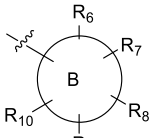
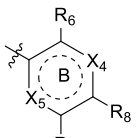
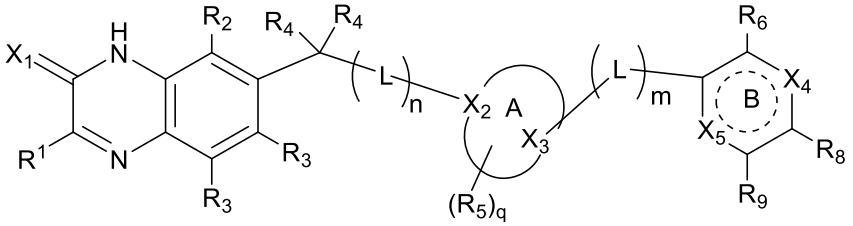
alkylene, alkoxy, alkenyl and alkynyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl; in some embodiments, R_8 is $-CONHR_{11}$ or $-NHCOR_{11}$;

each R_{11} is independently C_{3-6} cycloalkyl, 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, or 5- to 6-membered heteroaryl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl, heterocycloalkyl and heteroaryl are optionally substituted with 1-3 groups selected from D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, $-NHC_{1-4}$ alkyl, $-CONHC_{1-4}$ alkyl, $-NHCOC_{1-4}$ alkyl, OH, CN, NH_2 and C_{1-4} haloalkyl; in some embodiments, R_{11} is cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, azacyclopropyl, azetidinyl, tetrahydropyrrolyl, piperidyl, piperazinyl, tetrahydrofuryl, tetrahydropyranyl, morpholinyl, thiazolyl, thienyl, thiadiazolyl, pyrazolyl, imidazolyl, pyrrolyl, pyranyl, furyl, oxadiazolyl, pyridyl, pyrazinyl, pyridazinyl, pyrimidyl, etc.; in some embodiments, R_{11} is C_{3-6} cycloalkyl or 5- to 6-membered heteroaryl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl and heteroaryl are optionally substituted with 1-3 groups selected from D, F, Cl, C_{1-2} alkyl and C_{1-2} haloalkyl; in some embodiments, R_{11} is cyclopropyl or pyrazolyl, wherein the cyclopropyl and pyrazolyl are optionally substituted with 1-3 groups selected from D, F, Cl, C_{1-2} alkyl and C_{1-2} haloalkyl; in some embodiments, R_{11} is cyclopropyl or pyrazolyl, wherein the cyclopropyl and pyrazolyl are optionally substituted with 1-3 groups selected from C_{1-2} alkyl; each r is independently 1, 2 or 3; in some embodiments, r is 1 or 2; in some embodiments, r is 1;

in some embodiments,  is , that is, the compound as described previously has a structure of formula (II):



(II)

are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each L is independently -NH-, -CH_2-, -O-, -S-, -S(=O)-, -S(=O)$_2$- or -C(=O)-;

n and m are independently 0, 1, 2 or 3;

R_5, $R_{5'}$ and $R_{5''}$ are each independently H, D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, CN or C_{3-6} cycloalkyl, wherein the alkyl, alkoxy and cycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

optionally, one R_4 forms a bond with $R_{5'}$;

q is 0, 1, 2, 3 or 4;

X_4 is N, NR_7 or CR_7 (formula II or III);

X_5 is N, NR_{10} or CR_{10} (formula II or III);

ring B is six-membered heteroaryl (ring B in formula I can also be phenyl);

R_6, R_7, R_9 and R_{10} are independently H, D, CN, OH, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, C_{3-6} cycloalkyl or 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the alkyl, alkoxy, cycloalkyl and heterocycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

R_8 is C_{1-4} alkyl, C_{1-4} alkoxy, -NHC_{1-4} alkyl, -CONHC_{1-4} alkyl, -CONHC_{1-4} alkyleneOC_{1-4} alkyl, -NHCOC_{1-4} alkyl, -NHCOOC_{1-4} alkyl, -OCONHC_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, R_{11}, -NHR_{11}, -$(CH_2)_rR_{11}$, -OR_{11}, -COR_{11}, -$(CH_2)_rNHR_{11}$, -$NH(CH_2)_rR_{11}$, -$(CH_2)_rOR_{11}$, -$O(CH_2)_rR_{11}$, -$CONHR_{11}$, -$NHCOR_{11}$, -$NHCONHR_{11}$, -$CONH(CH_2)_rR_{11}$, -$CONH(CH_2)_rOR_{11}$, -$(CH_2)_rCONHR_{11}$, -$OCONHR_{11}$, -$COOR_{11}$, or -$CO(CH_2)_rNHR_{11}$, wherein the alkyl, alkylene, alkoxy, alkenyl and alkynyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each R_{11} is independently C_{3-6} cycloalkyl, 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, or 5- to 6-membered heteroaryl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl, heterocycloalkyl and heteroaryl are optionally substituted with 1-3 groups selected from D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, -NHC_{1-4} alkyl, -CONHC_{1-4} alkyl, -NHCOC_{1-4} alkyl, OH, CN, NH_2 and C_{1-4} haloalkyl;

each r is independently 1, 2 or 3.

alkoxy, cycloalkyl, alkenyl and alkynyl are optionally substituted with 1-5 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

optionally, two R_4 together with the carbon atom to which they are attached form C_{3-6} cycloalkyl or 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl and heterocycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each L is independently -NH-, $-CH_2-$, -O-, -S-, -S(=O)-, $-S(=O)_2-$ or -C(=O)-;

n and m are independently 0, 1, 2 or 3;

R_5, $R_{5'}$ and $R_{5''}$ are each independently H, D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, CN or C_{3-6} cycloalkyl, wherein the alkyl, alkoxy and cycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

optionally, one R_4 forms a bond with $R_{5'}$;

q is 0, 1, 2, 3 or 4;

X_4 is N, NR_7 or CR_7;

X_5 is N, NR_{10} or CR_{10};

ring B is six-membered heteroaryl;

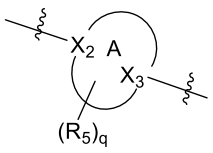
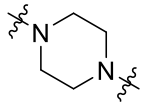
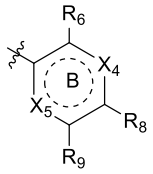
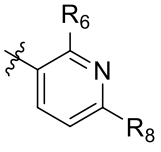
R_6, R_7, R_9 and R_{10} are independently H, D, CN, OH, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, C_{3-6} cycloalkyl or 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the alkyl, alkoxy, cycloalkyl and heterocycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

R_8 is C_{1-4} alkyl, C_{1-4} alkoxy, $-NHC_{1-4}$ alkyl, $-CONHC_{1-4}$ alkyl, $-CONHC_{1-4}$ alkyleneOC_{1-4} alkyl, $-NHCOC_{1-4}$ alkyl, $-NHCOOC_{1-4}$ alkyl, $-OCONHC_{1-4}$ alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, R_{11}, $-NHR_{11}$, $-(CH_2)_rR_{11}$, $-OR_{11}$, $-COR_{11}$, $-(CH_2)_rNHR_{11}$, $-NH(CH_2)_rR_{11}$, $-(CH_2)_rOR_{11}$, $-O(CH_2)_rR_{11}$, $-CONHR_{11}$, $-NHCOR_{11}$, $-NHCONHR_{11}$, $-CONH(CH_2)_rR_{11}$, $-CONH(CH_2)_rOR_{11}$, $-(CH_2)_rCONHR_{11}$, $-OCONHR_{11}$, $-COOR_{11}$, or $-CO(CH_2)_rNHR_{11}$, wherein the alkyl, alkylene, alkoxy, alkenyl and alkynyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each R_{11} is independently C_{3-6} cycloalkyl, 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, or 5- to 6-membered heteroaryl containing 1-3 heteroatoms selected from N, S and O, wherein the

cycloalkyl, heterocycloalkyl and heteroaryl are optionally substituted with 1-3 groups selected from D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, -NHC_{1-4} alkyl, -$CONHC_{1-4}$ alkyl, -$NHCOC_{1-4}$ alkyl, OH, CN, NH_2 and C_{1-4} haloalkyl;

each r is independently 1, 2 or 3;

provided that when  is , n and m are 0,  is , and R_6 is H, halogen, C_{1-4} alkyl or haloC_{1-4} alkyl, R_8 is not -$CONHC_{1-4}$ alkyl.

The present invention provides solution 6, i.e., the compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof as described in solution 5, wherein X_1 is O;

X_2 is N or $CR_{5'}$;

X_3 is N, C or $CR_{5''}$;

ring A is 4- to 9-membered monocyclic heterocycloalkyl, 6- to 12-membered spiroheterocycloalkyl, 6- to 12-membered fused heterocycloalkyl or 6- to 12-membered bridged heterocycloalkyl containing 1-3 N atoms and 0-2 heteroatoms selected from O and S;

R_1 is H, D, halogen, CN, C_{1-4} alkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, C_{1-4} alkoxy, C_{3-6} cycloalkyl, -O-C_{3-6} cycloalkyl, -$(CH_2)_r$-C_{3-6} cycloalkyl, heterocycloalkyl, -O-heterocycloalkyl or -$(CH_2)_r$-heterocycloalkyl, wherein the heterocycloalkyl is 4- to 7-membered heterocycle containing 1-3 heteroatoms selected from N, S and O, wherein the alkyl, alkenyl, alkynyl, alkoxy, cycloalkyl and heterocycloalkyl are optionally substituted with 1-5 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy and C_{1-4} haloalkyl;

R_2 and R_3 are independently H, D, halogen or C_{1-4} alkyl, wherein the alkyl is optionally substituted with 1-5 groups selected from D, halogen, OH, CN and NH_2;

each R_4 is independently selected from H, D, halogen, C_{1-4} alkyl, C_{3-6} cycloalkyl, OH, CN or NH_2, wherein the alkyl and cycloalkyl are optionally

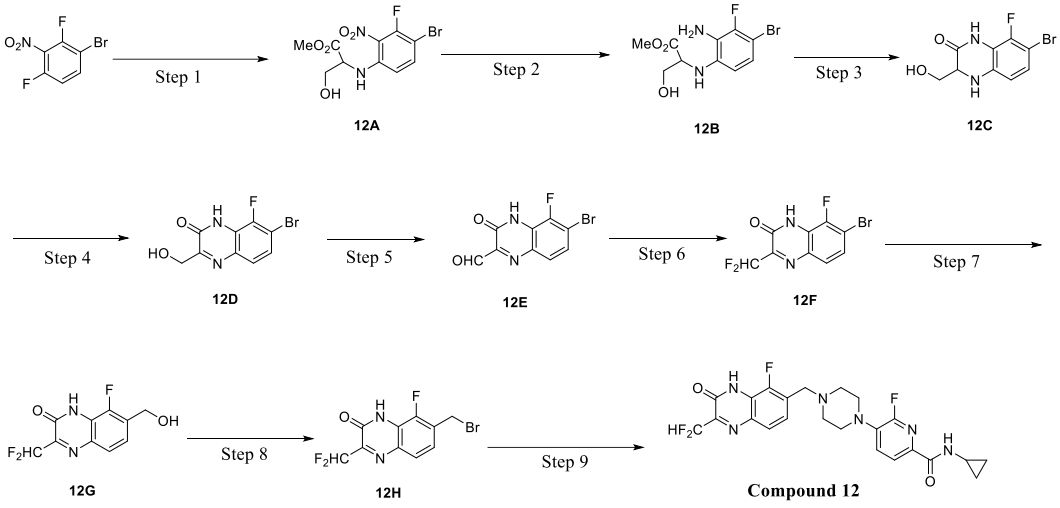
spun to dryness, and then separated and purified by liquid phase preparative column (liquid phase preparative conditions: C18 reverse-phase preparative column, mobile phase: deionized water containing 0.1% ammonia water (A) and acetonitrile (B), gradient elution, mobile phase B = 5%-50%, elution time: 15 min, flow rate: 12 mL/min, and column temperature: 30°C), to obtain the title compound 9 (194 mg, yield: 80.55%, retention time: about 2.752 min).

LC-MS (ESI): m/z = 492.20 $[M+H]^+$.

^{1}H NMR (400 MHz, DMSO-d_6) δ 12.45 (s, 1H), 10.73 (s, 1H), 8.15 - 8.04 (m, 2H), 8.00 (s, 1H), 7.72 (s, 1H), 7.52 (d, 1H), 7.33 - 7.29 (m, 1H), 6.28 - 6.26 (m, 1H), 3.79 (d, 5H), 3.19 (d, 2H), 2.71 - 2.42 (m, 7H).

Example 10

N-cyclopropyl-5-(4-((2-(difluoromethyl)-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoropicolinamide (compound 12)



Step 1: 1-Bromo-2,4-difluoro-3-nitrobenzene (23.8 g, 0.1 mol) was dissolved in 1,4-dioxane (240 mL), and serine methyl ester hydrochloride (16.5 g, 0.11 mol) and DIPEA (40 mL) were added with stirring. The mixture was reacted overnight at 40°C. After the reaction was completed as monitored by LCMS, the reaction liquid was spun to dryness to remove the solvent and separated by silica gel column chromatography (PE : EA = 5 : 1-1 : 1) to obtain the target product 12A (19.4 g, 57.55%).

LC-MS (ESI): m/z = 337.2, 339.1 $[M+H]^+$.

Step 2: 12A (19.4 g, 57.55 mmol) was dissolved in anhydrous methanol (250 mL) and water (25 mL), and ammonium chloride (32.1 g, 600 mmol) and zinc

mixture was extracted with ethyl acetate (200 mL × 3). The organic phases were combined, washed with saturated brine and dried over anhydrous sodium sulphate. Then, the residue was separated by silica gel column chromatography (PE : EA = 10 : 1-3 : 1) to obtain the target compound 12F (2.1 g, 27.3%).

LC-MS (ESI): m/z = 291.2, 293.2 $[M-H]^+$.

Step 7: 12F (2.1 g, 7.2 mmol) was dissolved in 1,4-dioxane (40 mL). (Tributylstannyl)methanol (2.54 g, 7.92 mmol) and X-phos Pd G2 (556 mg, 0.72 mmol) were added with stirring, and the mixture was reacted overnight at 80°C. Upon complete depletion of raw materials monitored by LCMS, the residue was separated by silica gel column chromatography (PE : EA = 1 : 1-0 : 1) to obtain the target compound 12G (1.65 g, 94.6%).

LC-MS (ESI): m/z = 245.2 $[M+H]^+$.

Step 8: Compound 12G (488 mg, 2.00 mmol) was dissolved in dichloromethane, and triphenylphosphine (1.57 g, 6.0 mmol) and carbon tetrabromide (1.98 g, 6.0 mmol) were added with stirring at 0°C. The reaction was stirred at room temperature for 2 h. After the reaction was completed as monitored by LCMS, the residue was separated by silica gel column chromatography (PE : EA = 5 : 1-1 : 1) to obtain the target compound 12H (512 mg, 83.4%).

LC-MS (ESI): m/z = 307.2, 309.2 $[M+H]^+$.

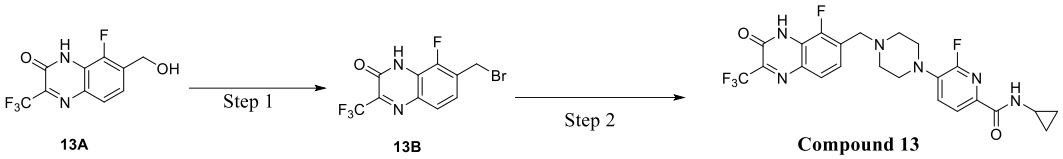
Step 9: 1D (264 mg, 1 mmol) and 12H (300 mg, 0.97 mmol) were dissolved in anhydrous acetonitrile (20 mL), and potassium iodide (8 mg, 0.05 mmol) and DIPEA (1 mL) were added. The mixture was subjected to nitrogen replacement, and then reacted at 60°C for 4 hours. Upon complete depletion of raw materials monitored by LCMS, the system was concentrated. A saturated sodium bicarbonate solution (20 mL) was added, and the mixture was extracted with a mixed solution of DCM : MeOH = 10 : 1 (10 mL × 3). The organic phases were combined, dried over anhydrous sodium sulphate, concentrated and subjected to column chromatography (DCM : MeOH = 1 : 0-0 : 1) to obtain compound 12 (334 mg, 70.21%).

^{1}H NMR (400 MHz, DMSO-d_6) δ 13.17 (s, 1H), 8.39 - 8.32 (m, 1H), 7.89 - 7.84 (m, 1H), 7.85 - 7.78 (m, 1H), 7.69 - 7.60 (m, 1H), 7.54 - 7.47 (m, 1H), 7.27 - 6.94 (m, 1H), 3.91 (s, 2H), 3.41 - 3.32 (m, 4H), 2.70 - 2.62 (m, 4H), 2.90 - 2.81 (m, 1H), 0.73 - 0.53 (m, 4H).

LC-MS (ESI): m/z= 491.2 $[M+H]^+$.

Example 11

N-cyclopropyl-6-fluoro-5-(4-((5-fluoro-3-oxo-2-(trifluoromethyl)-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)picolinamide (compound 13)



13A 13B Compound 13

Step 1: Compound 13A (synthesized according to patent US 2022/0009901 A1) (524 mg, 2.00 mmol) was dissolved in dichloromethane, and triphenylphosphine (1.57 g, 6.0 mmol) and carbon tetrabromide (1.98 g, 6.0 mmol) were added with stirring at 0°C. The reaction was stirred at room temperature for 2 h. After the reaction was completed as monitored by LCMS, the residue was separated by silica gel column chromatography (PE : EA = 5 : 1-1 : 1) to obtain the target compound 13B (552 mg, 84.9%).

LC-MS (ESI): m/z = 325.2, 327.2 $[M+H]^+$.

Step 2: 1D (264 mg, 1 mmol) and 13B (300 mg, 0.92 mmol) were dissolved in anhydrous acetonitrile (20 mL), and potassium iodide (8 mg, 0.05 mmol) and DIPEA (1 mL) were added. The mixture was subjected to nitrogen replacement, and then reacted at 60°C for 4 hours. Upon complete depletion of raw materials monitored by LCMS, the system was concentrated. A saturated sodium bicarbonate solution (20 mL) was added, and the mixture was extracted with a mixed solution of DCM : MeOH = 10 : 1 (10 mL × 3). The organic phases were combined, dried over anhydrous sodium sulphate, concentrated and separated by column chromatography (DCM : MeOH = 1 : 0-0 : 1) to obtain compound 13 (319 mg, 68.3%).

^{1}H NMR (400 MHz, DMSO-d_6) δ 13.17 (s, 1H), 8.34 - 8.28 (m, 1H), 7.86 - 7.81 (m, 1H), 7.74 - 7.69 (m, 1H), 7.59 - 7.52 (m, 1H), 7.44 - 7.37 (m, 1H), 3.75 (s, 2H), 3.21 - 3.13 (m, 4H), 2.89 - 2.81 (m, 1H), 2.65 - 2.61 (m, 4H), 0.69 - 0.59 (m, 4H).

LC-MS (ESI): m/z= 509.2 $[M+H]^+$.

Example 12

N-(5-(4-((2-(difluoromethyl)-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoropyridin-2-yl)-1-methyl-1H-pyrazole-4-carboxamide (compound 14)

^{1}H NMR (400 MHz, DMSO-d_6) δ 10.76 (s, 1H), 8.44 (s, 1H), 8.34 - 8.30 (m, 1H), 8.12 (s, 1H), 7.96 - 7.94 (m, 1H), 3.88 (s, 3H).

Step 6: Under nitrogen protection, compound 14D (1.35 g, 3.90 mmol) and N-Boc piperazine (1.45 g, 7.80 mmol) were successively weighed and added to 1,4-dioxane (30 mL). Then, caesium carbonate (3.81 g, 11.7 mmol), $Pd_2(dba)_3$ (0.71 g, 0.78 mmol) and RuPhos (0.73 g, 1.56 mmol) were added. After the addition was completed, the mixture was heated to 100°C and reacted for 3 h. After the reaction was completed, the reaction liquid was concentrated and purified by column chromatography (ethyl acetate : petroleum ether = 2 : 1) to obtain the target compound 14E (0.55 g, crude, yield: 34.87%), which was directly used in the next reaction.

LC-MS (ESI): m/z = 405.2 $[M+H]^+$.

Step 7: 14E (0.55 g, crude) was dissolved in methanol (10 mL), and a solution of hydrogen chloride in dioxane (4 mL, 4 M) was added. The mixture was reacted at room temperature for 4 hours and spun to dryness to obtain the title compound 14F (460 mg, crude). The crude was directly used in the next reaction.

LC-MS (ESI): m/z = 305.2 $[M+H]^+$.

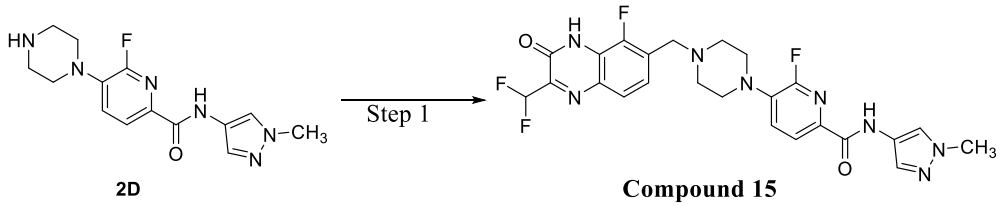
Step 8: 14F (200 mg, crude) and 12H (100 mg, 0.33 mmol) were dissolved in anhydrous acetonitrile (20 mL), and DIPEA (1 mL, 5.74 mmol) was added. The mixture was subjected to nitrogen replacement, and then reacted at 60°C for 2 h. Upon complete depletion of raw materials monitored by LCMS, the system was concentrated. A saturated sodium bicarbonate solution (20 mL) was added, and the mixture was extracted with a mixed solution of DCM : MeOH = 10 : 1 (10 mL × 3). The organic phases were combined, dried over anhydrous sodium sulphate, concentrated and separated by silica gel column chromatography (DCM : MeOH = 1 : 0-10 : 1) to obtain compound 14 (26 mg, yield: 14.86%).

LC-MS (ESI): m/z = 531.2 $[M+H]^+$.

^{1}H NMR (400 MHz, DMSO-d_6) δ 12.96 (s, 1H), 10.41 (s, 1H), 8.38 (s, 1H), 8.08 (s, 1H), 8.01 - 7.96 (m, 1H), 7.72 - 7.66 (m, 1H), 7.60 - 7.52 (m, 1H), 7.42 - 7.34 (m, 1H), 7.07 (t, 1H), 3.87 (s, 3H), 3.74 (s, 2H), 3.09 - 2.98 (m, 4H), 2.65 - 2.56 (m, 4H).

Example 13

5-(4-((2-(difluoromethyl)-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoro-N-(1-methyl)-1H-pyrazol-4-yl)picolinamide (compound 15)



2D Compound 15

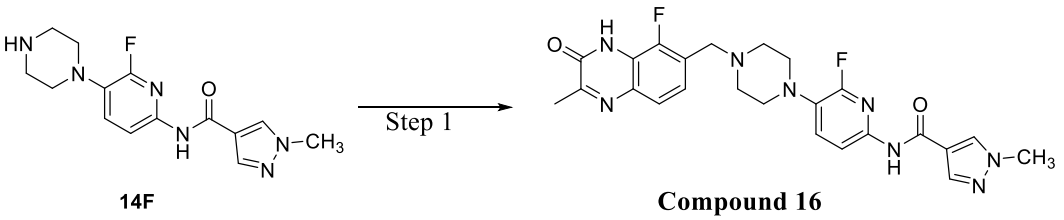
Step 1: 2D (200 mg, crude) and 12H (100 mg, 0.33 mmol) were dissolved in anhydrous acetonitrile (20 mL), and DIPEA (1 mL, 5.74 mmol) was added. The mixture was subjected to nitrogen replacement, and then reacted at 60°C for 2 h. Upon complete depletion of raw materials monitored by LCMS, the system was concentrated. A saturated sodium bicarbonate solution (20 mL) was added, and the mixture was extracted with a mixed solution of DCM : MeOH = 10 : 1 (10 mL × 3). The organic phases were combined, dried over anhydrous sodium sulphate, concentrated and separated by silica gel column chromatography (DCM : MeOH = 1 : 0-10 : 1) to obtain compound 15 (37 mg, yield: 21.14%).

^{1}H NMR (400 MHz, DMSO-d_6) δ 12.93 (s, 1H), 10.48 (s, 1H), 8.03 (s, 1H), 7.98 - 7.86 (m, 1H), 7.77 - 7.67 (m, 2H), 7.65 - 7.55 (m, 1H), 7.48 - 7.36 (m, 1H), 7.07 (t, 1H), 3.81 (s, 3H), 3.76 (s, 2H), 3.25 - 3.15 (m, 4H), 2.68 - 2.58 (m, 4H).

LC-MS (ESI): m/z= 531.2 $[M+H]^+$.

Example 14

N-(6-fluoro-5-(4-((5-fluoro-2-methyl-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)pyridin-2-yl)-1-methyl-1H-pyrazole-4-carboxamide (compound 16)



14F Compound 16

Step 1: 14F (200 mg, crude) and 1E (100 mg, 0.37 mmol) were dissolved in anhydrous acetonitrile (20 mL), and DIPEA (1 mL, 2.45 mmol) was added. The mixture was subjected to nitrogen replacement, and then reacted at 60°C for 2 h. Upon complete depletion of raw materials monitored by LCMS, the system was concentrated. A saturated sodium bicarbonate solution (20 mL) was added, and the

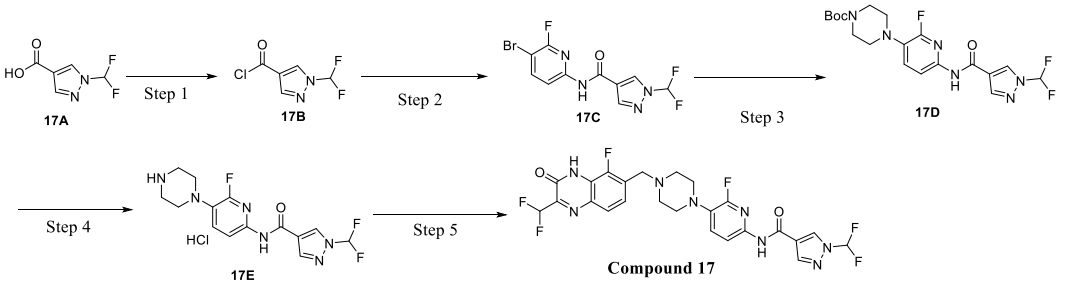
mixture was extracted with a mixed solution of DCM : MeOH = 10 : 1 (10 mL × 3). The organic phases were combined, dried over anhydrous sodium sulphate, concentrated and separated by silica gel column chromatography (DCM : MeOH = 1 : 0-10 : 1) to obtain compound 16 (37 mg, 21.14%).

^{1}H NMR (400 MHz, DMSO-d_6) δ 12.38 (s, 1H), 10.41 (s, 1H), 8.38 (s, 1H), 8.08 (s, 1H), 8.01 - 7.93 (m, 1H), 7.59 - 7.47 (m, 2H), 7.34 - 7.27 (m, 1H), 3.87 (s, 3H), 3.69 (s, 2H), 3.06 - 2.97(m, 4H), 2.62 - 2.53 (m, 4H), 2.42 (s, 3H).

LC-MS (ESI): m/z = 495.2 $[M+H]^+$.

Example 15

1-(difluoromethyl)-N-(5-(4-((2-(difluoroethyl(-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoropyridin-2-yl)-1H-pyrazole-4-carboxamide (compound 17)



Step 1: Compound 17A (synthesized according to patent WO 2016051193 A1) (9.62 g, 59 mmol) was dissolved in DCM (60 mL), and thionyl chloride (10 mL) was added. The mixture was reacted under reflux for 2 h and stopped until the system was completely clarified. The system was concentrated to remove the solvent, so as to obtain the title compound 17B (10.6 g, crude), which was directly used in the next step without further purification.

Step 2: 5-bromo-6-fluoropyridin-2-amine (10.6 g, 55.49 mmol) and pyridine (14.2 g, 180 mmol) were successively added to a 500 mL eggplant-shaped bottle and dissolved in 200 mL of dichloromethane, and the mixture was cooled to 0°C. 100 mL of a solution of compound 17B (10.6 g, crude) in dichloromethane was slowly added dropwise. After the dropwise addition was completed, the mixture was reacted at room temperature for another 1 h. 200 ml of half-saturated brine was added, and the mixture was shaken thoroughly and left to stand for layer separation. The aqueous phase was separated, and some of the organic phases were concentrated until a large number of solids were precipitated. The solids were

filtered, and the filter cake was washed with petroleum ether and dried under vacuum to obtain the title compound 17C (7.8 g, 41.95%).

LC-MS (ESI): m/z = 335.2, 337.2 $[M+H]^+$.

Step 3: Under nitrogen protection, compound 17C (7.8 g, 23 mmol) and N-Boc piperazine (6.34 g, 34 mmol) were successively weighed and added to 1,4-dioxane (100 mL). Then, caesium carbonate (15 g, 46 mmol), $Pd_2(dba)_3$ (4.2 g, 4.6 mmol) and Xphos (2.2 g, 4.6 mmol) were added. After the addition was completed, the mixture was heated to 100°C and reacted overnight. After the reaction was completed, the reaction liquid was concentrated and purified by column chromatography (ethyl acetate : petroleum ether = 1 : 1) to obtain the target compound 17D (0.464 g, yield: 4.8%).

LC-MS (ESI): m/z= 441.2 $[M+H]^+$.

Step 4: 17D (0.464 g, 1.05 mmol) was dissolved in methanol (10 mL), and a solution of hydrogen chloride in dioxane (5 mL, 4 M) was added. The mixture was reacted at room temperature for 2 h and concentrated to obtain the title compound 17E (388 mg, crude).

LC-MS (ESI): m/z = 341.2 $[M+H]^+$.

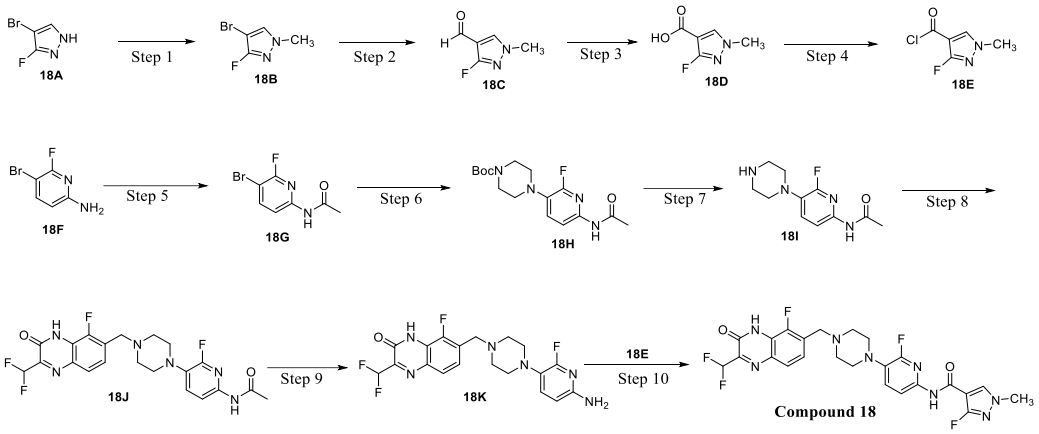
Step 5: 12H (305 mg, 1 mmol) and 17E (388 mg, crude) were dissolved in anhydrous acetonitrile (20 mL), and DIPEA (0.5 mL) was added. The mixture was subjected to nitrogen replacement, and then reacted at 60°C for 3 hours. Upon complete depletion of raw materials monitored by LCMS, the system was concentrated. A saturated sodium bicarbonate solution (20 mL) was added, and the mixture was extracted with a mixed solution of DCM : MeOH = 10 : 1 (10 mL × 3). The organic phases were combined, dried over anhydrous sodium sulphate, concentrated and separated by silica gel column chromatography (DCM : MeOH = 1 : 0-10 : 1) to obtain compound 17 (181 mg, 31.95%).

^{1}H NMR (400 MHz, DMSO-d_6) δ 13.00 (s, 1H), 10.76 (s, 1H), 8.95 (s, 1H), 8.37 (s, 1H), 8.02 - 7.96 (m, 1H), 8.04 - 7.73(m, 1H) 7.71 (d, 1H), 8.62 - 7.55 (m, 1H), 7.43 - 7.37 (m, 1H), 7.07 (t, 1H), 3.74 (s, 2H), 3.09 - 2.99 (m, 4H), 2.65 - 2.55 (m, 4H).

LC-MS (ESI): m/z=567.2 $[M+H]^+$.

Example 16

N-(5-(4-((2-(difluoromethyl)-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoropyridin-2-yl)-3-fluoro-1-methyl-1H-pyrazole-4-carboxamide (compound 18)



Step 1: Compound 18A (1 g, 6.1 mmol) was dissolved in THF (20 mL), and 500 mg (60%) of sodium hydride was added at 0°C. The mixture was stirred for 30 min. Iodomethane (0.6 mL, 9.6 mmol) was added, and the mixture was slowly warmed to room temperature and reacted for 2 h. The reaction was quenched by adding a saturated aqueous ammonium chloride solution and extracted with ethyl acetate. The organic phase was collected and concentrated, and the residue was separated by column chromatography (PE : EA = 20 : 1 to 5 : 1) to obtain compound 18B (601 mg, 56%).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.23 - 7.21 (m, 1H), 3.77 - 3.75 (m, 3H).

Step 2: Compound 18B (342 mg, 1.9 mmol) was dissolved in THF (5 mL), and the mixture was cooled to -78°C. n-Butyllithium (1.15 mL, 2.5 M in hexane) was added, and the mixture was stirred at -78°C for 15 min. DMF (0.3 mL, 3.9 mmol) was added, and the mixture was reacted at -78°C for 1 h. The system was quenched by adding ethyl acetate and water, and then extracted with ethyl acetate. The organic phase was collected and concentrated, and the residue was separated by column chromatography (PE : EA = 15 : 1 to 2 : 1) to obtain compound 18C (84 mg, 35%).

LC-MS (ESI): m/z = 129.1 $[M+H]^+$.

Step 3: Compound 18C (40 mg, 0.28 mmol) was dissolved in $KMnO_4$ solution (0.375 M). The mixture was warmed to 75°C, reacted for 1 h and cooled to room temperature. The system was adjusted to a basic pH by adding an aqueous KOH solution (10%), and solids appeared in the system. Suction filtration was performed to obtain a filtrate. The filtrate was adjusted to pH = 2 by adding hydrochloric acid.

Step 9: Compound 18J (60 mg, 0.13 mmol) was dissolved in a mixed solvent of concentrated hydrochloric acid/ethanol = 2 : 1 (6 mL), and the mixture was heated to 70°C and reacted for 1 h, and cooled to room temperature. The system was then directly concentrated to dryness to obtain compound 18K as a crude hydrochloride, which was directly used in the next step.

LC-MS (ESI): m/z = 423.2 $[M+H]^+$.

Step 10: Compound 18K (crude hydrochloride) and compound 18E were dissolved in dichloromethane (10 mL), and pyridine (1.5 mL) was added. The mixture was reacted at room temperature for 30 min. After the reaction was completed as monitored by LCMS, the system was concentrated to obtain a crude, which was purified by preparative TLC (developing agent: EA) to obtain the target compound 18 (8 mg, 11%).

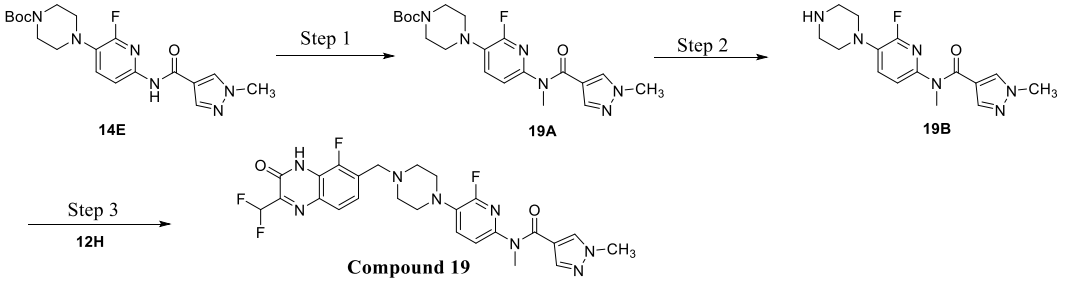
^{1}H NMR (400 MHz, DMSO-d_6) δ 10.24 (s, 1H), 8.37 (s, 1H), 7.95 - 7.88 (m, 1H), 7.70 - 7.63 (m, 1H), 7.61 - 7.51 (m, 1H), 7.35 (s, 1H), 7.06 (t, 1H), 3.76 (s, 3H), 3.73 (s, 2H), 3.02 (s, 4H), 2.60 (s, 4H).

^{19}F NMR (400 MHz, DMSO-d_6) δ -73.75, -122.05, -125.45, -132.16.

LC-MS (ESI): m/z= 549.1 $[M+H]^+$.

Example 17

N-(5-(4-((2-(difluoromethyl)-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoropyridin-2-yl)-N,1-dimethyl-1H-pyrazole-4-carboxamide (compound 19)



Step 1: Compound 14E (0.505 g, 1.25 mmol) was accurately weighed and added to DMF (10 mL). Under nitrogen protection, the mixture was cooled to about 0°C. NaH (100 mg, 2.5 mmol, 60%) was weighed and added to the reaction liquid, and after the addition was completed, the mixture was stirred at this temperature for 30 min. Iodomethane (0.27 g, 1.9 mmol) was added, and after the addition was completed, the mixture was warmed to room temperature and reacted for 1 h. After the reaction was completed as monitored by TLC spot plate

(developing agent: EA), the reaction was destroyed by adding saturated ammonium chloride to the reaction liquid. Then, water (100 mL) was added, and the mixture was extracted with ethyl acetate (150 mL × 2). The organic phases were combined, washed with saturated brine (150 mL × 2), dried over anhydrous sodium sulphate, filtered and concentrated to obtain the target compound 19A (0.44 g, crude, yield: 84.12%), which was directly used in the next reaction.

LC-MS (ESI): m/z = 419.5 $[M+H]^+$.

Step 2: Compound 19A (0.44 g, 1.05 mmol) was weighed and added to dichloromethane (10 mL), and then a solution of hydrogen chloride in dioxane (4 M, 10 mL) was added. The reaction was stirred overnight at room temperature. After the reaction was completed, the reaction liquid was concentrated to obtain compound 19B (0.38 g) as a crude hydrochloride, which was directly used in the next reaction.

LC-MS (ESI): m/z = 319.1 $[M+H]^+$.

Step 3: Compound 19B (0.38 g, crude) and compound 12H (0.29 g, 0.94 mmol) were weighed and dissolved in anhydrous acetonitrile (20 mL), and then diisopropylethylamine (1 mL) was added. The reaction was heated to 75°C and stirred for 3 h. After the reaction was completed as monitored by LCMS, the reaction liquid was cooled to room temperature and then concentrated to remove acetonitrile and DIPEA to obtain a crude, which was purified by Pre-TLC (developing agent: dichloromethane: methanol =15 : 1) to obtain compound 19 (0.276, yield: 53.90%).

LC-MS (ESI): m/z = 545.6$[M+H]^+$.

^{1}H NMR (400 MHz, DMSO-d_6) δ 13.00 (s, 1H), 7.73 - 7.71 (m, 1H), 7.66 (s, 1H), 7.52 - 7.48 (m, 1H), 7.44 - 7.40 (m, 1H), 7.21 - 6.93 (m, 2H), 6.86 (s, 1H), 3.74 (s, 5H), 3.26 (s, 3H), 3.10 (s, 4H), 2.61 (s, 4H).

Example 18

N-cyclopropyl-5-(4-((2-(difluoromethyl)-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoro-N-methylpicolinamide (compound 20)

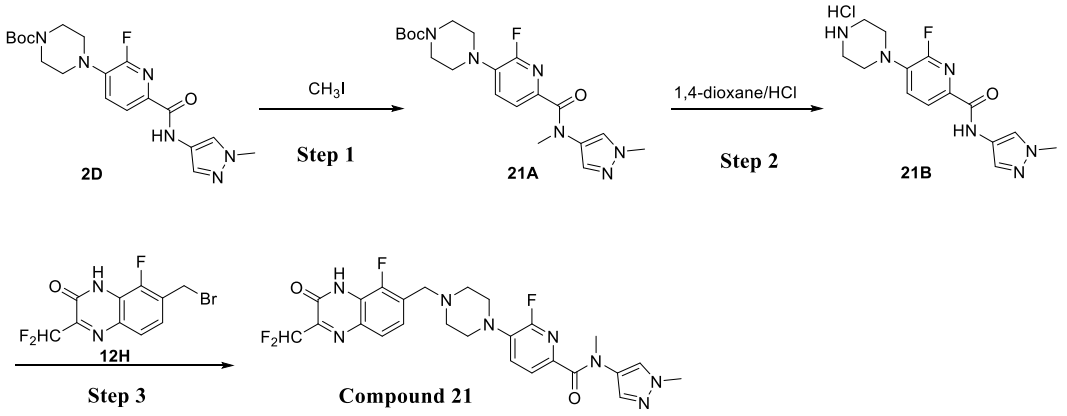
chromatography (DCM : MeOH = 1 : 0-10 : 1) to obtain compound 20 (172 mg, 52.5%).

^{1}H NMR (400 MHz, DMSO-d_6) δ 12.97 (s, 1H), 7.56 - 7.48 (m, 1H), 7.47 - 7.39 (m, 2H), 7.19 - 6.88 (m, 2H), 3.67 (s, 2H), 3.18 - 3.08 (m, 4H), 3.00 - 2.90 (m, 4H), 2.64 - 2.55 (m, 4H), 0.63- 0.19 (m, 4H).

LC-MS (ESI): m/z= 505.2 $[M+H]^+$.

Example 19

5-(4-((2-(difluoromethyl)-5-fluoro-3-oxo-3,4-dihydroquinoxalin-6-yl)methyl)piperazin-1-yl)-6-fluoro-N-methyl-N-(1-methyl-1H-pyrazol-4-yl)picolinamide (compound 21)



Step 1: Compound 2D (0.404 g, 1 mmol) was weighed and added to DMF (10 mL). Under nitrogen protection, the mixture was cooled to about 0°C. NaH (100 mg, 2.5 mmol, 60%) was weighed and added to the reaction liquid, and after the addition was completed, the mixture was stirred at this temperature for 30 min. Iodomethane (0.27 g, 1.9 mmol) was added, and after the addition was completed, the mixture was warmed to room temperature and reacted for 1 h. After the reaction was completed as monitored by TLC (developing agent: EA), a saturated ammonium chloride solution was added to the reaction liquid, and then water (100 mL) was added. The mixture was extracted with ethyl acetate (150 mL × 2). The organic phases were combined, washed with saturated brine (150 mL × 2), dried over anhydrous sodium sulphate, filtered and concentrated to obtain the target compound 21A (0.37 g, 88.3%), which was directly used without further purification.

LC-MS (ESI): m/z = 419.2 $[M+H]^+$.

Step 2: 21A (0.37 g, crude) was dissolved in methanol (10 mL), and an HCl/dioxane (2 mL, 4 M) solution was added. The mixture was reacted at room

Test compound	Mode of administration	CL (mL/min/kg)	Vd_{ss} (L/kg)	AUC_{0-t} (hr*ng/mL)	F (%)	Brain/Plasma Ratio (24 h)
Compound 12	i.v. (2.5 mg/kg)	2.16±0.31	0.420±0.017	18985±3590	-	/
	i.g. (10 mg/kg)	-	-	80830	≥98	
Compound 15	i.v. (2.5 mg/kg)	2.57±0.29	0.342±0.040	16299±1739	-	/
	i.g. (10 mg/kg)	-	-	67230	≥98	
Compound 18	i.v. (2.5 mg/kg)	5.14±0.53	0.582±0.029	8151±811	-	/
	i.g. (10 mg/kg)	-	-	32332	≥98	
Compound 2	i.v. (2.5 mg/kg)	21.6±1.3	2.09±0.52	1867±154	-	5.23
	i.g. (10 mg/kg)	-	-	7273±793	97.4	
Compound 5	i.v. (2.5 mg/kg)	15.2±1.1	2.85±0.23	2754±212	-	0.911
	i.g. (10 mg/kg)	-	-	12662±817	≥98	

-: not applicable.

Conclusion: the compounds of the present invention, especially the example compounds, such as compounds 2, 5, 12, 15 and 18, have good pharmacokinetic characteristics in mice.

5. Pharmacokinetic test in beagle dogs

5.1 Experimental animal: male beagle dogs, about 8-11 kg, 6 beagle dogs/compound, purchased from Beijing Marshall Biotechnology Co., Ltd.

5.2 Test method: on the day of the experiment, 6 beagle dogs were randomly grouped according to their body weights. The animals were fasted with water available for 12 to 14 h one day before the administration and were fed 4 h after the administration. The administration was performed according to Table 7.

Table 7. Administration information

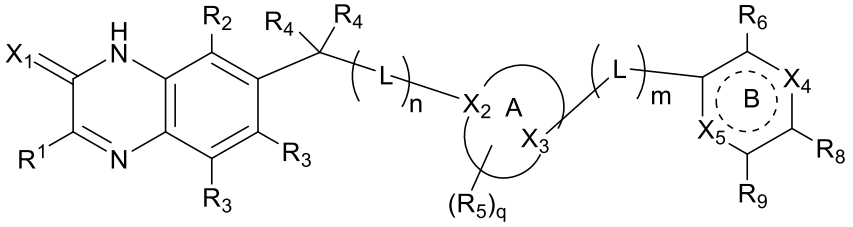
Group	Number	Administration information					
	Male	Test compound	Administration dosage (mg/kg)	Administration concentration (mg/mL)	Administration volume (mL/kg)	Collected sample	Mode of administration
G1	3	Compound 12	0.4	0.2	2	Plasma	Intravenous administration
G2	3	Compound 12	3	0.6	5	Plasma	Intragastric administration

Note: vehicle for intravenous administration: 5% DMA + 5% Solutol + 90% Saline; vehicle for intragastric administration: 5% DMSO + 5% Solutol + 30% PEG400 + 60% (20% SBE-CD)

(DMA: dimethylacetamide; Solutol: polyethylene glycol-15-hydroxystearate; Saline: physiological saline;)

CLAIMS

1. A compound represented by formula (II), or a stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof,



(II)

characterized in that X_1 is O or S;

X_2 is N, C or $CR_{5'}$;

X_3 is N, C or $CR_{5''}$;

ring A is 4- to 12-membered heterocycloalkyl containing 1-3 N atoms and 0-2 heteroatoms selected from O and S;

R_1, R_2 and R_3 are independently H, D, halogen, CN, NH_2, $-SF_5$, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{1-4} alkoxy, C_{3-6} cycloalkyl, $-O-C_{3-6}$ cycloalkyl, $-(CH_2)_r-C_{3-6}$ cycloalkyl, heterocycloalkyl, $-O$-heterocycloalkyl or $-(CH_2)_r$-heterocycloalkyl, wherein the heterocycloalkyl is 4- to 7-membered heterocycle containing 1-3 heteroatoms selected from N, S and O, and the alkyl, alkenyl, alkynyl, alkoxy, cycloalkyl and heterocycloalkyl are optionally substituted with 1-5 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each R_4 is independently selected from H, D, halogen, C_{1-4} alkyl, C_{3-6} cycloalkyl, OH, CN, NH_2, C_{1-4} alkoxy, C_{2-6} alkenyl or C_{2-6} alkynyl, wherein the alkyl, alkoxy, cycloalkyl, alkenyl and alkynyl are optionally substituted with 1-5 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

optionally, two R_4 together with the carbon atom to which they are attached form C_{3-6} cycloalkyl or 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl and heterocycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each L is independently $-NH-$, $-CH_2-$, $-O-$, $-S-$, $-S(=O)-$, $-S(=O)_2-$ or $-C(=O)-$;

n and m are independently 0, 1, 2 or 3;

R_5, $R_{5'}$ and $R_{5''}$ are each independently H, D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, CN or C_{3-6} cycloalkyl, wherein the alkyl, alkoxy and cycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

optionally, one R_4 forms a bond with $R_{5'}$;

q is 0, 1, 2, 3 or 4;

X_4 is N, NR_7 or CR_7;

X_5 is N, NR_{10} or CR_{10};

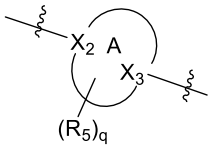
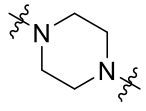
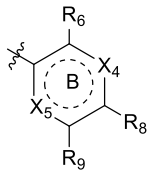
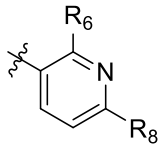
ring B is six-membered heteroaryl;

R_6, R_7, R_9 and R_{10} are independently H, D, CN, OH, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, C_{3-6} cycloalkyl or 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the alkyl, alkoxy, cycloalkyl and heterocycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

R_8 is C_{1-4} alkyl, C_{1-4} alkoxy, -NHC_{1-4} alkyl, -$CONHC_{1-4}$ alkyl, -$CONHC_{1-4}$ alkyleneOC_{1-4} alkyl, -$NHCOC_{1-4}$ alkyl, -$NHCOOC_{1-4}$ alkyl, -$OCONHC_{1-4}$ alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, R_{11}, -NHR_{11}, -$(CH_2)_rR_{11}$, -OR_{11}, -COR_{11}, -$(CH_2)_rNHR_{11}$, -$NH(CH_2)_rR_{11}$, -$(CH_2)_rOR_{11}$, -$O(CH_2)_rR_{11}$, -$CONHR_{11}$, -$NHCOR_{11}$, -$NHCONHR_{11}$, -$CONH(CH_2)_rR_{11}$, -$CONH(CH_2)_rOR_{11}$, -$(CH_2)_rCONHR_{11}$, -$OCONHR_{11}$, -$COOR_{11}$, or -$CO(CH_2)_rNHR_{11}$, wherein the alkyl, alkylene, alkoxy, alkenyl and alkynyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each R_{11} is independently C_{3-6} cycloalkyl, 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, or 5- to 6-membered heteroaryl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl, heterocycloalkyl and heteroaryl are optionally substituted with 1-3 groups selected from D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, -NHC_{1-4} alkyl, -$CONHC_{1-4}$ alkyl, -$NHCOC_{1-4}$ alkyl, OH, CN, NH_2 and C_{1-4} haloalkyl;

each r is independently 1, 2 or 3;

provided that when  is , n and m are 0,  is , and R_6 is H, halogen, C_{1-4} alkyl or haloC_{1-4} alkyl, R_8 is not -$CONHC_{1-4}$ alkyl.

2. The compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to claim 1,

characterized in that X_1 is O;

X_2 is N or $CR_{5'}$;

X_3 is N, C or $CR_{5''}$;

ring A is 4- to 9-membered monocyclic heterocycloalkyl, 6- to 12-membered spiroheterocycloalkyl, 6- to 12-membered fused heterocycloalkyl or 6- to 12-membered bridged heterocycloalkyl containing 1-3 N atoms and 0-2 heteroatoms selected from O and S;

R_1 is H, D, halogen, CN, C_{1-4} alkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, C_{1-4} alkoxy, C_{3-6} cycloalkyl, -O-C_{3-6} cycloalkyl, -$(CH_2)_r$-C_{3-6} cycloalkyl, heterocycloalkyl, -O-heterocycloalkyl or -$(CH_2)_r$-heterocycloalkyl, wherein the heterocycloalkyl is 4- to 7-membered heterocycle containing 1-3 heteroatoms selected from N, S and O, wherein the alkyl, alkenyl, alkynyl, alkoxy, cycloalkyl and heterocycloalkyl are optionally substituted with 1-5 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy and C_{1-4} haloalkyl;

R_2 and R_3 are independently H, D, halogen or C_{1-4} alkyl, wherein the alkyl is optionally substituted with 1-5 groups selected from D, halogen, OH, CN and NH_2;

each R_4 is independently selected from H, D, halogen, C_{1-4} alkyl, C_{3-6} cycloalkyl, OH, CN or NH_2, wherein the alkyl and cycloalkyl are optionally substituted with 1-5 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

optionally, two R_4 together with the carbon atom to which they are attached form C_{3-6} cycloalkyl or 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl and

heterocycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

each L is independently -NH-, -CH_2-, -O- or -C(=O)-;

n and m are independently 0, 1, 2 or 3;

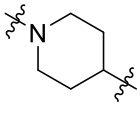
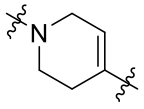
R_5, $R_{5'}$ and $R_{5''}$ are each independently H, D, =O, halogen, C_{1-4} alkyl or C_{1-4} alkoxy, wherein the alkyl and alkoxy are optionally substituted with 1-3 groups selected from D, halogen, OH, CN and NH_2;

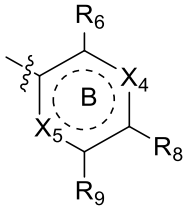
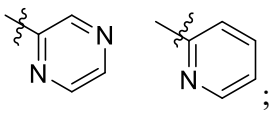
optionally, one R_4 forms a bond with $R_{5'}$;

q is 0, 1 or 2;

R_6, R_7, R_9 and R_{10} are independently H, D, CN, OH, halogen, C_{1-4} alkyl or C_{1-4} alkoxy, wherein the alkyl and alkoxy are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl.

3. The compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to claim 2,

characterized in that ring A is substituted or unsubstituted 6- to 10-membered fused heterocycloalkyl, substituted or unsubstituted 6- to 11-membered spiroheterocycloalkyl, substituted or unsubstituted 6- to 10-membered bridged heterocycloalkyl, substituted or unsubstituted 4- to 5-membered monocyclic heterocycloalkyl, substituted or unsubstituted 7- to 8-membered monocyclic heterocycloalkyl, substituted or unsubstituted , or substituted or unsubstituted ; or

 is selected from substituted or unsubstituted ;

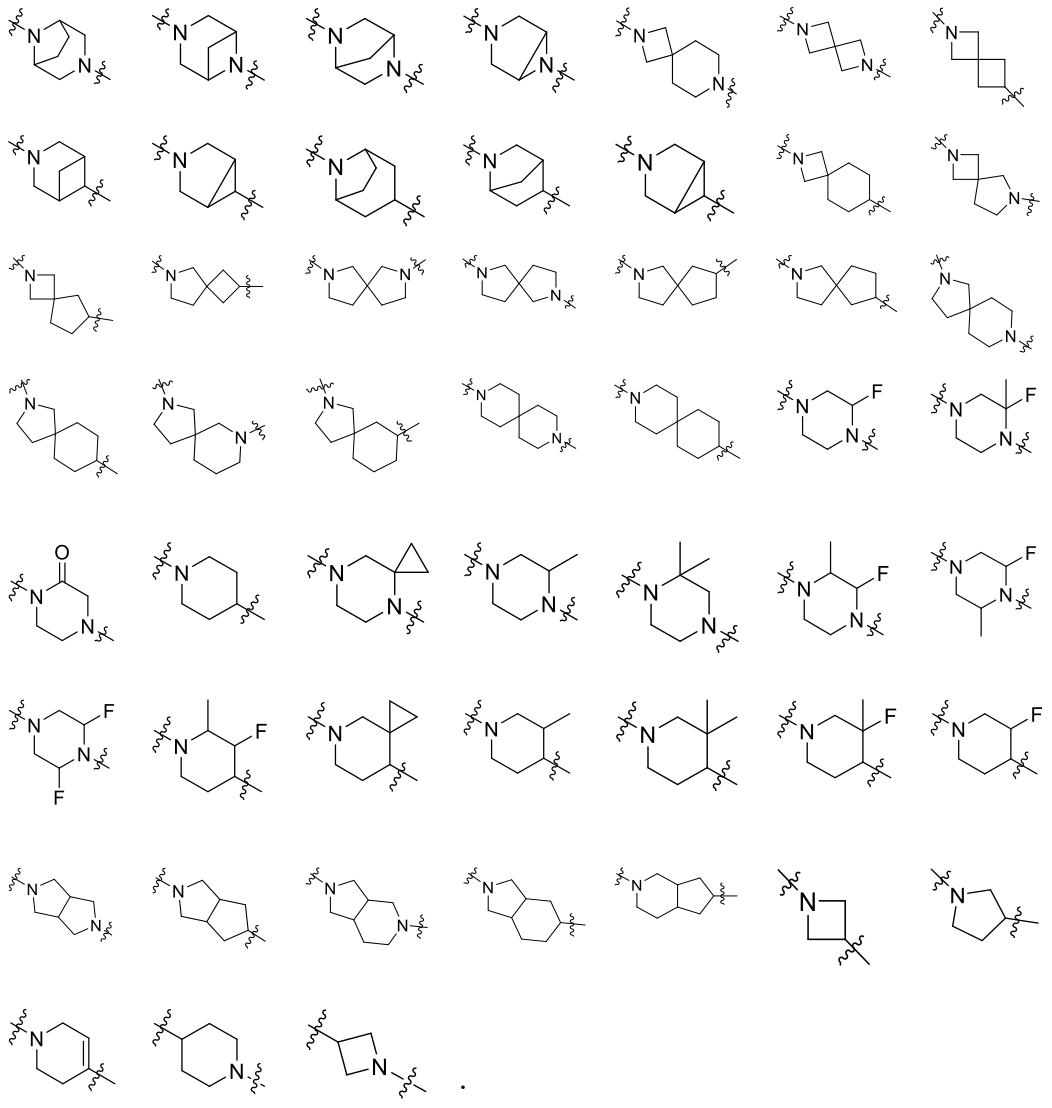
or

R_8 is C_{1-4} alkyl, C_{1-4} alkoxy, -NHC_{1-4} alkyl, -NHCOC_{1-4} alkyl, -NHCOOC_{1-4} alkyl, -OCONHC_{1-4} alkyl, -CONHC_{1-4} alkyleneOC_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, R_{11}, -NHR_{11}, -$(CH_2)_rR_{11}$, -OR_{11}, -COR_{11}, -$(CH_2)_rNHR_{11}$, -NH$(CH_2)_rR_{11}$, -$(CH_2)_rOR_{11}$, -O$(CH_2)_rR_{11}$, -CONHR_{11}, -NHCOR_{11}, -NHCONHR_{11}, -CONH$(CH_2)_rR_{11}$, -CONH$(CH_2)_rOR_{11}$, -COOR_{11}, -$(CH_2)_rCONHR_{11}$, -OCONHR_{11}, or -CO$(CH_2)_rNHR_{11}$, wherein the alkyl, alkoxy, alkenyl and alkynyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl.

4. The compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to claim 2,

characterized in that

ring A is selected from



.

5. The compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to claim 3 or 4, characterized in that

R_1 is H, D, F, Cl, Br, I, C_{1-4} alkyl or C_{3-6} cycloalkyl, wherein the alkyl and cycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy and C_{1-4} haloalkyl;

R_2 is H, D, F, Cl, Br, I or C_{1-4} alkyl, wherein the alkyl is optionally substituted with 1-5 groups selected from D, halogen, OH, CN and NH_2;

R_3 is H, D, F, Cl, Br or I;

each R_4 is independently selected from H, D, F, Cl, Br or I;

optionally, two R_4 together with the carbon atom to which they are attached form C_{3-6} cycloalkyl or 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl and heterocycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl;

n and m are 0;

R_5, $R_{5'}$ and $R_{5''}$ are each independently H, D, F, Cl, Br, I, C_{1-4} alkyl or C_{1-4} alkoxy, wherein the alkyl and alkoxy are optionally substituted with 1-3 groups selected from D, halogen, OH, CN and NH_2;

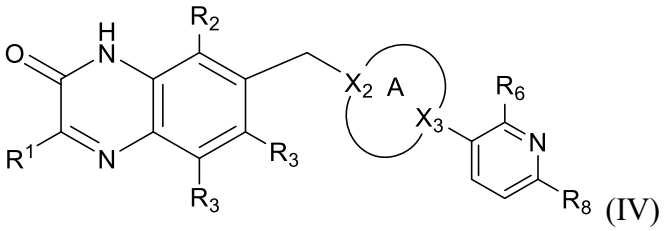
optionally, one R_4 forms a bond with $R_{5'}$;

q is 0, 1 or 2;

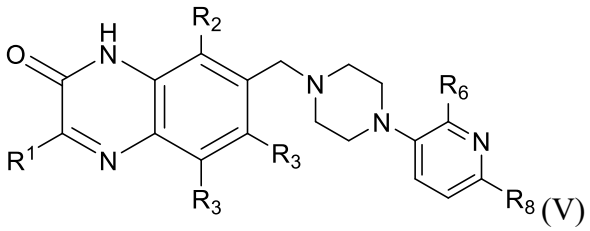
ring B is six-membered heteroaryl containing 1-2 N atoms;

R_6, R_7, R_9 and R_{10} are independently H, D, CN, OH, halogen, C_{1-4} alkyl or C_{1-4} alkoxy, wherein the alkyl and alkoxy are optionally substituted with 1-3 groups selected from D, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, OH, CN, NH_2 and C_{1-4} haloalkyl.

6. The compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to claim 1, characterized in that the compound has a structure of formula (IV) or (V):

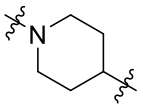
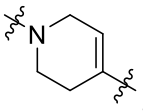
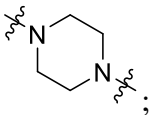


(IV)



(V)

wherein

ring A is selected from , , or ;

R_1 is C_{1-4} alkyl and C_{3-6} cycloalkyl, wherein the alkyl and cycloalkyl are optionally substituted with 1-3 groups selected from D, halogen, OH, CN and NH_2;

R_3 is H or D;

each R_2 is independently F, Cl, CN, NH_2, C_{1-2} alkyl, C_{2-4} alkenyl or C_{2-4} alkynyl, wherein the alkyl is optionally further substituted with 1-3 groups selected from D, F, Cl, OH, CN and NH_2;

R_6 is D, CN, OH, F, Cl, C_{1-2} alkyl, C_{1-2} alkoxy, C_{3-4} cycloalkyl or 4- to 5-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, wherein the alkyl, alkoxy, cycloalkyl and heterocycloalkyl are optionally substituted with 1-3 groups selected from D, F, Cl, OH, CN and NH_2;

R_8 is $-CONHR_{11}$ or $-NHCOR_{11}$;

each R_{11} is independently C_{3-6} cycloalkyl, 4- to 7-membered heterocycloalkyl containing 1-3 heteroatoms selected from N, S and O, or 5- to 6-membered heteroaryl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl, heterocycloalkyl and heteroaryl are optionally substituted with 1-3 groups selected from D, =O, halogen, C_{1-4} alkyl, C_{1-4} alkoxy, $-NHC_{1-4}$ alkyl, $-CONHC_{1-4}$ alkyl, $-NHCOC_{1-4}$ alkyl, OH, CN, NH_2 and C_{1-4} haloalkyl.

7. The compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to claim 6, characterized in that

R_1 is C_{1-2} alkyl, wherein the alkyl is optionally substituted with 1-3 groups selected from D, F and Cl;

R_3 is H;

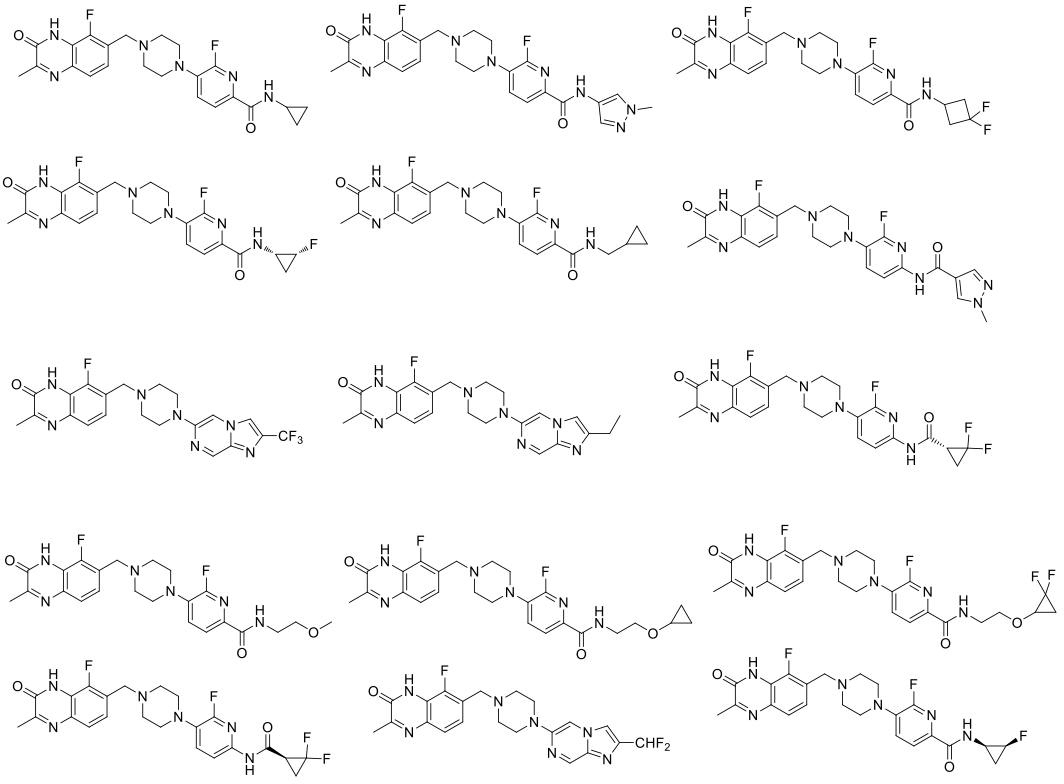
R_2 is F, Cl or C_{1-2} alkyl, wherein the alkyl is optionally further substituted with 1-3 groups selected from D, F and Cl;

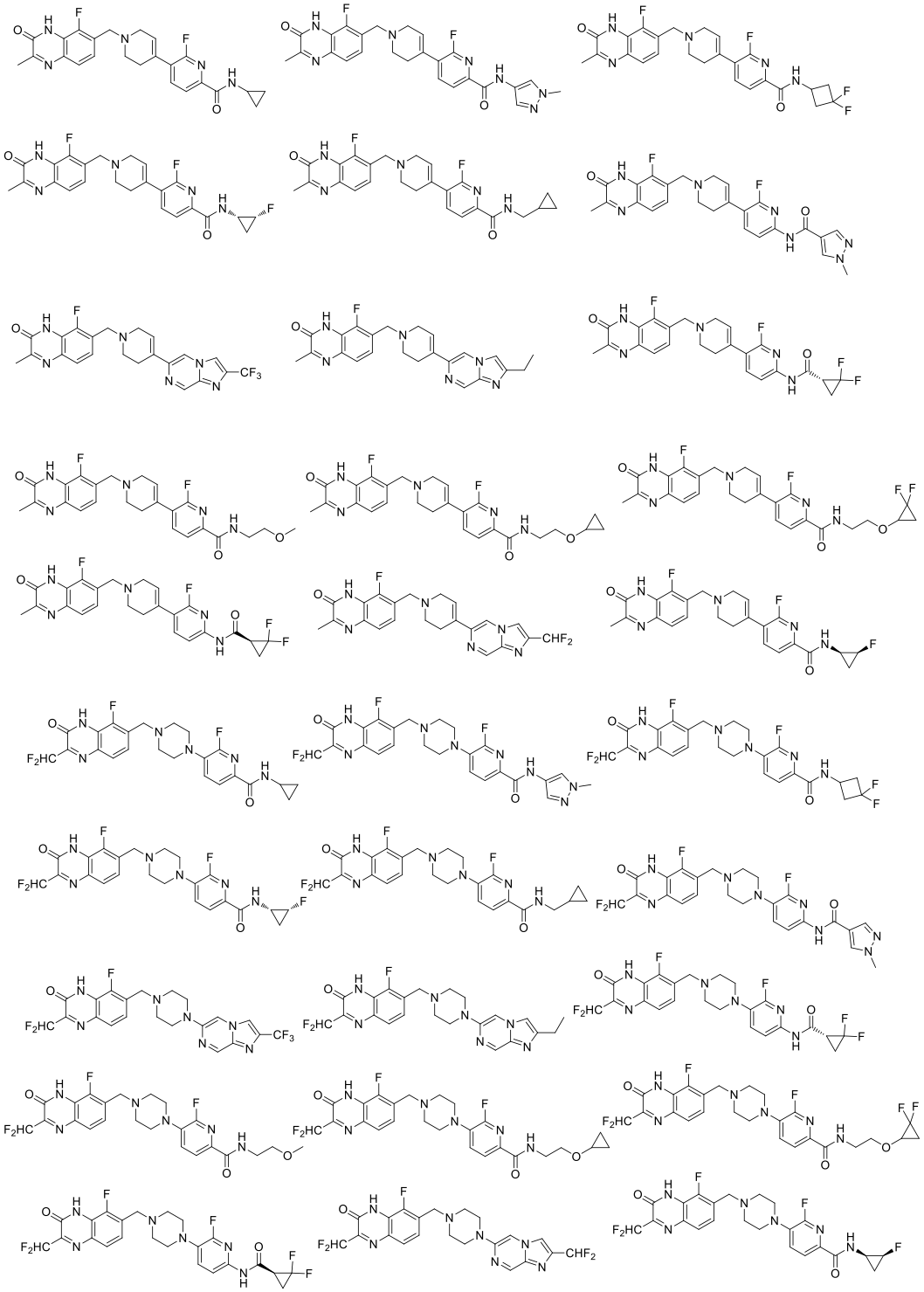
R_6 is D, F, Cl and C_{1-2} alkyl, wherein the alkyl is optionally substituted with 1-3 groups selected from D, F and Cl;

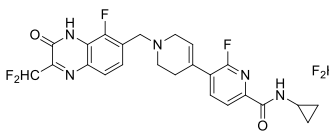
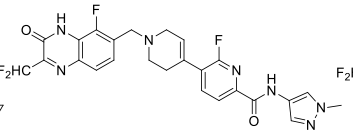
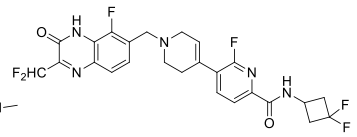
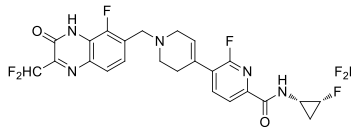
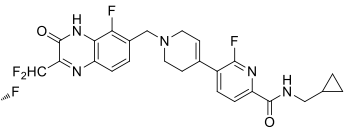
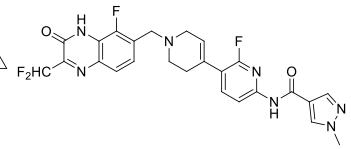
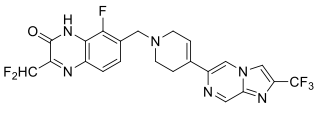
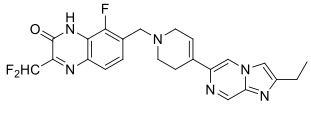
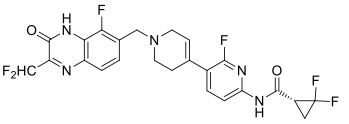
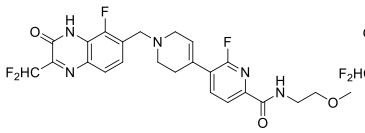
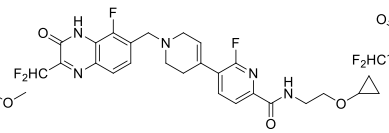
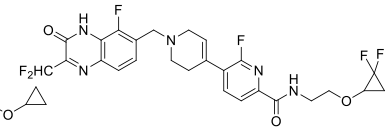
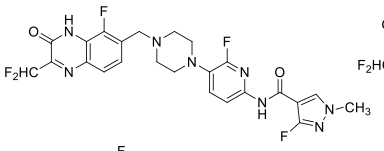
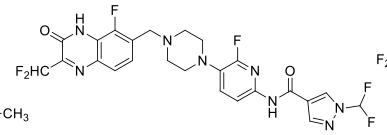
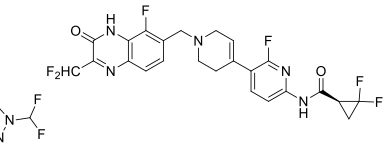
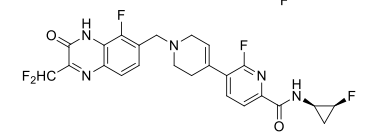
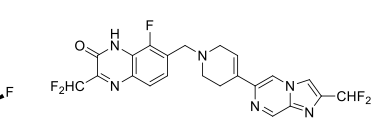
R_8 is -$CONHR_{11}$ or -$NHCOR_{11}$;

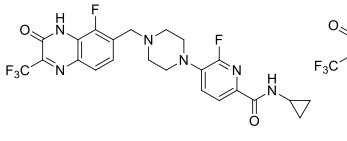
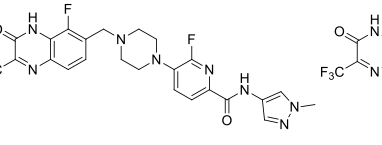
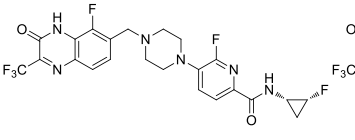
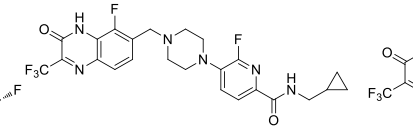
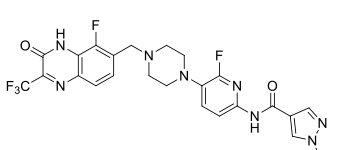
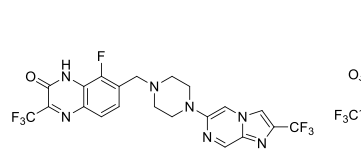
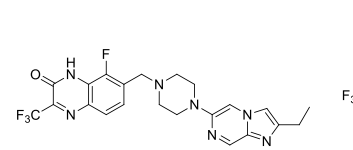
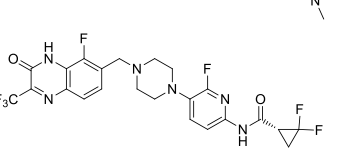
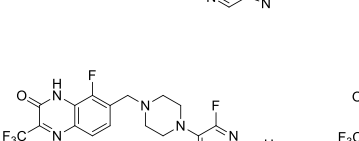
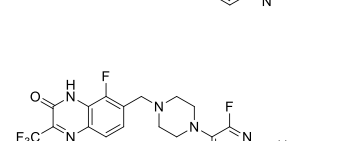
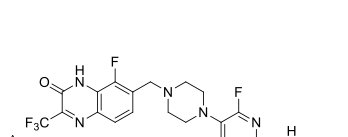
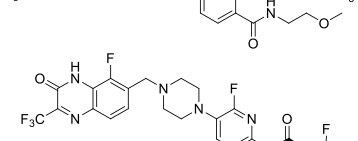
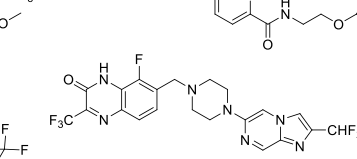
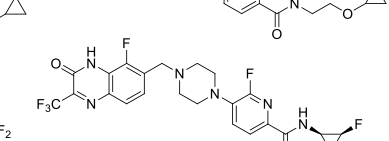
R_{11} is C_{3-6} cycloalkyl or 5- to 6-membered heteroaryl containing 1-3 heteroatoms selected from N, S and O, wherein the cycloalkyl and heteroaryl are optionally substituted with 1-3 groups selected from D, F, Cl, C_{1-2} alkyl and C_{1-2} haloalkyl.

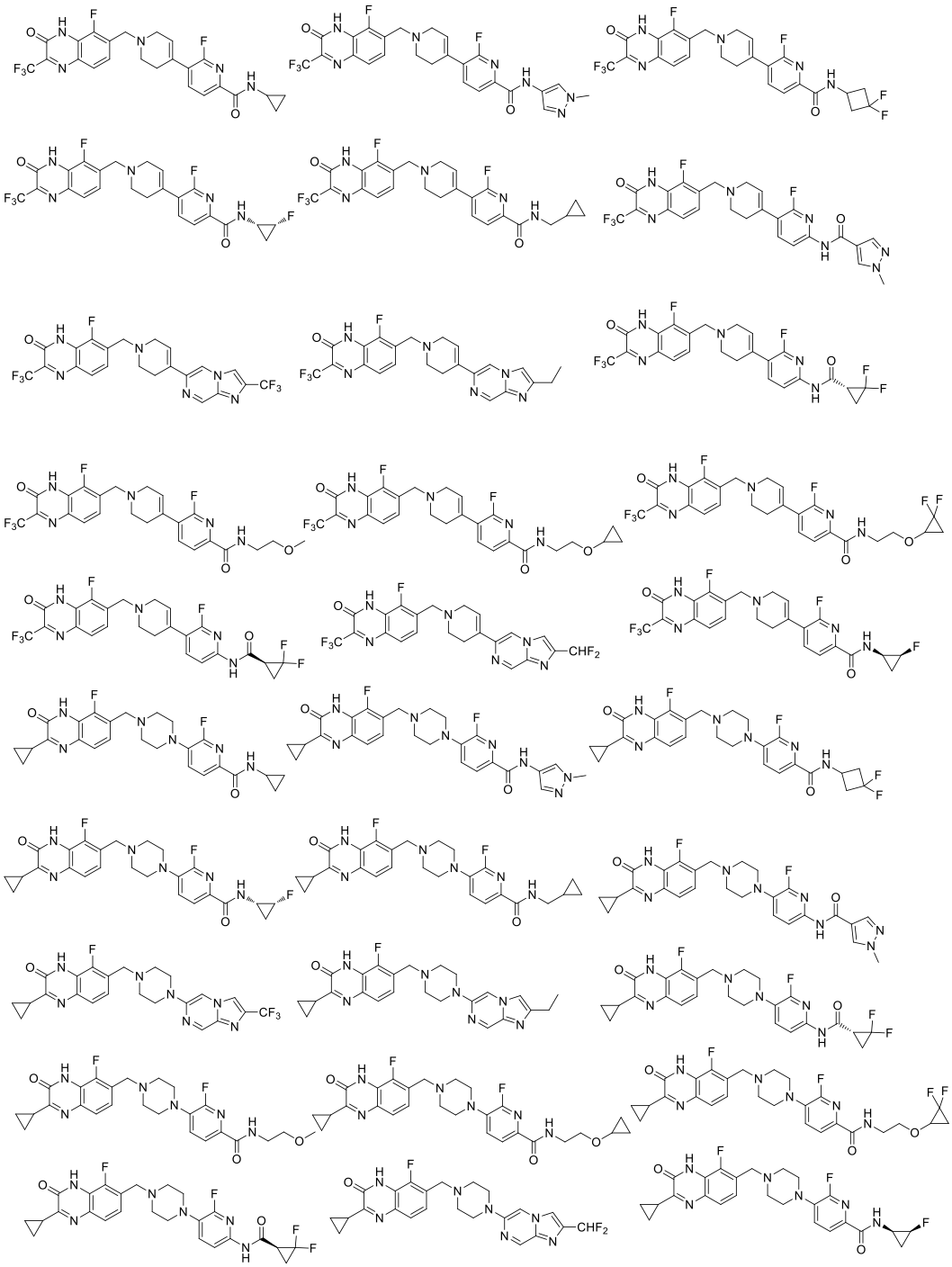
8. A compound represented by formula (II), formula (IV) or formula (V), or a stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof, characterized in that the compound has a structure selected from one of

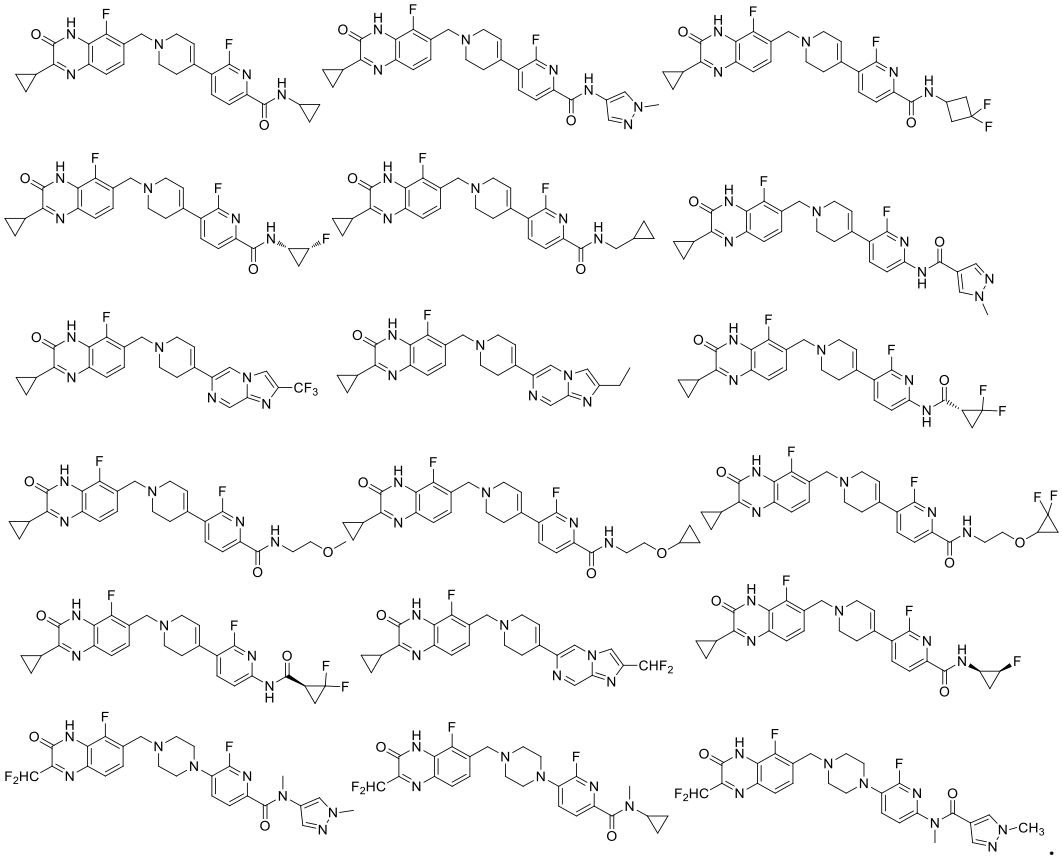






9. A pharmaceutical composition, characterized in that the pharmaceutical composition comprises the compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to any one of claims 1-8, and a pharmaceutically acceptable carrier and/or excipient.

10. Use of the compound, or the stereoisomer, solvate, deuterated form or pharmaceutically acceptable salt thereof according to any one of claims 1-8, or the composition according to claim 9 in the preparation of a drug for treating/preventing a PARP1-mediated disease.

11. The use according to claim 10, characterized in that the PARP1-mediated disease is selected from breast cancer, uterine cancer, cervical cancer, ovarian cancer and prostate cancer.

12. A pharmaceutical composition or pharmaceutical preparation, characterized in that the pharmaceutical composition or pharmaceutical preparation comprises 1-1440 mg of the compound, or the stereoisomer, solvate, deuterated

form or pharmaceutically acceptable salt thereof according to any one of claims 1-8, and a pharmaceutically acceptable carrier and/or excipient.