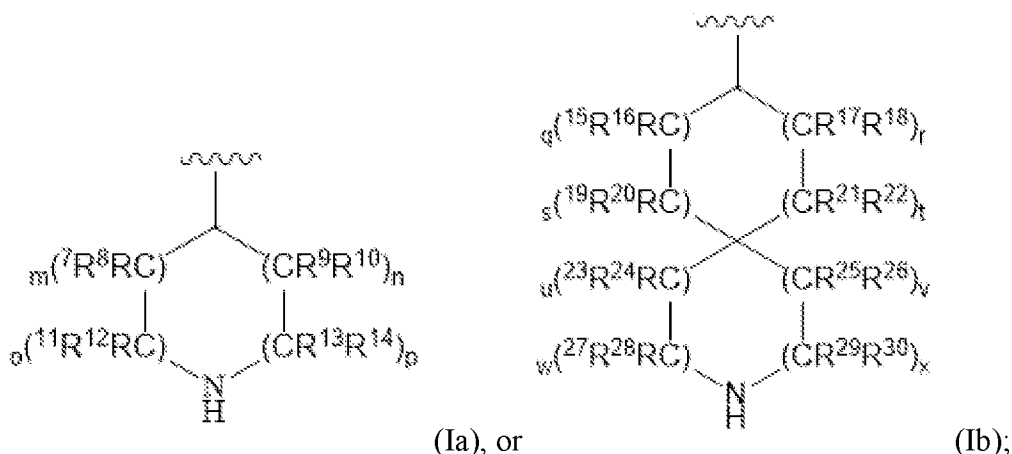
or a salt, ester, solvate, optical isomer, geometric isomer, salt of an isomer, prodrug, or derivative thereof. In some embodiments, the compound is a pharmaceutically acceptable salt, ester, solvate, optical isomer, geometric isomer, salt of an isomer, prodrug, or derivative of a compound of Formula (I-5008). In some embodiments, the compound is not an ester, not a solvate, and not a prodrug.

[0076] In exemplary embodiments, R^1 , R^2 , R^3 , R^4 , and R^5 are independently selected from H, halogen, hydroxy, oxo, -CN, amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl.

[0077] In some embodiments, R^1 can be H, halogen, hydroxy, oxo, -CN, amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl; R^2 can be H, halogen, hydroxy, oxo, -CN, amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, heteroaryl, or fused ring heteroaryl, which amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇

haloalkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, fused ring aryl, heteroaryl, fused ring heteroaryl, or C₁-C₇ alkyl which is substituted with cycloalkyl; R³, R⁴, and R⁵ can be H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl.

[0078] R⁶ can be



[0079] R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, R¹⁴ can be H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen; R¹⁵, R¹⁶, R¹⁷, R¹⁸, R¹⁹, R²⁰, R²¹, R²², R²³, R²⁴, R²⁵, R²⁶, R²⁷, R²⁹, R²⁹, and R³⁰ can be H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused

cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen; and m, n, o, p, q, r, s, t, u, v, w, and x can be 0, 1, 2, 3, 4, or 5, where q+r+s+t is at least 1, and where u+v+w+x is at least 1.

[0080] In some embodiments, R¹ is H, halogen, -CONH₂, -CONHCH₃, -CON(CH₃)₂, benzyl, C₁-C₇ alkyl, C₁-C₇ alkoxy, or cycloalkyl, which C₁-C₇ alkyl, C₁-C₇ alkoxy, or cycloalkyl is optionally substituted with one or more halogen, hydroxyl, C₁-C₇ alkyl, or C₁-C₇ haloalkyl. In some embodiments, R¹ is H, Cl, -CONH₂, -CONHCH₃, methoxy, ethoxy, cyclopropyl, or C₁-C₄ alkyl, which methoxy, ethoxy, cyclopropyl, or C₁-C₄ alkyl is optionally substituted with one or more F, -OH, methyl, or CF₃. In some embodiments, R¹ is not H.

[0081] In some embodiments, R² is H, halogen, hydroxy, O-aryl, amino, C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, aryl, fused ring aryl, heteroaryl, or fused ring heteroaryl, which O-aryl, amino, C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, heterocyclyl, aryl, fused ring aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, -CN, amino, cycloalkyl, heterocyclyl, aryl, heteroaryl, fused ring aryl, fused ring heteroaryl, pyrrolyl, piperidyl, piperazinyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl. In some embodiments, R² is H, halogen, hydroxy, O-aryl, amino, C₁-C₇ alkyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, aryl, fused ring aryl, heteroaryl, or fused ring heteroaryl which O-aryl, amino, C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, amino, cycloalkyl, heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl. In some embodiments, R² is H, Cl, hydroxy, -NHCH₃, -N(CH₃)₂, -OCH₃, -OCF₃, -OCHF₂, -OPh, -CF₃, -CHF₂, unsubstituted C₁-C₇ alkyl, substituted amino, substituted C₁-C₇ alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, unsubstituted heterocyclyl, substituted pyrazolyl, substituted fused ring heteroaryl, or unsubstituted fused ring heteroaryl. In some embodiments, R² is not H.

[0082] In some embodiments, R³ is H, halogen, hydroxy, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, or C₁-C₇ alkoxy, which C₁-C₇ alkyl, or C₂-C₆ alkoxy, is optionally

substituted with one or more of halogen, hydroxy, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl. In some embodiments, R³ is H, halogen, hydroxy, -CN, methyl, -CF₃, or methoxy.

[0083] In some embodiments, R⁴ is H, halogen, hydroxy, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, or C₁-C₇ alkoxy, which C₁-C₇ alkyl, or C₂-C₆ alkoxy, is optionally substituted with one or more of halogen, hydroxy, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl. In some embodiments, R⁴ is H, halogen, hydroxy, -CN, methyl, -CF₃, or methoxy.

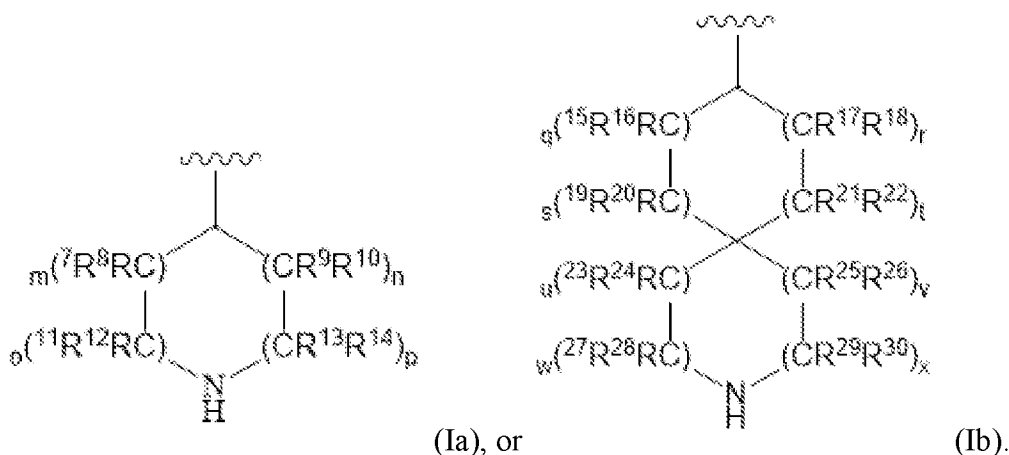
[0084] In some embodiments, R⁵ is H, halogen, hydroxy, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, or C₁-C₇ alkoxy, which C₁-C₇ alkyl, or C₂-C₆ alkoxy, is optionally substituted with one or more of halogen, hydroxy, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl. In some embodiments, R⁵ is H, halogen, hydroxy, -CN, methyl, -CF₃, or methoxy.

[0085] In some embodiments, R⁴ is methyl or -CF₃, and at least one of R³ and R⁵ is H or halogen.

[0086] In some embodiments, there is a chiral center at the R⁶ attachment carbon. In some embodiments, the chiral center is an R chiral center. In some embodiments, the chiral center is an S chiral center. In certain embodiments, the chiral center can be represented by the following bonds , or . Where a chiral center is possible at other positions of the compounds according to Formula (I), as would be appreciated by

one skilled in the art, the straight bond shown can also be can be , , , , or .

[0087] In some embodiments, R⁶ is



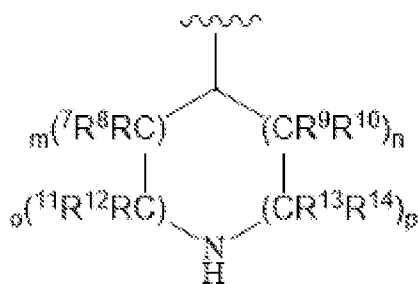
[0088] In some embodiments, R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, R¹⁴ are independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl, provided that at least one of R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, and R¹⁴ is not H. In some embodiments, R¹⁵, R¹⁶, R¹⁷, R¹⁸, R¹⁹, R²⁰, R²¹, R²², R²³, R²⁴, R²⁵, R²⁶, R²⁷, R²⁹, R²⁹, and R³⁰ are independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl,

pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl. In some embodiments, m, n, o, p, q, r, s, t, u, v, w, and x are independently selected from 0, 1, 2, 3, 4, or 5, where q+r+s+t is at least 1, and where u+v+w+x is at least 1.

[0089] In one embodiment, at least one of R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, and R¹⁴ is not H. In another embodiment, each of R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, and R¹⁴, if present, is H.

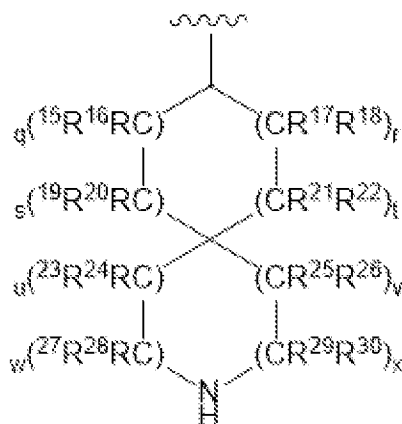
[0090] In one embodiment, at least one of R¹⁵, R¹⁶, R¹⁷, R¹⁸, R¹⁹, R²⁰, R²¹, R²², R²³, R²⁴, R²⁵, R²⁶, R²⁷, R²⁹, R²⁹, and R³⁰ is not H. In another embodiment, each of R¹⁵, R¹⁶, R¹⁷, R¹⁸, R¹⁹, R²⁰, R²¹, R²², R²³, R²⁴, R²⁵, R²⁶, R²⁷, R²⁹, R²⁹, and R³⁰, if present, is H.

[0091] In some embodiments, R⁶ is



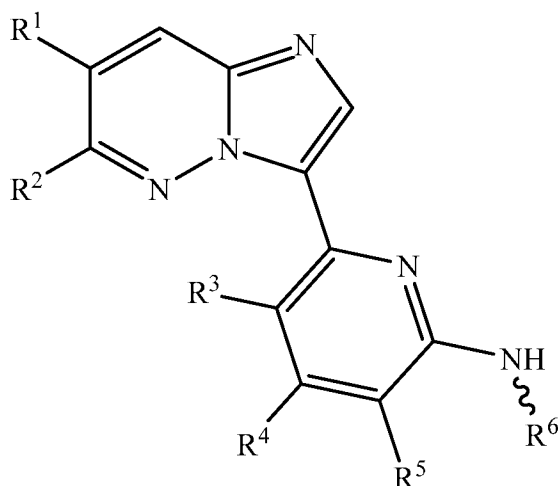
(Ia).

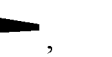
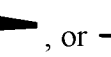
[0092] In some embodiments, R⁶ is



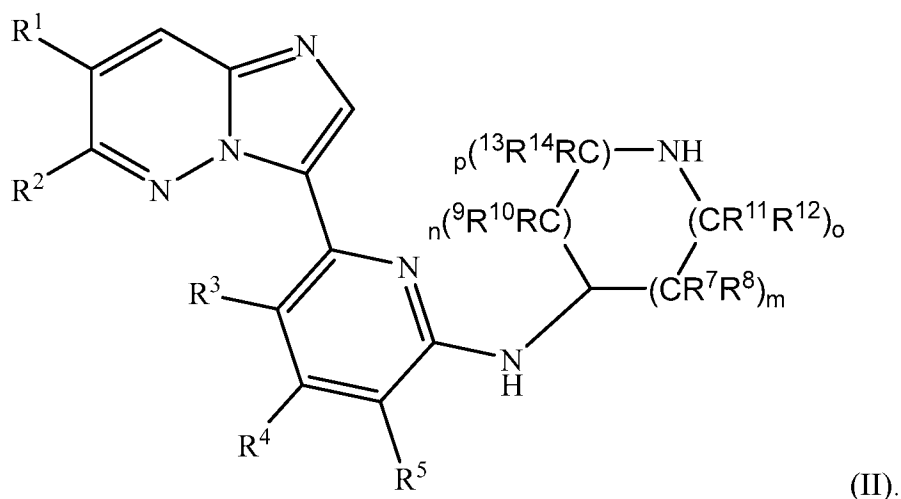
(Ib).

[0093] Some embodiments of the invention include compounds having a structure according to Formula (I):



wherein the wavy bond from Y to R⁶ (i.e., ) indicates that, in some instances, there is a chiral center at the R⁶ attachment carbon. In some embodiments, where there is a chiral center at the R⁶ attachment carbon, the wavy bond can indicate an R chiral center, an S chiral center, or a racemate. In certain embodiments,  can be , , , , or . Where a chiral center is possible at other positions of the compounds according to Formula (I), as would be appreciated by one skilled in the art, the straight bond shown can also be , , , , or .

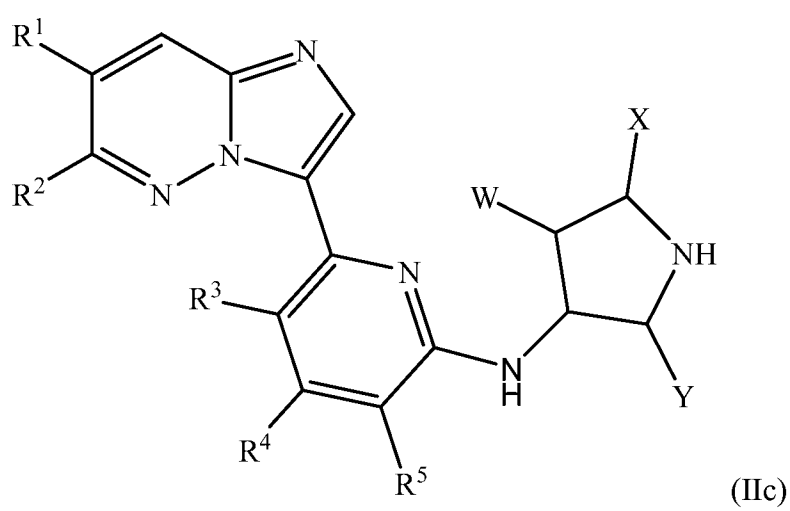
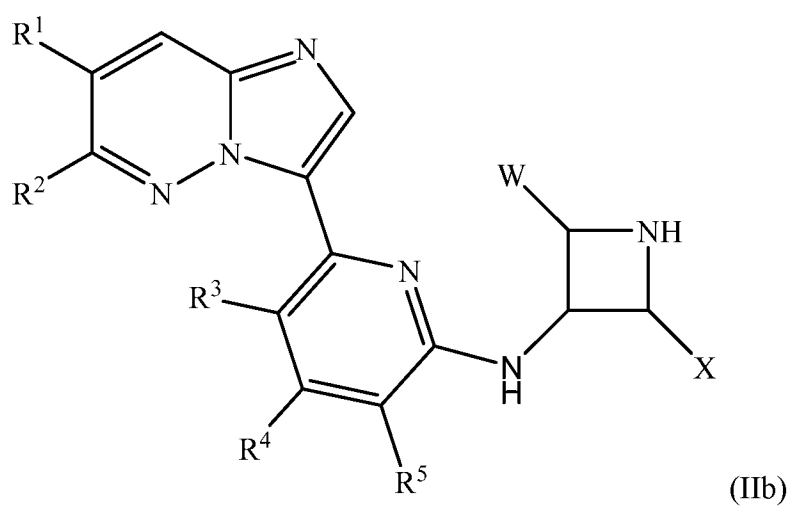
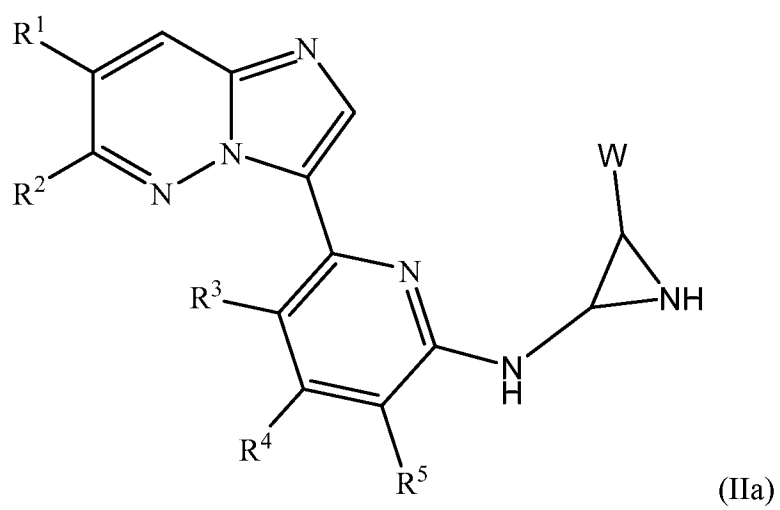
[0094] In some embodiments, R⁶ is (Ia), giving a structure of Formula (II), as follows:

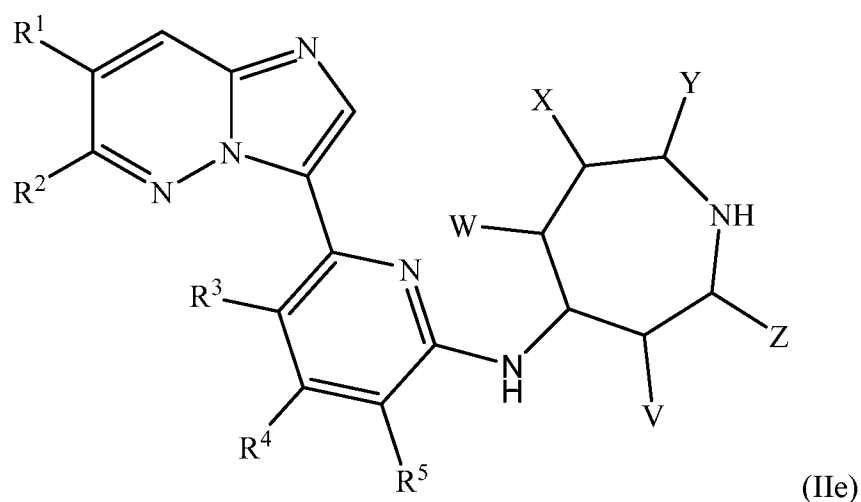
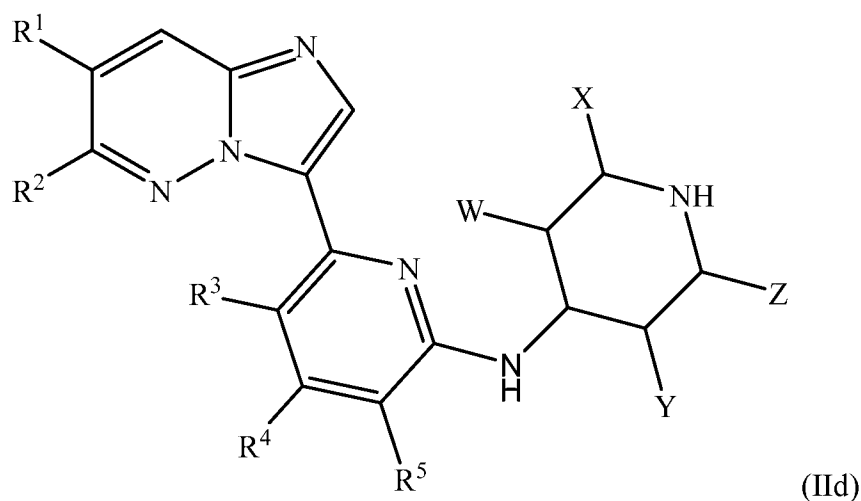


[0095] In some embodiments according to Formula (II), m is 0 or 1, n is 0 or 1, o is 0 or 1, and p is 0 or 1.

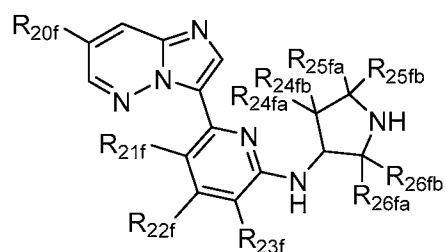
[0096] In some embodiments, R^7 , R^8 , R^9 , and R^{10} are H, and at least one of R^{11} , R^{12} , R^{13} , and R^{14} is not H, and/or R^{11} , R^{12} , R^{13} , and R^{14} are H, and at least one of R^7 , R^8 , R^9 , and R^{10} is not H. In particular embodiments, R^7 , R^8 , R^9 , R^{10} , R^{11} , R^{12} , R^{13} , and R^{14} are independently selected from H, halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen. In some embodiments, R^7 , R^8 , R^9 , and R^{10} are H, and at least one of R^{11} , R^{12} , R^{13} , and R^{14} is halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen. In some embodiments, R^{11} , R^{12} , R^{13} , and R^{14} are H, and at least one of R^7 , R^8 , R^9 , and R^{10} is halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen. In some embodiments, at least one of R^7 , R^8 , R^9 , and R^{10} is halogen, hydroxyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl. In some embodiments, at least one of R^7 , R^8 , R^9 , and R^{10} is F, hydroxyl, methyl, methoxy, -CHF₂, -CF₃, spiro-fused cyclopropyl, spiro-fused cyclobutyl, or spiro-fused cyclopentyl. In some embodiments, both of R^7 and R^8 or both of R^9 and R^{10} are F, or both of R^7 and R^8 or both of R^9 and R^{10} are methyl. In some embodiments, at least one of R^{11} , R^{12} , R^{13} , and R^{14} is halogen, hydroxyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl. In some embodiments, at least one of R^{11} , R^{12} , R^{13} , and R^{14} is F, hydroxyl, methyl, methoxy, -CHF₂, -CF₃, spiro-fused cyclopropyl, spiro-fused cyclobutyl, or spiro-fused cyclopentyl. In some embodiments, both of R^{11} and R^{12} or both of R^{13} and R^{14} are F, or wherein both of R^{11} and R^{12} or both of R^{13} and R^{14} are methyl

[0097] Further to any embodiment above wherein the compound has the structure of Formula (II), the compound can have a structure according to any of (IIa)-(IIe), wherein V, W, X, Y, and Z can independently represent any of R^7 , R^8 , R^9 , R^{10} , R^{11} , R^{12} , R^{13} , or R^{14} , and wherein at least one of V, W, X, Y, and Z is not H.





[0098] In an embodiment, the compound of Formula (II) is a compound of Formula (IIIf)



Formula (IIIf), or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:

R_{20f} is selected from H, halogen, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and -O-(C₃-C₆ cycloalkyl), wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, and C₃-C₆ cycloalkyl and -O-(C₃-C₆ cycloalkyl)

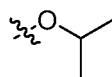
are each optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen;

R_{21f}, R_{22f}, and R_{23f} are each independently selected from H and halogen; and

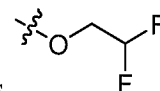
R_{24fa}, R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} are each independently selected from H, halogen, -OH, C₁-C₆ alkyl, and C₁-C₆ alkoxy, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more halogen atoms.

[0099] In an embodiment, one or more of R_{24fa}, R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is independently selected from halogen, -OH, optionally substituted C₁-C₆ alkyl, and optionally substituted C₁-C₆ alkoxy. In another embodiment, each of R_{24fa}, R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is H.

[00100] In an embodiment, R_{20f} is H. In another embodiment, R_{20f} is not H. In an embodiment, R_{20f} is halogen. In one embodiment, R_{20f} is Cl. In another embodiment, R_{20f} is

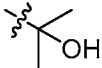


unsubstituted C₁-C₆ alkoxy. In one embodiment, R_{20f} is



C₁-C₆ alkoxy substituted with one or more fluorine atoms. In one embodiment, R_{20f} is

. In another embodiment, R_{21g} is C₁-C₆ alkyl substituted with one or more -OH. In one

embodiment, R_{20f} is . In another embodiment, R_{20f} is C₃-C₆ cycloalkyl. In one

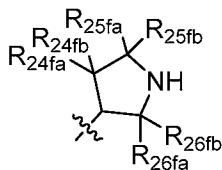
embodiment, R_{20f} is unsubstituted C₃ cycloalkyl. In one embodiment, R_{20f} is .

[00101] In an embodiment, each of R_{21f}, R_{22f}, and R_{23f} is H. In an embodiment, R_{21f} and R_{23f} are each independently halogen and R_{22f} is H. In one embodiment, R_{21f} and R_{23f} are each F and R_{22f} is H. In an embodiment, R_{21f} and R_{23f} are each H and R_{22f} is halogen. In one embodiment, R_{21f} and R_{23f} are each H and R_{22f} is F.

[00102] In an embodiment, each of R_{24fa}, R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is H. In an embodiment, each of R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is H and R_{24fa} and/or R_{24fb} is halogen. In one embodiment, each of R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is H and R_{24fa} is F. In one embodiment, each of R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is H and each of R_{24fa} and R_{24fb} is F. In an embodiment, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} are each H and R_{24fa} and/or R_{24fb} is C₁-C₆ alkyl. In one embodiment, each of

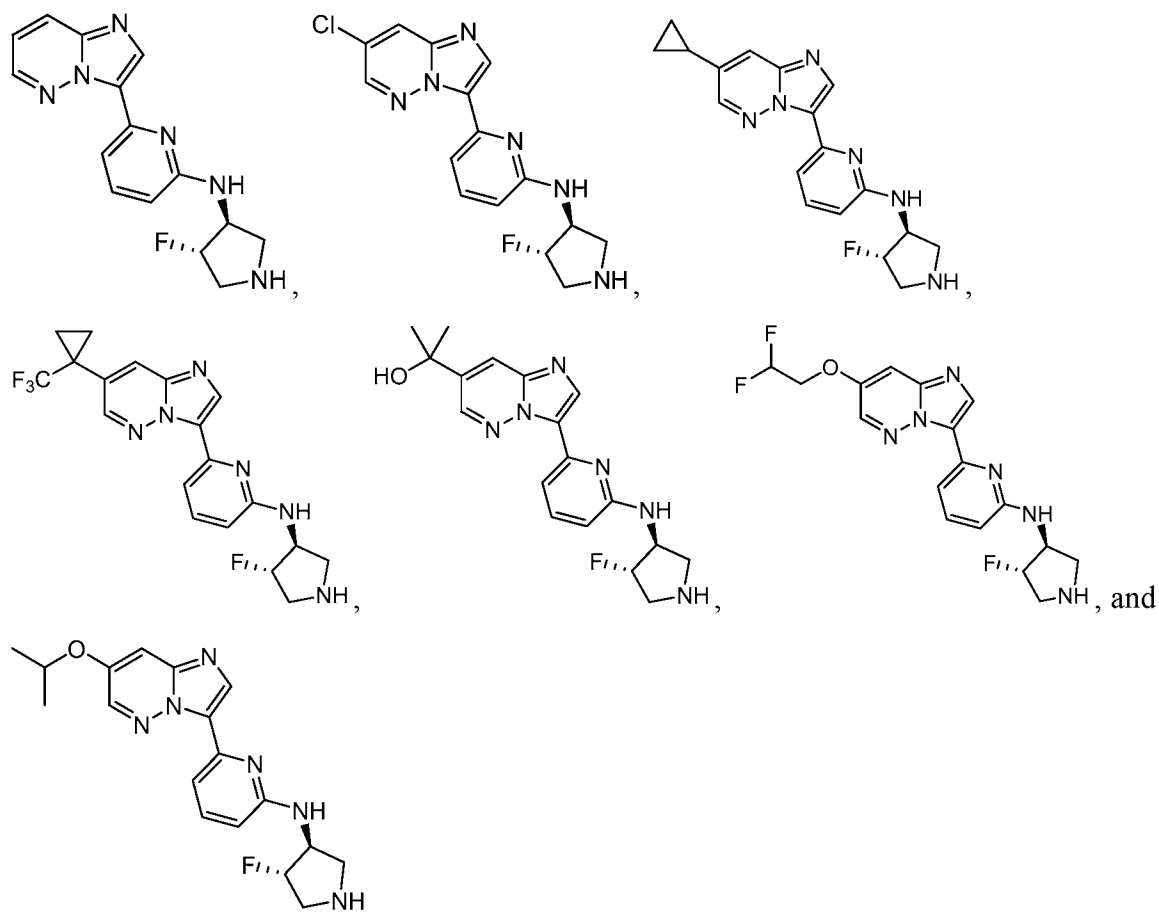
R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is H and each of R_{24fa} and R_{24fb} is -CH₃. In one embodiment, each of R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is H and R_{24fa} is -CH₃.

[00103] In an embodiment, the compound of Formula (IIf) has one or more stereocenters. In one embodiment, the compound of Formula (IIf) comprises a stereocenter where

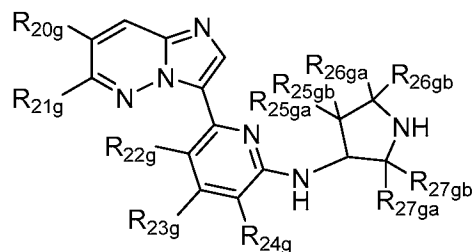


the moiety connects to the remaining portion of Formula (IIf). In one embodiment, the compound of Formula (IIf) comprises a stereocenter at one or more of R_{24fa}, R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and/or R_{26fb}. In one embodiment, the compound of Formula (IIf) comprises a stereocenter on R_{20f}.

[00104] In an embodiment, the compound of Formula (IIf) is selected from:



[00105] In an embodiment, the compound of Formula (II) is a compound of Formula (IIg)



formula (IIg) or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;

wherein:

R_{20g} is selected from H and C₁-C₆ alkoxy;

R_{21g} is selected from halogen, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, -O-(C₆-C₁₂ aryl), C₃-C₉ heterocyclyl, and -NR_{28ga}R_{28gb}, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, -OH, and halogen;

R_{22g}, R_{23g}, and R_{24g} are each independently selected from H and halogen;

R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} are each independently selected from H, halogen, -OH, C₁-C₆ alkyl, and C₁-C₆ alkoxy, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more halogen atoms; and

R_{28ga} and R_{28gb} are each independently selected from H, C₁-C₆ alkyl, and C₃-C₆ cycloalkyl.

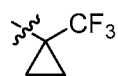
[00106] In an embodiment, one or more of R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} is independently selected from halogen, -OH, optionally substituted C₁-C₆ alkyl, and optionally substituted C₁-C₆ alkoxy. In another embodiment, each of R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} is H.

[00107] In an embodiment, R_{20g} is H. In an embodiment, R_{20g} is unsubstituted C₁-C₆ alkoxy. In one embodiment, R_{20g} is selected from -OCH₃, -OCH₂CH₃, and

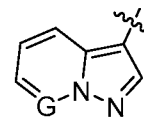
[00108] In an embodiment, R_{21g} is halogen. In one embodiment, R_{21g} is Cl. In an embodiment, R_{21g} is unsubstituted C₁-C₆ alkyl. In one embodiment, R_{21g} is t-butyl. In another embodiment, R_{21g} is C₁-C₆ alkyl substituted with one or more F and/or -OH. In one embodiment,

R_{21g} is selected from -CF₃, , , and . In another embodiment, R_{21g} is

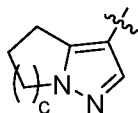
unsubstituted C₁-C₆ alkoxy. In one embodiment, R_{21g} is -OCH₃. In another embodiment, R_{21g} is C₁-C₆ alkoxy substituted with one or more halogen atoms. In another embodiment, R_{21g} is -O-(C₆-C₁₂ aryl). In one embodiment, R_{21g} is -O-phenyl. In another embodiment, R_{21g} is unsubstituted C₃-C₆ cycloalkyl. In one embodiment, R_{21g} is unsubstituted C₃ cycloalkyl. In one embodiment, R_{21g} is C₃ cycloalkyl substituted with one or more fluorine atoms. In one embodiment, R_{21g} is



. In another embodiment, R_{21g} is unsubstituted C₃-C₉ heterocyclyl. In one embodiment,



R_{21g} is selected from morpholinyl, azetidiny, piperdinyl, isoxazolyl, pyrazolyl,



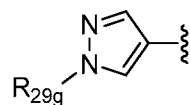
wherein G is N or CH, and wherein c is 1 or 2. In another embodiment, R_{21g} is C₃-C₉ heterocyclyl substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl,

C₃-C₉-heterocyclyl, -OH, and halogen. In one embodiment, R_{21g} is wherein R_{29g} is selected from H, C₁-C₆ alkyl, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₃-C₆ cycloalkyl are each optionally substituted with one or more halogen and/or -OH. In one

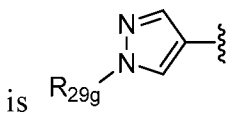
embodiment, R_{21g} is wherein R_{29g} is H. In one embodiment, R_{21g} is wherein

wherein R_{29g} is unsubstituted C₁-C₆ alkyl. In one embodiment, R_{21g} is wherein

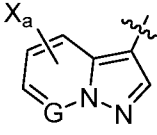
R_{29g} is selected from -CH₃ and isopropyl. In one embodiment, R_{21g} is wherein R_{29g} is C₁-C₆ alkyl substituted with one or more -OH and/or F. In one embodiment, R_{21g} is

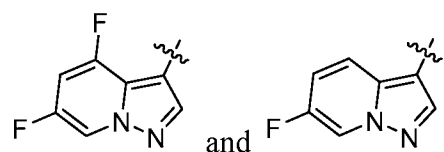


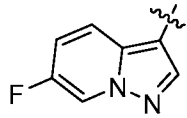
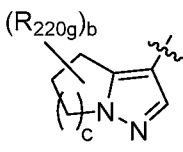
wherein R_{29g} is selected from and . In another embodiment, R_{21g} is

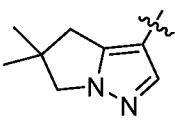


wherein R_{29g} is selected from unsubstituted C₃ cycloalkyl, azetidiny, and

tetrahydropyranyl. In another embodiment, R_{21g} is , wherein a is 1, 2, or 3, G is N or CH, and each X is independently halogen. In one embodiment, R_{21g} is selected from



and . In another embodiment, R_{21g} is , wherein b is 0, 1, 2, 3, 4, 5, or 6, c is 1 or 2, and each R_{220g} is independently C₁-C₆ alkyl. In one embodiment,

R_{21g} is . In another embodiment, R_{21g} is isoxazolyl substituted with C₁-C₆ alkyl. In one embodiment, R_{21g} is isoxazolyl monosubstituted with -CH₃. In another embodiment, R_{21g} is -NR_{28ga}R_{28gb} wherein R_{28ga} is H and R_{28gb} is selected from -CH₃, cyclobutyl, and cyclohexyl. In another embodiment, R_{21g} is -NR_{28ga}R_{28gb} wherein R_{28ga} and R_{28gb} are each independently C₁-C₆ alkyl. In one embodiment, R_{21g} is -NR_{28ga}R_{28gb} wherein R_{28ga} and R_{28gb} are each -CH₃.

[00109] In an embodiment, R_{22g} , R_{23g} , and R_{24g} are each H. In an embodiment, R_{22g} and R_{24g} are each independently halogen and R_{23g} is H. In one embodiment, R_{22g} and R_{24g} are each F and R_{23g} is H. In an embodiment, R_{22g} and R_{24g} are each H and R_{23g} is halogen. In one embodiment, R_{22g} and R_{24g} are each H and R_{23g} is F.

[00110] In an embodiment, each of R_{25ga} , R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H. In an embodiment, each of R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and R_{25ga} and/or R_{25gb} is halogen. In one embodiment, each of R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and R_{25ga} is F. In one embodiment, each of R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and each of R_{25ga} and R_{25gb} is F. In an embodiment, R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} are each H and R_{25ga} and/or R_{25gb} is C₁-C₆ alkyl. In one embodiment, R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} are each H and R_{25ga} and R_{25gb} are each -CH₃. In one embodiment, each of R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and R_{25ga} is -CH₃. In another embodiment, each of R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and R_{25ga} is selected from substituted C₁-C₆ alkyl and -OH. In one embodiment, each of R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and R_{25ga} is -OH. In one embodiment, each of R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and R_{25ga} is selected from -CF₃ and



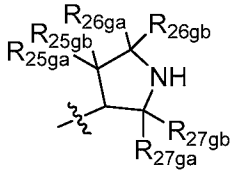
. In another embodiment, each of R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is H and R_{25ga} is

unsubstituted C₁-C₆ alkoxy. In one embodiment, each of R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} is H and R_{25ga} is -OCH₃.

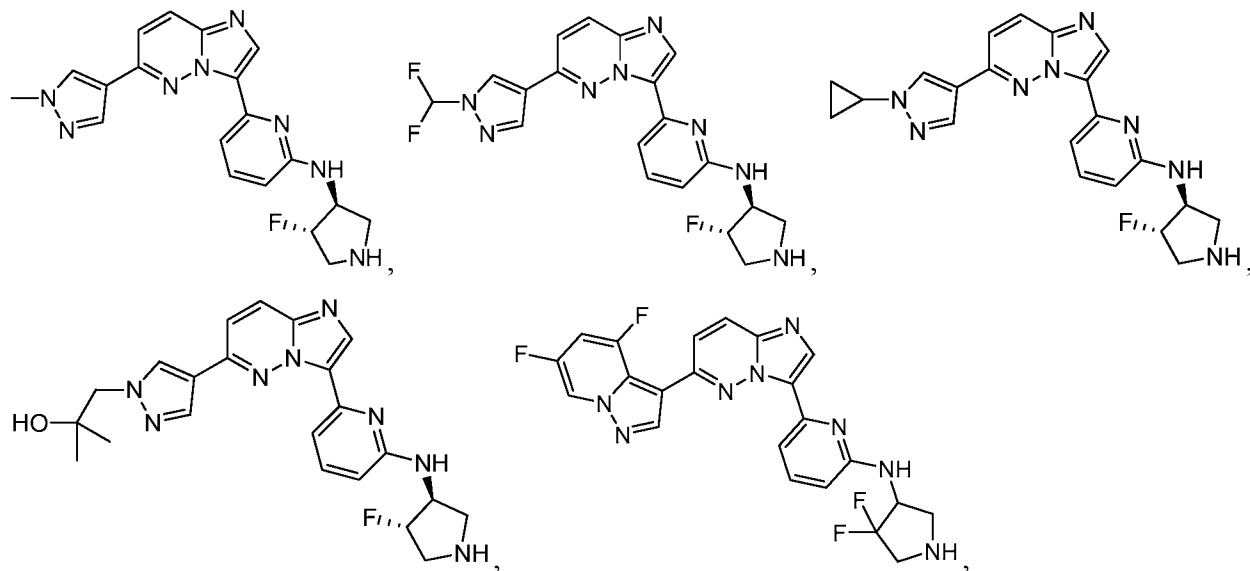
[00111] In an embodiment, each of R_{25ga}, R_{25gb}, R_{26gb}, R_{27ga}, and R_{27gb} is H and R_{26ga} is unsubstituted C₁-C₆ alkyl. In one embodiment, each of R_{25ga}, R_{25gb}, R_{26gb}, R_{27ga}, and R_{27gb} is H and R_{26ga} is -CH₃.

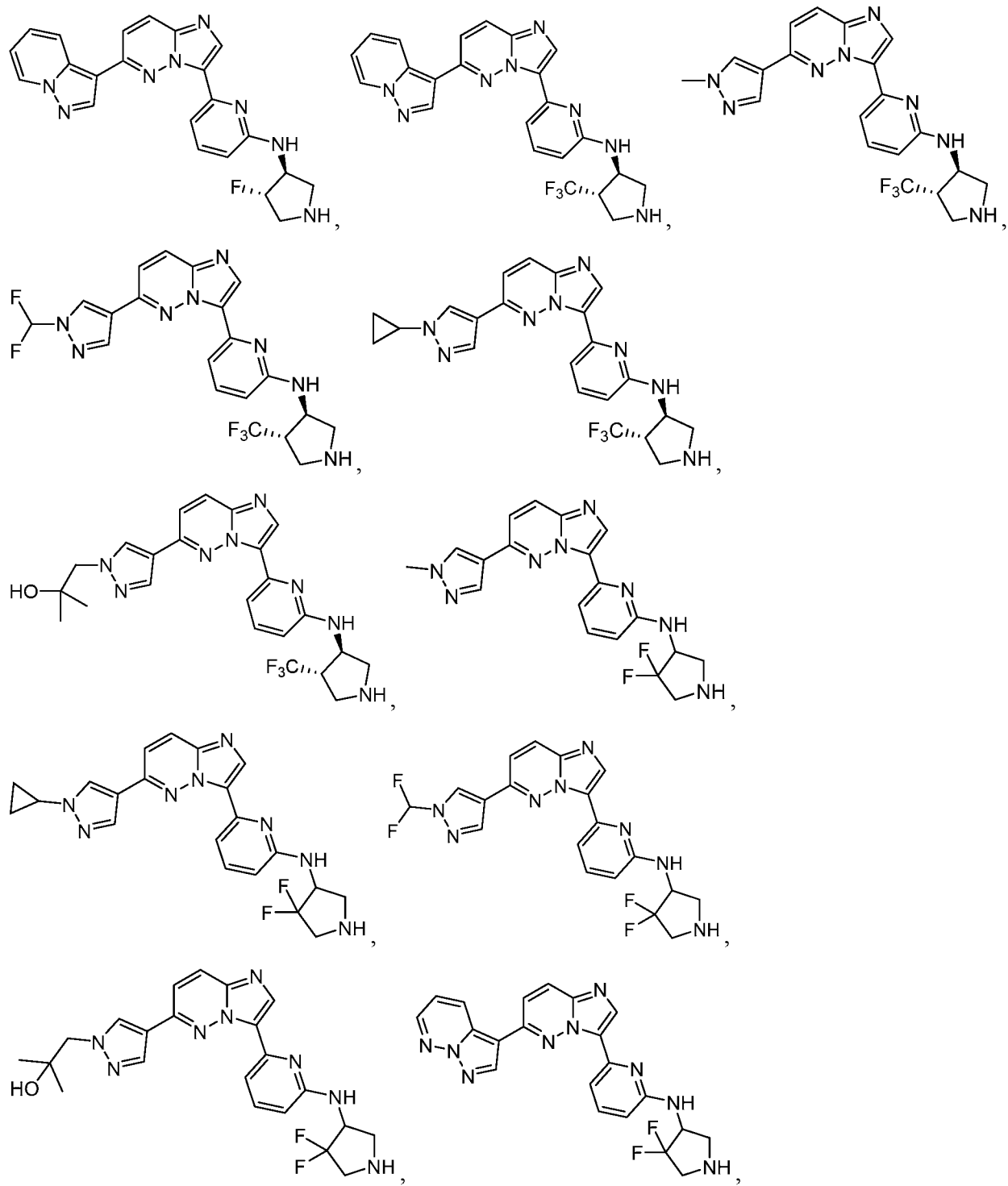
[00112] In an embodiment, each of R_{25ga}, R_{25gb}, R_{26ga}, and R_{26gb} is H and each of R_{27ga} and R_{27gb} is unsubstituted C₁-C₆ alkyl. In one embodiment, each of R_{25ga}, R_{25gb}, R_{26ga}, and R_{26gb} is H and each of R_{27ga} and R_{27gb} is -CH₃.

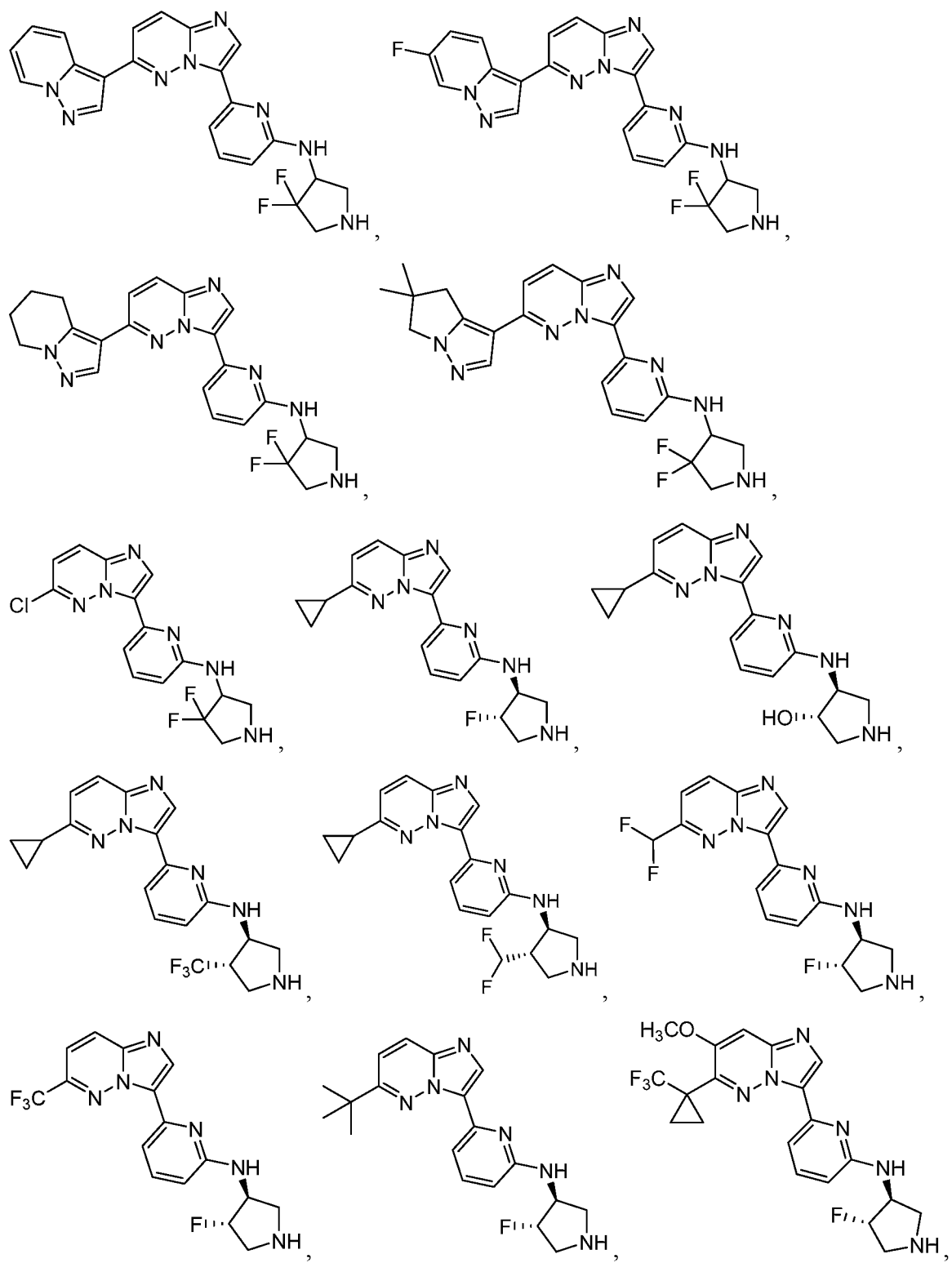
[00113] In an embodiment, the compound of Formula (IIg) comprises one or more stereocenters. In one embodiment, the compound of Formula (IIg) comprises a stereocenter on R_{21g}. In one embodiment, the compound of Formula (IIg) comprises a stereocenter where the

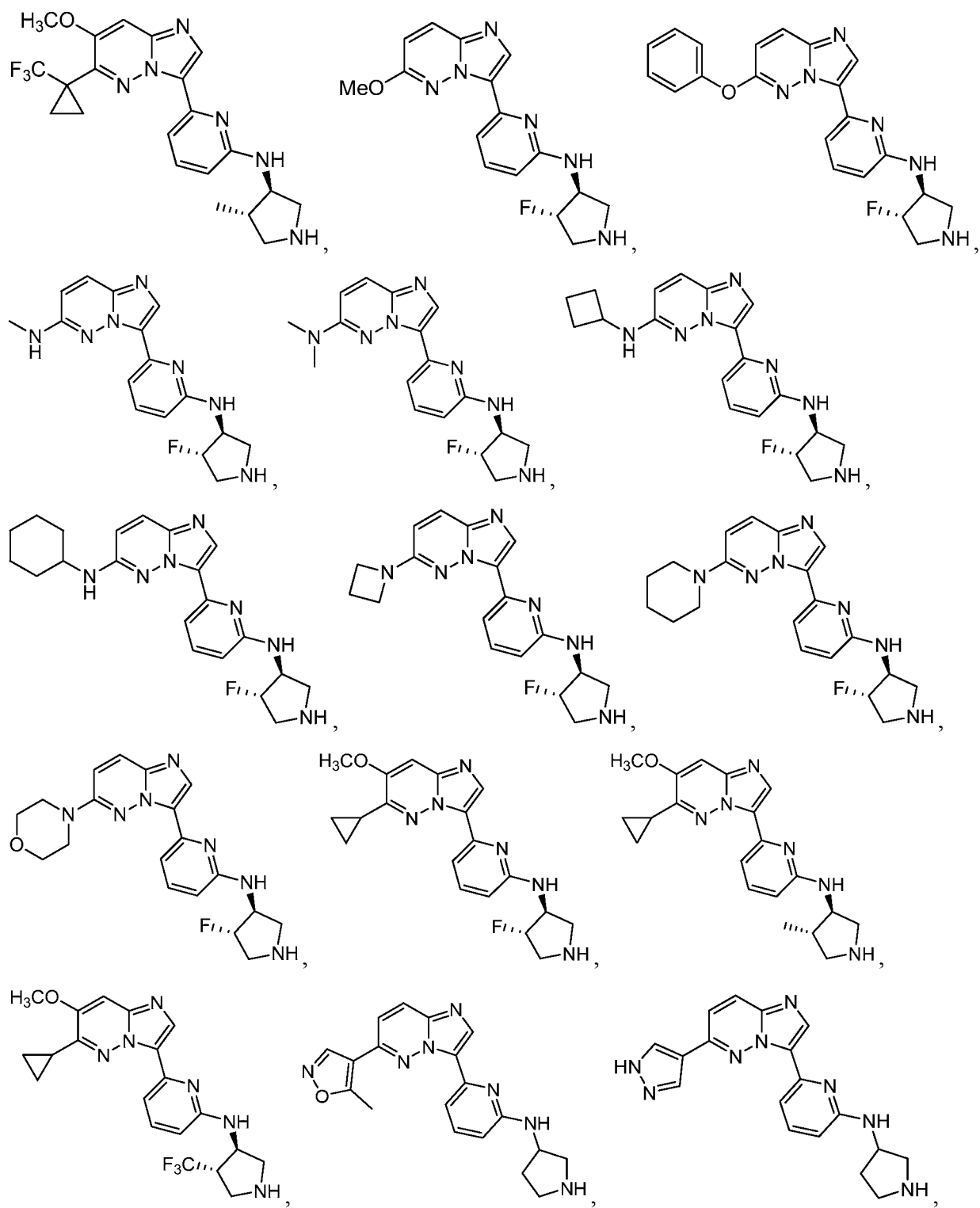
moiety  connects to the remaining portion of Formula (IIg). In one embodiment, the compound of Formula (IIg) comprises one or more stereocenters at R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and/or R_{27gb}.

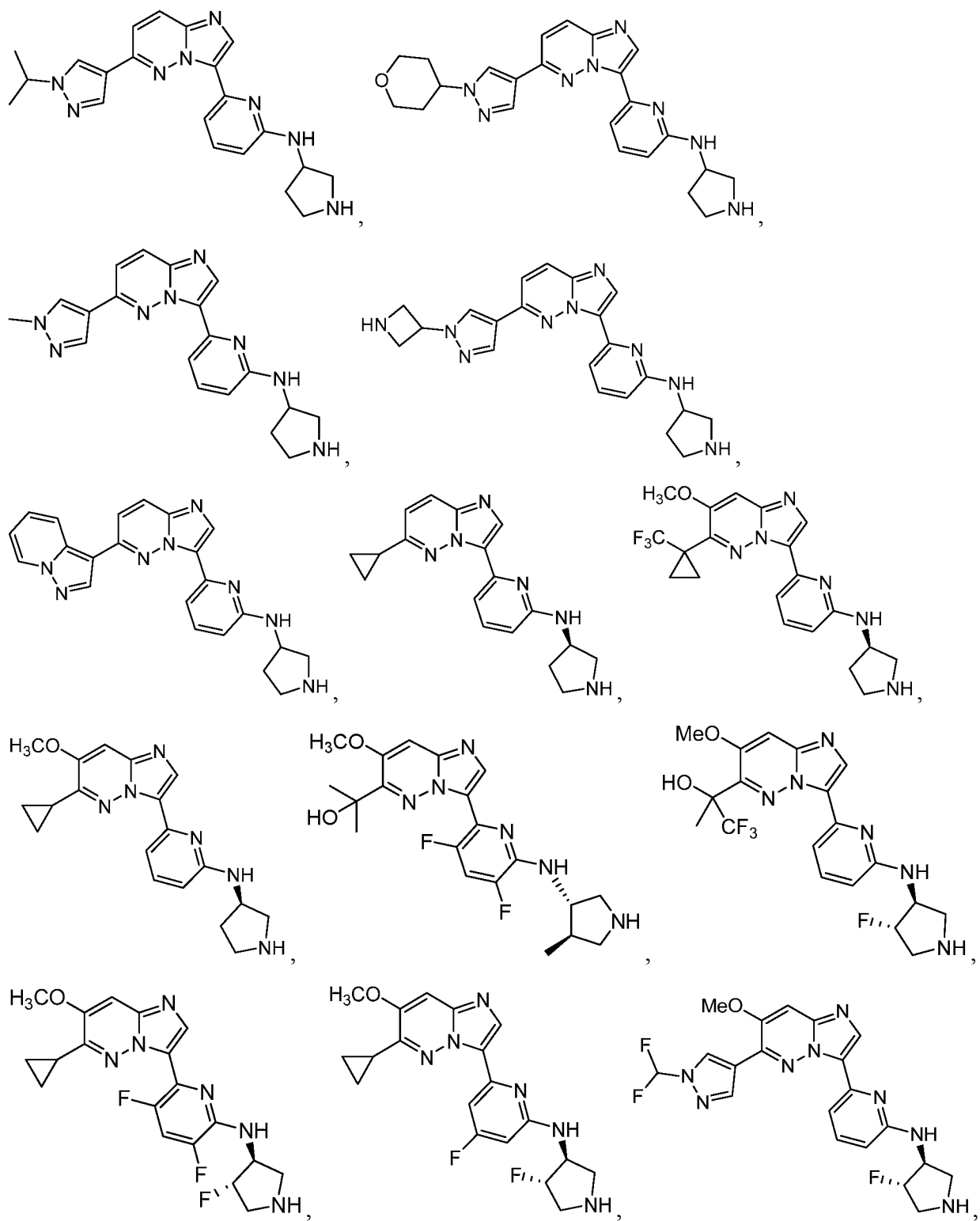
[00114] In an embodiment, the compound of Formula (IIg) is selected from:

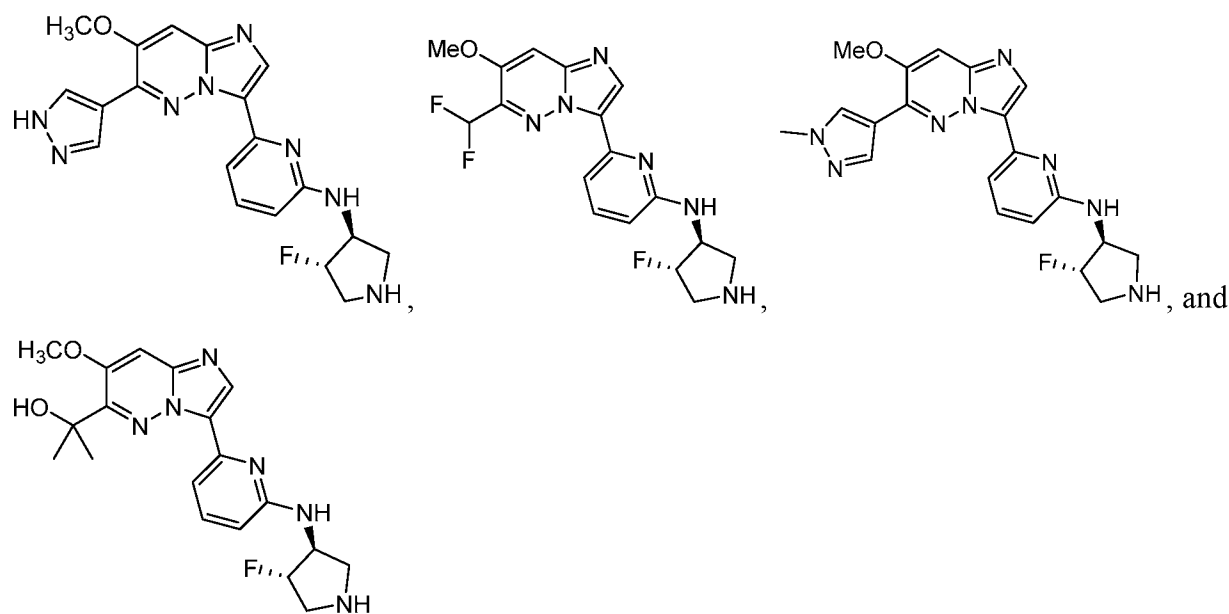




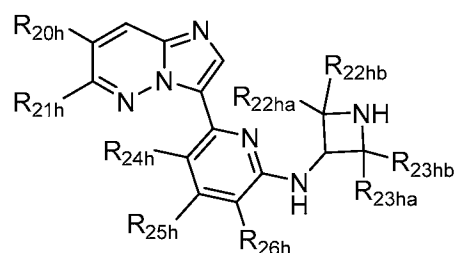








[00115] In an embodiment, the compound of Formula (II) is a compound of Formula (IIh)



Formula (IIh), or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

R_{20h} is selected from H and C_1 - C_6 alkoxy;

R_{21h} is selected from C_1 - C_6 alkyl, C_3 - C_6 cycloalkyl, and C_3 - C_9 heterocyclyl, wherein C_1 - C_6 alkyl is optionally substituted with one or more substituents selected from -OH and halogen and C_3 - C_6 cycloalkyl, and C_3 - C_9 heterocyclyl are each optionally substituted with one or more substituents selected from C_1 - C_6 alkyl, -OH, and halogen;

R_{22ha} , R_{22hb} , R_{23ha} , and R_{23hb} are each independently selected from H and C_1 - C_6 alkyl, wherein C_1 - C_6 alkyl is optionally substituted with one or more halogen atoms; and

R_{24h} , R_{25h} , and R_{26h} are each independently selected from H and halogen.

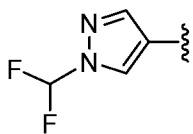
[00116] In an embodiment, R_{20h} is H.

[00117] In an embodiment, R_{21h} is C₃-C₉ heterocyclyl substituted with one or more substituents selected from C₁-C₆ alkyl, -OH, and halogen. In one embodiment, R_{21h} is pyrazolyl

substituted with C₁-C₆ alkyl and F. In one embodiment, R_{21h} is pyrazolyl substituted with



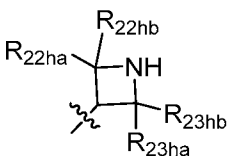
. In one embodiment, R_{21h} is



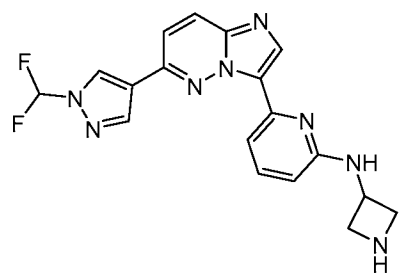
[00118] In an embodiment, one or more of R_{22ha}, R_{22hb}, R_{23ha}, and R_{23hb} is independently optionally substituted C₁-C₆ alkyl. In another embodiment, each of R_{22ha}, R_{22hb}, R_{23ha}, and R_{23hb} is H. In an embodiment, each of R_{22ha}, R_{22hb} are H and R_{23ha} and/or R_{23hb} is C₁-C₆ alkyl. In one embodiment, each of R_{22ha}, R_{22hb}, and R_{23ha} is H and R_{23hb} is -CH₃. In another embodiment, each of R_{22ha} and R_{22hb} is H and each of R_{23ha} and R_{23hb} is -CH₃.

[00119] In an embodiment, R_{24h}, R_{25h}, and R_{26h} are each H. In an embodiment, R_{24h} and R_{26h} are each independently halogen and R_{25h} is H. In one embodiment, R_{24h} and R_{26h} are each F and R_{25h} is H. In an embodiment, R_{24h} and R_{26h} are each H and R_{25h} is halogen. In one embodiment, R_{24h} and R_{26h} are each H and R_{25h} is F.

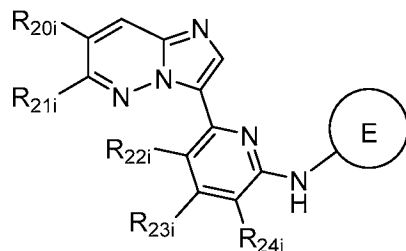
[00120] In an embodiment, the compound of Formula (IIh) comprises one or more stereocenters. In one embodiment, the compound of Formula (IIh) comprises a stereocenter on R_{21h}. In one embodiment, the compound of Formula (IIh) comprises a stereocenter where the

moiety  connects to the remaining portion of Formula (IIh). In one embodiment, one or more of R_{22ha}, R_{22hb}, R_{23ha}, and/or R_{23hb} comprises a stereocenter.

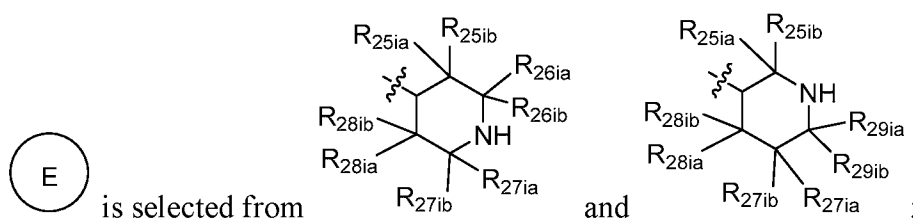
[00121] In an embodiment, the compound of Formula (IIh) is



[00122] In an embodiment, the compound of Formula (II) is a compound of Formula (IIi)



Formula (IIi), or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:



R_{20i} is selected from H, and C₁-C₆ alkoxy;

R_{21i} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, -OH, -C=O, and halogen;

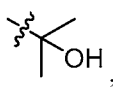
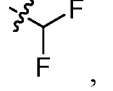
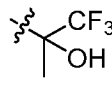
R_{22i}, R_{23i}, and R_{24i} are each independently selected from H and halogen; and

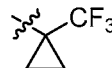
R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} are each independently selected from H, halogen, -OH, or C₁-C₆ alkyl.

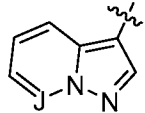
[00123] In an embodiment, one or more of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is independently selected from halogen, -OH, and C₁-C₆ alkyl. In another embodiment, each of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is H.

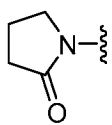
[00124] In an embodiment, R_{20i} is H. In another embodiment, R_{20i} is unsubstituted C₁-C₆ alkoxy. In one embodiment, R_{20i} is -OCH₃.

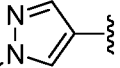
[00125] In an embodiment, R_{21i} is C_1 - C_6 alkyl substituted with one or more F and/or

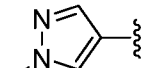
-OH. In one embodiment, R_{21i} is selected from , , and . In another embodiment, R_{21i} is unsubstituted C_3 - C_6 cycloalkyl. In one embodiment, R_{21i} is unsubstituted C_3 cycloalkyl. In one embodiment, R_{21i} is C_3 cycloalkyl substituted with C_1 - C_6 alkyl. In one

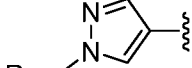
embodiment, R_{21i} is . In one embodiment, R_{21i} is C_3 cycloalkyl substituted with one or more C_1 - C_6 alkyl and one or more fluorine atoms. In one embodiment, R_{21i} is . In another embodiment, R_{21i} is unsubstituted C_3 - C_9 heterocyclyl. In one embodiment, R_{21i} is pyrazolyl. In

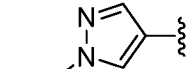
one embodiment, R_{21i} is  wherein J is N or CH. In another embodiment, R_{21i} is C_3 - C_9 heterocyclyl substituted with one or more substituents selected from C_1 - C_6 alkyl, C_3 - C_6 -cycloalkyl, C_3 - C_9 -heterocyclyl, -OH, -C=O, and halogen. In one embodiment, R_{21i} is pyrrolidinyl

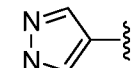
monosubstituted with -C=O. In one embodiment, R_{21i} is . In one embodiment, R_{21i} is

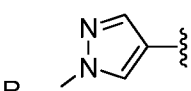
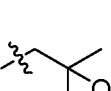
 wherein R_{220i} is selected from H, C_1 - C_6 alkyl, C_3 - C_6 cycloalkyl, and C_3 - C_9 heterocyclyl, wherein C_1 - C_6 alkyl and C_3 - C_6 cycloalkyl are each optionally substituted with one

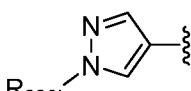
or more halogen and/or -OH. In one embodiment, R_{21i} is  wherein R_{220i} is H. In

one embodiment, R_{21i} is  wherein R_{220i} is unsubstituted C_1 - C_6 alkyl. In one

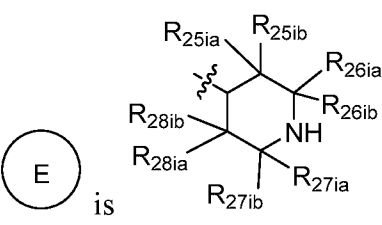
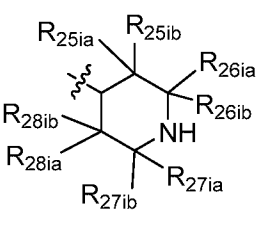
embodiment, R_{21i} is  wherein R_{220i} is -CH₃. In one embodiment, R_{21i} is

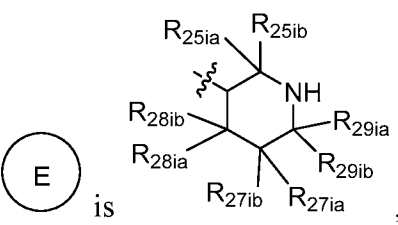
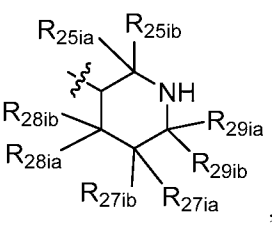
 wherein R_{220i} is C_1 - C_6 alkyl substituted with one or more -OH and/or F. In one

embodiment, R_{21i} is  wherein R_{220i} is selected from  and . In

another embodiment, R_{21i} is  wherein R_{220i} is unsubstituted C_3 cycloalkyl.

[00126] In an embodiment, each of R_{22i} , R_{23i} , and R_{24i} is H. In an embodiment, R_{22i} and R_{24i} are each independently halogen and R_{23i} is H. In one embodiment, R_{22i} and R_{24i} are each F and R_{23i} is H. In an embodiment, R_{22i} and R_{24i} are each H and R_{23i} is halogen. In one embodiment, R_{22i} and R_{24i} are each H and R_{23i} is F.

[00127] In an embodiment,  is , each of R_{25ia} , R_{25ib} , R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , and R_{28ib} is H. In an embodiment, each of R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , and R_{28ib} is H and R_{25ia} and/or R_{25ib} is halogen. In one embodiment, each of R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , and R_{28ib} is H and each of R_{25ia} and R_{25ib} is F. In one embodiment, each of R_{25ia} , R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , and R_{28ib} is H and R_{25ib} is F.

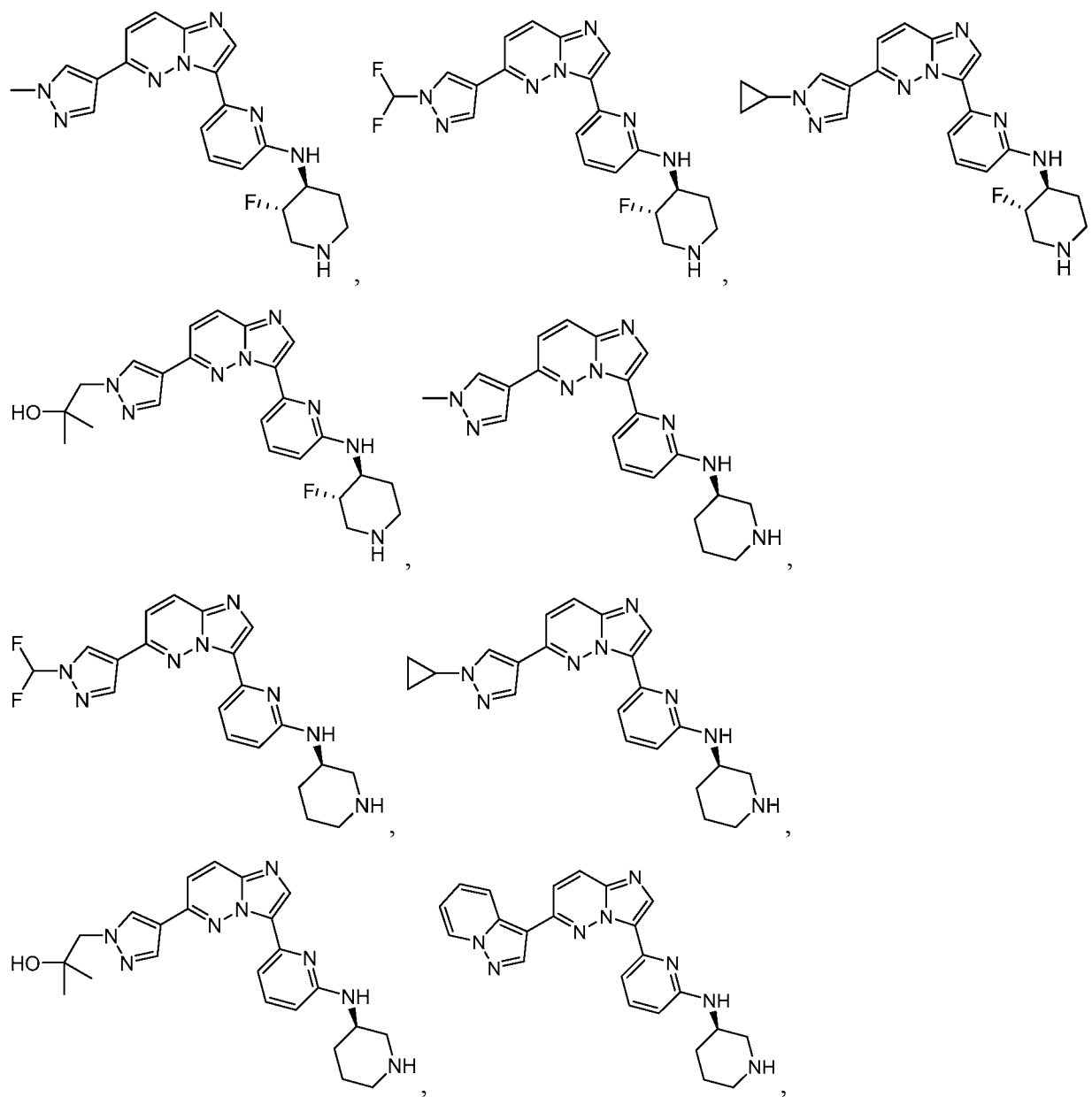
[00128] In an embodiment,  is , each of R_{25ia} , R_{25ib} , R_{27ia} , R_{27ib} , R_{28ia} , R_{28ib} , R_{29ia} , and R_{29ib} is H. In an embodiment, each of R_{25ia} , R_{25ib} , R_{27ia} , R_{27ib} , R_{29ia} , and R_{29ib} is H and R_{28ia} and/or R_{28ib} is halogen. In one embodiment, each of R_{25ia} , R_{25ib} , R_{27ia} , R_{27ib} , R_{29ia} , and R_{29ib} is H and each of R_{28ia} and R_{28ib} is F. In one embodiment, each of R_{25ia} , R_{25ib} , R_{27ia} , R_{27ib} , R_{28ia} , R_{29ia} , and R_{29ib} is H and R_{28ib} is F. In another embodiment, each of R_{25ia} , R_{25ib} , R_{28ia} , R_{28ib} , R_{29ia} , and R_{29ib} is H and R_{27ia} and/or R_{27ib} is halogen. In one embodiment, each of R_{25ia} , R_{25ib} , R_{27ia} , R_{28ia} , R_{28ib} , R_{29ia} , and R_{29ib} is H and R_{27ib} is F. In one embodiment, each of R_{25ia} , R_{25ib} , R_{27ia} , R_{28ia} , R_{28ib} , R_{29ia} , and R_{29ib} is H and each of R_{27ia} and R_{27ib} is F.

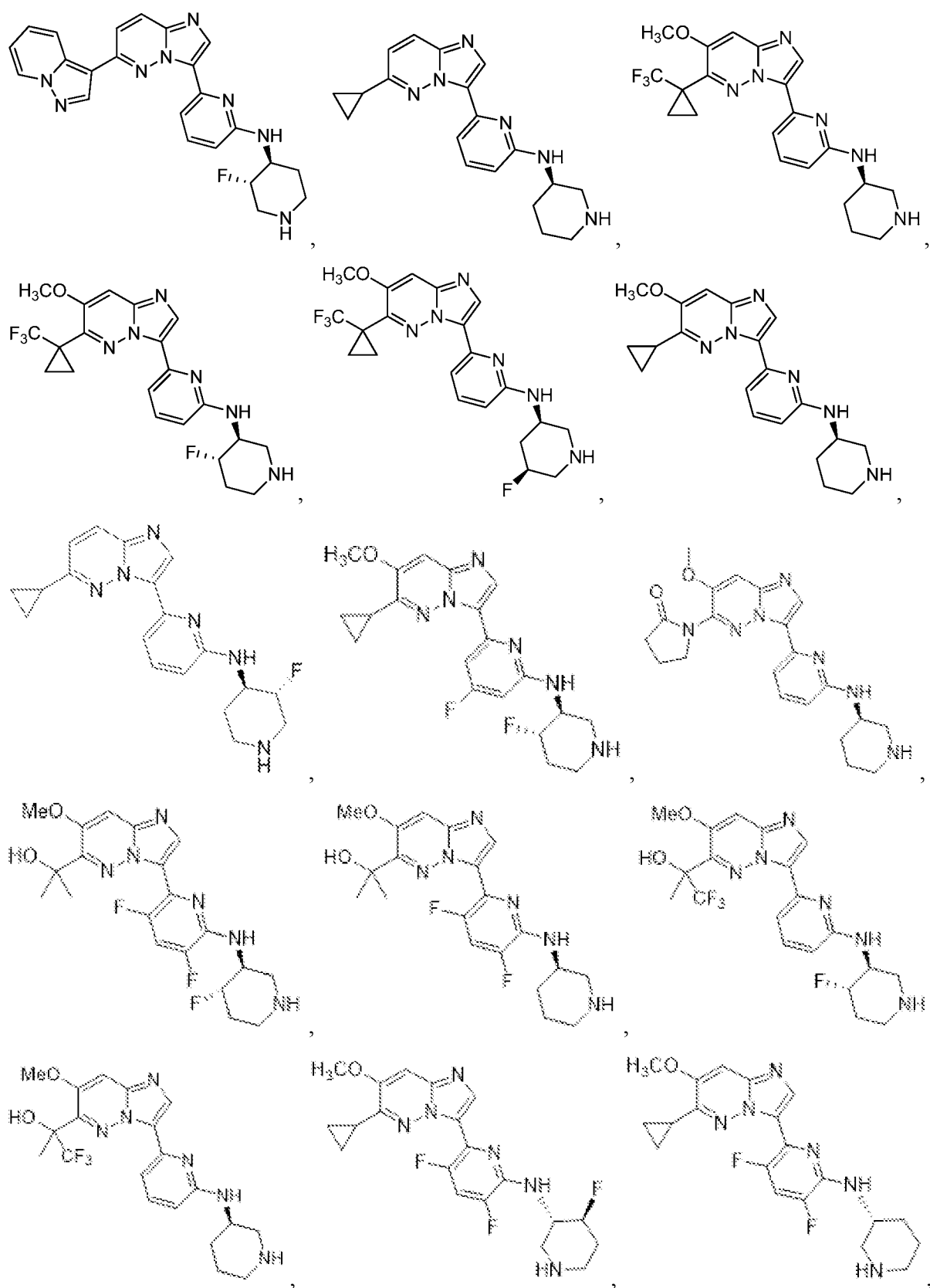
[00129] In an embodiment, the compound of Formula (III) comprises one or more stereocenters. In one embodiment, the compound of Formula (III) comprises a stereocenter on R_{20i} . In one embodiment, the compound of Formula (III) comprises a stereocenter on R_{21i} . In

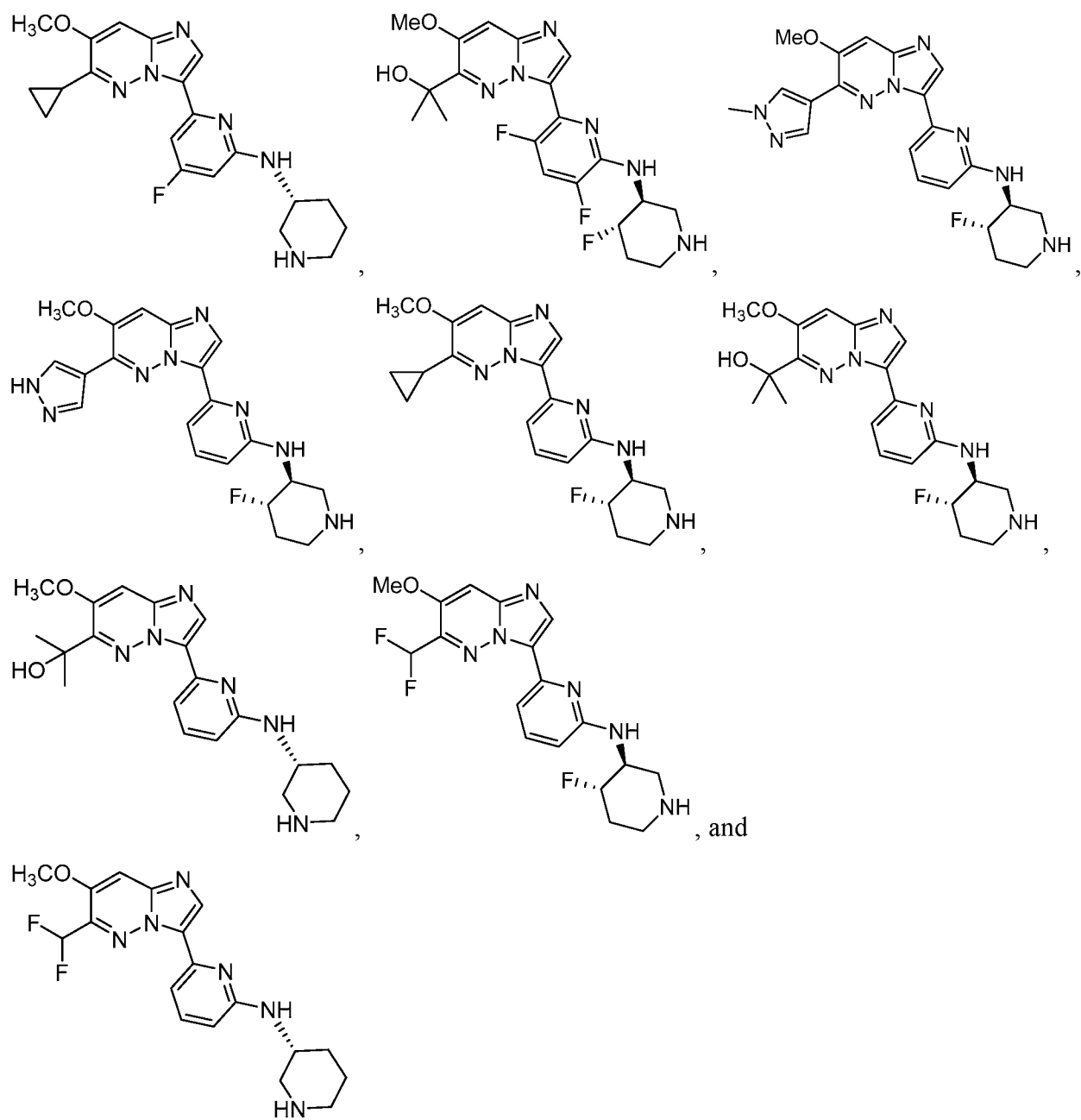
E

one embodiment, the compound of Formula (IIi) comprises a stereocenter where the moiety connects to the remaining portion of Formula (IIi). In one embodiment, one or more of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and/or R_{29ib} comprises a stereocenter.

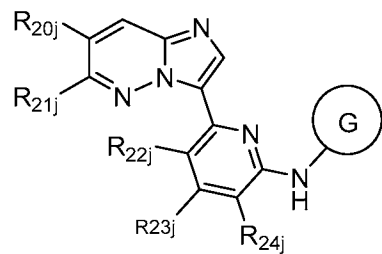
[00130] In an embodiment, the compound of Formula (IIi) is selected from:





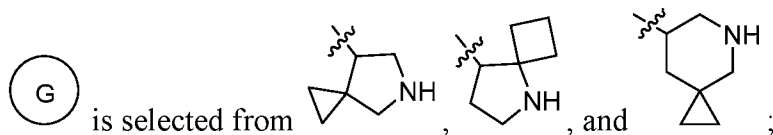


[00131] In an embodiment, the compound of Formula (II) is a compound of Formula (IIj)



Formula (IIj), or a salt, ester, solvate, optical isomer, geometric

isomer, or salt of an isomer thereof;
wherein:



R_{20j} is selected from H, and C₁-C₆ alkoxy;

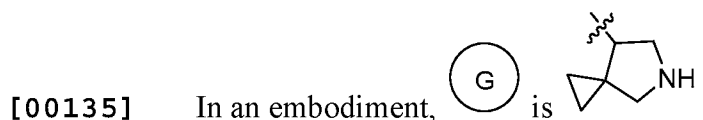
R_{21j} is selected from H, C₁-C₆ alkyl, C₁-C₆ alkoxy, and C₃-C₆ cycloalkyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from halogen and -OH, and C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen; and

R_{22j}, R_{23j}, and R_{24j} are each independently selected from H and halogen.

[00132] In an embodiment, R_{20j} is H. In another embodiment, R_{20j} is optionally substituted C₁-C₆ alkoxy. In one embodiment, R_{20j} is unsubstituted C₁-C₆ alkoxy. In one embodiment, R_{20j} is -OCH₃.

[00133] In an embodiment, R_{21j} is optionally substituted C₃-C₆ cycloalkyl. In one embodiment, R_{21j} is optionally substituted C₃ cycloalkyl. In one embodiment, R_{21j} is unsubstituted C₃ cycloalkyl.

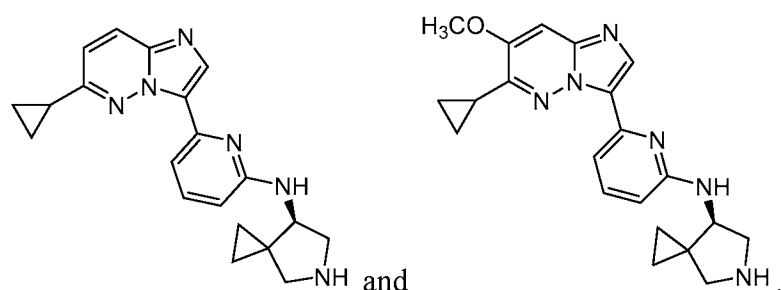
[00134] In an embodiment, R_{22j}, R_{23j}, and R_{24j} are each H. In an embodiment, R_{22j} and R_{24j} are each independently halogen and R_{23j} is H. In one embodiment, R_{22j} and R_{24j} are each F and R_{23j} is H. In an embodiment, R_{22j} and R_{24j} are each H and R_{23j} is halogen. In one embodiment, R_{22j} and R_{24j} are each H and R_{23j} is F.



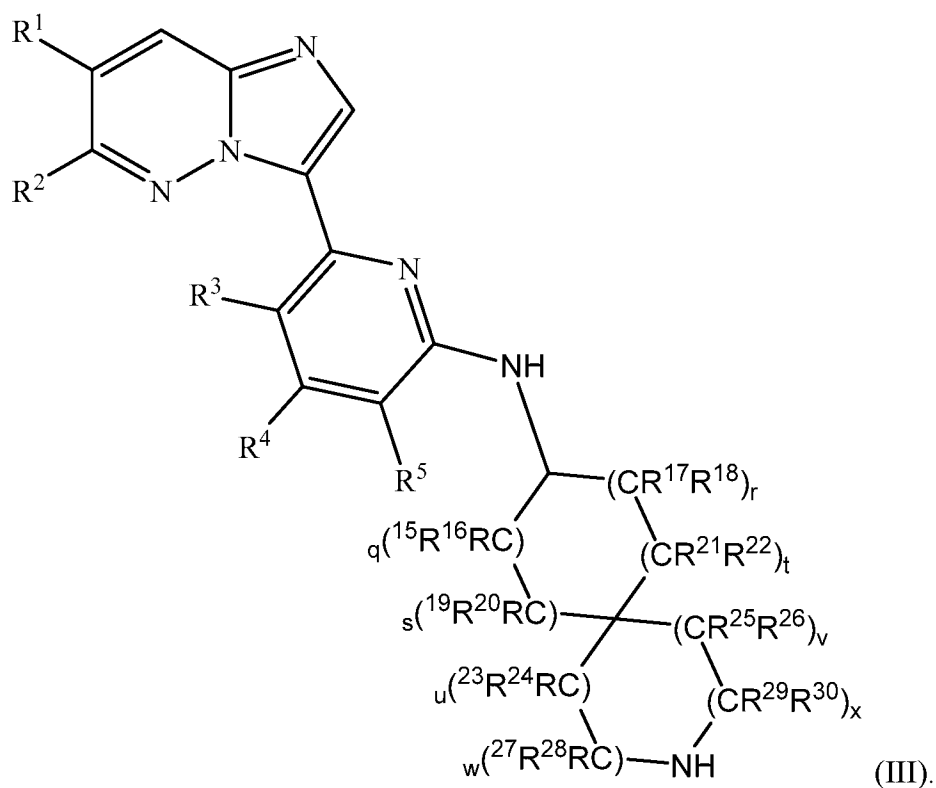
[00136] In an embodiment, the compound of Formula (IIj) comprises one or more stereocenters. In one embodiment, the compound of Formula (IIj) comprises a stereocenter on

R_{21j}. In one embodiment, the compound of Formula (IIj) comprises a stereocenter where the  moiety connects to the remaining portion of Formula (IIj).

[00137] In an embodiment, the compound of Formula (IIj) is selected from:



[00138] In some embodiments, R^6 is (Ib), giving a structure of Formula (III), as follows:

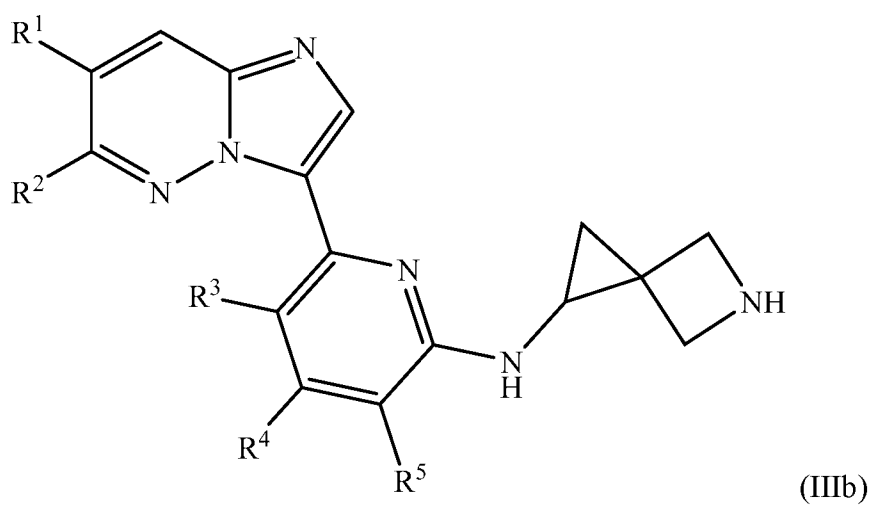
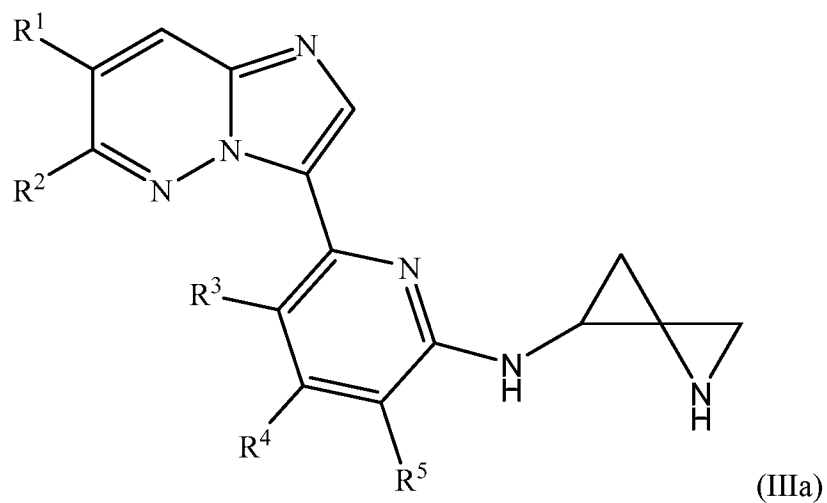


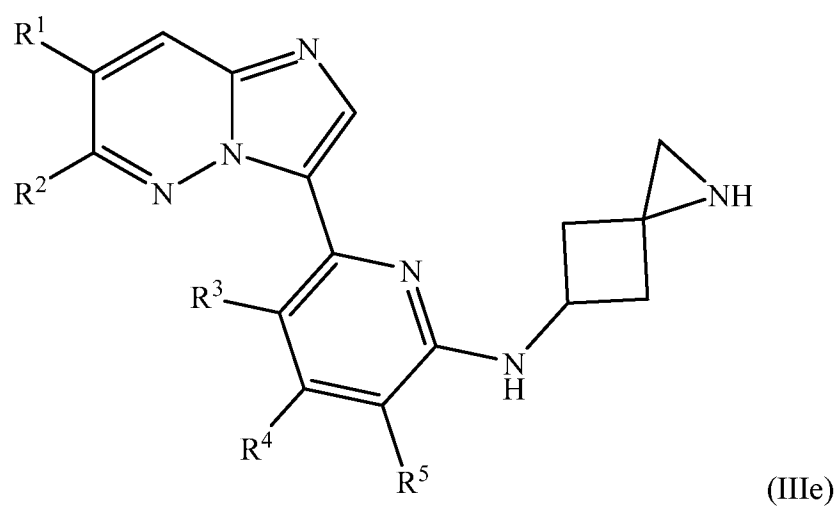
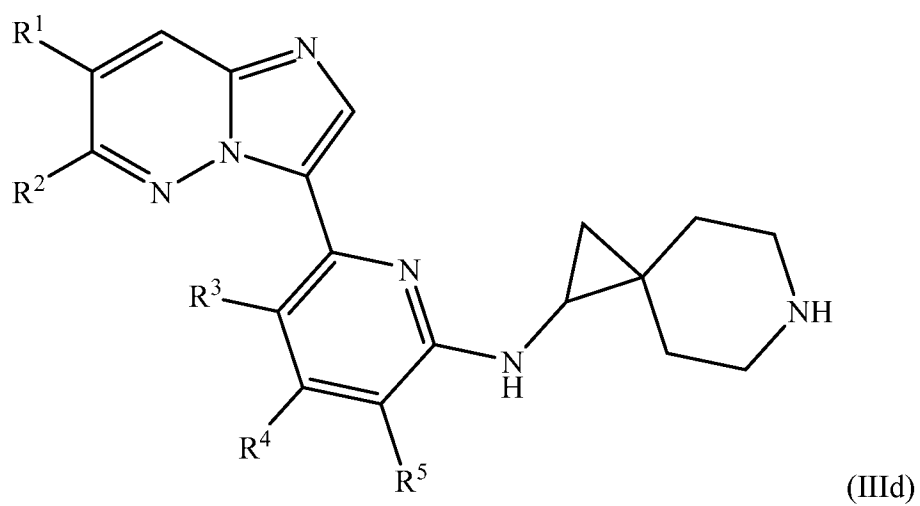
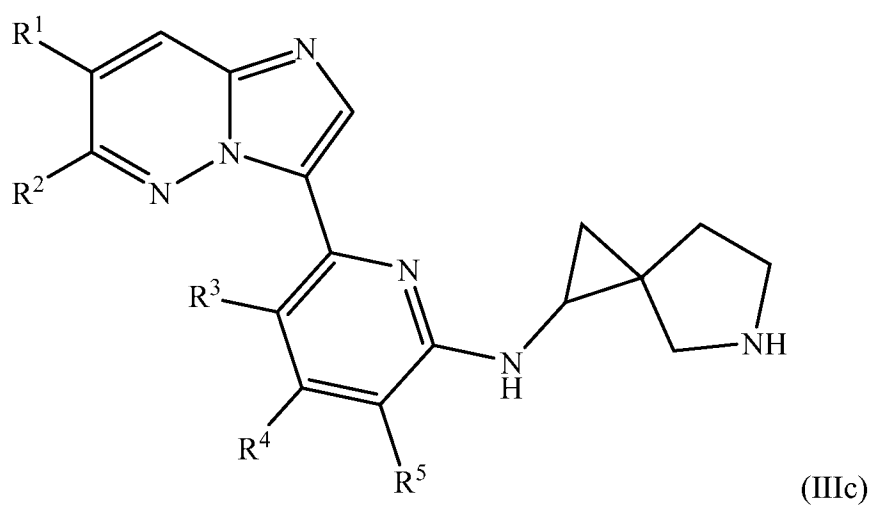
[00139] In some embodiments according to Formula (III), q , r , s , t , u , v , w , and x are independently 0, 1, or 2. In some embodiments, q is 0 or 1, r is 0 or 1, s is 0 or 1, t is 0 or 1, u is 0 or 1, v is 0 or 1, w is 0 or 1, and x is 0 or 1.

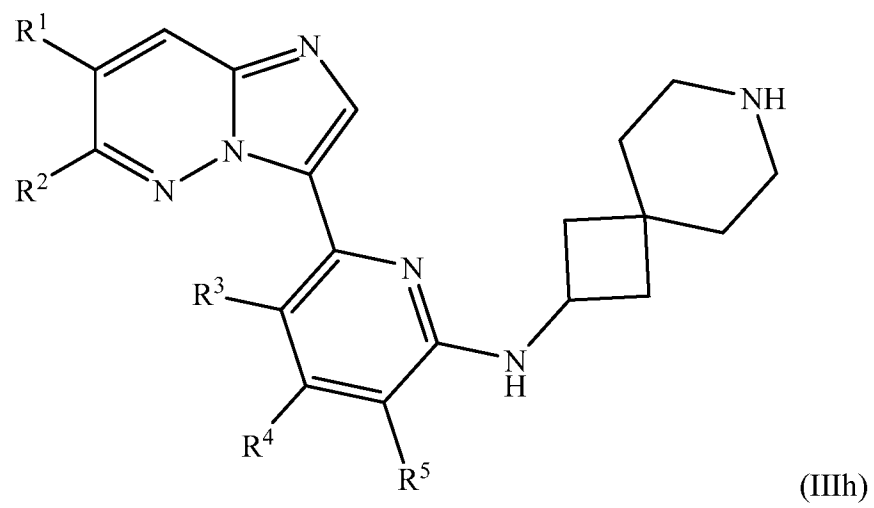
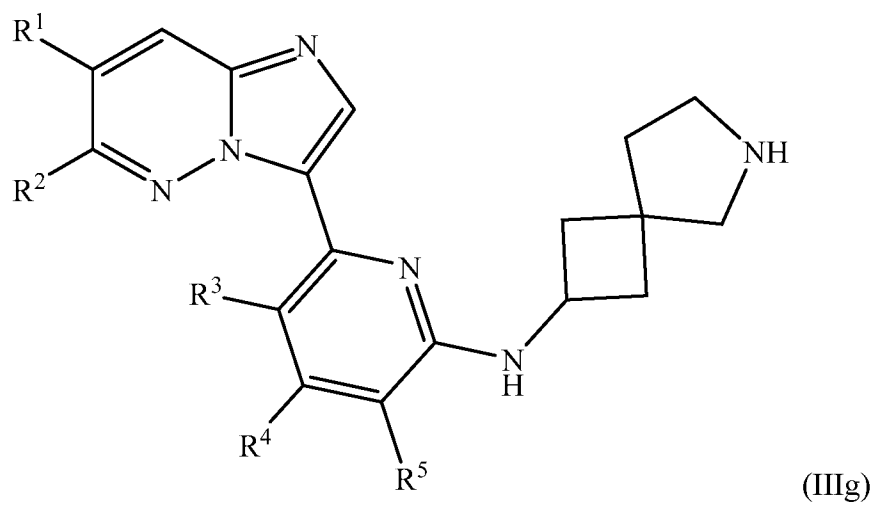
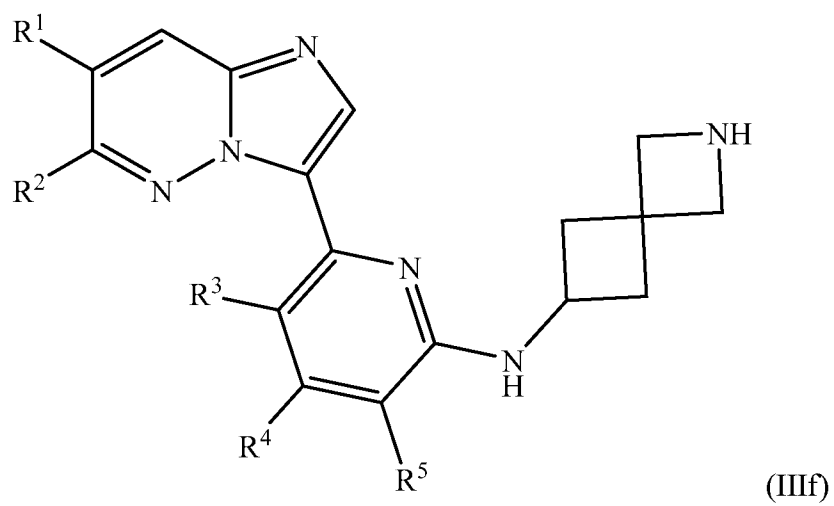
[00140] In some embodiments, R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , R^{29} , and R^{30} are independently selected from H, halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen. In some embodiments, one or more of R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , R^{29} , and R^{30} are H. In some

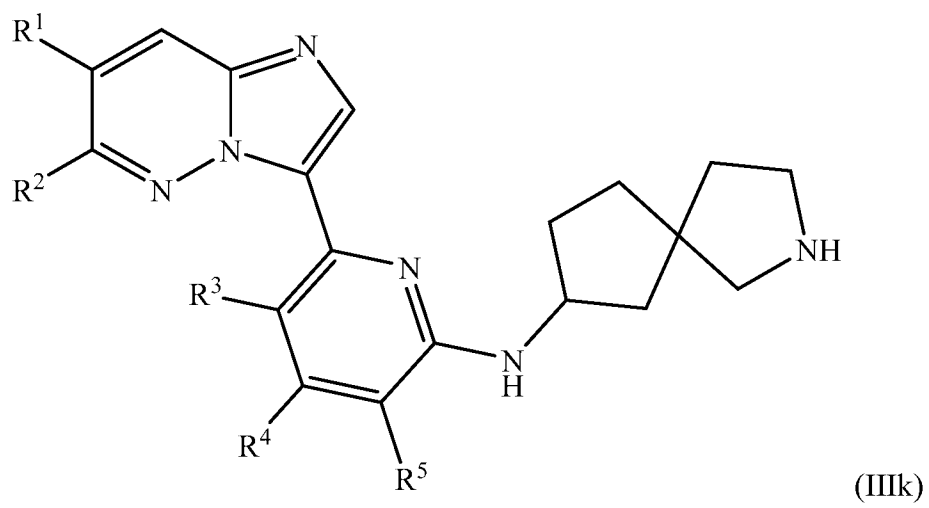
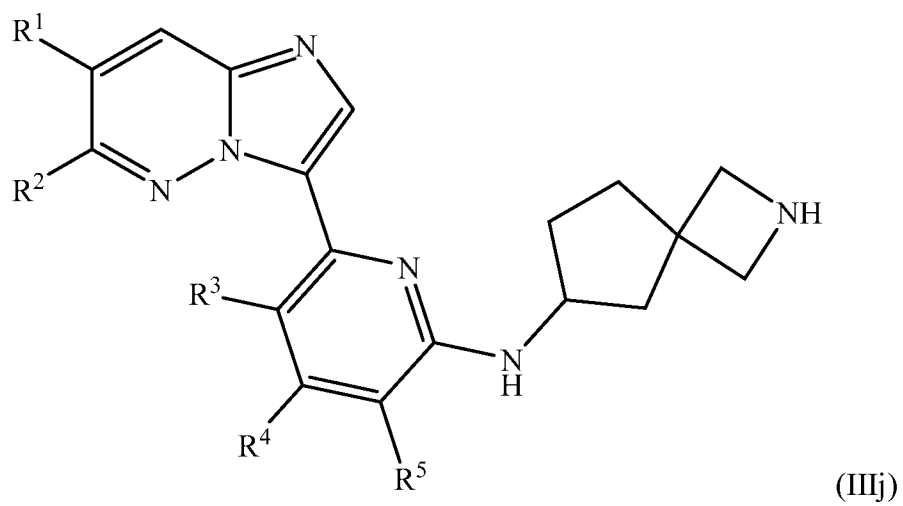
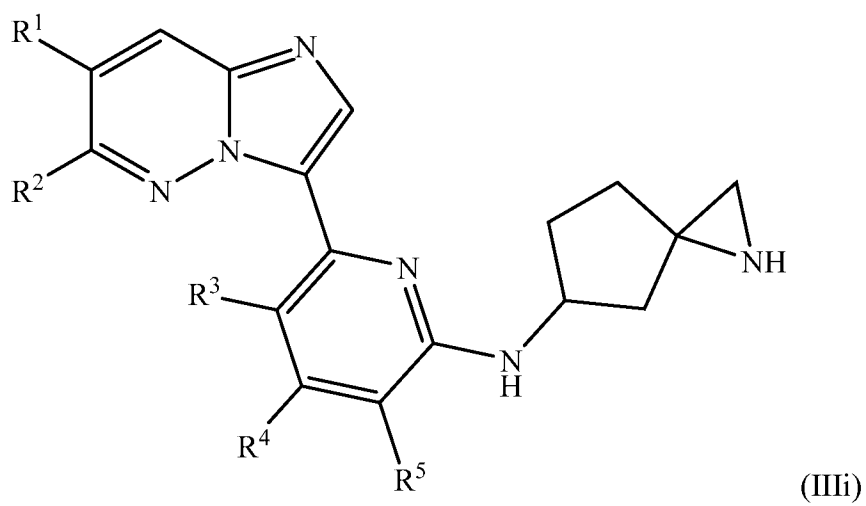
embodiments, all of R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , and R^{30} are H.

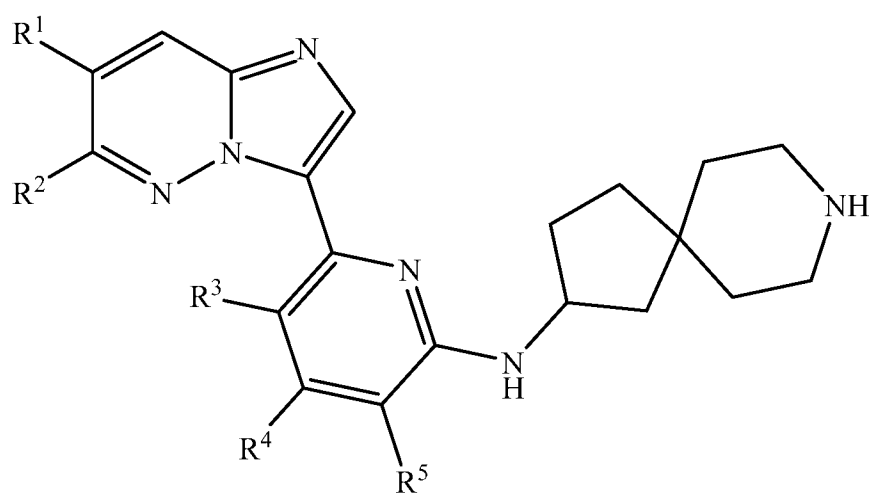
[00141] Further to any embodiment above wherein the compound has the structure of Formula (III), the compound can have a structure according to any of (IIIa)-(IIIp), as follows:



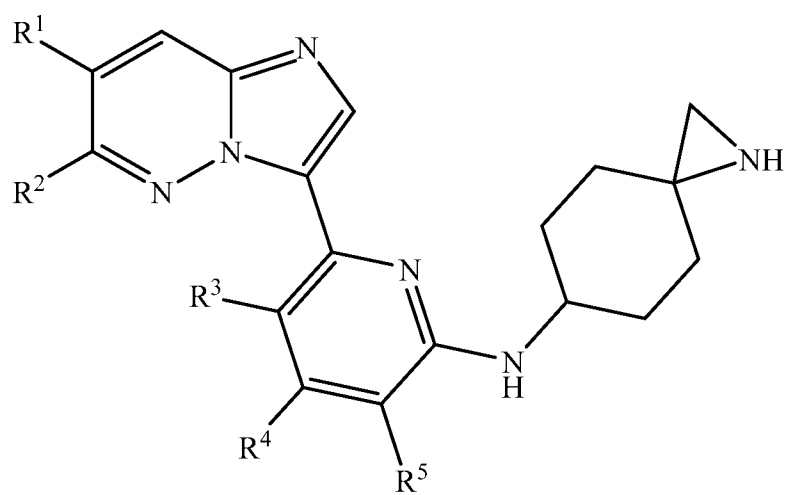




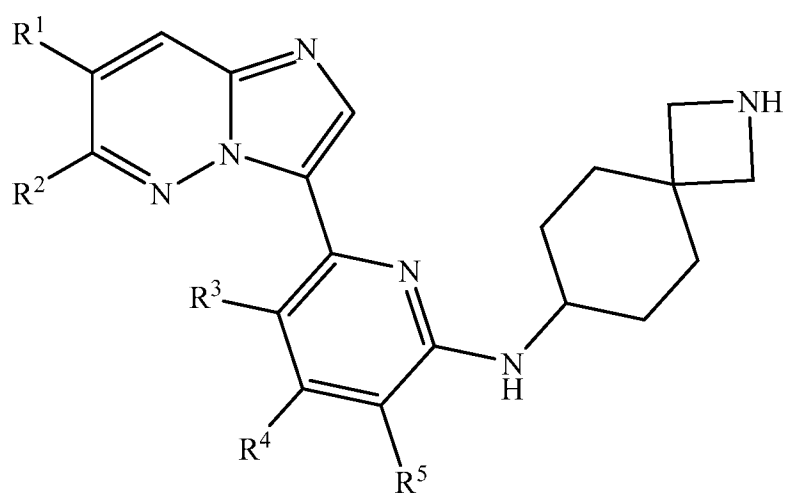




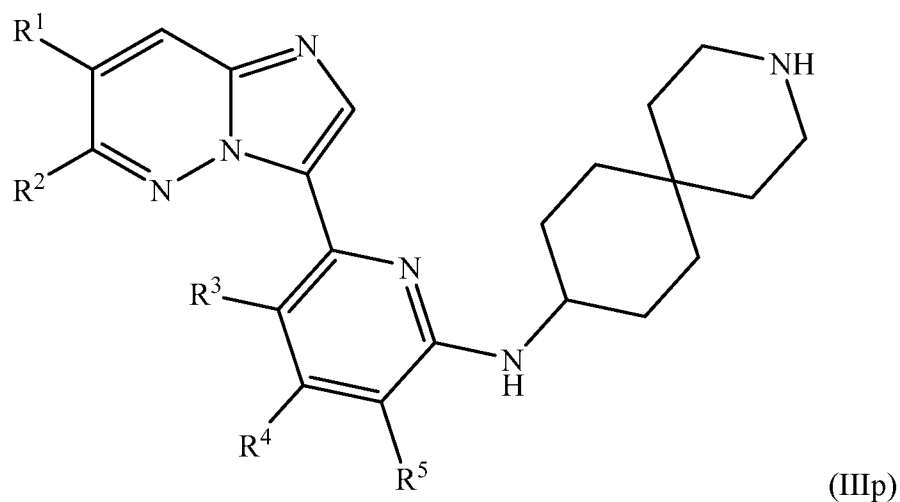
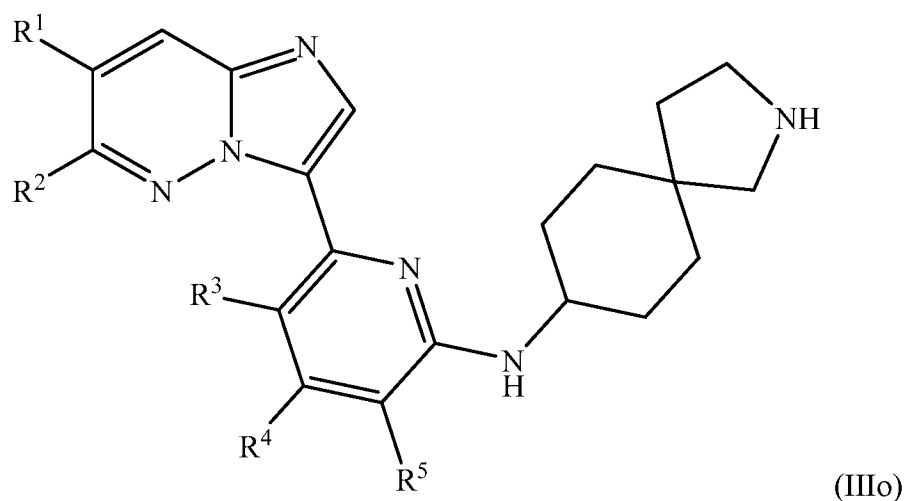
(III)



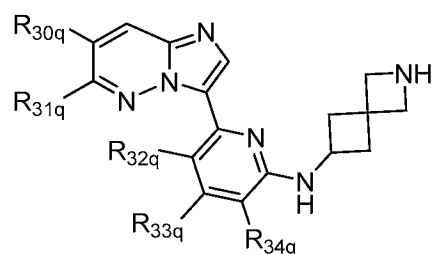
(III m)



(III n)



[00142] In an embodiment, the compound of Formula (III) is a compound of Formula (IIIq)



Formula (IIIq), or a salt, ester, solvate, optical isomer,

geometric isomer, or salt of an isomer thereof;

wherein:

R_{30q} is selected from H and C₁-C₆ alkoxy;

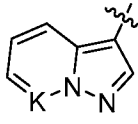
R_{31q} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents

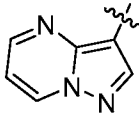
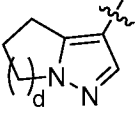
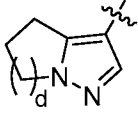
selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocycyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocycyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; and

R_{32q}, R_{33q}, and R_{34q} are each independently selected from H and halogen.

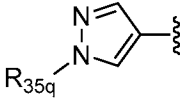
[00143] In an embodiment, R_{30q} is H.

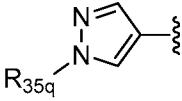
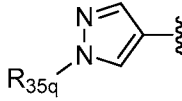
[00144] In an embodiment, R_{31q} is unsubstituted C₃-C₉ heterocycyl. In one

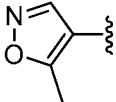
embodiment, R_{31q} is pyrazolyl. In one embodiment, R_{31q} is selected from  wherein K

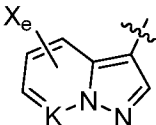
is N or CH, , and  wherein d is 1 or 2. In one embodiment, R_{31q} is 

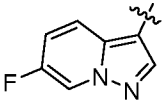
wherein d is 2. In another embodiment, R_{31q} is C₃-C₉ heterocycyl substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocycyl, C₆-C₁₂ aryl, -OH, -

C=O, and halogen. In an embodiment, R_{31q} is  wherein R_{35q} is selected from H, unsubstituted C₁-C₆ alkyl, unsubstituted C₆-C₁₂ aryl, and unsubstituted C₃-C₉ heterocycyl. In one

embodiment, R_{31q} is  wherein R_{35q} is H. In one embodiment, R_{31q} is  wherein R_{35q} is selected from -CH₃, isopropyl, phenyl, azetidyl, and tetrahydropyranyl. In another embodiment, R_{31q} is isoxazolyl substituted with C₁-C₆ alkyl. In one embodiment, R_{31q} is

isoxazolyl monosubstituted with -CH₃. In one embodiment, R_{31q} is . In another

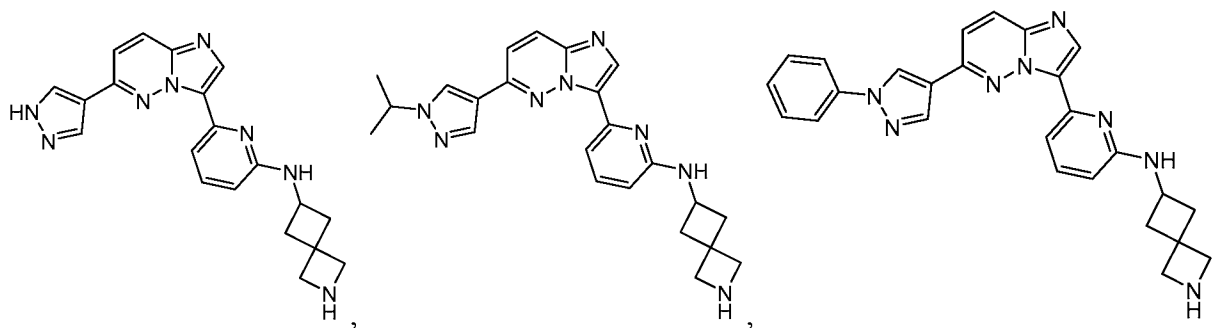
embodiment, R_{31q} is , wherein e is 1, 2, or 3, K is N or CH and each X is independently

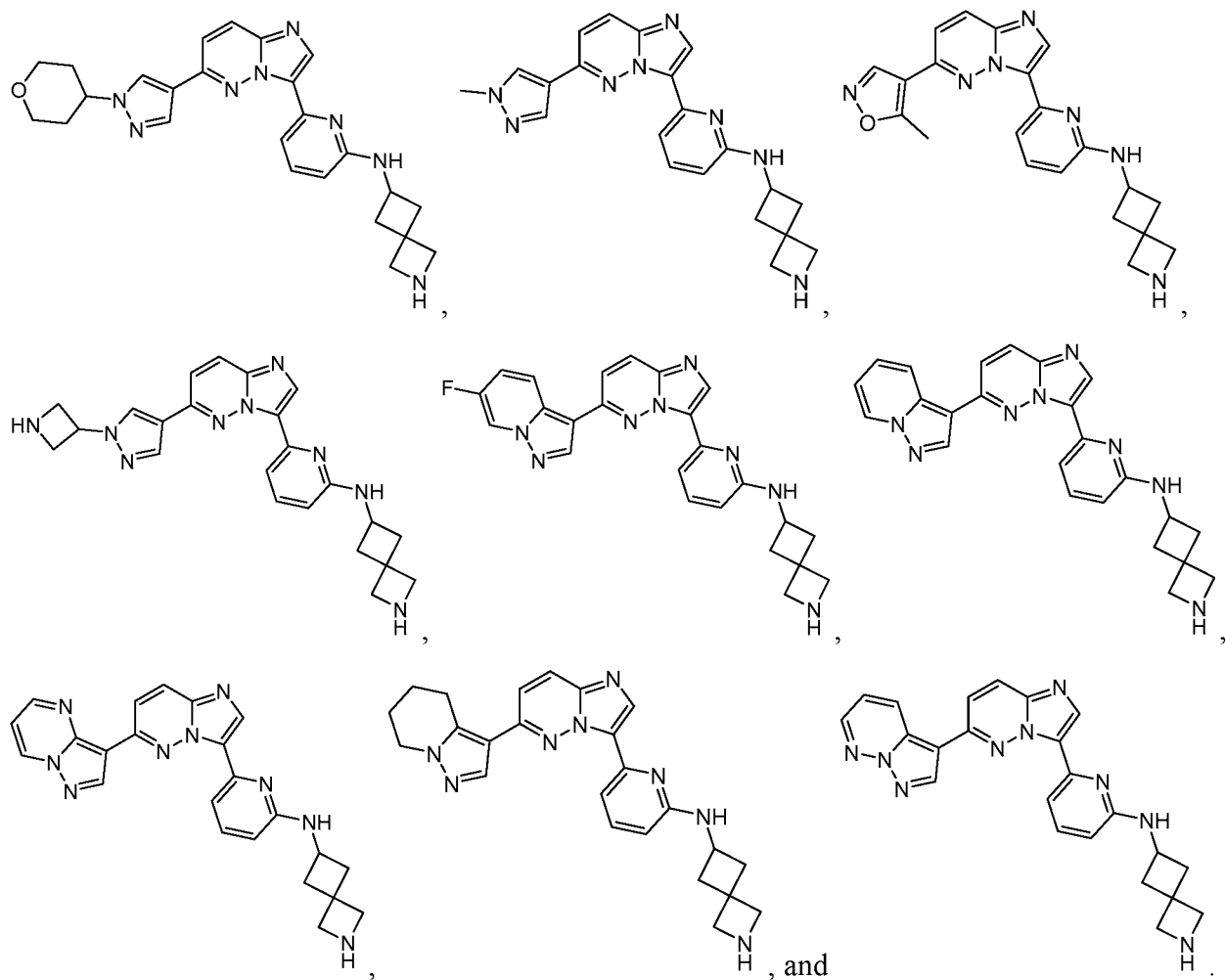
halogen. In one embodiment, R_{31q} is .

[00145] In an embodiment, R_{32q} , R_{33q} , and R_{34q} are each H. In an embodiment, R_{32q} and R_{34q} are each independently halogen and R_{33q} is H. In one embodiment, R_{32q} and R_{34q} are each F and R_{33q} is H. In an embodiment, R_{32q} and R_{34q} are each H and R_{33q} is halogen. In one embodiment, R_{32q} and R_{34q} are each H and R_{33q} is F.

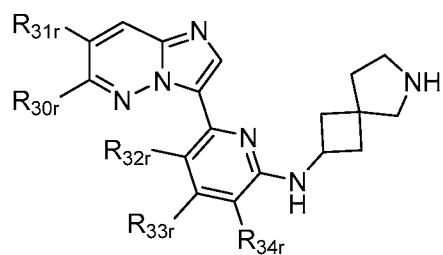
[00146] In an embodiment, the compound of Formula (IIIq) comprises one or more stereocenters.

[00147] In an embodiment, the compound of Formula (IIIq) is selected from:





[00148] In an embodiment, the compound of Formula (III) is a compound of Formula (IIIr)



Formula (IIIr), or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

R_{30r} is selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_3 - C_6 cycloalkyl, and C_3 - C_9 heterocyclyl, wherein C_1 - C_6 alkyl and C_1 - C_6 alkoxy are each optionally substituted with one or more substituents

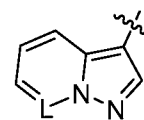
selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen;

R_{31r} is selected from H and C₁-C₆ alkoxy; and

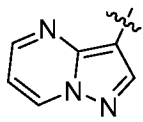
R_{32r}, R_{33r}, and R_{34r} are each independently selected from H and halogen.

[00149] In an embodiment, R_{30r} is unsubstituted C₃-C₉ heterocyclyl. In one

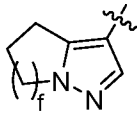
embodiment, R_{30r} is unsubstituted pyrazolyl. In one embodiment, R_{30r} is selected from



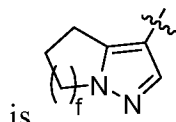
wherein L is N or CH,



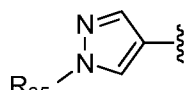
, and

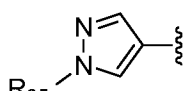


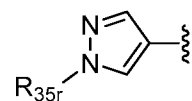
wherein f is 1 or 2. In one embodiment, R_{30r}



is wherein f is 2. In another embodiment, R_{30r} is C₃-C₉ heterocyclyl substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂

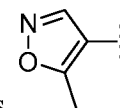
aryl, -OH, -C=O, and halogen. In an embodiment, R_{30r} is  wherein R_{35r} is selected from H, unsubstituted C₁-C₆ alkyl, unsubstituted C₆-C₁₂ aryl, and unsubstituted C₃-C₉ heterocyclyl.

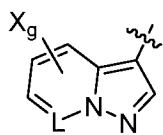
In an embodiment, R_{30r} is  wherein R_{35r} is H. In one embodiment, R_{30r} is

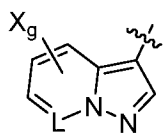


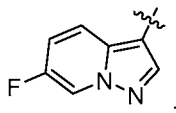
wherein R_{35r} is selected from -CH₃, isopropyl, phenyl, azetidyl, and tetrahydropyranyl. In another embodiment, R_{30r} is isoxazolyl substituted with C₁-C₆ alkyl. In one

embodiment, R_{30r} is isoxazolyl monosubstituted with -CH₃. In one embodiment, R_{30r} is





. In another embodiment, R_{30r} is , wherein g is 1, 2, or 3, L is N or CH and each X is

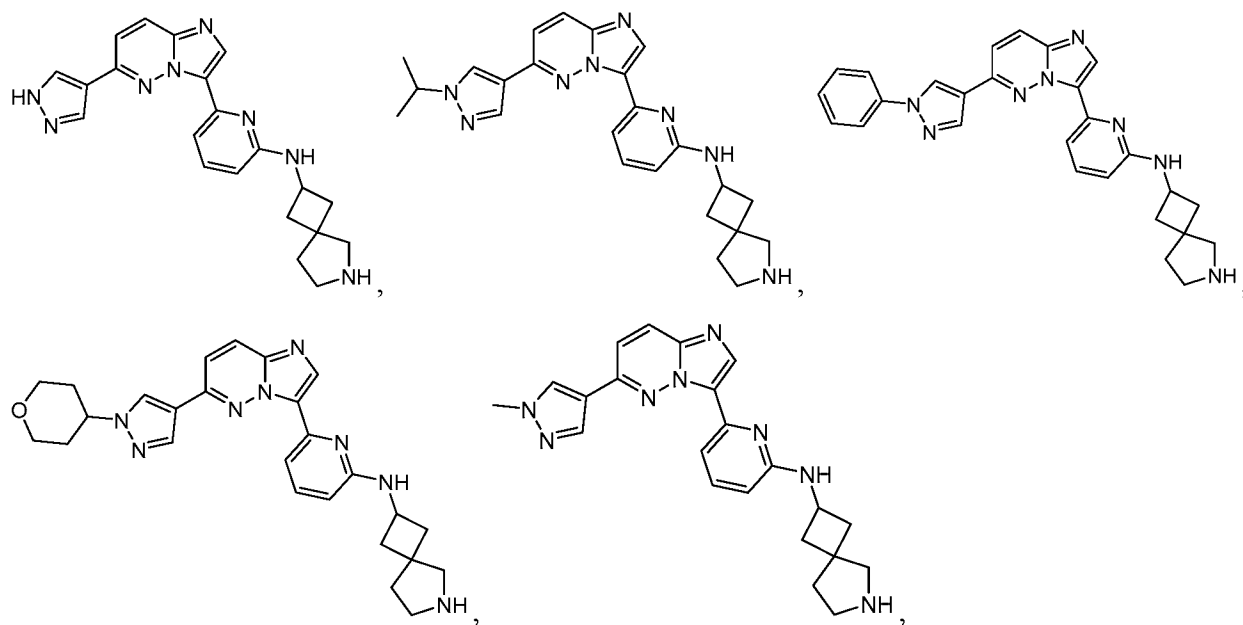
independently halogen. In one embodiment, R_{30r} is .

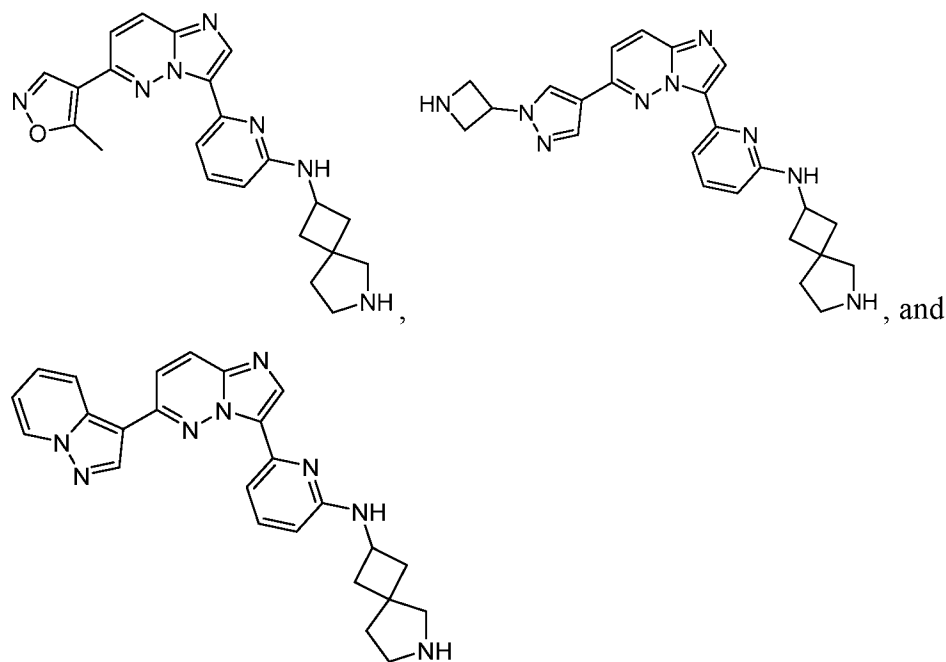
[00150] In an embodiment, R_{31r} is H.

[00151] In an embodiment, R_{32r} , R_{33r} , and R_{34r} are each H. In an embodiment, R_{32r} and R_{34r} are each independently halogen and R_{33r} is H. In one embodiment, R_{32r} and R_{34r} are each F and R_{33r} is H. In an embodiment, R_{32r} and R_{34r} are each H and R_{33r} is halogen. In one embodiment, R_{32r} and R_{34r} are each H and R_{33r} is F.

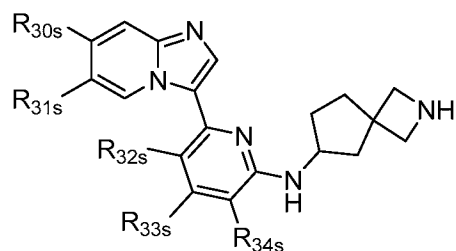
[00152] In an embodiment, the compound of Formula (IIIr) comprises one or more stereocenters.

[00153] In an embodiment, the compound of Formula (IIIr) is selected from:





[00154] In an embodiment, the compound of Formula (III) is a compound of Formula (III_s)



Formula (III_s), or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

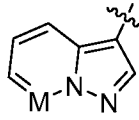
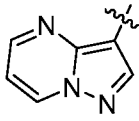
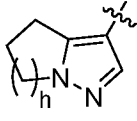
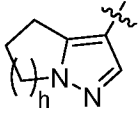
R_{30s} is selected from H and C₁-C₆ alkoxy;

R_{31s} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; and

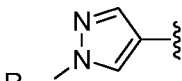
R_{32s} , R_{33s} , and R_{34s} are each independently selected from H and halogen.

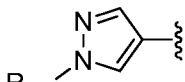
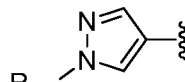
[00155] In an embodiment, R_{30s} is H.

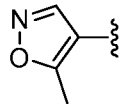
[00156] In an embodiment, R_{31s} is unsubstituted C₃-C₉ heterocyclyl. In one

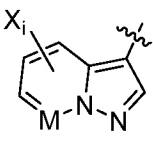
embodiment, R_{31s} is pyrazolyl. In one embodiment, R_{31s} is selected from  wherein M is N or CH, , and  wherein h is 1 or 2. In one embodiment, R_{31s} is  wherein h is 2.

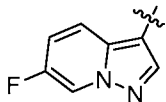
In another embodiment, R_{31s} is C₃-C₉ heterocyclyl substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -

C=O, and halogen. In an embodiment, R_{31s} is  wherein R_{35s} is selected from H, unsubstituted C₁-C₆ alkyl, unsubstituted C₆-C₁₂ aryl, and unsubstituted C₃-C₉ heterocyclyl. In one

embodiment, R_{31s} is  wherein R_{35s} is H. In one embodiment, R_{31s} is  wherein R_{35s} is selected from -CH₃, isopropyl, phenyl, azetidyl, and tetrahydropyranyl. In another embodiment, R_{31s} is isoxazolyl substituted with C₁-C₆ alkyl. In one embodiment, R_{31s} is

isoxazolyl monosubstituted with -CH₃. In one embodiment, R_{31s} is . In another

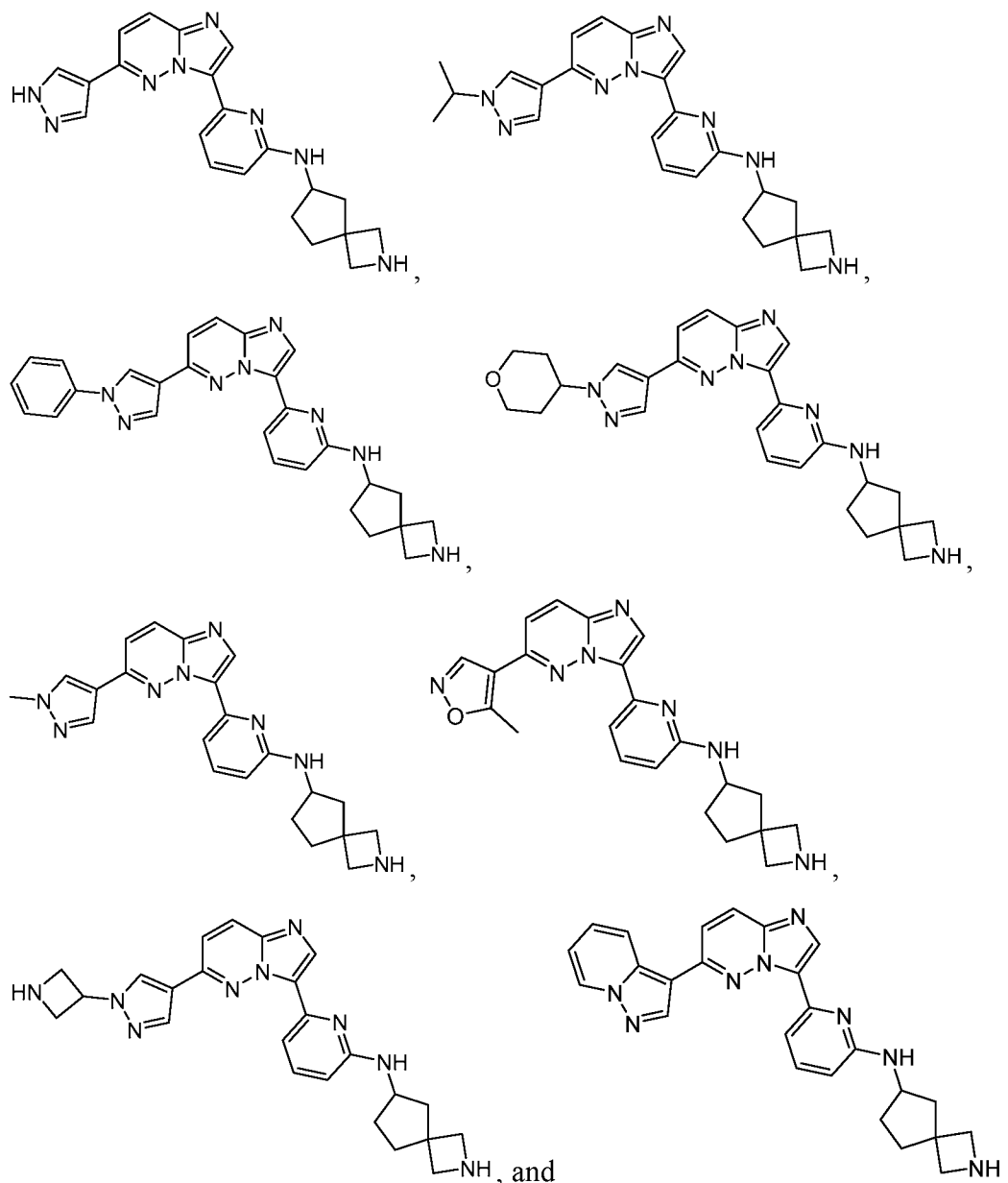
embodiment, R_{31s} is , wherein i is 1, 2, or 3, M is N or CH and each X is independently

halogen. In one embodiment, R_{31s} is .

[00157] In an embodiment, R_{32s} , R_{33s} , and R_{34s} are each H. In an embodiment, R_{32s} and R_{34s} are each independently halogen and R_{33s} is H. In one embodiment, R_{32s} and R_{34s} are each F and R_{33s} is H. In an embodiment, R_{32s} and R_{34s} are each H and R_{33s} is halogen. In one embodiment, R_{32s} and R_{34s} are each H and R_{33s} is F.

[00158] In an embodiment, the compound of Formula (III_s) comprises one or more stereocenters.

[00159] In an embodiment, the compound of Formula (III_s) is selected from:



[00160] In some embodiments, the compounds of Formula (I), such as compounds of Formula (II) or Formula (III), can be any of those specified in Compounds 1-137, as listed in Tables 1-15. In some embodiments, the compound can be Compound 1, Compound 9, Compound 19, Compound 20, Compound 21, Compound 26, Compound 31, Compound 38, Compound 45, Compound 56, Compound 60, Compound 61, Compound 62, Compound 63, Compound 81, Compound 84, Compound 96, Compound 97, or Compound 99.

[00161] In some embodiments, the compounds of Formula (I), such as compounds of Formula (II) or Formula (III), can be in the form of salts, optical and geometric isomers, and

salts of isomers. In other embodiments, the compounds can be in various forms, such as uncharged molecules, components of molecular complexes, or non-irritating pharmacologically acceptable salts, including but not limited to hydrochloride, hydrobromide, sulphate, phosphate, nitrate, borate, acetate, maleate, tartrate, and salicylate. In some instances, for acidic compounds, salts can include metals, amines, or organic cations (e.g. quaternary ammonium). In yet other embodiments, simple derivatives of the compounds (e.g., ethers, esters, or amides) which have desirable retention and release characteristics but which are easily hydrolyzed by body pH, enzymes, or other suitable means, can be employed.

[00162] In some embodiments, the compounds of the disclosure having a chiral center and can exist in and be isolated in optically active and racemic forms. In other embodiments, compounds may exhibit polymorphism. Some embodiments of the present disclosure encompass any racemic, optically active, polymorphic, or stereoisomeric form, or mixtures thereof, of a compound described herein, including isotopically-labeled and radio-labeled compounds. See e.g., Goding, 1986, *Monoclonal Antibodies Principles and Practice*; Academic Press, p. 104. Such isomers can be isolated by standard resolution techniques, including e.g., fractional crystallization, chiral chromatography, and the like. See e.g., Eliel, E. L. & Wilen S. H., 1993, *Stereochemistry in Organic Compounds*; John Wiley & Sons, New York. The preparation of optically active forms can be accomplished by any suitable method, including but not limited to, resolution of the racemic form by recrystallization techniques, synthesis from optically-active starting materials, chiral synthesis, or chromatographic separation using a chiral stationary phase.

[00163] In some embodiments, compounds disclosed herein have asymmetric centers and can occur as racemates, racemic mixtures, and as individual enantiomers or diastereoisomers, with all isomeric forms as well as mixtures thereof being contemplated for use in the compounds and methods described herein. The compounds contemplated for use in the compounds and methods described herein do not include those that are known in the art to be too unstable to synthesize and/or isolate.

[00164] The compounds disclosed herein can also contain unnatural proportions of atomic isotopes at one or more of the atoms that constitute such compounds. For example, the compounds can be radiolabeled with radioactive isotopes, such as for example tritium (^3H), iodine-125 (^{125}I), or carbon-14 (^{14}C). All isotopic variations of the compounds disclosed herein, whether radioactive or not, are encompassed within the contemplated scope.

[00165] In some embodiments, metabolites of the compounds disclosed herein are useful for the methods disclosed herein.

[00166] In some embodiments, compounds contemplated herein may be provided in the form of a prodrug. The term “prodrug” refers to a compound that can be converted into a compound (e.g., a biologically active compound) described herein *in vivo*. Prodrugs can be useful for a variety of reason known in the art, including e.g., ease of administration due e.g., to enhanced bioavailability in oral administration, and the like. The prodrug can also have improved solubility in pharmaceutical compositions over the biologically active compounds. An example, without limitation, of a prodrug is a compound which is administered as an ester (i.e., the “prodrug”) to facilitate transmittal across a cell membrane where water solubility is detrimental to mobility but which then is metabolically hydrolyzed to the carboxylic acid, the active entity, once inside the cell where water solubility is beneficial. Conventional procedures for the selection and preparation of suitable prodrug derivatives are described, for example, in *Design of Prodrugs*, (ed. H. Bundgaard, Elsevier, 1985), which is hereby incorporated herein by reference for the limited purpose describing procedures and preparation of suitable prodrug derivatives.

[00167] Certain compounds disclosed herein can exist in unsolvated forms as well as solvated forms, including hydrated forms. In general, the solvated forms are equivalent to unsolvated forms and are encompassed within the scope of contemplated compounds. Certain compounds of the present disclosure can exist in multiple crystalline or amorphous forms. In general, all physical forms are equivalent for the compounds and methods contemplated herein and are intended to be within the scope disclosed herein.

[00168] In certain embodiments, one or more compounds of the disclosure (e.g., Formula (I)) can be part of a composition and can be in an amount (by weight of the total composition) of at least about 0.0001%, at least about 0.001%, at least about 0.10%, at least about 0.15%, at least about 0.20%, at least about 0.25%, at least about 0.50%, at least about 0.75%, at least about 1%, at least about 10%, at least about 25%, at least about 50%, at least about 75%, at least about 90%, at least about 95%, at least about 99%, at least about 99.99%, no more than about 75%, no more than about 90%, no more than about 95%, no more than about 99%, or no more than about 99.99%, from about 0.0001% to about 99%, from about 0.0001% to about 50%, from about 0.01% to about 95%, from about 1% to about 95%, from about 10% to about 90%, or from about 25% to about 75%.

[00169] In some embodiments, one or more compounds of the disclosure (e.g., Formula (I)) can be purified or isolated in an amount (by weight of the total composition) of at least about 0.0001%, at least about 0.001%, at least about 0.10%, at least about 0.15%, at least about 0.20%, at least about 0.25%, at least about 0.50%, at least about 0.75%, at least about 1%, at least about 10%, at least about 25%, at least about 50%, at least about 75%, at least about 90%, at least about 95%, at least about 99%, at least about 99.99%, no more than about 75%, no more than about 90%, no more than about 95%, no more than about 99%, no more than about 99.99%, from about 0.0001% to about 99%, from about 0.0001% to about 50%, from about 0.01% to about 95%, from about 1% to about 95%, from about 10% to about 90%, or from about 25% to about 75%.

Methods for Preparing Compounds of Formula (I)

[00170] Some embodiments of the present disclosure include methods for the preparation of compounds of Formula (I). In certain embodiments, a compound of Formula (I) can be prepared comprising one or more of the steps set forth in Examples 1-25 herein. The synthetic routes shown and described in Examples 1-25 can, for example, be used to prepare Compounds 1-137, as set forth in Tables 1-15, and structurally related compounds.

Pharmaceutical Compositions and Formulations

[00171] Some embodiments of the present disclosure include compositions comprising one or more compounds of the disclosure (e.g., Formula (I)). In certain embodiments, the composition is a pharmaceutical composition, such as compositions that are suitable for administration to animals (e.g., mammals, primates, monkeys, humans, canine, feline, porcine, mice, rabbits, rats, etc.). In some embodiments, there is provided a pharmaceutical composition comprising a compound disclosed herein and a pharmaceutically acceptable excipient. The compound can be a compound of any of Formulae (I)-(III) as disclosed herein, a compound as set forth in Tables 1-16, or a pharmaceutically acceptable salt, ester, solvate, optical isomer, geometric isomer, salt of an isomer, prodrug, or derivative thereof. In some embodiments, the compound is set forth in any of Tables 1-16 herein.

[00172] Further embodiments of the disclosure relate to compositions including a compound as described above. In some embodiments, the amount of the compound can be from about 0.0001% (by weight total composition) to about 99%. In some embodiments, the

composition can further include a formulary ingredient, an adjuvant, or a carrier. In some embodiments, the composition can further include a BCL2 inhibitor. In some embodiments, the composition can be used in combination with a second composition including a BCL2 inhibitor. In some embodiments, the BCL2 can be venetoclax, or a salt, isomer, derivative or analog thereof.

[00173] The term “pharmaceutically acceptable salts” is meant to include salts of the active compounds that are prepared with relatively nontoxic acids or bases, depending on the particular substituents found on the compounds described herein. When compounds disclosed herein contain relatively acidic functionalities, base addition salts can be obtained by contacting the neutral form of such compounds with a sufficient amount of the desired base, either neat or in a suitable inert solvent. Examples of pharmaceutically acceptable base addition salts include sodium, potassium, calcium, ammonium, organic amino, or magnesium salt, or a similar salt. When compounds disclosed herein contain relatively basic functionalities, acid addition salts can be obtained by contacting the neutral form of such compounds with a sufficient amount of the desired acid, either neat or in a suitable inert solvent. Examples of pharmaceutically acceptable acid addition salts include those derived from inorganic acids like hydrochloric, hydrobromic, nitric, carbonic, monohydrogencarbonic, phosphoric, monohydrogenphosphoric, dihydrogenphosphoric, sulfuric, monohydrogensulfuric, hydriodic, or phosphorous acids and the like, as well as the salts derived from relatively nontoxic organic acids like acetic, propionic, isobutyric, maleic, malonic, benzoic, succinic, suberic, fumaric, lactic, mandelic, phthalic, benzenesulfonic, p-tolylsulfonic, citric, tartaric, oxalic, methanesulfonic, and the like. Also included are salts of amino acids such as arginate and the like, and salts of organic acids like glucuronic or galacturonic acids and the like (*see*, for example, Berge *et al.*, “Pharmaceutical Salts”, *Journal of Pharmaceutical Science*, 1977, 66, 1-19). Certain specific compounds disclosed herein contain both basic and acidic functionalities that allow the compounds to be converted into either base or acid addition salts.

[00174] Compounds disclosed herein can exist as salts, such as with pharmaceutically acceptable acids. Accordingly, the compounds contemplated herein include such salts. Examples of such salts include hydrochlorides, hydrobromides, sulfates, methanesulfonates, nitrates, maleates, acetates, citrates, fumarates, tartrates (e.g., (+)-tartrates, (-)-tartrates, or mixtures thereof including racemic mixtures), succinates, benzoates, and salts with amino acids such as glutamic acid. These salts can be prepared by methods known to those skilled in the art.

[00175] The neutral forms of the compounds are preferably regenerated by contacting the salt with a base or acid and isolating the parent compound in the conventional manner. The parent form of the compound differs from the various salt forms in certain physical properties, such as solubility in polar solvents.

[00176] Pharmaceutically acceptable salts of the compounds above, where a basic or acidic group is present in the structure, are also included within the scope of compounds contemplated herein. When an acidic substituent is present, such as $\text{-NHSO}_3\text{H}$, -COOH and -P(O)(OH)_2 , there can be formed the ammonium, sodium, potassium, calcium salt, and the like, for use as the dosage form. Basic groups, such as amino or basic heteroaryl radicals, or pyridyl and acidic salts, such as hydrochloride, hydrobromide, acetate, maleate, palmoate, methanesulfonate, p-toluenesulfonate, and the like, can be used as the dosage form.

[00177] Also, in the embodiments in which R-COOH is present, pharmaceutically acceptable esters can be employed, e. g. , methyl, ethyl, tert-butyl, pivaloyloxymethyl, and the like, and those esters known in the art for modifying solubility or hydrolysis characteristics for use as sustained release or prodrug formulations.

[00178] In some instances, the pharmaceutical composition is non-toxic, does not cause side effects, or both. In some embodiments, there may be inherent side effects (e.g., it may harm the patient or may be toxic or harmful to some degree in some patients).

[00179] In some embodiments, one or more compounds of the disclosure (e.g., Formula (I)) can be part of a pharmaceutical composition and can be in an amount of at least about 0.0001%, at least about 0.001%, at least about 0.10%, at least about 0.15%, at least about 0.20%, at least about 0.25%, at least about 0.50%, at least about 0.75%, at least about 1%, at least about 10%, at least about 25%, at least about 50%, at least about 75%, at least about 90%, at least about 95%, at least about 99%, at least about 99.99%, no more than about 75%, no more than about 90%, no more than about 95%, no more than about 99%, no more than about 99.99%, from about 0.001% to about 99%, from about 0.001% to about 50%, from about 0.1% to about 99%, from about 1% to about 95%, from about 10% to about 90%, or from about 25% to about 75%. In some embodiments, the pharmaceutical composition can be presented in a dosage form which is suitable for the topical, subcutaneous, intrathecal, intraperitoneal, oral, parenteral, rectal, cutaneous, nasal, vaginal, or ocular administration route. In other embodiments, the pharmaceutical composition can be presented in a dosage form which is suitable for parenteral administration, a mucosal

administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration. The pharmaceutical composition can be in the form of, for example, tablets, capsules, pills, powders granulates, suspensions, emulsions, solutions, gels (including hydrogels), pastes, ointments, creams, plasters, drenches, delivery devices, suppositories, enemas, injectables, implants, sprays, aerosols or other suitable forms.

[00180] In some embodiments, the compounds disclosed herein can be administered orally as tablets, aqueous or oily suspensions, lozenges, troches, powders, granules, emulsions, capsules, syrups or elixirs. The composition for oral use can contain one or more agents selected from the group of sweetening agents, flavoring agents, coloring agents and preserving agents in order to produce pharmaceutically elegant and palatable preparations. Accordingly, there are also provided pharmaceutical compositions comprising a pharmaceutically acceptable carrier or excipient and one or more compounds disclosed herein.

[00181] In some embodiments, tablets contain the acting ingredient in admixture with non-toxic pharmaceutically acceptable excipients that are suitable for the manufacture of tablets. These excipients can be, for example, (1) inert diluents, such as calcium carbonate, lactose, calcium phosphate, carboxymethylcellulose, or sodium phosphate; (2) granulating and disintegrating agents, such as corn starch or alginic acid; (3) binding agents, such as starch, gelatin or acacia; and (4) lubricating agents, such as magnesium stearate, stearic acid or talc. These tablets can be uncoated or coated by known techniques to delay disintegration and absorption in the gastrointestinal tract and thereby provide a sustained action over a longer period. For example, a time delay material such as glyceryl monostearate or glyceryl distearate can be employed.

[00182] For preparing pharmaceutical compositions from the compounds disclosed herein, pharmaceutically acceptable carriers can be either solid or liquid. Solid form preparations include powders, tablets, pills, capsules, cachets, suppositories, and dispersible granules. A solid carrier can be one or more substance that can also act as diluents, flavoring agents, binders, preservatives, tablet disintegrating agents, or an encapsulating material.

[00183] A compound disclosed herein, in the form of a free compound or a pharmaceutically-acceptable pro-drug, metabolite, analogue, derivative, solvate or salt, can be administered, for in vivo application, parenterally by injection or by gradual perfusion over time. Administration can be intravenously, intraperitoneally, intramuscularly, subcutaneously,

intracavity, or transdermally. For *in vitro* studies the compounds can be added or dissolved in an appropriate biologically acceptable buffer and added to a cell or tissue.

[00184] In powders, the carrier is a finely divided solid in a mixture with the finely divided active component. In tablets, the active component is mixed with the carrier having the necessary binding properties in suitable proportions and compacted in the shape and size desired.

[00185] The powders and tablets preferably contain from 5% to 70% of the active compound. Suitable carriers are magnesium carbonate, magnesium stearate, talc, sugar, lactose, pectin, dextrin, starch, gelatin, tragacanth, methylcellulose, sodium carboxymethylcellulose, a low melting wax, cocoa butter, and the like. The term “preparation” is intended to include the formulation of the active compound with encapsulating material as a carrier providing a capsule in which the active component with or without other carriers, is surrounded by a carrier, which is thus in association with it. Similarly, cachets and lozenges are included. Tablets, powders, capsules, pills, cachets, and lozenges can be used as solid dosage forms suitable for oral administration.

[00186] For preparing suppositories, a low melting wax, such as a mixture of fatty acid glycerides or cocoa butter, is first melted and the active component is dispersed homogeneously therein, as by stirring. The molten homogeneous mixture is then poured into convenient sized molds, allowed to cool, and thereby to solidify.

[00187] Liquid form preparations include solutions, suspensions, and emulsions, for example, water or water/propylene glycol solutions. For parenteral injection, liquid preparations can be formulated in solution in aqueous polyethylene glycol solution.

[00188] When parenteral application is needed or desired, particularly suitable admixtures for the compounds disclosed herein are injectable, sterile solutions, preferably oily or aqueous solutions, as well as suspensions, emulsions, or implants, including suppositories. This suspension can be formulated according to known methods using those suitable dispersing or wetting agents and suspending agents that have been mentioned above. The sterile injectable preparation can also be a sterile injectable solution or suspension in a non-toxic parenterally-acceptable diluent or solvent, for example, as a solution in 1,3-butanediol. Among the acceptable vehicles, carriers, and solvents that can be employed are water, Ringer’s solution, and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For this purpose, any bland fixed oil can be employed including synthetic

mono-or diglycerides. In addition, fatty acids such as oleic acid find use in the preparation of injectables. In particular, carriers for parenteral administration include aqueous solutions of dextrose, saline, pure water, ethanol, glycerol, propylene glycol, peanut oil, sesame oil, polyoxyethylene-block polymers, and the like. Ampoules are convenient unit dosages. The compounds disclosed herein can also be incorporated into liposomes or administered via transdermal pumps or patches. Pharmaceutical admixtures suitable for use in the pharmaceutical compositions and methods disclosed herein include those described, for example, in PHARMACEUTICAL SCIENCES (17th Ed., Mack Pub. Co., Easton, PA) and WO 96/05309, the teachings of both of which are hereby incorporated by reference.

[00189] In some embodiments, preparations for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, and emulsions. Examples of non-aqueous solvents are propylene glycol, polyethylene glycol, vegetable oils such as olive oil, and injectable organic esters such as ethyl oleate. Aqueous carriers include water, alcoholic/aqueous solutions, emulsions or suspensions, including saline and buffered media. Frequently used carriers or auxiliaries include magnesium carbonate, titanium dioxide, lactose, mannitol and other sugars, talc, milk protein, gelatin, starch, vitamins, cellulose and its derivatives, animal and vegetable oils, polyethylene glycols and solvents, such as sterile water, alcohols, glycerol and polyhydric alcohols. Intravenous vehicles include fluid and nutrient replenishers. Parenteral vehicles include sodium chloride solution, Ringer's dextrose, dextrose and sodium chloride, lactated Ringer's intravenous vehicles include fluid and nutrient replenishers, electrolyte replenishers (such as those based on Ringer's dextrose), and the like. Preservatives and other additives can also be present such as, for example, antimicrobials, anti-oxidants, chelating agents, growth factors and inert gases and the like.

[00190] Preservatives include antimicrobial, anti-oxidants, chelating agents and inert gases. Other pharmaceutically acceptable carriers include aqueous solutions, non-toxic excipients, including salts, preservatives, buffers and the like, as described, for instance, in Remington's Pharmaceutical Sciences, 15th ed. Easton: Mack Publishing Co. , 1405-1412, 1461-1487 (1975) and The National Formulary XIV., 14th ed. Washington: American Pharmaceutical Association (1975), the contents of which are hereby incorporated by reference. The pH and exact concentration of the various components of the pharmaceutical composition are adjusted according

to routine skills in the art. *See e.g., Goodman and Gilman (eds.), 1990, THE PHARMACOLOGICAL BASIS FOR THERAPEUTICS (7th ed.).*

[00191] Aqueous solutions suitable for oral use can be prepared by dissolving the active component in water and adding suitable colorants, flavors, stabilizers, and thickening agents as desired. Aqueous suspensions suitable for oral use can be made by dispersing the finely divided active component in water with viscous material, such as natural or synthetic gums, resins, methylcellulose, sodium carboxymethylcellulose, and other well-known suspending agents. Aqueous suspensions normally contain the active materials in admixture with excipients suitable for the manufacture of aqueous suspension. Such excipients can be (1) suspending agent such as sodium carboxymethyl cellulose, methyl cellulose, hydroxypropylmethylcellulose, sodium alginate, polyvinylpyrrolidone, gum tragacanth and gum acacia; (2) dispersing or wetting agents which can be (a) naturally occurring phosphatide such as lecithin; (b) a condensation product of an alkylene oxide with a fatty acid, for example, polyoxyethylene stearate ; (c) a condensation product of ethylene oxide with a long chain aliphatic alcohol, for example, heptadecaethylenoxycetanol; (d) a condensation product of ethylene oxide with a partial ester derived from a fatty acid and hexitol such as polyoxyethylene sorbitol monooleate, or (e) a condensation product of ethylene oxide with a partial ester derived from fatty acids and hexitol anhydrides, for example polyoxyethylene sorbitan monooleate

[00192] Also included are solid form preparations that are intended to be converted, shortly before use, to liquid form preparations for oral administration. Such liquid forms include solutions, suspensions, and emulsions. These preparations can contain, in addition to the active component, colorants, flavors, stabilizers, buffers, artificial and natural sweeteners, dispersants, thickeners, solubilizing agents, and the like.

[00193] The pharmaceutical preparation is preferably in unit dosage form. In such form the preparation is subdivided into unit doses containing appropriate quantities of the active component. The unit dosage form can be a packaged preparation, the package containing discrete quantities of preparation, such as packeted tablets, capsules, and powders in vials or ampoules. Also, the unit dosage form can be a capsule, tablet, cachet, or lozenge itself, or it can be the appropriate number of any of these in packaged form.

[00194] In some embodiments, the pharmaceutical composition can include one or more formulary ingredients. A “formulary ingredient” can be any suitable ingredient (e.g., suitable

for the drug(s), for the dosage of the drug(s), for the timing of release of the drugs(s), for the disease, for the disease state, or for the delivery route) including, but not limited to, water (e.g., boiled water, distilled water, filtered water, pyrogen-free water, or water with chloroform), sugar (e.g., sucrose, glucose, mannitol, sorbitol, xylitol, or syrups made therefrom), ethanol, glycerol, glycols (e.g., propylene glycol), acetone, ethers, DMSO, surfactants (e.g., anionic surfactants, cationic surfactants, zwitterionic surfactants, or nonionic surfactants (e.g., polysorbates)), oils (e.g., animal oils, plant oils (e.g., coconut oil or arachis oil), or mineral oils), oil derivatives (e.g., ethyl oleate, glyceryl monostearate, or hydrogenated glycerides), excipients, preservatives (e.g., cysteine, methionine, antioxidants (e.g., vitamins (e.g., A, E, or C), selenium, retinyl palmitate, sodium citrate, citric acid, chloroform, or parabens, (e.g., methyl paraben or propyl paraben))), or combinations thereof.

[00195] In certain embodiments, pharmaceutical compositions can be formulated to release the active ingredient (e.g., one or more compounds of the disclosure such as Formula (I)) substantially immediately upon the administration or any substantially predetermined time or time after administration. Such formulations can include, for example, controlled release formulations such as various controlled release compositions and coatings.

[00196] Other formulations (e.g., formulations of a pharmaceutical composition) can, in certain embodiments, include those incorporating the drug (or control release formulation) into food, food stuffs, feed, or drink.

[00197] Some compounds can have limited solubility in water and therefore can require a surfactant or other appropriate co-solvent in the composition. Such co-solvents include: Polysorbate 20, 60, and 80; Pluronic F-68, F-84, and P-103; cyclodextrin; and polyoxyl 35 castor oil. Such co-solvents are typically employed at a level between about 0.01 % and about 2% by weight.

[00198] Viscosity greater than that of simple aqueous solutions can be desirable to decrease variability in dispensing the formulations, to decrease physical separation of components of a suspension or emulsion of formulation, and/or otherwise to improve the formulation. Such viscosity building agents include, for example, polyvinyl alcohol, polyvinyl pyrrolidone, methyl cellulose, hydroxy propyl methylcellulose, hydroxyethyl cellulose, carboxymethyl cellulose, hydroxy propyl cellulose, chondroitin sulfate and salts thereof, hyaluronic acid and salts thereof,

and combinations of the foregoing. Such agents are typically employed at a level between about 0.01% and about 2% by weight.

[00199] The compositions disclosed herein can additionally include components to provide sustained release and/or comfort. Such components include high molecular weight, anionic mucomimetic polymers, gelling polysaccharides, and finely-divided drug carrier substrates. These components are discussed in greater detail in U.S. Pat. Nos. 4,911,920; 5,403,841; 5,212,162; and 4,861,760. The entire contents of these patents are incorporated herein by reference in their entirety for all purposes.

[00200] There are provided various pharmaceutical compositions useful for ameliorating certain diseases and disorders. The pharmaceutical compositions according to one embodiment are prepared by formulating a compound disclosed herein in the form of a free compound or a pharmaceutically-acceptable pro-drug, metabolite, analogue, derivative, solvate or salt, either alone or together with other pharmaceutical agents, suitable for administration to a subject using carriers, excipients and additives or auxiliaries. Frequently used carriers or auxiliaries include magnesium carbonate, titanium dioxide, lactose, mannitol and other sugars, talc, milk protein, gelatin, starch, vitamins, cellulose and its derivatives, animal and vegetable oils, polyethylene glycols and solvents, such as sterile water, alcohols, glycerol and polyhydric alcohols. Intravenous vehicles include fluid and nutrient replenishers.

[00201] There are provided various pharmaceutical compositions useful for ameliorating certain diseases and disorders. The pharmaceutical compositions according to one embodiment are prepared by formulating a compound disclosed herein in the form of a free compound or a pharmaceutically-acceptable pro-drug, metabolite, analogue, derivative, solvate or salt, either alone or together with other pharmaceutical agents, suitable for administration to a subject using carriers, excipients and additives or auxiliaries. Frequently used carriers or auxiliaries include magnesium carbonate, titanium dioxide, lactose, mannitol and other sugars, talc, milk protein, gelatin, starch, vitamins, cellulose and its derivatives, animal and vegetable oils, polyethylene glycols and solvents, such as sterile water, alcohols, glycerol and polyhydric alcohols. Intravenous vehicles include fluid and nutrient replenishers.

Methods of Treating and Preventing Disease

[00202] Further embodiments of the disclosure relate to methods for providing a subject with a compound including one or more administrations of one or more compositions including a compound as described above, the compositions may be the same or different if there is more than one administration. In some embodiments, at least one of the one or more compositions further includes a formulary ingredient. In some embodiments, at least one of the one or more compositions includes a composition including a compound as described above. In some embodiments, at least one of the one or more administrations includes parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration. In some embodiments, if there is more than one administration at least one composition used for at least one administration is different from the composition of at least one other administration. In some embodiments, the compound of at least one of the one or more compositions can be administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 50 mg /kg subject body weight. In some embodiments, the subject is a mammal, preferably a human, a rodent, or a primate.

[00203] Further embodiments of the disclosure relate to methods for treating a disease or disorder, where the method includes one or more administrations to a subject of one or more compositions including a compound as described above, where the compositions may be the same or different if there is more than one administration. In some embodiments, the disease or disorder can be responsive to at least one of interleukin-1 receptor-associated kinase (IRAK) inhibition or fms-like tyrosine kinase 3 (FLT3) inhibition. In some embodiments, at least one of the one or more compositions further includes a formulary ingredient. In some embodiments, at least one of the one or more compositions includes a composition as described above.

[00204] In some embodiments, at least one of the one or more administrations includes parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, transdermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration. In some embodiments, at least one of the one or more administrations includes an oral administration. In some embodiments, if there is more than one administration at least one composition used for at least one administration is different from the

composition of at least one other administration. In some embodiments, the compound of at least one of the one or more compositions is administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 50 mg /kg subject body weight. In some embodiments, the subject can be a mammal, preferably a human, a rodent, or a primate. In some embodiments, the subject is in need of the treatment.

[00205] In some embodiments, the method is for treating a hematopoietic cancer. In some embodiments, the method is for treating a myelodysplastic syndrome (MDS) and/or acute myeloid leukemia (AML). In some embodiments, the method is for treating at least one of lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL with MYD88 mutation, follicular lymphoma, or marginal zone lymphoma. In some embodiments, the method is for treating at least one cancer selected from glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, or one or more inflammatory diseases or autoimmune disease characterized by overactive IRAK1 and/or IRAK4, or combinations thereof. In some embodiments, the method is for treating one or more inflammatory diseases or autoimmune disease selected from chronic inflammation (i.e., associated with viral and bacterial infection), sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, or combinations thereof. In some embodiments, the method is for treating MDS, MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2, or the method is for treating AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or where the AML is not driven by FLT3 mutations but expresses IRAK4-Long. In some embodiments, the method is for treating DLBCL, and the DLBCL includes a L265P MYD88 mutant (ABC) subtype of DLBCL.

[00206] In some embodiments, the method further includes administration of a composition including a BTK inhibitor. In some embodiments, the BTK inhibitor includes ibrutinib.

[00207] In some embodiments, the subject is susceptible to AML and/or MDS, and/or the method prevents or ameliorates future AML and/or MDS. In some embodiments, the method occurs after one or more of having myelodysplastic syndrome, having myeloproliferative disease, an occurrence of chemical exposure, an exposure to ionizing radiation, or a treatment for cancer.

[00208] In some embodiments, the method further includes administration of a composition including a BCL2 inhibitor, or at least one of said compositions including a compound as described above further includes a BCL2 inhibitor. In some embodiments, the compound as described above and the BCL2 inhibitor may be administered together or separately, in one or more administrations of one or more compositions. In some embodiments, the BCL2 inhibitor includes venetoclax, or a salt, isomer, derivative or analog thereof.

[00209] In some embodiments, the method further includes administration of one or more additional therapy selected from one or more chemotherapy, DNA methyltransferase inhibitor/hypomethylating agent, anthracycline, histone deacetylase (HDAC) inhibitor, purine nucleoside analogue (antimetabolite), isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, antibody-drug conjugate, mAbs/immunotherapy, CAR-T cell therapy, Plk inhibitor, MEK inhibitor, CDK9 inhibitor, CDK8 inhibitor, retinoic acid receptor agonist, TP53 activator, smoothened receptor antagonist, ERK inhibitor, PI3K inhibitor, mTOR inhibitor, glucocorticoid receptor modulator, or EZH2 inhibitor, or one or more combinations thereof. In some embodiments, the DNA methyltransferase inhibitor/hypomethylating agent includes azacytidine, decitabine, cytarabine, and/or guadecitabine; the anthracycline includes daunorubicin, idarubicin, doxorubicin, mitoxantrone, epirubicin, and/or CPX-351 (a combination cytarabine and daunorubicin in a fixed 5:1 molar ratio); the histone deacetylase (HDAC) inhibitor includes vorinostat, panobinostat, valproic acid, and/or pracinostat; the purine nucleoside analogue (antimetabolite) includes fludarabine, cladribine, and/or clofarabine; the isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor includes ivosidenib and/or enasidenib; the antibody-drug conjugate includes Anti-CD33 (e.g. Ac225-lintuzumab, vadastuximab, or gemtuzumab-ozogamicin) and/or Anti-CD45 (e.g. I¹³¹-apamistamab); the mAbs/Immunotherapy includes Anti-

CD70 (e.g. ARGX-110, cusatuzumab), a bispecific antibody (e.g. floteuzumab (CD123 x CD3)), Anti-CTLA4 (e.g. ipilimumab), Anti-PD1/PDL1 (e.g. nivolumab, pembrolizumab, atezolizumab, avelumab, PDR001, MBG453), and/or Anti-CD47 (e.g. 5F9 (Magrolimab)); the Plk inhibitor includes volasertib and/or rigosertib; the MEK inhibitor includes trametinib, cobimetinib, selumetinib, pimasertib, and/or refametinib; the CDK9 inhibitor includes alvocidib and/or voruciclib; the CDK8 inhibitor includes SEL120; the retinoic acid receptor agonist includes ATRA (all-trans retinoic acid) and/or SY-1425 (a selective RAR α agonist); the TP53 activator includes APR-246 (Eprexetapopt); the smoothened receptor antagonist includes glasdegib; the ERK inhibitor includes an ERK2/MAPK1 or ERK1/MAPK3 inhibitor including ulixertinib, SCH772984, ravoxertinib, MK-8353, and/or VTX-11e; the PI3K inhibitor includes fimepinostat (CUDC-907), alpelisib, leniolisib (CDZ-173), pilaralisib (XL147, SAR245408), and/or bimiralisib (PQR-309); the mTOR inhibitor includes bimiralisib (PQR-309), sapanisertib (TAK-228, INK-128), ridaforolimus (MK-8669, AP-23573), everolimus, and/or vistusertib (AZD2014); the glucocorticoid receptor modulator includes an agonist including prednisolone, beclometasone, methylprednisolone, prednisone, fluticasone, budesonide, dexamethasone, and/or cortisol, and/or an antagonist including mifepristone, miricorilant, and/or onapristone, and/or another binding ligand including vamorolone (VBP15); and/or the EZH2 inhibitor includes tazemetostat.

[00210] Further embodiments of the disclosure relate to compounds as described above, for use in a method for treating a disease or disorder, the method including inhibiting at least one of IRAK and FLT3 by administering one or more compositions including the compound, where the compositions may be the same or different if there is more than one administration. In some embodiments, disease or disorder can be responsive to at least one of interleukin-1 receptor-associated kinase (IRAK) inhibition or fms-like tyrosine kinase 3 (FLT3) inhibition. In some embodiments, at least one of the one or more compositions further includes a formulary ingredient. In some embodiments, at least one of the one or more compositions includes the composition as described above. In some embodiments, at least one of the one or more administrations includes parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, transdermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration. In some embodiments, at least one of the one or more administrations includes an oral administration. In some embodiments, if there is more than one administration at least one

composition used for at least one administration is different from the composition of at least one other administration.

[00211] In some embodiments, the compound of at least one of the one or more compositions can be administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 50 mg /kg subject body weight. In some embodiments, the subject is a mammal, preferably a human, a rodent, or a primate. In some embodiments, the subject is in need of the treatment.

[00212] In some embodiments, the method is for treating a hematopoietic cancer. In some embodiments, the method is for treating MDS and/or AML. In some embodiments, the method is for treating at least one of lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL with MYD88 mutation, follicular lymphoma, or marginal zone lymphoma. In some embodiments, the method is for treating at least one cancer selected from glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, or one or more inflammatory diseases or autoimmune disease characterized by overactive IRAK1 and/or IRAK4, or combinations thereof. In some embodiments, the method is for treating one or more inflammatory diseases or autoimmune disease selected from chronic inflammation (i.e., associated with viral and bacterial infection), sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, or combinations thereof. In some embodiments, the method is for treating MDS, MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2, or the method is for treating AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or the AML is not driven by FLT3 mutations but expresses IRAK4-Long. In some embodiments, the method is for treating DLBCL, and the DLBCL includes a L265P MYD88 mutant (ABC) subtype of DLBCL.

[00213] In some embodiments, the method further includes administration of a composition including a BTK inhibitor. In some embodiments, the BTK inhibitor includes ibrutinib.

[00214] In some embodiments, the subject is susceptible to AML and/or MDS, and/or the method prevents or ameliorates future AML and/or MDS. In some embodiments, the method occurs after one or more of having myelodysplastic syndrome, having myeloproliferative disease, an occurrence of chemical exposure, an exposure to ionizing radiation, or a treatment for cancer. In some embodiments, method further includes administration of a composition including a BCL2 inhibitor, or at least one of said compositions including the compound of any of claims 1-39 further includes a BCL2 inhibitor. In some embodiments, the compound of any of claims 1-39 and the BCL2 inhibitor can be administered together or separately, in one or more administrations of one or more compositions. In some embodiments, the BCL2 inhibitor includes venetoclax, or a salt, isomer, derivative or analog thereof.

[00215] In some embodiments, the method further includes administration of one or more additional therapy selected from one or more chemotherapy, DNA methyltransferase inhibitor/hypomethylating agent, anthracycline, histone deacetylase (HDAC) inhibitor, purine nucleoside analogue (antimetabolite), isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, antibody-drug conjugate, mAbs/immunotherapy, CAR-T cell therapy, Plk inhibitor, MEK inhibitor, CDK9 inhibitor, CDK8 inhibitor, retinoic acid receptor agonist, TP53 activator, smoothened receptor antagonist, ERK inhibitor, PI3K inhibitor, mTOR inhibitor, glucocorticoid receptor modulator, or EZH2 inhibitor, or one or more combinations thereof. In some embodiments, the DNA methyltransferase inhibitor/hypomethylating agent includes azacytidine, decitabine, cytarabine, and/or guadecitabine; the anthracycline includes daunorubicin, idarubicin, doxorubicin, mitoxantrone, epirubicin, and/or CPX-351 (a combination cytarabine and daunorubicin in a fixed 5:1 molar ratio); the histone deacetylase (HDAC) inhibitor includes vorinostat, panobinostat, valproic acid, and/or pracinostat; the purine nucleoside analogue (antimetabolite) includes fludarabine, cladribine, and/or clofarabine; the isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor includes ivosidenib and/or enasidenib; the antibody-drug conjugate includes Anti-CD33 (e.g. Ac225-lintuzumab, vadastuximab, or gemtuzumab-ozogamicin) and/or Anti-CD45 (e.g. I¹³¹-apamistamab); the mAbs/Immunotherapy includes Anti-CD70 (e.g. ARGX-110, cusatuzumab), a bispecific antibody (e.g. floteuzumab (CD123 x CD3)),

Anti-CTLA4 (e.g. ipilimumab), Anti-PD1/PDL1 (e.g. nivolumab, pembrolizumab, atezolizumab, avelumab, PDR001, MBG453), and/or Anti-CD47 (e.g. 5F9 (Magrolimab)); the Plk inhibitor includes volasertib and/or rigosertib; the MEK inhibitor includes trametinib, cobimetinib, selumetinib, pimasertib, and/or refametinib; the CDK9 inhibitor includes alvocidib and/or voruciclib; the CDK8 inhibitor includes SEL120; the retinoic acid receptor agonist includes ATRA (all-trans retinoic acid) and/or SY-1425 (a selective RAR α agonist); the TP53 activator includes APR-246 (Eprexetapopt); the smoothened receptor antagonist includes glasdegib; the ERK inhibitor includes an ERK2/MAPK1 or ERK1/MAPK3 inhibitor including ulixertinib, SCH772984, ravoxertinib, MK-8353, and/or VTX-11e; wherein the PI3K inhibitor includes fimepinostat (CUDC-907), alpelisib, leniolisib (CDZ-173), pilaralisib (XL147, SAR245408), and/or bimiralisib (PQR-309); the mTOR inhibitor includes bimiralisib (PQR-309), sapanisertib (TAK-228, INK-128), ridaforolimus (MK-8669, AP-23573), everolimus, and/or vistusertib (AZD2014); the glucocorticoid receptor modulator includes an agonist including prednisolone, beclometasone, methylprednisolone, prednisone, fluticasone, budesonide, dexamethasone, and/or cortisol, and/or an antagonist including mifepristone, miricorilant, and/or onapristone, and/or another binding ligand including vamorolone (VBP15); and/or the EZH2 inhibitor includes tazemetostat.

[00216] In addition to their ability to inhibit IRAK, IRAK inhibitors have been demonstrated to have selectivity for multiple kinases. In some embodiments, compounds described herein according to Formula (I), such as Compounds 1-137, as listed in Tables 1-15, exhibit have inhibitory action against one or more kinase, such as interleukin-1 receptor-associated kinase (IRAK) and FMS-like tyrosine kinase 3 (FLT3). The inhibitory action against one or more kinase, such as IRAK and FLT3, can allow for treatment and/or prevention of diseases in an animal (e.g., mammals, porcine, canine, avian (e.g., chicken), bovine, feline, primates, rodents, monkeys, rabbits, mice, rats, and humans) using a compound of the disclosure (e.g., Formula (I)) including, but not limited to hematopoietic cancers (e.g., disorders of hematopoietic stem cells in the bone marrow or disorders related to myeloid lineage), MDS, AML, myeloproliferative disease, and diseases (e.g., hematopoietic cancers) related to mutations in IRAK1, IRAK4, and/or FLT3 (e.g., mutations in the juxtamembrane region of FLT3, mutations in the kinase domain of FLT3, FLT3 point mutations, FLT3 internal tandem duplication mutations, the FLT3-ITD mutation, the D835Y

FLT3 mutation, the D835V FLT3 mutation, the F691L FLT3 mutation, or the R834Q FLT3 mutation).

[00217] In some embodiments, the compounds of the disclosure can inhibit the activity of one or more of FLT3, mutations of FLT3 (e.g., mutations in the juxtamembrane region of FLT3, mutations in the kinase domain of FLT3, FLT3 point mutations, FLT3 internal tandem duplication mutations, the FLT3-ITD mutation, the D835Y FLT3 mutation, the D835V FLT3 mutation, the F691L FLT3 mutation, or the R834Q FLT3 mutation), IRAK4 (interleukin-1 receptor associated kinase 4), isoforms of IRAK4, mutations of IRAK4, IRAK1 (interleukin-1 receptor associated kinase 1), isoforms of IRAK1, and/or mutations of IRAK1. In some embodiments, the compounds of the disclosure can inhibit the activity of one or both of FLT3 and mutations of FLT3 (e.g., mutations in the juxtamembrane region of FLT3, mutations in the kinase domain of FLT3, FLT3 point mutations, FLT3 internal tandem duplication mutations, the FLT3-ITD mutation, the D835Y FLT3 mutation, the D835V FLT3 mutation, the F691L FLT3 mutation, or the R834Q FLT3 mutation) and optionally inhibits one or more of IRAK4, isoforms of IRAK4, mutations of IRAK4, IRAK1, isoforms of IRAK1, or mutations of IRAK1. In some embodiments, the compounds of the disclosure can inhibit the activity of one or both of FLT3 and mutations of FLT3 (e.g., mutations in the juxtamembrane region of FLT3, mutations in the kinase domain of FLT3, FLT3 point mutations, FLT3 internal tandem duplication mutations, the FLT3-ITD mutation, the D835Y FLT3 mutation, the D835V FLT3 mutation, the F691L FLT3 mutation, or the R834Q FLT3 mutation) and optionally inhibits one or both of IRAK4 and IRAK1, or an isoform or mutation thereof. In some embodiments, the compounds of the disclosure can inhibit FLT3 in combination with IRAK4, IRAK1, or with IRAK4 and IRAK1.

[00218] In some embodiments, compounds exhibit inhibitory activity against IRAK and/or FLT-3 with activities $\geq 1 \mu\text{M}$, e.g., about 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000 nM, or even greater. In some embodiments, the compounds exhibit inhibitory activity against IRAK and/or FLT-3 with activities between 0.1 nM and 1 nM, e.g., about 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 or 1.0 nM. In some embodiments, compounds described herein exhibit inhibitory activity against IRAK and/or FLT-3 with activities $\leq 0.1 \mu\text{M}$, e.g., about 1, 2, 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, or 100 nM. Ranges of values using a combination of any of the values recited herein as upper

and/or lower limits are also contemplated, for example, but not limited to, 1-10 nM, 10-100 nM, 1-100 nM, 0.1-1 nM, 0.1-100 nM, 0.1-200 nM, 1-200 nM, 10-200 nM, 100-200 nM, 200-500 nM, 0.1-500 nM, 1-500 nM, 10-500 nM, 500-1000 nM, 0.1-1000 nM, 1-1000 nM, 10-1000 nM, or 100-1000 nM. In some embodiments, the inhibitory activity is less than 0.1 nM, less than 1 nM, less than 10 nM, less than 100 nM, or less than 1000 nM. In some embodiments, the inhibitory activity is in the range of about 1-10 nM, 10-100 nM, 0.1-1 μ M, 1-10 μ M, 10-100 μ M, 100-200 μ M, 200-500 μ M, or even 500-1000 μ M. It is understood that for purposes of quantification, the terms “activity,” “inhibitory activity,” “biological activity,” “IRAK activity,” “IRAK1 activity,” “IRAK4 activity,” “FLT-3 activity,” and the like in the context of an inhibitory compound disclosed herein can be quantified in a variety of ways known in the art. Unless indicated otherwise, as used herein such terms refer to IC₅₀ in the customary sense (i.e., concentration to achieve half-maximal inhibition).

[00219] In some embodiments, hematopoietic cancers that can be treated in an animal (e.g., mammals, porcine, canine, avian (e.g., chicken), bovine, feline, primates, rodents, monkeys, rabbits, mice, rats, and humans) using a compound of the disclosure (e.g., Formula (I)) include, but are not limited to hematopoietic cancers and cancers of the myeloid line of blood cells, cancers with an increased risk of occurrence due to other blood disorders, cancers with an increased risk of occurrence due to chemical exposure (e.g., anti-cancer therapies or occupational chemical exposure), cancers with an increased risk of occurrence due to ionizing radiation (e.g., anti-cancer therapies), cancers evolving from myelodysplastic syndromes, cancers evolving from myeloproliferative disease, and cancers of the B cells.

[00220] In some embodiments, hematopoietic cancers that can be treated include, but are not limited to, MDS, AML, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom’s macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL) (e.g. ABC DLBCL with MYD88 mutation (e.g., L265P)), follicular lymphoma, or marginal zone lymphoma, or combinations thereof.

[00221] In some embodiments, cancers characterized by dysregulated IRAK expression (IRAK1 and/or IRAK4) and/or IRAK-mediated intracellular signaling, can be treated, and include, but are not limited to, glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma,

thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, and the like, and combinations thereof.

[00222] In some embodiments, compounds of the present disclosure can be used to inhibit targets in the context of additional conditions characterized by overactive IRAK1 and/or IRAK4. According to particular aspects of the disclosure, compounds of the present disclosure can be used to inhibit overactive IRAK1 and/or IRAK4 in conditions such as inflammatory diseases and autoimmune disease, wherein said inflammatory diseaess and autoimmune diseases are characterized by overactive IRAK1 and/or IRAK4. In some embodiments, inflammatory and autoimmune diseases characterized by dysregulated (e.g., hyperactive) IRAK expression (IRAK1 and/or IRAK4) and/or IRAK-meidated intracellular signaling, can be treated, and include, but are not limited to, chronic inflammation (i.e., associated with viral and bacterial infection), sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, and the like, and combinations thereof.

[00223] In certain embodiments, MDS that can be treated in a subject (e.g., mammals, porcine, canine, avian (e.g., chicken), bovine, feline, primates, rodents, monkeys, rabbits, mice, rats, and humans) using a compound of the disclosure (e.g., Formula (I)) include but are not limited to MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2, refractory cytopenia with unilineage dysplasia (e.g., refractory anemia, refractory neutropenia, and refractory thrombocytopenia), refractory anemia with ring sideroblasts, refractory cytopenia with multilineage dysplasia (e.g., refractory cytopenia with multilineage dysplasia and ring sideroblasts and animals/humans with pathological changes not restricted to red cells such as prominent white cell precursor and platelet precursor (megakaryocyte) dysplasia), refractory anemias with excess blasts I and II, 5q-syndrome, megakaryocyte dysplasia with fibrosis, and refractory cytopenia of childhood. In some embodiments, MDS that can be treated include, but are not limited to, MDS that is inherited, MDS with an increased risk of occurrence due to an inherited predisposition, MDS with an increased risk of occurrence due to other blood disorders, MDS with an increased risk of occurrence due to chemical exposure, MDS with an increased risk of occurrence due to

ionizing radiation, MDS with an increased risk of occurrence due to cancer treatment (e.g., a combination of radiation and the radiomimetic alkylating agents such as busulfan, nitrosourea, or procarbazine (with a latent period of 5 to 7 years) or DNA topoisomerase inhibitors), MDS evolving from acquired aplastic anemia following immunosuppressive treatment and Fanconi's anemia, MDS with an increased risk due to an mutation in splicing factors, MDS with an increased risk due to a mutation in isocitrate dehydrogenase 1, and MDS with an increased risk due to a mutation in isocitrate dehydrogenase 2. Animals that can be treated include but are not limited to mammals, rodents, primates, monkeys (e.g., macaque, rhesus macaque, pig tail macaque), humans, canine, feline, porcine, avian (e.g., chicken), bovine, mice, rabbits, and rats. In the methods, the term “subject” may refer to both human and non-human subjects. In some instances, the subject is in need of the treatment (e.g., by showing signs of disease, e.g. MDS, AML, cancer, autoimmune disease, inflammatory condition, etc., or by having a low blood cell count).

[00224] In some embodiments, MDS that can be treated in a subject (e.g., mammals, porcine, canine, avian (e.g., chicken), bovine, feline, primates, rodents, monkeys, rabbits, mice, rats, and humans) using a compound of the disclosure (e.g., Formula (I)) include, but are not limited to MDS that can be treated by inhibiting one or more of FLT3 (e.g., using FLT3 inhibitors), mutations of FLT3 (e.g., using inhibitors of FLT3 mutants), IRAK4 (e.g., using IRAK4 inhibitors), mutations of IRAK4 (e.g., using inhibitors of IRAK4 mutants), IRAK1 (e.g., using IRAK 1 inhibitors), and/or mutations of IRAK1 (e.g., using inhibitors of IRAK1 mutant). In certain embodiments, MDS that can be treated include, but are not limited to MDS that can be treated by inhibiting IRAK4 (or its mutations), MDS that can be treated by inhibiting and IRAK1 (or its mutations), or MDS that can be treated by inhibiting IRAK4 (or its mutations) and IRAK1 (or its mutations). In some embodiments, MDS that can be treated include, but are not limited to MDS that can be treated by inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1. In some embodiments, inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1 provides for treating tumors with FLT3 mutations, which can be or become resistant to FLT3 inhibitors due to adaptive resistance mechanism(s), e.g., driven by IRAK. In some embodiments, MDS that can be treated is characterized by MDS having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the MDS is not driven by FLT3 mutations but expresses IRAK4-Long, based on the use of IRAK4L and the ratio of IRAK4L to IRAK4S (e.g. as described in U.S. Patent Application No. 16/339,692; and Smith, M.

A., et al. (2019). “U2AF1 mutations induce oncogenic IRAK4 isoforms and activate innate immune pathways in myeloid malignancies.” Nat Cell Biol **21**(5): 640-650. DOI: 10.1038/s41556-019-0314-5, both incorporated by reference herein in their entirety).

[00225] In some embodiments, AML that can be treated in a subject (e.g., mammals, porcine, canine, avian (e.g., chicken), bovine, feline, primates, rodents, monkeys, rabbits, mice, rats, and humans) using a compound of the disclosure (e.g., Formula (I)) include, but are not limited to AML that is inherited, AML with an increased risk of occurrence due to an inherited predisposition, AML with one or more recurrent genetic abnormality (e.g., with inversions or translocations, such as MLLT3/MLL which is a translocation between chromosome 9 and 11 (“MLL”) AML with translocation between chromosomes 8 and 21, AML with translocation or inversion in chromosome 16, AML with translocation between chromosomes 9 and 11, APL (M3) with translocation between chromosomes 15 and 17, AML with translocation between chromosomes 6 and 9, AML with translocation or inversion in chromosome 3, and the like), AML (megakaryoblastic) with a translocation between chromosomes 1 and 22, AML with myelodysplasia-related changes, AML related to previous chemotherapy or radiation (such as, for example, alkylating agent-related AML, topoisomerase II inhibitor-related AML, and the like), AML not otherwise categorized (does not fall into above categories - similar to FAB classification; such as, for example, AML minimally differentiated (M0), AML with minimal maturation (M1), AML with maturation (M2), acute myelomonocytic leukemia (M4), acute monocytic leukemia (M5), acute erythroid leukemia (M6), acute megakaryoblastic leukemia (M7), acute basophilic leukemia, acute panmyelosis with fibrosis, and the like), myeloid sarcoma (also known as granulocytic sarcoma, chloroma or extramedullary myeloblastoma), undifferentiated and biphenotypic acute leukemias (also known as mixed phenotype acute leukemias), AML with an increased risk of occurrence due to other blood disorders, AML with an increased risk of occurrence due to chemical exposure, AML with an increased risk of occurrence due to ionizing radiation, AML evolving from myelodysplastic syndromes, AML evolving from myeloproliferative disease, AML with an increased risk due to an FLT3 mutation, AML with an increased risk due to an FLT3 mutation in the juxtamembrane region of FLT3, AML with an increased risk due to an FLT3 mutation of an internal tandem duplication in the juxtamembrane region of FLT3, AML with an increased risk due to an FLT3 mutation in the kinase domain of FLT3, AML with an increased risk due to the FLT3 mutation D835Y, AML with an increased risk

due to the FLT3 mutation D835V, AML with an increased risk due to the FLT3 mutation F691L, and AML with an increased risk due to the FLT3 mutation R834Q, and the like. In some embodiments, AML that can be treated include AML that by inhibiting one or more of FLT3 (e.g., using FLT3 inhibitors), mutations of FLT3 (e.g., using inhibitors of FLT3 mutants), IRAK4 (e.g., using IRAK4 inhibitors), mutations of IRAK4 (e.g., using inhibitors of IRAK4 mutants), IRAK1 (e.g., using IRAK 1 inhibitors), and/or mutations of IRAK1 (e.g., using inhibitors of IRAK1 mutant). In certain embodiments, AML that can be treated include, but are not limited to AML that can be treated by inhibiting IRAK4 (or its mutations), MDS that can be treated by inhibiting and IRAK1 (or its mutations), or AML that can be treated by inhibiting IRAK4 (or its mutations) and IRAK1 (or its mutations). In some embodiments, AML that can be treated include, but are not limited to AML that can be treated by inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1. In some embodiments, inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1 provides for treating tumors with FLT3 mutations which can be or become resistant to FLT3 inhibitors due to adaptive resistance mechanism(s), e.g. driven by IRAK. In some embodiments, AML that can be treated is characterized by AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the AML is not driven by FLT3 mutations but expresses IRAK4-Long, based on the use of IRAK4L and the ratio of IRAK4L to IRAK4S (e.g. as described in U.S. Patent Application No. 16/339,692; and Smith, M. A., et al. (2019). “U2AF1 mutations induce oncogenic IRAK4 isoforms and activate innate immune pathways in myeloid malignancies.” Nat Cell Biol **21**(5): 640-650. DOI: 10.1038/s41556-019-0314-5, both incorporated by reference herein in their entirety).

[00226] In some embodiments, hematopoietic cancers that can be treated in a subject (e.g., mammals, porcine, canine, avian (e.g., chicken), bovine, feline, primates, rodents, monkeys, rabbits, mice, rats, and humans) using a compound of the disclosure (e.g., Formula (I)) include, but are not limited to hematopoietic cancers (e.g. MDS, AML, DLBCL, and the like, as described previously) that can be treated by inhibiting (e.g., reducing the activity or expression of) one or more of FLT3 (e.g., using FLT3 inhibitors), mutations of FLT3 (e.g., using inhibitors of FLT3 mutants), IRAK4 (e.g., using IRAK4 inhibitors), isoforms of IRAK4, mutations of IRAK4 (e.g., using inhibitors of IRAK4 mutants), IRAK1 (e.g., using IRAK 1 inhibitors), isoforms of IRAK1, or mutations of IRAK1 (e.g., using inhibitors of IRAK1 mutants). In certain embodiments, hematopoietic cancers that can be treated include, but are not limited to cancers that can be treated

by inhibiting (e.g., reducing the activity or expression of) FLT3 (or its mutations) and IRAK4 (or its mutations), hematopoietic cancers that can be treated by inhibiting (e.g., reducing the activity or expression of) FLT3 (or its mutations) and IRAK1 (or its mutations), or hematopoietic cancers that can be treated by inhibiting (e.g., reducing the activity or expression of) FLT3 (or its mutations), IRAK4 (or its isoforms or mutations), and IRAK1 (or its isoforms or mutations). In some embodiments, hematopoietic cancer that can be treated include, but are not limited to hematopoietic cancer that can be treated by inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1. In some embodiments, inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1 provides for treating tumors with FLT3 mutations which can be or become resistant to FLT3 inhibitors due to adaptive resistance mechanism(s), e.g. driven by IRAK. In some embodiments, hematopoietic cancer that can be treated is characterized by hematopoietic cancer having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the hematopoietic cancer is not driven by FLT3 mutations but expresses IRAK4-Long, based on the use of IRAK4L and the ratio of IRAK4L to IRAK4S (e.g. as described in U.S. Patent Application No. 16/339,692; and Smith, M. A., et al. (2019). "U2AF1 mutations induce oncogenic IRAK4 isoforms and activate innate immune pathways in myeloid malignancies." Nat Cell Biol **21**(5): 640-650. DOI: 10.1038/s41556-019-0314-5, both incorporated by reference herein in their entirety).

[002271] In some embodiments, cancers that can be treated include, but are not limited to, glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, and the like, and combinations thereof, that can be treated by inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1. In some embodiments, inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1 provides for treating tumors with FLT3 mutations which can be or become resistant to FLT3 inhibitors due to adaptive resistance mechanism(s), e.g., driven by IRAK. In some embodiments, cancer that can be treated is characterized by cancer having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the cancer is not driven by FLT3 mutations but expresses IRAK4-Long, based on the use of IRAK4L

and the ratio of IRAK4L to IRAK4S (e.g. as described in U.S. Patent Application No. 16/339,692; and Smith, M. A., et al. (2019). “U2AF1 mutations induce oncogenic IRAK4 isoforms and activate innate immune pathways in myeloid malignancies.” *Nat Cell Biol* **21**(5): 640-650. DOI: 10.1038/s41556-019-0314-5, both incorporated by reference herein in their entirety).

[00228] In some embodiments, inflammatory and autoimmune diseases characterized by dysregulated (e.g., hyperactive) IRAK expression (IRAK1 and/or IRAK4) and/or IRAK-mediated intracellular signaling, that can be treated include, but are not limited to, chronic inflammation (i.e., associated with viral and bacterial infection), sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren’s syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, and the like, and combinations thereof, that can be treated by inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1. In some embodiments, inhibiting FLT3 in combination with IRAK4, IRAK1, or both IRAK4 and IRAK1 provides for treating inflammatory and autoimmune diseases with FLT3 mutations which can be or become resistant to FLT3 inhibitors due to adaptive resistance mechanism(s), e.g., driven by IRAK. In some embodiments, inflammatory and autoimmune disease that can be treated is characterized by inflammatory and autoimmune disease having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the inflammatory and autoimmune disease is not driven by FLT3 mutations but expresses IRAK4-Long, based on the use of IRAK4L and the ratio of IRAK4L to IRAK4S (e.g. as described in U.S. Patent Application No. 16/339,692; and Smith, M. A., et al. (2019). “U2AF1 mutations induce oncogenic IRAK4 isoforms and activate innate immune pathways in myeloid malignancies.” *Nat Cell Biol* **21**(5): 640-650. DOI: 10.1038/s41556-019-0314-5, both incorporated by reference herein in their entirety).

[00229] As related to treating MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2), treating can include but is not limited to prophylactic treatment and therapeutic treatment. As such, treatment can include, but is not limited to: preventing MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); reducing the risk of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); ameliorating or relieving symptoms of MDS (e.g., MDS with a splicing factor

mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); eliciting a bodily response against MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); inhibiting the development or progression of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); inhibiting or preventing the onset of symptoms associated with MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); reducing the severity of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); causing a regression of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2) or one or more of the symptoms associated with MDS (e.g., an increase in blood cell count); causing remission of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); causing remission of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2) by preventing or minimizing FLT3 mutations (e.g., internal tandem duplication mutations or the D835Y mutation); preventing relapse of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); or preventing relapse of MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2) in animals/humans that have intrinsic or acquired resistance to other MDS treatments. In some embodiments, treating does not include prophylactic treatment of MDS (e.g., preventing or ameliorating future MDS).

[00230] As related to treating hematopoietic cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, or Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation (e.g., ABC DLBCL with MYD88 mutation L265P), follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like), treating can include but is not limited to prophylactic treatment and therapeutic treatment. As such, treatment

can include, but is not limited to: preventing cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, or Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); reducing the risk of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, or Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); ameliorating or relieving symptoms of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, or Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); eliciting a bodily response against cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, or Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); inhibiting the development or progression of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, or Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); inhibiting or preventing the onset of symptoms associated with cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, or Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); reducing the severity of cancer (e.g., acute myeloid leukemia, lymphoma,

leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); causing a regression of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like) or one or more of the symptoms associated with cancer (e.g., a decrease in tumor size); causing remission of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); causing remission of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like) by preventing or minimizing FLT3 mutations (e.g., internal tandem duplication mutations or the D835Y mutation); causing remission of acute myeloid leukemia by preventing or minimizing FLT3 mutations (e.g., internal tandem duplication mutations or the D835Y mutation); preventing relapse of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like); preventing relapse of cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88

mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like) in animals/humans that have intrinsic or acquired resistance to other cancer treatments (e.g., from some FLT3 inhibitors or from MLL); or preventing relapse of acute myeloid leukemia in animals/humans that have intrinsic or acquired resistance to other cancer treatments (e.g., from some FLT3 inhibitors or from MLL). In some embodiments, treating does not include prophylactic treatment of cancer (e.g., preventing or ameliorating future cancer).

[00231] Treatment of a subject can occur using any suitable administration method (such as those disclosed herein) and using any suitable amount of a compound of the disclosure (e.g., Formula (I)). In some embodiments, methods of treatment comprise treating an animal or human for MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2). In some embodiments, methods of treatment comprise treating an animal or human for a hematopoietic cancer (e.g., acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like). Other embodiments include treatment after one or more of having a blood disorder, having myelodysplastic syndrome, having myeloproliferative disease, an occurrence of chemical exposure, an exposure to ionizing radiation, or a treatment for a hematopoietic cancer (e.g., with chemotherapy, ionizing radiation, or both). Some embodiments of the disclosure include a method for treating a subject (e.g., an animal such as a human or primate) with a composition comprising a compound of the disclosure (e.g., Formula (I)) (e.g., a pharmaceutical composition) which comprises one or more administrations of one or more such compositions; the compositions may be the same or different if there is more than one administration.

[00232] In some embodiments, the method of treatment includes administering to a subject an effective amount of a composition comprising a compound of the disclosure (e.g., Formula (I)). As used herein, the term "effective amount" refers to a dosage or a series of dosages sufficient to affect treatment (e.g., to treat MDS such as but not limited to MDS (e.g., MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, or MDS with a mutation in isocitrate dehydrogenase 2); or to treat a hematopoietic cancer, such as but not limited

to acute myeloid leukemia, lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL MYD88 mutation, follicular lymphoma, or marginal zone lymphoma, and combinations thereof, and the like) in a subject. In some embodiments, an effective amount can encompass a therapeutically effective amount, as disclosed herein. In certain embodiments, an effective amount can vary depending on the subject and the particular treatment being affected. The exact amount that is required can, for example, vary from subject to subject, depending on the age and general condition of the subject, the particular adjuvant being used (if applicable), administration protocol, and the like. As such, the effective amount can, for example, vary based on the particular circumstances, and an appropriate effective amount can be determined in a particular case. An effective amount can, for example, include any dosage or composition amount disclosed herein. In some embodiments, an effective amount of at least one compound of the disclosure (e.g., Formula (I) such as but not limited to Compounds 1-137, as listed in Tables 1-15) (which can be administered to a subject such as mammals, primates, monkeys or humans) can be an amount of about 0.005 to about 50 mg/kg body weight, about 0.01 to about 15 mg/kg body weight, about 0.1 to about 10 mg/kg body weight, about 0.5 to about 7 mg/kg body weight, about 0.005 mg/kg, about 0.01 mg/kg, about 0.05 mg/kg, about 0.1 mg/kg, about 0.5 mg/kg, about 1 mg/kg, about 3 mg/kg, about 5 mg/kg, about 5.5 mg/kg, about 6 mg/kg, about 6.5 mg/kg, about 7 mg/kg, about 7.5 mg/kg, about 8 mg/kg, about 10 mg/kg, about 12 mg/kg, or about 15 mg/kg. In regard to some embodiments, the dosage can be about 0.5 mg/kg body weight or about 6.5 mg/kg body weight. In some instances, an effective amount of at least one compound of the disclosure (e.g., Formula (I) such as but not limited to Compounds 1-137, as listed in Tables 1-15) (which can be administered to a subject such as mammals, rodents, mice, rabbits, feline, porcine, or canine) can be an amount of about 0.005 to about 50 mg/kg body weight, about 0.01 to about 15 mg/kg body weight, about 0.1 to about 10 mg/kg body weight, about 0.5 to about 7 mg/kg body weight, about 0.005 mg/kg, about 0.01 mg/kg, about 0.05 mg/kg, about 0.1 mg/kg, about 1 mg/kg, about 5 mg/kg, about 10 mg/kg, about 20 mg/kg, about 30 mg/kg, about 40 mg/kg, about 50 mg/kg, about 80 mg/kg, about 100 mg/kg, or about 150 mg/kg. In some embodiments, an effective amount of at least one compound of the disclosure (e.g., Formula (I) such as but not limited to Compounds 1-1137, as listed in Tables 1-15) (which can be administered to an animal such as mammals,

primates, monkeys or humans) can be an amount of about 1 to about 1000 mg/kg body weight, about 5 to about 500 mg/kg body weight, about 10 to about 200 mg/kg body weight, about 25 to about 100 mg/kg body weight, about 1 mg/kg, about 2 mg/kg, about 5 mg/kg, about 10 mg/kg, about 25 mg/kg, about 50 mg/kg, about 100 mg/kg, about 150 mg/kg, about 200 mg/kg, about 300 mg/kg, about 400 mg/kg, about 500 mg/kg, about 600 mg/kg, about 700 mg/kg, about 800 mg/kg, about 900 mg/kg, or about 1000 mg/kg. In regard to some conditions, the dosage can be about 20 mg/kg human body weight or about 100 mg/kg human body weight. In some instances, an effective amount of at least one compound of the disclosure (e.g., Formula (I) such as but not limited to Compounds 1-137, as listed in Tables 1-15) (which can be administered to an animal such as mammals, rodents, mice, rabbits, feline, porcine, or canine) can be an amount of about 1 to about 1000 mg/kg body weight, about 5 to about 500 mg/kg body weight, about 10 to about 200 mg/kg body weight, about 25 to about 100 mg/kg body weight, about 1 mg/kg, about 2 mg/kg, about 5 mg/kg, about 10 mg/kg, about 25 mg/kg, about 50 mg/kg, about 100 mg/kg, about 150 mg/kg, about 200 mg/kg, about 300 mg/kg, about 400 mg/kg, about 500 mg/kg, about 600 mg/kg, about 700 mg/kg, about 800 mg/kg, about 900 mg/kg, or about 1000 mg/kg.

[00233] In some embodiments, the treatments can also include one or more of surgical intervention, chemotherapy, radiation therapy, hormone therapies, immunotherapy, and adjuvant systematic therapies. Adjuvants may include but are not limited to chemotherapy (e.g., temozolomide), radiation therapy, antiangiogenic therapy (e.g., bevacizumab), and hormone therapies, such as administration of LHRH agonists; anti-estrogens, such as tamoxifen; high-dose progestogens; aromatase inhibitors; and/or adrenalectomy. Chemotherapy can be used as a single-agent or as a combination with known or new therapies.

[00234] In some embodiments, the administration to a subject of at least one compound of the disclosure (e.g., Formula (I)) is an adjuvant cancer therapy or part of an adjuvant cancer therapy. Adjuvant treatments include treatments by the mechanisms disclosed herein and of cancers as disclosed herein, including, but not limited to tumors. Corresponding primary therapies can include, but are not limited to, surgery, chemotherapy, or radiation therapy. In some instances, the adjuvant treatment can be a combination of chemokine receptor antagonists with traditional chemotoxic agents or with immunotherapy that increases the specificity of treatment to the cancer and potentially limits additional systemic side effects. In still other embodiments, a compound of the disclosure (e.g., Formula (I)) can be used as adjuvant with other

chemotherapeutic agents. The use of a compound of the disclosure (e.g., Formula (I)) may, in some instances, reduce the duration of the dose of both drugs and drug combinations reducing the side effects.

[00235] In some embodiments, the administration to a subject may decrease the incidence of one or more symptoms associated with MDS / AML / a type of hematopoietic cancer. In some embodiments, the administration may decrease marrow failure, immune dysfunction, transformation to overt leukemia, or combinations thereof in said subject, as compared to a subject not receiving said composition.

[00236] In some embodiments, the method may decrease a marker of viability of MDS cells AML cells, or cancer cells in a subject. In one aspect, the method may decrease a marker of viability of MDS, AML, and/or cancer cells. The marker may be selected from survival over time, proliferation, growth, migration, formation of colonies, chromatic assembly, DNA binding, RNA metabolism, cell migration, cell adhesion, inflammation, or a combination thereof.

Combination Therapies

[00237] In some embodiments, the treatments disclosed herein can include use of other drugs (e.g., antibiotics) or therapies for treating disease, e.g. MDS / AML / a type of hematopoietic cancer. For example, antibiotics can be used to treat infections and can be combined with a compound of the disclosure to treat disease (e.g., infections). In other embodiments, intravenous immunoglobulin (IVIG) therapy can be used as part of the treatment regime (i.e., in addition to administration of the compound(s) of the disclosure). For example, treatment regimens for various types of cancers can involve one or more elements selected from chemotherapy, targeted therapy, alternative therapy, immunotherapy, and the like.

[00238] Accordingly, in some embodiments, the compounds and/or compositions described herein can be used in one or more administrations to a subject, in combination with one or more BCL2 inhibitor, BTK inhibitor, chemotherapy, targeted therapy, alternative therapy, immunotherapy, DNA methyltransferase inhibitor/hypomethylating agent, anthracycline, histone deacetylase (HDAC) inhibitor, purine nucleoside analogue (antimetabolite), isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, antibody-drug conjugate, mAbs/immunotherapy, CAR-T cell therapy, Plk inhibitor, MEK inhibitor, CDK9 inhibitor, CDK8 inhibitor, retinoic acid receptor agonist, TP53 activator, smoothened receptor antagonist, ERK inhibitor, PI3K inhibitor, mTOR inhibitor, glucocorticoid receptor modulator, or EZH2 inhibitor,

and the like, or one or more combinations thereof, where the compositions may be the same or different if there is more than one administration. In some embodiments, if there is more than one administration at least one composition used for at least one administration is different from the composition of at least one other administration.

[00239] In particular, IRAK inhibitors have been demonstrated to have synergistic effects when administered in combination with an apoptosis modulator/inhibitor, such as a BCL2 inhibitor. As described in U.S. Patent Application No. 16/804,518 (incorporated herein by reference in its entirety), an exemplary apoptosis/BCL2 inhibitor has been shown to have a synergistic effect when used in combination with an exemplary IRAK inhibitor in multiple AML cell lines. Venetoclax was used as a representative apoptosis/BCL2 inhibitor.

[00240] When a concentration of an exemplary IRAK inhibitor was combined with venetoclax, the potency of venetoclax was increased by an unexpectedly high ~50-fold. According to particular aspects of the disclosure, this synergistic combination allows for increased efficacy of venetoclax at lower doses, to provide for avoiding at least some of the toxicity observed in the clinic. According to particular aspects, the degree of interaction is dependent on the dose ratio combination that is used, with lower concentrations of the exemplary IRAK inhibitor providing larger shifts in the venetoclax IC₅₀. This unexpected and dramatic shift in the venetoclax IC₅₀ is substantially more than an additive response and demonstrates the unexpected synergistic interaction of the two drugs even in cell lines that do not express activated FLT3 mutants.

[00241] Accordingly, the present disclosure encompasses methods for treating a disease or disorder which is responsive to inhibition of IRAK, comprising administration to a subject of a composition comprising an IRAK inhibiting compound, wherein some embodiments of the method can further involve administration of an apoptotic modulator. The apoptotic modulator may comprise a BTK and/or a BCL2 inhibitor. BTK and BCL2 inhibitors may be, for example, those known in the art. In some embodiments, the method may comprise the step of administering to the subject an apoptotic modulator. In some embodiments, the apoptotic modulator may comprise a BCL2 inhibitor selected from ABT-263 (Navitoclax), ABT-737, ABT-199 (venetoclax), GDC-0199, GX15-070 (Obatoclax) (all available from Abbott Laboratories), HA14-1, S1, 2-methoxy antimycin A3, gossypol, AT-101, apogossypol, WEHI-539, A-1155463, BXI-61, BXI-72, TW37, MIM1, UMI-77, and the like, and combinations thereof. One skilled in the art would appreciate that there are many known BCL2 inhibitors which can be used in

accordance with the present disclosure. In some embodiments, the BCL2 inhibitor comprises venetoclax.

[00242] In some embodiments, the administration step comprises administration to a subject of a composition comprising an IRAK inhibiting compound and a BCL2 inhibitor. In some embodiments, the administration step comprises administration of a composition comprising an IRAK inhibiting compound in combination with a composition comprising a BCL2 inhibitor.

[00243] In some embodiments, the IRAK inhibiting compound is selected from Compounds 1-137, or a salt, isomer, derivative or analog thereof, and the BCL2 inhibitor is venetoclax, or a salt, isomer, derivative or analog thereof.

[00244] In some embodiments, the method can further involve administration to a subject of an immune modulator. The immune modulator can include, for example, Lenalidomide (Revlamid; Celgene Corporation). In some embodiments, the method can involve administration of an epigenetic modulator. The epigenetic modulator can include, for example, a hypomethylating agent such as azacitidine, decitabine, or a combination thereof.

[00245] In some embodiments, the compounds and/or compositions described herein can be used in one or more administrations to a subject, together with or in combination with one or more BTK inhibitor, such as, for example, ibrutinib, or a salt, isomer, derivative or analog thereof.

[00246] For example, the compounds and/or compositions described herein can be used in one or more administrations, together with or in combination with a DNA methyltransferase inhibitor/hypomethylating agent, such as, for example, azacytidine, decitabine, cytarabine, and/or guadecitabine; an anthracycline, such as, for example, daunorubicin, idarubicin, doxorubicin, mitoxantrone, epirubicin, and/or CPX-351 (a combination cytarabine and daunorubicin in a fixed 5:1 molar ratio), and the like; a histone deacetylase (HDAC) inhibitor, such as, for example, vorinostat, panobinostat, valproic acid, and/or pracinostat, and the like; a purine nucleoside analogue (antimetabolite), such as, for example, fludarabine, cladribine, and/or clofarabine, and the like; an isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, such as, for example, ivosidenib and/or enasidenib, and the like; an antibody-drug conjugate, such as, for example, Anti-CD33 (e.g. Ac225-lintuzumab, vadastuximab, or gemtuzumab-ozogamicin) and/or Anti-CD45 (e.g. I¹³¹-apamistamab), and the like; an mAbs/Immunotherapy, such as, for example, Anti-CD70 (e.g. ARGX-110, cusatuzumab), a bispecific antibody (e.g. floteuzumab

(CD123 x CD3)), Anti-CTLA4 (e.g. ipilimumab), Anti-PD1/PDL1 (e.g. nivolumab, pembrolizumab, atezolizumab, avelumab, PDR001, MBG453), and/or Anti-CD47 (e.g. 5F9 (Magrolimab)), and the like; a Plk inhibitor, such as, for example, volasertib and/or rigosertib, and the like; a MEK inhibitor, such as, for example, trametinib, cobimetinib, selumetinib, pimasertib, and/or refametinib, and the like; a CDK9 inhibitor, such as, for example, alvocidib and/or voruciclib, and the like; a CDK8 inhibitor, such as, for example, SEL120, and the like; a retinoic acid receptor agonist, such as, for example, ATRA (all-trans retinoic acid) and/or SY-1425 (a selective RAR α agonist), and the like; a TP53 activator, such as, for example, APR-246 (Eprexetapopt), and the like; a smoothened receptor antagonist, such as, for example, glasdegib, and the like; an ERK inhibitor, such as, for example, an ERK2/MAPK1 or ERK1/MAPK3 inhibitor, such as, for example, ulixertinib, SCH772984, ravoxertinib, MK-8353, and/or VTX-11e, and the like; a PI3K inhibitor, such as, for example, fimepinostat (CUDC-907), alpelisib, leniolisib (CDZ-173), pilaralisib (XL147, SAR245408), and/or bimiralisib (PQR-309), and the like; an mTOR inhibitor, such as, for example, bimiralisib (PQR-309), sapanisertib (TAK-228, INK-128), ridaforolimus (MK-8669, AP-23573), everolimus, and/or vistusertib (AZD2014), and the like; a glucocorticoid receptor modulator, such as, for example, an agonist comprising prednisolone, beclometasone, methylprednisolone, prednisone, fluticasone, budesonide, dexamethasone, and/or cortisol, and/or an antagonist comprising mifepristone, miricorilant, and/or onapristone, and/or another binding ligand comprising vamorolone (VBP15), and the like; and/or an EZH2 inhibitor, such as, for example, tazemetostat, and the like. In some embodiments, compounds and pharmaceutical compositions including the same can be used in prevention of secondary malignancies when used in combination with an EZH2 inhibitor. Further therapies are described below and are contemplated in combination therapies in the context of the present disclosure.

Chemotherapy / Targeted Therapy / Alternative Therapy

[00247] Cancers are commonly treated with chemotherapy and/or targeted therapy and/or alternative therapy. Chemotherapies act by indiscriminately targeting rapidly dividing cells, including healthy cells as well as tumor cells, whereas targeted cancer therapies rather act by interfering with specific molecules, or molecular targets, which are involved in cancer growth and progression. Targeted therapy generally targets cancer cells exclusively, having minimal damage to normal cells. Chemotherapies and targeted therapies which are approved and/or in the clinical

trial stage are known to those skilled in the art. Any such compound can be utilized in the practice of the present disclosure.

[00248] For example, approved chemotherapies include abitrexate (Methotrexate Injection), abraxane (Paclitaxel Injection), adcetris (Brentuximab Vedotin Injection), adriamycin (Doxorubicin), adrucil Injection (5-FU (fluorouracil)), afinitor (Everolimus), afinitor Disperz (Everolimus), alimta (PEMETREXED), alkeran Injection (Melphalan Injection), alkeran Tablets (Melphalan), aredia (Pamidronate), arimidex (Anastrozole), aromasin (Exemestane), arranon (Nelarabine), arzerra (Ofatumumab Injection), avastin (Bevacizumab), beleodaq (Belinostat Injection), bexxar (Tositumomab), BiCNU (Carmustine), blenoxane (Bleomycin), blincyto (Blinatumoma b Injection), bosulif (Bosutinib), busulfex Injection (Busulfan Injection), campath (Alemtuzumab), camptosar (Irinotecan), caprelsa (Vandetanib), casodex (Bicalutamide), CeeNU (Lomustine), CeeNU Dose Pack (Lomustine), cerubidine (Daunorubicin), clolar (Clofarabine Injection), cometriq (Cabozantinib), cosmegen (Dactinomycin), cotellic (Cobimetinib), cyramza (Ramucirumab Injection), cytosarU (Cytarabine), cytoxan (Cytoxan), cytoxan Injection (Cyclophosphamide Injection), dacogen (Decitabine), daunoXome (Daunorubicin Lipid Complex Injection), decadron (Dexamethasone), depoCyt (Cytarabine Lipid Complex Injection), dexamethasone Intensol (Dexamethasone), dexpak Taperpak (Dexamethasone), docefrez (Docetaxel), doxil (Doxorubicin Lipid Complex Injection), droxia (Hydroxyurea), DTIC (Decarbazine), eligard (Leuprolide), ellence (Ellence (epirubicin)), eloxatin (Eloxatin (oxaliplatin)), elspar (Asparaginase), emcyt (Estramustine), erbitux (Cetuximab), erivedge (Vismodegib), erwinaze (Asparaginase *Erwinia chrysanthemi*), ethyol (Amifostine), etopophos (Etoposide Injection), eulexin (Flutamide), fareston (Toremifene), farydak (Panobinostat), faslodex (Fulvestrant), femara (Letrozole), firmagon (Degarelix Injection), fludara (Fludarabine), folex (Methotrexate Injection), folotylin (Pralatrexate Injection), FUDR (FUDR (floxuridine)), gazyva (Obinutuzumab Injection), gemzar (Gemcitabine), gilotrif (Afatinib), gleevec (Imatinib Mesylate), Gliadel Wafer (Carmustine wafer), Halaven (Eribulin Injection), Herceptin (Trastuzumab), Hexalen (Altretamine), Hycamtin (Topotecan), Hycamtin (Topotecan), Hydrea (Hydroxyurea), Ibrance (Palbociclib), Iclusig (Ponatinib), Idamycin PFS (Idarubicin), Ifex (Ifosfamide), Imbruvica (Ibrutinib), Inlyta (Axitinib), Intron A alfab (Interferon alfa-2a), Iressa (Gefitinib), Istodax (Romidepsin Injection), Ixempra (Ixabepilone Injection), Jakafi (Ruxolitinib), Jevtana (Cabazitaxel Injection), Kadcyla (Ado-trastuzumab Emtansine), Keytruda

(Pembrolizumab Injection), Kyprolis (Carfilzomib), Lanvima (Lenvatinib), Leukeran (Chlorambucil), Leukine (Sargramostim), Leustatin (Cladribine), Lonsurf (Trifluridine and Tipiracil), Lupron (Leuprolide), Lupron Depot (Leuprolide), Lupron DepotPED (Leuprolide), Lynparza (Olaparib), Lysodren (Mitotane), Marqibo Kit (Vincristine Lipid Complex Injection), Matulane (Procarbazine), Megace (Megestrol), Mekinist (Trametinib), Mesnex (Mesna), Mesnex (Mesna Injection), Metastron (Strontium-89 Chloride), Mexate (Methotrexate Injection), Mustargen (Mechlorethamine), Mutamycin (Mitomycin), Myleran (Busulfan), Mylotarg (Gemtuzumab Ozogamicin), Navelbine (Vinorelbine), Neosar Injection (Cyclophosphamide Injection), Neulasta (filgrastim), Neulasta (pegfilgrastim), Neupogen (filgrastim), Nexavar (Sorafenib), Nilandron (Nilandron (nilutamide)), Nipent (Pentostatin), Nolvadex (Tamoxifen), Novantrone (Mitoxantrone), Odomzo (Sonidegib), Oncaspar (Pegaspargase), Oncovin (Vincristine), Ontak (Denileukin Diftitox), onxol (Paclitaxel Injection), opdivo (Nivolumab Injection), panretin (Alitretinoin), paraplatin (Carboplatin), perjeta (Pertuzumab Injection), platinol (Cisplatin), platinol (Cisplatin Injection), platinolAQ (Cisplatin), platinolAQ (Cisplatin Injection), pomalyst (Pomalidomide), prednisone Intensol (Prednisone), proleukin (Aldesleukin), purinethol (Mercaptopurine), reclast (Zoledronic acid), revlimid (Lenalidomide), rheumatrex (Methotrexate), rituxan (Rituximab), roferonA alfaa (Interferon alfa-2a), rubex (Doxorubicin), sandostatin (Octreotide), sandostatin LAR Depot (Octreotide), soltamox (Tamoxifen), sprycel (Dasatinib), sterapred (Prednisone), sterapred DS (Prednisone), stivarga (Regorafenib), supprelin LA (Histrelin Implant), sutent (Sunitinib), sylatron (Peginterferon Alfa-2b Injection (Sylatron)), sylvant (Siltuximab Injection), synribo (Omacetaxine Injection), tabloid (Thioguanine), taflinar (Dabrafenib), tarceva (Erlotinib), targretin Capsules (Bexarotene), tassigna (Decarbazine), taxol (Paclitaxel Injection), taxotere (Docetaxel), temodar (Temozolomide), temodar (Temozolomide Injection), tepadina (Thiotepa), thalomid (Thalidomide), theraCys BCG (BCG), thioplex (Thiotepa), TICE BCG (BCG), toposar (Etoposide Injection), torisel (Temozolomide), treanda (Bendamustine hydrochloride), trelstar (Triptorelin Injection), trexall (Methotrexate), trisenox (Arsenic trioxide), tykerb (lapatinib), unituxin (Dinutuximab Injection), valstar (Valrubicin Intravesical), vantas (Histrelin Implant), vectibix (Panitumumab), velban (Vinblastine), velcade (Bortezomib), vepesid (Etoposide), vepesid (Etoposide Injection), vesanoid (Tretinoin), vidaza (Azacitidine), vincasar PFS (Vincristine), vincrex (Vincristine), votrient (Pazopanib), vumon (Teniposide), wellcovorin IV (Leucovorin Injection), xalkori (Crizotinib), xeloda (Capecitabine),

xtandi (Enzalutamide), yervoy (Ipilimumab Injection), yondelis (Trabectedin Injection), zaltrap (Ziv-aflibercept Injection), zanosar (Streptozocin), zelboraf (Vemurafenib), zevalin (Ibritumomab Tiuxetan), zoladex (Goserelin), zolinza (Vorinostat), zometa (Zoledronic acid), zortress (Everolimus), zydelig (Idelalisib), zykadia (Ceritinib), zytiga (Abiraterone), and the like, in addition to analogs and derivatives thereof. For example, approved targeted therapies include ado-trastuzumab emtansine (Kadcyla), afatinib (Gilotrif), aldesleukin (Proleukin), alectinib (Alecensa), alemtuzumab (Campath), axitinib (Inlyta), belimumab (Benlysta), belinostat (Beleodaq), bevacizumab (Avastin), bortezomib (Velcade), bosutinib (Bosulif), brentuximab vedotin (Adcetris), cabozantinib (Cabometyx [tablet], Cometriq [capsule]), canakinumab (Ilaris), carfilzomib (Kymprolis), ceritinib (Zykadia), cetuximab (Erbix), cobimetinib (Cotellic), crizotinib (Xalkori), dabrafenib (Tafinlar), daratumumab (Darzalex), dasatinib (Sprycel), denosumab (Xgeva), dinutuximab (Unituxin), elotuzumab (Empliciti), erlotinib (Tarceva), everolimus (Afinitor), gefitinib (Iressa), ibritumomab tiuxetan (Zevalin), ibrutinib (Imbruvica), idelalisib (Zydelig), imatinib (Gleevec), ipilimumab (Yervoy), ixazomib (Ninlaro), lapatinib (Tykerb), lenvatinib (Lenvima), necitumumab (Portrazza), nilotinib (Tasigna), nivolumab (Opdivo), obinutuzumab (Gazyva), ofatumumab (Arzerra, HuMax-CD20), olaparib (Lynparza), osimertinib (Tagrisso), palbociclib (Ibrance), panitumumab (Vectibix), panobinostat (Farydak), pazopanib (Votrient), pembrolizumab (Keytruda), pertuzumab (Perjeta), ponatinib (Iclusig), ramucirumab (Cyramza), rapamycin, regorafenib (Stivarga), rituximab (Rituxan, Mabthera), romidepsin (Istodax), ruxolitinib (Jakafi), siltuximab (Sylvant), sipuleucel-T (Provenge), sirolimus, sonidegib (Odomzo), sorafenib (Nexavar), sunitinib, tamoxifen, temsirolimus (Torisel), tocilizumab (Actemra), tofacitinib (Xeljanz), tositumomab (Bexxar), trametinib (Mekinist), trastuzumab (Herceptin), vandetanib (Caprelsa), vemurafenib (Zelboraf), venetoclax (Venclexta), vismodegib (Erivedge), vorinostat (Zolinza), ziv-aflibercept (Zaltrap), and the like, in addition to analogs and derivatives thereof.

[00249] Those skilled in the art can determine appropriate chemotherapy and/or targeted therapy and/or alternative therapy options, including treatments that have been approved and those that in clinical trials or otherwise under development. Some targeted therapies are also immunotherapies. Any relevant chemotherapy, target therapy, and alternative therapy treatment strategies can be utilized, alone or in combination with one or more additional cancer therapy, in the practice of the present disclosure.

Immunotherapy

[00250] In some embodiments, immunotherapies include cell-based immunotherapies, such as those involving cells which effect an immune response (such as, for example, lymphocytes, macrophages, natural killer (NK) cells, dendritic cells, cytotoxic T lymphocytes (CTL), antibodies and antibody derivatives (such as, for example, monoclonal antibodies, conjugated monoclonal antibodies, polyclonal antibodies, antibody fragments, radiolabeled antibodies, chemolabeled antibodies, etc.), immune checkpoint inhibitors, vaccines (such as, for example, cancer vaccines (e.g. tumor cell vaccines, antigen vaccines, dendritic cell vaccines, vector-based vaccines, etc.), e.g. oncopophage, sipuleucel-T, and the like), immunomodulators (such as, for example, interleukins, cytokines, chemokines, etc.), topical immunotherapies (such as, for example, imiquimod, and the like), injection immunotherapies, adoptive cell transfer, oncolytic virus therapies (such as, for example, talimogene laherparepvec (T-VEC), and the like), immunosuppressive drugs, helminthic therapies, other non-specific immunotherapies, and the like. Immune checkpoint inhibitor immunotherapies are those that target one or more specific proteins or receptors, such as PD-1, PD-L1, CTLA-4, and the like. Immune checkpoint inhibitor immunotherapies include ipilimumab (Yervoy), nivolumab (Opdivo), pembrolizumab (Keytruda), and the like. Non-specific immunotherapies include cytokines, interleukins, interferons, and the like. In some embodiments, an immunotherapy assigned or administered to a subject can include an interleukin, and/or interferon (IFN), and/or one or more suitable antibody-based reagent, such as denileukin diftitox and/or administration of an antibody-based reagent selected from the group consisting of ado-trastuzumab emtansine, alemtuzumab, atezolizumab, bevacizumab, blinatumomab, brentuximab vedotin, cetuximab, catumaxomab, gemtuzumab, ibritumomab tiuxetan, ilipimumab, natalizumab, nimotuzumab, nivolumab, ofatumumab, panitumumab, pembrolizumab, rituximab, tositumomab, trastuzumab, vivatuxin, and the like. In some embodiments, an immunotherapy assigned or administered to a subject can include an indoleamine 2,3-dioxygenase (IDO) inhibitor, adoptive T-cell therapy, virotherapy (T-VEC), and/or any other immunotherapy whose efficacy extensively depends on anti-tumor immunity.

[00251] Those skilled in the art can determine appropriate immunotherapy options, including treatments that have been approved and those that in clinical trials or otherwise under

development. Any relevant immunotherapy treatment strategies, alone or in combination with one or more additional cancer therapy, can be utilized in the practice of the present disclosure.

Other Cancer Treatments

[00252] In addition to chemotherapies, targeted therapies, alternative therapies, and immunotherapies, cancer can additionally be treated by other strategies. These include surgery, radiation therapy, hormone therapy, stem cell transplant, precision medicine, and the like; such treatments and the compounds and compositions utilized therein are known to those skilled in the art. Any such treatment strategies can be utilized in the practice of the present disclosure.

[00253] Alternative treatment strategies have also been used with various types of cancers. Such treatment can be used alone or in combination with any other treatment modality. These include exercise, massage, relaxation techniques, yoga, acupuncture, aromatherapy, hypnosis, music therapy, dietary changes, nutritional and dietary supplements, and the like; such treatments are known to those skilled in the art. Any such treatment strategies can be utilized, alone or in combination with one or more additional cancer therapy, in the practice of the present disclosure.

Dosage and Administration Routes

[00254] Other embodiments of the disclosure can include methods of administering or treating an animal/human, which can involve treatment with an amount of at least one compound of the disclosure (e.g., Formula (I)) that is effective to treat the disease, condition, or disorder that the organism has, or is suspected of having, or is susceptible to, or to bring about a desired physiological effect. In some embodiments, the composition or pharmaceutical composition comprises at least one compound of the disclosure (e.g., Formula (I)) which can be administered to an animal (e.g., mammals, primates, monkeys, or humans) in an amount of about 0.005 to about 50 mg/kg body weight, about 0.01 to about 15 mg/kg body weight, about 0.1 to about 10 mg/kg body weight, about 0.5 to about 7 mg/kg body weight, about 0.005 mg/kg, about 0.01 mg/kg, about 0.05 mg/kg, about 0.1 mg/kg, about 0.5 mg/kg, about 1 mg/kg, about 3 mg/kg, about 5 mg/kg, about 5.5 mg/kg, about 6 mg/kg, about 6.5 mg/kg, about 7 mg/kg, about 7.5 mg/kg, about 8 mg/kg, about 10 mg/kg, about 12 mg/kg, or about 15 mg/kg. In regard to some conditions, the dosage can be about 0.5 mg/kg human body weight or about 6.5 mg/kg human body weight. In some instances, some subjects (e.g., mammals, mice, rabbits, feline, porcine, or canine) can be

administered a dosage of about 0.005 to about 50 mg/kg body weight, about 0.01 to about 15 mg/kg body weight, about 0.1 to about 10 mg/kg body weight, about 0.5 to about 7 mg/kg body weight, about 0.005 mg/kg, about 0.01 mg/kg, about 0.05 mg/kg, about 0.1 mg/kg, about 1 mg/kg, about 5 mg/kg, about 10 mg/kg, about 20 mg/kg, about 30 mg/kg, about 40 mg/kg, about 50 mg/kg, about 80 mg/kg, about 100 mg/kg, or about 150 mg/kg. Of course, those skilled in the art will appreciate that it is possible to employ many concentrations in the methods of the present disclosure, and using, in part, the guidance provided herein, will be able to adjust and test any number of concentrations in order to find one that achieves the desired result in a given circumstance. In some embodiments, a dose or a therapeutically effective dose of a compound disclosed herein will be that which is sufficient to achieve a plasma concentration of the compound or its active metabolite(s) within a range set forth herein, e.g., 1-10 nM, 10-100 nM, 1-100 nM, 0.1-1 nM, 0.1-100 nM, 0.1-200 nM, 1-200 nM, 10-200 nM, 100-200 nM, 200-500 nM, 0.1-500 nM, 1-500 nM, 10-500 nM, 500-1000 nM, 0.1-1000 nM, 1-1000 nM, 10-1000 nM, or 100-1000 nM. In some embodiments, the inhibitory activity is less than 0.1 nM, less than 1 nM, less than 10 nM, less than 100 nM, or less than 1000 nM, 0.1-1 μ M, 1-10 μ M, 10-100 μ M, 100-200 μ M, 200-500 μ M, or even 500-1000 μ M, preferably about 1-10 nM, 10-100 nM, or 0.1-1 μ M. Without wishing to be bound by any theory, it is believed that such compounds are indicated in the treatment or management of hematopoietic cancers, such as, for example, MDS and/or AML and/or DLBCL, etc., other types of cancers, inflammatory conditions, and/or autoimmune diseases, as described herein.

[00255] In other embodiments, the compounds and/or pharmaceutical compounds of the disclosure (e.g., compounds of Formula (I) and pharmaceutical compositions including the same) can be administered in combination with one or more other therapeutic agents for a given disease, condition, or disorder.

[00256] The compounds and pharmaceutical compositions are preferably prepared and administered in dose units. Solid dose units are tablets, capsules and suppositories. For treatment of a subject, depending on activity of the compound, manner of administration, nature and severity of the disease or disorder, age and body weight of the subject, different daily doses can be used.

[00257] Under certain circumstances, however, higher or lower daily doses can be appropriate. The administration of the daily dose can be carried out both by single administration

in the form of an individual dose unit or else several smaller dose units and also by multiple administrations of subdivided doses at specific intervals.

[00258] The compounds and pharmaceutical compositions contemplated herein can be administered locally or systemically in a therapeutically effective dose. Amounts effective for this use will, of course, depend on the severity of the disease or disorder and the weight and general state of the subject. Typically, dosages used *in vitro* can provide useful guidance in the amounts useful for *in situ* administration of the pharmaceutical composition, and animal models can be used to determine effective dosages for treatment of particular disorders.

[00259] Various considerations are described, e. g. , in Langer, 1990, *Science*, **249**: 1527; Goodman and Gilman's (eds.), 1990, *Id.*, each of which is herein incorporated by reference and for all purposes. Dosages for parenteral administration of active pharmaceutical agents can be converted into corresponding dosages for oral administration by multiplying parenteral dosages by appropriate conversion factors. As to general applications, the parenteral dosage in mg/mL times 1.8 = the corresponding oral dosage in milligrams ("mg"). As to oncology applications, the parenteral dosage in mg/mL times 1.6 = the corresponding oral dosage in mg. An average adult weighs about 70 kg. *See* e.g., Miller-Keane, 1992, *Encyclopedia & Dictionary of Medicine, Nursing & Allied Health*, 5th Ed., (W. B. Saunders Co.), pp. 1708 and 1651.

[00260] It will be understood, however, that 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, diet, time of administration, route of administration, rate of excretion, drug combination and the severity of the particular disease undergoing therapy.

[00261] In some embodiments, the compounds and/or pharmaceutical compositions can include a unit dose of one or more compounds of the disclosure (e.g., compounds of Formula (I) and pharmaceutical compositions including the same) in combination with a pharmaceutically acceptable carrier and, in addition, can include other medicinal agents, pharmaceutical agents, carriers, adjuvants, diluents, and excipients. In certain embodiments, the carrier, vehicle or excipient can facilitate administration, delivery and/or improve preservation of the composition. In other embodiments, the one or more carriers, include but are not limited to, saline solutions such as normal saline, Ringer's solution, PBS (phosphate-buffered saline), and generally mixtures of various salts including potassium and phosphate salts with or without sugar additives such as

glucose. Carriers can include aqueous and non-aqueous sterile injection solutions that can contain antioxidants, buffers, bacteriostats, bactericidal antibiotics, and solutes that render the formulation isotonic with the bodily fluids of the intended recipient; and aqueous and non-aqueous sterile suspensions, which can include suspending agents and thickening agents. In other embodiments, the one or more excipients can include, but are not limited to water, saline, dextrose, glycerol, ethanol, or the like, and combinations thereof. Nontoxic auxiliary substances, such as wetting agents, buffers, or emulsifiers may also be added to the composition. Oral formulations can include such normally employed excipients as, for example, pharmaceutical grades of mannitol, lactose, starch, magnesium stearate, sodium saccharine, cellulose, and magnesium carbonate.

[00262] The quantity of active component in a unit dose preparation can be varied or adjusted from 0.1 mg to 10000 mg, more typically 1.0 mg to 1000 mg, most typically 10 mg to 500 mg, according to the particular application and the potency of the active component. The composition can, if desired, also contain other compatible therapeutic agents.

[00263] The compounds of the disclosure (e.g., compounds according to Formula (I)) can be administered to subjects by any number of suitable administration routes or formulations. The compounds of the disclosure (e.g., Formula (I)) of the disclosure can also be used to treat subjects for a variety of diseases. Subjects include but are not limited to mammals, primates, monkeys (e.g., macaque, rhesus macaque, or pig tail macaque), humans, canine, feline, bovine, porcine, avian (e.g., chicken), mice, rabbits, and rats. As used herein, the term “subject”, unless stated otherwise, encompasses both human and non-human subjects.

[00264] The route of administration of the compounds of the disclosure (e.g., Formula (I)) can be of any suitable route. Administration routes can be, but are not limited to the oral route, the parenteral route, the cutaneous route, the nasal route, the rectal route, the vaginal route, and the ocular route. In other embodiments, administration routes can be parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration. The choice of administration route can depend on the compound identity (e.g., the physical and chemical properties of the compound) as well as the age and weight of the animal/human, the particular disease (e.g., cancer or MDS), and the severity of the disease (e.g., stage or severity of cancer or MDS). Of course, combinations of administration routes can be administered, as desired.

[00265] Some embodiments of the disclosure include a method for providing a subject with a composition comprising one or more compounds of the disclosure (e.g., Formula (I)) described herein (e.g., a pharmaceutical composition) which comprises one or more administrations of one or more such compositions; the compositions may be the same or different if there is more than one administration.

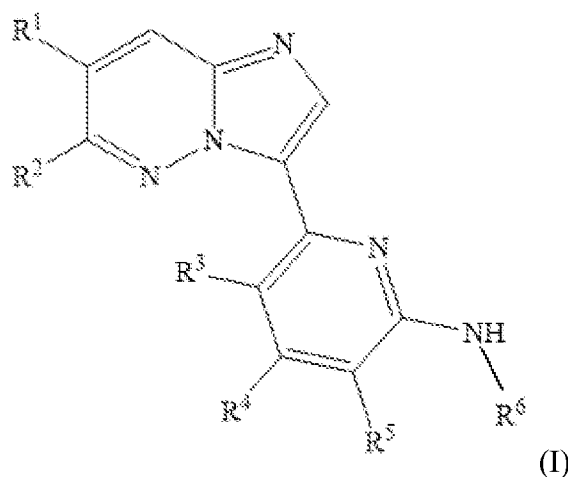
Toxicity

[00266] The ratio between toxicity and therapeutic effect for a particular compound is its therapeutic index and can be expressed as the ratio between LD₅₀ (the amount of compound lethal in 50% of the population) and ED₅₀ (the amount of compound effective in 50% of the population). Compounds that exhibit high therapeutic indices are preferred. Therapeutic index data obtained from *in vitro* assays, cell culture assays and/or animal studies can be used in formulating a range of dosages for use in humans. The dosage of such compounds preferably lies within a range of plasma concentrations that include the ED₅₀ with little or no toxicity. The dosage can vary within this range depending upon the dosage form employed and the route of administration utilized. See, e.g. Fingl *et al.*, *In: THE PHARMACOLOGICAL BASIS OF THERAPEUTICS*, Ch.1, p.1, 1975. The exact formulation, route of administration, and dosage can be chosen by the individual practitioner in view of the patient's condition and the particular method in which the compound is used. For *in vitro* formulations, the exact formulation and dosage can be chosen by the individual practitioner in view of the patient's condition and the particular method in which the compound is used.

[00267] Having described the disclosure in detail, it will be apparent that modifications, variations, and equivalent embodiments are possible without departing from the scope of the disclosure defined in the appended claims. Furthermore, it should be appreciated that all examples in the present disclosure are provided as non-limiting examples.

[00268] The following clauses describe certain embodiments.

[00269] Clause 1. A compound selected from Formula (I)



or a salt, ester, solvate, optical isomer, geometric isomer, salt of an isomer, prodrug, or derivative thereof, wherein:

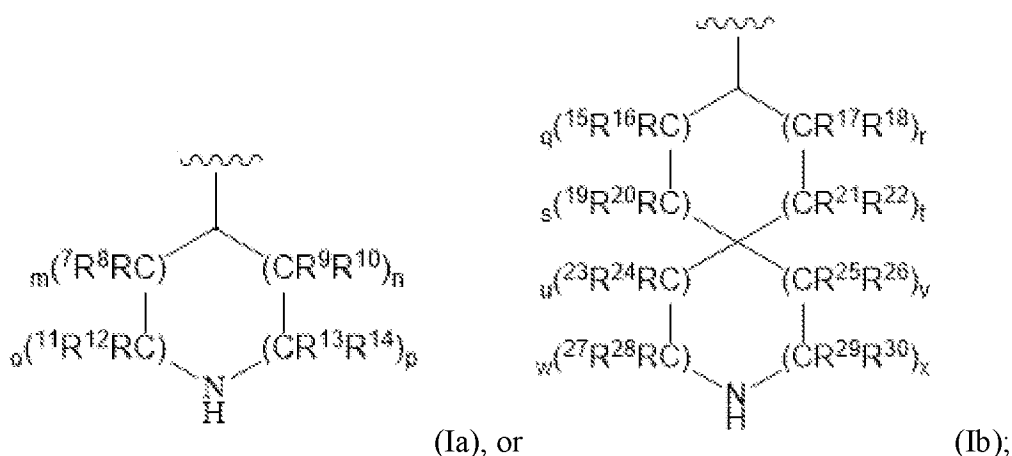
R¹ is H, halogen, hydroxy, oxo, -CN, amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R² is H, halogen, hydroxy, oxo, -CN, amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, heteroaryl, or fused ring heteroaryl, which amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇

haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, fused ring aryl, heteroaryl, fused ring heteroaryl, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R³, R⁴, and R⁵ are independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R⁶ is



R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, R¹⁴ are independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen;

R¹⁵, R¹⁶, R¹⁷, R¹⁸, R¹⁹, R²⁰, R²¹, R²², R²³, R²⁴, R²⁵, R²⁶, R²⁷, R²⁹, R²⁹, and R³⁰ are independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl,

C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen; and

m, n, o, p, q, r, s, t, u, v, w, and x are independently selected from 0, 1, 2, 3, 4, or 5, where q+r+s+t is at least 1, and where u+v+w+x is at least 1.

[002701] Clause 2. The compound of Clause 1, wherein R¹ is H, halogen, -CONH₂, -CONHCH₃, -CON(CH₃)₂, benzyl, C₁-C₇ alkyl, C₁-C₇ alkoxy, or cycloalkyl, which C₁-C₇ alkyl, C₁-C₇ alkoxy, or cycloalkyl is optionally substituted with one or more halogen, hydroxyl, C₁-C₇ alkyl, or C₁-C₇ haloalkyl.

[002711] Clause 3. The compound of Clause 1 or Clause 2, wherein R¹ is H, Cl, -CONH₂, -CONHCH₃, methoxy, ethoxy, cyclopropyl, or C₁-C₄ alkyl, which methoxy, ethoxy, cyclopropyl, or C₁-C₄ alkyl is optionally substituted with one or more F, -OH, methyl, or CF₃.

[002721] Clause 4. The compound of Clause 1 or Clause 2, wherein R¹ is not H.

[002731] Clause 5. The compound of any of Clauses 1-3, wherein R² is H, halogen, hydroxy, O-aryl, amino, C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, aryl, fused ring aryl, heteroaryl, or fused ring heteroaryl, which O-aryl, amino, C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, heterocyclyl, aryl, fused ring aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, -CN, amino, cycloalkyl, heterocyclyl, aryl, heteroaryl, fused ring aryl, fused ring heteroaryl, pyrrolyl, piperidyl, piperazinyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl.

[002741] Clause 6. The compound of any of Clauses 1-5, wherein R² is H, halogen, hydroxy, O-aryl, amino, C₁-C₇ alkyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, aryl, fused ring aryl, heteroaryl, or fused ring heteroaryl which O-aryl, amino, C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, amino, cycloalkyl, heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl.

[002751] Clause 7. The compound of any of Clauses 1-6, wherein R^2 is H, Cl, hydroxy, $-NHCH_3$, $-N(CH_3)_2$, $-OCH_3$, $-OCF_3$, $-OCHF_2$, $-OPh$, $-CF_3$, $-CHF_2$, unsubstituted C₁-C₇ alkyl, substituted amino, substituted C₁-C₇ alkyl, substituted cycloalkyl, unsubstituted cycloalkyl, unsubstituted heterocyclyl, substituted pyrazolyl, substituted fused ring heteroaryl, or unsubstituted fused ring heteroaryl.

[002761] Clause 8. The compound of Clause 1 or Clause 5, wherein R^2 is not H.

[002771] Clause 9. The compound of any of Clauses 1-8, wherein R^3 is H, halogen, hydroxy, $-CN$, methanoyl ($-COH$), carboxy ($-CO_2H$), C₁-C₇ alkyl, or C₁-C₇ alkoxy, which C₁-C₇ alkyl, or C₂-C₆ alkoxy, is optionally substituted with one or more of halogen, hydroxy, methanoyl ($-COH$), carboxy ($-CO_2H$), nitro ($-NO_2$), $-NH_2$, $-N(CH_3)_2$, cyano ($-CN$), ethynyl ($-CCH$), propynyl, sulfo ($-SO_3H$), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, $-CO$ -morpholin-4-yl, $-CONH_2$, $-CONHCH_3$, $-CON(CH_3)_2$, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl.

[002781] Clause 10. The compound of any of Clauses 1-9, wherein R^3 is H, halogen, hydroxy, $-CN$, methyl, $-CF_3$, or methoxy.

[002791] Clause 11. The compound of any of Clauses 1-10, wherein R^4 is H, halogen, hydroxy, $-CN$, methanoyl ($-COH$), carboxy ($-CO_2H$), C₁-C₇ alkyl, or C₁-C₇ alkoxy, which C₁-C₇ alkyl, or C₂-C₆ alkoxy, is optionally substituted with one or more of halogen, hydroxy, methanoyl ($-COH$), carboxy ($-CO_2H$), nitro ($-NO_2$), $-NH_2$, $-N(CH_3)_2$, cyano ($-CN$), ethynyl ($-CCH$), propynyl, sulfo ($-SO_3H$), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, $-CO$ -morpholin-4-yl, $-CONH_2$, $-CONHCH_3$, $-CON(CH_3)_2$, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl.

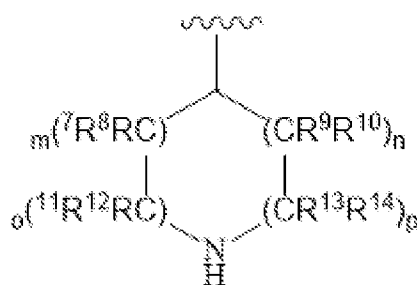
[002801] Clause 12. The compound of any of Clauses 1-11, wherein R^4 is H, halogen, hydroxy, $-CN$, methyl, $-CF_3$, or methoxy.

[002811] Clause 13. The compound of any of Clauses 1-12, wherein R^5 is H, halogen, hydroxy, $-CN$, methanoyl ($-COH$), carboxy ($-CO_2H$), C₁-C₇ alkyl, or C₁-C₇ alkoxy, which C₁-C₇ alkyl, or C₂-C₆ alkoxy, is optionally substituted with one or more of halogen, hydroxy, methanoyl ($-COH$), carboxy ($-CO_2H$), nitro ($-NO_2$), $-NH_2$, $-N(CH_3)_2$, cyano ($-CN$), ethynyl ($-CCH$), propynyl, sulfo ($-SO_3H$), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, $-CO$ -morpholin-4-yl, $-CONH_2$, $-CONHCH_3$, $-CON(CH_3)_2$, C₁-C₇ alkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl.

[00282] Clause 14. The compound of any of Clauses 1-13, wherein R^5 is H, halogen, hydroxy, -CN, methyl, -CF₃, or methoxy.

[00283] Clause 15. The compound of any of Clauses 1-11, wherein R^4 is methyl or -CF₃, and wherein at least one of R^3 and R^5 is H or halogen.

[00284] Clause 16. The compound of any of Clauses 1-15, wherein R^6 is



(Ia).

[00285] Clause 17. The compound of any of Clauses 1-16, wherein m is 0 or 1, wherein n is 0 or 1, wherein o is 0 or 1, and wherein p is 0 or 1.

[00286] Clause 18. The compound of any of Clauses 1-17, wherein R^7 , R^8 , R^9 , and R^{10} are H, and wherein at least one of R^{11} , R^{12} , R^{13} , and R^{14} is not H.

[00287] Clause 19. The compound of any of Clauses 1-18, wherein R^{11} , R^{12} , R^{13} , and R^{14} are H, and wherein at least one of R^7 , R^8 , R^9 , and R^{10} is not H.

[00288] Clause 20. The compound of any of Clauses 1-17, wherein all of R^7 , R^8 , R^9 , R^{10} , R^{11} , R^{12} , R^{13} , and R^{14} are H.

[00289] Clause 21. The compound of any of Clauses 1-20, wherein R^7 , R^8 , R^9 , R^{10} , R^{11} , R^{12} , R^{13} , and R^{14} are independently selected from H, halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen.

[00290] Clause 22. The compound of Clause 21, wherein R^7 , R^8 , R^9 , and R^{10} are H, and wherein at least one of R^{11} , R^{12} , R^{13} , and R^{14} is halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen.

[00291] Clause 23. The compound of Clause 21, wherein R^{11} , R^{12} , R^{13} , and R^{14} are H, and wherein at least one of R^7 , R^8 , R^9 , and R^{10} is halogen, hydroxy, oxo, methanoyl (-COH),

carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen.

[00292] Clause 24. The compound of any of Clauses 1-23, wherein at least one of R⁷, R⁸, R⁹, and R¹⁰ is halogen, hydroxyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl.

[00293] Clause 25. The compound of Clause 23, wherein at least one of R⁷, R⁸, R⁹, and R¹⁰ is F, hydroxyl, methyl, methoxy, -CHF₂, -CF₃, spiro-fused cyclopropyl, spiro-fused cyclobutyl, or spiro-fused cyclopentyl.

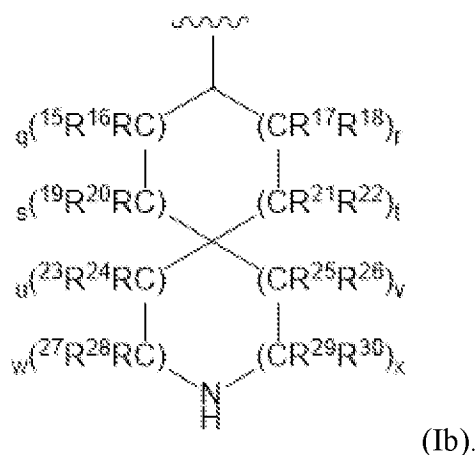
[00294] Clause 26. The compound of Clause 25, wherein both of R⁷ and R⁸ or both of R⁹ and R¹⁰ are F, or wherein both of R⁷ and R⁸ or both of R⁹ and R¹⁰ are methyl.

[00295] Clause 27. The compound of any of Clauses 1-26, wherein at least one of R¹¹, R¹², R¹³, and R¹⁴ is halogen, hydroxyl, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl.

[00296] Clause 28. The compound of Clause 27, wherein at least one of R¹¹, R¹², R¹³, and R¹⁴ is F, hydroxyl, methyl, methoxy, -CHF₂, -CF₃, spiro-fused cyclopropyl, spiro-fused cyclobutyl, or spiro-fused cyclopentyl.

[00297] Clause 29. The compound of Clause 28, wherein both of R¹¹ and R¹² or both of R¹³ and R¹⁴ are F, or wherein both of R¹¹ and R¹² or both of R¹³ and R¹⁴ are methyl.

[00298] Clause 30. The compound of any of Clauses 1-15, wherein R⁶ is



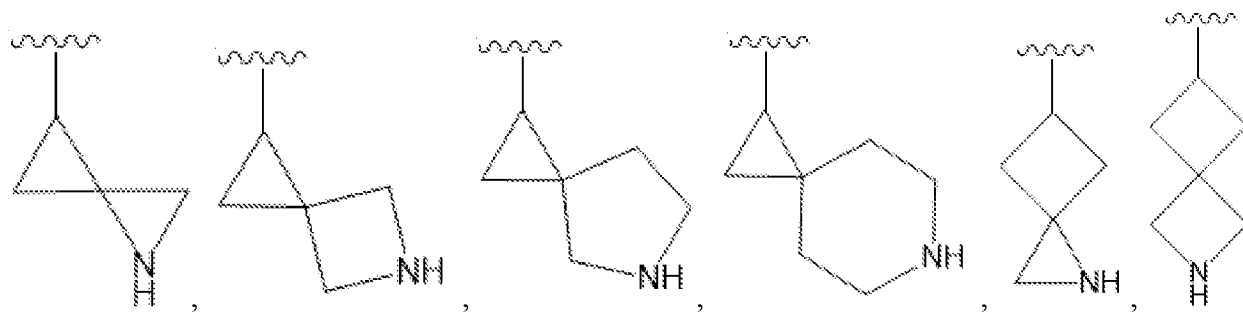
[00299] Clause 31. The compound of any of Clauses 1-15 or 30, wherein q, r, s, t, u, v, w, and x are independently 0, 1, or 2.

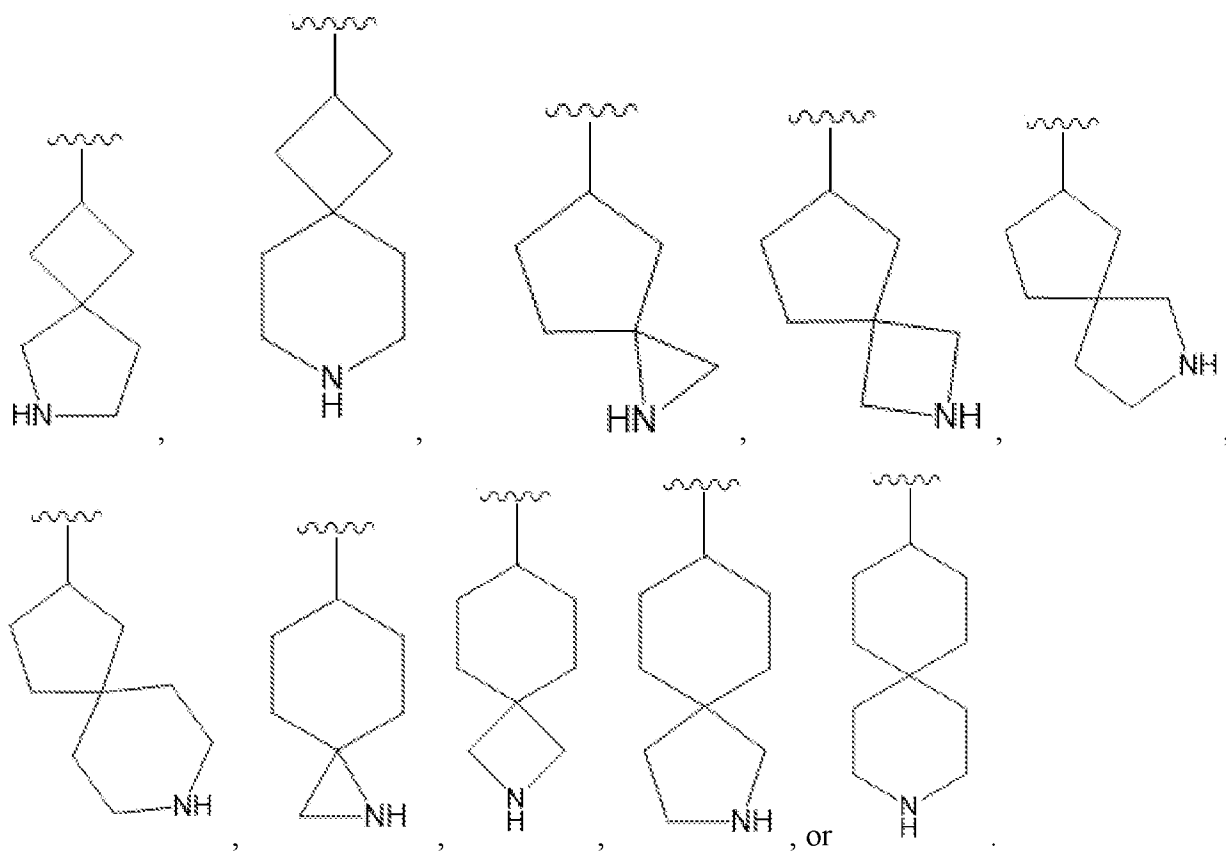
[00300] Clause 32. The compound of any of Clauses 1-15 or 30-31, wherein q is 0 or 1, wherein r is 0 or 1, wherein s is 0 or 1, wherein t is 0 or 1, wherein u is 0 or 1, wherein v is 0 or 1, wherein w is 0 or 1, and wherein x is 0 or 1.

[00301] Clause 33. The compound of any of Clauses 1-15 or 30-32, wherein R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , R^{29} , and R^{30} are independently selected from H, halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₁-C₇ alkoxy, or spiro-fused cycloalkyl, which methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₂-C₆ alkoxy, or spiro-fused cycloalkyl is optionally substituted with one or more halogen.

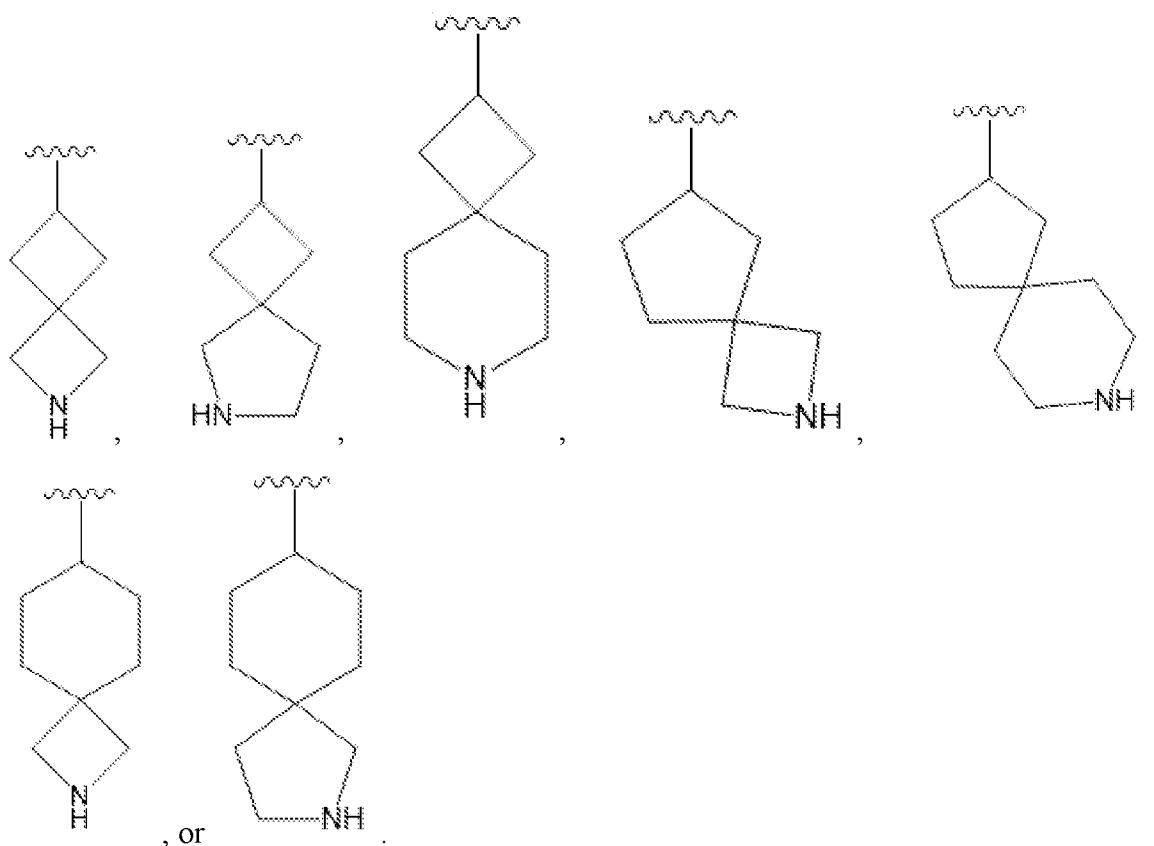
[00302] Clause 34. The compound of any of Clauses 1-15 or 30-33, wherein one or more of R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , R^{29} , and R^{30} are H, or wherein all of R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , R^{29} , and R^{30} are H.

[00303] Clause 35. The compound of any of Clauses 1-15 or 30-34, wherein R^6 is:





[00304] Clause 36. The compound of any of Clause 1-15 or 30-35, wherein R^6 is:



[00305] Clause 37. The compound of any of Clauses 1-36, wherein the compound is selected from Compounds 1-107, as listed in Tables 1-9.

[00306] Clause 38. The compound of any of Clauses 1-37, wherein the compound is selected from Compound 1, Compound 9, Compound 19, Compound 20, Compound 21, Compound 26, Compound 31, Compound 38, Compound 45, Compound 56, Compound 60, Compound 61, Compound 62, Compound 63, Compound 81, Compound 84, Compound 96, Compound 97, and Compound 99.

[00307] Clause 39. The compound of any of Clauses 1-38, wherein the compound is selected from Compound 9, Compound 19, Compound 20, Compound 21, Compound 26, Compound 31, Compound 38, Compound 45, Compound 56, Compound 60, Compound 61, Compound 62, Compound 63, Compound 81, Compound 84, Compound 96, Compound 97, and Compound 99.

[00308] Clause 40. A composition comprising a compound of any of Clauses 1-39.

[00309] Clause 41. The composition of Clause 40, wherein the amount of the compound is from about 0.0001% (by weight total composition) to about 99%.

[00310] Clause 42. The composition of Clause 40 or Clause 41, further comprising a formulary ingredient, an adjuvant, or a carrier.

[00311] Clause 43. The composition of any of Clauses 40-42, wherein the composition further comprises a BCL2 inhibitor.

[00312] Clause 44. The composition of any of Clauses 40-42, wherein the composition is used in combination with a second composition comprising a BCL2 inhibitor.

[00313] Clause 45. The composition of any of Clauses 40-44, wherein the BCL2 comprises venetoclax, or a salt, isomer, derivative or analog thereof.

[00314] Clause 46. The composition of any of Clauses 40-45, wherein the composition is used in combination with one or more chemotherapy, DNA methyltransferase inhibitor/hypomethylating agent, anthracycline, histone deacetylase (HDAC) inhibitor, purine nucleoside analogue (antimetabolite), isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, antibody-drug conjugate, mAbs/immunotherapy, CAR-T cell therapy, Plk inhibitor, MEK inhibitor, CDK9 inhibitor, CDK8 inhibitor, retinoic acid receptor agonist, TP53 activator, smoothened receptor antagonist, ERK inhibitor, PI3K inhibitor, mTOR inhibitor, glucocorticoid receptor modulator, or EZH2 inhibitor, or one or more combinations thereof.

[00315] Clause 47. The composition of any of Clauses 40-46, wherein the DNA methyltransferase inhibitor/hypomethylating agent comprises azacytidine, decitabine, cytarabine, and/or guadecitabine; wherein the anthracycline comprises daunorubicin, idarubicin, doxorubicin, mitoxantrone, epirubicin, and/or CPX-351 (a combination cytarabine and daunorubicin in a fixed 5:1 molar ratio); wherein the histone deacetylase (HDAC) inhibitor comprises vorinostat, panobinostat, valproic acid, and/or pracinostat; wherein the purine nucleoside analogue (antimetabolite) comprises fludarabine, cladribine, and/or clofarabine; wherein the isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor comprises ivosidenib and/or enasidenib; wherein the antibody-drug conjugate comprises Anti-CD33 (e.g. Ac225-lintuzumab, vadastuximab, or gemtuzumab-ozogamicin) and/or Anti-CD45 (e.g. I¹³¹-apamistamab); wherein the mAbs/Immunotherapy comprises Anti-CD70 (e.g. ARGX-110, cusatuzumab), a bispecific antibody (e.g. floteuzumab (CD123 x CD3)), Anti-CTLA4 (e.g. ipilimumab), Anti-PD1/PDL1 (e.g. nivolumab, pembrolizumab, atezolizumab, avelumab, PDR001, MBG453), and/or Anti-CD47 (e.g. 5F9 (Magrolimab)); wherein the Plk inhibitor comprises volasertib and/or rigosertib; wherein the MEK inhibitor comprises trametinib, cobimetinib, selumetinib, pimasertib, and/or

refametinib; wherein the CDK9 inhibitor comprises alvocidib and/or voruciclib; wherein the CDK8 inhibitor comprises SEL120; wherein the retinoic acid receptor agonist comprises ATRA (all-trans retinoic acid) and/or SY-1425 (a selective RAR α agonist); wherein the TP53 activator comprises APR-246 (Eprexetapopt); wherein the smoothened receptor antagonist comprises glasdegib; wherein the ERK inhibitor comprises an ERK2/MAPK1 or ERK1/MAPK3 inhibitor comprising ulixertinib, SCH772984, ravoxertinib, MK-8353, and/or VTX-11e; wherein the PI3K inhibitor comprises fimepinostat (CUDC-907), alpelisib, leniolisib (CDZ-173), pilaralisib (XL147, SAR245408), and/or bimiralisib (PQR-309); wherein the mTOR inhibitor comprises bimiralisib (PQR-309), sapanisertib (TAK-228, INK-128), ridaforolimus (MK-8669, AP-23573), everolimus, and/or vistusertib (AZD2014); wherein the glucocorticoid receptor modulator comprises an agonist comprising prednisolone, beclometasone, methylprednisolone, prednisone, fluticasone, budesonide, dexamethasone, and/or cortisol, and/or an antagonist comprising mifepristone, miricorilant, and/or onapristone, and/or another binding ligand comprising vamorolone (VBP15); and/or wherein the EZH2 inhibitor comprises tazemetostat.

[00316] Clause 48. A method for providing a subject with a compound comprising one or more administrations of one or more compositions comprising the compound of any of Clauses 1-39, wherein the compositions may be the same or different if there is more than one administration.

[00317] Clause 49. The method of Clause 48, wherein at least one of the one or more compositions further comprises a formulary ingredient.

[00318] Clause 50. The method of Clause 48 or Clause 49, wherein at least one of the one or more compositions comprises the composition of any of Clauses 40-47.

[00319] Clause 51. The method of any of Clauses 48-50, wherein at least one of the one or more administrations comprises parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration.

[00320] Clause 52. The method of any of Clauses 48-51, wherein if there is more than one administration at least one composition used for at least one administration is different from the composition of at least one other administration.

[00321] Clause 53. The method of any of Clauses 48-52, wherein the compound of at least one of the one or more compositions is administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 50 mg /kg subject body weight.

[00322] Clause 54. The method of any of Clauses 48-53, wherein the subject is a mammal, preferably wherein the subject is a human, a rodent, or a primate.

[00323] Clause 55. A method for treating a disease or disorder, comprising one or more administrations to a subject of one or more compositions comprising the compound of any of Clauses 1-39, wherein the compositions may be the same or different if there is more than one administration.

[00324] Clause 56. The method of Clause 55, wherein the disease or disorder is responsive to at least one of interleukin-1 receptor-associated kinase (IRAK) inhibition or fms-like tyrosine kinase 3 (FLT3) inhibition.

[00325] Clause 57. The method of Clause 55 or Clause 56, wherein at least one of the one or more compositions further comprises a formulary ingredient.

[00326] Clause 58. The method of any of Clauses 55-57, wherein at least one of the one or more compositions comprises the composition of any of Clauses 40-47.

[00327] Clause 59. The method of any of Clauses 55-58, wherein at least one of the one or more administrations comprises parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, transdermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration.

[00328] Clause 60. The method of any of Clauses 55-59, wherein at least one of the one or more administrations comprises an oral administration.

[00329] Clause 61. The method of any of Clauses 55-60, wherein if there is more than one administration at least one composition used for at least one administration is different from the composition of at least one other administration.

[00330] Clause 62. The method of any of Clauses 55-61, wherein the compound of at least one of the one or more compositions is administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 50 mg /kg subject body weight.

[00331] Clause 63. The method of any of Clauses 55-62, wherein the subject is a mammal, preferably wherein the subject is a human, a rodent, or a primate.

[00332] Clause 64. The method of any of Clauses 55-63, wherein the subject is in need of the treatment.

[00333] Clause 65. The method of any of Clauses 55-64, wherein the method is for treating a hematopoietic cancer.

[00334] Clause 66. The method of any of Clauses 55-65, wherein the method is for treating a myelodysplastic syndrome (MDS) and/or acute myeloid leukemia (AML).

[00335] Clause 67. The method of any of Clauses 55-65, wherein the method is for treating at least one of lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL with MYD88 mutation, follicular lymphoma, or marginal zone lymphoma.

[00336] Clause 68. The method of any of Clauses 55-64, wherein the method is for treating at least one cancer selected from glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, or one or more inflammatory diseases or autoimmune disease characterized by overactive IRAK1 and/or IRAK4, or combinations thereof.

[00337] Clause 69. The method of Clause 68, wherein the method is for treating one or more inflammatory diseases or autoimmune disease selected from chronic inflammation (i.e., associated with viral and bacterial infection), sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, or combinations thereof.

[00338] Clause 70. The method of any of Clauses 55-66, wherein the method is for treating MDS, MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2, or wherein the method is for treating AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the AML is not driven by FLT3 mutations but expresses IRAK4-Long.

[00339] Clause 71. The method of any of Clauses 55-67, wherein the method is for treating DLBCL, and wherein the DLBCL comprises a L265P MYD88 mutant (ABC) subtype of DLBCL.

[00340] Clause 72. The method of Clause 71, wherein the method further comprises administration of a composition comprising a BTK inhibitor.

[00341] Clause 73. The method of Clause 71, wherein the BTK inhibitor comprises ibrutinib.

[00342] Clause 74. The method of any of Clauses 55-73, wherein the subject is susceptible to AML and/or MDS, and/or wherein the method prevents or ameliorates future AML and/or MDS.

[00343] Clause 75. The method of any of Clauses 55-74, wherein the method occurs after one or more of having myelodysplastic syndrome, having myeloproliferative disease, an occurrence of chemical exposure, an exposure to ionizing radiation, or a treatment for cancer.

[00344] Clause 76. The method of any of Clauses 55-74, wherein the method further comprises administration of a composition comprising a BCL2 inhibitor, or wherein at least one of said compositions comprising the compound of any of Clauses 1-39 further comprises a BCL2 inhibitor.

[00345] Clause 77. The method of any of Clauses 55-76 wherein the compound of any of Clauses 1-39 and the BCL2 inhibitor may be administered together or separately, in one or more administrations of one or more compositions.

[00346] Clause 78. The method of any of Clauses 55-77, wherein the BCL2 inhibitor comprises venetoclax, or a salt, isomer, derivative or analog thereof.

[00347] Clause 79. The method of any of Clauses 55-78, wherein the method further comprises administration of one or more additional therapy selected from one or more chemotherapy, DNA methyltransferase inhibitor/hypomethylating agent, anthracycline, histone deacetylase (HDAC) inhibitor, purine nucleoside analogue (antimetabolite), isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, antibody-drug conjugate, mAbs/immunotherapy, CAR-T cell therapy, Plk inhibitor, MEK inhibitor, CDK9 inhibitor, CDK8 inhibitor, retinoic acid receptor agonist, TP53 activator, smoothened receptor antagonist, ERK inhibitor, PI3K inhibitor, mTOR inhibitor, glucocorticoid receptor modulator, or EZH2 inhibitor, or one or more combinations thereof.

[003481] Clause 80. The method of any of Clauses 55-79, wherein the DNA methyltransferase inhibitor/hypomethylating agent comprises azacytidine, decitabine, cytarabine, and/or guadecitabine; wherein the anthracycline comprises daunorubicin, idarubicin, doxorubicin, mitoxantrone, epirubicin, and/or CPX-351 (a combination cytarabine and daunorubicin in a fixed 5:1 molar ratio); wherein the histone deacetylase (HDAC) inhibitor comprises vorinostat, panobinostat, valproic acid, and/or pracinostat; wherein the purine nucleoside analogue (antimetabolite) comprises fludarabine, cladribine, and/or clofarabine; wherein the isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor comprises ivosidenib and/or enasidenib; wherein the antibody-drug conjugate comprises Anti-CD33 (e.g. Ac225-lintuzumab, vadastuximab, or gemtuzumab-ozogamicin) and/or Anti-CD45 (e.g. I¹³¹-apamistamab); wherein the mAbs/Immunotherapy comprises Anti-CD70 (e.g. ARGX-110, cusatuzumab), a bispecific antibody (e.g. floteuzumab (CD123 x CD3)), Anti-CTLA4 (e.g. ipilimumab), Anti-PD1/PDL1 (e.g. nivolumab, pembrolizumab, atezolizumab, avelumab, PDR001, MBG453), and/or Anti-CD47 (e.g. 5F9 (Magrolimab)); wherein the Plk inhibitor comprises volasertib and/or rigosertib; wherein the MEK inhibitor comprises trametinib, cobimetinib, selumetinib, pimasertib, and/or refametinib; wherein the CDK9 inhibitor comprises alvocidib and/or voruciclib; wherein the CDK8 inhibitor comprises SEL120; wherein the retinoic acid receptor agonist comprises ATRA (all-trans retinoic acid) and/or SY-1425 (a selective RAR α agonist); wherein the TP53 activator comprises APR-246 (Eprenetapopt); wherein the smoothened receptor antagonist comprises glasdegib; wherein the ERK inhibitor comprises an ERK2/MAPK1 or ERK1/MAPK3 inhibitor comprising ulixertinib, SCH772984, ravoxertinib, MK-8353, and/or VTX-11e; wherein the PI3K inhibitor comprises fimepinostat (CUDC-907), alpelisib, leniolisib (CDZ-173), pilaralisib (XL147, SAR245408), and/or bimiralisib (PQR-309); wherein the mTOR inhibitor comprises bimiralisib (PQR-309), sapanisertib (TAK-228, INK-128), ridaforolimus (MK-8669, AP-23573), everolimus, and/or vistusertib (AZD2014); wherein the glucocorticoid receptor modulator comprises an agonist comprising prednisolone, beclometasone, methylprednisolone, prednisone, fluticasone, budesonide, dexamethasone, and/or cortisol, and/or an antagonist comprising mifepristone, miricorilant, and/or onapristone, and/or another binding ligand comprising vamorolone (VBP15); and/or wherein the EZH2 inhibitor comprises tazemetostat.

[003491] Clause 81. A compound according to any one of Clauses 1-39, for use in a method for treating a disease or disorder, the method comprising inhibiting at least one of IRAK

and FLT3 by administering one or more compositions comprising the compound, wherein the compositions may be the same or different if there is more than one administration.

[00350] Clause 82. The compound of Clause 81, wherein the disease or disorder is responsive to at least one of interleukin-1 receptor-associated kinase (IRAK) inhibition or fms-like tyrosine kinase 3 (FLT3) inhibition.

[00351] Clause 83. The compound of Clause 81 or Clause 82, wherein at least one of the one or more compositions further comprises a formulary ingredient.

[00352] Clause 84. The compound of any of Clauses 81-83, wherein at least one of the one or more compositions comprises the composition of any of Clauses 40-47.

[00353] Clause 85. The compound of any of Clauses 81-84, wherein at least one of the one or more administrations comprises parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, transdermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration.

[00354] Clause 86. The compound of any of Clauses 81-85, wherein at least one of the one or more administrations comprises an oral administration.

[00355] Clause 87. The compound of any of Clauses 81-86, wherein if there is more than one administration at least one composition used for at least one administration is different from the composition of at least one other administration.

[00356] Clause 88. The compound of any of Clauses 81-87, wherein the compound of at least one of the one or more compositions is administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 50 mg /kg subject body weight.

[00357] Clause 89. The compound of any of Clauses 81-88, wherein the subject is a mammal, preferably wherein the subject is a human, a rodent, or a primate.

[00358] Clause 90. The compound of any of Clauses 81-89, wherein the subject is in need of the treatment.

[00359] Clause 91. The compound of any of Clauses 81-90, wherein the method is for treating a hematopoietic cancer.

[00360] Clause 92. The compound of any of Clauses 81-91, wherein the method is for treating MDS and/or AML.

[003611] Clause 93. The compound of any of Clauses 81-91, wherein the method is for treating at least one of lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL with MYD88 mutation, follicular lymphoma, or marginal zone lymphoma.

[003621] Clause 94. The compound of any of Clauses 81-90, wherein the method is for treating at least one cancer selected from glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, or one or more inflammatory diseases or autoimmune disease characterized by overactive IRAK1 and/or IRAK4, or combinations thereof.

[003631] Clause 95. The compound of Clause 94, wherein the method is for treating one or more inflammatory diseases or autoimmune disease selected from chronic inflammation (i.e., associated with viral and bacterial infection), sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, or combinations thereof.

[003641] Clause 96. The compound of any of Clauses 81-92, wherein the method is for treating MDS, MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2, or wherein the method is for treating AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the AML is not driven by FLT3 mutations but expresses IRAK4-Long.

[003651] Clause 97. The compound of any of Clauses 81-93, wherein the method is for treating DLBCL, and wherein the DLBCL comprises a L265P MYD88 mutant (ABC) subtype of DLBCL.

[003661] Clause 98. The compound of Clause 97, wherein the method further comprises administration of a composition comprising a BTK inhibitor.

[003671] Clause 99. The compound of Clause 98, wherein the BTK inhibitor comprises ibrutinib.

[00368] Clause 100. The compound of any of Clauses 81-99, wherein the subject is susceptible to AML and/or MDS, and/or wherein the method prevents or ameliorates future AML and/or MDS.

[00369] Clause 101. The compound of any of Clauses 81-100, wherein the method occurs after one or more of having myelodysplastic syndrome, having myeloproliferative disease, an occurrence of chemical exposure, an exposure to ionizing radiation, or a treatment for cancer.

[00370] Clause 102. The compound of any of Clauses 81-101, wherein the method further comprises administration of a composition comprising a BCL2 inhibitor, or wherein at least one of said compositions comprising the compound of any of claims 1-39 further comprises a BCL2 inhibitor.

[00371] Clause 103. The compound of any of Clauses 81-102, wherein the compound of any of claims 1-39 and the BCL2 inhibitor may be administered together or separately, in one or more administrations of one or more compositions.

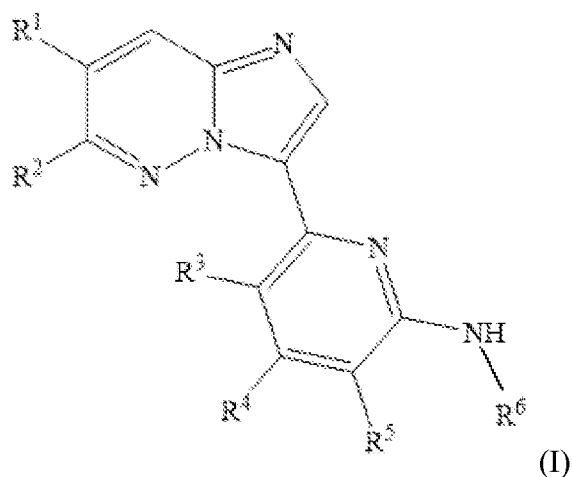
[00372] Clause 104. The compound of any of Clauses 81-103, wherein the BCL2 inhibitor comprises venetoclax, or a salt, isomer, derivative or analog thereof.

[00373] Clause 105. The compound of any of Clauses 81-104, wherein the method further comprises administration of one or more additional therapy selected from one or more chemotherapy, DNA methyltransferase inhibitor/hypomethylating agent, anthracycline, histone deacetylase (HDAC) inhibitor, purine nucleoside analogue (antimetabolite), isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, antibody-drug conjugate, mAbs/immunotherapy, CAR-T cell therapy, Plk inhibitor, MEK inhibitor, CDK9 inhibitor, CDK8 inhibitor, retinoic acid receptor agonist, TP53 activator, smoothened receptor antagonist, ERK inhibitor, PI3K inhibitor, mTOR inhibitor, glucocorticoid receptor modulator, or EZH2 inhibitor, or one or more combinations thereof.

[00374] Clause 106. The compound of any of Clauses 81-105, wherein the DNA methyltransferase inhibitor/hypomethylating agent comprises azacytidine, decitabine, cytarabine, and/or guadecitabine; wherein the anthracycline comprises daunorubicin, idarubicin, doxorubicin, mitoxantrone, epirubicin, and/or CPX-351 (a combination cytarabine and daunorubicin in a fixed 5:1 molar ratio); wherein the histone deacetylase (HDAC) inhibitor comprises vorinostat, panobinostat, valproic acid, and/or pracinostat; wherein the purine nucleoside analogue (antimetabolite) comprises fludarabine, cladribine, and/or clofarabine; wherein the isocitrate

dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor comprises ivosidenib and/or enasidenib; wherein the antibody-drug conjugate comprises Anti-CD33 (e.g. Ac225-lintuzumab, vadastuximab, or gemtuzumab-ozogamicin) and/or Anti-CD45 (e.g. I¹³¹-apamistamab); wherein the mAbs/Immunotherapy comprises Anti-CD70 (e.g. ARGX-110, cusatuzumab), a bispecific antibody (e.g. floteuzumab (CD123 x CD3)), Anti-CTLA4 (e.g. ipilimumab), Anti-PD1/PDL1 (e.g. nivolumab, pembrolizumab, atezolizumab, avelumab, PDR001, MBG453), and/or Anti-CD47 (e.g. 5F9 (Magrolimab)); wherein the Plk inhibitor comprises volasertib and/or rigosertib; wherein the MEK inhibitor comprises trametinib, cobimetinib, selumetinib, pimasertib, and/or refametinib; wherein the CDK9 inhibitor comprises alvocidib and/or voruciclib; wherein the CDK8 inhibitor comprises SEL120; wherein the retinoic acid receptor agonist comprises ATRA (all-trans retinoic acid) and/or SY-1425 (a selective RAR α agonist); wherein the TP53 activator comprises APR-246 (Eprexetapopt); wherein the smoothened receptor antagonist comprises glasdegib; wherein the ERK inhibitor comprises an ERK2/MAPK1 or ERK1/MAPK3 inhibitor comprising ulixertinib, SCH772984, ravoxertinib, MK-8353, and/or VTX-11e; wherein the PI3K inhibitor comprises fimepinostat (CUDC-907), alpelisib, leniolisib (CDZ-173), pilaralisib (XL147, SAR245408), and/or bimiralisib (PQR-309); wherein the mTOR inhibitor comprises bimiralisib (PQR-309), sapanisertib (TAK-228, INK-128), ridaforolimus (MK-8669, AP-23573), everolimus, and/or vistusertib (AZD2014); wherein the glucocorticoid receptor modulator comprises an agonist comprising prednisolone, beclometasone, methylprednisolone, prednisone, fluticasone, budesonide, dexamethasone, and/or cortisol, and/or an antagonist comprising mifepristone, miricorilant, and/or onapristone, and/or another binding ligand comprising vamorolone (VBP15); and/or wherein the EZH2 inhibitor comprises tazemetostat.

[00375] Clause 201. A compound of Formula (I)



or a salt, ester, solvate, optical isomer, geometric isomer, salt of an isomer, prodrug, or derivative thereof,

wherein:

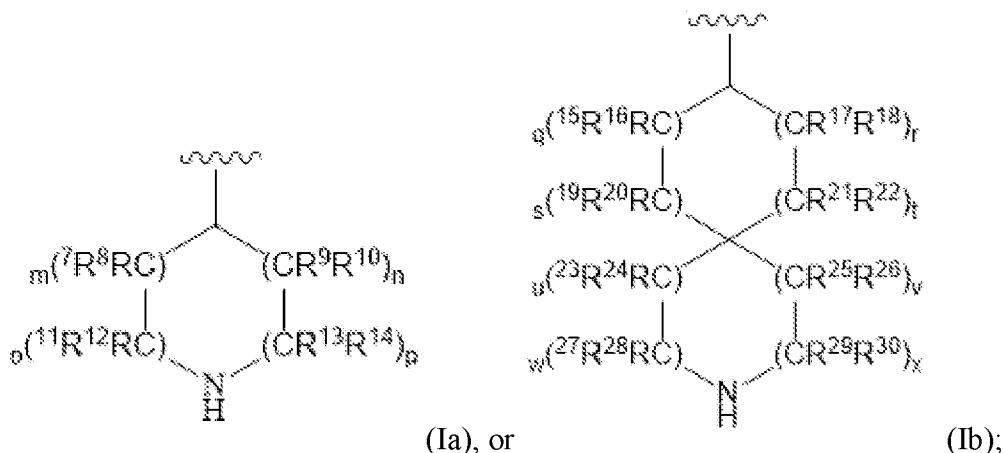
R^1 is selected from H, halogen, hydroxy, oxo, -CN, amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R^2 is selected from H, halogen, hydroxy, oxo, -CN, amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heteroaryl, pyrrolyl, piperidyl, piperazinyl,

morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, fused ring aryl, heteroaryl, fused ring heteroaryl, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R³, R⁴, and R⁵ are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R⁶ is

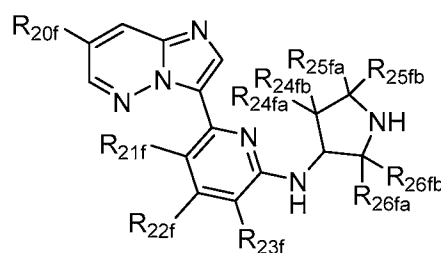


R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, R¹⁴ are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen;

R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , R^{29} , R^{29} , and R^{30} are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen; and

m, n, o, p, q, r, s, t, u, v, w, and x are each independently selected from 0, 1, 2, 3, 4, or 5, where q+r+s+t is at least 1, and where u+v+w+x is at least 1.

[00376] Clause 202. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (Iif)



Formula (Iif),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

R_{20f} is selected from H, halogen, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and -O-(C₃-C₆ cycloalkyl), wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, and wherein C₃-C₆ cycloalkyl and -O-(C₃-C₆ cycloalkyl) are each optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen;

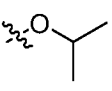
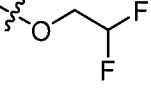
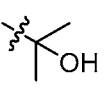
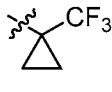
R_{21f}, R_{22f}, and R_{23f} are each independently selected from H and halogen; and

R_{24fa}, R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} are each independently selected from H, halogen, -OH, C₁-C₆ alkyl, and C₁-C₆ alkoxy, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more halogen atoms.

[00377] Clause 203. The compound of clause 202, wherein one or more of R_{24fa}, R_{24fb}, R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} is independently selected from halogen, -OH, optionally substituted C₁-C₆ alkyl, and optionally substituted C₁-C₆ alkoxy.

[003781] Clause 204. The compound of clause 202 or 203, wherein R_{20f} is H.

[003791] Clause 205. The compound of any one of clauses 202-204, wherein at least one of (i)-(iii) applies:

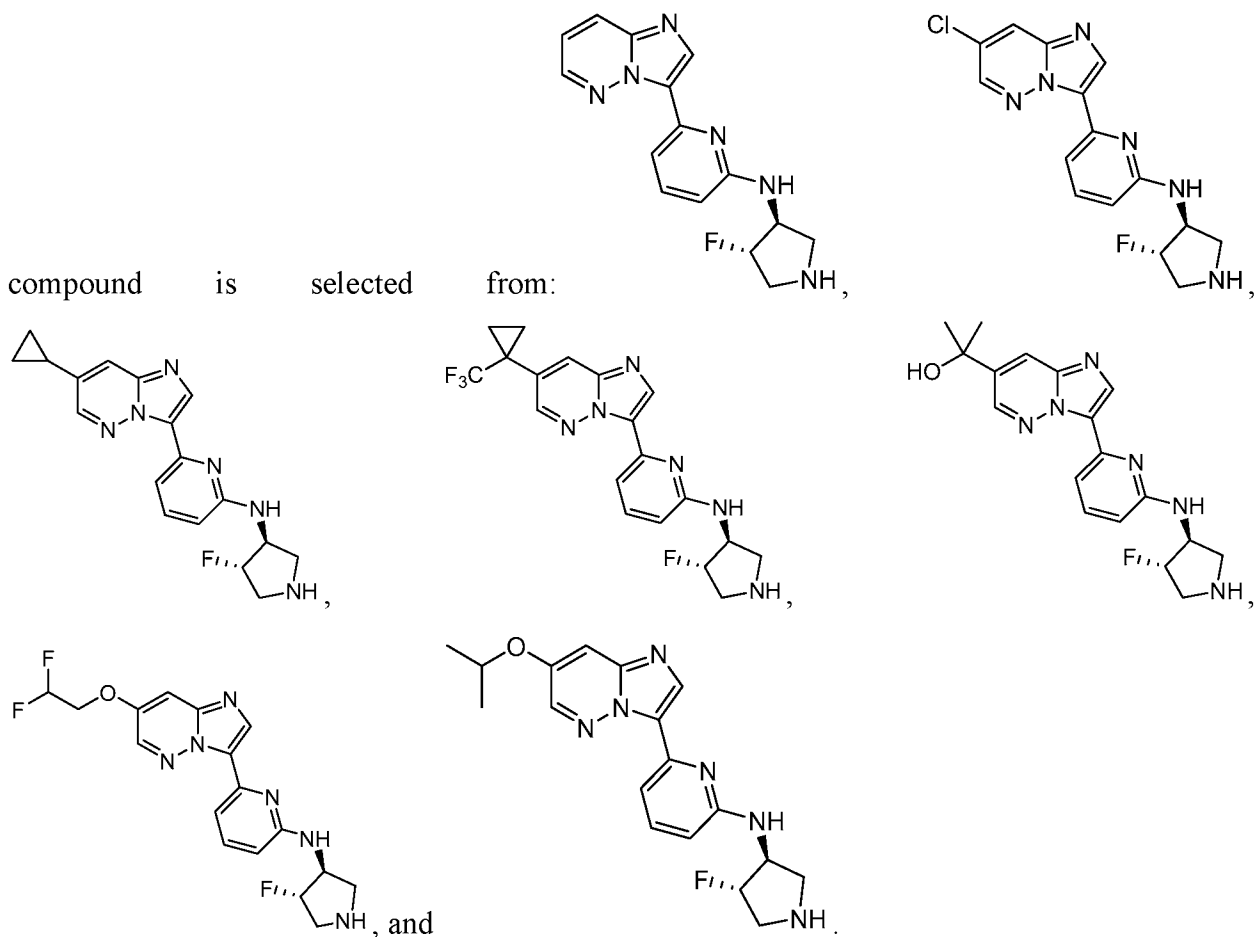
(i) R_{20f} is selected from Cl, , , , unsubstituted C₃ cycloalkyl, and  ;

(ii) R_{21f}, R_{22f}, and R_{23f} are each H;

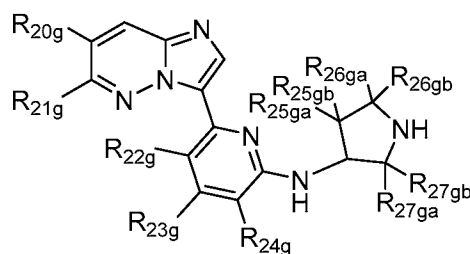
(iii) R_{25fa}, R_{25fb}, R_{26fa}, and R_{26fb} are each H and R_{24fa} and/or R_{24fb} is F.

[003801] Clause 206. The compound of any one of clauses 202-2055, wherein the

compound is selected from:



[003811] Clause 207. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (IIg)



formula (IIg),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

R_{20g} is selected from H and C₁-C₆ alkoxy;

R_{21g} is selected from halogen, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, -O-(C₆-C₁₂ aryl), C₃-C₉ heterocyclyl, and -NR_{28ga}R_{28gb}, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and wherein C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, -OH, and halogen;

R_{22g}, R_{23g}, and R_{24g} are each independently selected from H and halogen;

R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} are each independently selected from H, halogen, -OH, C₁-C₆ alkyl, and C₁-C₆ alkoxy, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more halogen atoms; and

R_{28ga} and R_{28gb} are each independently selected from H, C₁-C₆ alkyl, and C₃-C₆ cycloalkyl.

[00382] Clause 208. The compound of clause 207, wherein one or more of R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} is independently selected from halogen, -OH, optionally substituted C₁-C₆ alkyl, and optionally substituted C₁-C₆ alkoxy.

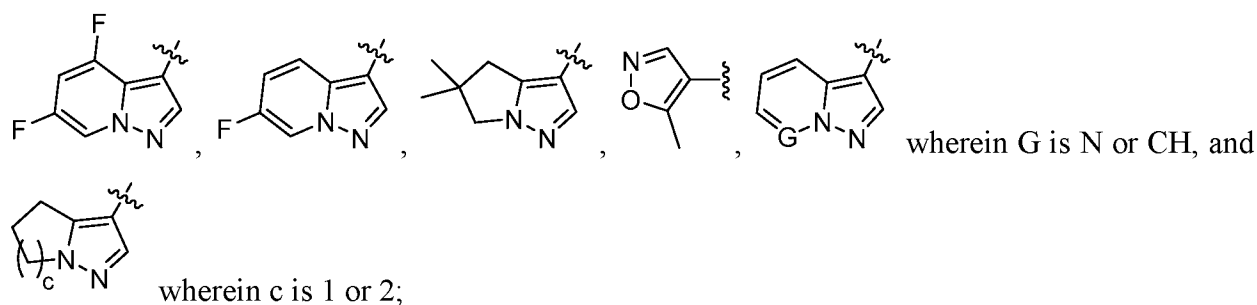
[00383] Clause 209. The compound of clause 207 or 208, wherein R_{20g} is H.

[00384] Clause 210. The compound of any one of clauses 206-209, wherein at least one of (i)-(ix) applies:

(i) R_{20g} is selected from -OCH₃ and ;

(ii) R_{21g} is selected from t-butyl, unsubstituted C₃ cycloalkyl, morpholinyl, azetidiny,

piperdiny, isoxazoly, Cl, -CF₃, -OCH₃, -O-phenyl, , , , ,



(iii) R_{21g} is  wherein R_{29g} is selected from H, isopropyl, unsubstituted C₃

cycloalkyl, azetidiny, tetrahydropyranyl -CH₃, , and .

(iv) R_{21g} is -NR_{28ga}R_{28gb} wherein R_{28ga} is H and R_{28gb} is selected from -CH₃, cyclobutyl, and cyclohexyl or wherein R_{28ga} and R_{28gb} are each -CH₃;

(v) R_{22g} , R_{23g} , and R_{24g} are each H;

(vi) R_{22g} and R_{24g} are each F and R_{23g} is H;

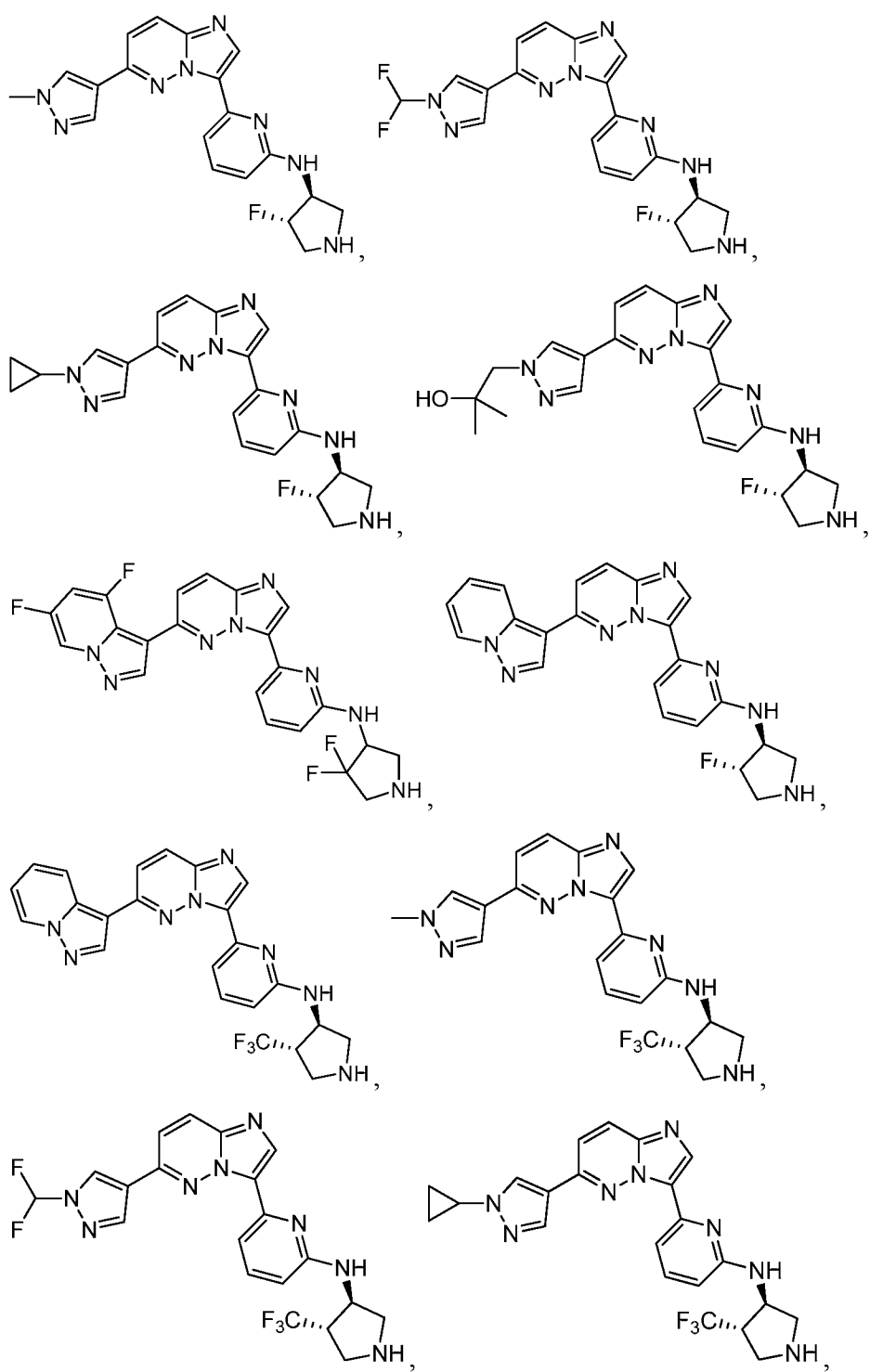
(vii) R_{22g} and R_{24g} are each H and R_{23g} is F;

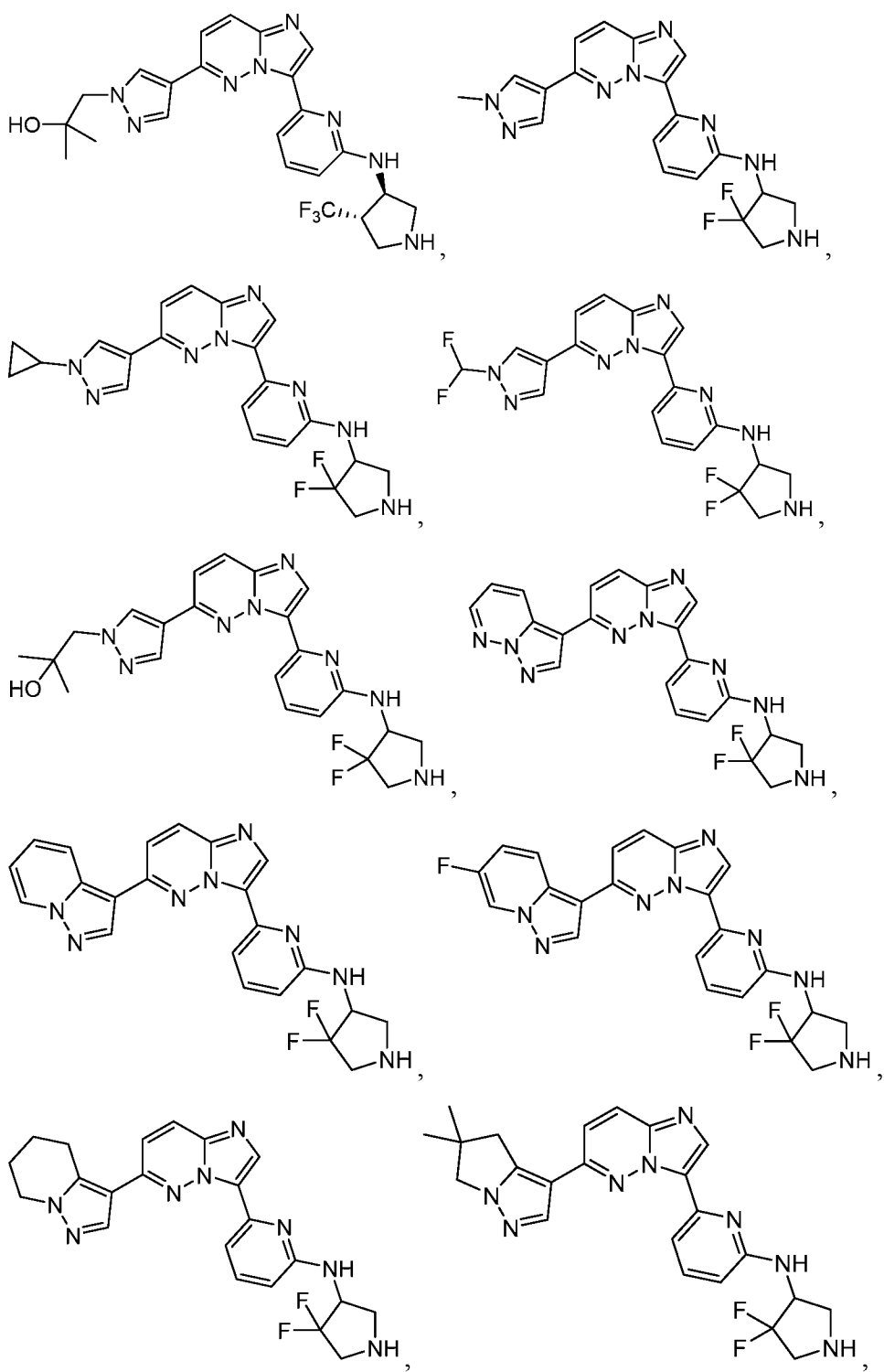
(viii) R_{25ga} , R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} are each H;

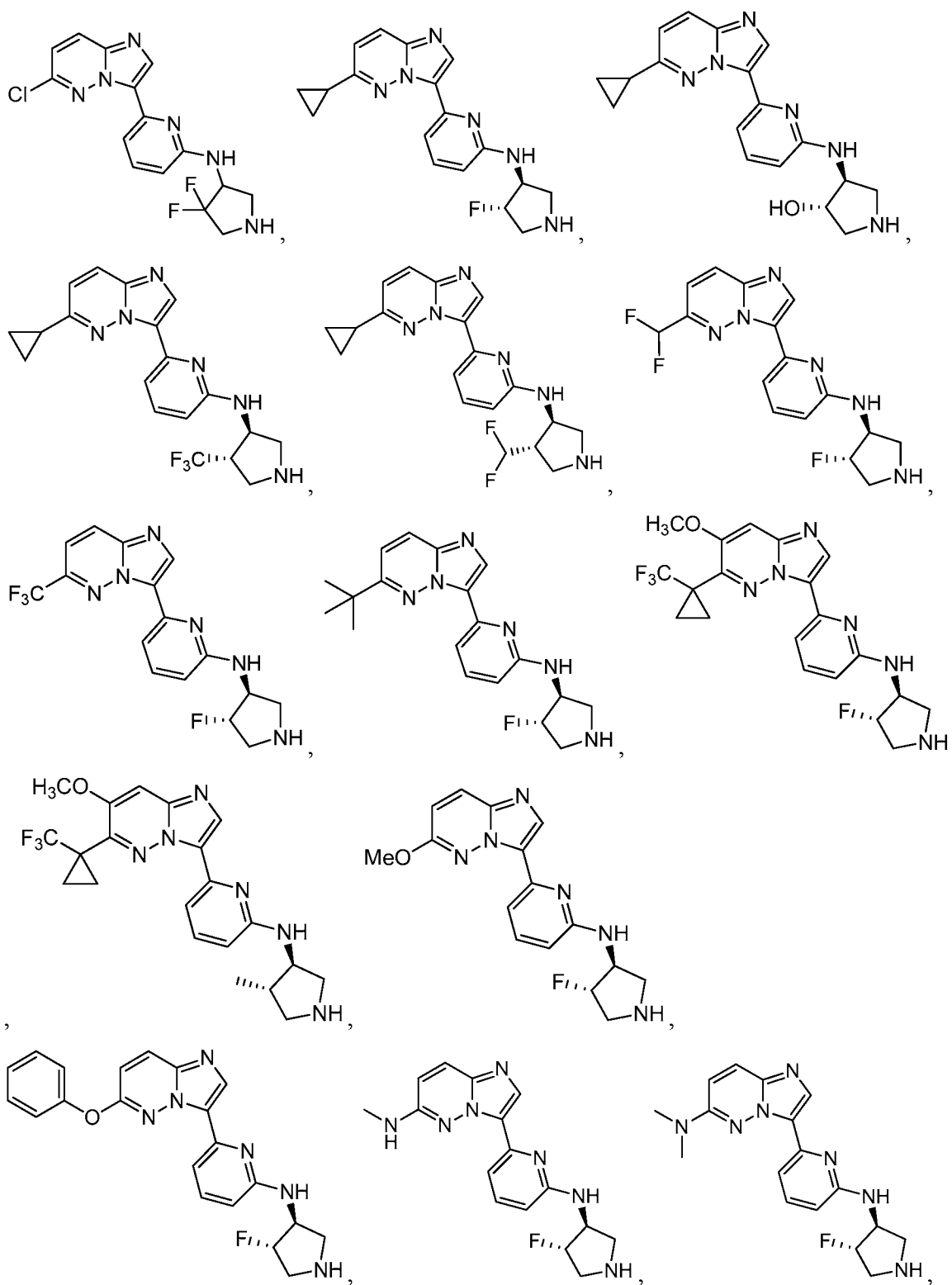
(ix) R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} are each H and R_{25ga} and/or R_{25gb} are selected from F, -

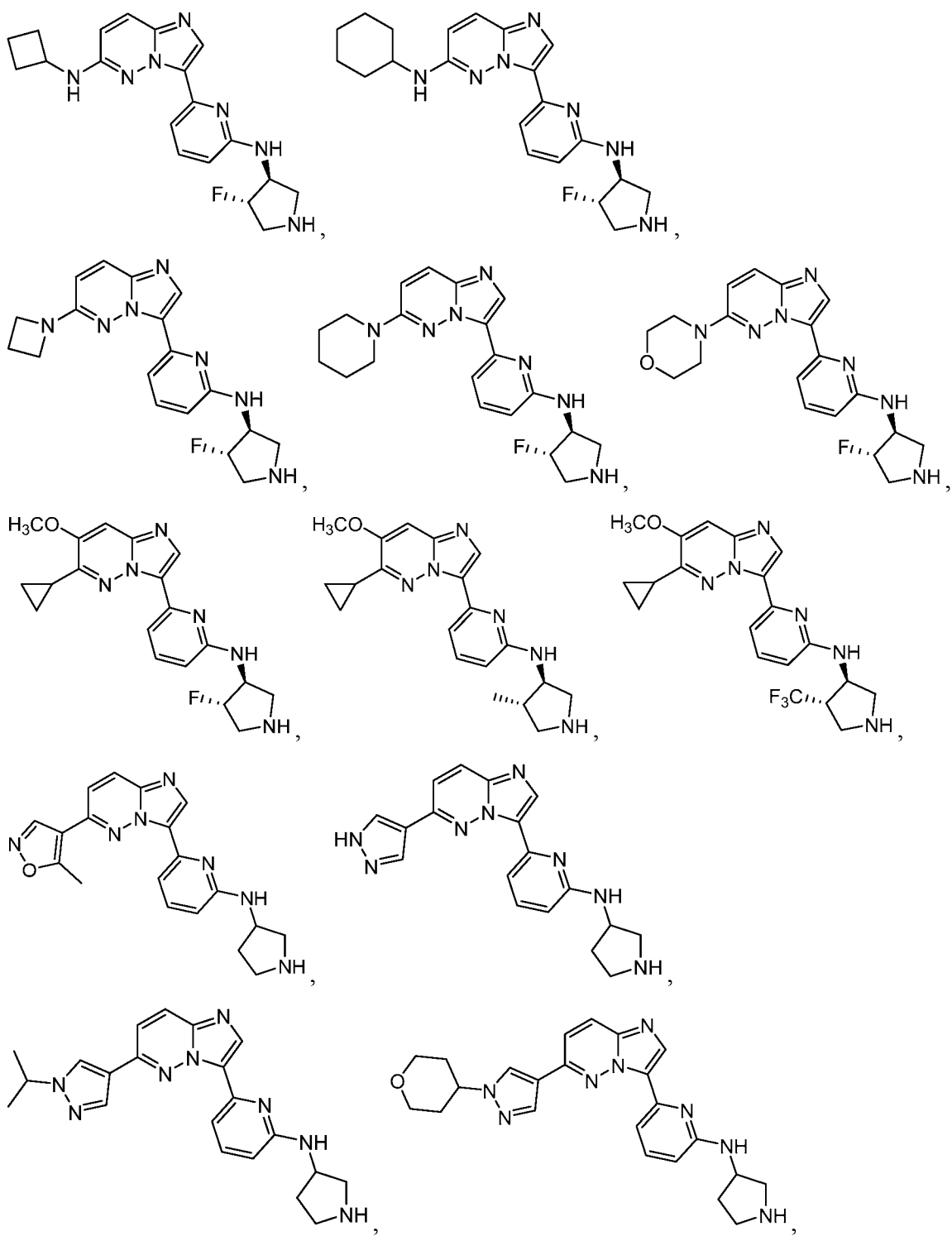
CH₃, -OH, -CF₃, , and -OCH₃.

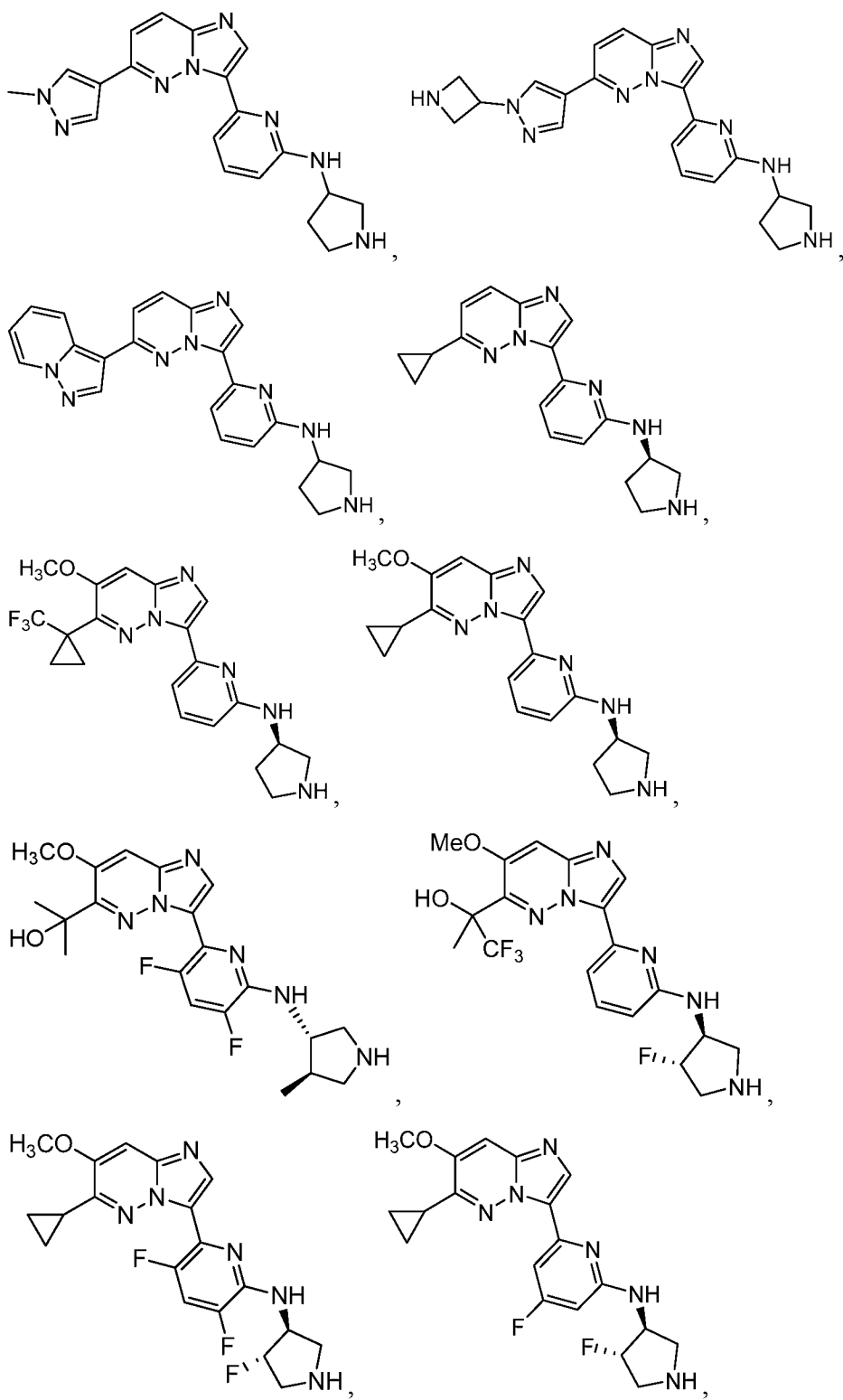
[00385] Clause 211. The compound of any one of clauses 207-210, wherein the compound is selected from:

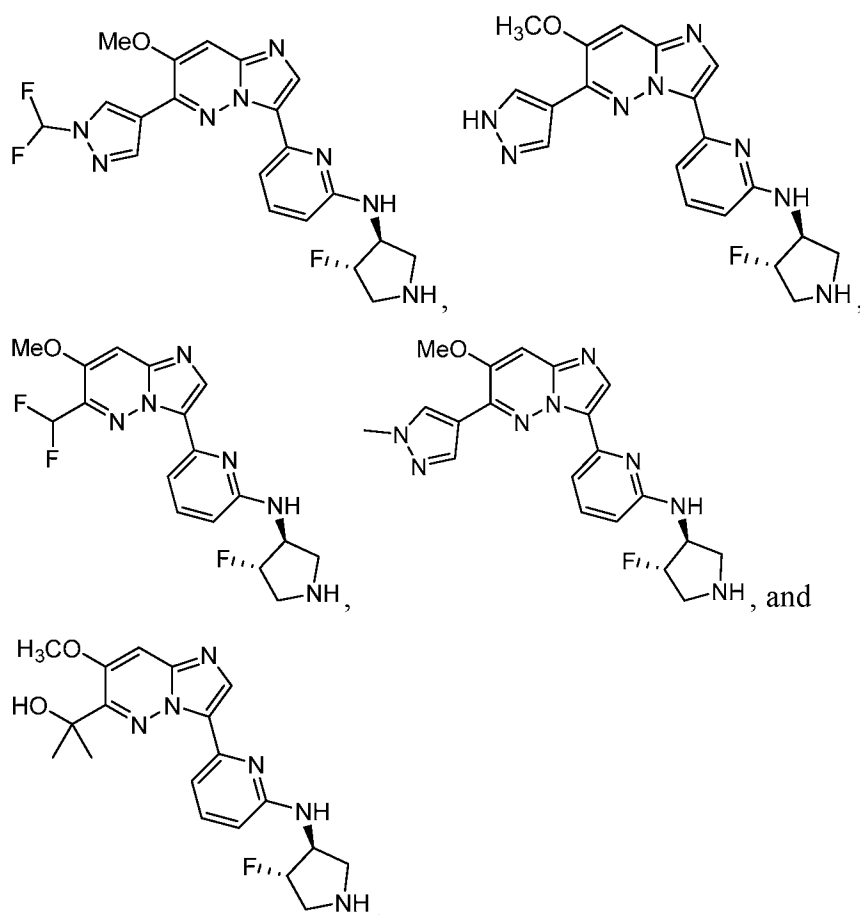




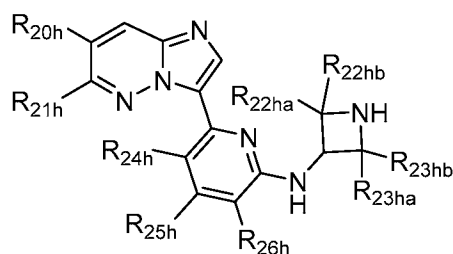








[00386] Clause 212. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (IIh)



Formula (IIh),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

R_{20h} is selected from H and C₁-C₆ alkoxy;

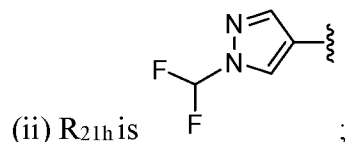
R_{21h} is selected from C₁-C₆ alkyl, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl is optionally substituted with one or more substituents selected from -OH and halogen and wherein C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl are each optionally substituted with one or more substituents selected from C₁-C₆ alkyl, -OH, and halogen;

R_{22ha} , R_{22hb} , R_{23ha} , and R_{23hb} are each independently selected from H and C_1 - C_6 alkyl, wherein C_1 - C_6 alkyl is optionally substituted with one or more halogen atoms; and

R_{24h} , R_{25h} , and R_{26h} are each independently selected from H and halogen.

[00387] Clause 213. The compound of clause 212, wherein at least one of (i)-(iv) applies:

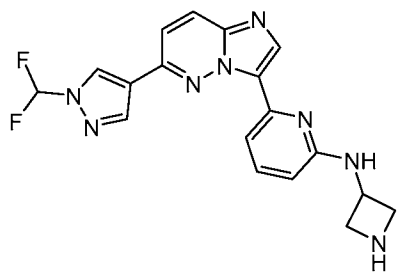
(i) R_{20h} is H;



(iii) R_{22ha} , R_{22hb} , R_{23ha} , and R_{23hb} are each H;

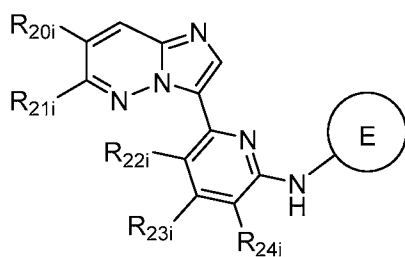
(iii) R_{24h} , R_{25h} , and R_{26h} are each H.

[00388] Clause 214. The compound of clause 212 or 213, wherein the compound



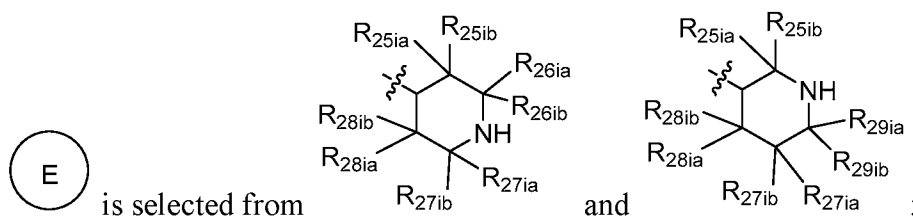
is

[00389] Clause 215. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (IIi)



Formula (IIi),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:



R_{20i} is selected from H, and C₁-C₆ alkoxy;

R_{21i} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and wherein C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, -OH, -C=O, and halogen;

R_{22i}, R_{23i}, and R_{24i} are each independently selected from H and halogen; and

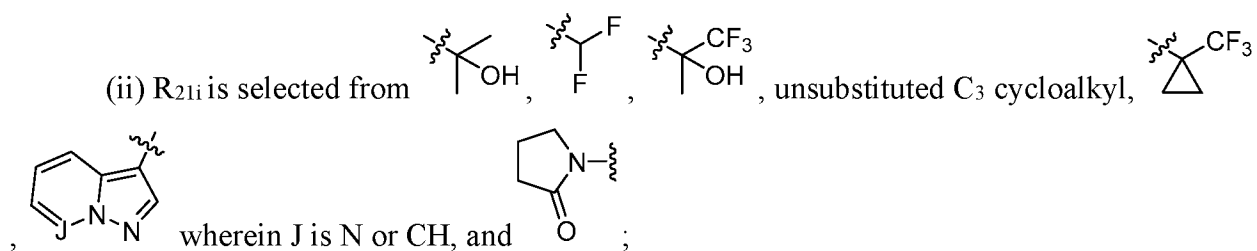
R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} are each independently selected from H, halogen, -OH, or C₁-C₆ alkyl.

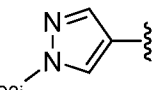
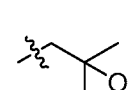
[00390] Clause 216. The compound of clause 215, wherein one or more of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is independently selected from halogen, -OH, and C₁-C₆ alkyl.

[00391] Clause 217. The compound of clause 215, wherein each of R_{25ia}, R_{25ib}, R_{26ia}, R_{26ib}, R_{27ia}, R_{27ib}, R_{28ia}, R_{28ib}, R_{29ia}, and R_{29ib} is H.

[00392] Clause 218. The compound of any one of clauses 215-217, wherein at least one of (i)-(xi) applies:

(i) R_{20i} is selected from H and -OCH₃;

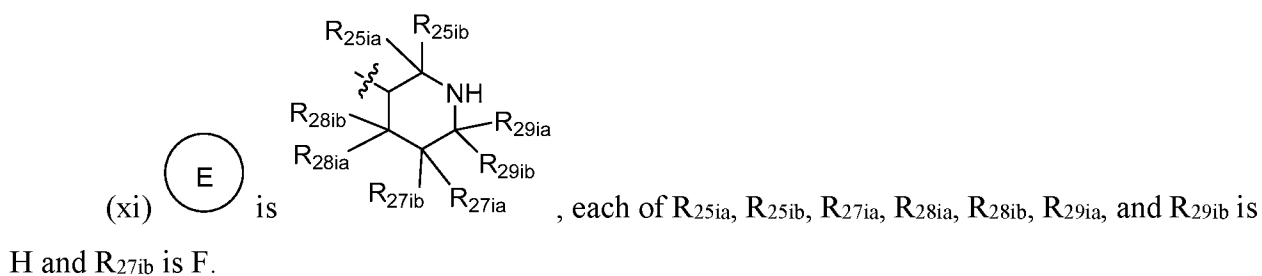
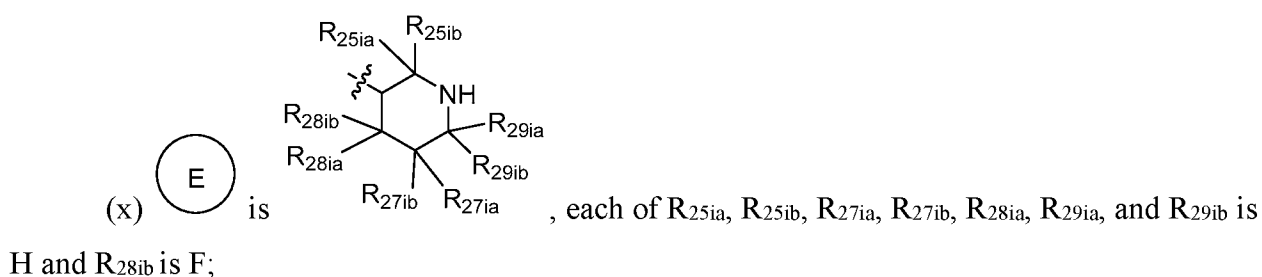
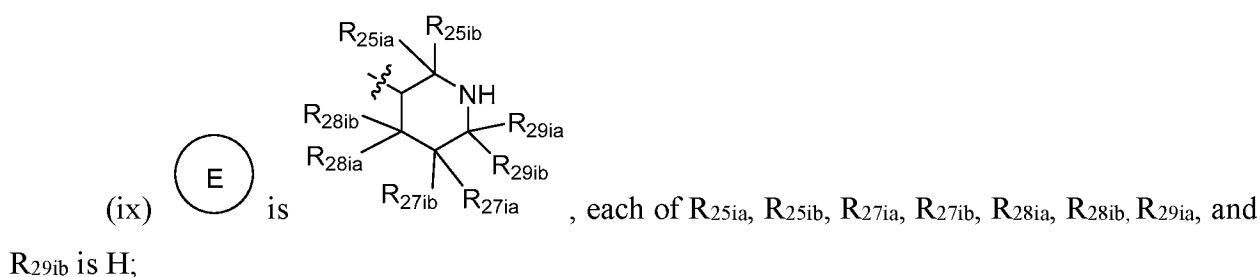
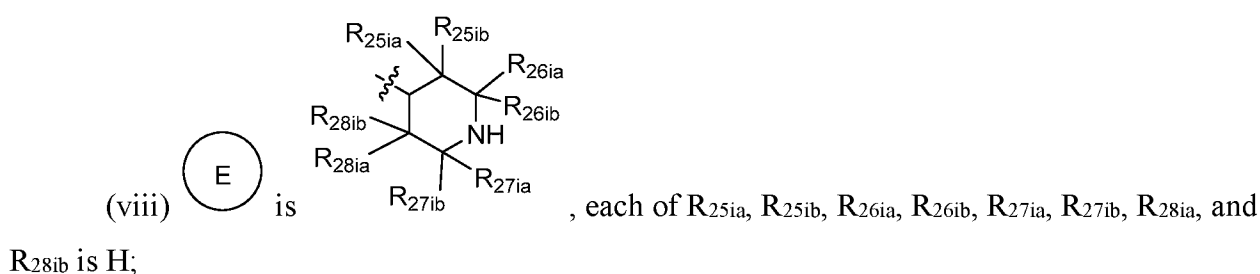
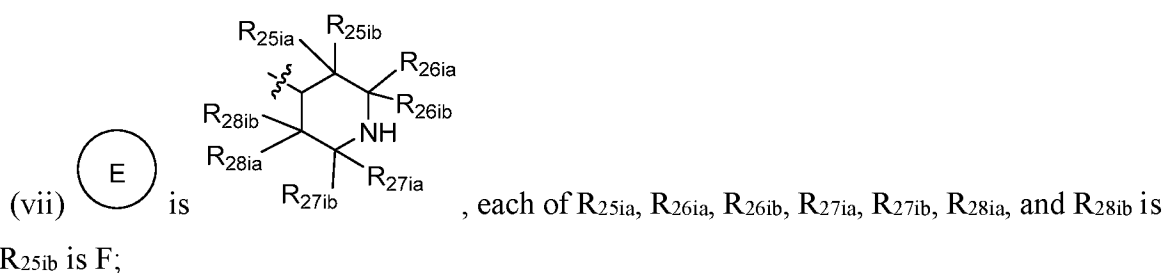


(iii) R_{21i} is R_{220i}

 wherein R_{220i} is selected from H, -CH₃,
 
,
 
, and unsubstituted C₃ cycloalkyl;

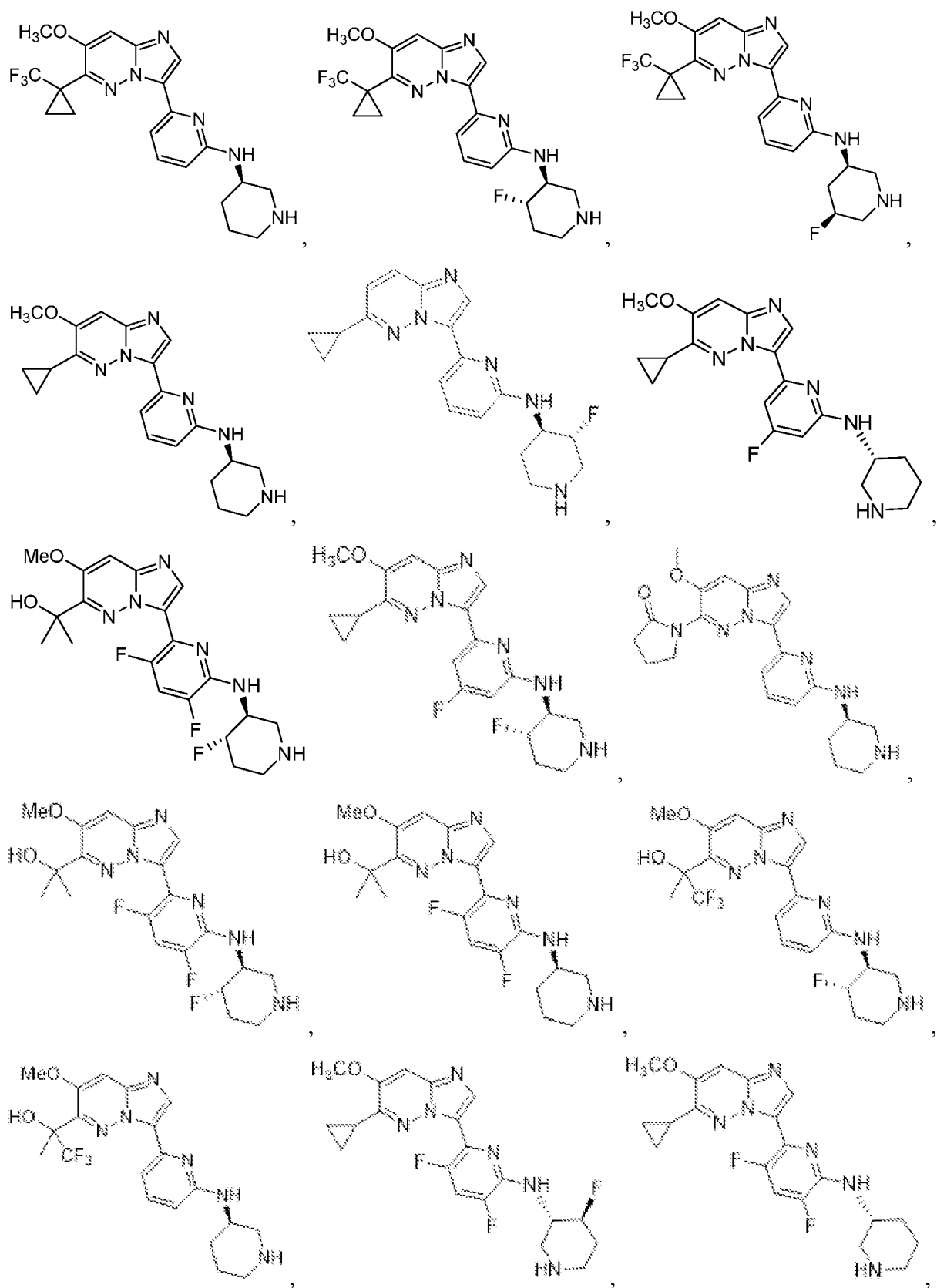
(iv) R_{22i}, R_{23i}, and R_{24i} are each H;

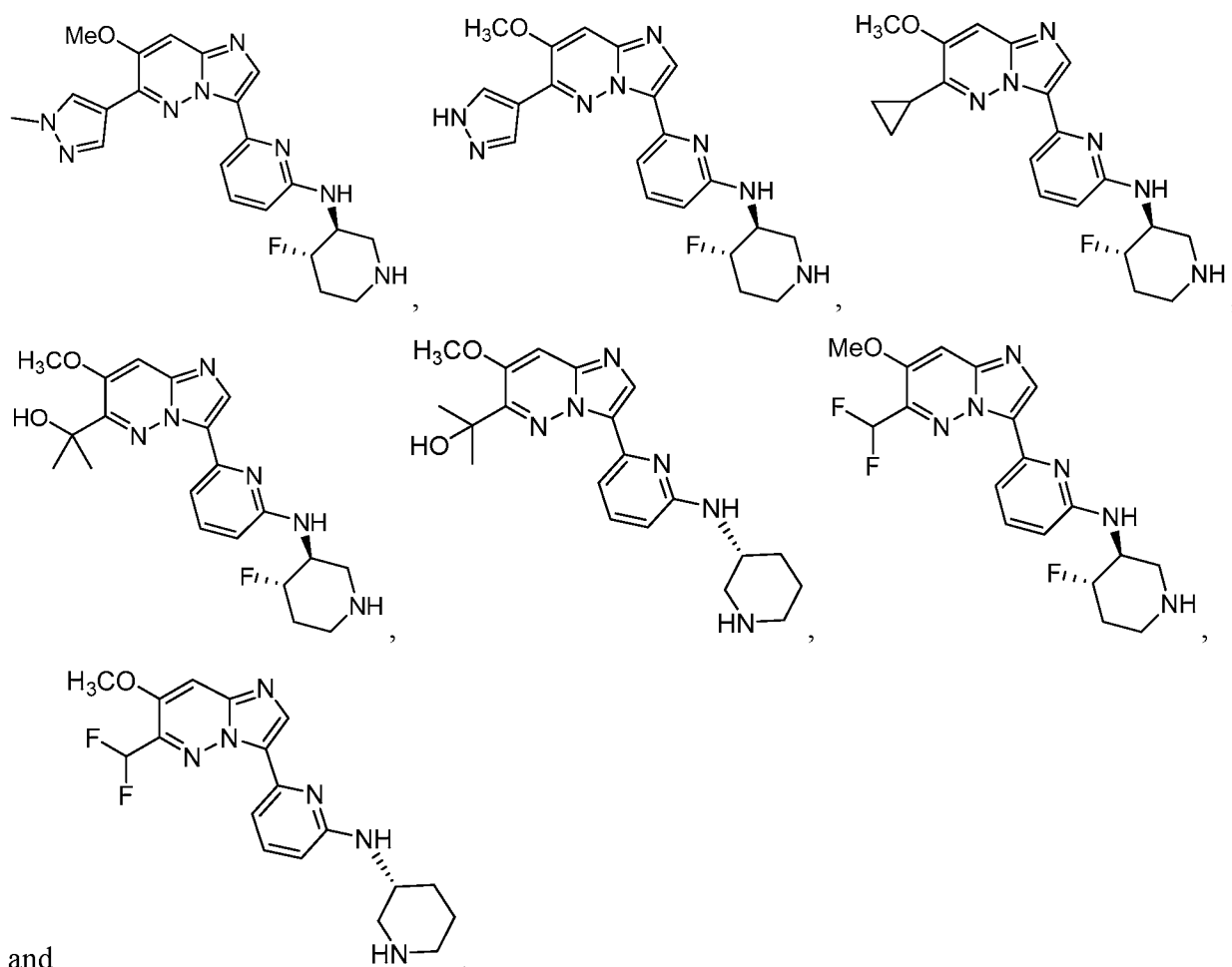
(v) R_{22i} and R_{24i} are each F and R_{23i} is H;

(vi) R_{22i} and R_{24i} are each H and R_{23i} is F;

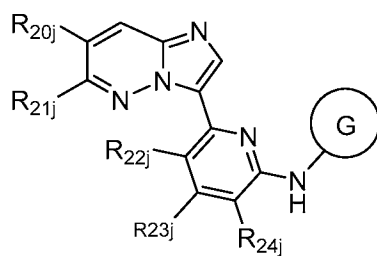


[00393] Clause 219. The compound of any one of clauses 215-218, wherein the compound is selected from:



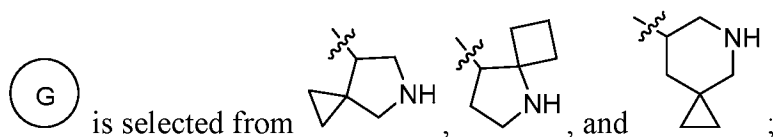


[00395] Clause 220. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (IIj)



Formula (IIj),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:



R_{20j} is selected from H, and C₁-C₆ alkoxy;

R_{21j} is selected from H, C₁-C₆ alkyl, C₁-C₆ alkoxy, and C₃-C₆ cycloalkyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from halogen and -OH, and wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen; and

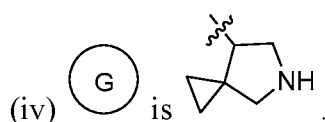
R_{22j}, R_{23j}, and R_{24j} are each independently selected from H and halogen.

[00396] Clause 221. The compound of clause 220, wherein at least one of (i)-(iv) applies:

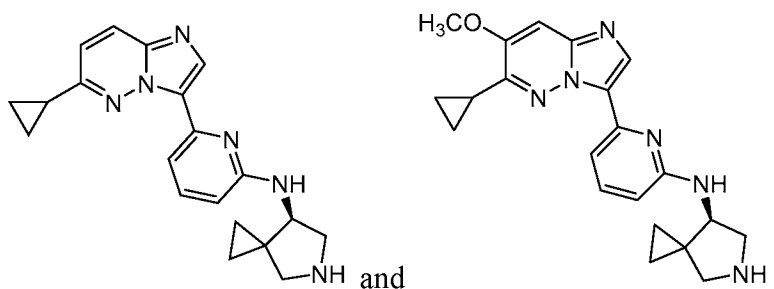
(i) R_{20j} is selected from H and -OCH₃;

(ii) R_{21j} is unsubstituted C₃ cycloalkyl;

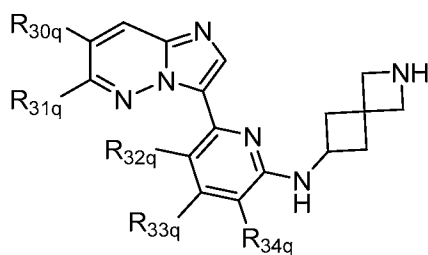
(iii) R_{22j}, R_{23j}, and R_{24j} are each H;



[00397] Clause 222. The compound of clause 220 or 221, wherein the compound is selected from:



[00398] Clause 223. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (IIIq)



Formula (IIIq),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

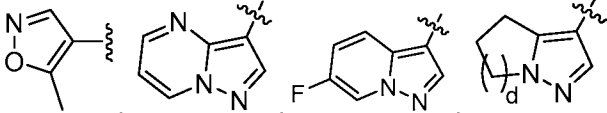
R_{30q} is selected from H and C₁-C₆ alkoxy;

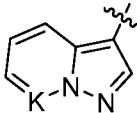
R_{31q} is selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_3 - C_6 cycloalkyl, and C_3 - C_9 heterocyclyl, wherein C_1 - C_6 alkyl and C_1 - C_6 alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C_3 - C_6 cycloalkyl is optionally substituted with one or more substituents selected from C_1 - C_6 alkyl and halogen, and wherein C_3 - C_9 heterocyclyl is optionally substituted with one or more substituents selected from C_1 - C_6 alkyl, C_3 - C_6 -cycloalkyl, C_3 - C_9 -heterocyclyl, C_6 - C_{12} aryl, -OH, -C=O, and halogen; and

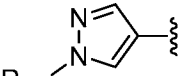
R_{32q} , R_{33q} , and R_{34q} are each independently selected from H and halogen.

[00399] Clause 224. The compound of clause 223, wherein at least one of (i)-(iv) applies:

(i) R_{30q} is H;

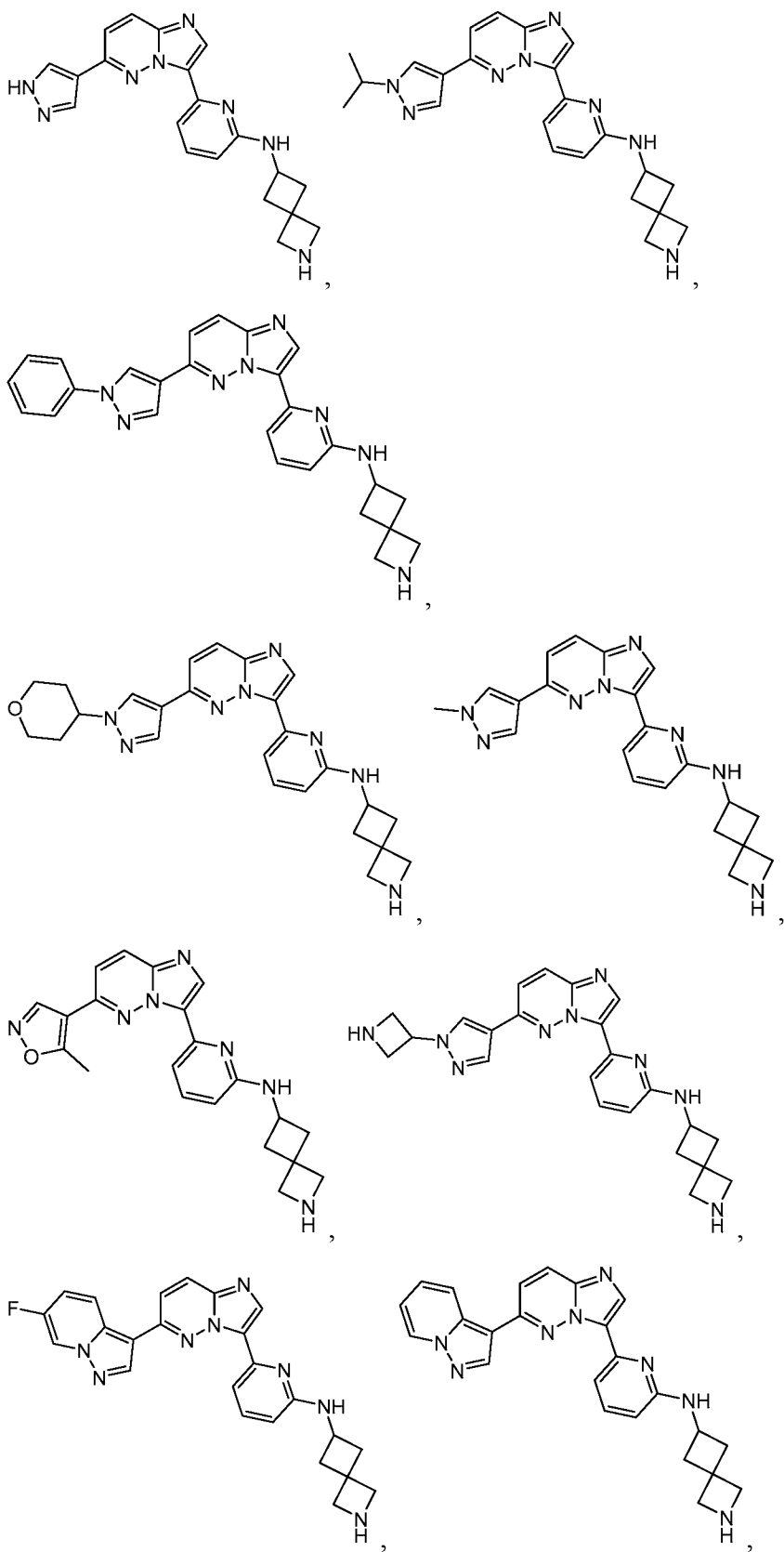
(ii) R_{31q} is selected from  wherein d is 1 or

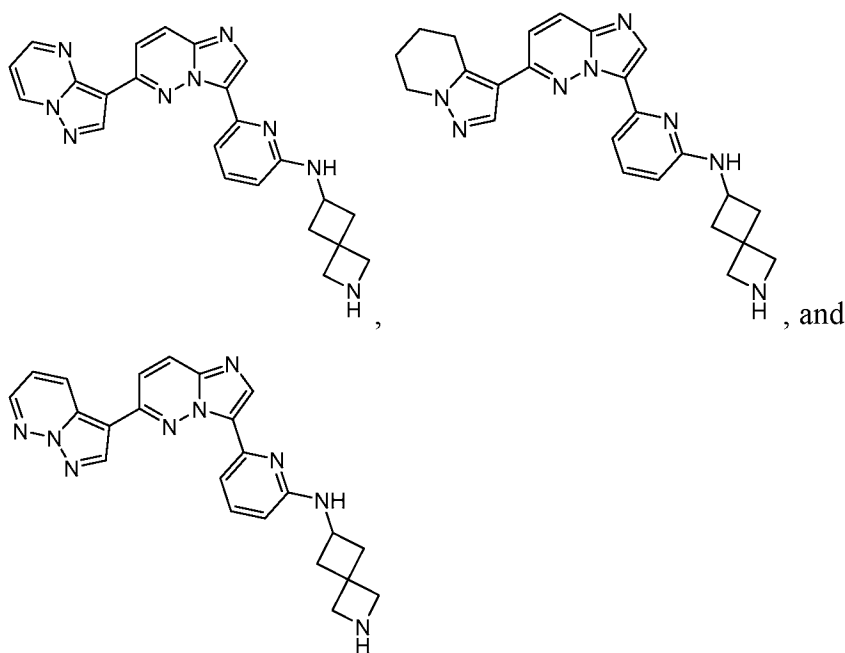
2, and  wherein K is N or CH;

(iii) R_{31q} is  wherein R_{35q} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyranyl;

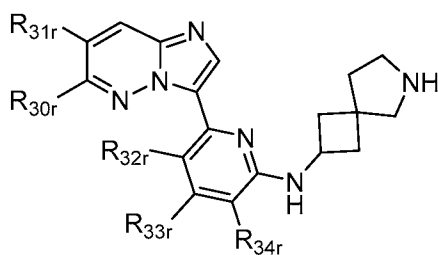
(iv) R_{32q} , R_{33q} , and R_{34q} are each H.

[00400] Clause 225. The compound of clause 223 or 224, wherein the compound is selected from:





[00401] Clause 226. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (IIIr)



Formula (IIIr),

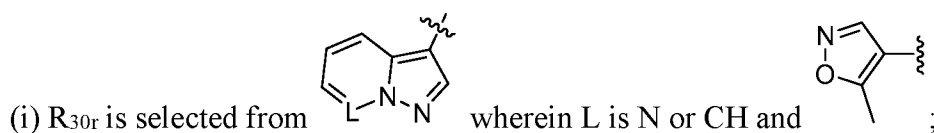
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

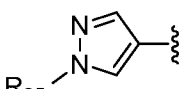
R_{30r} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and wherein C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen;

R_{31r} is selected from H and C₁-C₆ alkoxy; and

R_{32r}, R_{33r}, and R_{34r} are each independently selected from H and halogen.

[00402] Clause 227. The compound of clause 226, wherein at least one of (i)-(iv) applies:

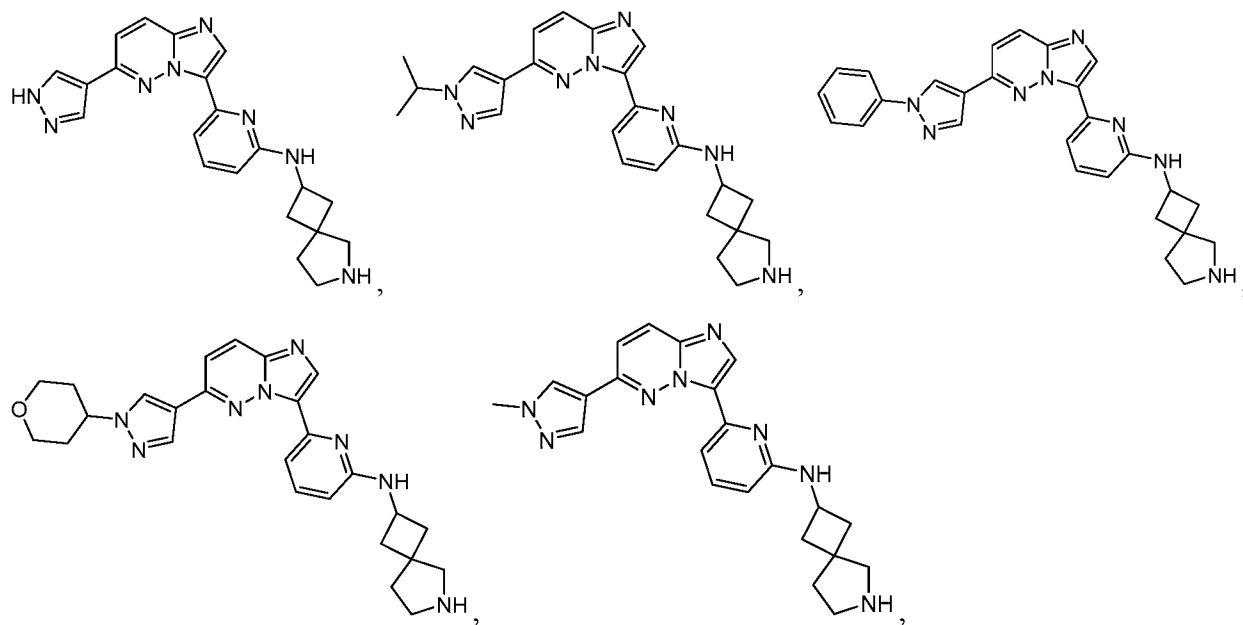


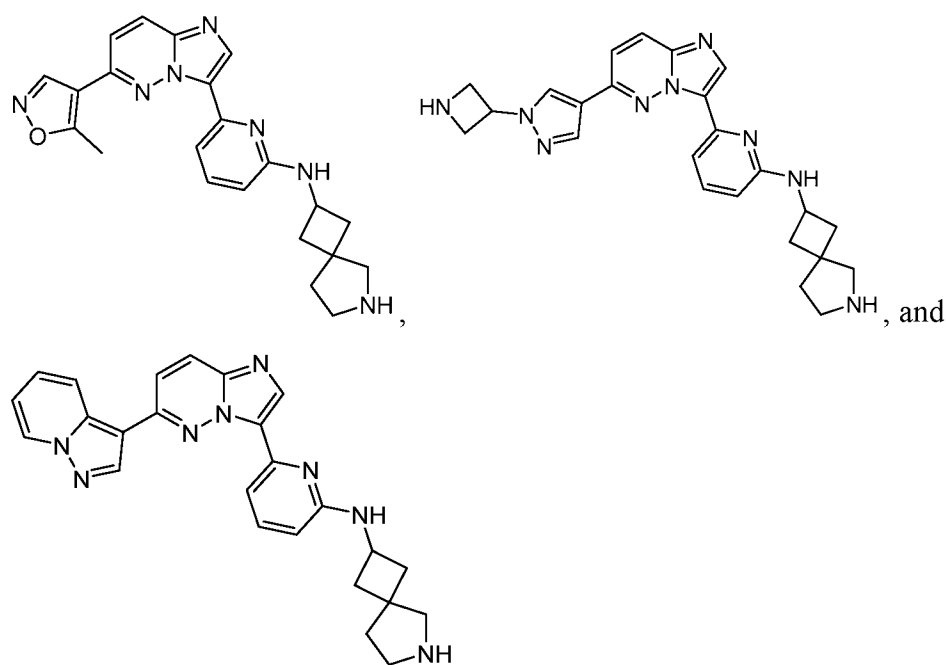
(ii) R_{30r} is  wherein R_{35r} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyranyl;

(iii) R_{31r} is H;

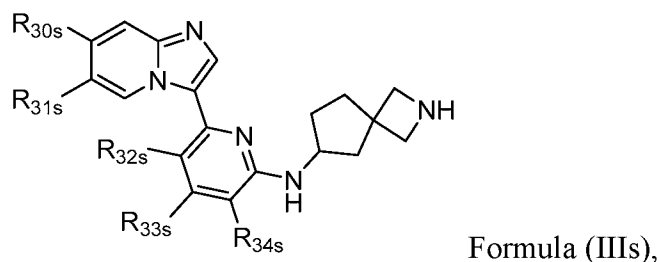
(iv) R_{32r} , R_{33r} , and R_{34r} are each H.

[00403] Clause 228. The compound of clause 226 or clause 227, wherein the compound is selected from:





[00404] Clause 229. The compound of clause 201, wherein the compound of Formula (I) is a compound of Formula (III_s)



Formula (III_s),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:

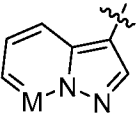
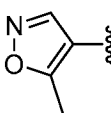
R_{30s} is selected from H and C₁-C₆ alkoxy;

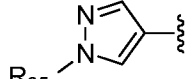
R_{31s} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and wherein C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; and

R_{32s} , R_{33s} , and R_{34s} are each independently selected from H and halogen.

[00405] Clause 230. The compound of clause 229, wherein at least one of (i)-(iv) applies:

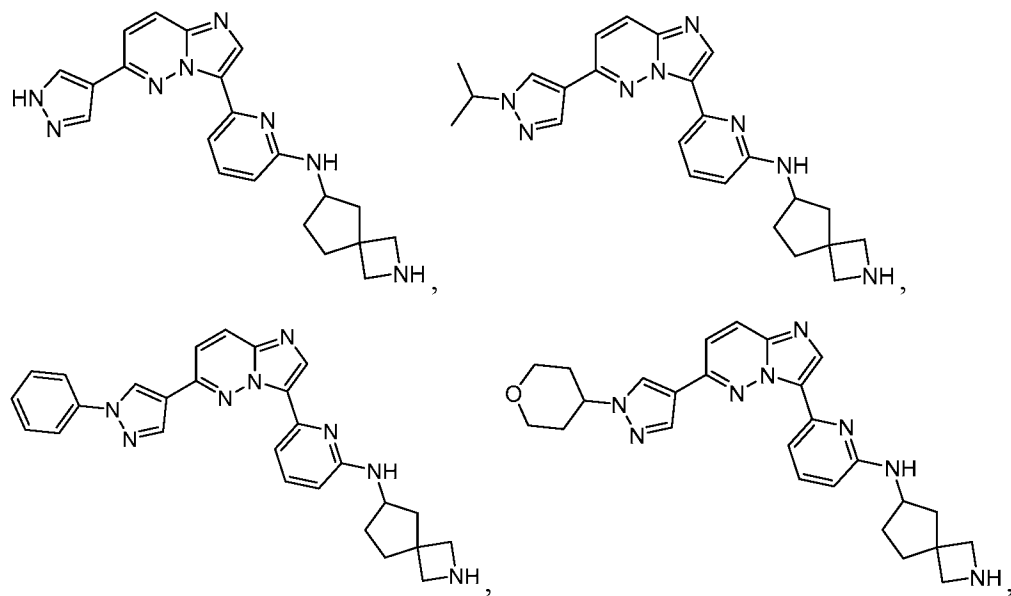
(i) R_{30s} is H;

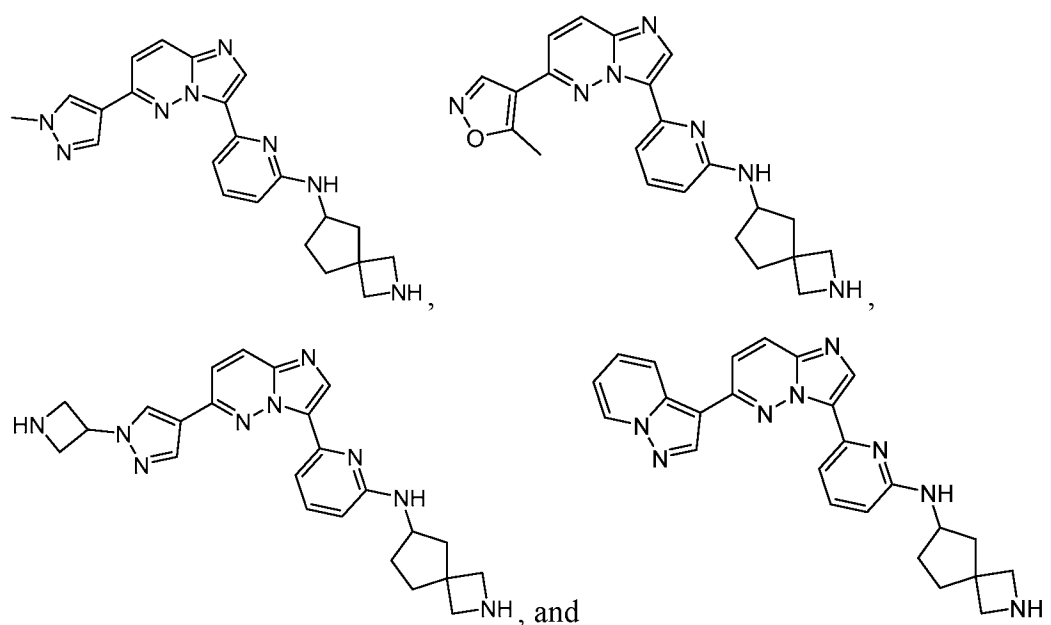
(ii) R_{31s} is selected from  wherein M is N or CH and  ;

(iii) R_{31s} is  wherein R_{35s} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyrany;

(iv) R_{32s} , R_{33s} , and R_{34s} are each H.

[00406] Clause 231. The compound of clause 229 or 230, wherein the compound is selected from:





[00407] Clause 232. The compound of any one of clauses 201-231, wherein the compound is an inhibitor of at least one of IRAK1, IRAK4, and FLT3.

[00408] Clause 233. The compound of any one of clauses 201-132, wherein the compound is an inhibitor of at least two of IRAK1, IRAK4, and FLT3.

[00409] Clause 234. The compound of any one of clauses 201-233, wherein the compound is an inhibitor of IRAK1 and IRAK4.

[00410] Clause 235. The compound of any one of clauses 201-234, wherein the compound is an inhibitor of IRAK1, IRAK4, and FLT3.

[00411] Clause 236. The compound of any one of clauses 232, 233, or 235, wherein FLT3 is selected from WT FLT3, activated FLT3, and mutated FLT3.

[00412] Clause 237. The compound of clause 236, wherein the mutated FLT3 is D835Y mutated FLT3 or F691L mutated FLT3.

[00413] Clause 238. A composition comprising a compound of any one of clauses 201-237, wherein the composition further comprises a formulary ingredient, an adjuvant, or a carrier.

[00414] Clause 239. The composition of clause 238, wherein the composition is used in combination with one or more of: a chemotherapy agent, a BCL2 inhibitor, an immune modulator, a BTK inhibitor, a DNA methyltransferase inhibitor/hypomethylating agent, an anthracycline, a histone deacetylase (HDAC) inhibitor, a purine nucleoside analogue

(antimetabolite), an isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, an antibody-drug conjugate, an mAbs/immunotherapy, a Plk inhibitor, a MEK inhibitor, a CDK inhibitor, a CDK9 inhibitor, a CDK8 inhibitor, a retinoic acid receptor agonist, a TP53 activator, a CELMoD, a smoothened receptor antagonist, an ERK inhibitor including an ERK2/MAPK1 or ERK1/MAPK3 inhibitor, a PI3K inhibitor, an mTOR inhibitor, a steroid or glucocorticoid receptor modulator, an EZH2 inhibitor, a hedgehog (Hh) inhibitor, a Topoisomerase I inhibitor, a Topoisomerase II inhibitor, an aminopeptidase/Leukotriene A4 hydrolase inhibitor, a FLT3/Axl/ALK inhibitor, a FLT3/KIT/PDGFR, PKC, and/or KDR inhibitor, a Syk inhibitor, an E-selectin inhibitor, an NEDD8-activator, an MDM2 inhibitor, a PLK1 inhibitor, an Aurora A inhibitor, an aurora kinase inhibitor, an EGFR inhibitor, an AuroraB/C/VEGFR1/2/3/FLT3/CSF-1R/Kit/PDGFR α /B inhibitor, an AKT 1, 2, and/or 3 inhibitor, a ABL1/2/SRC/EPHA2/LCK/YES1/KIT/PDGFR β /FYN inhibitor, a farnesyltransferase inhibitor, a BRAF/MAP2K1/MAP2K2 inhibitor, a Menin-KMT2A/MLL inhibitor, and a multikinase inhibitor.

[00415] Clause 240. The composition of clause 239, wherein the composition is used in combination with a BCL2 inhibitor.

[00416] Clause 241. The composition of clause 240, wherein the BCL2 inhibitor is venetoclax or a pharmaceutically acceptable salt thereof.

[00417] Clause 242. A method of treating a disease or disorder in a subject, the method comprising administering to the subject a therapeutically effective amount of a compound of any one of clauses 201-237 or a composition of any one of clauses 238-241.

[00418] Clause 243. The method of clause 242, wherein the method comprises administering to the subject a composition comprising the therapeutically effective amount of the compound of clause 201 and a formulary ingredient, an adjuvant, or a carrier.

[00419] Clause 244. The method of clause 242 or 243, wherein the disease or disorder is responsive to at least one of interleukin-1 receptor-associated kinase (IRAK) inhibition and fms-like tyrosine kinase 3 (FLT3) inhibition.

[00420] Clause 245. The method of any one of clauses 242-244, wherein the administration comprises parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration,

oral administration, sublingual administration, intranasal administration, or intramuscular administration.

[00421] Clause 246. The method of any one of clauses 242-245, wherein the compound is administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 1,000 mg /kg subject body weight.

[00422] Clause 247. The method of any one of clauses 242-246, wherein the disease or disorder comprises a hematopoietic cancer.

[00423] Clause 248. The method of any one of clauses 242-246, wherein the disease or disorder comprises myelodysplastic syndrome (MDS) and/or acute myeloid leukemia (AML).

[00424] Clause 249. The method of any one of clauses 242-246, wherein the disease or disorder comprises lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL with MYD88 mutation, follicular lymphoma, or marginal zone lymphoma.

[00425] Clause 250. The method of any one of clauses 242-246, wherein the disease or disorder comprises at least one cancer selected from glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, or one or more inflammatory diseases or autoimmune disease characterized by overactive IRAK1 and/or IRAK4, or combinations thereof.

[00426] Clause 251. The method of any one of clauses 242-246, wherein the disease or disorder comprises one or more inflammatory diseases or autoimmune disease selected from chronic inflammation, sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, or combinations thereof.

[00427] Clause 252. The method of any one of clauses 242-246, wherein the disease or disorder comprises:

(i) MDS, MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2; or

(ii) AML with a splicing factor mutation, AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the AML is not driven by FLT3 mutations but expresses IRAK4-Long.

[00428] Clause 253. The method of clause 252, wherein the MDS with a splicing factor mutation comprises MDS with a splicing factor mutation in U2AF1 or SF3B1 and the AML splicing factor mutation comprises AML with a splicing factor mutation in U2AF1 or SF3B1.

[00429] Clause 254. The method of any one of clauses 242-246, wherein the disease or disorder comprises DLBCL, and wherein the DLBCL comprises a L265P MYD88 mutant (ABC) subtype of DLBCL or a S219C MYD88 mutant (GCB) subtype of DLBCL.

[00430] Clause 255. The method of any one of clauses 242-254, further comprising administering to the subject one or more additional therapies selected from: a chemotherapy agent, a BCL2 inhibitor, an immune modulator, a BTK inhibitor, a DNA methyltransferase inhibitor/hypomethylating agent, an anthracycline, a histone deacetylase (HDAC) inhibitor, a purine nucleoside analogue (antimetabolite), an isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, an antibody-drug conjugate, an mAbs/immunotherapy, a Plk inhibitor, a MEK inhibitor, a CDK inhibitor, a CDK9 inhibitor, a CDK8 inhibitor, a retinoic acid receptor agonist, a TP53 activator, a CELMoD, a smoothened receptor antagonist, an ERK inhibitor including an ERK2/MAPK1 or ERK1/MAPK3 inhibitor, a PI3K inhibitor, an mTOR inhibitor, a steroid or glucocorticoid receptor modulator, an EZH2 inhibitor, a hedgehog (Hh) inhibitor, a Topoisomerase I inhibitor, a Topoisomerase II inhibitor, an aminopeptidase/Leukotriene A4 hydrolase inhibitor, a FLT3/Axl/ALK inhibitor, a FLT3/KIT/PDGFR, PKC, and/or KDR inhibitor, a Syk inhibitor, an E-selectin inhibitor, an NEDD8-activator, an MDM2 inhibitor, a PLK1 inhibitor, an Aurora A inhibitor, an aurora kinase inhibitor, an EGFR inhibitor, an AuroraB/C/VEGFR1/2/3/FLT3/CSF-1R/Kit/PDGFRB/B inhibitor, an AKT 1, 2, and/or 3 inhibitor, a ABL1/2/SRC/EPHA2/LCK/YES1/KIT/PDGFRB/FYN inhibitor, a farnesyltransferase inhibitor, a BRAF/MAP2K1/MAP2K2 inhibitor, a Menin-KMT2A/MLL inhibitor, and a multikinase inhibitor.

[00431] Clause 256. The method of clause 255, wherein the additional therapy is a BCL2 inhibitor.

[00432] Clause 257. The method of clause 256, wherein the BCL2 inhibitor is venetoclax or a pharmaceutically acceptable salt thereof.

[00433] Clause 258. The method of any one of clauses 242-257, wherein the disease or disorder is a BCL2 inhibitor resistant disease or disorder.

[00434] Clause 259. The method of any one of clauses 242-257, wherein the disease or disorder is a venetoclax resistant disease or disorder.

[00435] Clause 260. The method of any one of clauses 242-257, wherein the disease or disorder is a FLT3 inhibitor resistant disease or disorder.

[00436] Clause 261. The method of any one of clauses 242-257, wherein the disease or disorder is BCL2 inhibitor resistant acute myeloid leukemia (AML).

[00437] Clause 262. The method of any one of clauses 242-257, wherein the disease or disorder is venetoclax resistant acute myeloid leukemia (AML).

[00438] Clause 263. The method of any one of clauses 242-257, wherein the disease or disorder is FLT3 inhibitor resistant acute myeloid leukemia (AML).

[00439] Clause 264. The method of any one of clauses 242-257, wherein the disease or disorder is BCL2 inhibitor resistant refractory acute myeloid leukemia (AML).

[00440] Clause 265. The method of any one of clauses 242-257, wherein the disease or disorder is venetoclax resistant refractory acute myeloid leukemia (AML).

[00441] Clause 266. The method of any one of clauses 242-257, wherein the disease or disorder is FLT3 inhibitor resistant refractory acute myeloid leukemia (AML).

[00442] Clause 267. The method of any one of clauses 242-257, wherein the disease or disorder is BCL2 inhibitor resistant relapsed acute myeloid leukemia (AML).

[00443] Clause 268. The method of any one of clauses 242-257, wherein the disease or disorder is venetoclax resistant relapsed acute myeloid leukemia (AML).

[00444] Clause 269. The method of any one of clauses 242-257, wherein the disease or disorder is FLT3 inhibitor resistant relapsed acute myeloid leukemia (AML).

[00445] Clause 270. The method of clause 255, wherein the compound of any one of clauses 201-237 or the composition of any one of clauses 238-241 and the one or more additional therapies are administered together in one administration or composition.

[00446] Clause 271. The method of clause 255, wherein the compound of any one of clauses 201-237 or the composition any one of clauses 238-241 and the one or more additional therapies are administered separately in more than one administration or more than one composition.

[00447] Clause 272. The method of any one of clauses 242-271, wherein the disease or disorder is alleviated by inhibiting at least one of IRAK1, IRAK4, and FLT3 in the subject.

[00448] Clause 273. The method of any one of clauses 242-272, wherein the disease or disorder is alleviated by inhibiting at least two of IRAK1, IRAK4, and FLT3 in the subject.

[00449] Clause 274. The method of any one of clauses 242-273, wherein the disease or disorder is alleviated by inhibiting IRAK1 and IRAK4 in the subject.

[00450] Clause 275. The method of any one of clauses 242-273, wherein the disease or disorder is alleviated by inhibiting IRAK1, IRAK4, and FLT3 in the subject.

[00451] Clause 276. The method of any one of clauses 272, 273, or 275, wherein FLT3 is selected from WT FLT3, activated FLT3, and mutated FLT3.

[00452] Clause 277. The method of clause 276, wherein the mutated FLT3 is D835Y mutated FLT3 or F691L mutated FLT3.

EXAMPLES

[00453] The following non-limiting examples are provided to further illustrate embodiments of the disclosure disclosed herein. It should be appreciated by those of skill in the art that the techniques disclosed in the examples that follow represent approaches that have been found to function well in the practice of the disclosure, and thus can be considered to constitute examples of modes for its practice. However, those of skill in the art should, in light of the present disclosure, appreciate that many changes can be made in the specific embodiments that are disclosed and still obtain a like or similar result without departing from the spirit and scope of the disclosure.

List of Abbreviations

[00454] In the accompanying procedures and schemes, abbreviations are used with the following meanings unless otherwise indicated: Ac = acetate; aq, aq. = aqueous; Ar = aryl;

BOC, Boc = *t*-butyloxycarbonyl; Bn = benzyl; BSA = bovine serum albumin; Bu = butyl, *t*-Bu = *tert*-butyl; BuLi, *n*-BuLi = *n*-butyllithium; CBZ, Cbz = Benzyloxycarbonyl; conc, conc. = concentrated; *c*-Bu = cyclobutyl; *c*-Pr = cyclopropyl; Cy = cyclohexyl; DAST = (diethylamino)sulfur trifluoride; dba = dibenzylideneacetone; DCM = dichloromethane; DIAD = diisopropylazodicarboxylate; DIBAL, DIBAL-H = diisobutylaluminum hydride; DIEA = diisopropylethylamine; DMAC, DMA = dimethylacetamide; DME = 1,2-dimethoxyethane; DMEM = Dulbecco's modified eagle medium; DMAP = 4-dimethylaminopyridine; DMF = *N,N*-dimethylformamide; DMSO = dimethylsulfoxide; eq. = equivalent(s); EDC = N-[3-(dimethylamino)propyl]-N-ethylcarbodiimide; EDTA = ethylenediaminetetraacetic acid; ESI = electrospray ionization; Et = ethyl; EtOAc = ethyl acetate; EtOH = ethanol; FBS = Fetal Bovine Serum; h, hr = hour; HATU = N-[(dimethylamino)-1H-1,2,3-triazolo[4,5-b]pyridin-1-ylmethylene]-N-methylmethanaminium hexafluorophosphate N-oxide; HOAc = acetic acid; HOAt = 3H-[1,2,3]-triazolo[4,5-b]pyridin-3-ol; HOBt = 1H-benzotriazol-1-ol; HPLC = High pressure liquid chromatography; HTRF = homogenous time resolved fluorescence; IPA, i-PrOH = isopropanol; iPr = isopropyl; LAH = lithium aluminum hydride; LCMS = liquid chromatography - mass spectroscopy; LHMDs = lithium bis(trimethylsilyl)amide; Me = methyl; MeOH = methanol; min, min. = minute; μ W = microwave; NaHMDs = sodium bis(trimethylsilyl)amide; NBS = 1-bromopyrrolidine-2,5-dione; NCS = 1-chloropyrrolidine-2,5-dione; NMP = N-methylpyrrolidinone; NMR = nuclear magnetic resonance; OMs, mesyl = methanesulfonyl; Oxone, OXONE = potassium peroxymonosulfate; PBS = phosphate buffered saline; Pd₂dba₃ = *tris*(dibenzylideneacetone)dipalladium; Pd/C = palladium on activated carbon; Ph = phenyl; PMB = 4-methoxybenzyl; PMBCl = 1-(chloromethyl)-4-methoxybenzene; Pr = propyl; Py = pyridyl; RT, rt = room temperature; RuPhos Pd G3 = (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate; sat. = saturated; TBAF = tetrabutylammonium fluoride; TBAI = tetrabutylammonium iodide; *t*-Bu = *tert*-butyl; TFA = trifluoroacetic acid; THF = tetrahydrofuran; TLC = thin layer chromatography; prep TLC = preparative thin layer chromatography; Tosyl = toluenesulfonyl; triflate, OTf = trifluoromethanesulfonate; triflic = trifluoromethanesulfonic; Xantphos = 4,5-bis(diphenylphosphino)-9,9-dimethylxanthene; XPhos Pd G2 or XPhos-PD-G2 = chloro(2-dicyclohexylphosphino-2',4',6'-triisopropyl-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II).

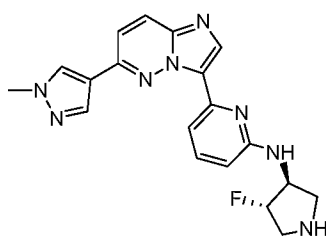
[00455] General Methods

[00456] Unless otherwise stated, all reactions were carried out under an atmosphere of dry nitrogen in dried glassware. Indicated reaction temperatures refer to those of the reaction bath, while room temperature (rt) is noted as 25 °C. Unless otherwise noted, all solvents were of anhydrous quality purchased from Aldrich Chemical Co. and were used as received. Commercially available starting materials and reagents were purchased from commercial suppliers and were used as received.

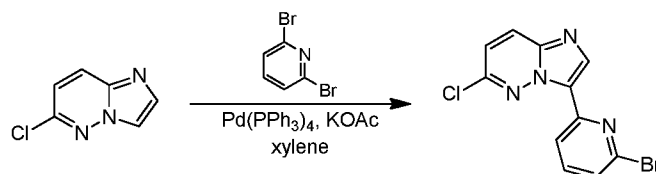
[00457] Analytical thin layer chromatography (TLC) was performed with Sigma Aldrich TLC plates (5 x 20 cm, 60 Å, 250 µm). Visualization was accomplished by irradiation under a 254 nm UV lamp. Chromatography on silica gel was performed using forced flow (liquid) of the indicated solvent system on Biotage KP-Sil pre-packed cartridges and using the Biotage SP-1 automated chromatography system. ¹H NMR spectra were recorded on a Varian Inova 400 MHz spectrometer. Chemical shifts are reported in ppm with the solvent resonance as the internal standard (DMSO-*d*₆ 2.50 ppm for ¹H). Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, br = broad, m = multiplet), coupling constants, and number of protons. Low resolution mass spectra (electrospray ionization) were acquired on an Agilent Technologies 6130 quadrupole spectrometer coupled to the HPLC system. Unless otherwise noted, all LCMS ions listed are [M+H]. If needed, products were purified via semi-preparative HPLC using the columns and mobile phases noted. Samples were analyzed for purity on an Agilent 1200 series LC/MS equipped with a Luna® C18 reverse phase (3 micron, 3 x 75 mm) column having a flow rate of 0.8 – 1.0 mL/min over a 7 minute gradient and an 8.5 minute run time (Method 1). Unless otherwise noted, the mobile phase was a mixture of acetonitrile (0.025% TFA) and H₂O (0.05% TFA), with temperature maintained at 50 °C. Purity of final compounds was determined to be >95% using a 3 µL injection with quantitation by AUC at 220 and 254 nm (Agilent Diode Array Detector).

Example 1***Exemplary Synthetic Procedure #1 (Compounds 1 – 8)***

Compound 1, N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

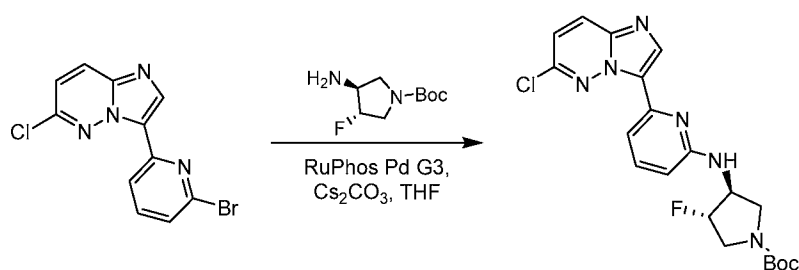


Step A. 3-(6-bromo-2-pyridyl)-6-chloro-imidazo[1,2-b]pyridazine



[00458] A mixture of 2,6-dibromopyridine (23.14 g, 97.68 mmol), 6-chloroimidazo[1,2-b]pyridazine (5.00 g, 32.6 mmol), potassium acetate (6.39 g, 65.1 mmol), and tetrakis(triphenylphosphine)palladium(0) (3.76 g, 3.26 mmol) in xylene (150 mL) was degassed and purged with nitrogen 3 times, and was then stirred at 140 °C for 15 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 40% ethyl acetate in petroleum ether) to provide a product that was then washed with petroleum ether (9 x 10 mL), filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 308.9 $[M+H]^+$.

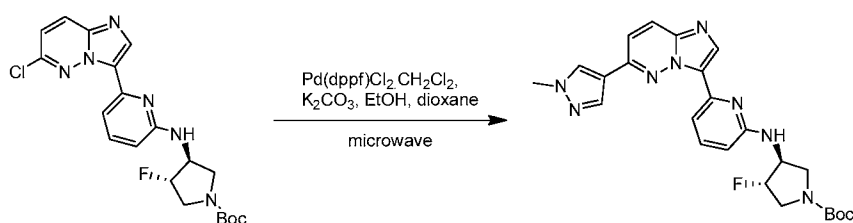
Step B. tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate



[00459] A mixture of 3-(6-bromo-2-pyridyl)-6-chloro-imidazo[1,2-b]pyridazine (500 mg, 1.62 mmol), tert-butyl (3S,4S)-3-amino-4-fluoro-pyrrolidine-1-carboxylate (330 mg, 1.62 mmol), cesium carbonate (1.58 g, 4.85 mmol), and (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (135 mg, 0.162 mmol) in tetrahydrofuran (10 mL) was degassed and purged with nitrogen 3 times, and was then stirred at 80 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled

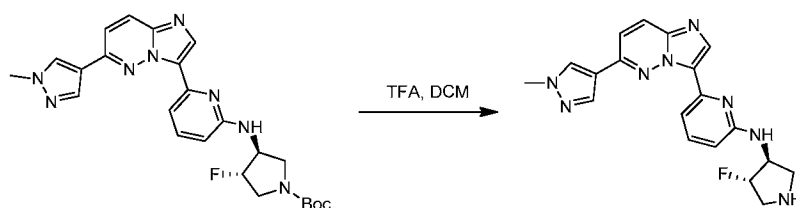
to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 15 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (2 x 15 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 433.3 $[M+H]^+$; ^1H NMR (400 MHz, $CDCl_3$) δ 8.63 – 8.37 (s, 1 H), 8.04 – 7.94 (m, 2 H), 7.63 (t, $J = 7.9$ Hz, 1 H), 7.13 (d, $J = 9.4$ Hz, 1 H), 6.47 (d, $J = 8.1$ Hz, 1 H), 5.42 – 5.14 (m, 1 H), 4.67 – 4.37 (m, 2 H), 3.90 (br dd, $J = 5.0, 11.7$ Hz, 1 H), 3.80 – 3.59 (m, 2 H), 1.57 – 1.44 (s, 9 H).

Step C. tert-butyl (3S,4S)-3-fluoro-4-[[6-[6-(1-methylpyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate



[00460] A mixture of tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (60 mg, 0.139 mmol), 1-methyl-4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrazole (29 mg, 0.139 mmol), [1,1-bis(diphenylphosphino)ferrocene]palladium(II) chloride dichloromethane complex (11.3 mg, 0.014 mmol), and potassium carbonate (2 M in water, 0.208 mL) in ethanol (1 mL) and dioxane (2 mL) was degassed and purged with nitrogen 3 times, was then heated by microwave at 90 °C for 20 minutes. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 479.2 $[M+H]^+$.

Step D. N-[(3S,4S)-4-fluoropyrrolidin-3-yl]-6-[6-(1-methylpyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl]pyridin-2-amine

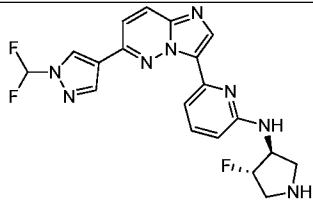
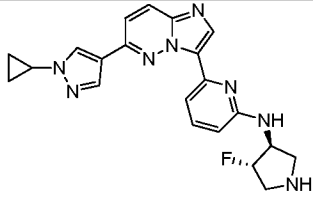
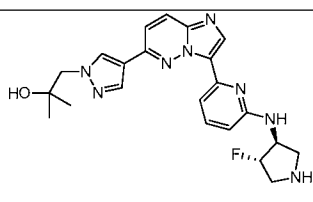
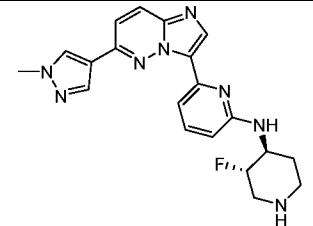


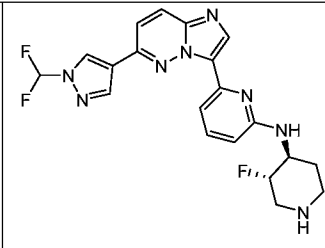
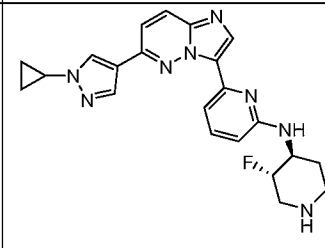
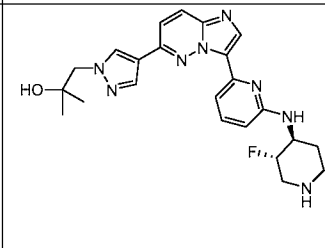
[00461] To a solution of tert-butyl (3S, 4S)-3-fluoro-4-[[6-[6-(1-methylpyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate (60 mg, 0.125 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.3 mL, 4.1 mmol). The mixture

was stirred at 20 °C for 1 hour, and was then filtered and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Nano-micro Kromasil C18 column, 3 micron, 100 x 40 mm; 8 – 38% acetonitrile in water containing 0.1% TFA) to provide the title compound: LCMS m/z 379.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.55 – 8.40 (m, 2 H), 8.28 – 8.12 (m, 3 H), 7.88 (d, J = 9.5 Hz, 1 H), 7.74 (t, J = 7.9 Hz, 1 H), 6.70 (d, J = 8.3 Hz, 1 H), 5.65 – 5.40 (m, 1 H), 4.81 (br d, J = 3.5 Hz, 1 H), 4.04 (s, 3 H), 3.91 (dd, J = 6.2, 12.7 Hz, 1 H), 3.80 – 3.59 (m, 3 H).

[00462] The compounds in Table 1 were all prepared using the synthetic procedures described in **Example 1**.

Table 1. Additional compounds prepared according to **Example 1**.

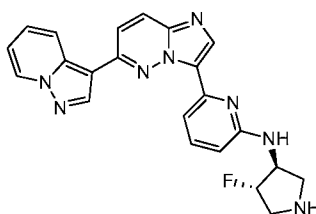
Compound #	Structure	IUPAC Name	LCMS
2		6-(6-(1-(difluoromethyl)-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine	415.0
3		6-(6-(1-cyclopropyl-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine	405.1
4		1-(4-(3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)-1 H-pyrazol-1-yl)-2-methylpropan-2-ol	437.1
5		N-((3S,4S)-3-fluoropiperidin-4-yl)-6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	393.1

6		6-(6-(1-(difluoromethyl)-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-3-fluoropiperidin-4-yl)pyridin-2-amine	429.0
7		6-(6-(1-cyclopropyl-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-3-fluoropiperidin-4-yl)pyridin-2-amine	419.1
8		1-(4-(3-(6-(((3S,4S)-3-fluoropiperidin-4-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)-1 H-pyrazol-1-yl)-2-methylpropan-2-ol	451.1

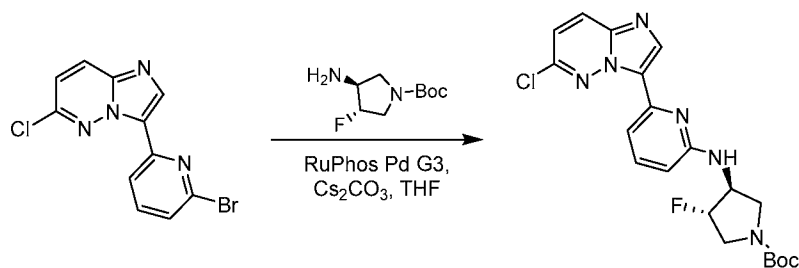
Example 2

Exemplary Synthetic Procedure #2 (Compounds 9 – 19)

Compound 9, N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

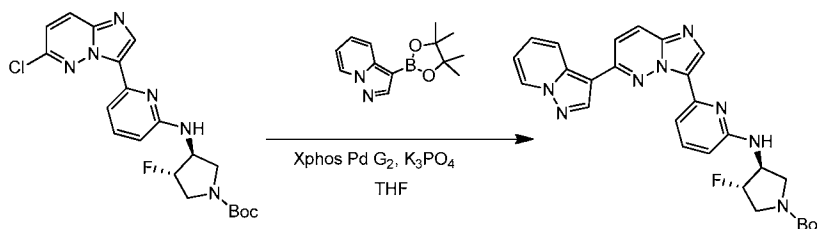


Step A. tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate



[00463] A mixture of 3-(6-bromo-2-pyridyl)-6-chloro-imidazo[1,2-b]pyridazine (500 mg, 1.62 mmol), tert-butyl (3S,4S)-3-amino-4-fluoro-pyrrolidine-1-carboxylate (330 mg, 1.62 mmol), cesium carbonate (1.58 g, 4.85 mmol), and (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (135 mg, 0.162 mmol) in tetrahydrofuran (10 mL) was degassed and purged with nitrogen 3 times, and was then stirred at 80 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 15 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (2 x 15 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 433.3 $[M+H]^+$; ^1H NMR (400 MHz, $CDCl_3$) δ 8.63 – 8.37 (s, 1 H), 8.04 – 7.94 (m, 2 H), 7.63 (t, $J = 7.9$ Hz, 1 H), 7.13 (d, $J = 9.4$ Hz, 1 H), 6.47 (d, $J = 8.1$ Hz, 1 H), 5.42 – 5.14 (m, 1 H), 4.67 – 4.37 (m, 2 H), 3.90 (br dd, $J = 5.0, 11.7$ Hz, 1 H), 3.80 – 3.59 (m, 2 H), 1.57 – 1.44 (s, 9 H).

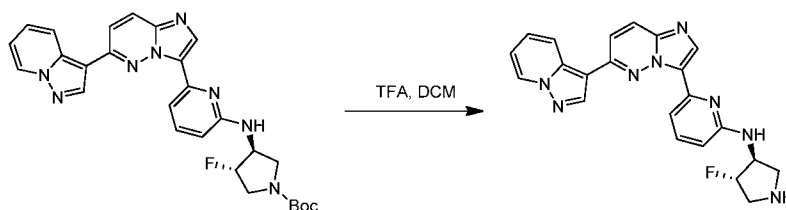
Step B. tert-butyl (3S,4S)-3-fluoro-4-[[6-(6-pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate



[00464] A mixture of tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.120 g, 0.277 mmol), 3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrazolo[1,5-a]pyridine (0.074 g, 0.305 mmol), chloro(2-dicyclohexylphosphino-2',4',6'-triisopropyl-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II) (0.022 g, 0.028 mmol), and aqueous potassium phosphate solution (1 M, 0.832 mL) in tetrahydrofuran (2 mL) was degassed and purged with nitrogen 3 times, and was then heated by microwave at 80 °C for 1 hour. The reaction mixture was then cooled to room temperature, diluted with water (5 mL), and extracted with ethyl acetate (2 x 5 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (2 x 5 mL), dried

over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 515.4 $[M+H]^+$.

Step C. N-[(3S,4S)-4-fluoropyrrolidin-3-yl]-6-(6-pyrazolo[1,5-a]pyridin-3-ylimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

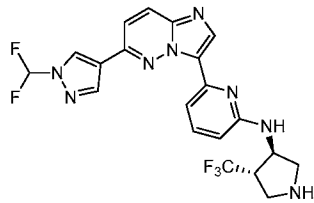
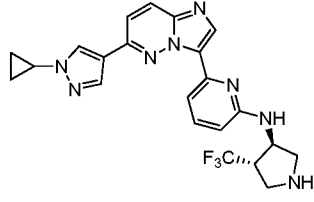
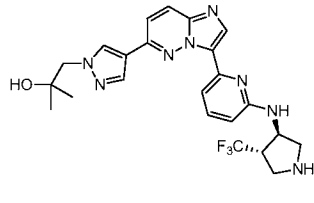
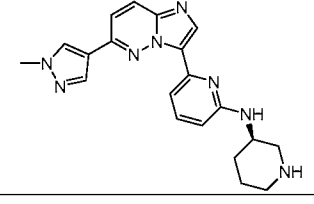
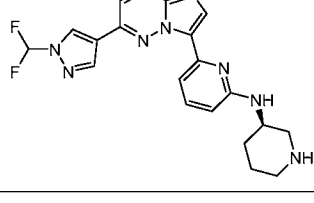
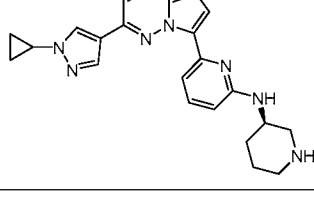
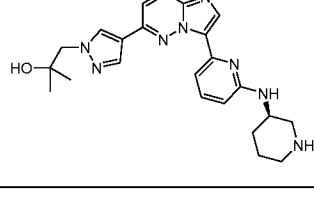


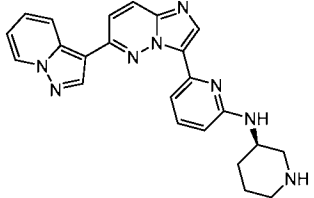
[00465] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[[6-(6-pyrazolo[1,5-a]pyridin-3-ylimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]pyrrolidine-1-carboxylate (0.120 g, 0.233 mmol) in dichloromethane (5 mL) was added trifluoroacetic acid (0.770 g, 6.75 mmol, 0.500 mL). The mixture was stirred at 20 °C for 2 hours, and was then filtered and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 15 – 45% acetonitrile in water containing 0.1% TFA) to provide the title compound: LCMS m/z 415.2 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.74 – 8.65 (m, 2 H), 8.45 – 8.36 (m, 2 H), 8.19 (d, J = 9.7 Hz, 1 H), 8.04 (d, J = 9.7 Hz, 1 H), 7.95 (d, J = 7.4 Hz, 1 H), 7.75 – 7.67 (m, 1 H), 7.53 (ddd, J = 1.0, 6.9, 8.9 Hz, 1 H), 7.13 (dt, J = 1.3, 6.9 Hz, 1 H), 6.70 (d, J = 8.2 Hz, 1 H), 5.60 – 5.42 (m, 1 H), 4.85 – 4.78 (m, 1 H), 3.90 (dd, J = 6.3, 12.5 Hz, 1 H), 3.81 – 3.75 (m, 1 H), 3.71 – 3.60 (m, 2 H).

[00466] The compounds in Table 2 were all prepared using the synthetic procedures described in **Example 2**.

Table 2. Additional compounds prepared according to **Example 2**.

Compound #	Structure	IUPAC Name	LCMS
10		6-(6-(pyrazolo[1,5-a]pyridin-3-ylimidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-(trifluoromethyl)pyrrolidin-3-yl)pyridin-2-amine	465.1
11		6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-(trifluoromethyl)pyrrolidin-3-yl)pyridin-2-amine	429.0

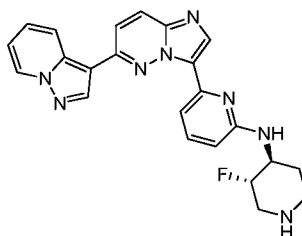
		-3-yl)pyridin-2-amine	
12		6-(6-(1-(difluoromethyl)-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-(trifluoromethyl)pyrrolidin-3-yl)pyridin-2-amine	465.0
13		6-(6-(1-cyclopropyl-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-(trifluoromethyl)pyrrolidin-3-yl)pyridin-2-amine	455.0
14		2-methyl-1-(4-(3-(6-(((3R,4S)-4-(trifluoromethyl)pyrrolidin-3-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)-1 H-pyrazol-1-yl)propan-2-ol	487.1
15		(R)-6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(piperidin-3-yl)pyridin-2-amine	375.2
16		(R)-6-(6-(1-(difluoromethyl)-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(piperidin-3-yl)pyridin-2-amine	411.2
17		(R)-6-(6-(1-cyclopropyl-1 H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(piperidin-3-yl)pyridin-2-amine	401.2
18		(R)-2-methyl-1-(4-(3-(6-(piperidin-3-ylamino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)-1 H-pyrazol-1-yl)propan-2-ol	433.2

19		(R)-N-(piperidin-3-yl)-6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	411.2
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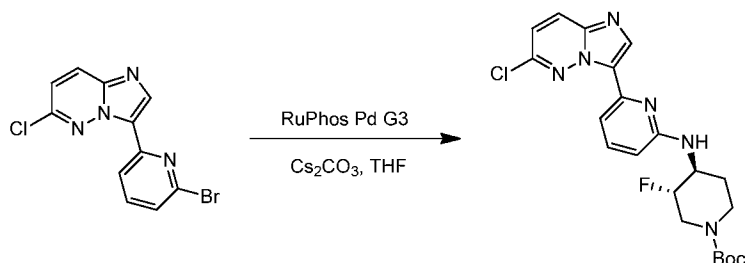
Example 3

Exemplary Synthetic Procedure #3 (Compound 20)

Compound 20, N-((3S,4S)-3-fluoropiperidin-4-yl)-6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

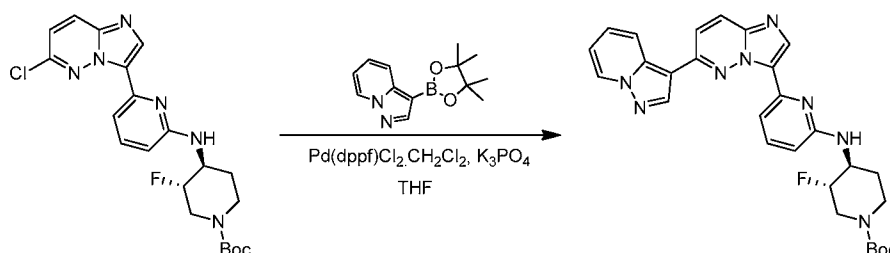


Step A. tert-butyl (3S,4S)-4-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-3-fluoro-piperidine-1-carboxylate



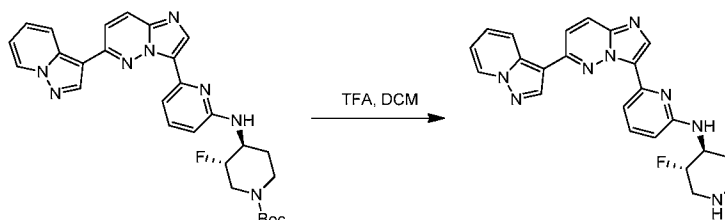
[00467] A mixture of 3-(6-bromo-2-pyridyl)-6-chloro-imidazo[1,2-b]pyridazine (0.150 g, 0.485 mmol), tert-butyl (3S,4S)-4-amino-3-fluoro-piperidine-1-carboxylate (0.106 g, 0.485 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.041 g, 0.048 mmol), and cesium carbonate (0.395 g, 1.21 mmol) in tetrahydrofuran (4 mL) was degassed and purged with nitrogen 3 times, and was then stirred at 80 °C for 10 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 447.3 [M+H]⁺.

Step B. tert-butyl (3S,4S)-3-fluoro-4-[[6-(6-pyrazolo[1,5-a]pyridin-3-ylimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]piperidine-1-carboxylate



[00468] A mixture of tert-butyl (3S,4S)-4-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-3-fluoro-piperidine-1-carboxylate (0.100 g, 0.224 mmol), 3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrazolo[1,5-a]pyridine (0.055 g, 0.224 mmol), chloro(2-dicyclohexylphosphino-2',4',6'-triisopropyl-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II) (0.018 g, 0.022 mmol), and aqueous potassium phosphate solution (1 M, 0.67 mL) in THF (3 mL) was degassed and purged with nitrogen 3 times, and was then heated by microwave at 90 °C for 5 hours. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 529.4 $[M+H]^+$.

Step C. N-[(3S,4S)-3-fluoro-4-piperidyl]-6-(6-pyrazolo[1,5-a]pyridin-3-ylimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine



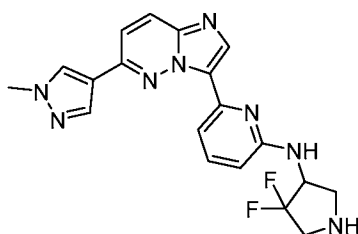
[00469] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[[6-(6-pyrazolo[1,5-a]pyridin-3-ylimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]piperidine-1-carboxylate (0.030 g, 0.057 mmol) in dichloromethane (1 mL) was added trifluoroacetic acid (0.058 g, 0.506 mmol, 0.038 mL). The mixture was stirred at 20 °C for 2 hours, and was then filtered and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 3 micron, 100 x 40 mm; 5 – 25% acetonitrile in water containing 0.1% TFA) to give a product that was further purified by HPLC (Xtimate C18 column, 3 micron, 100 x 40 mm; 15 – 45% acetonitrile in aqueous 10 mM NH_4CO_3) to provide the title compound: LCMS m/z 429.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.74 – 8.62 (m, 2 H), 8.52 (d, J = 8.9 Hz, 1 H), 8.29 –

8.15 (m, 1 H), 8.04 (d, $J = 9.5$ Hz, 1 H), 7.86 – 7.77 (m, 2 H), 7.61 (t, $J = 7.9$ Hz, 1 H), 7.53 – 7.38 (m, 1 H), 7.10 (t, $J = 6.4$ Hz, 1 H), 6.63 (d, $J = 8.4$ Hz, 1 H), 4.81 – 4.56 (m, 1 H), 4.39 – 4.21 (m, 1 H), 3.28 (br d, $J = 3.3$ Hz, 1 H), 3.15 – 2.98 (m, 1 H), 2.97 – 2.78 (m, 2 H), 2.43 – 2.24 (m, 1 H), 1.72 – 1.55 (m, 1 H).

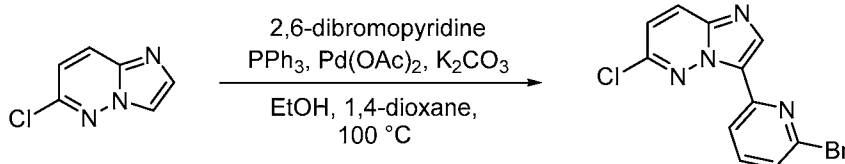
Example 4

Exemplary Synthetic Procedure #4 (Compounds 21 – 53)

Compound 21, N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

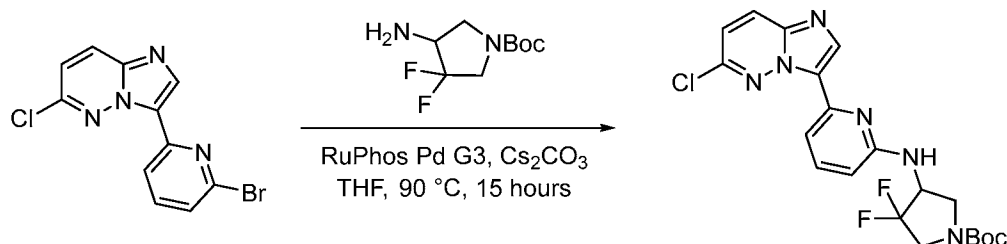


Step A. 3-(6-bromopyridin-2-yl)-6-chloroimidazo[1,2-b]pyridazine



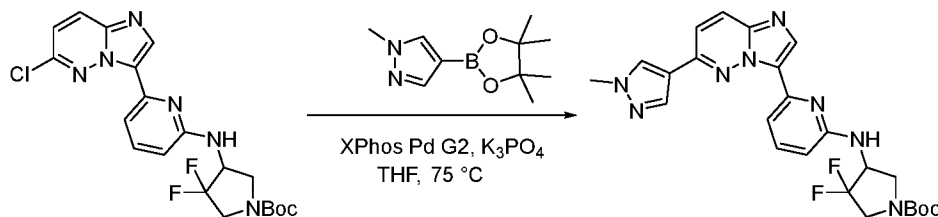
[004701] To a heavy-walled sealable flask equipped with a magnetic stir bar were added 6-chloroimidazo[1,2-b]pyridazine (1.00 g, 6.51 mmol), 2,6-dibromopyridine (2.31 g, 9.77 mmol), triphenylphosphine (0.171 g, 0.651 mmol), potassium carbonate (2.70 g, 19.54 mmol), palladium (II) acetate (0.073 g, 0.326 mmol), 1,4-dioxane (20 mL), and ethanol (10 mL). The vessel was sealed with a teflon screw cap and warmed to 100 °C. After 18 hours, the reaction mixture was cooled to room temperature, diluted with ethyl acetate (2 x 10 mL), filtered through silica, and concentrated under reduced pressure. The resulting crude product was then purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to afford the title compound: LCMS m/z 308.9 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.52 (d, $J = 7.9$ Hz, 1 H), 8.44 (s, 1 H), 8.14 (dd, $J = 9.5, 0.7$ Hz, 1 H), 7.84 – 7.77 (m, 1 H), 7.52 (d, $J = 7.9$ Hz, 1 H), 7.42 (dd, $J = 9.5, 0.7$ Hz, 1 H).

Step B. tert-butyl 4-((6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-3,3-difluoropyrrolidine-1-carboxylate



[00471] To a heavy-walled sealable flask equipped with a magnetic stir bar were added 3-(6-bromopyridin-2-yl)-6-chloroimidazo[1,2-b]pyridazine (0.741 g, 2.39 mmol), tert-butyl 4-amino-3,3-difluoropyrrolidine-1-carboxylate (0.532 g, 2.39 mmol), RuPhos Pd G3 (0.200 g, 0.239 mmol), and cesium carbonate (2.34 g, 7.18 mmol), in that order. The vessel was sealed with a rubber septum and flushed with nitrogen for 30 minutes. Tetrahydrofuran (15 mL, dried and stored over 4 Å molecular sieves, deoxygenated via sparging with nitrogen for 30 minutes) was then added via syringe. The septum was removed, and the flask was quickly sealed with a teflon screwcap. The reaction mixture was warmed to 90 °C for 15 hours, then cooled to room temperature, diluted with ethyl acetate (2 x 25 mL), filtered through silica, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to yield the title compound: LCMS *m/z* 451.0 [M + H]⁺; ¹H NMR (400 MHz, DMSO-*d*₆) δ 8.53 (s, 1 H), 7.74 (d, *J* = 7.4 Hz, 1 H), 7.62 (t, *J* = 7.8 Hz, 1 H), 7.46 – 7.41 (m, 1 H), 7.15 (d, *J* = 8.4 Hz, 1 H), 6.63 (d, *J* = 8.3 Hz, 1 H), 5.36 – 5.15 (m, 1 H), 4.03 – 3.44 (m, 5 H), 1.41 (s, 9 H).

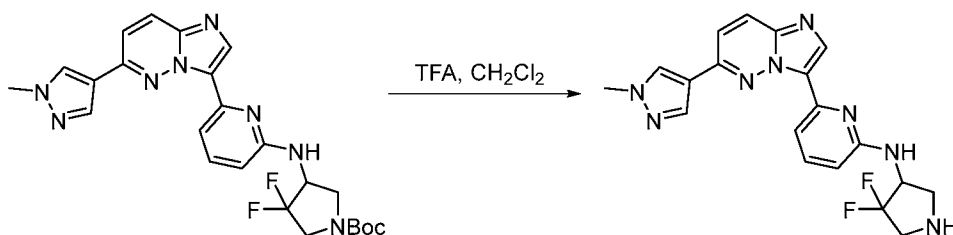
Step C. tert-butyl 3,3-difluoro-4-((6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[00472] To a microwave vial equipped with a stir bar were added tert-butyl 4-((6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-3,3-difluoropyrrolidine-1-carboxylate (0.088 g, 0.196 mmol), 1-methyl-4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1H-pyrazole (0.081 g, 0.392 mmol), and XPhos Pd G2 (0.022 g, 0.029 mmol). The vessel was

sealed with a pressure release cap and purged with nitrogen for 30 minutes. Aqueous potassium phosphate tribasic solution (1.0 M, 0.783 mL, 0.783 mmol, deoxygenated via sparging with nitrogen for 30 minutes) and tetrahydrofuran (1.5 mL, dried and stored over 4 Å molecular sieves, deoxygenated via sparging with nitrogen for 30 minutes) were then added, and the resulting reaction was warmed to 75 °C. After 6 hours the reaction mixture was cooled to room temperature, diluted with ethyl acetate (10 mL), dried over magnesium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to afford the title compound: LCMS m/z 496.9 $[M + H]^+$; ^1H NMR (400 MHz, DMSO- d_6) δ 8.52 (s, 1 H), 8.44 (s, 1 H), 8.23 – 8.15 (m, 2 H), 8.06 – 8.02 (m, 1 H), 7.65 – 7.61 (m, 1 H), 7.08 (d, J = 8.3 Hz, 1 H), 6.61 (d, J = 8.3 Hz, 1 H), 5.30 (d, J = 9.7 Hz, 1 H), 3.94 (s, 3 H), 3.92 – 3.85 (m, 2 H), 3.83 – 3.67 (m, 2 H), 3.26 – 3.11 (m, 1 H), 1.41 (s, 9 H).

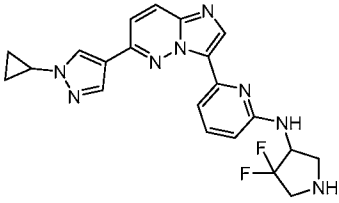
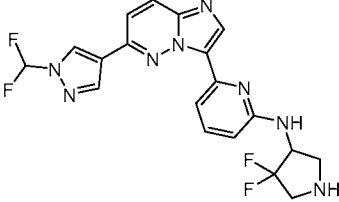
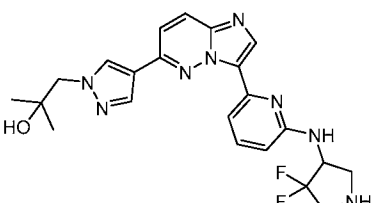
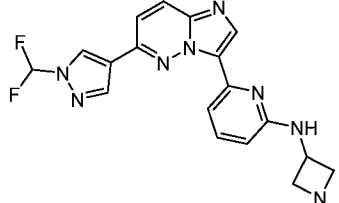
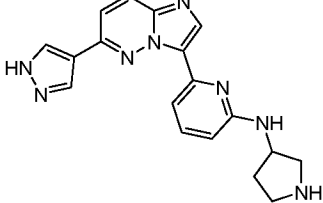
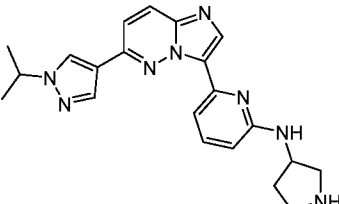
Step D. N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

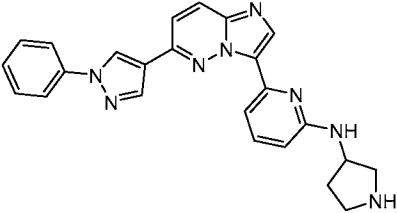
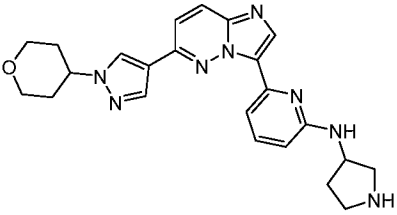
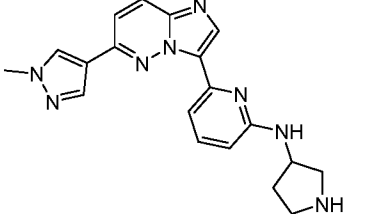
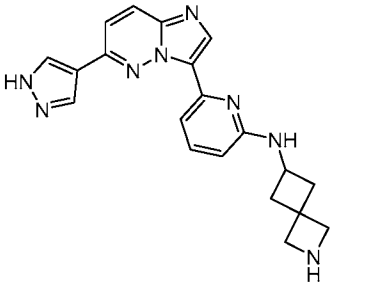
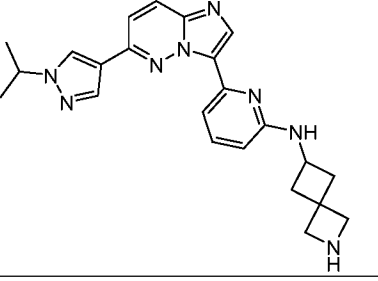
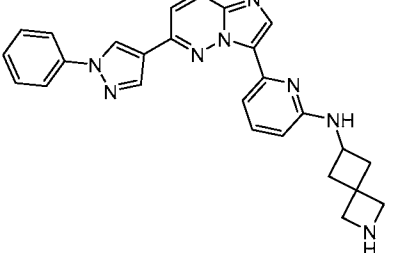


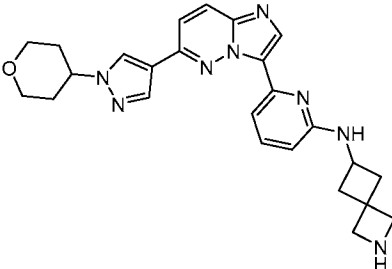
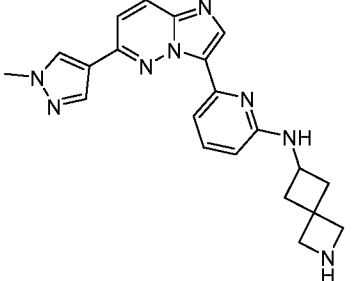
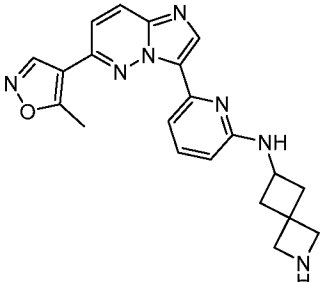
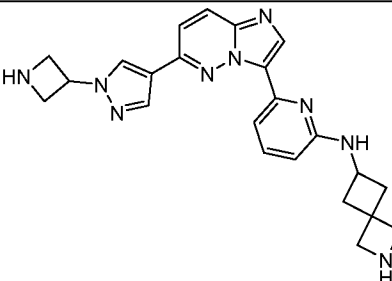
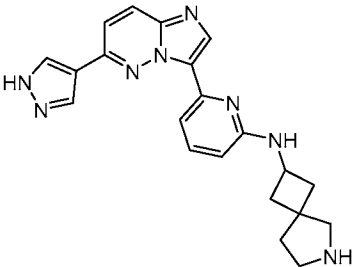
[00473] To a microwave vial were added tert-butyl 3,3-difluoro-4-((6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate (0.166 g, 0.335 mmol), dichloromethane (2.0 mL), and trifluoroacetic acid (1.0 mL). The vial was sealed with a pressure relief cap and stirred at room temperature for 18 hours. The reaction was then concentrated under reduced pressure to give a crude product that was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 75 x 30 mm; 5 – 40% acetonitrile in water containing 0.1% TFA) to provide the title compound: LCMS m/z 397.2 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.47 (s, 1 H), 8.41 (s, 1 H), 8.21 – 8.13 (m, 3 H), 7.81 – 7.70 (m, 2 H), 6.76 – 6.70 (m, 1 H), 5.48 – 5.24 (m, 1 H), 4.10 – 4.03 (m, 1 H), 4.02 (s, 3 H), 3.99 – 3.79 (m, 3 H), 3.50 – 3.35 (m, 2 H).

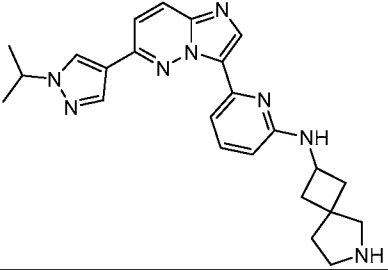
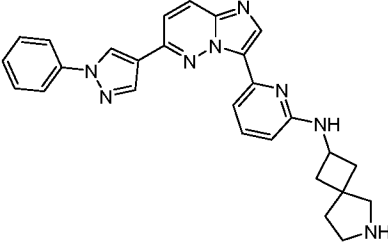
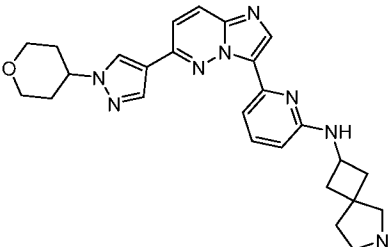
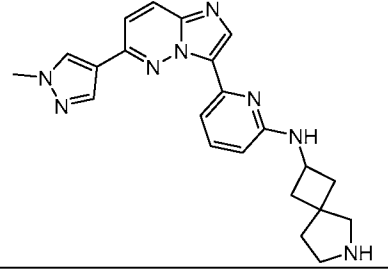
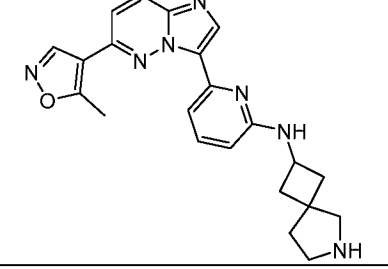
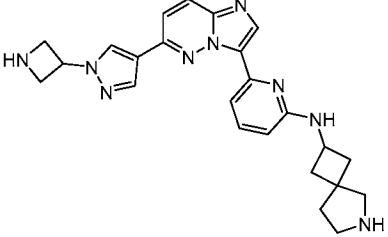
[00474] The compounds in Table 3 were all prepared using the chemistry described in **Example 4**.

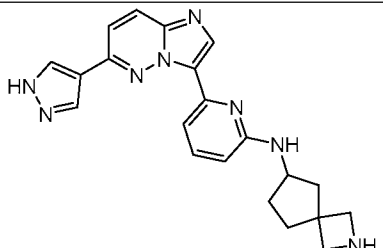
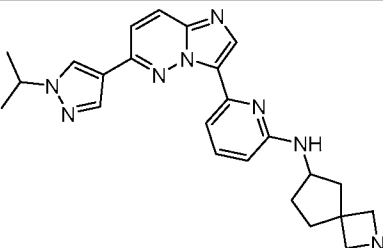
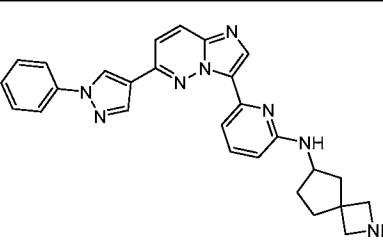
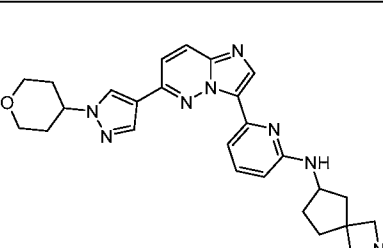
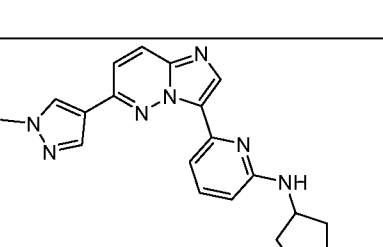
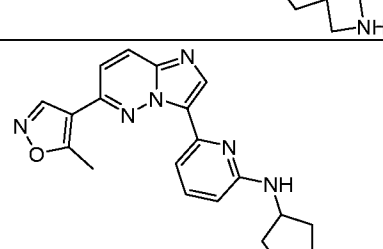
Table 3. Additional compounds prepared according to **Example 4**.

Compound #	Structure	IUPAC Name	LCMS
22		6-(6-(1-cyclopropyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(4,4-difluoropyrrolidin-3-yl)pyridin-2-amine	423.2
23		6-(6-(1-(difluoromethyl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(4,4-difluoropyrrolidin-3-yl)pyridin-2-amine	433.2
24		1-(4-(3-(6-((4,4-difluoropyrrolidin-3-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)-1H-pyrazol-1-yl)-2-methylpropan-2-ol	455.2
25		N-(azetidin-3-yl)-6-(6-(1-(difluoromethyl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	383.1
26		6-(6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	347.1
27		6-(6-(1-isopropyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	389.2

28		6-(6-(1-phenyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	423.2
29		N-(pyrrolidin-3-yl)-6-(6-(1-(tetrahydro-2H-pyran-4-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	431.2
30		6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	361.2
31		N-(6-(6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	373.2
32		N-(6-(6-(1-isopropyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	415.2
33		N-(6-(6-(1-phenyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	449.2

34		N-(6-(6-(1-(tetrahydro-2H-pyran-4-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	457.2
35		N-(6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	387.2
36		N-(6-(6-(5-methylisoxazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	388.2
37		N-(6-(6-(1-(azetidin-3-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	428.2
38		N-(6-(6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	387.2

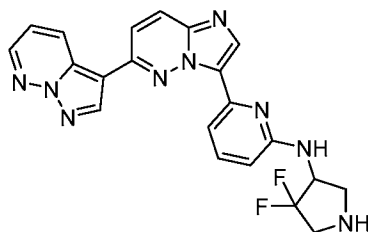
39		N-(6-(6-(1-isopropyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	429.2
40		N-(6-(6-(1-phenyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	463.2
41		N-(6-(6-(1-(tetrahydro-2H-pyran-4-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	471.3
42		N-(6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	401.2
43		N-(6-(6-(5-methylisoxazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	402.2
44		N-(6-(6-(1-(azetidin-3-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	442.2

45		N-(6-(6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	387.2
46		N-(6-(6-(1-isopropyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	429.3
47		N-(6-(6-(1-phenyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	463.2
48		N-(6-(6-(1-(tetrahydro-2H-pyran-4-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	471.3
49		N-(6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	401.2
50		N-(6-(6-(5-methylisoxazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	402.2

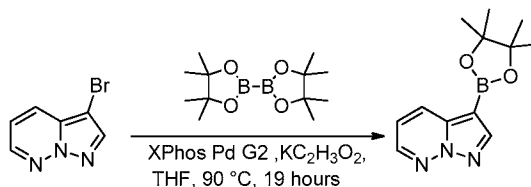
51		N-(6-(6-(1-(azetidin-3-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	442.2
52		6-(6-(5-methylisoxazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	362.1
53		6-(6-(1-(azetidin-3-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	402.2

Example 5**Exemplary Synthetic Procedure #5 (Compounds 54 – 67)**

Compound 54, N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(pyrazolo[1,5-b]pyridazin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine



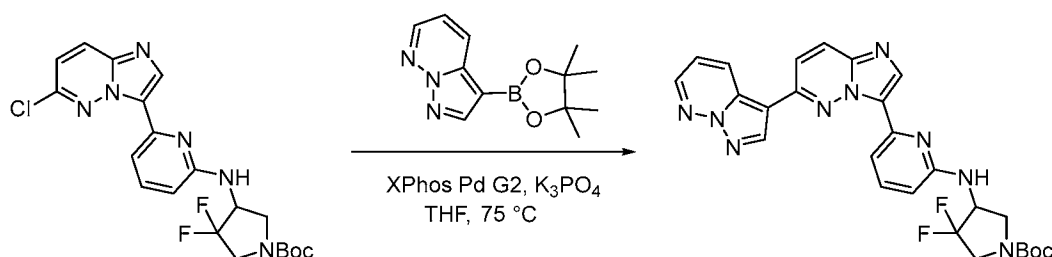
Step A. 3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrazolo[1,5-b]pyridazine



[004751] To a microwave vial equipped with a stir bar were added 3-bromopyrazolo[1,5-b]pyridazine (0.100 g, 0.505 mmol), 4,4,4',4',5,5,5',5'-octamethyl-2,2'-

bi(1,3,2-dioxaborolane) (0.256 g, 1.01 mmol), potassium acetate (0.154 g, 1.57 mmol), and XPhos Pd G2 (0.019 g, 0.025 mmol). The vessel was sealed with a pressure release cap and flushed with nitrogen for 30 minutes. Tetrahydrofuran (3 mL, dried and stored over 4 Å molecular sieves, deoxygenated via sparging with nitrogen for 30 minutes) was added and the reaction warmed to 90 °C. After 18 hours the reaction was then cooled to room temperature, diluted with ethyl acetate (2 x 5 mL), filtered through silica, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to afford the title compound: LCMS m/z 246.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.42 (d, J = 4.5 Hz, 1 H), 8.38 (d, J = 9.0 Hz, 1 H), 8.22 (s, 1 H), 7.27 (t, J = 9.0, 4.4 Hz, 1 H), 1.37 (s, 12 H).

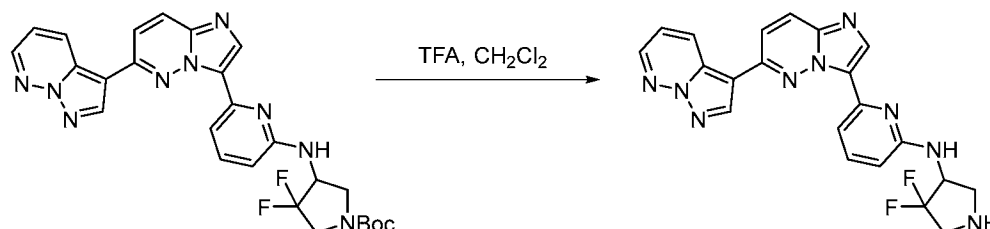
Step B. tert-butyl 3,3-difluoro-4-((6-(6-(pyrazolo[1,5-b]pyridazin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[004761] To a microwave vial equipped with a stir bar were added tert-butyl 4-((6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-3,3-difluoropyrrolidine-1-carboxylate (0.089 g, 0.197 mmol), 3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrazolo[1,5-b]pyridazine (0.097 g, 0.395 mmol), and XPhos Pd G2 (0.022 g, 0.030 mmol). The vessel was sealed with a pressure release cap and flushed with nitrogen for 30 minutes. Aqueous potassium phosphate tribasic solution (1.0 M, 0.790 milliliters, 0.790 mmol, deoxygenated via sparging with nitrogen for 30 minutes) and tetrahydrofuran (1.0 mL, dried and stored over 4 Å molecular sieves, deoxygenated via sparging with nitrogen for 30 minutes) were added, and the resulting reaction was warmed to 75 °C. After 6 hours the reaction mixture was then cooled to room temperature, diluted with ethyl acetate (5 mL), dried over magnesium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to afford the title compound: LCMS m/z 533.9 $[M+H]^+$; ^1H NMR (400 MHz, $DMSO-d_6$) δ 8.96 (s, 1 H), 8.84 (dd, J = 9.1, 1.9 Hz, 1 H), 8.65 (dd, J = 4.5, 1.8 Hz, 1 H), 8.39 (s, 1 H), 8.31 (d, J = 9.5 Hz, 1 H), 7.93 (d, J = 9.5 Hz, 1 H), 7.84 (d, J = 7.4 Hz, 1

H), 7.52 (dd, $J = 9.1, 4.5$ Hz, 1 H), 7.15 (d, $J = 8.4$ Hz, 1 H), 6.66 (d, $J = 8.3$ Hz, 1 H), 5.43 – 5.18 (m, 1 H), 3.98 – 3.66 (m, 4 H), 3.26 – 3.16 (m, 1 H), 1.41 (s, 9 H).

Step C. N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(pyrazolo[1,5-b]pyridazin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

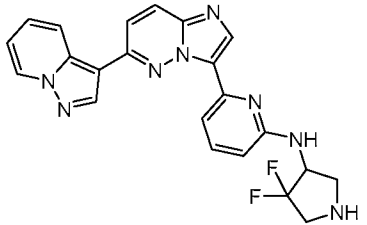
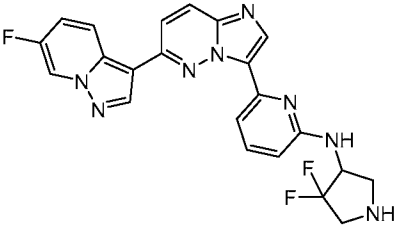
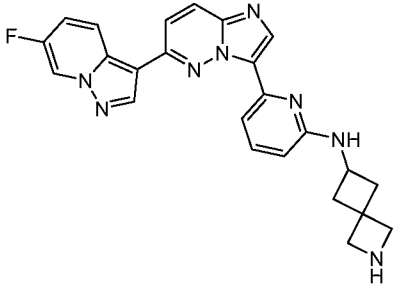
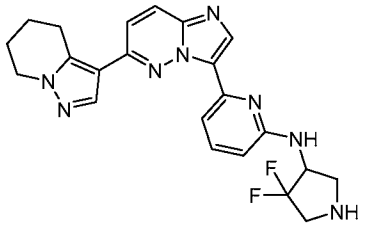
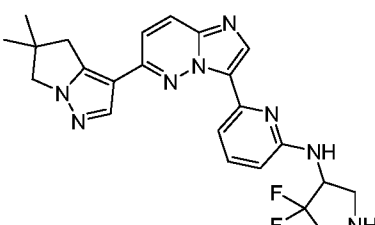
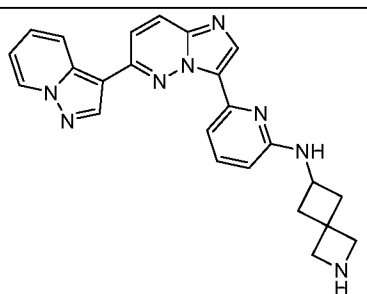


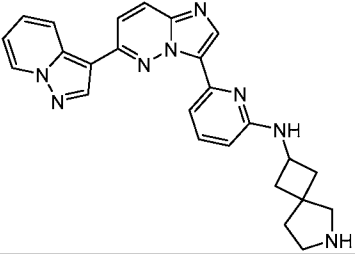
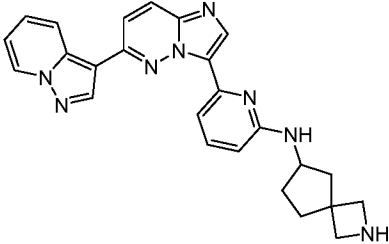
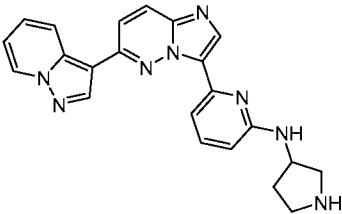
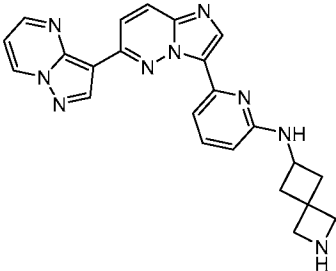
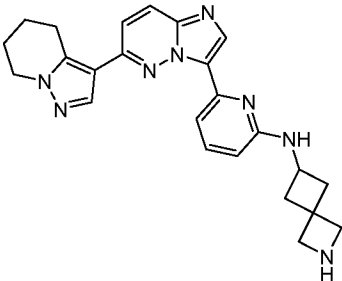
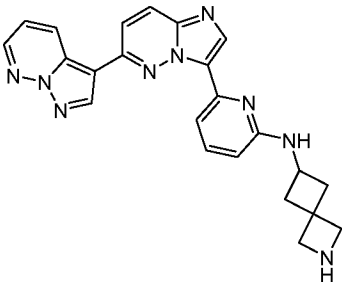
[00477] To a microwave vial were added tert-butyl 3,3-difluoro-4-((6-(6-(pyrazolo[1,5-b]pyridazin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate (0.140 g, 0.262 mmol), dichloromethane (2.0 mL), and trifluoroacetic acid (1.0 mL). The vial was sealed with a pressure relief cap and stirred overnight at room temperature. The reaction was then concentrated under reduced pressure to give a crude product that was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 75 x 30 mm; 5 – 40% acetonitrile in water containing 0.1% TFA) to provide the title compound: LCMS m/z 434.2 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.89 (dd, $J = 9.1, 2.1$ Hz, 1 H), 8.78 (s, 1 H), 8.55 (dd, $J = 4.5, 1.9$ Hz, 1 H), 8.36 (s, 1 H), 8.18 (d, $J = 9.4$ Hz, 1 H), 8.01 – 7.89 (m, 2 H), 7.74 (dd, $J = 8.4, 7.4$ Hz, 1 H), 7.47 – 7.40 (m, 1 H), 6.75 (dd, $J = 8.3, 0.9$ Hz, 1 H), 5.43 – 5.28 (m, 1 H), 4.97 – 4.86 (m, 1 H), 4.08 – 3.79 (m, 3 H), 3.50 – 3.35 (m, 2 H).

[00478] The compounds in Table 4 were all prepared using the chemistry described in **Example 5**.

Table 4. Additional compounds prepared according to **Example 5**.

Compound #	Structure	IUPAC Name	LCMS
55		6-(6-(4,6-difluoropyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(4,4-difluoropyrrolidin-3-yl)pyridin-2-amine	469.1

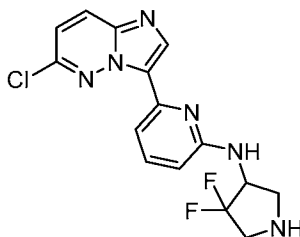
56		N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	433.2
57		N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(6-fluoropyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	450.8
58		N-(6-(6-(6-fluoropyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	441.0
59		N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(4,5,6,7-tetrahydropyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	437.2
60		N-(4,4-difluoropyrrolidin-3-yl)-6-(6-(5,5-dimethyl-5,6-dihydro-4H-pyrrolo[1,2-b]pyrazol-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	451.2
61		N-(6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	423.2

62		N-(6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-6-azaspiro[3.4]octan-2-amine	437.2
63		N-(6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.4]octan-6-amine	437.2
64		6-(6-(pyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	397.2
65		N-(6-(6-(pyrazolo[1,5-a]pyrimidin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	424.0
66		N-(6-(6-(4,5,6,7-tetrahydropyrazolo[1,5-a]pyridin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	427.0
67		N-(6-(6-(pyrazolo[1,5-b]pyridazin-3-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-2-azaspiro[3.3]heptan-6-amine	424.0

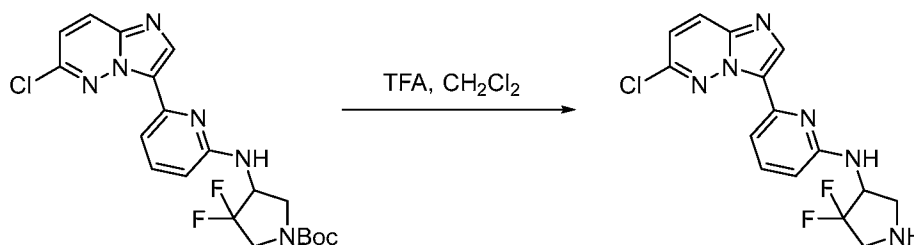
Example 6

Exemplary Synthetic Procedure #6 (Compound 68)

Compound 68, 6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-N-(4,4-difluoropyrrolidin-3-yl)pyridin-2-amine



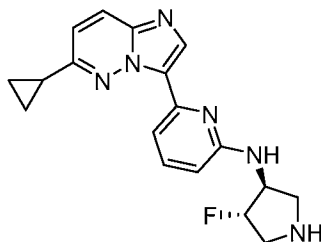
Step A. 6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-N-(4,4-difluoropyrrolidin-3-yl)pyridin-2-amine



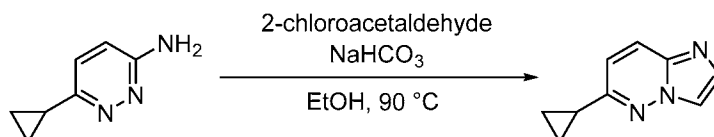
[004791] To a microwave vial were added tert-butyl 4-((6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-3,3-difluoropyrrolidine-1-carboxylate (0.049 g, 0.108 mmol), dichloromethane (2.0 mL), and trifluoroacetic acid (1.0 mL), in that order. The vial was sealed with a pressure relief cap and stirred at room temperature overnight. The reaction was then concentrated under reduced pressure to give a crude product that was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 75 x 30 mm; 5 – 25% acetonitrile in water containing 0.1% TFA) to provide the title compound: LCMS m/z 351.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.46 (s, 1 H), 8.15 (d, $J = 9.3$ Hz, 1 H), 7.93 (d, $J = 7.7$ Hz, 1 H), 7.73 – 7.65 (m, 1 H), 7.45 – 7.36 (m, 1H), 6.75 – 6.67 (m, 1 H), 5.38 – 5.25 (m, 1 H), 4.11 – 3.79 (m, 3 H), 3.50 – 3.40 (m, 1 H), 3.21 (d, $J = 7.4$ Hz, 1 H), 1.34 – 1.28 (m, 1 H).

*Example 7**Exemplary Synthetic Procedure #7 (Compounds 69 – 80)*

Compound 69, 6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

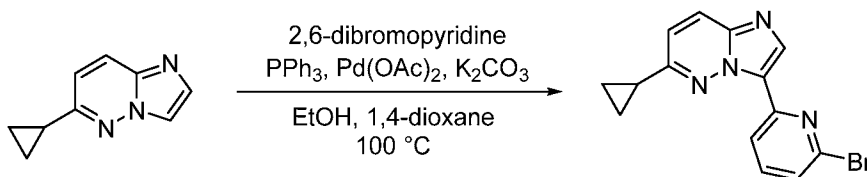


Step A. 6-cyclopropylimidazo[1,2-b]pyridazine



[004801] To a heavy-walled sealable flask equipped with a magnetic stir bar were added 6-cyclopropylpyridazin-3-amine (2.50 g, 18.5 mmol), sodium bicarbonate (3.88 g, 46.2 mmol), ethanol (75 mL), and 2-chloroacetaldehyde (7.20 mL, 48.4 mmol, 45% weight in H₂O). The vessel was sealed with a teflon screwcap and the reaction mixture warmed to 90 °C. After 8 hours the reaction mixture was cooled to room temperature, filtered through silica, poured into water (20 mL), and extracted with ethyl acetate (2 x 20 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (2 x 20 mL), dried over magnesium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to afford the title compound: LCMS *m/z* 160.0 [M+H]⁺; ¹H NMR (400 MHz, CD₃OD) δ 7.95 (d, *J* = 1.3 Hz, 1 H), 7.83 (d, *J* = 9.4 Hz, 1 H), 7.62 (d, *J* = 1.3 Hz, 1 H), 7.09 (d, *J* = 9.4 Hz, 1 H), 2.22 – 2.07 (m, 1 H), 1.15 – 1.00 (m, 4 H).

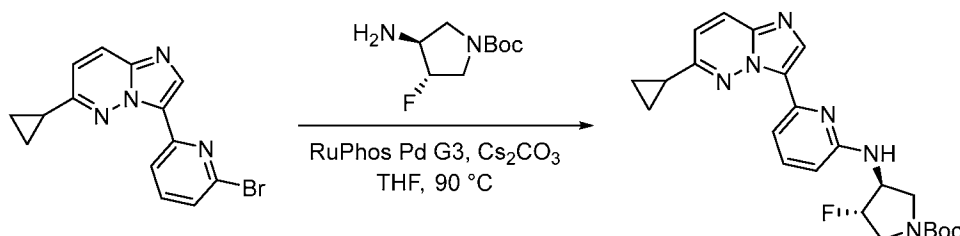
Step B. 3-(6-bromopyridin-2-yl)-6-cyclopropylimidazo[1,2-b]pyridazine



[004811] To a heavy-walled sealable flask equipped with a magnetic stir bar were added 6-cyclopropylimidazo[1,2-b]pyridazine (0.118 g, 0.739 mmol), 2,6-dibromopyridine (0.263 g, 1.11 mmol), triphenylphosphine (0.019 g, 0.074 mmol), potassium carbonate (0.307 g, 2.22 mmol), palladium (II) acetate (0.008 g, 0.037 mmol), 1,4-dioxane (2.0 mL), and ethanol (1.0 mL).

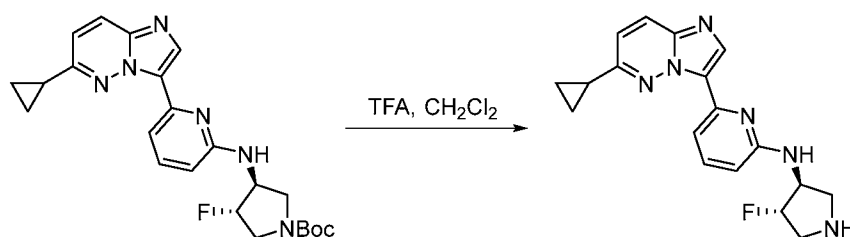
The flask was sealed with a teflon screwcap, and the reaction mixture warmed to 100 °C for 9 hours. The reaction mixture was then cooled to room temperature, diluted with ethyl acetate (30 mL), filtered through silica, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to deliver the title compound: LCMS m/z 316.9 $[M+H]^+$; ^1H NMR (400 MHz, DMSO- d_6) δ 8.57 (d, J = 7.8 Hz, 1 H), 8.30 (s, 1 H), 8.14 (d, J = 9.5 Hz, 1 H), 7.94 – 7.86 (m, 1 H), 7.56 (d, J = 7.9 Hz, 1 H), 7.28 (d, J = 9.4 Hz, 1 H), 2.38 – 2.23 (m, 1 H), 1.41 – 1.07 (m, 4 H).

Step C. tert-butyl (3S,4S)-3-((6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropyrrolidine-1-carboxylate



[00482] To a microwave vial equipped with a magnetic stir bar were added 3-(6-bromopyridin-2-yl)-6-cyclopropylimidazo[1,2-b]pyridazine (0.094 g, 0.298 mmol), tert-butyl (3S,4S)-3-amino-4-fluoropyrrolidine-1-carboxylate (0.061 g, 0.298 mmol), (2-Dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.025 g, 0.030 mmol), and cesium carbonate (0.291 g, 0.894 mmol). The vessel was sealed with a pressure relief cap and flushed with nitrogen for 30 minutes. Tetrahydrofuran (1.0 mL, dried and stored over 4 Å molecular sieves, deoxygenated via sparging with nitrogen for 30 minutes) was added, and the resulting reaction mixture warmed to 90 °C. After 9 hours the reaction mixture was cooled to room temperature, diluted with ethyl acetate (2 x 5 mL), filtered through silica, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in hexanes) to yield the title compound: LCMS m/z 439.2 $[M+H]^+$; ^1H NMR (400 MHz, DMSO- d_6) δ 8.25 (s, 1 H), 8.06 (d, J = 9.4 Hz, 1 H), 7.81 (d, J = 7.4 Hz, 1 H), 7.56 (t, J = 7.8 Hz, 1 H), 7.16 (d, J = 9.4 Hz, 1 H), 6.50 (d, J = 8.3 Hz, 1 H), 5.20 (d, J = 50.9 Hz, 1 H), 4.71 – 4.40 (m, 1 H), 3.80 – 3.36 (m, 5 H), 2.39 – 2.22 (m, 1 H), 1.40 (s, 9 H), 1.18 – 1.06 (m, 4 H).

Step D. 6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

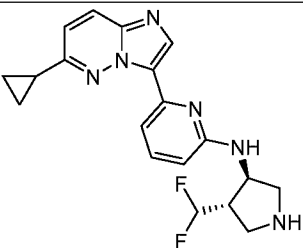
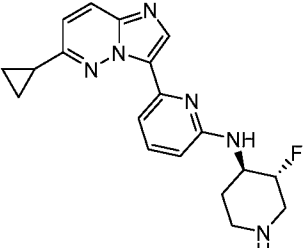
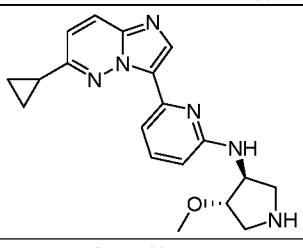
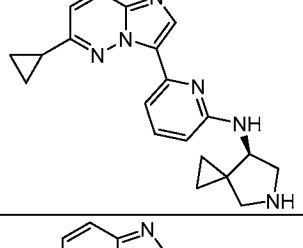
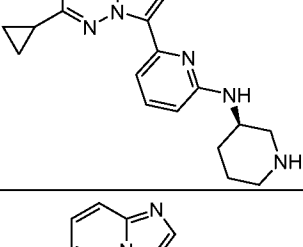
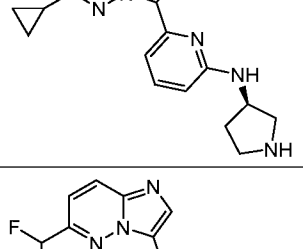
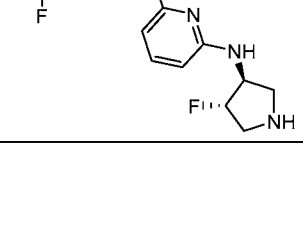


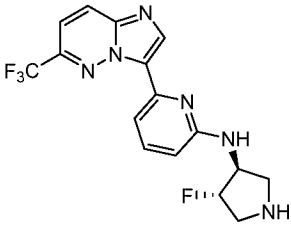
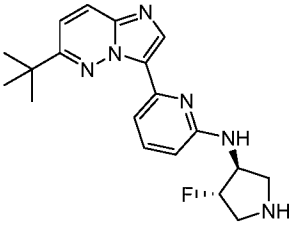
[00483] To a microwave vial were added tert-butyl (3*S*,4*S*)-3-((6-(6-cyclopropylimidazo[1,2-*b*]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropyrrolidine-1-carboxylate (0.025 g, 0.058 mmol), dichloromethane (1.0 mL), and trifluoroacetic acid (1.0 mL). The vial was sealed with a pressure relief cap, and the reaction was stirred overnight at room temperature. The reaction was then concentrated under reduced pressure to give a crude product that was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 75 x 30 mm; 5 – 30% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS *m/z* 339.2 [*M*+*H*]⁺; ¹H NMR (400 MHz, CD₃OD) δ 8.41 (s, 1 H), 8.16 – 8.05 (m, 1 H), 8.02 (dt, *J* = 7.5, 0.7 Hz, 1 H), 7.72 – 7.63 (m, 1 H), 7.45 – 7.35 (m, 1 H), 6.65 (dt, *J* = 8.5, 0.9 Hz, 1 H), 5.62 – 5.40 (m, 1 H), 4.81 – 4.73 (m, 1 H), 3.96 – 3.83 (m, 1 H), 3.80 – 3.54 (m, 4 H), 2.44 – 2.21 (m, 1 H), 1.35 – 1.11 (m, 5 H).

[00484] The compounds in Table 5 were all prepared using the chemistry described in **Example 7**.

Table 5. Additional compounds prepared according to **Example 7**.

Compound #	Structure	IUPAC Name	LCMS
70		(3 <i>S</i> ,4 <i>S</i>)-4-((6-(6-cyclopropylimidazo[1,2- <i>b</i>]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidin-3-ol	337.2
71		6-(6-cyclopropylimidazo[1,2- <i>b</i>]pyridazin-3-yl)-N-((3 <i>R</i> ,4 <i>S</i>)-4-(trifluoromethyl)pyrrolidin-3-yl)pyridin-2-amine	389.2

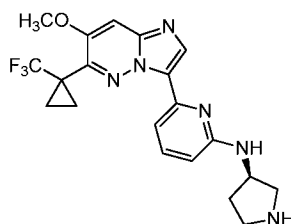
72		6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-(difluoromethyl)pyrrolidin-3-yl)pyridin-2-amine	371.2
73		6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-((3R,4R)-3-fluoropiperidin-4-yl)pyridin-2-amine	353.2
74		6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-methoxypyrrolidin-3-yl)pyridin-2-amine	351.2
75		(R)-N-(6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-5-azaspiro[2.4]heptan-7-amine	346.9
76		(R)-6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-(piperidin-3-yl)pyridin-2-amine	335.2
77		(R)-6-(6-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	320.9
78		6-(6-(difluoromethyl)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine	449.0

79		N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-(trifluoromethyl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	367.1
80		6-(6-(tert-butyl)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine	355.2

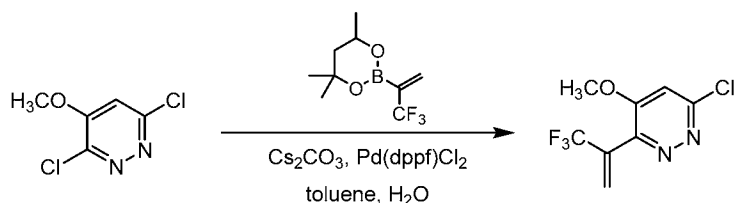
Example 8

Exemplary Synthetic Procedure #8 (Compounds 81 – 86)

Compound 81, (R)-6-(7-methoxy-6-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine



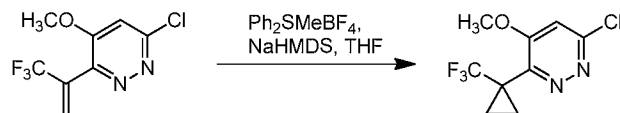
Step A. 6-chloro-4-methoxy-3-[1-(trifluoromethyl)vinyl]pyridazine



[00485] A mixture of 3,6-dichloro-4-methoxy-pyridazine (8.47 g, 47.3 mmol), 4,4,6-trimethyl-2-[1-(trifluoromethyl)vinyl]-1,3,2-dioxaborinane (7.00 g, 31.5 mmol), cesium carbonate (25.68 g, 78.82 mmol), and [1,1-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (2.31 g, 3.15 mmol) in toluene (120 mL) and water (40 mL) was degassed and purged with nitrogen 3 times, and was then stirred at 90 °C for 10 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (50 mL), and extracted with ethyl acetate (3 x 50 mL). The

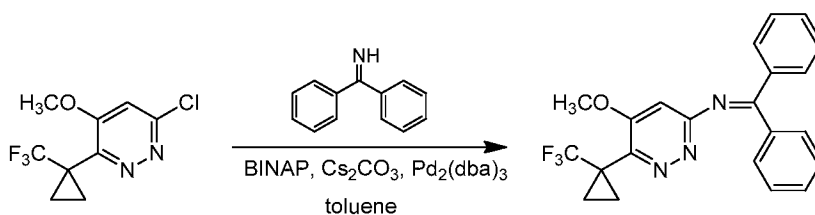
combined organic layers were washed with saturated aqueous sodium chloride solution (2 x 50 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 25% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 239.1 $[M+H]^+$; ^1H NMR (400 MHz, $CDCl_3$) δ 7.02 (s, 1 H), 6.40 (d, J = 1.3 Hz, 1 H), 6.16 (d, J = 1.1 Hz, 1 H), 3.98 (s, 3 H).

Step B. 6-chloro-4-methoxy-3-[1-(trifluoromethyl)cyclopropyl]pyridazine



[00486] To a cooled 0 °C solution of 6-chloro-4-methoxy-3-[1-(trifluoromethyl)vinyl]pyridazine (3.80 g, 15.9 mmol) and methyl(diphenyl)sulfonium tetrafluoroborate (5.51 g, 19.1 mmol) in tetrahydrofuran (100 mL) was added a solution of sodium bis(trimethylsilyl)amide in tetrahydrofuran (1 M, 31.85 mL, 31.85 mmol). The resulting mixture was stirred at 0 °C for 30 minutes, and was then allowed to warm to 20 °C over 2 hours. The reaction mixture was then cooled to 0 °C, quenched by addition of water (50 mL), and extracted with ethyl acetate (3 x 50 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (100 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 30% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 253.1 $[M+H]^+$; ^1H NMR (400 MHz, $CDCl_3$) δ 6.90 – 6.72 (s, 1 H), 3.89 – 3.77 (s, 3 H), 1.41 – 1.33 (m, 2 H), 1.14 – 1.05 (m, 2 H).

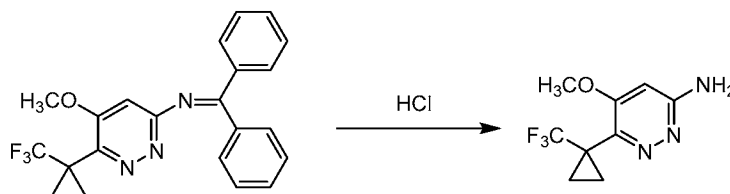
Step C. N-[5-methoxy-6-[1-(trifluoromethyl)cyclopropyl]pyridazin-3-yl]-1,1-diphenylmethanimine



[00487] A mixture of 6-chloro-4-methoxy-3-[1-(trifluoromethyl)cyclopropyl]pyridazine (2.50 g, 9.90 mmol), diphenylmethanimine (2.15 g, 11.9 mmol, 1.99 mL), cesium carbonate (9.67 g, 29.7 mmol), ($\pm$)-2,2-bis(diphenylphosphino)-1,1'-binaphthalene (0.616 g, 0.990 mmol), and tris-(dibenzylideneacetone)dipalladium(0) (0.906 g,

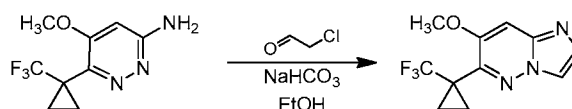
0.990 mmol) in toluene (50 mL) was degassed and purged with nitrogen 3 times, and was then stirred at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 398.2 $[M+H]^+$.

Step D. 5-methoxy-6-[1-(trifluoromethyl)cyclopropyl]pyridazin-3-amine



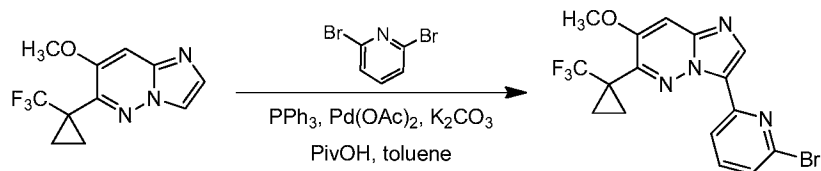
[00488] To a solution of a solution of N-[5-methoxy-6-[1-(trifluoromethyl)cyclopropyl]pyridazin-3-yl]-1,1-diphenyl-methanimine (3.00 g, 7.55 mmol) in tetrahydrofuran (30 mL) was added hydrochloric acid (6 M, 18.87 mL). The mixture was stirred at 20 °C for 3 hours, and was then washed with ethyl acetate (2 x 20 mL). The aqueous layer was basified to pH = 8 – 9 by addition of aqueous sodium hydroxide solution (6 N, 20 mL), causing a precipitate to form. The resulting mixture was filtered, and the solid collected and dried under reduced pressure to provide the title compound: LCMS m/z 234.1 $[M+H]^+$; ^1H NMR (400 MHz, DMSO- d_6) δ 6.03 (br d, J = 4.1 Hz, 1 H), 3.74 (s, 3 H), 1.34 – 1.21 (m, 2 H), 1.04 (br s, 2 H).

Step E. 7-methoxy-6-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazine



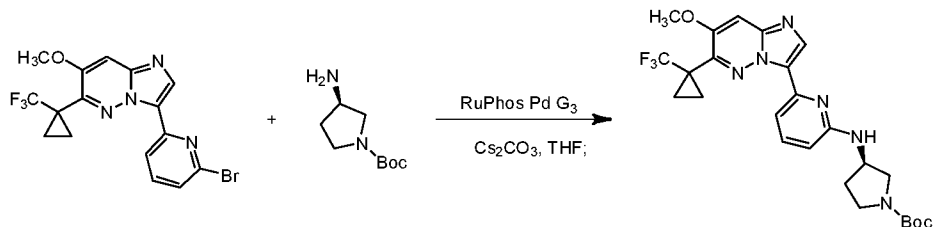
[00489] To a solution of 5-methoxy-6-[1-(trifluoromethyl)cyclopropyl]pyridazin-3-amine (1.00 g, 4.29 mmol) in ethanol (20 mL) were added sodium hydrogen carbonate (0.901 g, 10.72 mmol) and 2-chloroacetaldehyde (8.42 g, 42.9 mmol, 6.90 mL, 40% purity). The resulting mixture was stirred at 80 °C for 10 hours. The reaction was then cooled to room temperature, diluted with water (25 mL), and extracted with ethyl acetate (2 x 25 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (30 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 258.2 $[M+H]^+$.

Step F. 3-(6-bromo-2-pyridyl)-7-methoxy-6-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazine



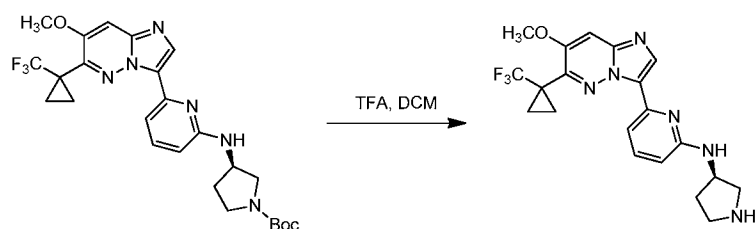
[00490] A mixture of 7-methoxy-6-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazine (0.30 g, 1.2 mmol), 2,6-dibromopyridine (0.829 g, 3.50 mmol), potassium carbonate (0.484 g, 3.50 mmol), triphenylphosphine (0.031 g, 0.117 mmol), palladium acetate (0.026 g, 0.117 mmol), and 2,2-dimethylpropanoic acid (0.036 g, 0.350 mmol) in toluene (10 mL) was degassed and purged with nitrogen times, and was then stirred at 100 °C for 10 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 70% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 413.1 $[M+H]^+$.

Step G. tert-butyl (3R)-3-[[6-[7-methoxy-6-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate



[00491] A mixture of 3-(6-bromo-2-pyridyl)-7-methoxy-6-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazine (20 mg, 0.048 mmol), tert-butyl (3R)-3-aminopyrrolidine-1-carboxylate (9.0 mg, 0.048 mmol, 8.2 μ L), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (4.0 mg, 0.005 mmol), and cesium carbonate (39.4 mg, 0.121 mmol) in tetrahydrofuran (2 mL) was degassed and purged with nitrogen 3 times, and was then stirred at 80 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 519.3 $[M+H]^+$.

Step H. 6-[7-methoxy-6-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazin-3-yl]-N-[(3R)-pyrrolidin-3-yl]pyridin-2-amine



[00492] To a solution of tert-butyl (3R)-3-[[6-[[7-methoxy-6-[[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate (0.030 g, 0.058 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (0.478 g, 4.19 mmol, 0.310 mL). The resulting mixture was stirred at 20 °C for 1 hour, and was then filtered and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 100 x 40 mm; 10 – 38% acetonitrile in water containing 0.1% TFA) to provide the title compound: LCMS m/z 419.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.37 (s, 1 H), 7.87 (d, $J = 7.5$ Hz, 1 H), 7.70 – 7.59 (m, 2 H), 6.63 (d, $J = 8.4$ Hz, 1 H), 4.72 – 4.61 (m, 1 H), 4.11 (s, 3 H), 3.68 (dd, $J = 6.0, 12.1$ Hz, 1 H), 3.57 – 3.38 (m, 3 H), 2.48 – 2.36 (m, 1 H), 2.22 – 2.08 (m, 1 H), 1.63 – 1.56 (m, 2 H), 1.48 – 1.35 (m, 2 H).

[00493] The compounds in Table 6 were all prepared using the synthetic procedures described in **Example 8**.

[00494] **Table 6.** Additional compounds prepared according to **Example 8**.

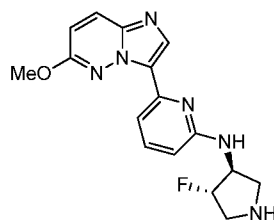
Compound #	Structure	IUPAC Name	LCMS
82		N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(7-methoxy-6-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	437.0
83		6-(7-methoxy-6-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-methylpyrrolidin-3-yl)pyridin-2-amine	433.1

84		(R)-6-(7-methoxy-6-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)-N-(piperidin-3-yl)pyridin-2-amine	433.1
85		N-((3S,4S)-4-fluoropiperidin-3-yl)-6-(7-methoxy-6-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	451.1
86		N-((3R,5S)-5-fluoropiperidin-3-yl)-6-(7-methoxy-6-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	451.1

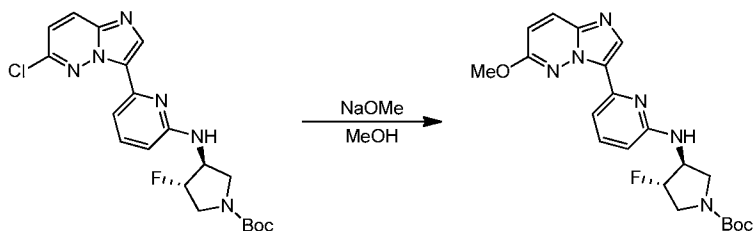
Example 9

Exemplary Synthetic Procedure #9 (Compound 87)

Compound 87, N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

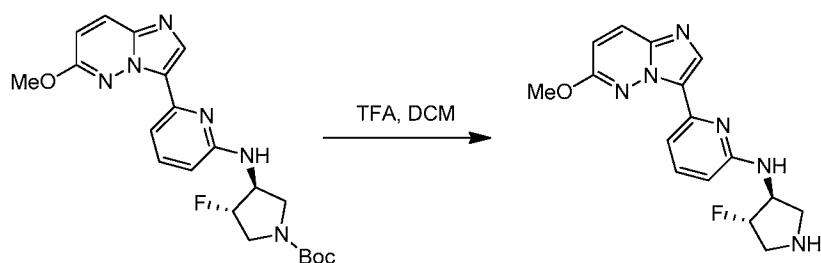


Step A. (3S, 4S)-tert-butyl 3-fluoro-4-((6-(6-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[00495] To a solution of tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoropyrrolidine-1-carboxylate (0.070 g, 0.162 mmol) in methanol (1 mL) was added sodium methoxide (0.087 g, 0.485 mmol, 30% purity). The resulting reaction was stirred at 80 °C for 3 hours, and was then cooled to room temperature and concentrated under reduced pressure to provide the title compound: LCMS m/z 429.2 [M+H]⁺.

Step B. N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

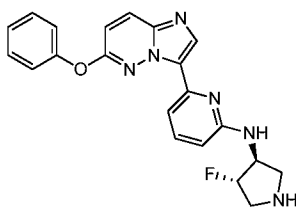


[00496] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[[6-(6-methoxyimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]pyrrolidine-1-carboxylate (0.080 g, 0.187 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.770 g, 6.75 mmol, 0.500 mL). The reaction was stirred at room temperature for 1 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Nano-micro Kromasil C18 column, 3 micron, 80 x 25 mm; 7 – 27% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 329.1 [M+H]⁺; ¹H NMR (400 MHz, CD₃OD) δ 8.41 (s, 1 H), 8.14 (d, *J* = 9.9 Hz, 1 H), 8.07 (d, *J* = 7.1 Hz, 1 H), 7.69 (t, *J* = 7.9 Hz, 1 H), 7.24 (d, *J* = 9.7 Hz, 1 H), 6.68 (d, *J* = 8.2 Hz, 1 H), 5.60 - 5.40 (m, 1 H), 4.85 – 4.75 (m, 1 H), 4.18 (s, 3 H), 3.90 (dd, *J* = 6.1, 12.9 Hz, 1 H), 3.77 – 3.72 (m, 1 H), 3.70 – 3.65 (m, 1 H), 3.64 – 3.56 (m, 1 H).

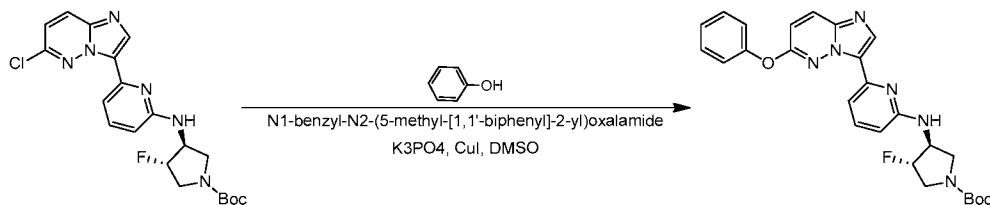
Example 10

Exemplary Synthetic Procedure #10 (Compound 88)

Compound 88, N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-phenoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

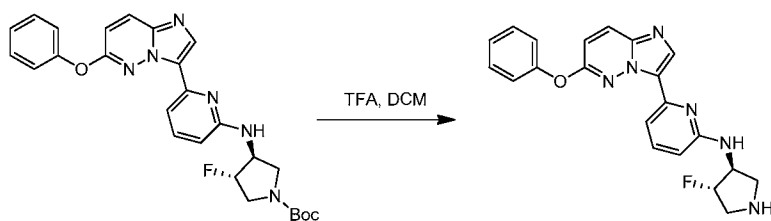


Step A. (3S,4S)-tert-butyl 3-fluoro-4-(((6-(6-phenoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[00497] A mixture of tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.060 g, 0.139 mmol), phenol (0.026 g, 0.277 mmol, 0.024 mL), potassium phosphate (0.044 g, 0.208 mmol), cuprous iodide (1.3 mg, 0.007 mmol), and N1-benzyl-N2-(5-methyl-[1,1'-biphenyl]-2-yl)oxalamide (5 mg, 0.007 mmol) in dimethyl sulfoxide (2 mL) was degassed and purged with nitrogen three times, and was then stirred at 120 °C for 18 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, diluted with water (3 mL), and extracted with ethyl acetate (3 x 3 mL). The combined organic layers were dried over magnesium sulfate, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 491.2 $[M+H]^+$.

Step B. N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-phenoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine



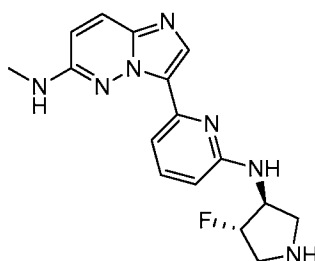
[00498] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[[6-(6-phenoxyimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]pyrrolidine-1-carboxylate (0.070 g, 0.143 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (1.54 g, 13.5 mmol, 1.00 mL). The reaction was stirred at 20 °C for 2 hours, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 20 – 50% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound:

LCMS m/z 391.0 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.38 (br s, 1 H), 8.23 (d, $J = 9.8$ Hz, 1 H), 7.60 – 7.52 (m, 2 H), 7.47 – 7.34 (m, 5H), 7.29 (t, $J = 7.8$ Hz, 1 H), 6.55 (d, $J = 8.3$ Hz, 1 H), 5.57 – 5.37 (m, 1 H), 4.81 – 4.71 (m, 1 H), 3.88 (dd, $J = 6.2, 12.7$ Hz, 1 H), 3.75 – 3.70 (m, 1 H), 3.68 – 3.62 (m, 1 H), 3.61 – 3.53 (m, 1 H).

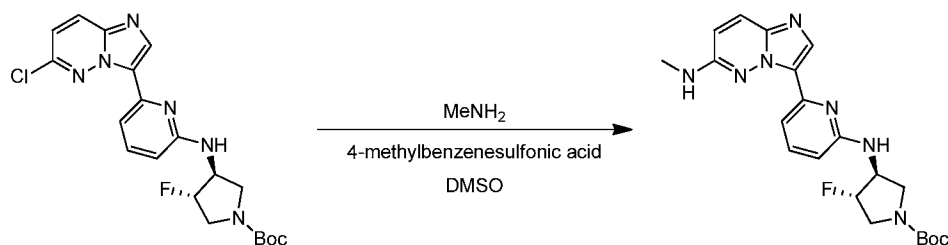
Example 11

Exemplary Synthetic Procedure #11 (Compounds 89 – 90)

Compound 89, 3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)-N-methylimidazo[1,2-b]pyridazin-6-amine

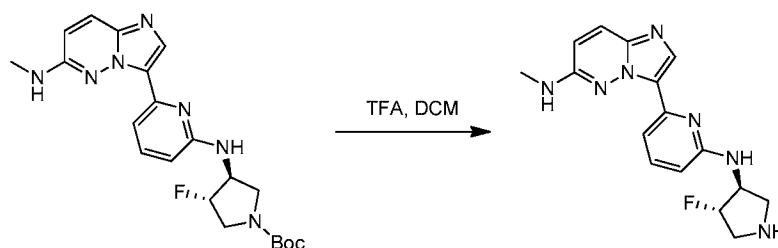


Step A. (3S,4S)-tert-butyl 3-fluoro-4-(((6-(6-(methylamino)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[00499] To a solution of tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.050 g, 0.116 mmol) and 4-methylbenzenesulfonic acid (0.030 g, 0.173 mmol) in dimethyl sulfoxide (1 mL) was added methanamine (0.062 g, 2.00 mmol, 0.50 mL). The reaction was stirred at 100 °C for 12 hours, and was then cooled to room temperature, diluted with water (2 mL), and extracted with ethyl acetate (3 x 3 mL). The combined organic layers were dried over magnesium sulfate, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 428.2 $[M+H]^+$.

Step B. 3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)-N-methylimidazo[1,2-b]pyridazin-6-amine



[00500] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[[6-[6-(methylamino)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate (0.050 g, 0.117 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (0.770 g, 6.75 mmol, 0.50 mL). The reaction was stirred at 20 °C for 1 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 10 – 40% acetonitrile in water containing 0.1% TFA) to provide the title compound: LCMS m/z 328.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.32 (s, 1 H), 8.19 (d, J = 7.6 Hz, 1 H), 7.91 (d, J = 9.8 Hz, 1 H), 7.67 (t, J = 7.9 Hz, 1 H), 7.15 (d, J = 9.9 Hz, 1 H), 6.68 (d, J = 8.3 Hz, 1 H), 5.57 – 5.37 (m, 1 H), 4.83 – 4.76 (m, 1 H), 3.89 (dd, J = 6.0, 12.6 Hz, 1 H), 3.79 – 3.73 (m, 1 H), 3.70 – 3.63 (m, 1 H), 3.61 – 3.54 (m, 1 H), 3.04 (s, 3 H).

[00501] The compounds in Table 7 were all prepared using the synthetic procedures described in **Example 11**.

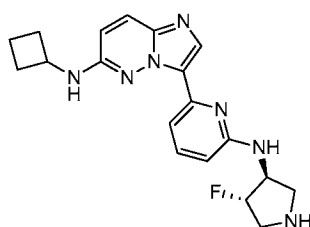
Table 7. Additional compounds prepared according to **Example 11**.

Compound #	Structure	IUPAC Name	LCMS
90		3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)-N,N-dimethylimidazo[1,2-b]pyridazin-6-amine	342.1

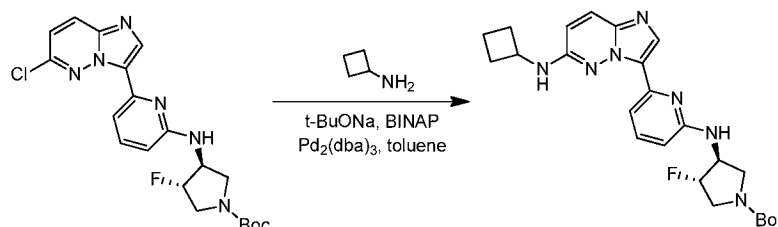
Example 12

Exemplary Synthetic Procedure #12 (Compounds 91 – 95)

Compound 91, N-cyclobutyl-3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-amine

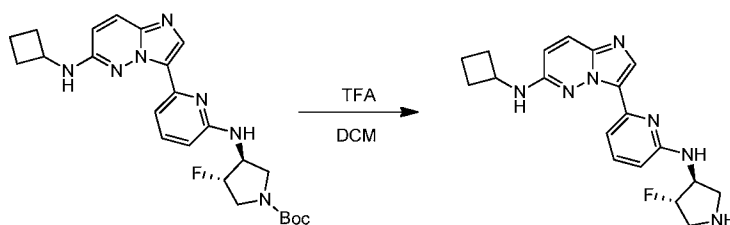


Step A. (3S,4S)-tert-butyl 3-(((6-(6-(cyclobutylamino)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropyrrolidine-1-carboxylate



[00502] A mixture of tert-butyl (3S,4S)-3-[[6-(6-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.070 g, 0.162 mmol), cyclobutanamine (0.014 g, 0.194 mmol, 0.017 mL), sodium tert-butoxide (0.031 g, 0.323 mmol), (R)-(+)-2,2'-bis(diphenylphosphino)-1,1'-binaphthyl (0.010 g, 0.016 mmol), and (1E,4E)-1,5-diphenylpenta-1,4-dien-3-one;palladium (0.015 g, 0.016 mmol) in toluene (1 mL) was degassed and purged with nitrogen three times, and was then stirred at 100 °C for 15 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 468.3 [M+H]⁺.

Step B. N-cyclobutyl-3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-amine

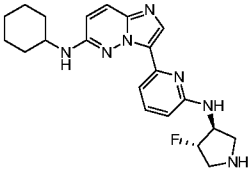
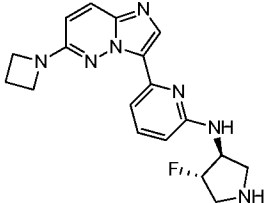
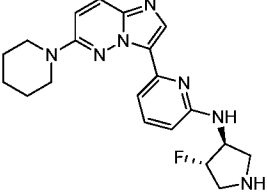
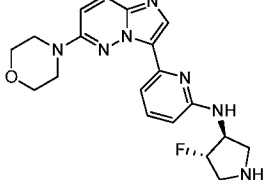


[00503] To a solution of tert-butyl (3S,4S)-3-[[6-[6-(cyclobutylamino)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.070 g, 0.150 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (0.437 g, 3.83 mmol, 0.284 mL). The reaction was stirred at 20 °C for 1 hour, and was then concentrated under pressure. The resulting crude product was purified by HPLC (Nano-micro Kromasil C18 column, 3 micron, 80 x 25 mm; 13 – 33% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound:

LCMS m/z 368.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.30 (s, 1 H), 8.17 (br d, $J = 7.3$ Hz, 1 H), 7.91 (br dd, $J = 1.5, 9.8$ Hz, 1 H), 7.70 (br t, $J = 7.9$ Hz, 1 H), 7.12 (br dd, $J = 1.9, 9.8$ Hz, 1 H), 6.69 (br d, $J = 8.3$ Hz, 1 H), 5.61 – 5.35 (m, 1 H), 5.11 – 4.97 (m, 1 H), 4.38 (quint, $J = 7.8$ Hz, 1 H), 3.89 (br dd, $J = 6.0, 12.3$ Hz, 1 H), 3.79 – 3.63 (m, 2 H), 3.62 – 3.35 (m, 2 H), 2.52 (br s, 2 H), 2.18 – 2.00 (m, 2 H), 1.92 (br dd, $J = 5.3, 9.3$ Hz, 2 H).

[00504] The compounds in Table 8 were all prepared using the synthetic procedures described in **Example 12**.

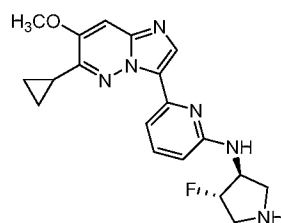
Table 8. Additional compounds prepared according to **Example 12**.

Compound #	Structure	IUPAC Name	LCMS
92		N-cyclohexyl-3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-amine	396.1
93		6-(6-(azetidin-1-yl)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine	354.0
94		N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-(piperidin-1-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	382.1
95		N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-morpholinoimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	384.1

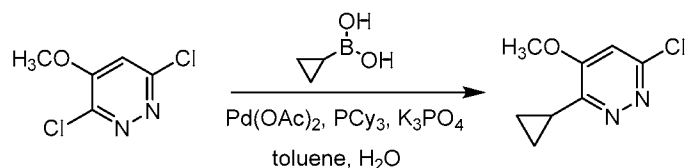
Example 13

Exemplary Synthetic Procedure #13 (Compounds 96 – 108)

Compound 96, 6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

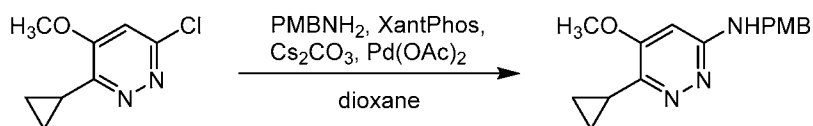


Step A. 6-chloro-3-cyclopropyl-4-methoxypyridazine



[00505] A mixture of 3,6-dichloro-4-methoxy-pyridazine (10.00 g, 55.86 mmol), cyclopropylboronic acid (7.20 g, 83.8 mmol), potassium phosphate (35.57 g, 167.6 mmol), palladium(II)acetate (1.25 g, 5.59 mmol), and tricyclohexylphosphine (2.35 g, 8.38 mmol, 2.72 mL) in toluene (100 mL) and water (10 mL) was degassed and purged with nitrogen three times, and was then stirred at 100 °C for 16 hours under nitrogen atmosphere. The reaction was then cooled to room temperature and concentrated under reduced pressure. The resulting crude product was diluted with water (50 mL) and extracted with ethyl acetate (3 x 80 mL). The combined organic layers were then washed with saturated aqueous sodium chloride solution (60 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 20% ethyl acetate in petroleum ether) to provide the title compound: ¹H NMR (400 MHz, CDCl₃) δ 6.69 (s, 1 H), 3.87 (s, 3 H), 2.33 – 2.25 (m, 1 H), 1.22 – 1.17 (m, 2 H), 1.07 – 0.96 (m, 2 H).

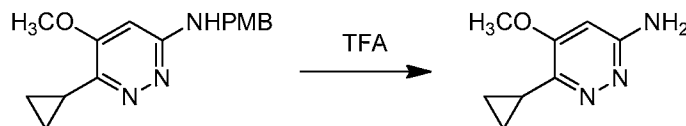
Step B. 6-cyclopropyl-5-methoxy-N-(4-methoxybenzyl)pyridazin-3-amine



[00506] A mixture of 6-chloro-3-cyclopropyl-4-methoxy-pyridazine (4.00 g, 21.7 mmol), (4-methoxyphenyl)methanamine (8.92 g, 65.0 mmol, 8.41 mL), 4,5-bis(diphenylphosphino)-9,9-dimethyl-9H-xanthene (1.88 g, 3.25 mmol), palladium(II)acetate (0.730 g, 3.25 mmol), and cesium carbonate (21.18 g, 65.00 mmol) in dioxane (50 mL) was degassed and purged with nitrogen three times, and was then stirred at 120 °C for 16 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, diluted with water (40

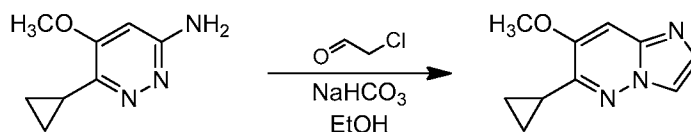
mL), and extracted with ethyl acetate (3 x 40 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (50 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 30% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 286.2 $[M+H]^+$.

Step C. 6-cyclopropyl-5-methoxypyridazin-3-amine



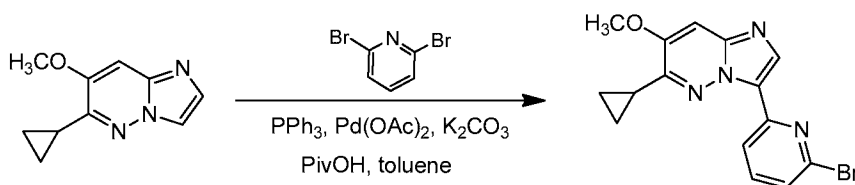
[00507] A solution of 6-cyclopropyl-5-methoxy-N-[(4-methoxyphenyl)methyl]pyridazin-3-amine (3.00 g, 10.5 mmol) in trifluoroacetic acid (30 mL) was stirred at 20 °C for 16 hours. Methanol was added, causing precipitation of a solid. The resulting mixture was filtered, and the mother liquor was concentrated under reduced pressure to provide the title compound: LCMS m/z 166.1 $[M+H]^+$.

Step D. 6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazine



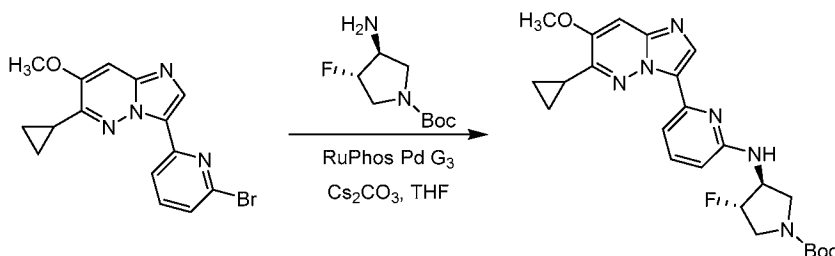
[00508] To a solution of 6-cyclopropyl-5-methoxy-pyridazin-3-amine (1.00 g, 6.05 mmol) and 2-chloroacetaldehyde (4.75 g, 60.5 mmol, 3.89 mL) in ethanol (2 mL) was added sodium bicarbonate (1.02 g, 12.1 mmol). The resulting reaction mixture was stirred at 80 °C for 4 hours, and was then cooled to room temperature and concentrated under reduced pressure. The resulting residue was diluted with water (10 mL) and extracted with ethyl acetate (3 x 10 mL). The combined organic layers were then washed with saturated aqueous sodium chloride solution (5 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to give the title compound: LCMS m/z 166.1 $[M+H]^+$; ^1H NMR (400 MHz, $CDCl_3$) δ 7.64 – 7.52 (m, 1 H), 7.40 – 7.29 (m, 1 H), 7.02 (s, 1 H), 3.88 (s, 3 H), 2.44 – 2.19 (m, 1 H), 1.10 – 1.02 (m, 2 H), 1.00 – 0.92 (m, 2 H).

Step E. 3-(6-bromopyridin-2-yl)-6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazine



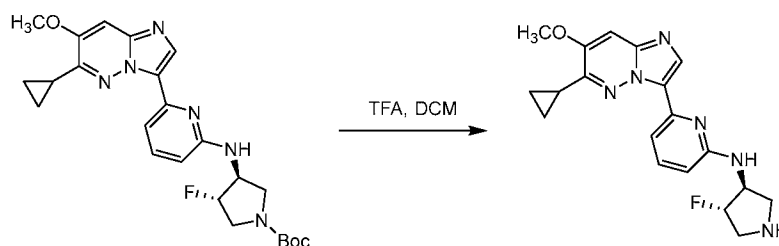
[00509] A mixture of 6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazine (0.600 g, 3.17 mmol), 2,6-dibromopyridine (2.25 g, 9.51 mmol), triphenylphosphine (0.125 g, 0.476 mmol), palladium(II)acetate (0.071 g, 0.317 mmol), potassium carbonate (1.31 g, 9.51 mmol), and 2,2-dimethylpropanoic acid (0.097 g, 0.951 mmol, 109 μ L) in toluene (20 mL) was degassed and purged with nitrogen three times, and was then stirred at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature and concentrated under reduced pressure. The resulting residue was diluted with water (10 mL) and extracted with ethyl acetate (3 x 10 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (10 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 345.1 $[M+H]^+$.

Step F. tert-butyl (3S,4S)-3-[[6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate



[00510] A mixture of 3-(6-bromo-2-pyridyl)-6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazine (0.080 g, 0.232 mmol), tert-butyl (3S,4S)-3-amino-4-fluoro-pyrrolidine-1-carboxylate (0.047 g, 0.232 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.019 g, 0.023 mmol), and cesium carbonate (0.227 g, 0.695 mmol) in tetrahydrofuran (3 mL) was degassed and purged with nitrogen three times, and was then stirred at 80 °C for 4 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 469.2 $[M+H]^+$.

Step G. 6-(6-cyclopropyl-7-methoxy-imidazo[1,2-b]pyridazin-3-yl)-N-[(3S,4S)-4-fluoropyrrolidin-3-yl]pyridin-2-amine

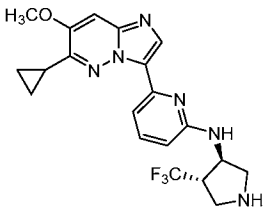
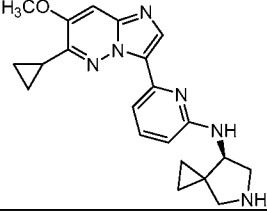
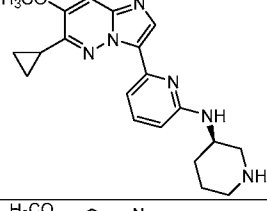
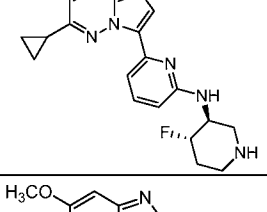
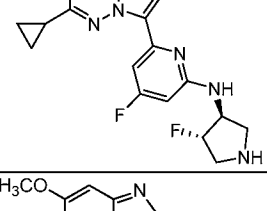
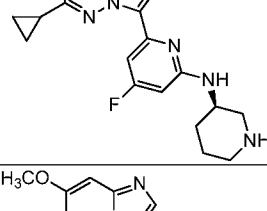
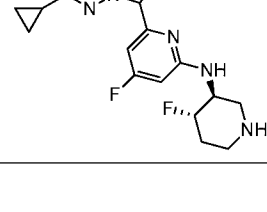


[00511] To a solution of tert-butyl (3S,4S)-3-[[6-(6-cyclopropyl-7-methoxy-imidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.100 g, 0.213 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (1.51 g, 13.2 mmol, 0.980 mL). The reaction mixture was stirred at 20 °C for 1 hour, and was then filtered and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 100 x 40 mm; 5 – 35% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 369.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.33 (s, 1 H), 7.84 (d, $J = 7.67$ Hz, 1 H), 7.64 – 7.70 (m, 1 H), 7.61 (s, 1 H), 6.69 (d, $J = 8.33$ Hz, 1 H), 5.38 – 5.54 (m, 1 H), 4.80 (br dd, $J = 13.48, 4.49$ Hz, 1 H), 4.17 (s, 3 H), 3.88 (dd, $J = 12.61, 6.03$ Hz, 1 H), 3.71 – 3.75 (m, 1 H), 3.61 – 3.71 (m, 1 H), 3.58 (dd, $J = 12.72, 2.63$ Hz, 1 H), 2.59 – 2.69 (m, 1 H), 1.27 – 1.31 (m, 4 H).

[00512] The compounds in Table 9 were all prepared using the synthetic procedures described in **Example 13**.

Table 9. Additional compounds prepared according to **Example 13**.

Compound #	Structure	IUPAC Name	LCMS
97		(R)-6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-(pyrrolidin-3-yl)pyridin-2-amine	351.1
98		6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-methylpyrrolidin-3-yl)pyridin-2-amine	365.1

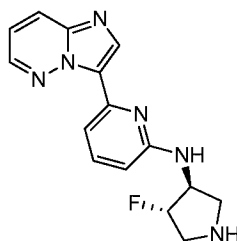
99		6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3R,4S)-4-(trifluoromethyl)pyrrolidin-3-yl)pyridin-2-amine	419.1
100		(R)-N-(6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-5-azaspiro[2.4]heptan-7-amine	377.1
101		(R)-N-(6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)-5-azaspiro[2.4]heptan-7-amine	365.1
102		6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropiperidin-3-yl)pyridin-2-amine	383.1
103		6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-4-fluoro-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine	387.1
104		(R)-6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-4-fluoro-N-(piperidin-3-yl)pyridin-2-amine	383.1
105		6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-4-fluoro-N-((3S,4S)-4-fluoropiperidin-3-yl)pyridin-2-amine	401.1

106		(R)-6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-3,5-difluoro-N-(piperidin-3-yl)pyridin-2-amine	401.1
107		6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-3,5-difluoro-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine	405.1
108		6-(6-cyclopropyl-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-3,5-difluoro-N-((3S,4S)-4-fluoropiperidin-3-yl)pyridin-2-amine	419.1

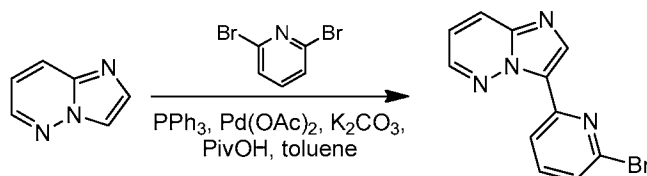
Example 14

Exemplary Synthetic Procedure #14 (Compound 109)

Compound 109, N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine



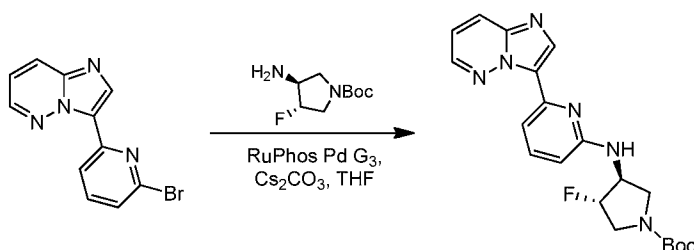
Step A. 3-(6-bromo-2-pyridyl)imidazo[1,2-b]pyridazine



[00513] A mixture of imidazo[1,2-b]pyridazine (0.500 g, 4.20 mmol), 2,6-dibromopyridine (2.98 g, 12.6 mmol), potassium carbonate (1.74 g, 12.6 mmol),

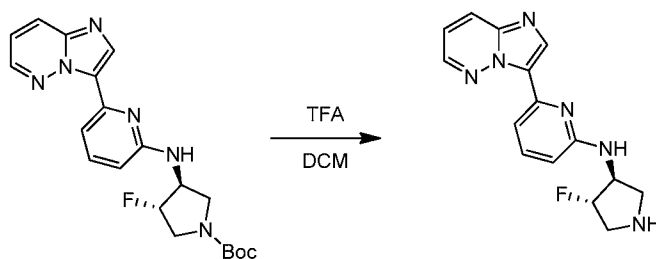
triphenylphosphine (0.220 g, 0.839 mmol), palladium(II)acetate (0.094 g, 0.420 mmol), and 2,2-dimethylpropanoic acid (0.129 g, 1.26 mmol, 0.145 mL) in toluene (10 mL) was degassed and purged with nitrogen three times, and was then stirred at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 20 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 10% methanol in dichloromethane) to give the title compound: LCMS m/z 275.0 $[M+H]^+$.

Step B. tert-butyl (3S,4S)-3-fluoro-4-[(6-imidazo[1,2-b]pyridazin-3-yl-2-pyridyl)amino]pyrrolidine-1-carboxylate



[00514] A mixture of 3-(6-bromo-2-pyridyl)imidazo[1,2-b]pyridazine (0.120 g, 0.436 mmol), tert-butyl (3S,4S)-3-amino-4-fluoro-pyrrolidine-1-carboxylate (0.071 g, 0.349 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.036 g, 0.044 mmol), and cesium carbonate (0.426 g, 1.31 mmol) in tetrahydrofuran (3 mL) was degassed and purged with nitrogen three times, and was then stirred at 80 °C for 4 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 399.2 $[M+H]^+$.

Step C. N-[(3S,4S)-4-fluoropyrrolidin-3-yl]-6-imidazo[1,2-b]pyridazin-3-yl-pyridin-2-amine

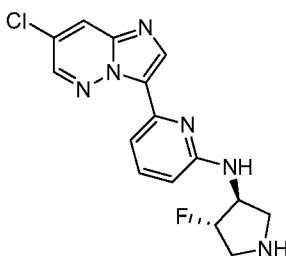


[00515] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[(6-imidazo[1,2-b]pyridazin-3-yl-2-pyridyl)amino]pyrrolidine-1-carboxylate (0.120 g, 0.301 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (1.54 g, 13.5 mmol, 1.00 mL). The resulting mixture was stirred at 20 °C for 1 hour, and was then filtered and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Gemini-NX C18 column, 3 micron, 75 x 30 mm; 2 – 20% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 299.0 [M+H]⁺; ¹H NMR (400 MHz, CD₃OD) δ = 8.81 (dd, *J* = 4.60, 1.53 Hz, 1 H), 8.53 (s, 1 H), 8.28 (dd, *J* = 9.32, 1.64 Hz, 1 H), 8.02 (dd, *J* = 7.45, 0.66 Hz, 1 H), 7.65 (dd, *J* = 8.33, 7.45 Hz, 1 H), 7.54 – 7.58 (m, 1 H), 6.66 (dd, *J* = 8.44, 0.77 Hz, 1 H), 5.36 – 5.67 (m, 1 H), 4.75 – 4.82 (m, 1 H), 3.88 (dd, *J* = 12.61, 6.25 Hz, 1 H), 3.72 – 3.77 (m, 1 H), 3.64 – 3.72 (m, 1 H), 3.60 (dd, *J* = 12.72, 2.85 Hz, 1 H).

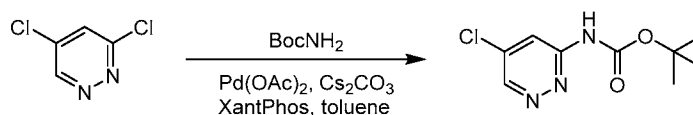
Example 15

Exemplary Synthetic Procedure #15 (Compound 110)

Compound 110, 6-(7-chloroimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine



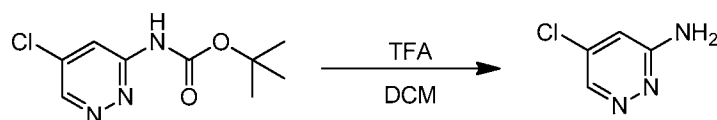
Step A. tert-butyl (5-chloropyridazin-3-yl)carbamate



[00516] A mixture of 3,5-dichloropyridazine (2.00 g, 13.4 mmol), tert-butyl carbamate (1.57 g, 13.4 mmol), [1,1-bis(diphenylphosphino)ferrocene]palladium(II) chloride dichloromethane complex (1.10 g, 1.34 mmol), cesium carbonate (13.12 g, 40.27 mmol), and 4,5-bis(diphenylphosphino)-9,9-dimethyl-9 H-xanthene (0.777 g, 1.34 mmol) in toluene (20 mL) was degassed and purged with nitrogen three times, and was then stirred at 80 °C for 16 hours under

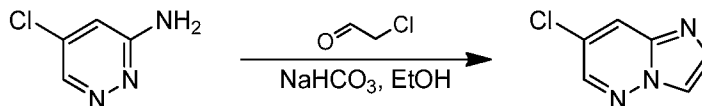
nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting residue was diluted with water (20 mL) and extracted with ethyl acetate (3 x 20 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 30% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 230.1 $[M+H]^+$; ^1H NMR (400 MHz, DMSO- d_6) δ 10.79 (s, 1 H), 9.04 (d, J = 1.75 Hz, 1 H), 8.18 (s, 1 H), 1.49 (s, 9 H).

Step B. 5-chloropyridazin-3-amine



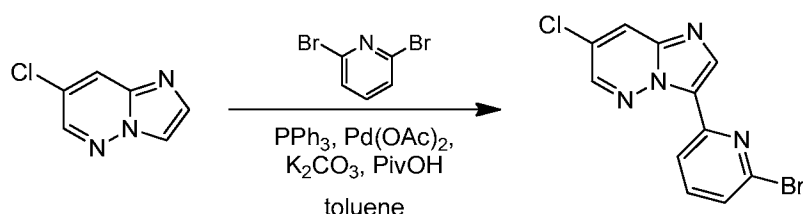
[00517] A mixture of tert-butyl N-(5-chloropyridazin-3-yl)carbamate (1.70 g, 7.40 mmol) and trifluoroacetic acid (15.4 g, 135 mmol, 10.0 mL) in dichloromethane (20 mL) was stirred for 0.5 hour at 20 °C. The reaction mixture was then concentrated under reduced pressure to provide the title compound: LCMS m/z 259.0 $[M+H]^+$.

Step C. 7-chloroimidazo[1,2-b]pyridazine



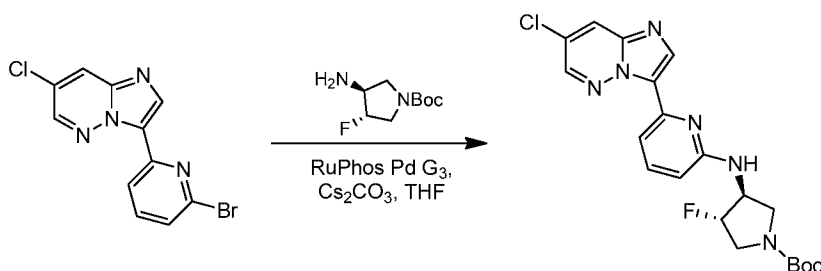
[00518] To a solution of 5-chloropyridazin-3-amine (1.30 g, 10.0 mmol) and sodium bicarbonate (1.69 g, 20.07 mmol) in ethanol (20 mL) was added 2-chloroacetaldehyde (14.07 g, 71.70 mmol, 11.53 mL, 40% purity). The resulting reaction mixture was stirred at 80 °C for 4 hours, and was then cooled to room temperature and concentrated under reduced pressure. The resulting residue was diluted with water (20 mL) and extracted with ethyl acetate (3 x 30 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (20 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 40% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 154.0 $[M+H]^+$.

Step D. 3-(6-bromopyridin-2-yl)-7-chloroimidazo[1,2-b]pyridazine



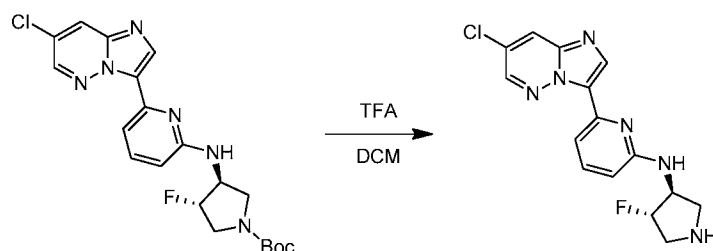
[00519] A mixture of 7-chloroimidazo[1,2-b]pyridazine (0.900 g, 5.86 mmol), 2,6-dibromopyridine (4.16 g, 17.6 mmol), potassium carbonate (2.43 g, 17.6 mmol), triphenylphosphine (0.231 g, 0.879 mmol), 2,2-dimethylpropanoic acid (0.180 g, 1.76 mmol, 0.202 mL), and palladium(II)acetate (0.132 g, 0.586 mmol) in toluene (20 mL) was degassed and purged with nitrogen three times, and was then stirred at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 55% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 311.0 $[\text{M}+\text{H}]^+$.

Step E. (3S,4S)-tert-butyl 3-((6-(7-chloroimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropyrrolidine-1-carboxylate



[00520] A mixture of 3-(6-bromo-2-pyridyl)-7-chloroimidazo[1,2-b]pyridazine (0.500 g, 1.62 mmol), tert-butyl (3S,4S)-3-amino-4-fluoropyrrolidine-1-carboxylate (0.330 g, 1.62 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.135 g, 0.162 mmol), and cesium carbonate (1.58 g, 4.85 mmol) in tetrahydrofuran (10 mL) was degassed and purged with nitrogen three times, and was then stirred at 80 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, concentrated under reduced pressure, and purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 433.1 $[\text{M}+\text{H}]^+$.

Step F. 6-(7-chloroimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

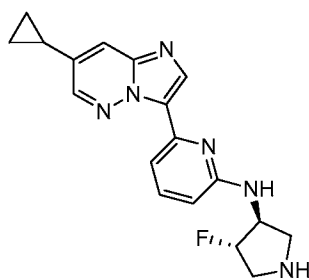


[00521] To a mixture of tert-butyl (3S,4S)-3-[[6-(7-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.080 g, 0.185 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (1.54 g, 13.5 mmol, 1.00 mL). The reaction was stirred for 0.5 hour at 20 °C, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 100 x 40 mm; 1 – 25% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 333.0 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.66 (d, $J = 2.51$ Hz, 1 H), 8.40 (s, 1 H), 8.22 (d, $J = 2.51$ Hz, 1 H), 7.93 (d, $J = 7.53$ Hz, 1 H), 7.61 (dd, $J = 8.22, 7.59$ Hz, 1 H), 6.61 (d, $J = 8.03$ Hz, 1 H), 5.45 – 5.62 (m, 1 H), 4.73 – 4.81 (m, 1 H), 3.89 (dd, $J = 12.67, 6.15$ Hz, 1 H), 3.74 (d, $J = 2.26$ Hz, 1 H), 3.59 – 3.70 (m, 2 H).

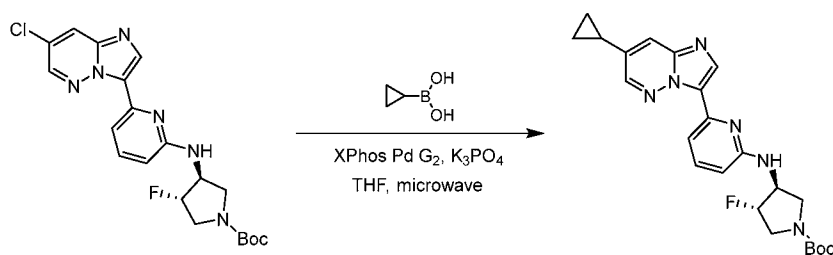
Example 16

Exemplary Synthetic Procedure #16 (Compound 111)

Compound 111, 6-(7-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

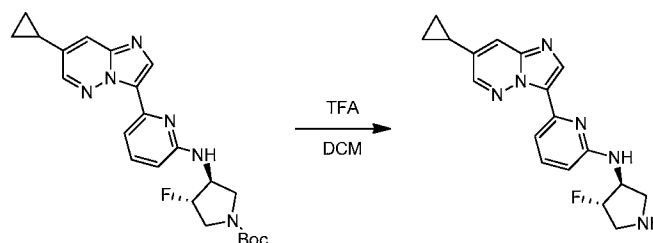


Step A. (3S,4S)-tert-butyl 3-((6-(7-cyclopropylimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropyrrolidine-1-carboxylate



[00522] A mixture of tert-butyl (3S,4S)-3-[[6-(7-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoropyrrolidine-1-carboxylate (0.080 g, 0.185 mmol), cyclopropylboronic acid (0.024 g, 0.277 mmol), aqueous potassium phosphate solution (1 M, 0.554 mL, 0.554 mmol), and chloro(2-dicyclohexylphosphino-2',4',6'-triisopropyl-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II) (0.015 g, 0.018 mmol) in tetrahydrofuran (1 mL) was degassed and purged with nitrogen three times, and was then heated by microwave at 90 °C for 0.5 hour under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to give the title compound: LCMS m/z 439.1 $[M+H]^+$.

Step B. 6-(7-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine



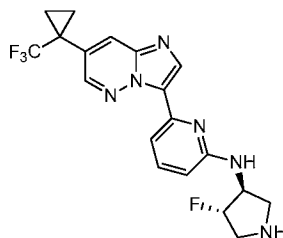
[00523] To a mixture of tert-butyl (3S,4S)-3-[[6-(7-cyclopropylimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoropyrrolidine-1-carboxylate (0.100 g, 0.228 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (1.54 g, 13.5 mmol, 1.00 mL). The resulting reaction was stirred for 0.5 hour at 20 °C, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 100 x 40 mm; 1 – 22% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 339.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.78 (d, J = 1.98 Hz, 1 H), 8.48 (s, 1 H), 7.99 (d, J = 7.28 Hz, 1 H), 7.93 (d, J = 1.98 Hz, 1 H), 7.67 (t, J = 7.94 Hz, 1 H), 6.69 (d, J = 8.38 Hz, 1 H), 5.41 – 5.60 (m, 1 H), 4.74 – 4.85 (m, 1 H), 3.89 (dd, J =

12.79, 6.39 Hz, 1 H), 3.70 – 3.78 (m, 1 H), 3.65 – 3.69 (m, 1 H), 3.61 (dd, $J = 12.68, 2.76$ Hz, 1 H), 2.17 – 2.32 (m, 1 H), 1.29 – 1.36 (m, 2 H), 1.05 – 1.11 (m, 2 H).

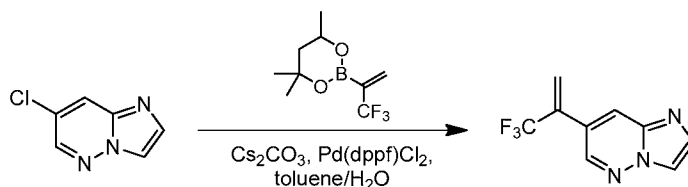
Example 17

Exemplary Synthetic Procedure #17 (Compound 112)

Compound 112, N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(7-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

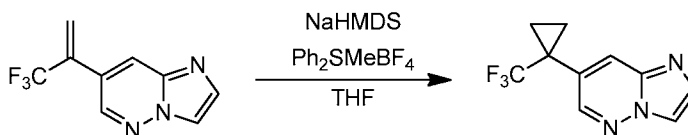


Step A. 7-(3,3,3-trifluoroprop-1-en-2-yl)imidazo[1,2-b]pyridazine



[00524] A mixture of 7-chloroimidazo[1,2-b]pyridazine (0.291 g, 1.89 mmol), 4,4,6-trimethyl-2-[1-(trifluoromethyl)vinyl]-1,3,2-dioxaborinane (0.400 g, 1.80 mmol), [1,1-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (0.132 g, 0.180 mmol), and cesium carbonate (1.47 g, 4.50 mmol) in toluene (3 mL) and water (1.5 mL) was degassed and purged with nitrogen three times, and was then stirred at 90 °C for 15 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 30% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 214.2 $[M+H]^+$.

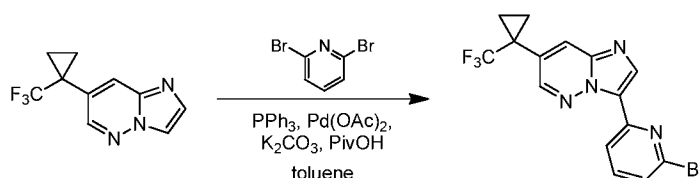
Step B. 7-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazine



[00525] To a cooled 0 °C solution of 7-[1-(trifluoromethyl)vinyl]imidazo[1,2-b]pyridazine (0.250 g, 1.17 mmol) and methyl(diphenyl)sulfonium tetrafluoroborate (0.405 g, 1.41

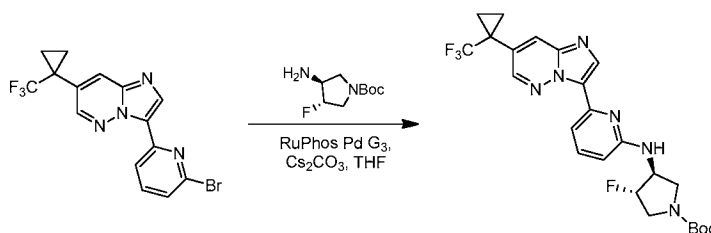
mmol) in tetrahydrofuran (3 mL) was added a solution of sodium bis(trimethylsilyl)amide in tetrahydrofuran (1 M, 2.35 mL, 2.35 mmol). The resulting reaction was stirred at 0 °C for 0.5 hour, warmed to 20 °C, and stirred for an additional 2 hours. The reaction mixture was then quenched by addition of water (5 mL) at 0 °C and extracted with ethyl acetate (3 x 5 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (5 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 30% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 228.1 $[M+H]^+$.

Step C. 3-(6-bromopyridin-2-yl)-7-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazine



[00526] A mixture of 7-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazine (0.130 g, 0.572 mmol), 2,6-dibromopyridine (0.407 g, 1.72 mmol), palladium(II)acetate (0.013 g, 0.057 mmol), triphenylphosphine (0.023 g, 0.086 mmol), 2,2-dimethylpropanoic acid (0.018 g, 0.172 mmol, 0.020 mL), and potassium carbonate (0.237 g, 1.72 mmol) in toluene (1 mL) was degassed and purged with nitrogen three times, and was then stirred at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 383.0 $[M+H]^+$.

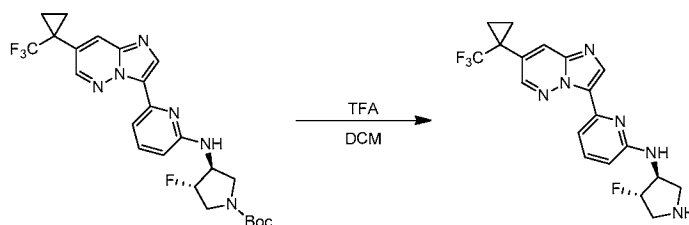
Step D. (3S,4S)-tert-butyl 3-fluoro-4-((6-(7-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[00527] A mixture of 3-(6-bromo-2-pyridyl)-7-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazine (0.090 g, 0.235 mmol), tert-butyl (3S,4S)-3-amino-4-fluoropyrrolidine-1-carboxylate (0.048 g, 0.235 mmol), (2-dicyclohexylphosphino-

2',6'-diisopropoxy-1,1'-biphenyl][2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.020 g, 0.023 mmol), and cesium carbonate (0.230 g, 0.705 mmol) in tetrahydrofuran (3 mL) was degassed and purged with nitrogen three times, and was then stirred at 80 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to give the title compound: LCMS m/z 507.1 $[M+H]^+$.

Step E. N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(7-(1-(trifluoromethyl)cyclopropyl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine

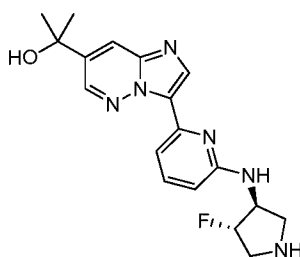
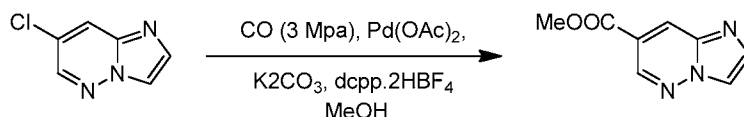


[005281] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[[6-[7-[1-(trifluoromethyl)cyclopropyl]imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate (0.100 g, 0.197 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (1.54 g, 13.5 mmol, 1.00 mL). The resulting reaction was stirred for 0.5 hour at 20 °C, and was then filtered and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 100 x 40 mm; 5 – 36% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 407.0 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.81 (d, $J = 1.76$ Hz, 1 H), 8.50 (s, 1 H), 8.26 (d, $J = 1.98$ Hz, 1 H), 8.03 (d, $J = 7.50$ Hz, 1 H), 7.65 (t, $J = 7.94$ Hz, 1 H), 6.65 (d, $J = 8.16$ Hz, 1 H), 5.42 – 5.62 (m, 1 H), 4.75 – 4.83 (m, 1 H), 3.90 (dd, $J = 12.57, 6.17$ Hz, 1 H), 3.75 (s, 1 H), 3.66 – 3.69 (m, 1 H), 3.62 (dd, $J = 12.68, 2.76$ Hz, 1 H), 1.53 – 1.60 (m, 2 H), 1.35 (br s, 2 H).

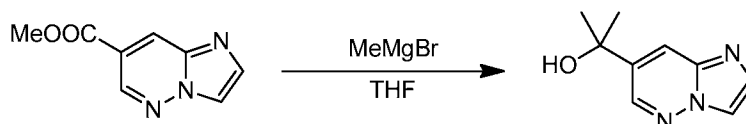
Example 18

Exemplary Synthetic Procedure #18 (Compound 113)

Compound 113, 2-(3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)imidazo[1,2-b]pyridazin-7-yl)propan-2-ol

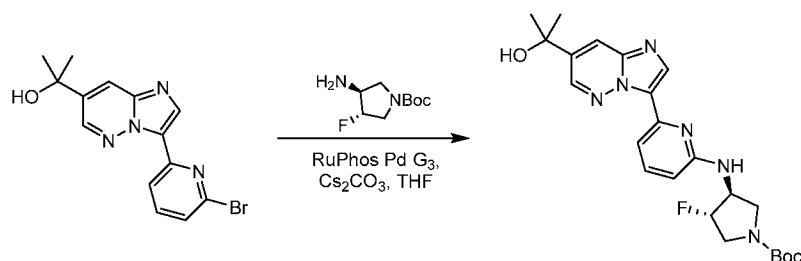
**Step A.** methyl imidazo[1,2-b]pyridazine-7-carboxylate

[00529] A mixture of 7-chloroimidazo[1,2-b]pyridazine (0.700 g, 4.56 mmol), potassium carbonate (0.944 g, 6.84 mmol), palladium(II)acetate (0.205 g, 0.912 mmol), and dicyclohexyl(3-dicyclohexylphosphonium)propylphosphonium ditetrafluoroborate (1.12 g, 1.82 mmol) in methanol (20 mL) was degassed and purged with carbon monoxide (3 Mpa) 3 times, and was then stirred at 80 °C for 15 hours under carbon monoxide (3 Mpa) atmosphere. The reaction was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 178.2 $[M+H]^+$.

Step B. 2-imidazo[1,2-b]pyridazin-7-ylpropan-2-ol

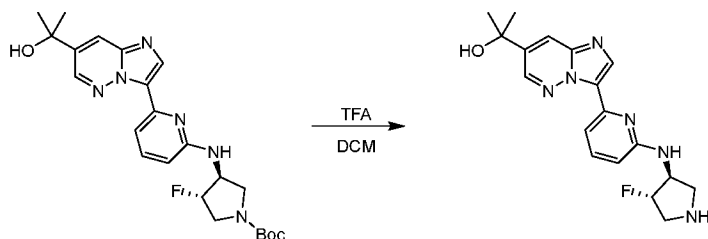
[00530] To a cooled 0 °C solution of methyl imidazo[1,2-b]pyridazine-7-carboxylate (0.500 g, 2.82 mmol) in tetrahydrofuran (15 mL) was added magnesium methyl bromide (3 M in diethyl ether, 5.64 mL). The resulting reaction was stirred at 0 °C for 2 hours, and was then quenched by addition of water (15 mL) at 0 °C, and extracted with ethyl acetate (3 x 15 mL). The combined organic layers were washed with saturated aqueous sodium chloride solution (15 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 80% ethyl acetate in petroleum ether) to provide the title compound:

Step C. (3S,4S)-tert-butyl 3-fluoro-4-((6-(7-(2-hydroxypropan-2-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[00531] A mixture of 2-[3-(6-bromo-2-pyridyl)imidazo[1,2-b]pyridazin-7-yl]propan-2-ol (0.070 g, 0.210 mmol), tert-butyl (3S,4S)-3-amino-4-fluoro-pyrrolidine-1-carboxylate (0.043 g, 0.210 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.018 g, 0.021 mmol), and cesium carbonate (0.205 g, 0.630 mmol) in tetrahydrofuran (2 mL) was degassed and purged with nitrogen three times, and was then stirred at 80 °C for 2 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 457.2 $[M+H]^+$.

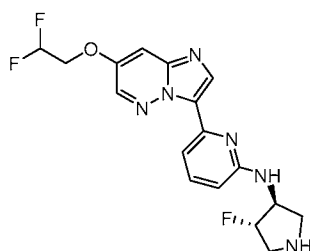
Step D. N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine



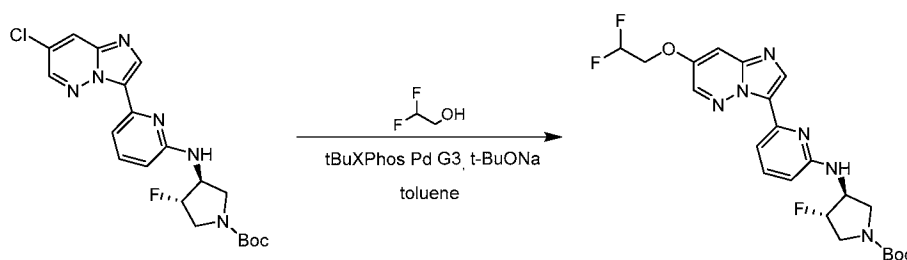
[00532] To a solution of tert-butyl (3S,4S)-3-fluoro-4-[[6-[7-(1-hydroxy-1-methylethyl)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]pyrrolidine-1-carboxylate (0.080 g, 0.175 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.770 g, 6.75 mmol, 0.50 mL). The resulting reaction was stirred at 20 °C for 0.5 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Gemini-NX C18 column, 3 micron, 75 x 30 mm; 1 – 30% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 357.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 9.03 (s, 1 H), 8.52 (s, 1 H), 8.36 – 8.20 (m, 1 H), 8.05 (d, $J = 7.5$ Hz, 1 H), 7.69 (t, $J = 7.9$ Hz, 1 H), 6.69 (d, $J = 8.3$ Hz, 1 H), 5.67 – 5.43 (m, 1 H), 4.99 – 4.95 (m, 1 H), 3.92 (dd, $J = 6.1, 12.7$ Hz, 1 H), 3.79 – 3.75 (m, 1 H), 3.72 – 3.68 (m, 1 H), 3.67 – 3.61 (m, 1 H), 1.69 (s, 6 H).

Example 19**Exemplary Synthetic Procedure #19 (Compounds 114 – 115)**

Compound 114, 6-(7-(2,2-difluoroethoxy)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

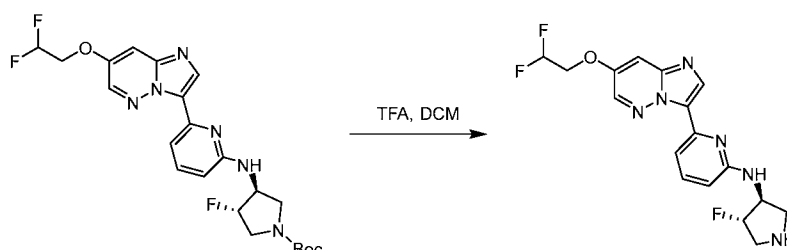


Step A. (3S,4S)-tert-butyl 3-((6-(7-(2,2-difluoroethoxy)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropyrrolidine-1-carboxylate



[00533] A mixture of tert-butyl (3S,4S)-3-[[6-(7-chloroimidazo[1,2-b]pyridazin-3-yl)-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.080 g, 0.185 mmol), 2,2-difluoroethanol (0.076 g, 0.924 mmol), sodium tert-butoxide (0.036 g, 0.370 mmol), and [2-(2-aminophenyl)phenyl]-methylsulfonyloxy-palladium ditert-butyl-[2-(2,4,6-triisopropylphenyl)phenyl]phosphane (0.015 g, 0.018 mmol) in toluene (3 mL) was degassed and purged with nitrogen three times, and was then stirred at 100 °C for 15 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 479.3 $[M+H]^+$.

Step B. 6-(7-(2,2-difluoroethoxy)imidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine



[00534] To a solution tert-butyl (3S,4S)-3-[[6-[7-(2,2-difluoroethoxy)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.080 g, 0.167 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (1.23 g, 10.8 mmol, 0.80 mL). The resulting reaction was stirred at 20 °C for 0.5 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 100 x 40 mm; 5 – 29% acetonitrile in water containing 0.1% trifluoroacetic acid) to provide the title compound: LCMS m/z 379.0 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.80 (d, J = 2.8 Hz, 1 H), 8.42 (s, 1 H), 7.93 (d, J = 7.5 Hz, 1 H), 7.81 (d, J = 2.9 Hz, 1 H), 7.67 (t, J = 7.9 Hz, 1 H), 6.70 (d, J = 8.4 Hz, 1 H), 6.54 – 6.19 (m, 1 H), 5.62 – 5.44 (m, 1 H), 4.81 (br dd, J = 4.1, 14.6 Hz, 1 H), 4.60 (dt, J = 3.5, 13.7 Hz, 2 H), 3.90 (dd, J = 6.2, 12.7 Hz, 1 H), 3.80 – 3.73 (m, 1 H), 3.70 – 3.59 (m, 2 H).

[00535] The compounds in Table 10 were all prepared using the synthetic procedures described in **Example 19**.

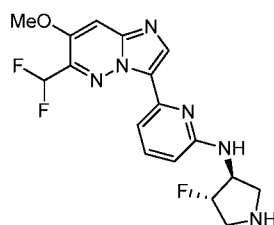
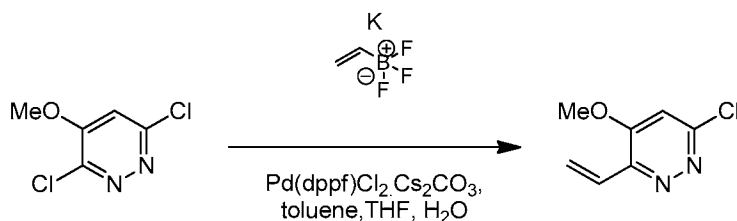
Table 10. Additional compounds prepared according to **Example 19**.

Example	Structure	IUPAC Name	LCMS
115		N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(7-isopropoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	357.1

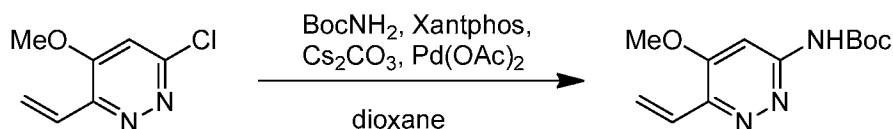
Example 20

Exemplary Synthetic Procedure #20 (Compounds 116 – 118)

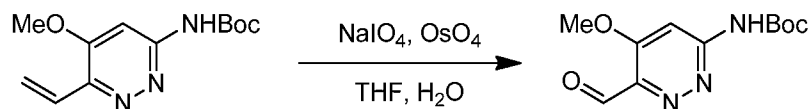
Compound 116, 6-(6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

**Step A.** 6-chloro-4-methoxy-3-vinylpyridazine

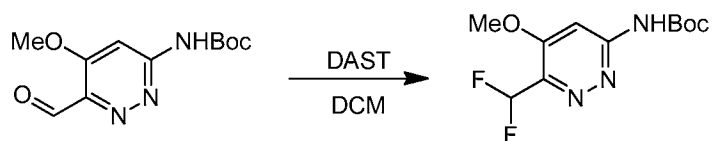
[00536] A mixture of 3,6-dichloro-4-methoxy-pyridazine (10.0 g, 55.9 mmol), potassium trifluoro(vinyl)boronate (7.48 g, 55.9 mmol), [1,1-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (4.09 g, 5.59 mmol), and cesium carbonate (54.61 g, 167.6 mmol) in tetrahydrofuran (210 mL), water (70 mL) and toluene (70 mL) was purged with nitrogen, and was then heated at 100 °C for 16 hours. The reaction mixture was then cooled to room temperature, poured into water (200 mL), and extracted with ethyl acetate (3 x 100 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (200 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 171.2 $[M+H]^+$.

Step B. tert-butyl (5-methoxy-6-vinylpyridazin-3-yl)carbamate

[00537] A mixture of 6-chloro-4-methoxy-3-vinyl-pyridazine (4.00 g, 23.5 mmol), tert-butyl carbamate (8.24 g, 70.3 mmol), palladium acetate (0.526 g, 2.34 mmol), (5-diphenylphosphanyl-9,9-dimethyl-xanthen-4-yl)-diphenyl-phosphane (2.04 g, 3.52 mmol), and cesium carbonate (22.92 g, 70.34 mmol) in dioxane (50 mL) was purged with nitrogen, and was then heated at 100 °C for 16 hours. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 252.2 $[M+H]^+$.

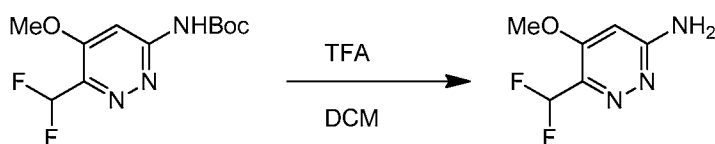
Step C. tert-butyl (6-formyl-5-methoxypyridazin-3-yl)carbamate

[00538] To a solution of tert-butyl N-(5-methoxy-6-vinylpyridazin-3-yl)carbamate (5.60 g, 22.3 mmol) in dioxane (45 mL) and water (15 mL) were added sodium periodate (7.15 g, 33.4 mmol, 1.85 mL), osmium tetroxide (0.453 g, 1.78 mmol), and 2,6-dimethylpyridine (4.78 g, 44.6 mmol, 5.19 mL), in that order. The resulting mixture was stirred at room temperature for 16 hours. The reaction mixture was then quenched by addition of saturated aqueous sodium sulfite solution (50 mL) and extracted with ethyl acetate (2 x 50 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (2 x 50 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS *m/z* 254.1 [M+H]⁺; ¹H NMR (400 MHz, DMSO-*d*₆) δ 10.99 (s, 1 H), 10.13 (s, 1 H), 7.82 (s, 1 H), 3.97 (s, 3 H), 1.51 (s, 9 H).

Step D. tert-butyl (6-(difluoromethyl)-5-methoxypyridazin-3-yl)carbamate

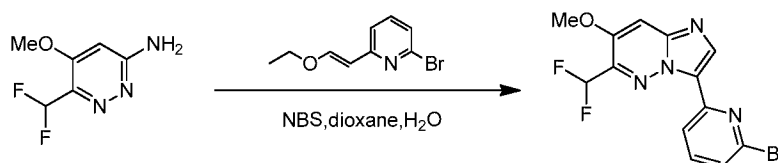
[00539] To a cooled 0 °C solution of tert-butyl N-(6-formyl-5-methoxy-pyridazin-3-yl)carbamate (1.50 g, 5.92 mmol) in dichloromethane (15 mL) was added dropwise diethylamino-sulfur trifluoride (1.91 g, 11.9 mmol, 1.57 mL). The resulting mixture was removed from the cold bath and stirred for 10 hours while slowly warming to room temperature. The reaction was then poured into water (10 mL) and extracted with ethyl acetate (3 x 10 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (20 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 40% ethyl acetate in petroleum ether) to give the title compound: LCMS *m/z* 276.1 [M+H]⁺; ¹H NMR (400 MHz, CDCl₃) δ 7.89 (s, 1 H), 6.99 – 6.72 (m, 1 H), 4.02 (s, 3 H), 1.48 (s, 9 H).

Step E. tert-butyl (6-(difluoromethyl)-5-methoxypyridazin-3-yl)carbamate



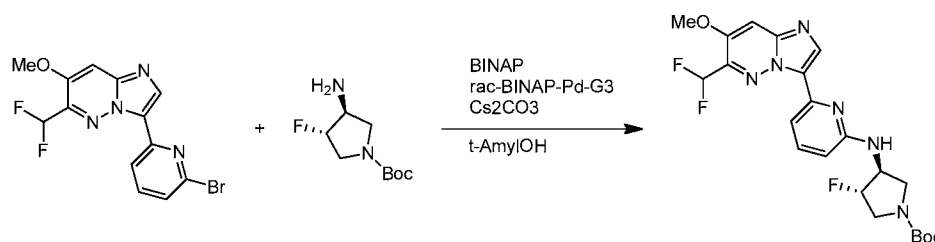
[00540] To a solution of tert-butyl N-[6-(difluoromethyl)-5-methoxy-pyridazin-3-yl]carbamate (0.800 g, 2.91 mmol) in dichloromethane (10 mL) was added trifluoroacetic acid (4.62 g, 40.5 mmol, 3.00 mL). The resulting reaction was stirred at room temperature for 1 hour, and was then concentrated under reduced pressure to give the title compound: LCMS m/z 176.1 $[M+H]^+$.

Step F. 3-(6-bromopyridin-2-yl)-6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazine



[00541] To a solution of 2-bromo-6-[(E)-2-ethoxyvinyl]pyridine (2.15 g, 9.42 mmol) in dioxane (15 mL) and water (5 mL) was added 1-bromopyrrolidine-2,5-dione (1.68 g, 9.42 mmol). The resulting reaction mixture was stirred at room temperature for 1 hour. 6-(difluoromethyl)-5-methoxy-pyridazin-3-amine (1.10 g, 6.28 mmol) was then added, and the resulting mixture was heated at 80 °C for 15 hours. The reaction was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (2 x 30 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (2 x 50 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to give the title compound: LCMS m/z 354.9 $[M+H]^+$.

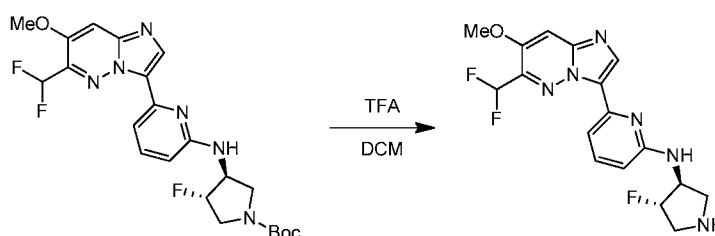
Step G. (3S,4S)-tert-butyl 3-((6-(6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropyrrolidine-1-carboxylate



[00542] A mixture of 3-(6-bromo-2-pyridyl)-6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazine (0.070 g, 0.197 mmol), tert-butyl (3S,4S)-3-amino-4-fluoropyrrolidine-

1-carboxylate (0.060 g, 0.296 mmol), cesium carbonate (0.161 g, 0.493 mmol), [2-(2-aminophenyl)phenyl]-methylsulfonyloxy-palladium[1-(2-diphenylphosphanyl-1-naphthyl)-2-naphthyl]-diphenyl-phosphane (0.020 g, 0.020 mmol), and [1-(2-diphenylphosphanyl-1-naphthyl)-2-naphthyl]-diphenyl-phosphane (0.012 g, 0.020 mmol) in 2-methylbutan-2-ol (3 mL) was purged with nitrogen, and was then heated at 100 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to give the title compound: LCMS m/z 479.1 $[M+H]^+$.

Step H. 6-(6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropyrrolidin-3-yl)pyridin-2-amine

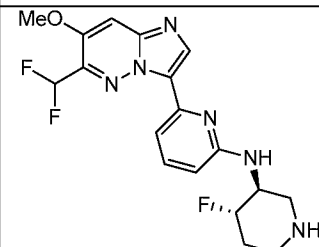


[00543] To a solution of tert-butyl (3S,4S)-3-[[6-[6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]-4-fluoro-pyrrolidine-1-carboxylate (0.080 g, 0.167 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.770 g, 6.75 mmol, 0.500 mL). The resulting reaction mixture was stirred at room temperature for 1 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 1 – 30% acetonitrile in water containing 0.04% trifluoroacetic acid) to give the title compound: LCMS m/z 379.0 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.44 (s, 1 H), 7.91 – 7.86 (m, 2 H), 7.70 (t, J = 7.9 Hz, 1 H), 7.30 – 7.04 (m, 1 H), 6.67 (d, J = 8.4 Hz, 1 H), 5.56 – 5.43 (m, 1 H), 4.85 – 4.76 (m, 1 H), 4.16 (s, 3 H), 3.87 – 3.74 (m, 1 H), 3.67 – 3.31 (m, 3 H).

[00544] The compounds in Table 11 were all prepared using the synthetic procedures described in **Example 20**.

Table 11. Additional compounds prepared according to **Example 20**.

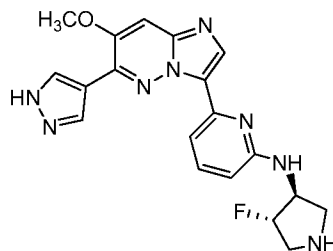
Example	Structure	IUPAC Name	LCMS
117		(R)-6-(6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-(piperidin-3-yl)pyridin-2-	375.1

		amine	
118		6-(6-(difluoromethyl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropiperidin-3-yl)pyridin-2-amine	393.0

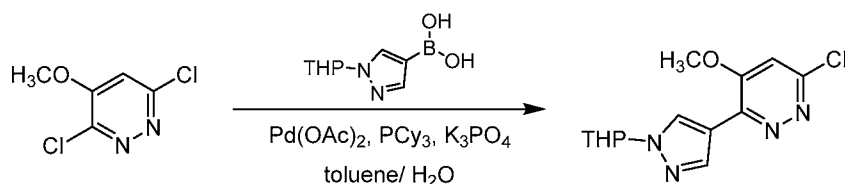
Example 21

Exemplary Synthetic Procedure #21 (Compounds 119 – 122)

Compound 119, N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine



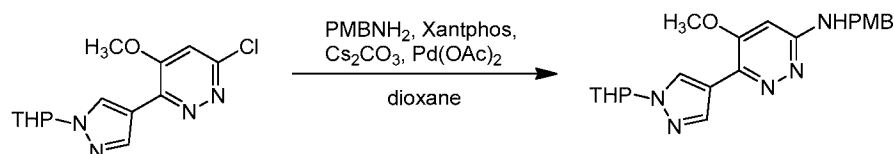
Step A. 6-chloro-4-methoxy-3-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl) pyridazine



[00545] A mixture of 3,6-dichloro-4-methoxypyridazine (6.00 g, 33.5 mmol), 1-tetrahydropyran-2-yl-4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrazole (8.86 g, 31.8 mmol), [1,1-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (2.45 g, 3.35 mmol), and potassium phosphate (28.46 g, 134.1 mmol) in N,N-dimethylformamide (100 mL) and water (20 mL) was purged with nitrogen, and was then heated at 110 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (100 mL), and extracted with ethyl acetate (3 x 100 mL). The organic extracts were combined, washed sequentially with water (3 x 50 mL) and saturated aqueous sodium chloride solution (50 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product

was purified by flash chromatography on silica gel (0 – 35% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 295.1 $[M+H]^+$.

Step B. 5-methoxy-N-(4-methoxybenzyl)-6-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)pyridazin-3-amine



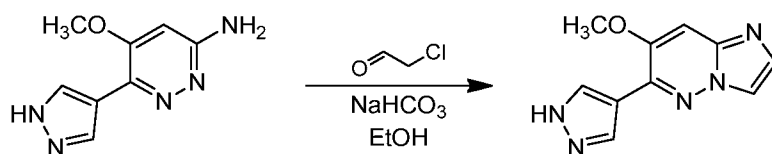
[00546] A mixture of 6-chloro-4-methoxy-3-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)pyridazine (6.00 g, 20.4 mmol), (4-methoxyphenyl)methanamine (8.38 g, 61.1 mmol, 7.90 mL), palladium(II)acetate (0.457 g, 2.04 mmol), 4,5-bis(diphenylphosphino)-9,9-dimethyl-9H-xanthene (1.77 g, 3.05 mmol), and cesium carbonate (19.90 g, 61.07 mmol) in dioxane (100 mL) was purged with nitrogen, and was then heated at 120 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (50 mL), and extracted with ethyl acetate (3 x 50 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (50 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 396.2 $[M+H]^+$.

Step C. 5-methoxy-6-(1H-pyrazol-4-yl)pyridazin-3-amine



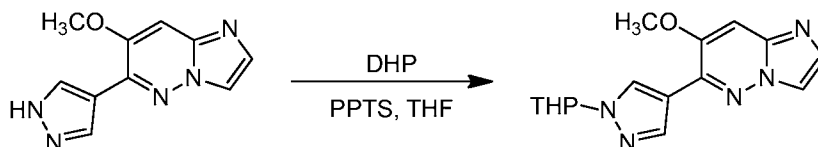
[00547] A solution of 5-methoxy-N-(4-methoxybenzyl)-6-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)pyridazin-3-amine (2.00 g, 5.06 mmol) in trifluoroacetic acid (15 mL) was stirred at 50 °C for 16 hours. The reaction mixture was then cooled to room temperature and concentrated under reduced pressure. The resulting crude product was washed with methanol (2 x 5 mL), filtered, and the filter liquor concentrated under reduced pressure to provide the title compound: LCMS m/z 192.2 $[M+H]^+$.

Step D. 7-methoxy-6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazine



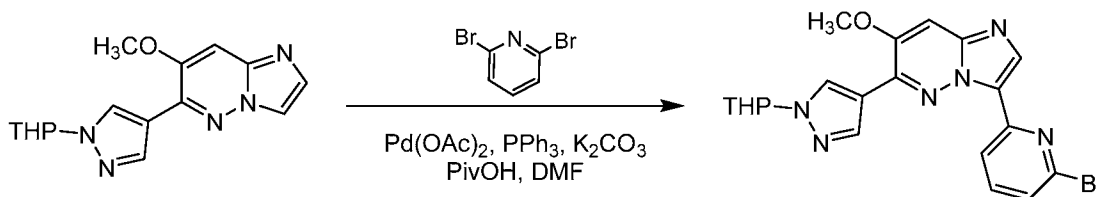
[00548] To a solution of 5-methoxy-6-(1H-pyrazol-4-yl)pyridazin-3-amine (1.50 g, 4.91 mmol, TFA salt) and 2-chloroacetaldehyde (4.82 g, 24.57 mmol, 3.95 mL, 40% purity) in ethanol (20 mL) was added sodium bicarbonate (0.826 g, 9.83 mmol). The resulting reaction was heated at 80 °C for 2 hours. The reaction was then cooled to room temperature, concentrated under reduced pressure, diluted with water (5 mL), and extracted with ethyl acetate (3 x 8 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (10 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 15% methanol in dichloromethane) to provide the title compound: LCMS m/z 216.2 $[M+H]^+$.

Step E. 7-methoxy-6-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazine



[00549] To a solution of 7-methoxy-6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazine (0.600 g, 1.82 mmol, TFA salt) in tetrahydrofuran (20 mL) were added 3,4-dihydro-2H-pyran (0.920 g, 10.9 mmol) and 4-methylbenzenesulfonic acid pyridine (0.458 g, 1.82 mmol). The resulting reaction was heated at 80 °C for 12 hours, and was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 10% methanol in dichloromethane) to provide the title compound: LCMS m/z 300.1 $[M+H]^+$.

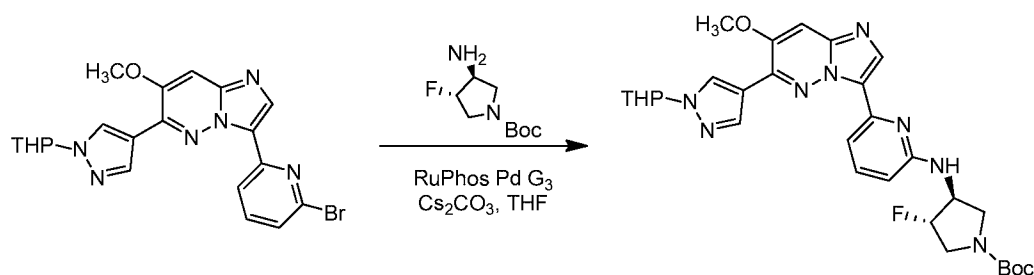
Step F. 3-(6-bromopyridin-2-yl)-7-methoxy-6-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazine



[00550] A mixture of 7-methoxy-6-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazine (0.200 g, 0.668 mmol), 2,6-dibromopyridine (0.317 g, 1.34 mmol),

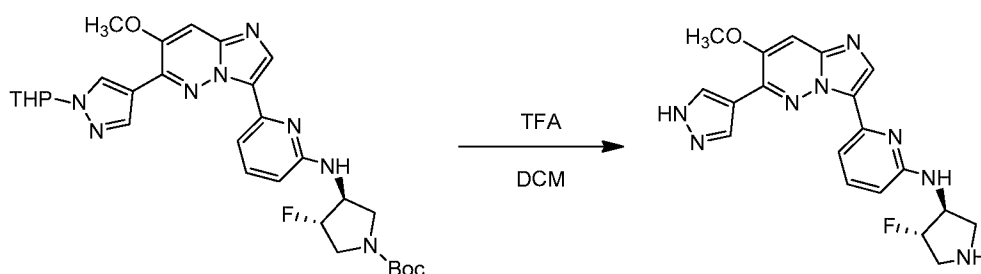
potassium carbonate (0.277 g, 2.00 mmol), 2,2-dimethylpropanoic acid (0.020 g, 0.200 mmol), triphenylphosphine (0.026 g, 0.100 mmol), and palladium(II)acetate (0.015 g, 0.067 mmol) in N,N-dimethylformamide (6 mL) was purged with nitrogen, and was then heated at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 15 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 15% methanol in dichloromethane) to provide the title compound: LCMS m/z 455.1 $[M+H]^+$.

Step G. (3S,4S)-tert-butyl 3-fluoro-4-((6-(7-methoxy-6-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate



[005511] A mixture of 3-(6-bromo-2-pyridyl)-7-methoxy-6-(1-tetrahydropyran-2-yl)pyrazol-4-yl)imidazo[1,2-b]pyridazine (0.035 g, 0.077 mmol), tert-butyl (3S,4S)-3-amino-4-fluoro-pyrrolidine-1-carboxylate (0.016 g, 0.077 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.006 g, 0.008 mmol), and cesium carbonate (0.075 g, 0.231 mmol) in tetrahydrofuran (2 mL) was purged with nitrogen, and was then heated at 80 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 579.2 $[M+H]^+$

Step H. N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(7-methoxy-6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine



[00552] To a solution of (3S,4S)-tert-butyl 3-fluoro-4-((6-(7-methoxy-6-(1-(tetrahydro-2H-pyran-2-yl)-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)pyrrolidine-1-carboxylate (0.030 g, 0.052 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.30 mL). The resulting reaction was stirred at room temperature for 1 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 8 micron, 100 x 40 mm; 1 – 26% acetonitrile in water containing 0.04% trifluoroacetic acid) to provide the title compound: LCMS m/z 395.2 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.51 (s, 2 H), 8.41 (s, 1 H), 8.11 (d, $J = 7.5$ Hz, 1 H), 7.81 – 7.74 (m, 2 H), 6.74 (d, $J = 8.3$ Hz, 1 H), 5.65 – 5.44 (m, 1 H), 4.88 – 4.80 (m, 1 H), 4.28 (s, 3 H), 3.92 (dd, $J = 6.1, 12.8$ Hz, 1 H), 3.80 – 3.75 (m, 1 H), 3.71 – 3.57 (m, 2 H).

[00553] The compounds in Table 12 were all prepared using the synthetic procedures described in **Example 21**.

Table 12. Additional compounds prepared according to **Example 21**.

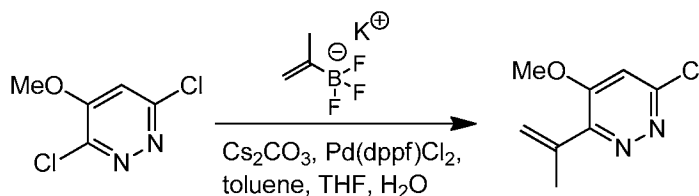
Compound #	Structure	IUPAC Name	LCMS
120		N-((3S,4S)-4-fluoropiperidin-3-yl)-6-(7-methoxy-6-(1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	409.2
121		N-((3S,4S)-4-fluoropyrrolidin-3-yl)-6-(7-methoxy-6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	409.0
122		N-((3S,4S)-4-fluoropiperidin-3-yl)-6-(7-methoxy-6-(1-methyl-1H-pyrazol-4-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-amine	423.2

Example 22

Exemplary Synthetic Procedure #22 (Compounds 123 – 128)

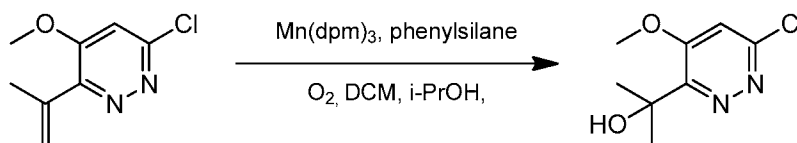
Compound 123, (R)-2-(7-methoxy-3-(6-(piperidin-3-ylamino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)propan-2-ol

Step A. 6-chloro-4-methoxy-3-(prop-1-en-2-yl)pyridazine



[00554] A mixture of 3,6-dichloro-4-methoxy-pyridazine (5.00 g, 27.9 mmol), potassium trifluoro(isopropenyl)boronate (3.72 g, 25.1 mmol), cesium carbonate (27.30 g, 83.80 mmol), and [1,1-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (2.04 g, 2.79 mmol) in toluene (60 mL), tetrahydrofuran (20 mL) and water (20 mL) was purged with nitrogen, and was then heated at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 60 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (30 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 185.2 $[M+H]^+$; ^1H NMR (400 MHz, $CDCl_3$) δ 6.84 (s, 1 H), 5.70 (d, $J = 0.6$ Hz, 1 H), 5.55 – 5.49 (m, 1 H), 3.87 (s, 3 H), 2.20 – 2.16 (m, 3 H).

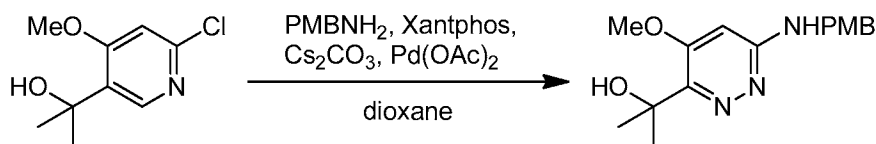
Step B. 2-(6-chloro-4-methoxypyridazin-3-yl) propan-2-ol



[00555] To a solution of 6-chloro-3-isopropenyl-4-methoxy-pyridazine (3.00 g, 16.3 mmol) in dichloromethane (3 mL) and propan-2-ol (15 mL) was added phenylsilane (3.34 g, 30.9 mmol, 3.81 mL). The resulting mixture was purged with oxygen (16.3 mmol) 3 times, and tris[(Z)-1-tert-butyl-4,4-dimethyl-3-oxo-pent-1-en-1-yl]manganese (0.983 g, 1.62 mmol) was then added.

The resulting reaction mixture was stirred at 0 °C for 30 minutes under oxygen atmosphere, and was then diluted with water (20 mL) and extracted with ethyl acetate (3 x 60 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (30 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 203.1 $[M+H]^+$.

Step C. 2-(4-methoxy-6-((4-methoxybenzyl)amino)pyridazin-3-yl)propan-2-ol

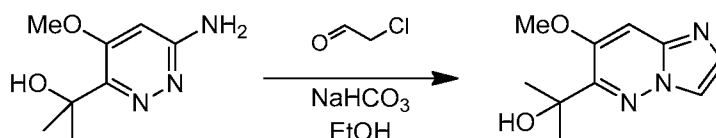


[00556] A mixture of 2-(6-chloro-4-methoxy-pyridazin-3-yl)propan-2-ol (1.80 g, 8.88 mmol), (4-methoxyphenyl)methanamine (3.66 g, 26.7 mmol, 3.45 mL), palladium(II)acetate (0.199 g, 0.888 mmol), 4,5-bis(diphenylphosphino)-9,9-dimethyl-9H-xanthene (0.771 g, 1.33 mmol), and cesium carbonate (8.68 g, 26.7 mmol) in dioxane (20 mL) was purged with nitrogen, and was then heated at 120 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 20 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 10 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 70% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 304.2 $[M+H]^+$.

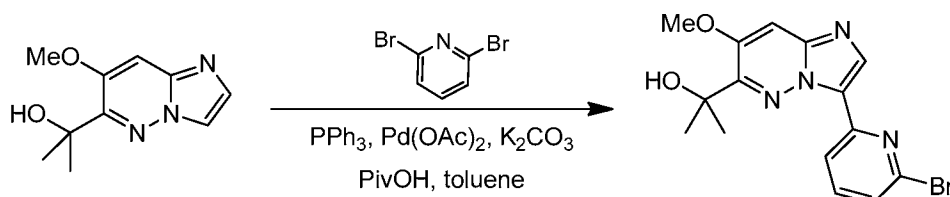
Step D. 2-(6-amino-4-methoxypyridazin-3-yl)propan-2-ol



[00557] To a solution of 2-[4-methoxy-6-[(4-methoxyphenyl)methylamino]pyridazin-3-yl]propan-2-ol (1.30 g, 4.29 mmol) in dichloromethane (20 mL) was added trifluoroacetic acid (0.489 g, 4.29 mmol, 0.317 mL). The resulting reaction was stirred at 50 °C for 12 hours, and was then cooled to room temperature and concentrated under reduced pressure. The resulting crude product was washed with methanol (3 x 20 mL) and filtered, and the filter liquor was concentrated under reduced pressure to give the title compound: LCMS m/z 184.3 $[M+H]^+$.

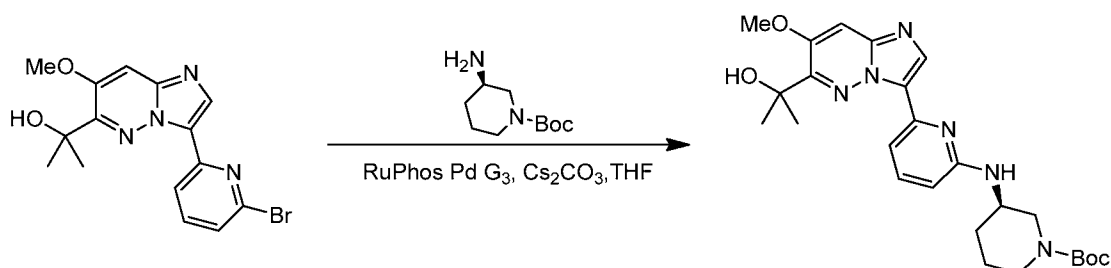
Step E. 2-(7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol

[00558] To a solution of 2-(6-amino-4-methoxy-pyridazin-3-yl)propan-2-ol (0.800 mg, 4.37 mmol) and 2-chloroacetaldehyde (4.28 g, 21.8 mmol, 3.51 mL, 40% purity) in ethanol (10 mL) was added sodium bicarbonate (0.734 g, 8.73 mmol). The resulting reaction mixture was heated at 80 °C for 4 hours. The reaction was then cooled to room temperature and concentrated under reduced pressure. The residue thus obtained was diluted with water (10 mL) and extracted with ethyl acetate (3 x 15 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 10 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 70% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 208.0 [M+H]⁺.

Step F. 2-(3-(6-bromopyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol

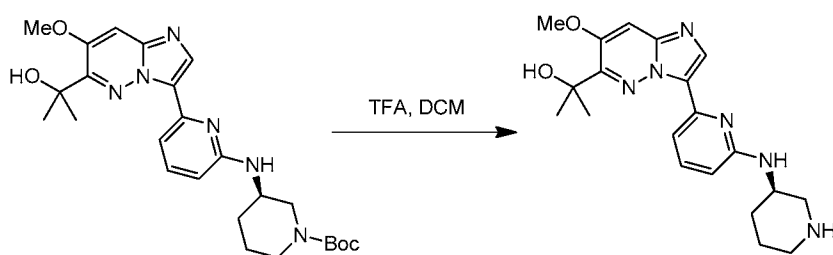
[00559] To a solution of 2-(7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol (0.240 g, 1.16 mmol) and 2,6-dibromopyridine (0.823 g, 3.47 mmol) in toluene (3 mL) were added triphenylphosphine (0.046 g, 0.174 mmol), 2,2-dimethylpropanoic acid (0.035 g, 0.347 mmol, 0.040 mL), potassium carbonate (0.480 g, 3.47 mmol), and palladium(II)acetate (0.026 g, 0.116 mmol). The resulting reaction mixture was heated at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 363.1 [M+H]⁺.

Step G. (R)-tert-butyl 3-((6-(6-(2-hydroxypropan-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)piperidine-1-carboxylate



[00560] A mixture of 2-[3-(6-bromo-2-pyridyl)-7-methoxy-imidazo[1,2-b]pyridazin-6-yl]propan-2-ol (0.030 g, 0.083 mmol), tert-butyl (3R)-3-aminopiperidine-1-carboxylate (0.018 g, 0.091 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.007 g, 0.008 mmol), and cesium carbonate (0.067 g, 0.206 mmol) in tetrahydrofuran (5 mL) was purged with nitrogen, and was then heated at 80 °C for 5 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 483.4 $[M+H]^+$.

Step H. (R)-2-(7-methoxy-3-(6-(piperidin-3-ylamino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)propan-2-ol



[00561] To a solution of tert-butyl (3R)-3-[[[6-[6-(1-hydroxy-1-methyl-ethyl)-7-methoxy-imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]piperidine-1-carboxylate (0.050 g, 0.104 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.50 mL). The resulting reaction was stirred at room temperature for 1 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 3 – 30% acetonitrile in water containing 0.04% trifluoroacetic acid) to provide the title compound: LCMS m/z 383.2 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.45 (s, 1 H), 7.97 (d, $J = 7.3$ Hz, 1 H), 7.73 (s, 1 H), 7.62 (s, 1 H), 6.64 (d, $J = 8.4$ Hz, 1 H), 4.32 (br s, 1 H), 4.16 (s, 3 H), 3.68 (br d, $J = 11.0$ Hz, 1 H), 3.37 (br s, 1 H), 3.13 – 2.90 (m, 2 H), 2.21 – 2.07 (m, 2 H), 2.00 – 1.87 (m, 1 H), 1.78 (s, 7 H).

The compounds in Table 13 were all prepared using the synthetic procedures described in **Example 22**.

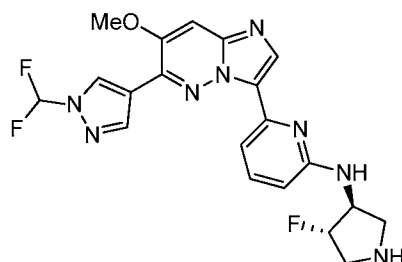
Table 13. Additional compounds prepared according to **Example 22**.

Compound #	Structure	IUPAC Name	LCMS
124		2-(3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	387.1
125		2-(3-(6-(((3S,4S)-4-fluoropiperidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	401.1
126		2-(3-(3,5-difluoro-6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	423.1
127		(R)-2-(3-(3,5-difluoro-6-(piperidin-3-ylamino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	419.1
128		2-(3-(3,5-difluoro-6-(((3S,4S)-4-fluoropiperidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	437.1

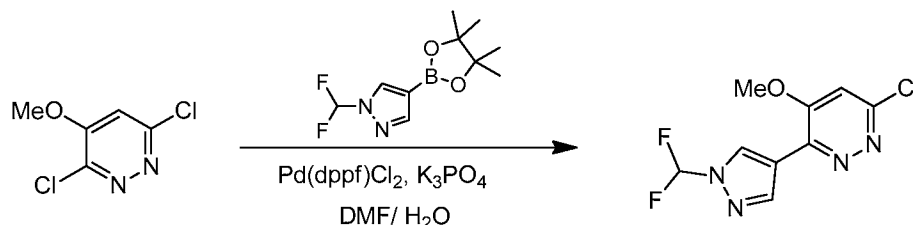
Example 23

Exemplary Synthetic Procedure #23 (Compounds 129 – 130)

Compound 129, 6-(6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropiperidin-3-yl)pyridin-2-amine

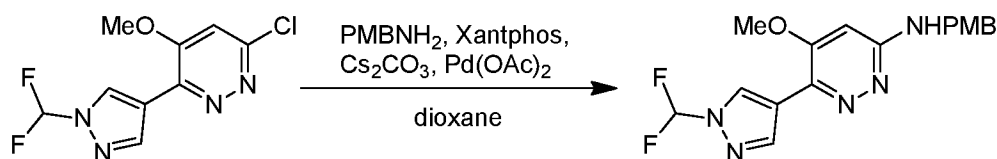


Step A. 6-chloro-3-(1-(difluoromethyl)-1H-pyrazol-4-yl)-4-methoxypyridazine



[00562] A mixture of 3,6-dichloro-4-methoxy-pyridazine (6.00 g, 33.5 mmol), 1-(difluoromethyl)-4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrazole (8.18 g, 33.5 mmol), [1,1-bis(diphenylphosphino)ferrocene]dichloropalladium(II) (2.45 g, 3.35 mmol), and potassium phosphate (28.46 g, 134.1 mmol) in N,N-dimethylformamide (120 mL) and water (25 mL) was purged with nitrogen, and was then heated at 130 °C for 2 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (50 mL), and extracted with ethyl acetate (3 x 100 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 50 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 261.2 $[M+H]^+$.

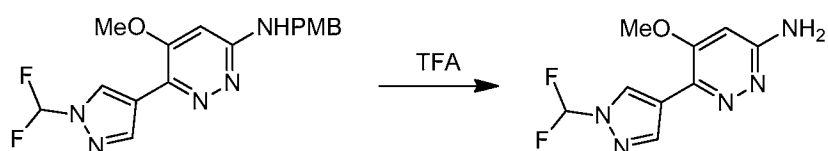
Step B. 6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-5-methoxy-N-(4-methoxybenzyl)pyridazin-3-amine



[00563] A mixture of 6-chloro-3-[1-(difluoromethyl)pyrazol-4-yl]-4-methoxy-pyridazine (1.50 g, 5.76 mmol), (4-methoxyphenyl)methanamine (2.37 g, 17.3 mmol, 2.23 mL),

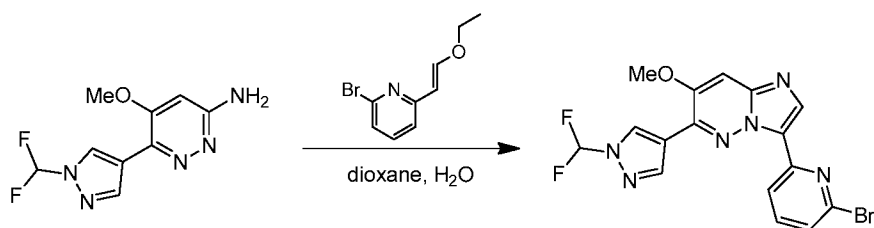
palladium(II)acetate (0.129 g, 0.576 mmol), 4,5-bis(diphenylphosphino)-9,9-dimethyl-9H-xanthene (0.500 g, 0.863 mmol), and cesium carbonate (5.63 g, 17.3 mmol) in dioxane (20 mL) was purged with nitrogen, and was then heated at 120 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 20 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 10 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 362.2 [M+H]⁺.

Step C. 6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-5-methoxypyridazin-3-amine



[00564] A mixture of 6-[1-(difluoromethyl)pyrazol-4-yl]-5-methoxy-N-[(4-methoxyphenyl)methyl]pyridazin-3-amine (0.500 g, 1.38 mmol) in trifluoroacetic acid (10 mL) was stirred at 50 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature and concentrated under reduced pressure. The residue thus obtained was washed with methanol (3 x 10 mL), filtered, and then the filter liquor was concentrated under reduced pressure to provide the title compound: LCMS m/z 242.2 [M+H]⁺.

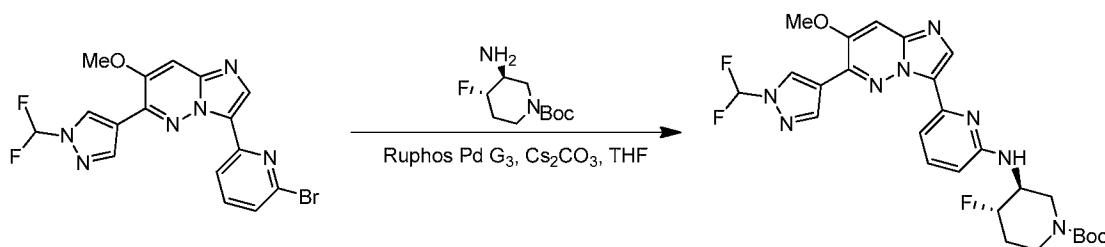
Step D. 3-(6-bromopyridin-2-yl)-6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-7-methoxyimidazo[1,2-b]pyridazine



[00565] To a solution of 2-bromo-6-[(E)-2-ethoxyvinyl]pyridine (1.05 g, 4.61 mmol) in dioxane (15 mL) and water (5 mL) was added 1-bromopyrrolidine-2,5-dione (0.821 g, 4.61 mmol). The resulting reaction mixture was stirred at room temperature for 1 hour. 6-[1-(Difluoromethyl)pyrazol-4-yl]-5-methoxy-pyridazin-3-amine (0.371 g, 1.54 mmol) was then added, and the resulting reaction was heated at 80 °C for 15 hours. The reaction mixture was then

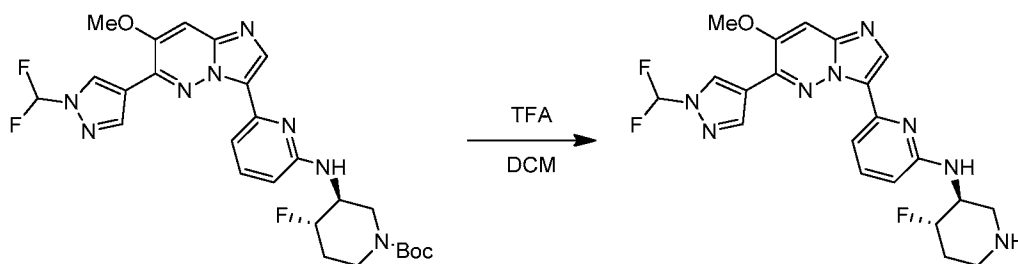
cooled to room temperature, diluted with water (10 mL), and extracted with ethyl acetate (3 x 20 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 10 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 423.1 $[M+H]^+$.

Step E. (3S,4S)-tert-butyl 3-((6-(6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropiperidine-1-carboxylate



[00566] A mixture of 3-(6-bromo-2-pyridyl)-6-[1-(difluoromethyl)pyrazol-4-yl]-7-methoxy-imidazo[1,2-b]pyridazine (0.050 g, 0.119 mmol), tert-butyl (3S,4S)-3-amino-4-fluoropiperidine-1-carboxylate (0.031 g, 0.142 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.010 g, 0.012 mmol), and cesium carbonate (0.097 g, 0.297 mmol) in tetrahydrofuran (3 mL) was purged with nitrogen, and was then heated at 80 °C for 5 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 559.4 $[M+H]^+$.

Step F. 6-(6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropiperidin-3-yl)pyridin-2-amine



[00567] To a solution of (3S,4S)-tert-butyl 3-((6-(6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)-4-fluoropiperidine-1-carboxylate (0.050 g, 0.090 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.50 mL). The resulting reaction was stirred at room temperature for 1 hour, and was then

concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 1 – 40% acetonitrile in water containing 0.04% trifluoroacetic acid). LCMS m/z 459.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.90 (s, 1 H), 8.50 (s, 1 H), 8.46 – 8.41 (m, 1 H), 8.03 – 7.96 (m, 1 H), 7.74 (s, 3 H), 6.69 (d, J = 8.4 Hz, 1 H), 5.03 – 4.90 (m, 1 H), 4.63 – 4.47 (m, 1 H), 4.24 (s, 3 H), 3.73 (d, J = 12.8 Hz, 1 H), 3.54 – 3.43 (m, 1 H), 3.27 – 3.10 (m, 2 H), 2.60 – 2.35 (m, 1 H), 2.21 – 1.98 (m, 1 H).

[00568] The compounds in Table 14 were all prepared using the synthetic procedures described in **Example 23**.

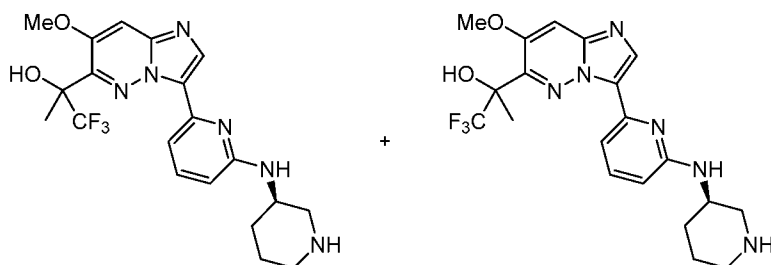
Table 14. Additional compounds prepared according to **Example 23**.

Compound #	Structure	IUPAC Name	LCMS
130		6-(6-(1-(difluoromethyl)-1H-pyrazol-4-yl)-7-methoxyimidazo[1,2-b]pyridazin-3-yl)-N-((3S,4S)-4-fluoropiperidin-3-yl)pyridin-2-amine	459.1

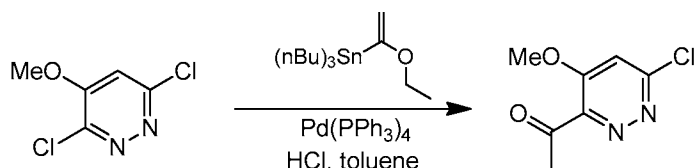
Example 24

Exemplary Synthetic Procedure #24 (Compounds 131 – 136)

Compounds 131 and 132, Fast- and slow-eluting diastereomers of 1,1,1-trifluoro-2-(7-methoxy-3-(6-((R)-piperidin-3-ylamino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)propan-2-ol



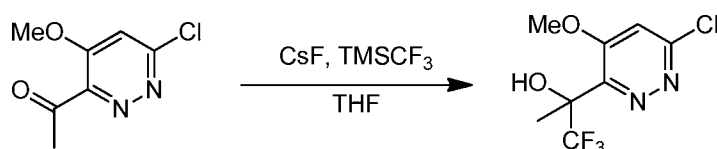
Step A. 1-(6-chloro-4-methoxypyridazin-3-yl)ethanone



[00569] A mixture of 3,6-dichloro-4-methoxy-pyridazine (15.0 g, 83.8 mmol), tributyl(1-ethoxyvinyl)stannane (30.26 g, 83.80 mmol, 28.28 mL), and

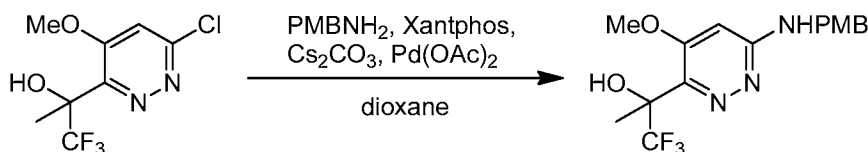
tetrakis(triphenylphosphine)palladium(0) (9.68 g, 8.38 mmol) in toluene (150 mL) was purged with nitrogen, and was then heated at 100 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature. Hydrochloric acid (2 M, 210 mL) was added, and the resulting mixture was stirred at room temperature for 1 hour. The reaction was then quenched by addition of aqueous 20% potassium fluoride solution (100 mL), and extracted with ethyl acetate (3 x 100 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 50 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 187.1 $[M+H]^+$; ^1H NMR (400MHz, $CDCl_3$): δ 7.08 (s, 1 H), 3.99 (s, 3 H), 2.78 (s, 3 H).

Step B. 2-(6-chloro-4-methoxypyridazin-3-yl)-1,1,1-trifluoropropan-2-ol



[00570] To a solution of 1-(6-chloro-4-methoxy-pyridazin-3-yl)ethanone (4.00 g, 21.4 mmol) in tetrahydrofuran (50 mL) were added cesium fluoride (3.26 g, 21.4 mmol) and trimethyl(trifluoromethyl)silane (6.10 g, 42.9 mmol). The resulting reaction mixture was stirred at room temperature for 8 hours. Hydrochloric acid (2 M, 10.72 mL) was then added, and the reaction was stirred at room temperature for an additional 2 hours. The reaction was then diluted with water (50 mL) and extracted with ethyl acetate (3 x 50 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 30 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 257.1 $[M+H]^+$; ^1H NMR (400MHz, CD_3OD): δ = 7.56 (s, 1 H), 4.03 (s, 3 H), 1.85 (d, J = 0.9 Hz, 3 H).

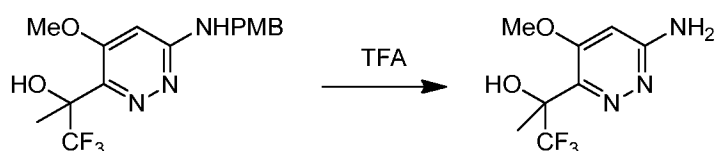
Step C. 1,1,1-trifluoro-2-(4-methoxy-6-((4-methoxybenzyl)amino)pyridazin-3-yl)propan-2-ol



[00571] A mixture of 2-(6-chloro-4-methoxy-pyridazin-3-yl)-1,1,1-trifluoropropan-2-ol (3.50 g, 13.6 mmol), (4-methoxyphenyl)methanamine (5.61 g, 40.9 mmol, 5.30 mL),

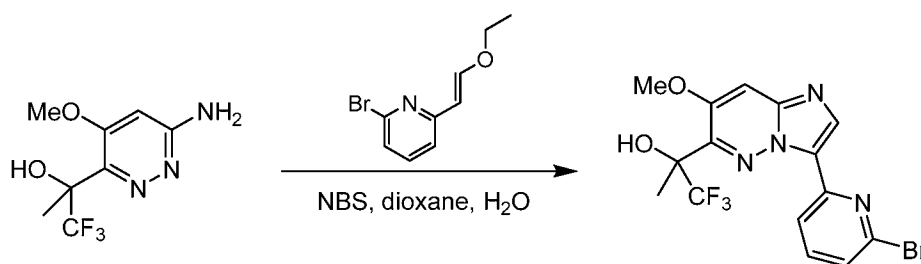
palladium(II)acetate (0.306 g, 1.36 mmol), 4,5-bis(diphenylphosphino)-9,9-dimethyl-9H-xanthene (1.18 g, 2.05 mmol), and cesium carbonate (13.33 g, 40.92 mmol) in dioxane (30 mL) was purged with nitrogen, and was then heated at 120 °C for 16 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 30 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (3 x 20 mL), dried over sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 358.2 $[M+H]^+$.

Step D. 2-(6-amino-4-methoxypyridazin-3-yl)-1,1,1-trifluoropropan-2-ol



[00572] A mixture of 1,1,1-trifluoro-2-[4-methoxy-6-[(4-methoxyphenyl)methylamino]pyridazin-3-yl]propan-2-ol (3.50 g, 9.79 mmol) in trifluoroacetic acid (5 mL) was stirred at 50 °C for 1 hour. The reaction mixture was then cooled to room temperature and concentrated under reduced pressure. The residue thus obtained was washed with methanol (3 x 30 mL) and filtered, and the filter liquor was concentrated under reduced pressure to provide the title compound: LCMS m/z 238.2 $[M+H]^+$.

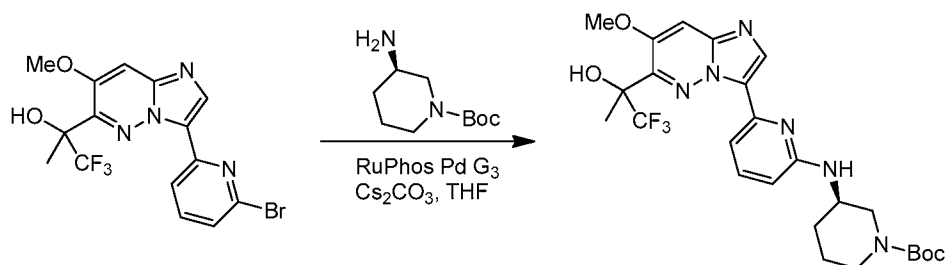
Step E. 2-(3-(6-bromopyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)-1,1,1-trifluoropropan-2-ol



[00573] To cooled 0 °C solution of 2-(6-amino-4-methoxy-pyridazin-3-yl)-1,1,1-trifluoro-propan-2-ol (1.00 g, 4.22 mmol) in dioxane (15 mL) and water (5 mL) was added N-bromosuccinimide (2.25 g, 12.6 mmol). The reaction was then removed from the cold bath and stirred for 1 hour while slowly warming to room temperature. 2-Bromo-6-[(E)-2-ethoxyvinyl]pyridine (2.88 g, 12.7 mmol) was then added, and the resulting mixture was heated at 80 °C for 10

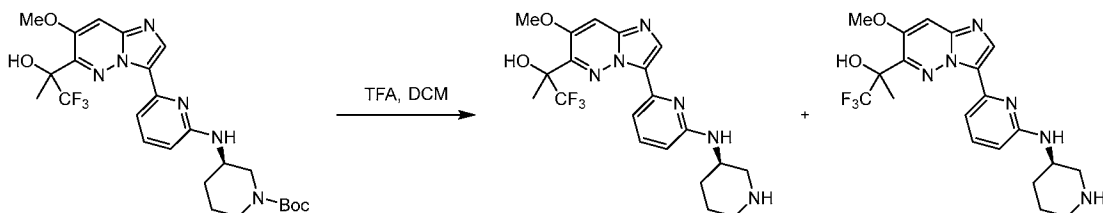
hours. The reaction mixture was then cooled to room temperature, diluted with water (20 mL), and extracted with ethyl acetate (3 x 20 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (30 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 100% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 419.1 $[M+H]^+$.

Step F. (3R)-tert-butyl 3-((6-(7-methoxy-6-(1,1,1-trifluoro-2-hydroxypropan-2-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)piperidine-1-carboxylate



[00574] A mixture of 2-[3-(6-bromo-2-pyridyl)-7-methoxy-imidazo[1,2-b]pyridazin-6-yl]-1,1,1-trifluoro-propan-2-ol (0.100 g, 0.240 mmol), tert-butyl (3R)-3-aminopiperidine-1-carboxylate (0.053 g, 0.264 mmol), cesium carbonate (0.195 g, 0.599 mmol), and (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.020 g, 0.024 mmol) in tetrahydrofuran (5 mL) was purged with nitrogen, and was then heated at 80 °C for 5 hours under nitrogen atmosphere. The reaction mixture was then cooled to room temperature, filtered, and concentrated under reduced pressure to provide the title compound: LCMS m/z 537.3 $[M+H]^+$.

Step G. Fast- and slow-eluting diastereomers of 1,1,1-trifluoro-2-(7-methoxy-3-(6-((R)-piperidin-3-ylamino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)propan-2-ol

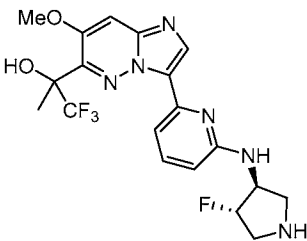
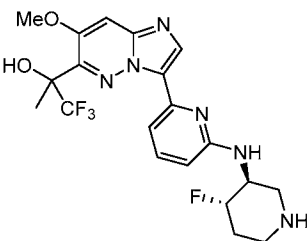


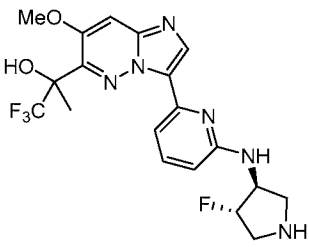
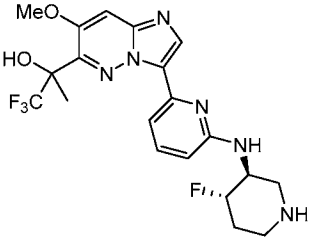
[00575] To a solution of tert-butyl (3R)-3-[[6-[7-methoxy-6-(2,2,2-trifluoro-1-hydroxy-1-methyl-ethyl)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]piperidine-1-carboxylate (0.100 g, 0.186 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.50 mL). The resulting reaction was stirred at room temperature for 16 hours, and was then

concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 1 – 37% acetonitrile in water containing 0.04% trifluoroacetic acid) to give a product that was further purified by SFC (Daicel Chiralpak IC column, 10 micron, 250 x 30 mm; mobile phase: [0.1% ammonium hydroxide IPA]; B%: 60%-60%) to provide the title compounds as diastereomers of unknown absolute configuration. Fast-eluting diastereomer: LCMS m/z 437.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.29 (s, 1 H), 7.80 (d, $J = 7.5$ Hz, 1 H), 7.55 (s, 2 H), 6.49 (d, $J = 8.3$ Hz, 1 H), 4.26 – 4.13 (m, 1 H), 4.05 (s, 3 H), 3.59 (d, $J = 12.0$ Hz, 1 H), 3.25 – 3.14 (m, 1 H), 2.99 – 2.73 (m, 2 H), 2.19 – 2.07 (m, 1 H), 2.06 – 1.97 (m, 1 H), 1.93 (s, 3 H), 1.81 (s, 1 H), 1.65 (br d, $J = 10.5$ Hz, 1 H). Slow-eluting diastereomer: LCMS m/z 437.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.36 (s, 1 H), 7.85 (d, $J = 7.4$ Hz, 1 H), 7.66 – 7.47 (m, 2 H), 6.56 (d, $J = 8.2$ Hz, 1 H), 4.38 – 4.23 (m, 1 H), 4.09 (s, 3 H), 3.70 (d, $J = 10.0$ Hz, 1 H), 3.35 (s, 1 H), 3.12 – 2.91 (m, 2 H), 2.14 (d, $J = 5.2$ Hz, 1 H), 1.95 (s, 3 H), 1.92 – 1.84 (m, 1 H), 1.74 (d, $J = 10.1$ Hz, 1 H), 1.30 (d, $J = 9.1$ Hz, 1 H).

[00576] The compounds in Table 15 were all prepared using the chemistry described in Example 24.

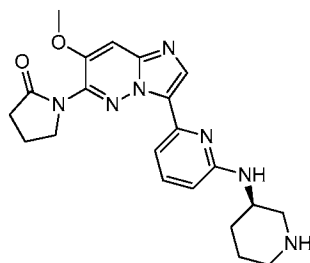
Table 15. Additional compounds prepared according to **Example 24**.

Compound #	Structure	IUPAC Name	LCMS
133		Fast-eluting diastereomer of 1,1,1-trifluoro-2-(3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	441.1
134		Fast-eluting diastereomer of 1,1,1-trifluoro-2-(3-(6-(((3S,4S)-4-fluoropiperidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	455.1

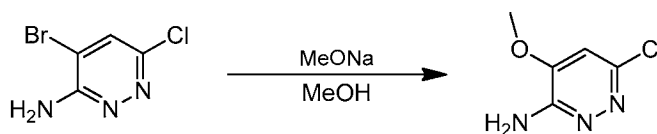
135		Slow-eluting diastereomer of 1,1,1-trifluoro-2-(3-(6-(((3S,4S)-4-fluoropyrrolidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	441.1
136		Slow-eluting diastereomer of 1,1,1-trifluoro-2-(3-(6-(((3S,4S)-4-fluoropiperidin-3-yl)amino)pyridin-2-yl)-7-methoxyimidazo[1,2-b]pyridazin-6-yl)propan-2-ol	455.1

Example 25**Exemplary Synthetic Procedure #25 (Compound 137)**

Compound 137, (R)-1-(7-methoxy-3-(6-(piperidin-3-ylamino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)pyrrolidin-2-one



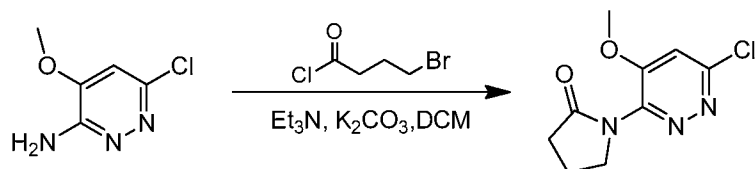
Step A. 3-(6-bromo-4-fluoro-2-pyridyl)-7-isopropoxy-imidazo[1,2-a]pyridine



[00577] To a solution of 4-bromo-6-chloro-pyridazin-3-amine (8.00 g, 38.4 mmol) in methyl alcohol (10 mL) was added sodium methanolate (0.5 M, 154 mL) at 0 °C. The resulting mixture was stirred at room temperature for 12 hours, and was then concentrated under reduced pressure. The residue thus obtained was poured into water (50 mL) and extracted with ethyl acetate

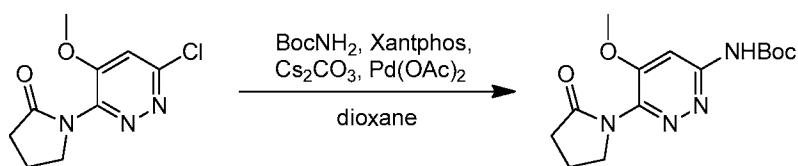
(3 x 40 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (100 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 40% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 160.2 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 6.98 (s, 1 H), 3.98 (s, 3 H).

Step B. 1-(6-chloro-4-methoxypyridazin-3-yl)pyrrolidin-2-one



[00578] To a solution of 6-chloro-4-methoxy-pyridazin-3-amine (2.00 g, 12.5 mmol) in dichloromethane (20 mL) were added triethylamine (2.54 g, 25.1 mmol, 3.49 mL) and 4-bromobutanoyl chloride (4.65 g, 25.1 mmol, 2.91 mL). The resulting mixture was stirred at room temperature for 1 hour. Potassium carbonate (2.60 g, 18.8 mmol) was then added, and the mixture was stirred at room temperature for an additional 15 hours. The reaction was then poured into water (30 mL) and extracted with dichloromethane (3 x 20 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (20 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography on silica gel (0 – 50% ethyl acetate in petroleum ether) to provide the title compound: LCMS m/z 227.9 $[M+H]^+$.

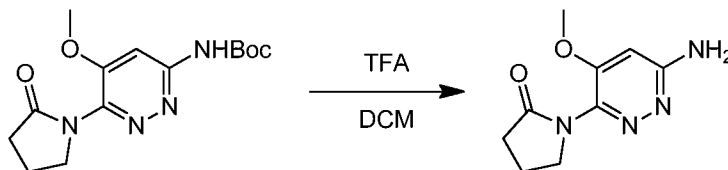
Step C. tert-butyl (5-methoxy-6-(2-oxopyrrolidin-1-yl)pyridazin-3-yl)carbamate



[00579] A mixture of 1-(6-chloro-4-methoxy-pyridazin-3-yl)pyrrolidin-2-one (1.80 g, 7.91 mmol), tert-butyl carbamate (2.78 g, 23.7 mmol), palladium acetate (0.178 g, 0.791 mmol), (5-diphenylphosphanyl-9,9-dimethyl-xanthen-4-yl)-diphenyl-phosphane (0.686 g, 1.19 mmol), and cesium carbonate (7.73 g, 23.7 mmol) in dioxane (20 mL) was purged with nitrogen, and was then heated at 80 °C for 16 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, filtered, and concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 3 micron, 80 x 40 mm; 15 – 35%

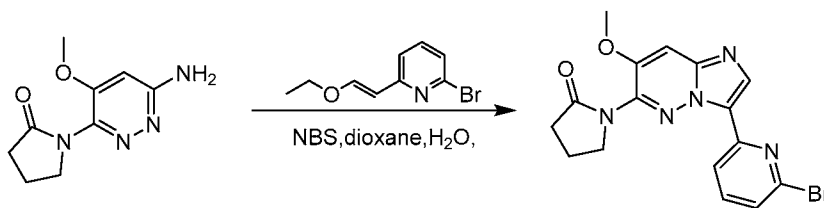
acetonitrile in water containing 0.04% trifluoroacetic acid) to give the title compound: LCMS m/z 309.1 $[M+H]^+$.

Step D. 1-(6-amino-4-methoxypyridazin-3-yl)pyrrolidin-2-one



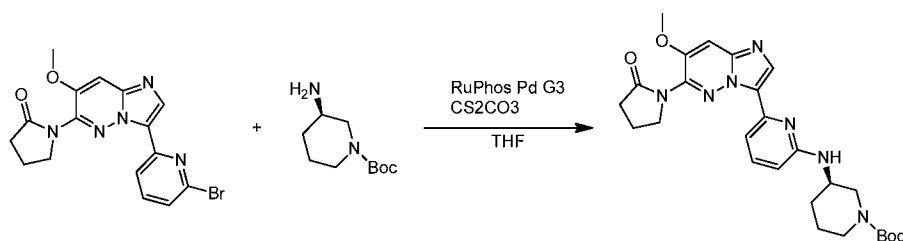
[00580] To a solution of tert-butyl N-[5-methoxy-6-(2-oxopyrrolidin-1-yl)pyridazin-3-yl]carbamate (0.050 g, 0.162 mmol) in dichloromethane (3 mL) was added trifluoroacetic acid (0.770 g, 6.75 mmol, 0.50 mL). The resulting reaction was stirred at room temperature for 2 hours, and was then filtered and concentrated under reduced pressure to give the title compound: LCMS m/z 209.1 $[M+H]^+$.

Step E. 1-(6-amino-4-methoxypyridazin-3-yl)pyrrolidin-2-one



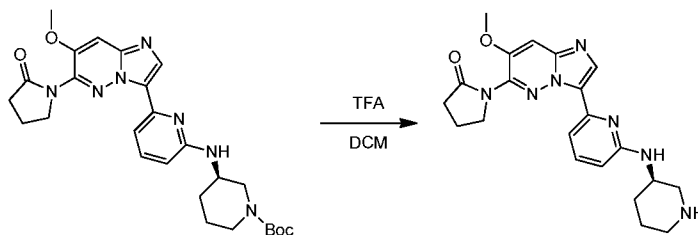
[00581] To a solution of 2-bromo-6-[(E)-2-ethoxyvinyl]pyridine (0.082 g, 0.360 mmol) in dioxane (3 mL) and water (1 mL) was added 1-bromopyrrolidine-2,5-dione (0.064 g, 0.360 mmol). The resulting reaction was stirred at room temperature for 1 hour. 1-(6-Amino-4-methoxy-pyridazin-3-yl)pyrrolidin-2-one (0.050 g, 0.240 mmol) was then added, and the resulting mixture was heated at 80 °C for 15 hours. The reaction was then cooled to 0 °C, basified to pH = 9 by addition of aqueous 2 N sodium hydroxide solution, and extracted with ethyl acetate (3 x 5 mL). The organic extracts were combined, washed with saturated aqueous sodium chloride solution (5 mL), dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure to give the title compound: LCMS m/z 387.9 $[M+H]^+$.

Step F. (R)-tert-butyl 3-((6-(7-methoxy-6-(2-oxopyrrolidin-1-yl)imidazo[1,2-b]pyridazin-3-yl)pyridin-2-yl)amino)piperidine-1-carboxylate



[00582] A mixture of 1-[3-(6-bromo-2-pyridyl)-7-methoxy-imidazo[1,2-b]pyridazin-6-yl]pyrrolidin-2-one (0.030 g, 0.077 mmol), tert-butyl (3R)-3-aminopiperidine-1-carboxylate (0.015 g, 0.077 mmol), (2-dicyclohexylphosphino-2',6'-diisopropoxy-1,1'-biphenyl)[2-(2'-amino-1,1'-biphenyl)]palladium(II)methanesulfonate (0.006 g, 0.008 mmol), and cesium carbonate (0.063 g, 0.193 mmol) in tetrahydrofuran (2 mL) was purged with nitrogen, and was then heated at 80 °C for 2 hours under nitrogen atmosphere. The reaction was then cooled to room temperature, filtered, and concentrated under reduced pressure to give the title compound: LCMS m/z 508.2 $[M+H]^+$.

Step G. (R)-1-(7-methoxy-3-(6-(piperidin-3-ylamino)pyridin-2-yl)imidazo[1,2-b]pyridazin-6-yl)pyrrolidin-2-one



[00583] To a solution of tert-butyl (3R)-3-[[6-[7-methoxy-6-(2-oxopyrrolidin-1-yl)imidazo[1,2-b]pyridazin-3-yl]-2-pyridyl]amino]piperidine-1-carboxylate (0.040 g, 0.079 mmol) in dichloromethane (2 mL) was added trifluoroacetic acid (0.770 g, 6.75 mmol, 0.50 mL). The resulting reaction was stirred at room temperature for 1 hour, and was then concentrated under reduced pressure. The resulting crude product was purified by HPLC (Phenomenex Luna C18 column, 5 micron, 150 x 30 mm; 1 – 30% acetonitrile in water containing 0.04% trifluoroacetic acid) to give the title compound: LCMS m/z 408.1 $[M+H]^+$; ^1H NMR (400 MHz, CD_3OD) δ 8.36 (s, 1 H), 7.77 – 7.69 (m, 2 H), 7.58 (dt, J = 4.3, 7.8 Hz, 1 H), 6.64 – 6.57 (m, 1 H), 4.88 (d, J = 2.0 Hz, 1 H), 4.34 – 4.24 (m, 1 H), 4.10 – 4.04 (m, 5 H), 3.67 (br dd, J = 3.2, 12.1 Hz, 1 H), 3.38 – 3.33 (m, 1 H), 3.11 – 2.92 (m, 2 H), 2.68 – 2.62 (m, 2 H), 2.39 – 2.29 (m, 2 H), 2.17 – 2.05 (m, 2 H), 1.94 – 1.84 (m, 1 H), 1.77 – 1.68 (m, 1 H).

Example 26***Biological Data for Exemplary Compounds***

[00584] Kinase inhibitory data were obtained for various exemplary compounds prepared according to Examples 1-25 using the RBC HotSpot Kinase Assay Protocol (Anastassiadis T, *et al.* Comprehensive assay of kinase catalytic activity reveals features of kinase inhibitor selectivity. *Nat Biotechnol.* 2011 Oct 30; 29(11):1039-45), as described below. This assay uses the isolated kinase enzyme. This assay is very useful for determining competition of the inhibitor for ATP and/or substrates and for measuring the kinetics of enzyme inhibition. It also allows for measuring the relative affinity of binding to the isolated enzyme protein, and hence determines selectivity. Unlike kinase binding assays that measure competition for ATP, the HotSpot Kinase Assay is a functional assay that measures catalytic activity; as such it measures relative functional potency regardless of the mechanism of enzyme inhibition. This assay uses the form of the various enzymes that are easiest to express, which may not necessarily be the form of the enzyme that exist in the cell. (Sometimes the carboxy terminus has been truncated to aid in expression, or, if it is a receptor kinase, the enzyme itself is isolated from the other parts of the receptor that are involved in regulating kinase activity.)

[00585] The reagent used was as follows: Base Reaction buffer; 20 mM Hepes (pH 7.5), 10 mM MgCl₂, 1 mM EGTA, 0.01% Brij35, 0.02 mg/ml BSA, 0.1 mM Na₃VO₄, 2 mM DTT, 1% DMSO. Required cofactors were added individually to each kinase reaction.

[00586] The reaction procedure was as follows:

- 1) Substrates were prepared in freshly prepared Reaction Buffer.
- 2) Any required cofactors were delivered to the substrate solution above.
- 3) Kinase was delivered into the substrate solution and gently mixed.
- 4) Compounds were delivered in 100% DMSO into the kinase reaction mixture by Acoustic technology (Echo550; nanoliter range), followed by incubation for 20 min at room temp.
- 5) ³³P-ATP was delivered into the reaction mixture to initiate the reaction.
- 6) The mixture was incubated for 2 hours at room temperature.
- 7) Kinase activity was detected by P81 filter-binding method.

Table 16. Biological data obtained in accordance with the protocol described in Example 26.

Compound #	IRAK1 IC ₅₀ (nM)	IRAK4 IC ₅₀ (nM)	FLT3 IC ₅₀ (nM)
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1	331	13	0.6
2	948	115	2
3	449	71	1
4	1360	114	3
5	266	51	5
6	296	62	4
7	284	52	4
8	704	586	8
9	81	7	<0.5
11	860	21	<0.5
12	2060	128	3
13	1840	106	2
14	1850	100	3
15	226	13	<0.5
16	3060	157	<0.5
17	1820	9	<0.5
18	2440	1410	4
19	194	3	<0.5
20	3	<0.5	<0.5
21	497	38	6
22	678	44	6
23	1150	75	16
24	1640	261	17
26	114	20	0.9
27	1620	609	5
28	6580	2360	2
29	13000	2460	4
30	565	104	2
31	49	6	0.5
32	3410	630	9
33	>10000	3360	16
34	>10000	5070	16
35	2820	126	3
36	3780	2700	5
37	>10000	4320	7
38	23	2	<0.5
39	2330	321	8
40	>10000	1300	9
41	>10000	3480	18
42	2220	113	3
44	>10000	4340	4
45	37	8	<0.5
46	2180	985	6
47	>10000	3200	19

48	>10000	4080	12
49	1200	204	2
50	1060	2670	8
54	1690	8	<0.5
55	6840	113	16
56	80	1	0.8
59	621	12	2
60	274	4	2
61	349	26	1
62	403	16	<0.5
63	269	28	<0.5
69	3970	45	3
70	5190	586	18
71	2650	36	0.8
72	3590	36	1
73	1830	292	10
74	5860	148	4
76	3140	345	0.6
78	1860	29	6
79	4570	21	3
80	3420	231	11
81	954	25	2
82	595	18	1
83	3670	25	0.8
84	536	83	1
86	937	37	2
87	1650	83	3
88	7240	959	22
89	8050	58	5
90	6290	61	4
91	1640	101	6
92	1640	1080	78
93	2680	39	4
94	1050	33	6
95	1180	24	4
96	153	3	0.6
97	253	2	0.6
98	375	2	<0.5
99	821	0.5	0.6
100	1380	<0.5	<0.5
101	2320	11	<0.5
102	109	1	<0.5
103	218	16	<0.5
104	1340	45	<0.5

105	272	7	<0.5
106	15	0.8	<0.5
107	3	<0.5	<0.5
108	5	0.6	<0.5
109	>10000	399	9
110	3710	190	6
111	774	131	4
114	3470	94	3
115	3190	323	9
116	25	<0.5	<0.5
117	383	4	<0.5
118	70	2	<0.5
119	75	<0.5	<0.5
120	85	<0.5	<0.5
121	778	11	1
122	537	37	0.7
126	135	4	<0.5
127	146	16	<0.5
128	129	6	<0.5
129	1140	24	<0.5
130	734	103	<0.5
131	8200	424	<0.5
132	>10000	1770	5
133	3320	<0.5	<0.5
134	8640	183	<0.5
135	>10000	169	<0.5
136	3140	10	<0.5
137	>10000	1980	13

Example 27

Biological Data for Exemplary Compounds

[00587] Kinase binding data were obtained for various exemplary compounds prepared according to Examples 1-25 using the DiscoverX KINOMEScan[®] active site-directed competition binding site-directed assay protocol described below. Unlike other kinase competitive binding site assays, KINOMEScan[®] assays do not require ATP. As a result, the data report thermodynamic interaction affinities (K_d values), rather than IC_{50} values that are dependent on ATP concentrations. The assay uses a DNA-tagged version of the protein kinase, and an immobilized ligand bound to a solid support. Compounds that directly or indirectly prevent kinase binding to the immobilized ligand reduce the amount of kinase captured on the solid support, which

is detected using an ultra-sensitive qPCR method. Affinity constants reported from the assay have been reported to be independent of the immobilized ligand used that is coupled to the solid support (See supplemental information in Fabian, M.A. et. al., (2005) Nat. Biotechnol. 23, 329-336; Wodicka, L.M. et. al., (2010) Chem. Biol. 17, 1241-1249.)

[00588] Kinase-tagged T7 phage strains were prepared in an *E. coli* host derived from the BL21 strain. *E. coli* were grown to log-phase and infected with T7 phage and incubated with shaking at 32 °C until lysis. The lysates were centrifuged and filtered to remove cell debris. The remaining kinases were produced in HEK-293 cells and subsequently tagged with DNA for qPCR detection. Streptavidin-coated magnetic beads were treated with biotinylated small molecule ligands for 30 minutes at room temperature to generate affinity resins for kinase assays. The liganded beads were blocked with excess biotin and washed with blocking buffer (SeaBlock (Pierce), 1% BSA, 0.05% Tween 20, 1 mM DTT) to remove unbound ligand and to reduce non-specific binding. Binding reactions were assembled by combining kinases, liganded affinity beads, and test compounds in 1x binding buffer (20% SeaBlock, 0.17x PBS, 0.05% Tween 20, 6 mM DTT). Test compounds were prepared as 111x stocks in 100% DMSO. K_{ds} were determined using an 11-point 3-fold compound dilution series with three DMSO control points. All compounds for K_d measurements are distributed by acoustic transfer (non-contact dispensing) in 100% DMSO. The compounds were then diluted directly into the assays such that the final concentration of DMSO was 0.9%. All reactions were performed in polypropylene 384-well plates. Each was a final volume of 0.02 mL. The assay plates were incubated at room temperature with shaking for 1 hour and the affinity beads were washed with wash buffer (1x PBS, 0.05% Tween 20). The beads were then re-suspended in elution buffer (1x PBS, 0.05% Tween 20, 0.5 μ M nonbiotinylated affinity ligand) and incubated at room temperature with shaking for 30 minutes. The kinase concentration in the eluates was measured by qPCR.

[00589] Binding constants (K_{ds}) were calculated with a standard dose-response curve using the Hill equation. The Hill Slope was set to -1. Curves were fitted using a non-linear least square fit with the Levenberg-Marquardt algorithm.

Table 17. Biological data obtained in accordance with the protocol described in Example 27.

Compound #	FLT3 K_d (nM)	FLT3 D835H K_d (nM)	FLT3 D835V K_d (nM)	FLT3 D835Y K_d (nM)	FLT3 ITD K_d (nM)	FLT3 ITD,D835V K_d (nM)
96	0.31	0.23	0.12	0.46	1	0.07

97	0.19	0.18	0.067	0.063	0.19	0.034
102	0.13	0.21	0.11	0.16	0.54	0.045

Table 18. Biological data obtained in accordance with the protocol described in Example 27.

Compound #	FLT3 ITD,F691L K _d (nM)	FLT3 K663Q K _d (nM)	FLT3 N841I K _d (nM)	FLT3 R834Q K _d (nM)	FLT3 Autoinh. K _d (nM)
96	0.37	0.6	0.91	1.6	11
97	0.19	1.4	0.55	0.8	13
102	0.14	0.37	0.36	0.61	17

Example 28

Biological Data for Exemplary Compounds

[00590] Kinase cellular potency data were obtained for various exemplary compounds prepared according to Examples 1-25, using the Reaction Biology NanoBRET assay protocol described below. The NanoBRET assay measures kinase engagement in real time in the context of the intact cell. Unlike the previously described biochemical kinase assay methodologies in Examples 26-27, the NanoBRET assay measures the binding and activity characteristics under equilibrium conditions using full-length kinases in the presence of cellular concentrations of ATP in live, uncompromised cells. As such, the assay provides a more relevant assessment of kinase potency and selectivity that would be expected to be observed in the native cellular environment, where potency is often considerably lower than that observed in the isolated biochemical assays (Vasta, J.D. et al., (2018) Cell Chem. Biol. 25, 206-214). The assay uses a Kinase-NanoLuc[®] fusion vector expressing a kinase protein to which a luciferase tag has been added, a cell-permeant fluorescent NanoBRET[™] tracer, a NanoLuc[®] substrate, and an extracellular NanoLuc[®] inhibitor. Upon expression of the luciferase-tagged kinase, cells will produce a strong BRET signal only in the presence of the NanoBRET[™] tracer. The extracellular NanoLuc[®] inhibitor ensures that the BRET signal observed emanates only from live cells. Because the BRET signal has tight distance constraints, addition of the test compound will decrease the BRET signal if the compound competes with the NanoBRET[™] tracer for binding to the kinase domain. Under the appropriate tracer conditions established by the manufacturer, quantitative intracellular affinity and relative potency can then be determined using Mass Action model equations.

[00591] HEK-293 cells were purchased from ATCC. FuGENEHD Transfection Reagent, Kinase-NanoLucfusion plasmids, Transfection Carrier DNA, NanoBRETTracers and

dilution buffer, NanoBRET Nano-Glo Substrate, Extracellular NanoLuc Inhibitor were obtained from Promega.

[00592] Assays were conducted following Promega assay protocol with some modifications. HEK-293 Cells were transiently transfected with Kinase-NanoLuc Fusion Vector DNA by FuGENE HD Transfection Reagent. Testing compounds were delivered into 384 well assay plate by Echo 550 (Labcyte Inc, Sunnyvale, CA). Transfected cells were harvested and mixed with NanoBRET Tracer Reagent and dispensed into 384 well plates and incubated at 37 °C in 5% CO₂ cell culture incubator for 1 hour. The NanoBRET Nano-Glo Substrate plus Extracellular NanoLuc Inhibitor Solution were added into the wells of the assay plate and incubated for 2 - 3 minutes at room temperature. The donor emission wavelength (460 nm) and acceptor emission wavelength (600 nm) were measured in the EnVision plate reader. The BRET Ratios were calculated. BRET Ratio = [(Acceptor sample ÷ Donor sample) – (Acceptor no-tracer control ÷ Donor no-tracer control)]. The IC₅₀ values of compounds were calculated with Prism GraphPad program.

NanoBRET™ Target Engagement Assay Protocol

1. Transient Transfection of HEK-293 Cells NanoLuc® Fusion Vector DNA
 - 1). Cultivate HEK-293 cells (70-80% confluence) appropriately prior to assay. Trypsinize and collect HEK-293 cells.
 - 2). Prepare lipid: DNA complexes as follows:
 - a. Prepare a 10 µg/ml solution of DNA in Opti-MEM without serum that consists of the following ratios of carrier DNA and DNA encoding NanoLuc® fusion. 9.0 µg/mL of Transfection Carrier DNA, 1.0 µg/mL of NanoLuc fusion vector DNA and 1 mL of Opti-MEM without phenol red. Mix thoroughly.
 - b. Add 30 µl of FuGENE HD Transfection Reagent into each milliliter of DNA mixture to form lipid: DNA complex.
 - c. Mix by inversion 10 times.
 - d. Incubate at ambient temperature for 20 minutes to allow complexes to form.
 - 3). In a sterile, conical tube, mix 1 part of lipid: DNA complex with 20 parts of HEK-293 cells in suspension. Mix gently by inversion 5 times.
 - 4). Dispense cells + lipid: DNA complex into a sterile tissue culture dish and incubate for

22-24 hours.

2. Addition of Test Compounds (dry plate shooting)

Each test compound is delivered from the compound source plate to the wells of 384-well white NBS plate by Echo 550.

3. Preparation of Cells with NanoBRET™ Tracer Reagent

1). Remove medium from dish with transfected HEK-293 cells via aspiration, trypsinize and allow cells to dissociate from the dish.

2). Neutralize trypsin using medium containing serum and centrifuge at $200 \times g$ for 5 minutes to pellet the cells. Adjust the cell density to 2×10^5 cells/mL in Opti-MEM without phenol red.

3). Prepare Complete 20X NanoBRET™ Tracer Reagent with Tracer Dilution Buffer.

4). Dispense one part of Complete 20X NanoBRET™ Tracer Reagent to 20 parts of cells in the tube. Mix gently by inversion 10 times.

5). Dispense cell suspension into white, 384-well NBS plates. Incubate the plate at 37 °C, 5% CO₂ for 1 hour.

Note: Prepare a separate set of samples without tracer for background correction steps.

4. NanoBRET™ Assay

1). Remove plate from incubator and equilibrate to room temperature for 15 minutes.

2). Prepare 3X Complete Substrate plus Inhibitor Solution in Assay Medium (Opti-MEMR I Reduced Serum Medium, no phenol red) just before measuring BRET.

3). Add 3X Complete Substrate plus Inhibitor Solution to each well of the 384-well plate. Incubate for 2–3 minutes at room temperature.

4). Measure donor emission wavelength (460 nm) and acceptor emission wavelength (600 nm) using the Envision 2104 plate reader.

5. Determination of BRET Ratio

To generate raw BRET ratio values, divide the acceptor emission value (600 nm) by the

donor emission value (460 nm) for each sample. To correct for background, subtract the BRET ratio in the absence of tracer (average of no-tracer control samples) from the BRET ratio of each sample.

NanoBRET™ ratio equation:

$$\text{BRET Ratio} = (\text{Acceptor sample} \div \text{Donor sample})$$

NanoBRET™ ratio equation, including optional background correction:

$$\text{BRET Ratio} = [(\text{Acceptor sample} \div \text{Donor sample}) - (\text{Acceptor no-tracer control} \div \text{Donor no-tracer control})]$$

Normalized Bret Response equation (%):

$$(\text{BRET Ratio of Compound Treated Sample} / \text{BRET Ratio of DMSO Control Sample}) \times 100\%$$

6. Determination of IC₅₀ Values

IC₅₀ curves are plotted and IC₅₀ values are calculated using the GraphPad Prism 4 program based on a sigmoidal dose-response equation.

Table 19. Biological data obtained in accordance with the protocol described in Example 28.

Compound #	NanoBRET FLT3 IC ₅₀ (nM)	NanoBRET IRAK4 IC ₅₀ (nM)
9	367	54
19	142	511
96	18	2
99	3	3
102	4	2
106	<0.5	<0.5
107	4890	<0.5
108	<0.5	<0.5
126	1160	7
127	196	30
128	102	15
133	226	98

Example 29

Biological Data for Exemplary Compounds

[00593] Cellular potency data were obtained for various exemplary compounds prepared according to Examples 1-25 using the NF- κ B assay protocol described below. Activation of NF- κ B gene transcription is a downstream signal in the IRAK signaling pathway (Balka, K.R. and DeNardo, D., J. Leukoc. Biol. (2019) 105, 339-351. Because THP-1 cells do not contain activated FLT3 receptors, measurement of the ability of a FLT3/IRAK1/IRAK4 inhibitor compound to inhibit the NF- κ B production reflects the ability to inhibit signaling downstream of blocking signaling through the IRAK1/4 complex and is not a composite measurement of activity that includes FLT3 kinase inhibition.

[00594] THP-1-Blue NF- κ B cells (InvivoGen) carrying a stable integrated NF- κ B-inducible secreted embryonic alkaline phosphatase (SEAP) reporter construct were plated at a concentration of 1×10^5 cells per well. The cells were stimulated with Pam3CSK4 (1ng/mL) or hIL1B (1ng/mL). After 10 – 20 minutes, the cells were then treated with vehicle (DMSO) or serial dilutions of the test compounds (10 doses tested for each test compound, with a 1:10 dilution series starting at 1 μ M or 3 μ M) with a final volume of 200 μ L for 24 hours at 37 °C. After 24 hours, the cells were centrifuged and 20 μ L supernatant was incubated with 180 μ L QUANTI-Blue reagent at 37 °C for 30 – 60 minutes. The levels of NF- κ B-induced gene expression were measured in a microplate reader at 620 nm.

Table 20. Biological data obtained in accordance with the protocol described in Example 29.

Compound #	NF-κB Pam3SCK4 IC₅₀ (nM)	NF-κB IL1B IC₅₀ (nM)
96	93	121
99	121	340
102	135	254
106	63	59
107	18	15
108	30	13
116	20	46
118	76	216
126	92	121
127	254	359
128	108	196

Example 30

Biological Data for Exemplary Compounds

[00595] Cellular potency data were obtained for various exemplary compounds prepared according to Examples 1-25, using the MOLM14 D835Y and MOLM14 F691L cell viability assay protocols described below. Both cell lines have activated FLT3 receptors, each of which carry additional resistance mutations in the kinase domain (D835Y and F691L, respectively). Leukemias from patients harboring these kinase domain resistance mutations are resistant to FLT3 inhibitors that do not inhibit the mutant kinase. Because the activated FLT3 receptor drives a mitogenic response, and because there can be a discrepancy between activity in the biochemical kinase assay and in the context of a whole cell (Vasta, J.D. et al., (2018) Cell Chem. Biol. 25, 206-214), demonstration of antiproliferative activity in these cell lines with compounds known to inhibit the D835Y or F691L kinases in biochemical assays provides a more relevant cellular context for demonstration of activity.

[00596] MOLM14 D835Y and MOLM14 F691L cells were grown in RPMI-1640 media supplemented with 20% fetal bovine serum (FBS). For viability/cytotoxicity assessments, cells were seeded into 1536-well white polystyrene tissue culture-treated Greiner plates using a Multidrop Combi dispenser (ThermoFisher), in final volume 5 μ L of growth media per well, at a density of 1000 cells per well. After cell addition, 23 nL of test compound were transferred into individual wells (22 doses tested for each test compound, with a 1:2 dilution series starting at 10 μ M) via a 1536 pin-tool. Bortezomib (final concentration 2.3 μ M) was used as a positive control for cell cytotoxicity. Plates were incubated for 48 hours at standard incubator conditions covered by a stainless steel gasketed lid to prevent evaporation. 48 hours post compound addition, 3 μ L of Cell Titer Glo (Promega) were added to each well and plates were incubated at room temperature for 15 minutes with the stainless-steel lid in place. Luminescence readings were taken using a Viewlux imager (PerkinElmer) with a 2 second exposure time per plate.

Table 21. Biological data obtained in accordance with the protocol described in Example 30.

Compound #	MOLM14 D835Y IC ₅₀ (nM)	MOLM14 F691L IC ₅₀ (nM)
1	60	1680
9	101	N.D.
19	402	N.D.

20	333	N.D.
81	591	N.D.
82	357	N.D.
83	259	N.D.
84	179	N.D.
96	55	673
97	34	N.D.
99	17	269
100	20	N.D.
101	N.D.	596
102	34	388
103	205	1453
104	193	1154
105	231	1220
106	3	29
107	11	137
108	3	29
109	968	N.D.
110	591	N.D.
111	1007	N.D.
114	326	N.D.
116	77	1088
117	109	1369
118	61	770
119	103	1536
120	20	275
121	97	1369
122	49	686
126	109	1536
127	1220	6117
128	34	386
129	154	2170
130	137	1369
131	69	545
132	486	3440
133	86	969
134	244	1724
135	386	4330
136	31	344

N.D. = experiment not performed

Example 31

Drug Screening for Exemplary Compounds

[00597] Combination drug therapy has the potential to produce enhanced effects with lower side effects not obtained using either agent alone, or beyond the additive effect of the different concentrations of the two different agents. To determine whether enhanced effects are observed in different drug combinations in the setting of FLT3 resistance, combination drug screening was performed as previously described (Mathews-Griner, L. A. et al., Proc. Nat. Acad. Sci., 2014, 111:2439-2454; Lin, G. L. et al., Sci. Trans. Med., 2019, 11:eaaw0064). Briefly, 10 nL of compounds were acoustically dispensed into 1536-well white polystyrene tissue culture-treated plates with an Echo 550 acoustic liquid handler (Labcyte). MOLM14 (D835Y) cells were then added to compound-containing plates at a density of 500-cells/well in 5 μ L of medium. A 10-point custom concentration range was used for all listed drugs. Plates were incubated for 48 hours at standard incubator conditions covered by a stainless steel gasketed lid to prevent evaporation. 48h post compound addition, 3 μ L of Cell Titer Glo (Promega) were added to each well and plates were incubated at room temperature for 15 minutes with the stainless-steel lid in place. Luminescence readings were taken using a Viewlux imager (PerkinElmer) with a 2 second exposure time per plate. The results can be seen in Tables 22-23 and FIGS. 1A-3B.

Table 22. Sum Excess HSA scores for a combination therapy of Compounds 96, 99, 102, 106, and 108 with Venetoclax obtained in MOLM14 (D835Y) cells in a 10 x 10 dataset.

Compound #	Sum Excess HSA	Interaction with Venetoclax
Compound 99	-789.42805	Synergistic
Compound 96	-543.20363	
Compound 108	-480.37013	
Compound 106	-334.04079	
Compound 102	-188.83566	

[00598] The excess HSA scores for Compounds 96, 99, 102, 106, and 108 in Table 22 were used to quantitate drug interactions for enhanced pharmacological effects in the MOLM14 (D835Y) cell line. This is a FLT3-ITD cell line that harbors a FLT3 resistance mutation in the tyrosine kinase domain at position 835 (D835Y). Table 22 summarizes the combination results of Compounds 96, 99, 102, 106, and 108 with Venetoclax. The large negative sum excess HSA score indicates profound synergism for each of these compounds with Venetoclax.

[00599] A combination analysis of Compound 106 and Venetoclax was obtained in a 10 x 10 dataset in the MOLM14 (FLT3 ITD, D835Y) cancer cell model. In this experiment,

cell viability (% response) decreases with increasing drug concentration (FIG. 1A), and the dose-response of each drug is enhanced in the combination relative to that of each drug alone. FIG 1B measures the degree of synergy as an excess HSA score, with the degree of synergy being highest for those drug combinations where the largest negative excess HSA values are observed. A similar analysis of Compound 108 and Venetoclax was obtained in a 10 x 10 array in the MOLM14 (FLT3 ITD, D835Y) cancer cell model. The excess HSA scores in FIG. 2B illustrate that the synergy is highest when combining 15.6 nM Venetoclax with 0.8-1.6 nM Compound 108.

Table 23. Sum Excess HSA scores for a combination therapy of Compound 96 and an additional pharmaceutically active compound obtained in MOLM14 (D835Y) cells in a 10 x 10 dataset.

Pharmaceutically Active Compound	Classification	Sum Excess HSA	Interaction with Compound 96
GSK-2982772	RIP1 kinase Inhibitor	-576.96986	Synergistic
Venetoclax (ABT-199)	Bcl-2 Inhibitor	-549.6211	
Copanlisib	PI3K alpha/delta Inhibitor	-542.75374	
SPC-839	IKK beta Inhibitor	-326.80008	
Trametinib	Mek 1/2 Inhibitor	-231.89354	
Navitoclax (ABT-263)	Bcl-xL Inhibitor	-227.25427	
AMG-232	MDM2 (hdm2) Inhibitor	-222.93285	
Tazarotene	Retinoid RAR Agonist	-188.98567	
CC-885	Unknown	-112.95338	
Iberdomide	IL-2 Production Enhancers	-86.86499	
Dexamethasone	Antiinflammatory agent	-69.66678	
Prednisolone	Glucocorticoid steroid	-46.09679	
CC-885	Unknown	-44.05192	Antagonistic
Iberdomide	IL-2 Production Enhancers	29.61236	
Gemcitabine	Ribonucleotide reductase Inhibitor	30.68985	
Tazemetostat	EZH2 Inhibitor	74.35983	
Methotrexate hydrate	Unknown	80.4717	
Idasanutlin	MDM2 (hdm2) Inhibitor	192.32547	

Omaveloxolone	Nuclear Factor Erythroid 2-Related Factor 2 (NFE2-Related Factor 2; NFE2L2; NRF2) Activator	195.97179	
Necrostatin 2	RIP1 Kinase Inhibitor	288.72247	
S63845	Mcl-1 Inhibitor	297.30249	
Lenalidomide	TNF-alpha Production Inhibitor	325.84003	
Tamibarotene	Retinoid RAR Agonist	850.38612	
Methylprednisolone	Glucocorticoid steroid	891.01205	
Palbociclib	CDK4/6 Inhibitor	999.17097	
Lenalidomide	TNF-alpha Production Inhibitor	1288.82325	

[0001] Table 23 summarizes the combination results of Compound 96 with 24 pharmaceutically active compounds obtained in MOLM14 (FLT3 ITD, D835Y) cells in a 10 x 10 dataset. Certain drug combinations are synergistic as reflected by negative sum excess HSA scores, whereas other drug combinations are antagonistic as reflected by positive sum excess HSA scores.

[0002] The excess HSA scores for Compounds 96, 99, 102, 106, and 108 in Tables 22-23 are used herein to quantitate drug interactions for enhanced pharmacological effects. More information on excess HSA scores can be found in Vlot, Anna H. C. et al., Drug Discovery Today, 2019, 24(12):2286-2298. While there are other methods of quantitating drug interactions, excess HSA method is preferred because it does not require making assumptions about similarities in the mechanism of action of the drugs involved or the shape of the dose-response curves being compared and does not place arbitrary requirements on the computational algorithm that the two drugs produce similar efficacy in the given system. However, different methodologies may yield different numerical scores, and different definitions of what constitutes a deviation from mere additivity vs true drug synergy.

[0003] A negative excess HSA score illustrates that the drug combination is better than either drug alone (at the concentrations being studied), and the excess HSA score is a measurement of the overall deviation from additivity that is observed across the entire matrix of

concentrations studied. Hence, the drug combinations that are noteworthy as having more profound synergistic effects are those with greater negative excess HSA scores. However, the utility in certain drug combinations *vs* others should not be distinguished based on cutoffs between HSA scores, because the score itself is only a relative indicator that is completely dependent on experimental design and is not an absolute number. Furthermore, the concept of what constitutes clinically meaningful drug synergy is something that is still being debated, not only between pharmacologists and physicians, but amongst pharmacologists themselves.

[0004] The degree to which combination therapy has to potential to produce enhanced effects with lower side effects not obtained using either agent alone, or beyond the additive effect of the different concentrations of the two different agents depends on the nature of the drugs used in the combination, and the specific doses/concentrations at which they are ultimately used in the therapeutic regimen. Ideally, side effects are minimized when the dose/concentration of each agent can be administered at substantially lower doses needed to obtain adequate efficacy as a single agent. FIGS. 3A-3B illustrate the relative potency of 36 compounds to synergize with Venetoclax in the Cell Titer Glo assay using a 10 x 10 array in the MOLM14 (FLT3 ITD, D835Y) cancer cell model. Depending on the potency of the compound used, different amounts of compound are needed to fully potentiate the 7.8 nM Venetoclax response to <5%. While the known FLT3 inhibitors CG-806 (Aptose), Gilteritinib hemifumerate (Xospata®), Quizartinib (VANFLYTA®), and CA-4948 (Curis) all synergize with Venetoclax, Compounds 106 and 108 are 30-300 x more potent in producing the same degree of synergy (FIGS. 3A-3B). These data imply that Compounds 106 and 108 will have an improved therapeutic index in a drug combination with Venetoclax *vs.* the known FLT3 inhibitors. This finding with respect to the synergy of Compounds 106 and 108 with venetoclax distinguishes them from the known FLT3 inhibitors that are currently being studied in the clinic in combination with Venetoclax while a higher therapeutic index for Compounds 106 and 108 means that a lower dosage of these compounds could be administered to a subject than known FLT3 inhibitors, and that a much lower dose of Venetoclax could be used in the context of the combination *vs.* that used when Venetoclax is used in the absence of these compounds. This lower dosage is especially beneficial in the context of a combination therapy, where one wants to be at as low a dose as possible to avoid compounding toxicities within the drug combination.

[0005] The headings used in the disclosure are not meant to suggest that all disclosure relating to the heading is found within the section that starts with that heading. Disclosure for any subject may be found throughout the specification.

[0006] It is noted that terms like “preferably,” “commonly,” and “typically” are not used herein to limit the scope of the claimed disclosure or to imply that certain features are critical, essential, or even important to the structure or function of the claimed disclosure. Rather, these terms are merely intended to highlight alternative or additional features that may or may not be utilized in a particular embodiment of the present disclosure.

[0007] The various methods and techniques described above provide a number of ways to carry out the disclosure. Of course, it is to be understood that not necessarily all objectives or advantages described can be achieved in accordance with any particular embodiment described herein. Thus, for example, those skilled in the art will recognize that the methods can be performed in a manner that achieves or optimizes one advantage or group of advantages as taught herein without necessarily achieving other objectives or advantages as taught or suggested herein. A variety of alternatives are mentioned herein. It is to be understood that some preferred embodiments specifically include one, another, or several features, while others specifically exclude one, another, or several features, while still others mitigate a particular feature by inclusion of one, another, or several advantageous features.

[0008] Furthermore, the skilled artisan will recognize the applicability of various features from different embodiments. Similarly, the various elements, features and steps discussed above, as well as other known equivalents for each such element, feature or step, can be employed in various combinations by one of ordinary skill in this art to perform methods in accordance with the principles described herein. Among the various elements, features, and steps some will be specifically included and others specifically excluded in diverse embodiments.

[0009] Although the application has been disclosed in the context of certain embodiments and examples, it will be understood by those skilled in the art that the embodiments of the disclosure extend beyond the specifically disclosed embodiments to other alternative embodiments and/or uses and modifications and equivalents thereof.

[0010] In some embodiments, the numbers expressing quantities of ingredients, properties such as molecular weight, reaction conditions, and so forth, used to describe and claim certain embodiments of the application are to be understood as being modified in some instances

by the term “about.” Accordingly, in some embodiments, the numerical parameters set forth in the written description and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by a particular embodiment. In some embodiments, the numerical parameters should be construed in light of the number of reported significant digits and by applying ordinary rounding techniques. Notwithstanding that the numerical ranges and parameters setting forth the broad scope of some embodiments of the application are approximations, the numerical values set forth in the specific examples are reported as precisely as practicable.

[0011] In some embodiments, the terms “a” and “an” and “the” and similar references used in the context of describing a particular embodiment of the application (especially in the context of certain of the following claims) can be construed to cover both the singular and the plural. The recitation of ranges of values herein is merely intended to serve as a shorthand method of referring individually to each separate value falling within the range. Unless otherwise indicated herein, each individual value is incorporated into the specification as if it were individually recited herein. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (for example, “such as”) provided with respect to certain embodiments herein is intended merely to better illuminate the application and does not pose a limitation on the scope of the application otherwise claimed. As used in the disclosure or claims, “another” means at least a second or more, unless otherwise specified. As used in the disclosure, the phrases “such as”, “for example”, and “e.g.” mean “for example, but not limited to” in that the list following the term (“such as”, “for example”, or “e.g.”) provides some examples but the list is not necessarily a fully inclusive list. The word “comprising” means that the items following the word “comprising” may include additional unrecited elements or steps; that is, “comprising” does not exclude additional unrecited steps or elements. No language in the specification should be construed as indicating any non-claimed element essential to the practice of the application.

[0012] In certain instances, sequences disclosed herein are included in publicly available databases, such as GENBANK[®] and SWISSPROT. Unless otherwise indicated or apparent the references to such publicly available databases are references to the most recent version of the database as of the filing date of this Application.

[0013] Unless otherwise indicated, all numbers expressing quantities of ingredients, properties such as reaction conditions, and so forth used in the specification and claims are to be understood as being modified in all instances by the term “about”. Accordingly, unless indicated to the contrary, the numerical parameters set forth in this specification and claims are approximations that can vary depending upon the desired properties sought to be obtained by the presently disclosed subject matter. As used herein, the term “about,” when referring to a value or to an amount of mass, weight, time, volume, concentration or percentage is meant to encompass variations of in some embodiments $\pm 20\%$, in some embodiments $\pm 10\%$, in some embodiments $\pm 5\%$, in some embodiments $\pm 1\%$, in some embodiments $\pm 0.5\%$, and in some embodiments $\pm 0.1\%$ from the specified amount, as such variations are appropriate to perform the disclosed method.

[0014] Preferred embodiments of this application are described herein. Variations on those preferred embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. It is contemplated that skilled artisans can employ such variations as appropriate, and the application can be practiced otherwise than specifically described herein. Accordingly, many embodiments of this application include all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is encompassed by the application unless otherwise indicated herein or otherwise clearly contradicted by context.

[0015] All patents, patent applications, publications of patent applications, and other material, such as articles, books, specifications, publications, documents, things, and/or the like, referenced herein are hereby incorporated herein by this reference in their entirety for all purposes, excepting any prosecution file history associated with same, any of same that is inconsistent with or in conflict with the present document, or any of same that may have a limiting affect as to the broadest scope of the claims now or later associated with the present document. By way of example, should there be any inconsistency or conflict between the description, definition, and/or the use of a term associated with any of the incorporated material and that associated with the present document, the description, definition, and/or the use of the term in the present document shall prevail.

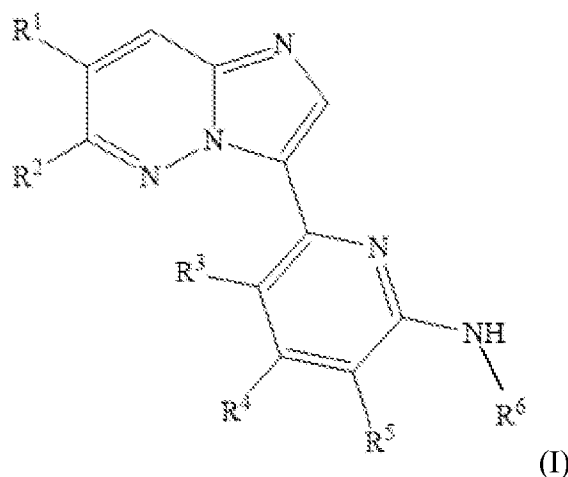
[0016] In closing, it is to be understood that the embodiments of the application disclosed herein are illustrative of the principles of the embodiments of the disclosure. Other

modifications that can be employed can be within the scope of the application. Thus, by way of example, but not of limitation, alternative configurations of the embodiments of the application can be utilized in accordance with the teachings herein. Accordingly, embodiments of the present application are not limited to that precisely as shown and described.

CLAIMS

What is claimed is:

1. A compound of Formula (I)



or a salt, ester, solvate, optical isomer, geometric isomer, salt of an isomer, prodrug, or derivative thereof,

wherein:

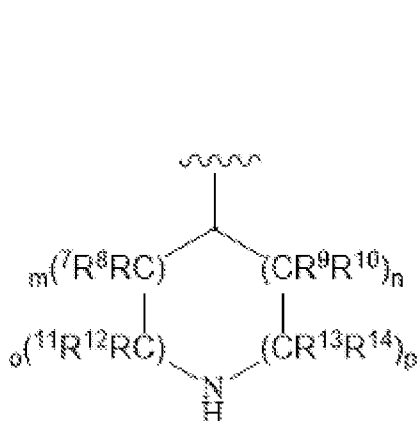
R¹ is selected from H, halogen, hydroxy, oxo, -CN, amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the amido, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R² is selected from H, halogen, hydroxy, oxo, -CN, amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the

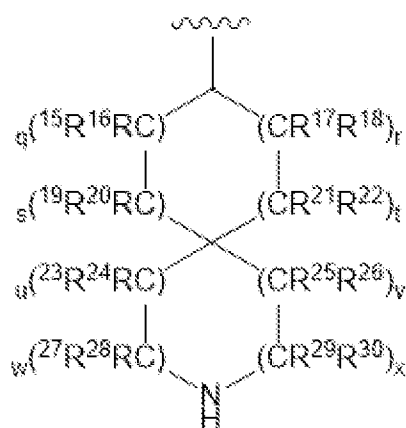
amino, -O-aryl, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ heteroalkyl, C₁-C₇ alkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ heteroalkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, cycloalkyl, heterocyclyl, spiro-fused cycloalkyl, aryl, fused ring aryl, heteroaryl, fused ring heteroaryl, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R³, R⁴, and R⁵ are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more of halogen, hydroxy, oxo, methanoyl (-COH), carboxy (-CO₂H), nitro (-NO₂), -NH₂, -NHCH₃, -N(CH₃)₂, cyano (-CN), ethynyl (-CCH), propynyl, sulfo (-SO₃H), heterocyclyl, aryl, heteroaryl, pyrrolyl, piperidyl, piperazinyl, morpholinyl, -CO-morpholin-4-yl, -CONH₂, -CONHCH₃, -CON(CH₃)₂, C₁-C₇ alkyl, C₁-C₇ haloalkyl, C₁-C₇ perfluorinated alkyl, C₁-C₇ alkoxy, C₁-C₇ haloalkoxy, or C₁-C₇ alkyl which is substituted with cycloalkyl;

R⁶ is



(Ia), or



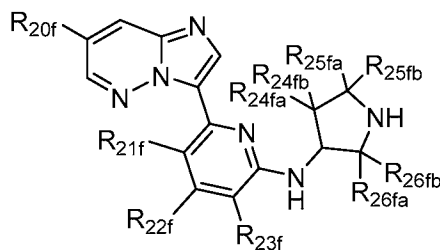
(Ib);

$R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}$ are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen;

$R^{15}, R^{16}, R^{17}, R^{18}, R^{19}, R^{20}, R^{21}, R^{22}, R^{23}, R^{24}, R^{25}, R^{26}, R^{27}, R^{29}, R^{29},$ and R^{30} are each independently selected from H, halogen, hydroxy, oxo, -CN, methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl, wherein the methanoyl (-COH), carboxy (-CO₂H), C₁-C₇ alkyl, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, cycloalkyl, spiro-fused cycloalkyl, heterocyclyl, aryl, heteroaryl, or fused ring heteroaryl is optionally substituted with one or more halogen; and

m, n, o, p, q, r, s, t, u, v, w, and x are each independently selected from 0, 1, 2, 3, 4, or 5, where q+r+s+t is at least 1, and where u+v+w+x is at least 1.

2. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (II_f)



Formula (II_f),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof; wherein:

R_{20f} is selected from H, halogen, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and -O-(C₃-C₆ cycloalkyl), wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, and wherein C₃-C₆ cycloalkyl and -O-(C₃-C₆ cycloalkyl) are each optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen;

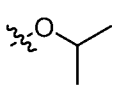
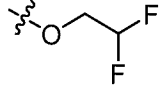
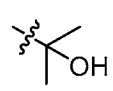
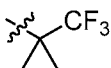
$R_{21f}, R_{22f},$ and R_{23f} are each independently selected from H and halogen; and

R_{24fa} , R_{24fb} , R_{25fa} , R_{25fb} , R_{26fa} , and R_{26fb} are each independently selected from H, halogen, -OH, C_1 - C_6 alkyl, and C_1 - C_6 alkoxy, wherein C_1 - C_6 alkyl and C_1 - C_6 alkoxy are each optionally substituted with one or more halogen atoms.

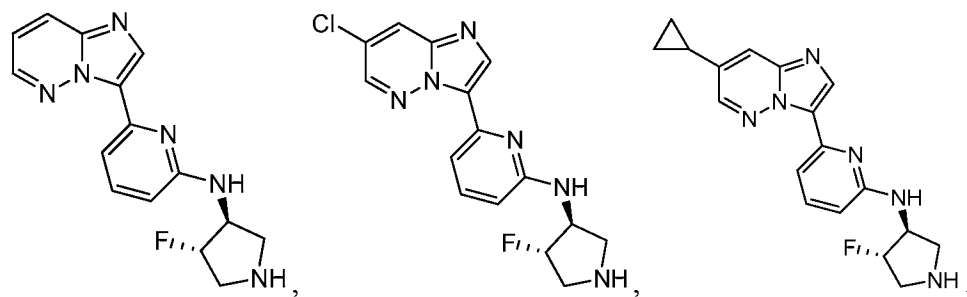
3. The compound of claim 2, wherein one or more of R_{24fa} , R_{24fb} , R_{25fa} , R_{25fb} , R_{26fa} , and R_{26fb} is independently selected from halogen, -OH, optionally substituted C_1 - C_6 alkyl, and optionally substituted C_1 - C_6 alkoxy.

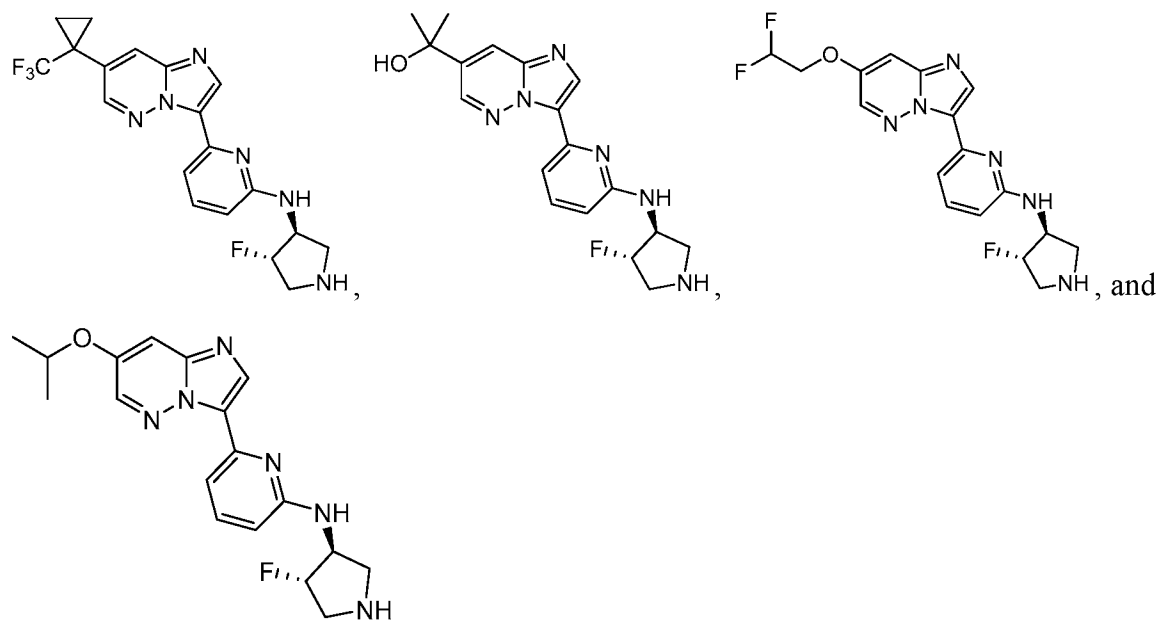
4. The compound of claim 2 or 3, wherein R_{20f} is H.

5. The compound of any one of claims 2-4, wherein at least one of (i)-(iii) applies:

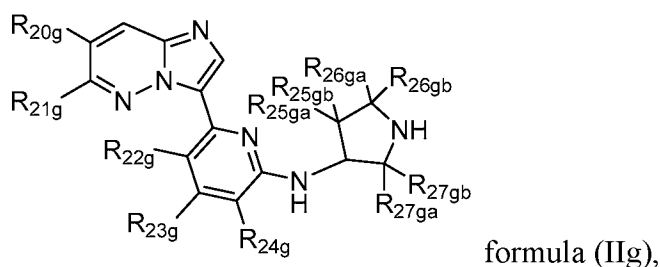
- (i) R_{20f} is selected from Cl, , , , unsubstituted C_3 cycloalkyl, and ;
 (ii) R_{21f} , R_{22f} , and R_{23f} are each H;
 (iii) R_{25fa} , R_{25fb} , R_{26fa} , and R_{26fb} are each H and R_{24fa} and/or R_{24fb} is F.

6. The compound of any one of claims 2-5, wherein the compound is selected from:





7. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (IIg)



or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:

R_{20g} is selected from H and C₁-C₆ alkoxy;

R_{21g} is selected from halogen, C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, -O-(C₆-C₁₂ aryl), C₃-C₉ heterocyclyl, and -NR_{28ga}R_{28gb}, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and wherein C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, -OH, and halogen;

R_{22g} , R_{23g} , and R_{24g} are each independently selected from H and halogen;

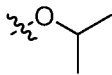
R_{25ga} , R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} are each independently selected from H, halogen, -OH, C₁-C₆ alkyl, and C₁-C₆ alkoxy, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more halogen atoms; and

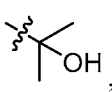
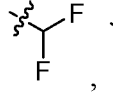
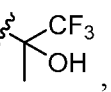
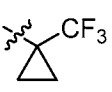
R_{28ga} and R_{28gb} are each independently selected from H, C₁-C₆ alkyl, and C₃-C₆ cycloalkyl.

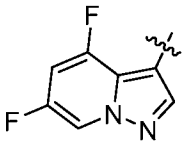
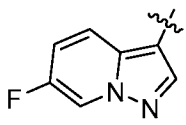
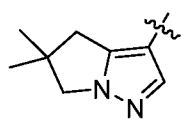
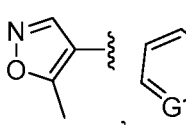
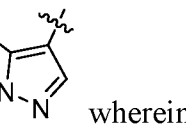
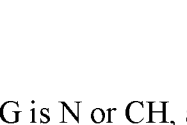
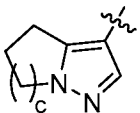
8. The compound of claim 7, wherein one or more of R_{25ga} , R_{25gb} , R_{26ga} , R_{26gb} , R_{27ga} , and R_{27gb} is independently selected from halogen, -OH, optionally substituted C₁-C₆ alkyl, and optionally substituted C₁-C₆ alkoxy.

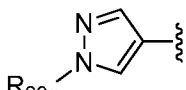
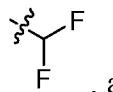
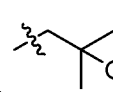
9. The compound of claim 7 or 8, wherein R_{20g} is H.

10. The compound of any one of claims 6-9, wherein at least one of (i)-(ix) applies:

(i) R_{20g} is selected from -OCH₃ and  ;

(ii) R_{21g} is selected from t-butyl, unsubstituted C₃ cycloalkyl, morpholinyl, azetidiny, piperdiny, isoxazolyl, Cl, -CF₃, -OCH₃, -O-phenyl, , , , , and

, , , , ,  wherein G is N or CH, and  wherein c is 1 or 2;

(iii) R_{21g} is  wherein R_{29g} is selected from H, isopropyl, unsubstituted C₃ cycloalkyl, azetidiny, tetrahydropyranyl -CH₃, , and  ;

(iv) R_{21g} is -NR_{28ga}R_{28gb} wherein R_{28ga} is H and R_{28gb} is selected from -CH₃, cyclobutyl, and cyclohexyl or wherein R_{28ga} and R_{28gb} are each -CH₃;

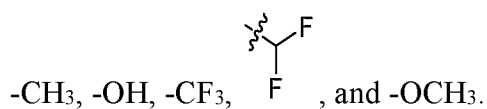
(v) R_{22g} , R_{23g} , and R_{24g} are each H;

(vi) R_{22g} and R_{24g} are each F and R_{23g} is H;

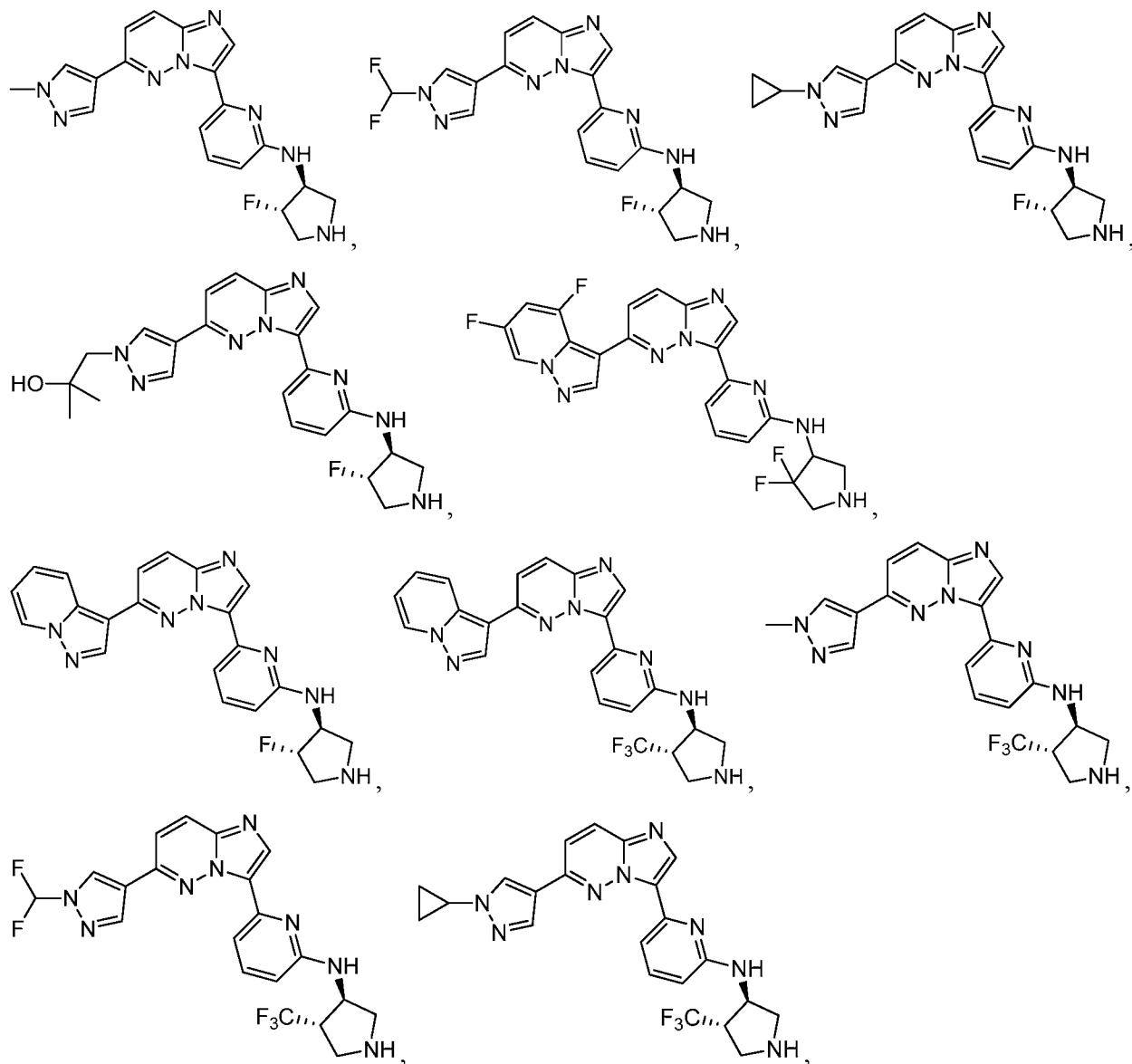
(vii) R_{22g} and R_{24g} are each H and R_{23g} is F;

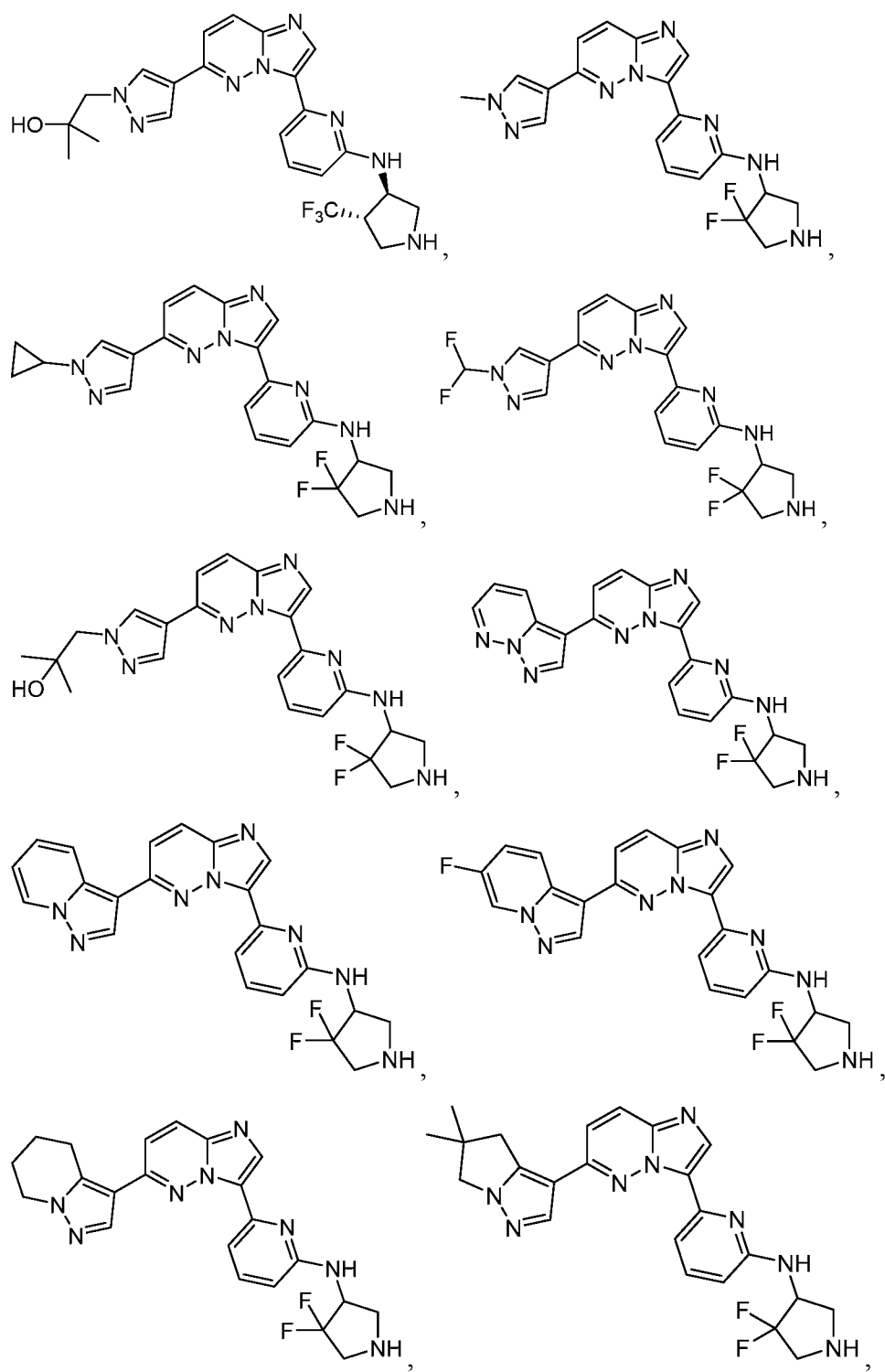
(viii) R_{25ga}, R_{25gb}, R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} are each H;

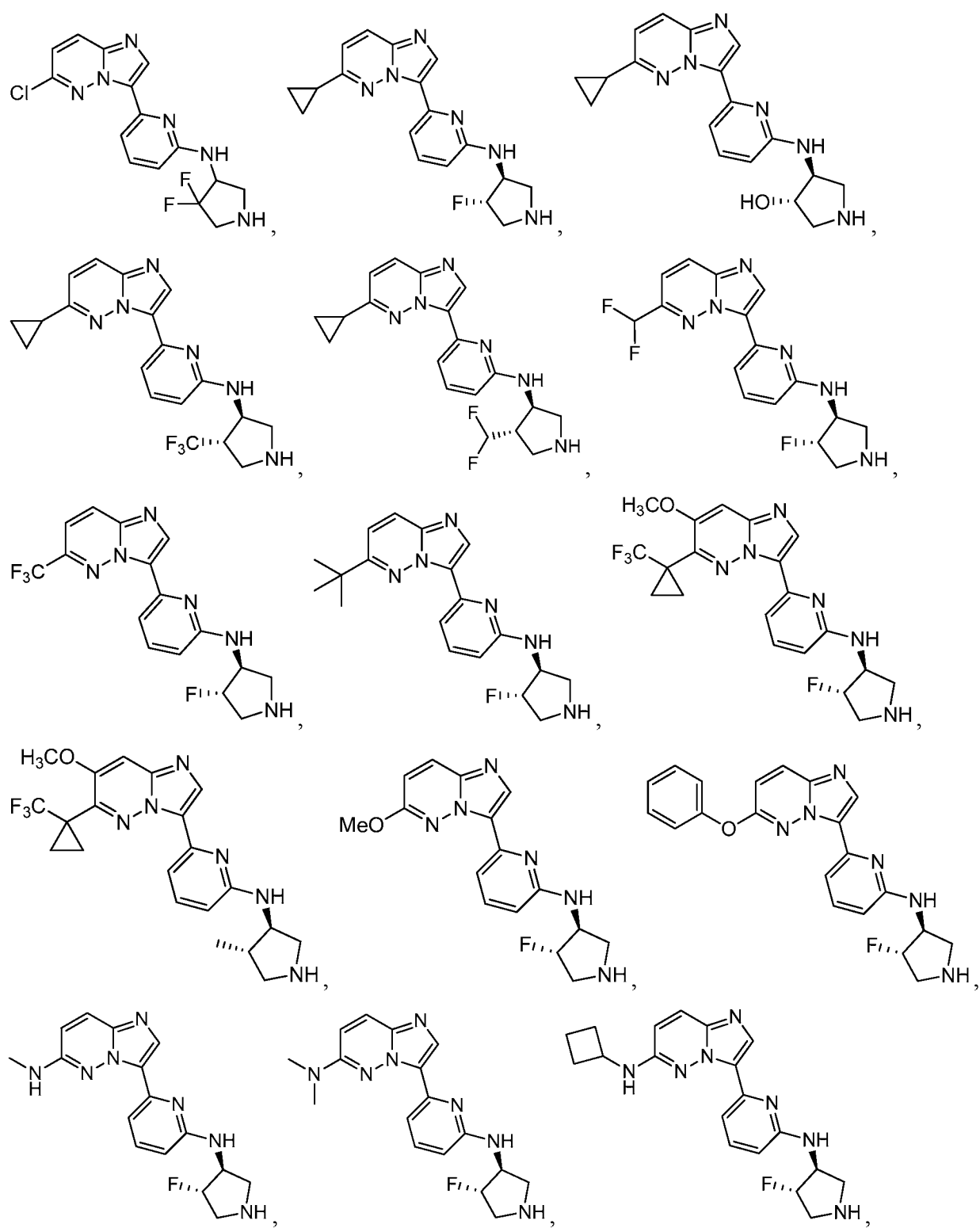
(ix) R_{26ga}, R_{26gb}, R_{27ga}, and R_{27gb} are each H and R_{25ga} and/or R_{25gb} are selected from F,

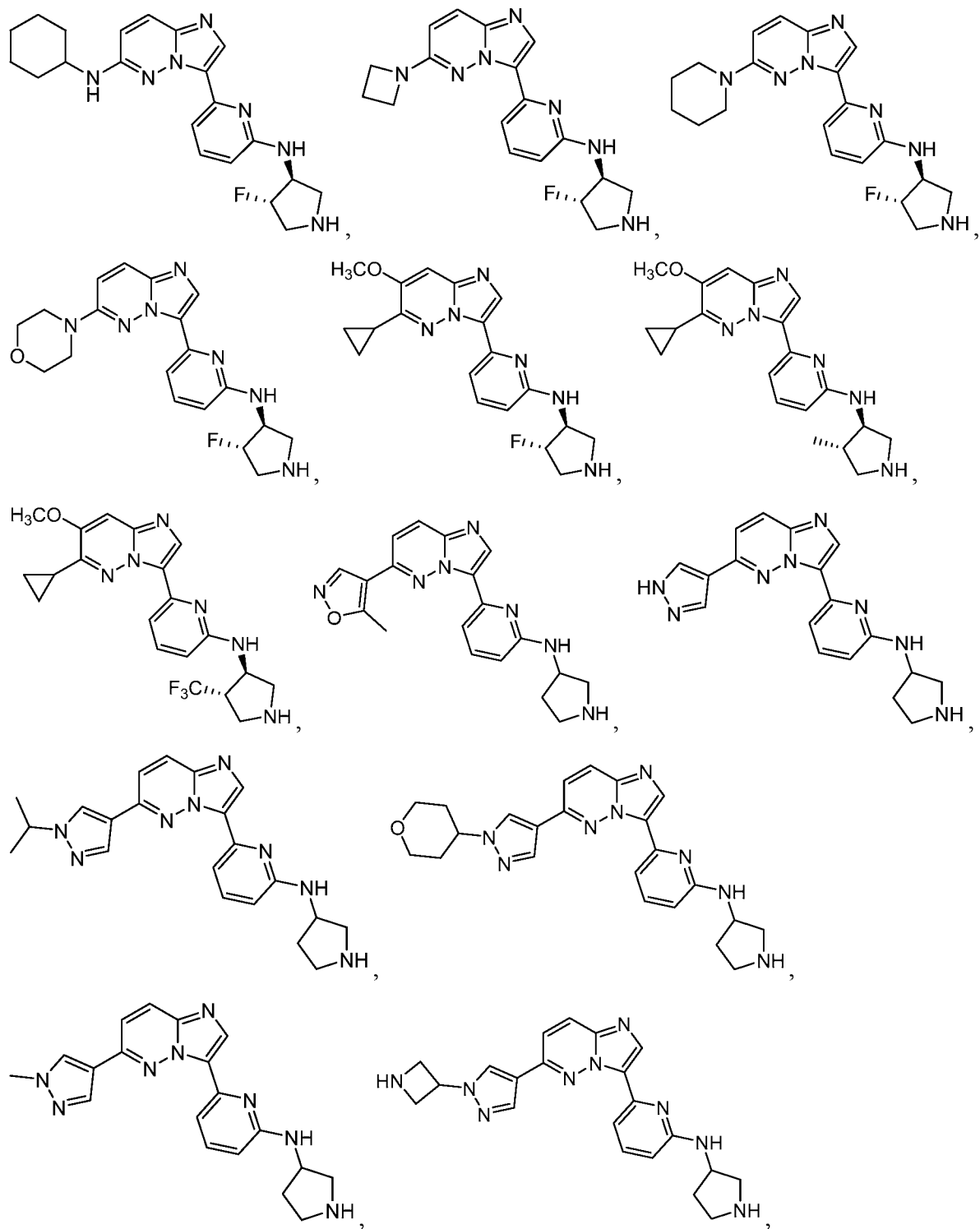


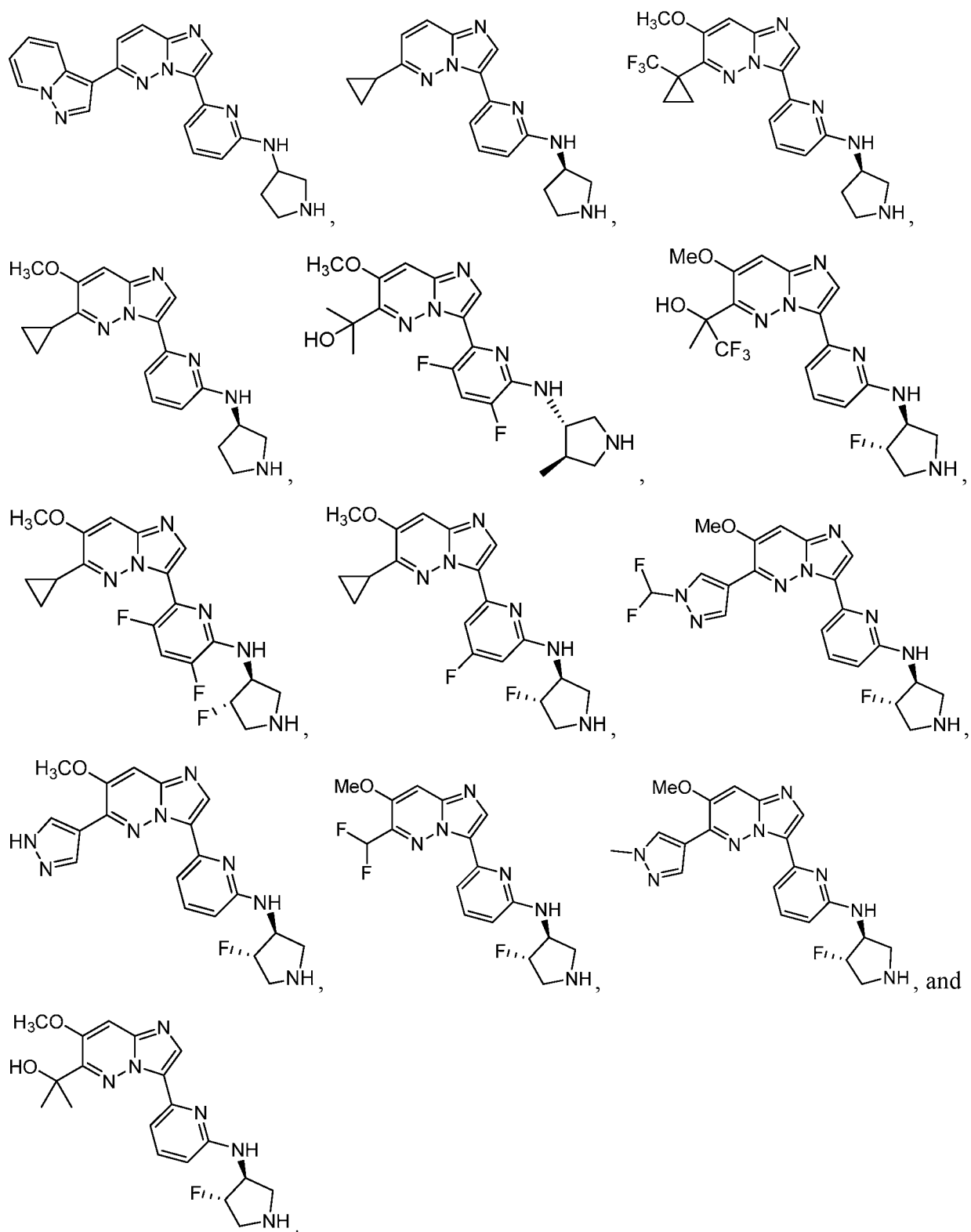
11. The compound of any one of claims 7-10, wherein the compound is selected from:



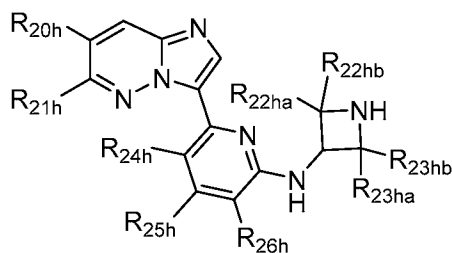








12. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (IIIh)



Formula (IIh),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:

R_{20h} is selected from H and C₁-C₆ alkoxy;

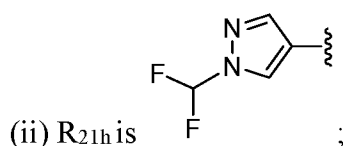
R_{21h} is selected from C₁-C₆ alkyl, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl is optionally substituted with one or more substituents selected from -OH and halogen and wherein C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl are each optionally substituted with one or more substituents selected from C₁-C₆ alkyl, -OH, and halogen;

R_{22ha}, R_{22hb}, R_{23ha}, and R_{23hb} are each independently selected from H and C₁-C₆ alkyl, wherein C₁-C₆ alkyl is optionally substituted with one or more halogen atoms; and

R_{24h}, R_{25h}, and R_{26h} are each independently selected from H and halogen.

13. The compound of claim 12, wherein at least one of (i)-(iv) applies:

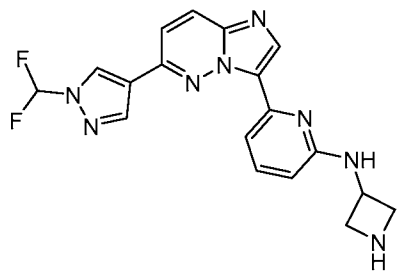
(i) R_{20h} is H ;



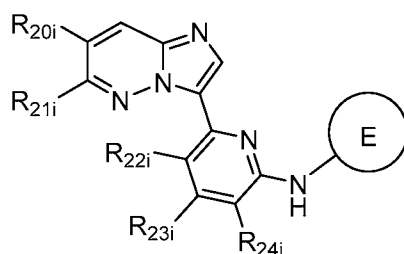
(iii) R_{22ha} , R_{22hb} , R_{23ha} , and R_{23hb} are each H;

(iii) R_{24h} , R_{25h} , and R_{26h} are each H.

14. The compound of claim 12 or 13, wherein the compound is

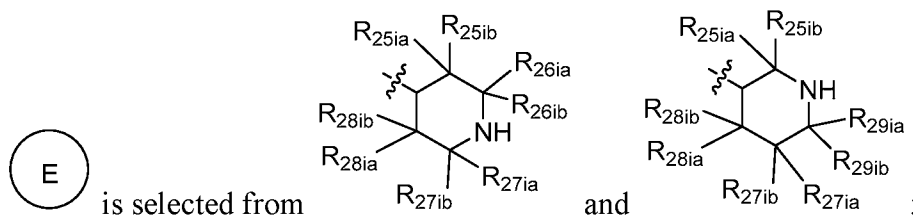


15. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (III)



Formula (III),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:



R_{20i} is selected from H, and C₁-C₆ alkoxy;

R_{21i} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and wherein C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, -OH, -C=O, and halogen;

R_{22i} , R_{23i} , and R_{24i} are each independently selected from H and halogen; and

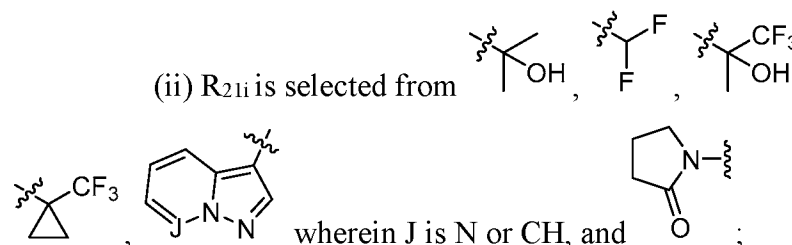
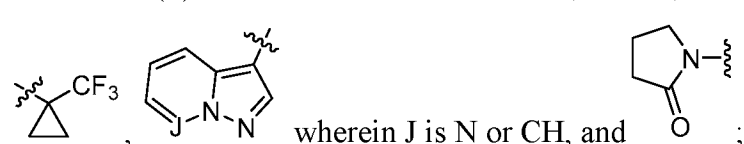
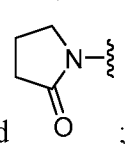
R_{25ia} , R_{25ib} , R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , R_{28ib} , R_{29ia} , and R_{29ib} are each independently selected from H, halogen, -OH, or C₁-C₆ alkyl.

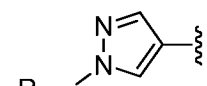
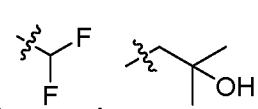
16. The compound of claim 15, wherein one or more of R_{25ia} , R_{25ib} , R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , R_{28ib} , R_{29ia} , and R_{29ib} is independently selected from halogen, -OH, and C_1 - C_6 alkyl.

17. The compound of claim 15, wherein each of R_{25ia} , R_{25ib} , R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , R_{28ib} , R_{29ia} , and R_{29ib} is H.

18. The compound of any one of claims 15-17, wherein at least one of (i)-(xi) applies:

(i) R_{20i} is selected from H and -OCH₃;

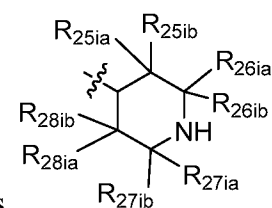
(ii) R_{21i} is selected from , unsubstituted C_3 cycloalkyl,  wherein J is N or CH, and  ;

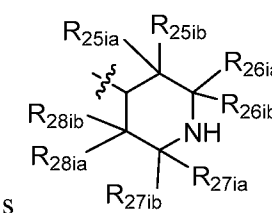
(iii) R_{21i} is  wherein R_{220i} is selected from H, -CH₃, , and unsubstituted C_3 cycloalkyl;

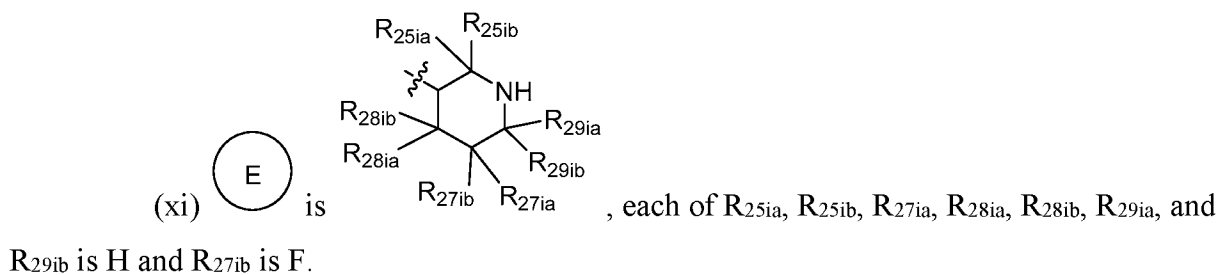
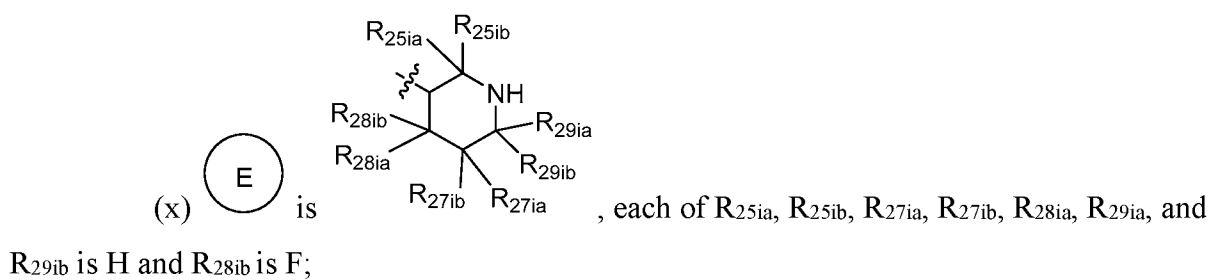
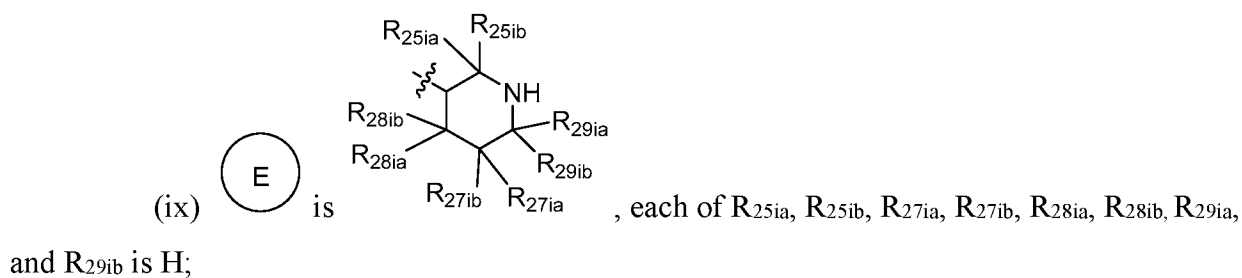
(iv) R_{22i} , R_{23i} , and R_{24i} are each H;

(v) R_{22i} and R_{24i} are each F and R_{23i} is H;

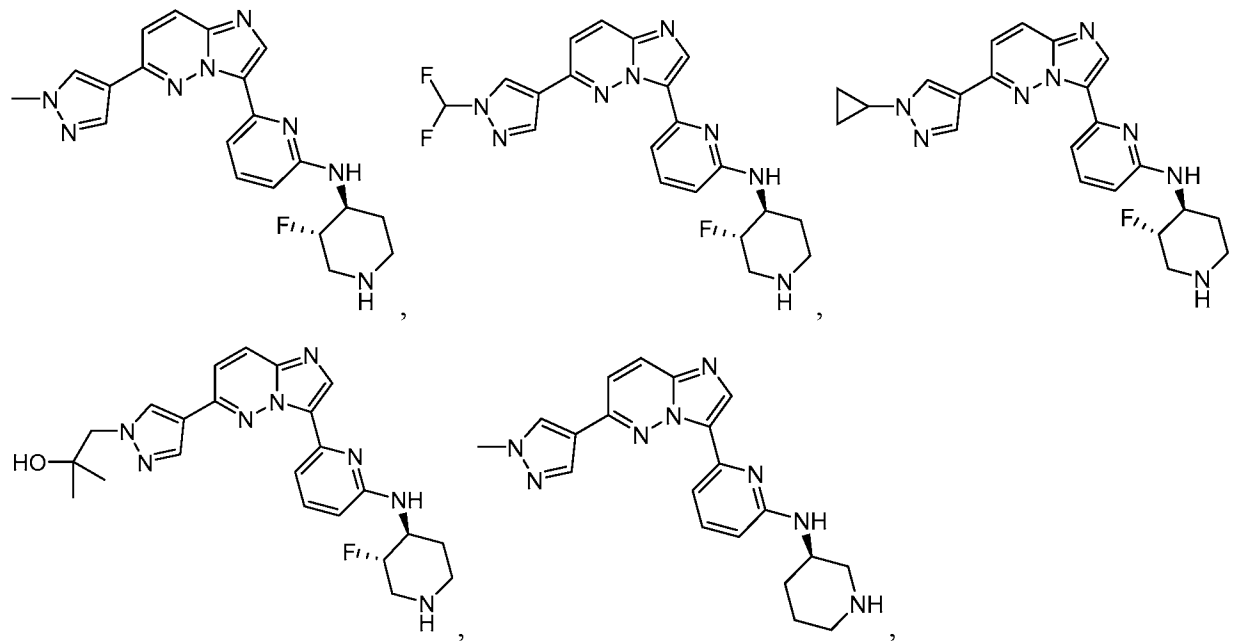
(vi) R_{22i} and R_{24i} are each H and R_{23i} is F;

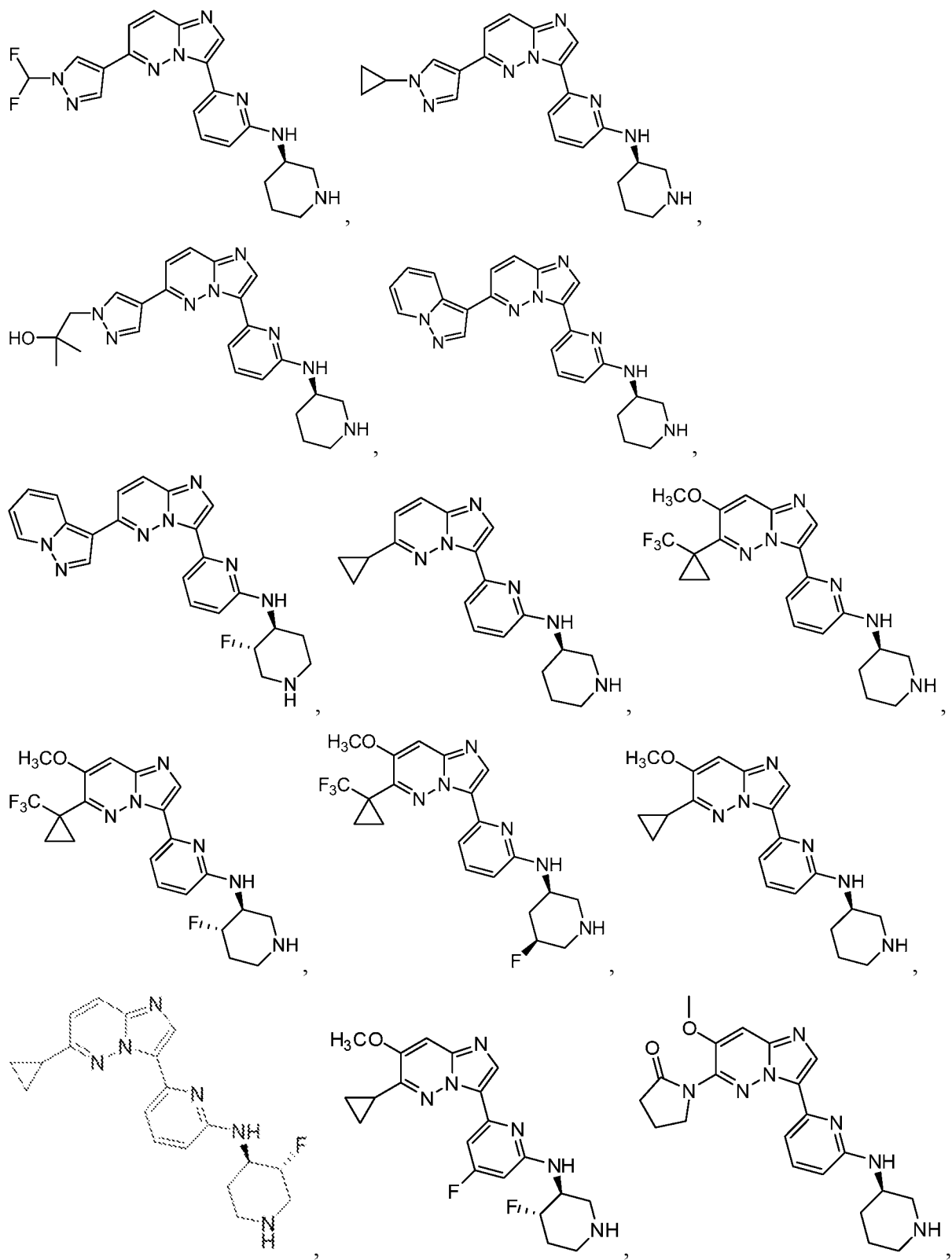
(vii)  is , each of R_{25ia} , R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , and R_{28ib} is H and R_{25ib} is F;

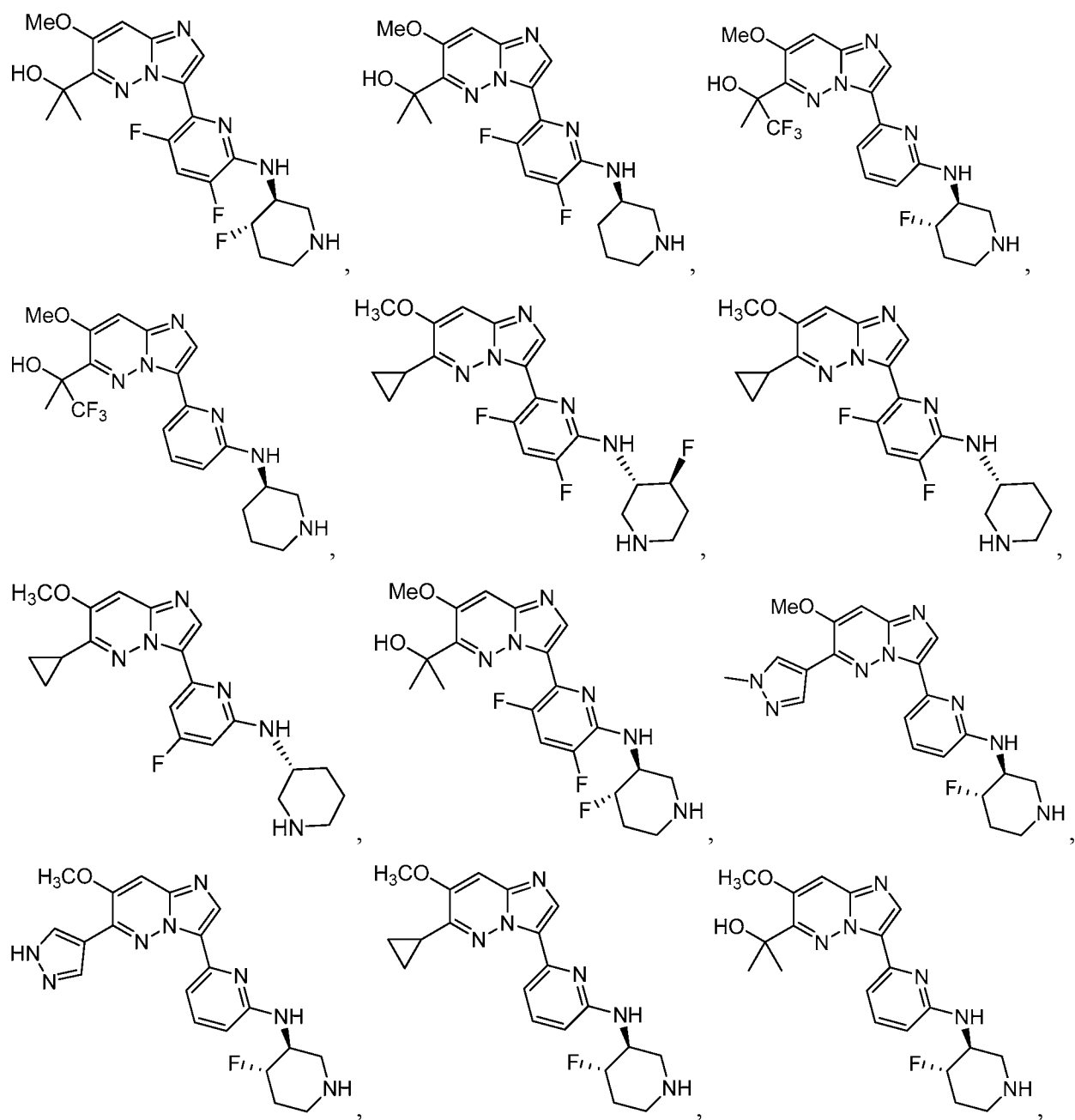
(viii)  is , each of R_{25ia} , R_{25ib} , R_{26ia} , R_{26ib} , R_{27ia} , R_{27ib} , R_{28ia} , and R_{28ib} is H;

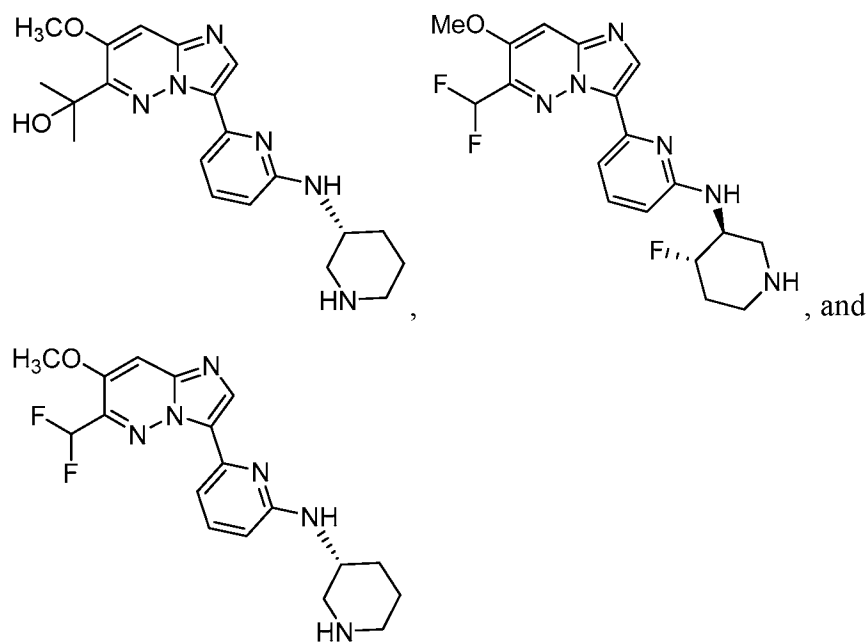


19. The compound of any one of claims 15-18, wherein the compound is selected from:

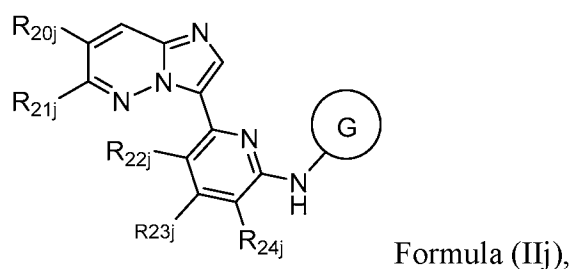




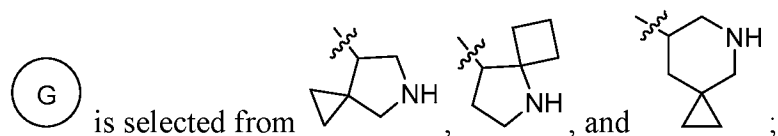




20. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (IIj)



or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:



R_{20j} is selected from H, and C₁-C₆ alkoxy;

R_{21j} is selected from H, C₁-C₆ alkyl, C₁-C₆ alkoxy, and C₃-C₆ cycloalkyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from halogen and -OH, and wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen; and

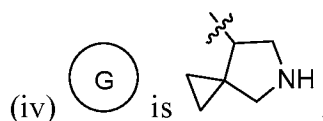
R_{22j} , R_{23j} , and R_{24j} are each independently selected from H and halogen.

21. The compound of claim 20, wherein at least one of (i)-(iv) applies:

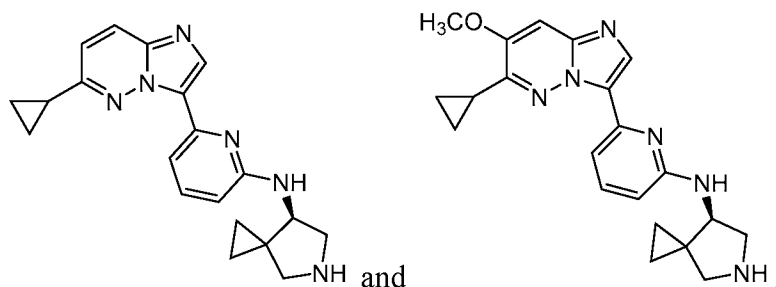
(i) R_{20j} is selected from H and $-OCH_3$;

(ii) R_{21j} is unsubstituted C_3 cycloalkyl;

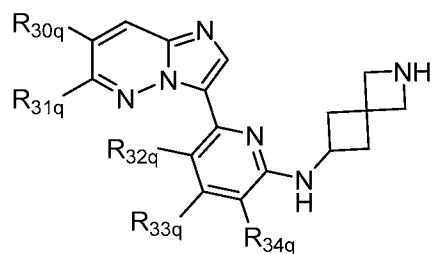
(iii) R_{22j} , R_{23j} , and R_{24j} are each H;



22. The compound of claim 20 or 21, wherein the compound is selected from:



23. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (IIIq)



Formula (IIIq),

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:

R_{30q} is selected from H and C_1 - C_6 alkoxy;

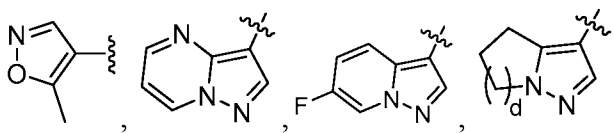
R_{31q} is selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_3 - C_6 cycloalkyl, and C_3 - C_9 heterocyclyl,
wherein C_1 - C_6 alkyl and C_1 - C_6 alkoxy are each optionally substituted with one or more
substituents selected from $-OH$ and halogen, wherein C_3 - C_6 cycloalkyl is optionally substituted
with one or more substituents selected from C_1 - C_6 alkyl and halogen, and wherein C_3 - C_9

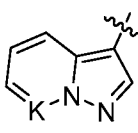
heterocycyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; and

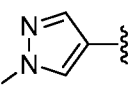
R_{32q}, R_{33q}, and R_{34q} are each independently selected from H and halogen.

24. The compound of claim 23, wherein at least one of (i)-(iv) applies:

(i) R_{30q} is H;

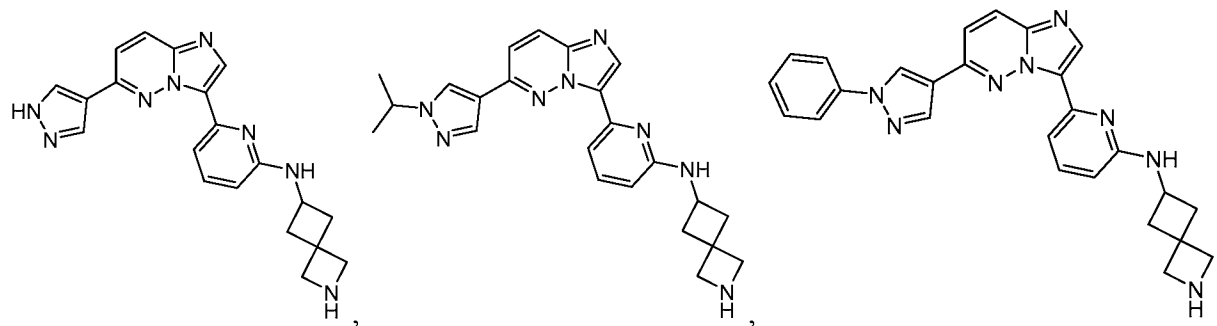
(ii) R_{31q} is selected from , wherein d is

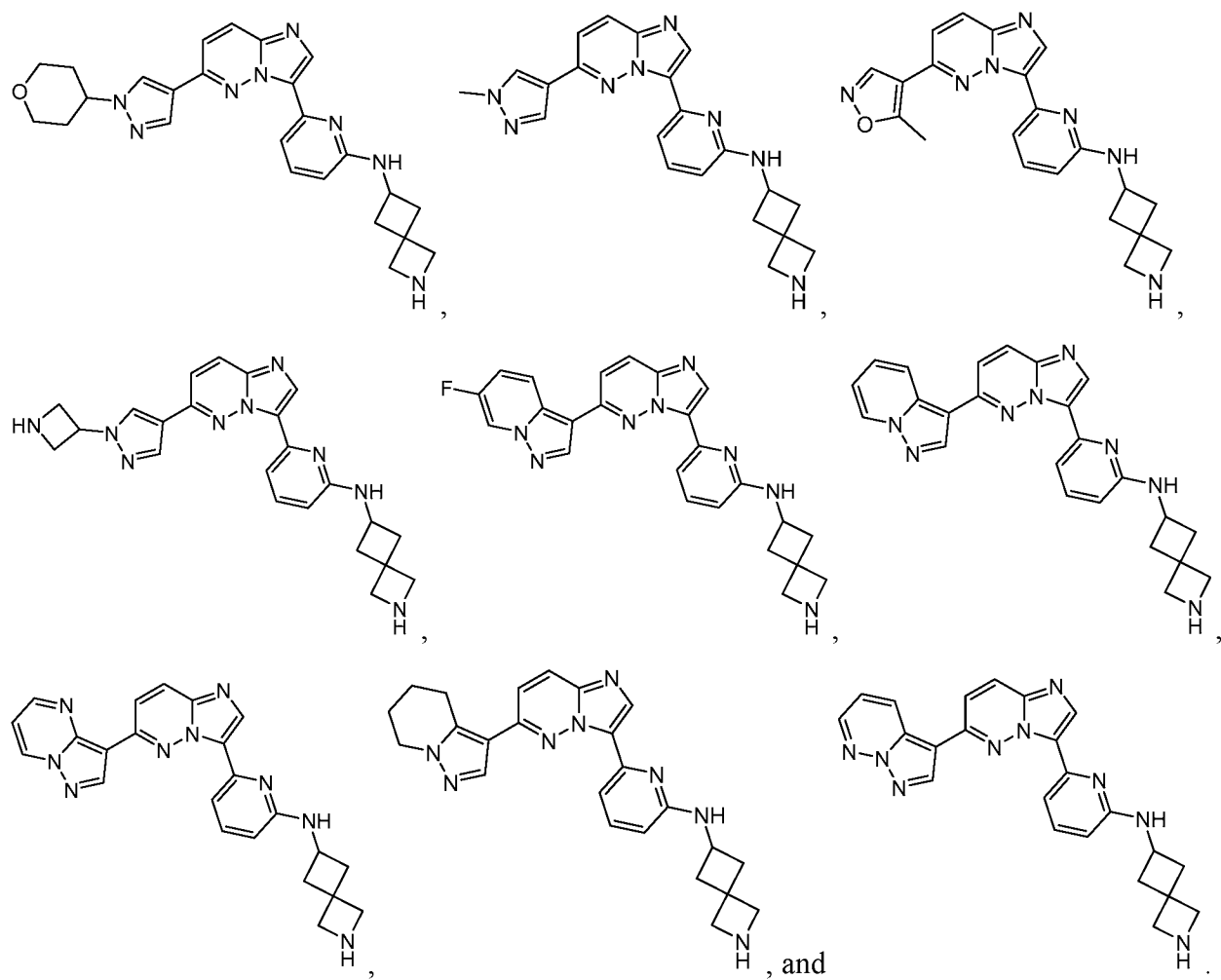
1 or 2, and  wherein K is N or CH;

(iii) R_{31q} is  wherein R_{35q} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyrany;

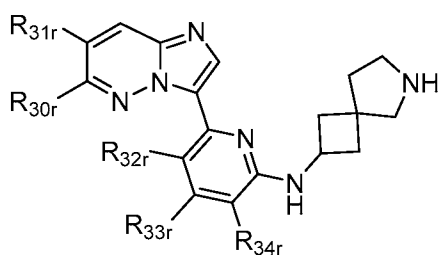
(iv) R_{32q}, R_{33q}, and R_{34q} are each H.

25. The compound of claim 23 or 24, wherein the compound is selected from:





26. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (IIIr)



Formula (IIIr),

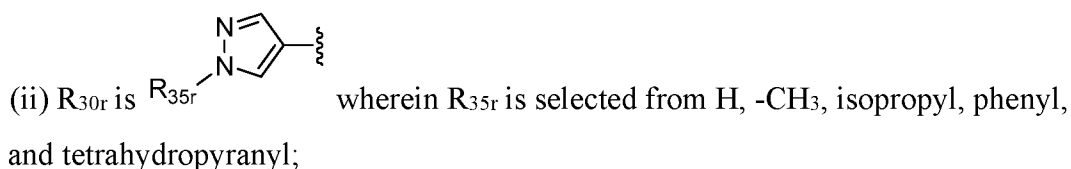
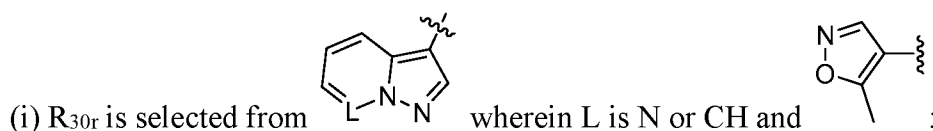
or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:

R_{30r} is selected from C_1 - C_6 alkyl, C_1 - C_6 alkoxy, C_3 - C_6 cycloalkyl, and C_3 - C_9 heterocyclyl, wherein C_1 - C_6 alkyl and C_1 - C_6 alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C_3 - C_6 cycloalkyl is optionally substituted with one or more substituents selected from C_1 - C_6 alkyl and halogen, and wherein C_3 - C_9 heterocyclyl is optionally substituted with one or more substituents selected from C_1 - C_6 alkyl, C_3 - C_6 -cycloalkyl, C_3 - C_9 -heterocyclyl, C_6 - C_{12} aryl, -OH, -C=O, and halogen;

R_{31r} is selected from H and C_1 - C_6 alkoxy; and

R_{32r} , R_{33r} , and R_{34r} are each independently selected from H and halogen.

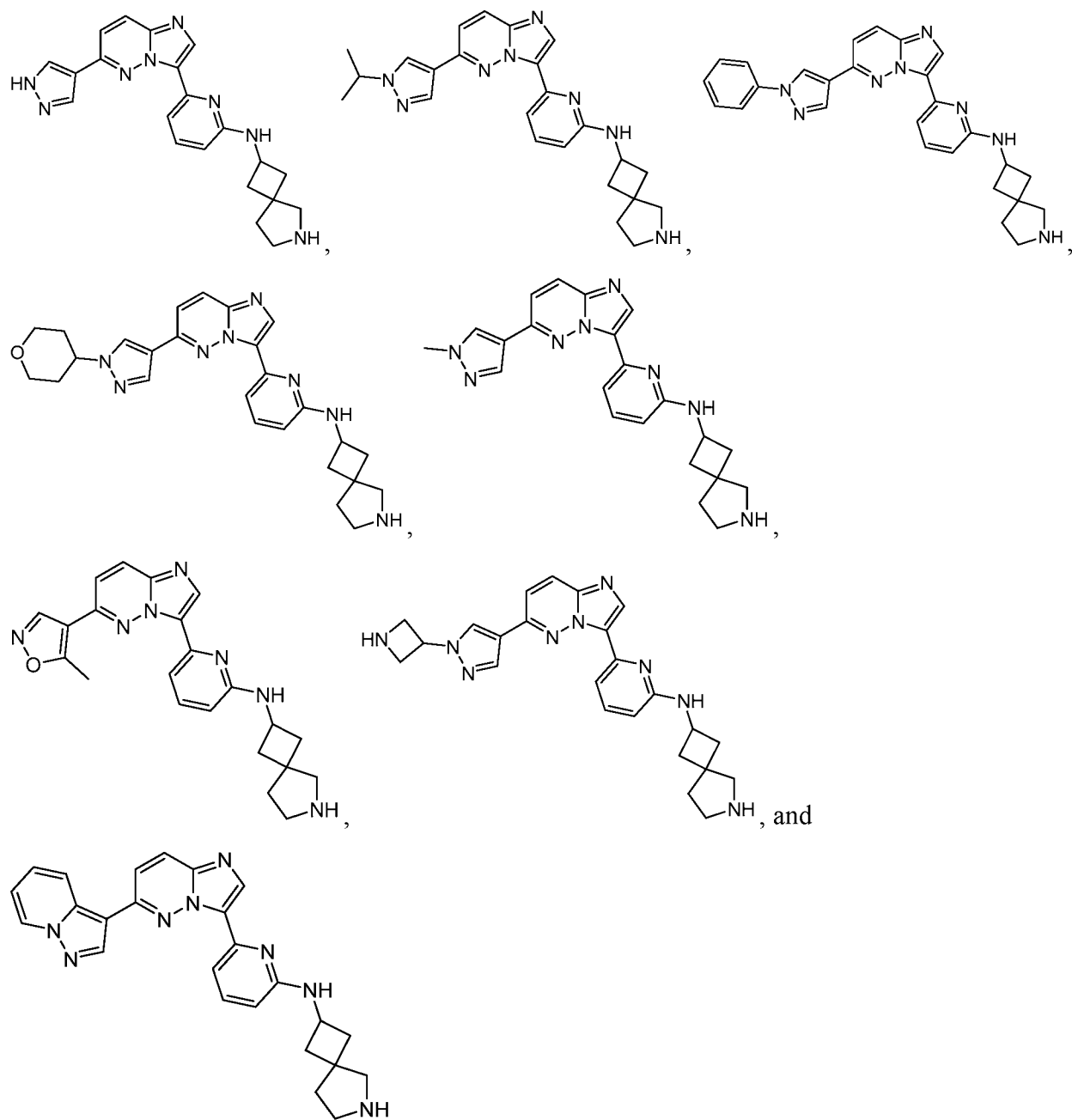
27. The compound of claim 26, wherein at least one of (i)-(iv) applies:



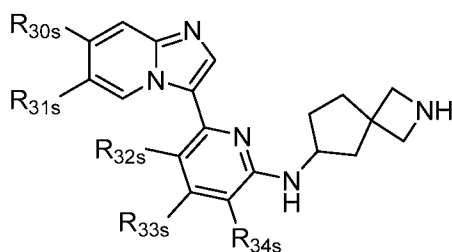
(iii) R_{31r} is H;

(iv) R_{32r} , R_{33r} , and R_{34r} are each H.

28. The compound of claim 26 or claim 27, wherein the compound is selected from:



29. The compound of claim 1, wherein the compound of Formula (I) is a compound of Formula (IIIs)



Formula (III)s,

or a salt, ester, solvate, optical isomer, geometric isomer, or salt of an isomer thereof;
wherein:

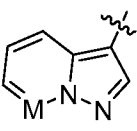
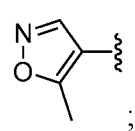
R_{30s} is selected from H and C₁-C₆ alkoxy;

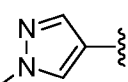
R_{31s} is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₆ cycloalkyl, and C₃-C₉ heterocyclyl, wherein C₁-C₆ alkyl and C₁-C₆ alkoxy are each optionally substituted with one or more substituents selected from -OH and halogen, wherein C₃-C₆ cycloalkyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl and halogen, and wherein C₃-C₉ heterocyclyl is optionally substituted with one or more substituents selected from C₁-C₆ alkyl, C₃-C₆-cycloalkyl, C₃-C₉-heterocyclyl, C₆-C₁₂ aryl, -OH, -C=O, and halogen; and

R_{32s} , R_{33s} , and R_{34s} are each independently selected from H and halogen.

30. The compound of claim 29, wherein at least one of (i)-(iv) applies:

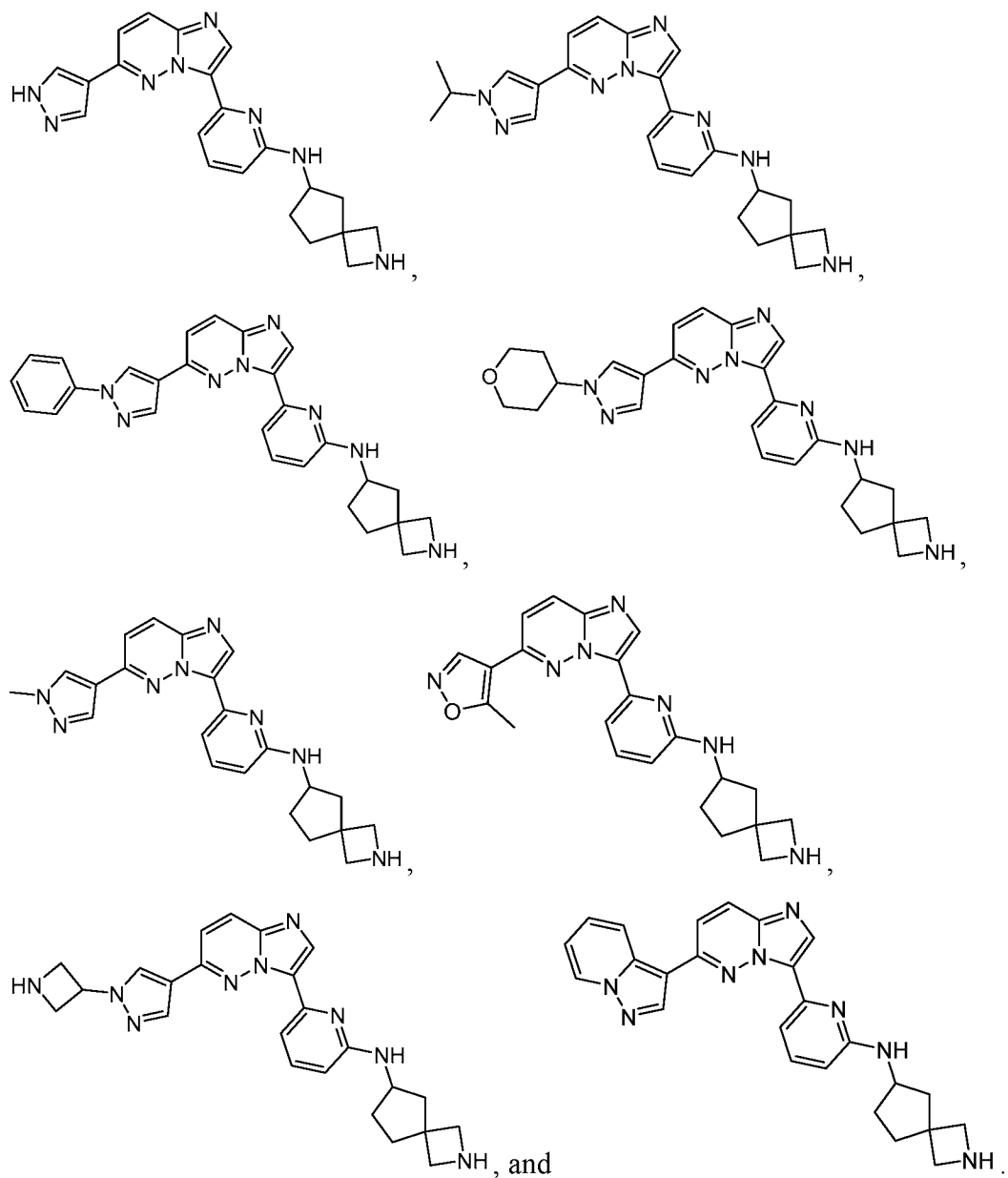
(i) R_{30s} is H;

(ii) R_{31s} is selected from  wherein M is N or CH and  ;

(iii) R_{31s} is  wherein R_{35s} is selected from H, -CH₃, isopropyl, phenyl, azetidiny, and tetrahydropyrany;

(iv) R_{32s} , R_{33s} , and R_{34s} are each H.

31. The compound of claim 29 or 30, wherein the compound is selected from:



32. The compound of any one of claims 1-31, wherein the compound is an inhibitor of at least one of IRAK1, IRAK4, and FLT3.

33. The compound of any one of claims 1-32, wherein the compound is an inhibitor of at least two of IRAK1, IRAK4, and FLT3.

34. The compound of any one of claims 1-33, wherein the compound is an inhibitor of IRAK1 and IRAK4.

35. The compound of any one of claims 1-34, wherein the compound is an inhibitor of IRAK1, IRAK4, and FLT3.

36. The compound of any one of claims 32, 33, or 35, wherein FLT3 is selected from WT FLT3, activated FLT3, and mutated FLT3.

37. The compound of claim 36, wherein the mutated FLT3 is D835Y mutated FLT3 or F691L mutated FLT3.

38. A composition comprising a compound of any one of claims 1-37, wherein the composition further comprises a formulary ingredient, an adjuvant, or a carrier.

39. The composition of claim 38, wherein the composition is used in combination with one or more of: a chemotherapy agent, a BCL2 inhibitor, an immune modulator, a BTK inhibitor, a DNA methyltransferase inhibitor/hypomethylating agent, an anthracycline, a histone deacetylase (HDAC) inhibitor, a purine nucleoside analogue (antimetabolite), an isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, an antibody-drug conjugate, an mAbs/immunotherapy, a Plk inhibitor, a MEK inhibitor, a CDK inhibitor, a CDK9 inhibitor, a CDK8 inhibitor, a retinoic acid receptor agonist, a TP53 activator, a CELMoD, a smoothened receptor antagonist, an ERK inhibitor including an ERK2/MAPK1 or ERK1/MAPK3 inhibitor, a PI3K inhibitor, an mTOR inhibitor, a steroid or glucocorticoid receptor modulator, an EZH2 inhibitor, a hedgehog (Hh) inhibitor, a Topoisomerase I inhibitor, a Topoisomerase II inhibitor, an aminopeptidase/Leukotriene A4 hydrolase inhibitor, a FLT3/Axl/ALK inhibitor, a FLT3/KIT/PDGFR, PKC, and/or KDR inhibitor, a Syk inhibitor, an E-selectin inhibitor, an NEDD8-activator, an MDM2 inhibitor, a PLK1 inhibitor, an Aurora A inhibitor, an aurora kinase inhibitor, an EGFR inhibitor, an AuroraB/C/VEGFR1/2/3/FLT3/CSF-1R/Kit/PDGFR/AB inhibitor, an AKT 1, 2, and/or 3 inhibitor, a ABL1/2/SRC/EPHA2/LCK/YES1/KIT/PDGFRB/FYN inhibitor, a farnesyltransferase inhibitor,

a BRAF/MAP2K1/MAP2K2 inhibitor, a Menin-KMT2A/MLL inhibitor, and a multikinase inhibitor.

40. The composition of claim 39, wherein the composition is used in combination with a BCL2 inhibitor.

41. The composition of claim 40, wherein the BCL2 inhibitor is venetoclax or a pharmaceutically acceptable salt thereof.

42. A method of treating a disease or disorder in a subject, the method comprising administering to the subject a therapeutically effective amount of a compound of any one of claims 1-37 or a composition of any one of claims 38-41.

43. The method of claim 42, wherein the method comprises administering to the subject a composition comprising the therapeutically effective amount of the compound of claim 1 and a formulary ingredient, an adjuvant, or a carrier.

44. The method of claim 42 or 43, wherein the disease or disorder is responsive to at least one of interleukin-1 receptor-associated kinase (IRAK) inhibition and fms-like tyrosine kinase 3 (FLT3) inhibition.

45. The method of any one of claims 42-44, wherein the administration comprises parenteral administration, a mucosal administration, intravenous administration, subcutaneous administration, topical administration, intradermal administration, oral administration, sublingual administration, intranasal administration, or intramuscular administration.

46. The method of any one of claims 42-45, wherein the compound is administered to the subject in an amount of from about 0.005 mg/kg subject body weight to about 1,000 mg/kg subject body weight.

47. The method of any one of claims 42-46, wherein the disease or disorder comprises a hematopoietic cancer.

48. The method of any one of claims 42-46, wherein the disease or disorder comprises myelodysplastic syndrome (MDS) and/or acute myeloid leukemia (AML).

49. The method of any one of claims 42-46, wherein the disease or disorder comprises lymphoma, leukemia, chronic lymphocytic leukemia (CLL), chronic myeloid leukemia (CML), acute lymphoblastic leukemia (ALL), bone marrow cancer, non-Hodgkin lymphoma, Waldenstrom's macroglobulinemia, B cell lymphoma, diffuse large B-cell lymphoma (DLBCL), DLBCL with MYD88 mutation, follicular lymphoma, or marginal zone lymphoma.

50. The method of any one of claims 42-46, wherein the disease or disorder comprises at least one cancer selected from glioblastoma multiforme, endometrial cancer, melanoma, prostate cancer, lung cancer, breast cancer, kidney cancer, bladder cancer, basal cell carcinoma, thyroid cancer, squamous cell carcinoma, neuroblastoma, ovarian cancer, renal cell carcinoma, hepatocellular carcinoma, colon cancer, pancreatic cancer, rhabdomyosarcoma, meningioma, gastric cancer, Glioma, oral cancer, nasopharyngeal carcinoma, rectal cancer, stomach cancer, and uterine cancer, or one or more inflammatory diseases or autoimmune disease characterized by overactive IRAK1 and/or IRAK4, or combinations thereof.

51. The method of any one of claims 42-46, wherein the disease or disorder comprises one or more inflammatory diseases or autoimmune disease selected from chronic inflammation, sepsis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, multiple sclerosis, psoriasis, Sjögren's syndrome, Ankylosing spondylitis, systemic sclerosis, Type 1 diabetes mellitus, or combinations thereof.

52. The method of any one of claims 42-46, wherein the disease or disorder comprises:
(i) MDS, MDS with a splicing factor mutation, MDS with a mutation in isocitrate dehydrogenase 1, MDS with a mutation in isocitrate dehydrogenase 2; or

(ii) AML with a splicing factor mutation, AML having enhanced IRAK4-Long expression and/or activity relative to IRAK4-Short, and/or wherein the AML is not driven by FLT3 mutations but expresses IRAK4-Long.

53. The method of claim 52, wherein the MDS with a splicing factor mutation comprises MDS with a splicing factor mutation in U2AF1 or SF3B1 and the AML splicing factor mutation comprises AML with a splicing factor mutation in U2AF1 or SF3B1.

54. The method of any one of claims 42-46, wherein the disease or disorder comprises DLBCL, and wherein the DLBCL comprises a L265P MYD88 mutant (ABC) subtype of DLBCL or a S219C MYD88 mutant (GCB) subtype of DLBCL.

55. The method of any one of claims 42-54, further comprising administering to the subject one or more additional therapies selected from: a chemotherapy agent, a BCL2 inhibitor, an immune modulator, a BTK inhibitor, a DNA methyltransferase inhibitor/hypomethylating agent, an anthracycline, a histone deacetylase (HDAC) inhibitor, a purine nucleoside analogue (antimetabolite), an isocitrate dehydrogenase 1 or 2 (IDH1 and/or IDH2) inhibitor, an antibody-drug conjugate, an mAbs/immunotherapy, a Plk inhibitor, a MEK inhibitor, a CDK inhibitor, a CDK9 inhibitor, a CDK8 inhibitor, a retinoic acid receptor agonist, a TP53 activator, a CELMoD, a smoothened receptor antagonist, an ERK inhibitor including an ERK2/MAPK1 or ERK1/MAPK3 inhibitor, a PI3K inhibitor, an mTOR inhibitor, a steroid or glucocorticoid receptor modulator, an EZH2 inhibitor, a hedgehog (Hh) inhibitor, a Topoisomerase I inhibitor, a Topoisomerase II inhibitor, an aminopeptidase/Leukotriene A4 hydrolase inhibitor, a FLT3/Axl/ALK inhibitor, a FLT3/KIT/PDGFR, PKC, and/or KDR inhibitor, a Syk inhibitor, an E-selectin inhibitor, an NEDD8-activator, an MDM2 inhibitor, a PLK1 inhibitor, an Aurora A inhibitor, an aurora kinase inhibitor, an EGFR inhibitor, an AuroraB/C/VEGFR1/2/3/FLT3/CSF-1R/Kit/PDGFR/AB inhibitor, an AKT 1, 2, and/or 3 inhibitor, a ABL1/2/SRC/EPHA2/LCK/YES1/KIT/PDGFRB/FYN inhibitor, a farnesyltransferase inhibitor, a BRAF/MAP2K1/MAP2K2 inhibitor, a Menin-KMT2A/MLL inhibitor, and a multikinase inhibitor.

56. The method of claim 55, wherein the additional therapy is a BCL2 inhibitor.
57. The method of claim 56, wherein the BCL2 inhibitor is venetoclax or a pharmaceutically acceptable salt thereof.
58. The method of any one of claims 42-57, wherein the disease or disorder is a BCL2 inhibitor resistant disease or disorder.
59. The method of any one of claims 42-57, wherein the disease or disorder is a venetoclax resistant disease or disorder.
60. The method of any one of claims 42-57, wherein the disease or disorder is a FLT3 inhibitor resistant disease or disorder.
61. The method of any one of claims 42-57, wherein the disease or disorder is BCL2 inhibitor resistant acute myeloid leukemia (AML).
62. The method of any one of claims 42-57, wherein the disease or disorder is venetoclax resistant acute myeloid leukemia (AML).
63. The method of any one of claims 42-57, wherein the disease or disorder is FLT3 inhibitor resistant acute myeloid leukemia (AML).
64. The method of any one of claims 42-57, wherein the disease or disorder is BCL2 inhibitor resistant refractory acute myeloid leukemia (AML).
65. The method of any one of claims 42-57, wherein the disease or disorder is venetoclax resistant refractory acute myeloid leukemia (AML).
66. The method of any one of claims 42-57, wherein the disease or disorder is FLT3 inhibitor resistant refractory acute myeloid leukemia (AML).

67. The method of any one of claims 42-57, wherein the disease or disorder is BCL2 inhibitor resistant relapsed acute myeloid leukemia (AML).
68. The method of any one of claims 42-57, wherein the disease or disorder is venetoclax resistant relapsed acute myeloid leukemia (AML).
69. The method of any one of claims 42-57, wherein the disease or disorder is FLT3 inhibitor resistant relapsed acute myeloid leukemia (AML).
70. The method of claim 55, wherein the compound of any one of claims 1-37 or the composition of any one of claims 38-41 and the one or more additional therapies are administered together in one administration or composition.
71. The method of claim 55, wherein the compound of any one of claims 1-37 or the composition any one of claims 38-41 and the one or more additional therapies are administered separately in more than one administration or more than one composition.
72. The method of any one of claims 42-71, wherein the disease or disorder is alleviated by inhibiting at least one of IRAK1, IRAK4, and FLT3 in the subject.
73. The method of any one of claims 42-72, wherein the disease or disorder is alleviated by inhibiting at least two of IRAK1, IRAK4, and FLT3 in the subject.
74. The method of any one of claims 42-73, wherein the disease or disorder is alleviated by inhibiting IRAK1 and IRAK4 in the subject.
75. The method of any one of claims 42-73, wherein the disease or disorder is alleviated by inhibiting IRAK1, IRAK4, and FLT3 in the subject.

76. The method of any one of claims 72, 73, or 75, wherein FLT3 is selected from WT FLT3, activated FLT3, and mutated FLT3.

77. The method of claim 76, wherein the mutated FLT3 is D835Y mutated FLT3 or F691L mutated FLT3.

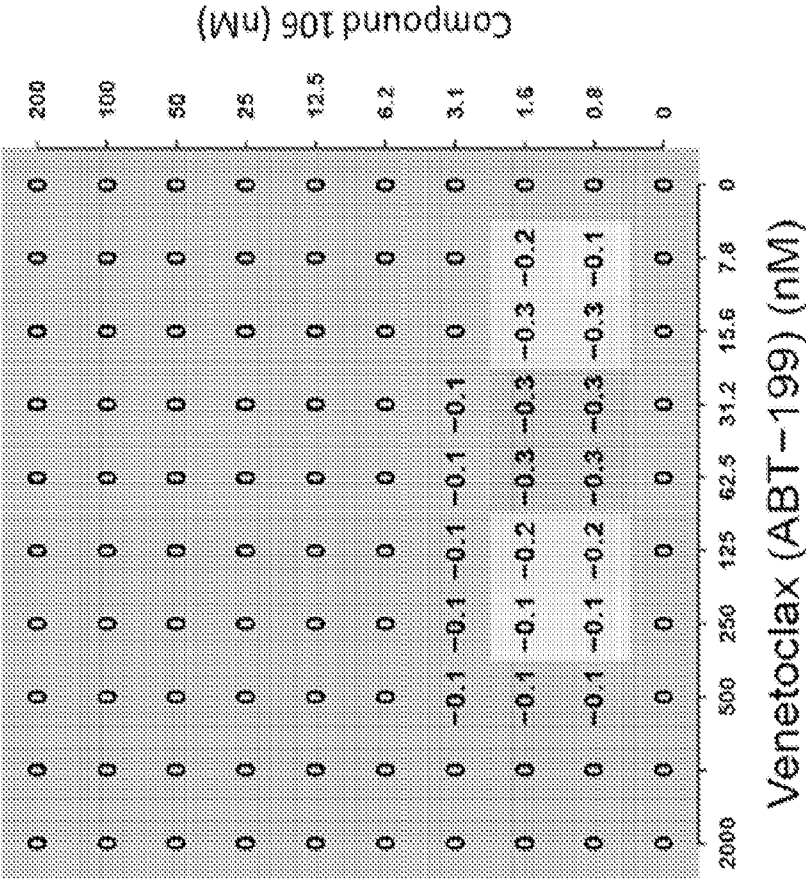


FIG. 1B

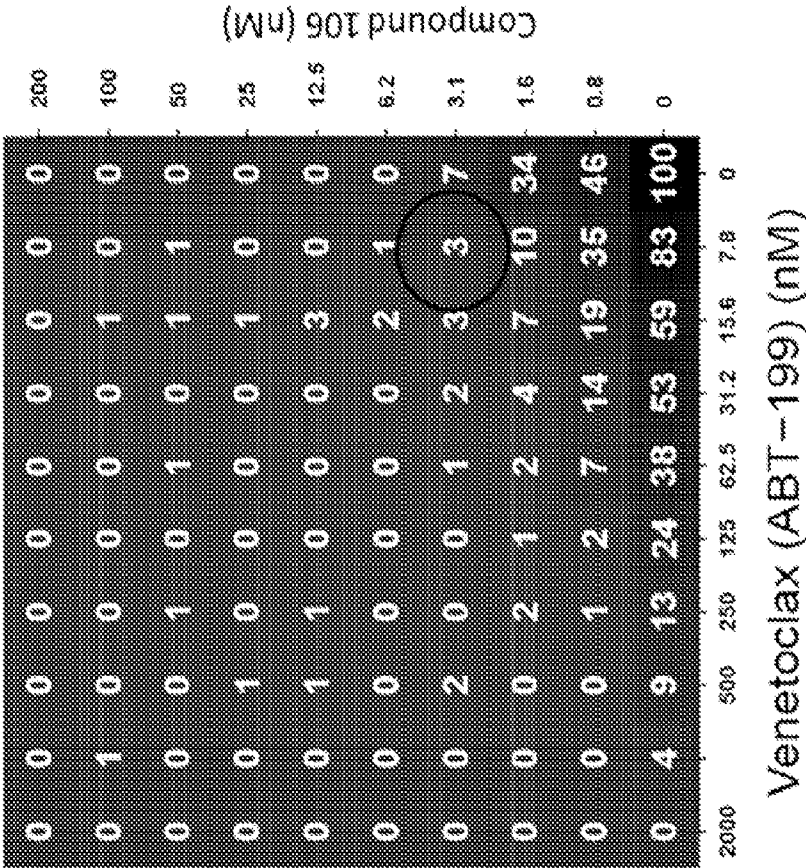


FIG. 1A

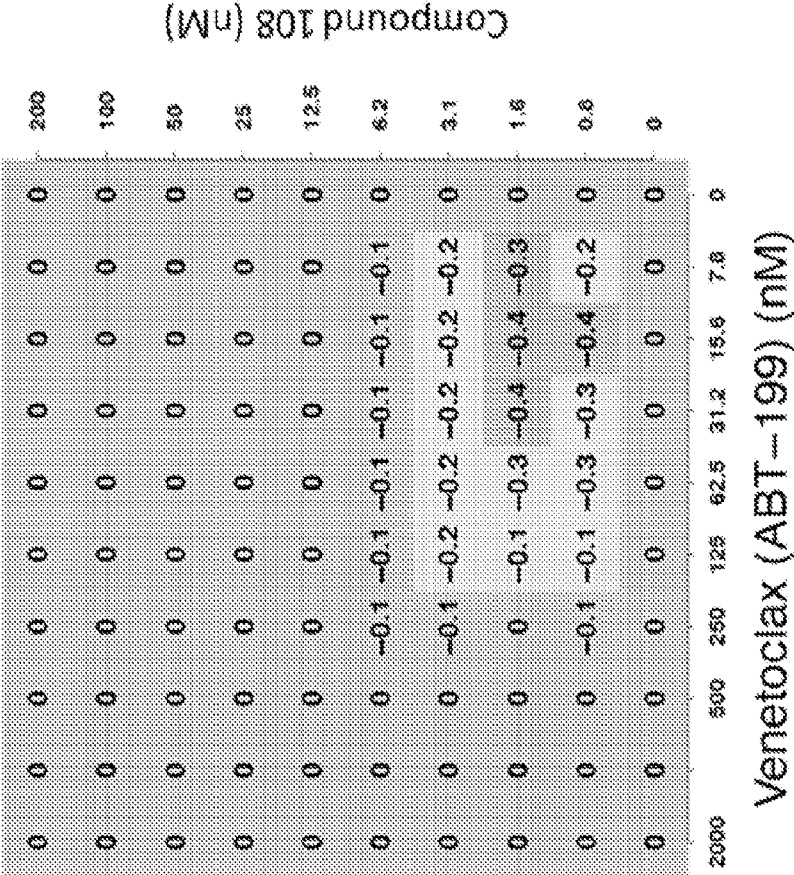


FIG. 2B

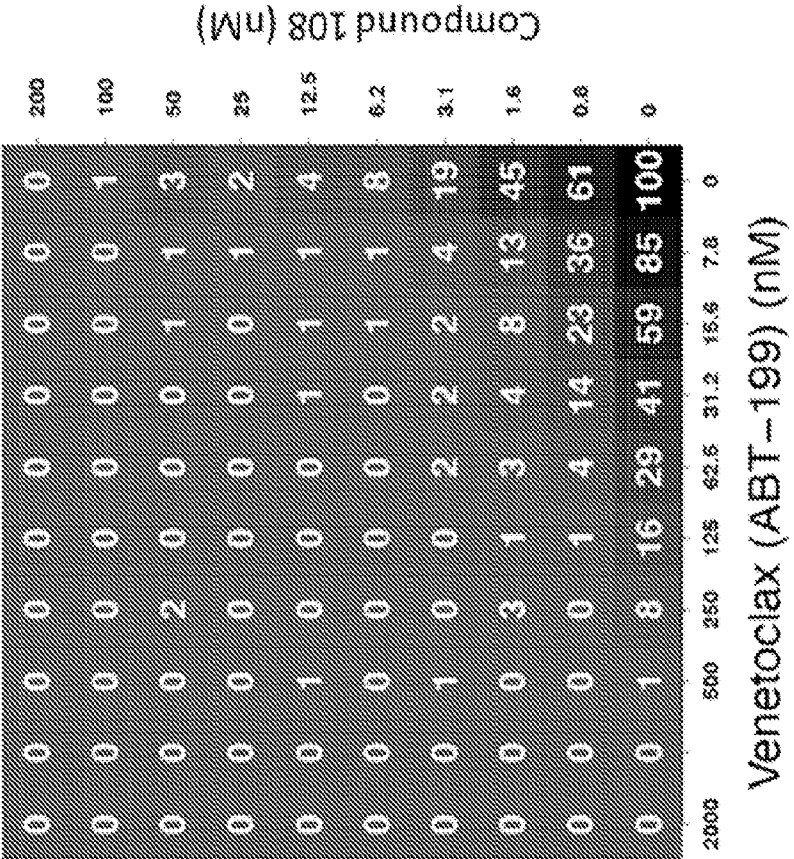


FIG. 2A

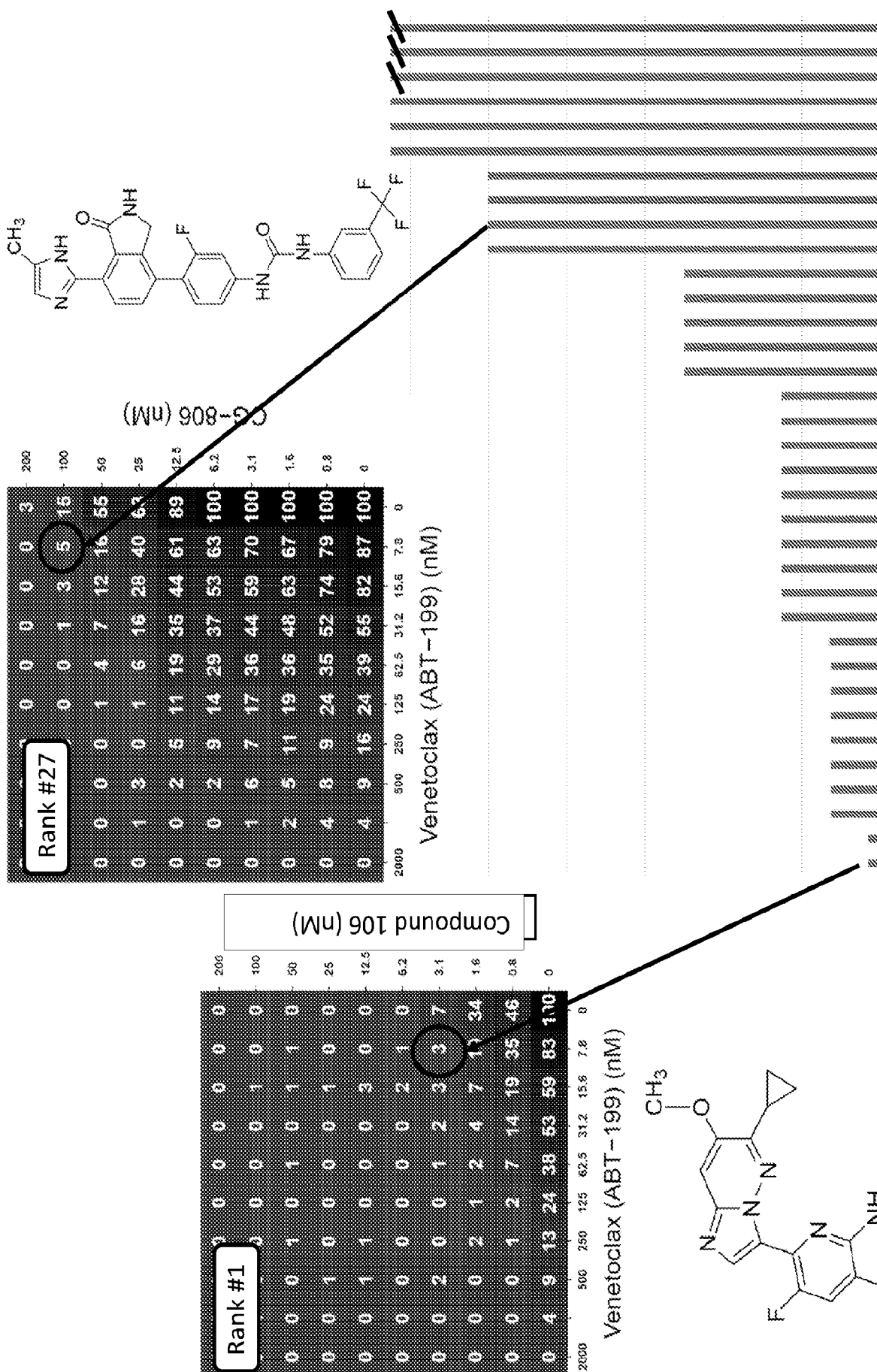


FIG. 3A



WO 2022/132936

INTERNATIONAL SEARCH REPORT

PCT/US2021/063567

International application No.

PCT/US 21/63567

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

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

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

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

3. ☒ Claims Nos.: 5-6, 10-11, 19 and 32-77
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

This International Searching Authority found multiple inventions in this international application, as follows:
 --Please see attached sheet--

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1, 2 and 4

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 21/63567

A. CLASSIFICATION OF SUBJECT MATTER

IPC - A61K 31/5025; C07D 487/04; C07D 401/04; C07D 401/14; A61P 35/00 (2022.01)

CPC - A61K 31/5025; C07D 487/04; C07D 401/04; C07D 401/14; A61P 35/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

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

See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2011/123751 A2 (AMGEN, INC.) 06 October 2011 (06.10.2011) abstract; pg 199, ln 2-4	1, 2, 4
A	US 2013/0210825 A1 (REHWINKEL et al.) 15 August 2013 (15.08.2013) para [0010], [0632], Example 3; para [0694], Table	1, 2, 4
A	US 2018/0250297 A1 (LAU) 06 September 2018 (06.09.2018) para [0002], pg 86, Table 3	1, 2, 4
A	US 2011/0166133 A1 (ALBAUGH et al.) 07 July 2011 (07.07.2011) para [0008]-[0011], [0020], [0025], [0028], [0039]; pg 59, Table 2, compound 10	1, 2, 4

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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

"D" document cited by the applicant in the international application

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

07 February 2022

Date of mailing of the international search report

APR 18 2022

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Authorized officer

Kari Rodriguez

Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 21/63567

Attachment to Box.No.III:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I+: Claims 1-4, 7-9, 12-18 and 20-31, directed to a compound of Formula I, further represented by Formula (Ilf), (Ilg), (Ilh), (Ili), (Ilj), (Ilq), (Ilr), or (Ils), and selected from the compounds specified in claim 28 and 31.

The compound will be searched to the extent that the compound encompasses the first species of claim 1, represented by Formula I, wherein

R1, R2, R3, R4 and R5 are each H;

R6 is the moiety of Formula (Ia), wherein R7-R14 are each H and m, n, o and p are independently selected from 0 or 1, such that the compound has the structure of Formula (Ilf) (see claim 2).

It is believed that claims 1, 2 and 4 read on this first named invention, and thus these claims will be searched without fee to the extent that they encompass the first species of claim 1, described above.

Applicant is invited to elect additional compound(s) wherein each additional compound elected will require one additional invention fee.

Applicants must specify the claims that encompass any additionally elected compound. Applicants must further indicate, if applicable, the claims which encompass the first named invention, if different than what was indicated above for this group. Failure to clearly identify how any paid additional invention fees are to be applied to the '+' group(s) will result in only the first claimed invention to be searched.

Additionally, an exemplary election wherein different actual variables are selected is suggested. An exemplary election would be the first -listed compound of claim 28, represented by formula I, wherein

R1 is heteroaryl, which is unsubstituted; R2, R3, R4 and R5 are each H;

R6 is the moiety of Formula (Ib), wherein R15-R30 are each H and q, r, s, t, u, v, w, and x are each independently selected from 0 or 1, such that the compound is further represented by Formula (Ilr) (see claim 26) (i.e., claims 1 and 26-28).

The group of inventions listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features:

Group I+ includes the technical feature of a unique compound, which is not required by any other invention of Group I+.

Common technical features:

The inventions of Group I+ share the technical features of a compound represented by Formula I.

This shared technical feature, however, does not provide a contribution over the prior art, as being obvious over US 2011/0166133 A1 to Albaugh et al. (hereinafter Albaugh), which discloses a kinase inhibitor compound (para [0007], [0562], Table 8) analogous in structure to Formula (I), wherein an N-heterocycle replaces the NHR6 attached to the pyridine ring of Formula (I), wherein

R1, R3, R4 and R5 are each H; and

R2 is heterocyclyl, substituted with aryl (pg 59, Table 2, Compound 10).

Albaugh does not teach a specific compound of Formula (I) with the NHR6 group, Albaugh does teach in the general description of the kinase inhibitor compound (para [0008]-[0011], Formula (I), wherein X1, X2, X3 and X4 are each independently CR9, C or N) that the pyridine ring of Formula (I) can be substituted with an NHR6, wherein R6 is a heterocyclic ring (para [0039], R2 is selected from the first structure specified; each optionally substituted with 1 to 3 substituents selected from...L1R6,...; para [0020], L1 is -N(R9); para [0028], R9 is H; para [0025], R6 is a C2-C14 heterocycloalkyl, optionally substituted). Based on such a description in Albaugh, it would have been obvious to one of ordinary skill in the art to have designed the compound of Formula (I) wherein R6 is a heterocycle, through routine experimentation, as a potent kinase inhibitor for therapeutic use (para [0049]).

As said compound was known in the art at the time of the invention, this cannot be considered a special technical feature, that would otherwise unify the inventions of Group I+.

The inventions of Groups I+, thus lack unity under PCT Rule 13.

Item 4(contd.): Claims 5-6, 10-11, 19 and 32-77 are unsearchable because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a). These claims are, therefore, not included in the above analysis.