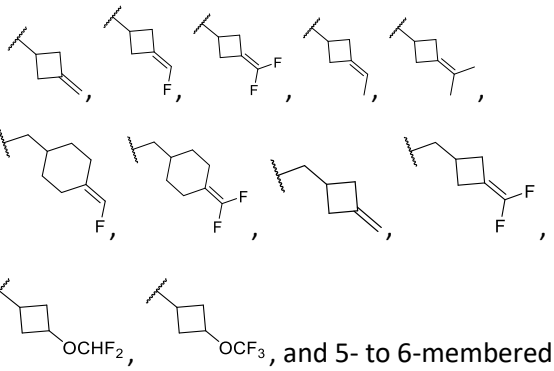
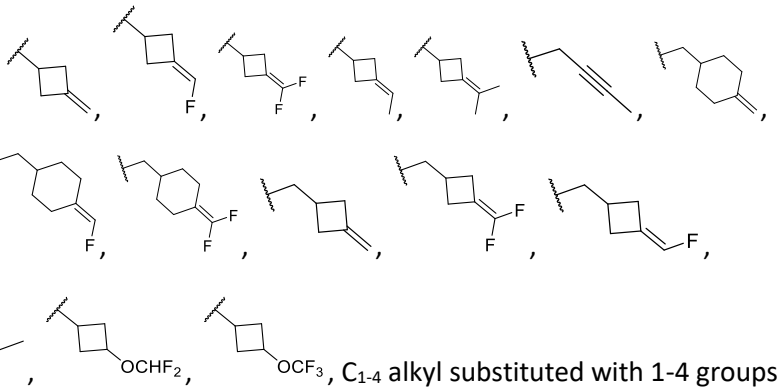
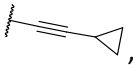
in some embodiments, R^{L21} and R^{L22} are each independently selected from H, C_{1-2} alkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, and C_{3-6} cycloalkyl, wherein the alkyl, alkenyl, alkynyl, cycloalkyl, and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, =O, OH, NH_2, CN, and C_{1-4} alkyl;

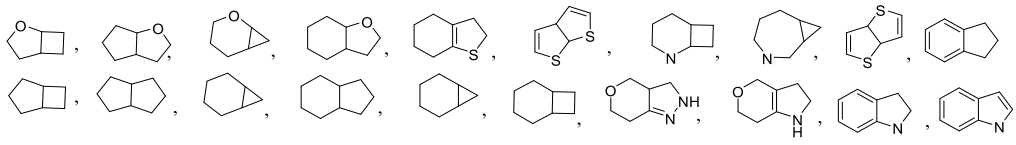
in some embodiments, R^{L21} and R^{L22} are each independently selected from H, C_{1-2} alkyl, and C_{3-6} cycloalkyl, wherein the alkyl and cycloalkyl are optionally further substituted with 1-4 groups selected from F, Cl, OH, NH_2, and CN;

in some embodiments, R^{L21} and R^{L22} are each independently selected from H, methyl, ethyl, and cyclopropyl;

in some embodiments, each R^{L23} is independently selected from C_{1-4} alkyl, $-(CH_2)_p-O-C_{3-6}$ cycloalkyl, C_{3-6} cycloalkyl, $-O-C_{3-6}$ cycloalkyl, $-(CH_2)_p-$(4- to 7-membered heterocycloalkyl), 6- to 12-membered bicyclic heterocycloalkyl, , and 5- to 6-membered heteroaryl, wherein the heterocycloalkyl and heteroaryl contain 1-3 heteroatoms selected from N, O, S, S(O) and $S(O)_2$; the alkyl, heterocycloalkyl and heteroaryl are optionally further substituted with 1-4 groups selected from =O, halogen, OH, $-OCF_3$, $-OCHF_2$, $-SCF_3$, NH_2, CN, acetyl, $-S(O)_2CH_3$, and ;

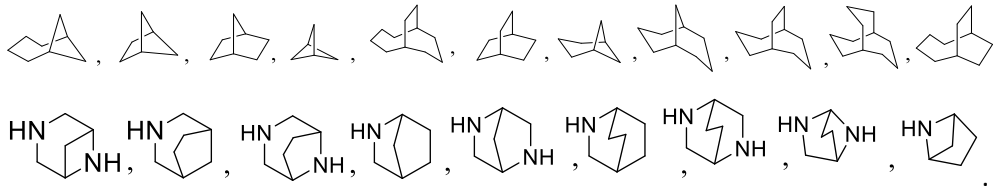
and when R^{L21} and R^{L22} are both H, and L_1 is O, at least one R^{L23} is selected from $-(CH_2)_p-$(4- to 7-membered heterocycloalkyl), 6- to 12-membered bicyclic heterocycloalkyl, 5- to 6-membered heteroaryl, , C_{1-4} alkyl substituted with 1-4 groups selected from $-OCF_3$, $-OCHF_2$, $-SCF_3$, NH_2, CN, acetyl, $-S(O)_2CH_3$, and , $-O-C_{3-6}$ cycloalkyl, $-(CH_2)_p-O-C_{3-6}$ cycloalkyl, and C_{3-6} cycloalkyl substituted with 1-4 groups selected

[50]The term "fused ring" refers to a polycyclic group in which the rings share two adjacent ring atoms and one chemical bond, which may contain one or more double or triple bonds, and may contain 0 to 5 heteroatoms selected from N, S and O and their oxidation states. Typically, the fused ring is a 5- to 20-membered ring, or a 5- to 14-membered ring, or a 5- to 12-membered ring, or a 5- to 10-membered ring. Typically, the fused ring includes [3,4]-fused rings (indicating a ring system formed by fusion of a three-membered ring and a four-membered ring; according to IUPC nomenclature rules, either the three-membered or the four-membered ring may serve as the parent ring, and the same applies analogously to the following cases), [3,5]-fused rings, [3,6]-fused rings, [4,4]-fused rings, [4,5]-fused rings, [4,6]-fused rings, [5,5]-fused rings, [5,6]-fused rings, and [6,6]-fused rings. Non-limiting examples of the fused ring include purine, quinoline, isoquinoline, benzopyran, benzofuran, benzothiophene, and


; and

the fused ring may be optionally substituted with a substituent.

[51]The term "bridged ring" refers to a ring system in which two rings share two non-adjacent ring atoms, which may contain one or more double or triple bonds. The bridged ring may contain 0 to 5 heteroatoms selected from N, S, and O and their oxidation states. Typically, the bridged ring has 5 to 20, or 5 to 14, or 5 to 12, or 5 to 10 ring atoms. Non-limiting examples of the bridged ring include adamantane,


.

[52]The term "carbon-fused ring", "fused cycloalkyl", "fused carbocyclyl", or "carbon-fused ring group" refers to a "fused ring" composed solely of carbon atoms. The definition of the "carbon-fused ring", "fused cycloalkyl", "fused carbocyclyl", or "carbon-fused ring group" herein is consistent with that of a fused ring.

[53]The term "fused heterocyclic ring", "fused heterocycloalkyl", "fused heterocyclyl", or "fused heterocyclic ring group" refers to a "fused ring" containing a heteroatom. The definition of the "fused heterocyclic ring", "fused heterocycloalkyl", "fused heterocyclyl", or "fused heterocyclic ring group" herein is consistent with that of a fused ring.

[54]The term "spiro heterocyclic ring", "spiro heterocyclic ring group", or "spiroheterocyclyl" refers to a "spiro ring" containing a heteroatom. The definition of the "spiro heterocyclic ring", "spiro heterocyclic ring group" or "spiroheterocyclyl" herein is consistent with that of a spiro ring.

[55]The term "bridged heterocyclic ring", "bridged heterocyclic ring group", or "bridged heterocyclyl" refers to a "bridged ring" containing a heteroatom. The definition of the "bridged heterocyclic ring", "bridged heterocyclic ring group", or "bridged heterocyclyl" herein is consistent with that of a bridged ring. The term "optional" or "optionally" means that the events or circumstances subsequently described may but not necessarily occur, and the description includes the occasions where the events or circumstances occur or do not occur. For example, "alkyl optionally substituted with F" means that the alkyl may but not necessarily be substituted with F, and the description includes the case where the alkyl is substituted with F and the case where the alkyl is not substituted with F.

[56]When the connecting groups listed do not specify their connection direction, their connection direction includes both the left-to-right and right-to-left reading orders. For example, for A-L-B, wherein L is -M-W-, it includes both A-M-W-B and A-W-M-B. A specific example is A-C(O)NR^{L1}-B, which includes both A-C(O)NR^{L1}-B and A-NR^{L1}C(O)-B.

[57]The term "pharmaceutically acceptable salt" refers to a salt of the compound of the present invention, which salt maintains the biological effectiveness and characteristics of a free acid or a free base and is obtained by reacting the free acid with a non-toxic inorganic base or organic base, or reacting the free base with a non-toxic inorganic acid or organic acid.

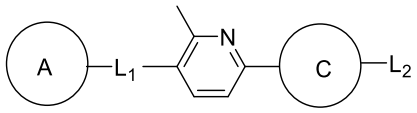
[58]The term "pharmaceutical composition" represents a mixture of one or more compounds or stereoisomers, solvates, pharmaceutically acceptable salts or co-crystals thereof as described herein and other components including physiologically/pharmaceutically acceptable carriers and/or excipients.

[59]The term "carrier" refers to a system that does not cause significant irritation to the organism and does not eliminate the biological activity and characteristics of the administered compound and can change the way the drug enters the human body and the distribution of the drug in the body, control the release rate of the drug and deliver the drug to targeted organs. Non-limiting examples of the carrier include microcapsule, microsphere, nanoparticle, liposome, etc.

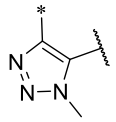
[60]The term "excipient" refers to a substance that is not a therapeutic agent per se, but is used as a diluent, auxiliary material, binder and/or vehicle added to a pharmaceutical

Claims

1. A compound as shown in formula (I), or a stereoisomer, a deuterated substance, or a pharmaceutically acceptable salt thereof, wherein



(I)

ring C is , wherein the "*" end is connected to a pyridine ring on the left side, and the "〰" end is connected to L_2;

ring A is selected from 3- to 12-membered carbocyclyl and 4- to 12-membered heterocyclyl, or ring A is absent, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the carbocyclyl and heterocyclyl are optionally further substituted with 1-4 R^A;

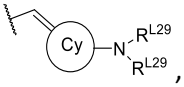
each R^A is independently selected from H, halogen, =O, CN, OH, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, -OC_{1-4} alkyl, -$(CH_2)_p$-(5- to 10-membered heterocyclyl), -(a 3- to 6-membered carbocyclic ring)-$COOR^{a1}$, -$(CH_2)_p$-$COOR^{a1}$, -$(CH_2)_p$-$C(O)NR^{a1}R^{a2}$, -$(CH_2)_p$-C(O)NHC(O)R^{a1}, -$(CH_2)_p$-C(O)NHS$(O)_2R^{a1}$, -$(CH_2)_p$-C(O)NHS(O)R^{a1}, -$(CH_2)_p$-$S(O)_2OH$, -$(CH_2)_p$-$S(O)_2NHC(O)R^{a1}$, -$(CH_2)_p$-$P(O)(OH)_2$, =CH_2, =CF_2, =CH-CH_3 or =C-$(CH_3)_2$, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the alkyl, alkenyl, alkynyl and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, CN, and -O-halogenated C_{1-4} alkyl;

L_1 is selected from a bond, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, -O-, -O-C_{1-6} alkyl-, -S-, -S-C_{1-6} alkyl-, -$C(O)NR^{L1}$-, -$NR^{L1}C(O)$-, , -NR^{L1}-, and -NR^{L1}-C_{1-6} alkyl-, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 R^{L1};

each R^{L1} is independently selected from H, halogen, OH, C_{1-4} alkyl, halogenated C_{1-4} alkyl, 3- to 6-membered cycloalkyl, and -COOH, wherein the alkyl and cycloalkyl are optionally further substituted with 1-4 groups selected from halogen, OH, and NH_2;

when ring A is absent, L_1 is selected from -OC_{1-6} alkyl substituted with one COOH, C_{2-6} alkenyl, and C_{2-6} alkynyl;

L_2 is selected from -$(CR^{L21}R^{L22})_p$-$OC(O)$-$N(R^{L23})_2$, -$(CR^{L21}R^{L22})_p$$N(R^{L24})S(O)_2N(R^{L25})_2$, -$(CR^{L21}R^{L22})_p$$N(R^{L26})C(O)N(R^{L27})(R^{L28})$, -$(CR^{L21}R^{L22})_p$$N(R^{L29})(R^{L30})$, -$C(=O)N(R^{L31})_2$, -$N(R^{L31})$-$C(=O)OR^{L32}$, -$(CH_2)_pR^{L33}$, -$(CR^{L21}R^{L22})_p$-$C(O)$-$N(R^{L29})$-$C(O)R^{L21}$, -$(CR^{L21}R^{L22})_p$-$C(O)$-$N(R^{L29})$-$S(O)_2R^{L21}$, -(3- to 6-membered cycloalkyl)-$C(=O)N(R^{L25})_2$, -(4- to 7-membered heterocyclyl)-

$C(=O)N(R^{L25})_2$, $-(C_{2-4}$ alkenyl$)$-(4- to 7-membered heterocyclyl$)$-$N(R^{L25})_2$, $-(CR^{L21}R^{L22})_p$-SC(O)-$N(R^{L25})_2$, $-(CR^{L21}R^{L22})_pN(R^{L29})C(S)N(R^{L27})(R^{L28})$, , $-(CR^{L21}R^{L22})_p$-OC(O)-R^{L23}, $-(CR^{L21}R^{L22})_p$-O-R^{L23}, and $-(CR^{L21}R^{L22})_p$-N(R^{L26})C(O)O-R^{L23}, wherein Cy is 4- to 7-membered heterocyclyl; the cycloalkyl and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, =O, OH, NH_2, CN, C_{1-4} alkyl, C_{1-4} alkoxy, halogenated C_{1-4} alkyl, C_{3-6} cycloalkyl, and 5- to 7-membered heterocyclyl;

R^{a1}, R^{a2}, R^{L1}, R^{L2}, R^{L21}, R^{L22}, R^{L23}, R^{L24}, R^{L25}, R^{L26}, R^{L27}, R^{L28}, R^{L29}, R^{L30}, and R^{L31} are each independently selected from H, halogen, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{1-4} alkoxy, 5- to 14-membered heterocyclyl, $-(CH_2)_p$-(4- to 7-membered heterocyclyl), $-(CH_2)_p$-C_{3-10} cycloalkyl, $-(CH_2)_p$-O-C_{3-10} cycloalkyl, and -O-C_{3-10} cycloalkyl, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the alkyl, alkenyl, alkynyl, cycloalkyl, and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, =O, $=CH_2$, $=CF_2$, $=CH\text{-}CH_3$, $=C\text{-}(CH_3)_2$, OH, NH_2, CN, acetyl, $-SCF_3$, $-S(O)_2CH_3$, C_{1-4} alkyl, C_{1-4} alkoxy, halogenated C_{1-4} alkoxy, halogenated C_{1-4} alkyl, C_{3-10} cycloalkyl, 5- to 12-membered heterocyclyl, and $-C\equiv C$-C_{3-10} cycloalkyl;

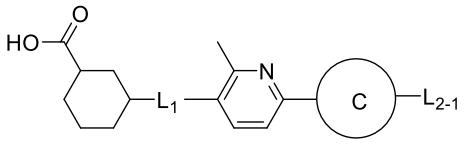
R^{L32} is selected from $-C_{1-4}$ alkyl-(5- to 10-membered heteroaryl) and $-C_{1-4}$ alkyl-(6- to 10-membered aryl), wherein the heteroaryl and aryl are optionally further substituted with 1-3 substituents selected from halogen, CN, OH, NO_2, NH_2, halogenated C_{1-4} alkyl, $-OC_{1-4}$ alkyl, C_{2-6} alkenyl or C_{2-6} alkynyl;

R^{L33} is selected from C_{1-4} alkyl, halogen, OH, NH_2, CN, C_{2-6} alkenyl, C_{2-6} alkynyl, -C(=O)H, -C(=O)OH, C_{3-10} cycloalkyl, C_{1-4} alkoxy, and 5- to 14-membered heterocyclyl, wherein the alkyl, alkoxy, alkenyl, alkynyl, cycloalkyl, alkoxy and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, CN, N_3, C_{1-4} alkoxy, halogenated C_{1-4} alkoxy, C_{3-5} cycloalkyl, 4- to 6-membered heterocycloalkyl, 6- to 10-membered aryl, and 5- to 10-membered heteroaryl;

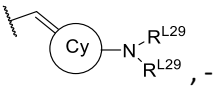
alternatively, R^{L24} and R^{L25} or R^{L26} and R^{L27} or two R^{L23}, together with the atoms to which they are attached, form a 5- to 7-membered heterocyclic ring containing 1-3 heteroatoms selected from N, O and S, wherein the heterocyclic ring is optionally further substituted with 1-3 groups selected from halogen, =O, OH, NH_2, CN, C_{1-4} alkyl, and acetyl;

each p is independently selected from 0, 1, 2, 3 and 4.

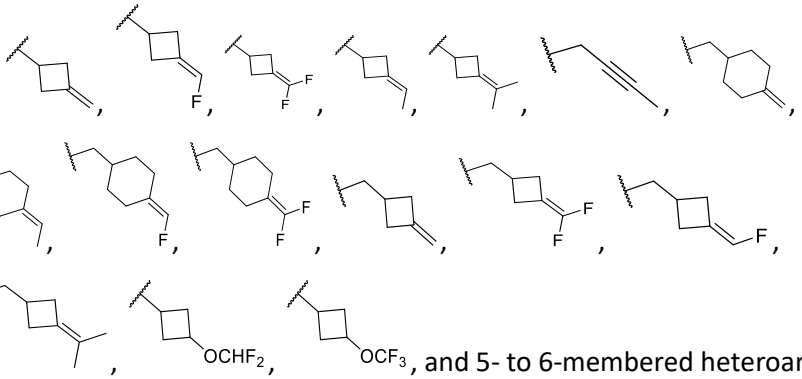
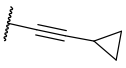
2. The compound as shown in formula (I), or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 1, having a structure of formula (I-1), wherein

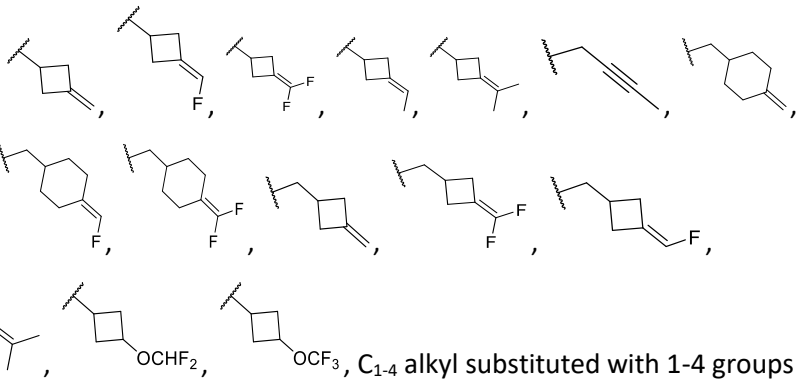
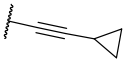
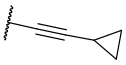
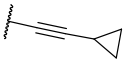


(I-1)

L_{2-1} is selected from -$(CR^{L21}R^{L22})_p$-OC(O)-N$(R^{L23})_2$, -$(CR^{L21}R^{L22})_p$N(R^{L24})S$(O)_2$N$(R^{L25})_2$, -$(CR^{L21}R^{L22})_p$N(R^{L26})C(O)N$(R^{L27})(R^{L28})$, -$(CR^{L21}R^{L22})_p$N$(R^{L29})(R^{L30})$, -$(CR^{L21}R^{L22})_p$-C(O)-N(R^{L29})-C(O)R^{L21}, -$(CR^{L21}R^{L22})_p$-C(O)-N(R^{L29})-S$(O)_2R^{L21}$, -(3- to 6-membered cycloalkyl)-C(=O)N$(R^{L25})_2$, -(4- to 7-membered heterocyclyl)-C(=O)N$(R^{L25})_2$, -(C_{2-4} alkenyl)-(4- to 7-membered heterocyclyl)-N$(R^{L25})_2$, -$(CR^{L21}R^{L22})_p$-SC(O)-N$(R^{L25})_2$, -$(CR^{L21}R^{L22})_p$N(R^{L26})C(S)N$(R^{L27})(R^{L28})$, , -$(CR^{L21}R^{L22})_p$-OC(O)-R^{L23}, -$(CR^{L21}R^{L22})_p$-O-R^{L23}, and -$(CR^{L21}R^{L22})_p$-N(R^{L26})C(O)O-R^{L23}, wherein Cy is 4- to 7-membered heterocyclyl; the cycloalkyl and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, =O, OH, NH_2, CN, C_{1-4} alkyl, C_{1-4} alkoxy, halogenated C_{1-4} alkyl, C_{3-6} cycloalkyl, and 5- to 7-membered heterocyclyl;

R^{L21} and R^{L22} are each independently selected from H, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{3-10} cycloalkyl, and 5- to 12-membered heterocyclyl, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the alkyl, alkenyl, alkynyl, cycloalkyl, and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, =O, OH, NH_2, CN, and C_{1-4} alkyl;

each R^{L23} is independently selected from C_{1-4} alkyl, -$(CH_2)_p$-O-C_{3-6} cycloalkyl, C_{3-6} cycloalkyl, -O-C_{3-6} cycloalkyl, -$(CH_2)_p$-(4- to 7-membered heterocycloalkyl), 6- to 12-membered bicyclic heterocycloalkyl, , and 5- to 6-membered heteroaryl, wherein the heterocycloalkyl and heteroaryl contain 1-3 heteroatoms selected from N, O, S, S(O) and $S(O)_2$; the alkyl, heterocycloalkyl and heteroaryl are optionally further substituted with 1-4 groups selected from =O, halogen, OH, -OCF_3, -$OCHF_2$, -SCF_3, NH_2, CN, acetyl, -$S(O)_2CH_3$, and ;

and when R^{L21} and R^{L22} are both H, and L_1 is O, at least one R^{L23} is selected from -$(CH_2)_p$-(4- to 7-membered heterocycloalkyl), 6- to 12-membered bicyclic heterocycloalkyl, 5- to 6-membered heteroaryl, , C_{1-4} alkyl substituted with 1-4 groups selected from -OCF_3, -$OCHF_2$, -SCF_3, NH_2, CN, acetyl, -$S(O)_2CH_3$, and , -O-C_{3-6} cycloalkyl, -$(CH_2)_p$-O-C_{3-6} cycloalkyl, and C_{3-6} cycloalkyl substituted with 1-4 groups selected from -OCF_3, -$OCHF_2$, -SCF_3, NH_2, CN, acetyl, -$S(O)_2CH_3$, and , wherein the heterocycloalkyl and heteroaryl are optionally further substituted with 1-4 groups selected from =O, halogen, OH, -OCF_3, -$OCHF_2$, -SCF_3, NH_2, CN, acetyl, -$S(O)_2CH_3$, and ;

each R^{L24} is independently selected from H, C_{2-6} alkenyl, and C_{2-6} alkynyl, wherein the alkenyl and alkynyl are optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, CN, C_{3-10} cycloalkyl, and 5- to 12-membered heterocyclyl;

R^{L25}, R^{L27}, and R^{L28} are each independently selected from C_{1-3} alkyl, C_{2-6} alkenyl, and C_{2-6} alkynyl, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, and CN;

each R^{L26} is independently selected from C_{2-6} alkenyl, C_{2-6} alkynyl, and C_{3-6} cycloalkyl, wherein the alkenyl, alkynyl, and cycloalkyl are optionally further substituted with 1-4 groups selected from halogen, =O, OH, NH_2, CN, and C_{1-4} alkyl;

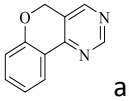
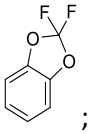
R^{L29} is selected from H, C_{1-4} alkyl, C_{2-6} alkenyl, and C_{2-6} alkynyl, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, and CN;

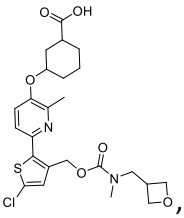
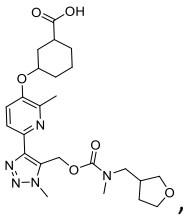
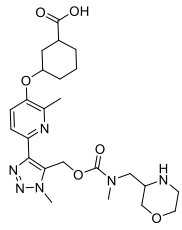
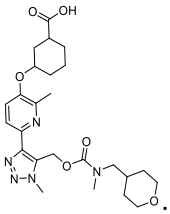
R^{L30} is selected from 6- to 14-membered bicyclic or tricyclic heterocyclyl, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the heterocyclyl is optionally further substituted with 1-4 groups selected from halogen, CN, OH, NH_2, C_{1-4} alkyl, and halogenated C_{1-4} alkyl;

p is selected from 0, 1, 2, 3 and 4;

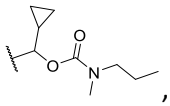
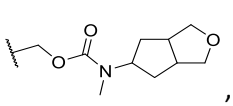
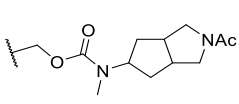
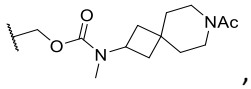
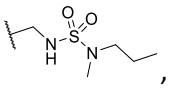
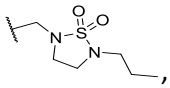
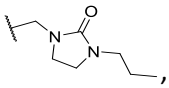
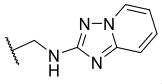
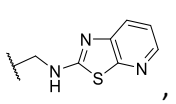
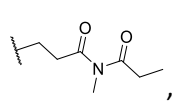
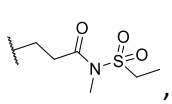
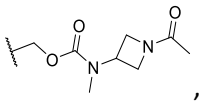
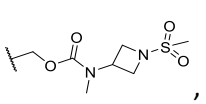
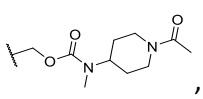
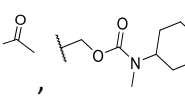
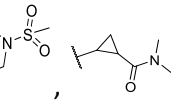
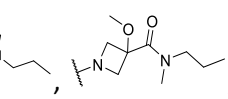
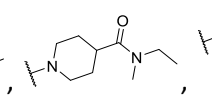
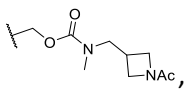
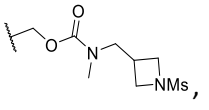
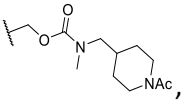
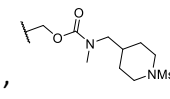
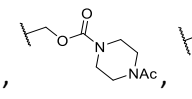
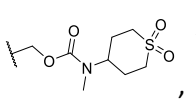
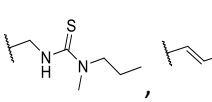
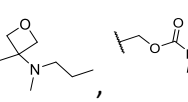
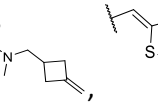
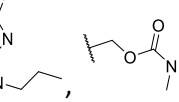
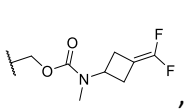
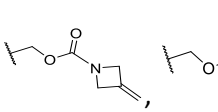
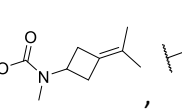
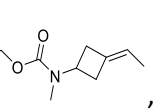
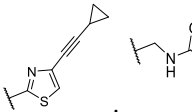
alternatively, R^{L24} and R^{L25} or R^{L26} and R^{L27}, together with the atoms to which they are attached, form a 5- to 7-membered heterocyclic ring containing 1-3 heteroatoms selected from N, O and S, wherein the heterocyclic ring is optionally further substituted with 1-3 groups selected from halogen, =O, OH, NH_2, CN, C_{1-4} alkyl, and acetyl;

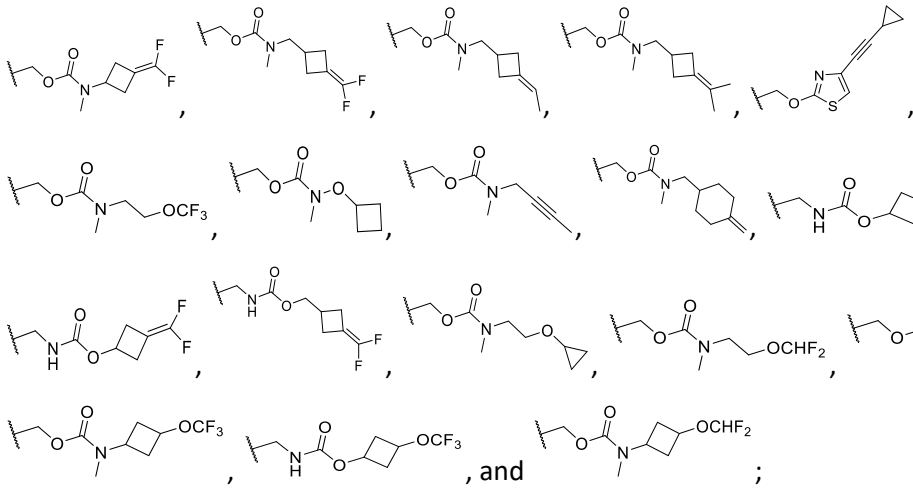
alternatively, two R^{L23}, together with the atoms to which they are attached, form a 5- to 7-membered heterocyclic ring containing 1-3 heteroatoms selected from N, O and S, wherein the heterocyclic ring is optionally further substituted with 1-3 groups selected from =O, OH, NH_2, CN, and acetyl;

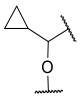
provided that (1). R^{L30} is not ,  and ;

(2). the compound is not , ,  and .

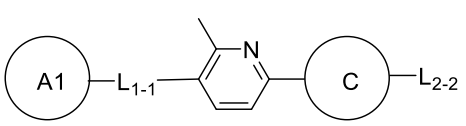
3. The compound as shown in formula (I-1), or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 2, wherein

L_{2-1} is selected from , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , , .

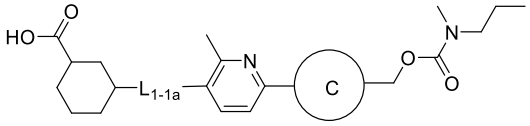


L_1 is selected from a bond, $-OCH_2-$, -S-, $-OCH(CH_3)-$, $-OCH(CF_3)-$, , -O-, -C(=O)-, -NHC(O)-, $-CH_2-$, -NH-, $-N(CH_3)-$, and $-NHCH(CH_3)-$.

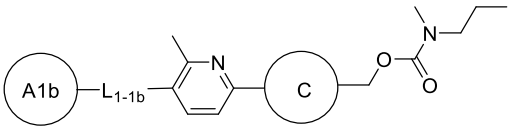
4. The compound as shown in formula (I), or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 1, having a structure of formula (I-2), (I-2a), (I-2b), or (I-2c), wherein



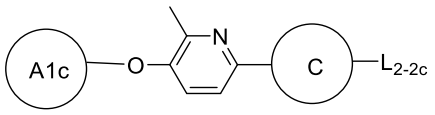
(I-2)



(I-2a)



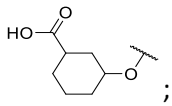
(I-2b)



(I-2c)

rings A1, A1b, and A1c are each independently selected from 3- to 12-membered carbocyclyl and 4- to 12-membered heterocyclyl, or are absent, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the carbocyclyl and heterocyclyl are optionally further substituted with 1-4 R^A;

each R^A is independently selected from H, =O, halogen, CN, OH, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, $-OC_{1-4}$ alkyl, $-(CH_2)_p$-5- to 10-membered heterocyclyl, -(a 3- to 6-membered carbocyclic ring)-$COOR^{a1}$, $-(CH_2)_p-COOR^{a1}$, $-(CH_2)_p-C(O)NR^{a1}R^{a2}$, $-(CH_2)_p-C(O)NHC(O)R^{a1}$, $-(CH_2)_p-C(O)NHS(O)_2R^{a1}$, $-(CH_2)_p-C(O)NHS(O)R^{a1}$, $-(CH_2)_p-S(O)_2OH$, $-(CH_2)_p-S(O)_2NHC(O)R^{a1}$, $-(CH_2)_p-P(O)(OH)_2$, $=CH_2$, $=CF_2$, $=CH-CH_3$ or $=C-(CH_3)_2$, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the alkyl, alkenyl, alkynyl and heterocyclyl are

optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, CN, and -O-halogenated C_{1-4} alkyl; and L_{1-1}-A1, L_{1-1b}-A1b, and O-A1c are not ;

L_{1-1} and L_{1-1b} are each independently selected from a bond, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, -O-, -O-C_{1-6} alkyl-, -S-, -S-C_{1-6} alkyl-, -C(O)NR^{L1}-, -NR^{L1}C(O)-, , -NR^{L1}-, and -NR^{L1}-C_{1-6} alkyl-, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 R^{L1};

L_{1-1a} is selected from a bond, C_{1-4} alkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, -O-C_{1-4} alkyl-, -S-, -S-C_{1-4} alkyl-, -C(O)NR^{L1}-, -NR^{L1}C(O)-, , -NR^{L1}-, and -NR^{L1}-C_{1-6} alkyl-, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 R^{L1};

each R^{L1} is independently selected from H, halogen, OH, C_{1-4} alkyl, halogenated C_{1-4} alkyl, 3- to 6-membered cycloalkyl, and -COOH, wherein the alkyl and cycloalkyl are optionally further substituted with 1-4 groups selected from halogen, OH, and NH_2;

when rings A1 and A1b are each independently absent, L_{1-1} and L_{1-1b} are each independently selected from -OC_{1-6} alkyl substituted with one COOH, C_{2-6} alkenyl, and C_{2-6} alkynyl;

L_{2-2} and L_{2-2c} are each independently selected from -$(CR^{L21}R^{L22})_p$-OC(O)-$N(R^{L23})_2$, -$(CR^{L21}R^{L22})_p$$N(R^{L24})S(O)_2N(R^{L25})_2$, -$(CR^{L21}R^{L22})_p$$N(R^{L26})$C(O)$N(R^{L27})(R^{L28})$, -$(CR^{L21}R^{L22})_p$$N(R^{L29})(R^{L30})$, -$(CR^{L21}R^{L22})_p$-OC(O)-$R^{L23}$, -$(CR^{L21}R^{L22})_p$-O-$R^{L23}$, and -$(CR^{L21}R^{L22})_p$-$N(R^{L26})$C(O)O-$R^{L23}$;

R^{a1}, R^{a2}, R^{L1}, R^{L2}, R^{L21}, R^{L22}, R^{L23}, R^{L24}, R^{L25}, R^{L26}, R^{L27}, and R^{L28} are each independently selected from H, halogen, C_{1-4} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, C_{1-4} alkoxy, 5- to 10-membered heterocycloalkyl, -$(CH_2)_p$-(4- to 7-membered heterocyclyl), -$(CH_2)_p$-C_{3-10} cycloalkyl, and -$(CH_2)_p$-OC_{3-10} cycloalkyl, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the alkyl, alkenyl, alkynyl, cycloalkyl, and heterocycloalkyl are optionally further substituted with 1-4 groups selected from halogen, =O, $=CH_2$, $=CF_2$, =CH-CH_3, =C-$(CH_3)_2$, OH, NH_2, CN, acetyl, -$S(O)_2CH_3$, C_{1-4} alkyl, C_{1-4} alkoxy, halogenated C_{1-4} alkyl, halogenated C_{1-4} alkoxy, -SCF_3, C_{3-10} cycloalkyl, 5- to 12-membered heterocyclyl, and -C≡C-C_{3-10} cycloalkyl;

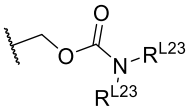
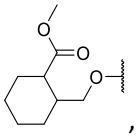
R^{L29} is selected from H, C_{1-4} alkyl, C_{2-6} alkenyl, and C_{2-6} alkynyl, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, and CN;

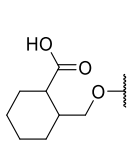
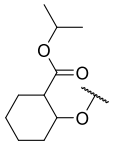
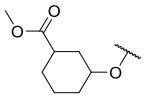
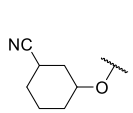
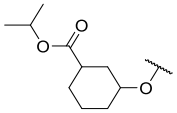
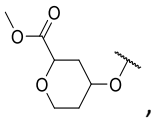
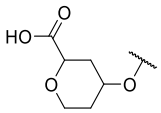
R^{L30} is selected from 6- to 14-membered bicyclic or tricyclic heterocyclyl, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the heterocyclyl is optionally further substituted with 1-4 groups selected from halogen, CN, OH, NH_2, C_{1-4} alkyl, and halogenated C_{1-4} alkyl;

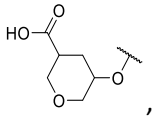
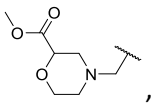
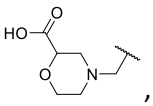
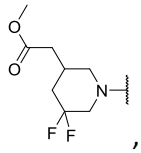
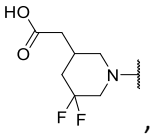
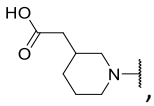
alternatively, R^{L24} and R^{L25} or R^{L26} and R^{L27}, together with the atoms to which they are attached, form a 5- to 7-membered heterocyclic ring containing 1-3 heteroatoms selected from N, O and S, wherein the heterocyclic ring is optionally further substituted with 1-3 groups selected from halogen, =O, OH, NH_2, CN, and C_{1-4} alkyl;

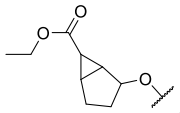
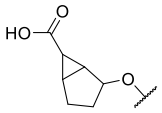
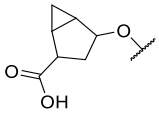
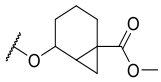
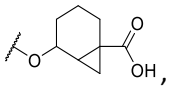
each p is independently selected from 0, 1, 2, 3 and 4;

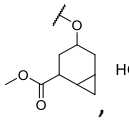
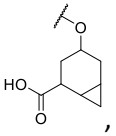
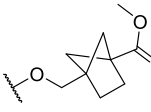
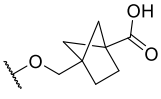
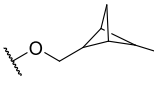
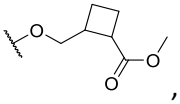
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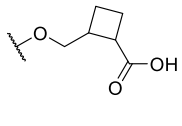
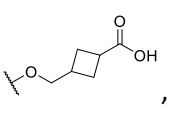
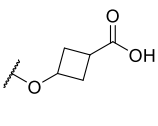
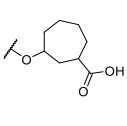
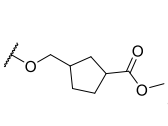
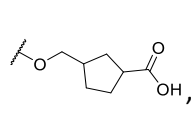
(1). for formula (I-2), when L_{2-2} is , L_{1-1}-A1 is not selected from ,

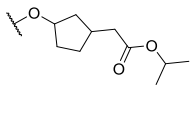
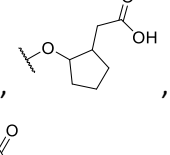
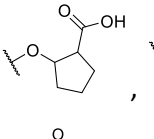
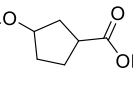
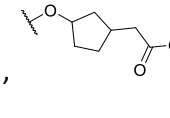
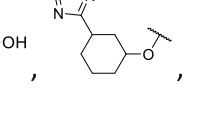
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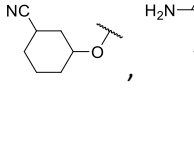
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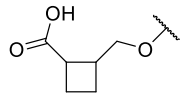
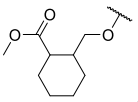
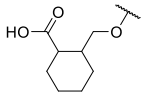
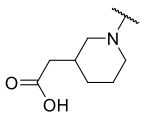
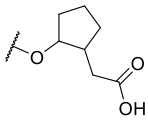
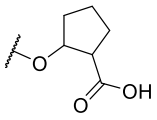
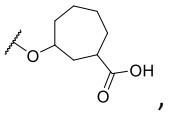
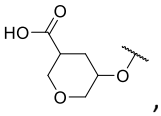
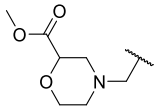
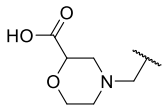
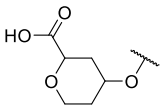
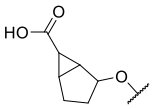
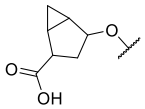
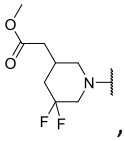
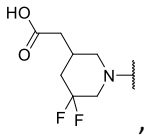
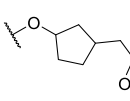
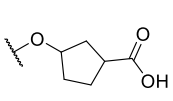
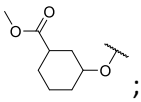
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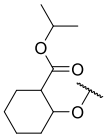
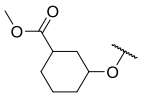
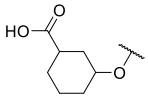
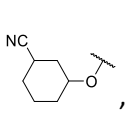
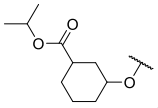
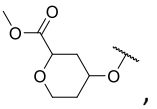
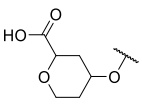
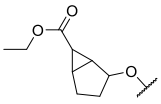
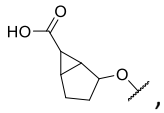
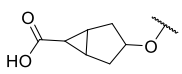
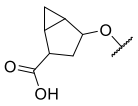
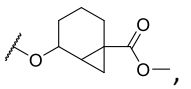
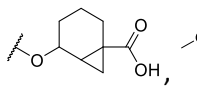
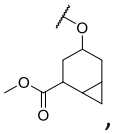
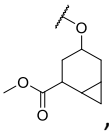
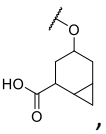
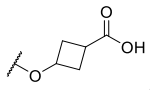
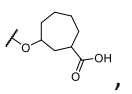
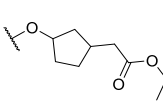
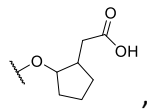
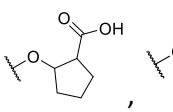
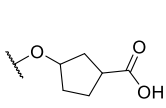
, , , , ,

, , , , , ,

, , , and ;

(2). for formula (I-2), when L_{2-2} is , L_{1-1}-A1 is not ;

(3). for formula (I-2b), $L_{1\text{-}1b}$-A1b is not selected from , , , , , , , , , , , , , , , , , and ;

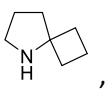
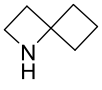
(4). for formula (I-2c), O-A1c is not selected from , , , , , , , , , , , , , , , , , , , , , , and .

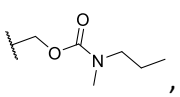
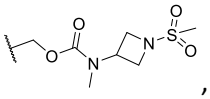
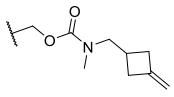
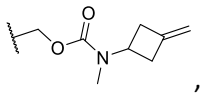
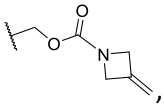
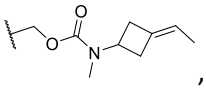
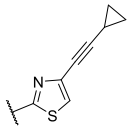
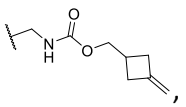
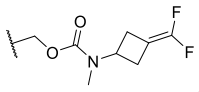
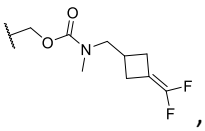
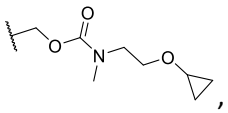
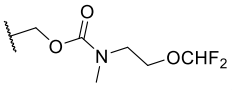
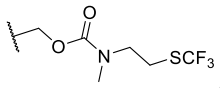
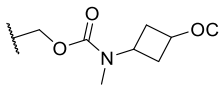
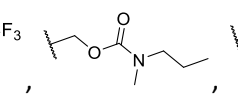
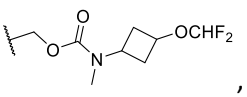
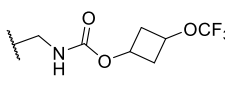
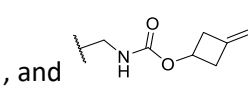
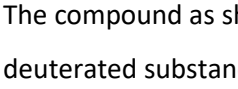
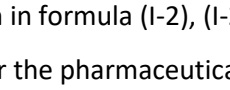
5. The compound as shown in formula (I-2), (I-2b) or (I-2c), or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 4, wherein rings A1, A1b, and A1c are selected from 3- to 8-membered monocyclic cycloalkyl, 6- to 12-membered fused cycloalkyl, 4- to 8-membered monocyclic heterocycloalkyl, 6- to 12-membered fused heterocycloalkyl, 6- to 10-membered spiroheterocyclyl, and 6- to 10-membered bridged heterocyclyl, or are absent, wherein the heterocycloalkyl, fused heterocycloalkyl, spiroheterocyclyl, and bridged heterocyclyl contain 1-3 heteroatoms selected from N, O and S; the cycloalkyl, heterocycloalkyl, fused heterocycloalkyl, spiroheterocyclyl, and bridged heterocyclyl are optionally further substituted with 1-4 R^A;

each R^A is independently selected from H, halogen, =O, CN, OH, C_{1-4} alkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, -OC_{1-2} alkyl, -$(CH_2)_p$-(5- to 8-membered heterocyclyl), -(a 3- to 6-membered carbocyclic ring)-$COOR^{a1}$, -$(CH_2)_p$-$COOR^{a1}$, $=CH_2$, $=CF_2$, =CH-CH_3 or =C-$(CH_3)_2$, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the alkyl, alkenyl, alkynyl, and heterocyclyl are optionally further substituted with 1-4 groups selected from halogen, OH, NH_2, CN, and -O-halogenated C_{1-2} alkyl;

L_{1-1} and L_{1-1b} are each independently selected from a bond, C_{1-4} alkyl, C_{2-4} alkenyl, C_{2-4} alkynyl, -O-, -O-C_{1-4} alkyl-, -S-, -S-C_{1-4} alkyl-, -C(O)NR^{L1}-, and -NR^{L1}C(O)-, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 R^{L1};

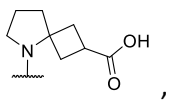
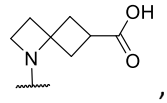
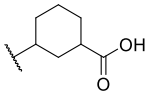
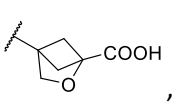
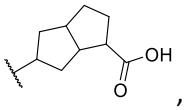
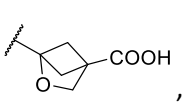
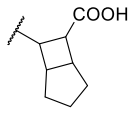
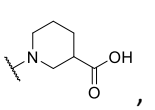
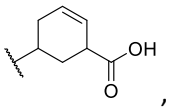
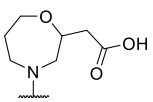
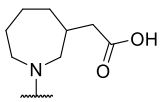
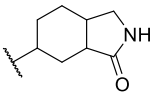
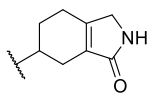
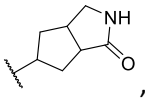
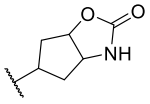
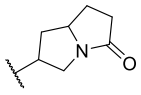
each R^{L1} is independently selected from H, halogen, OH, C_{1-2} alkyl, halogenated C_{1-2} alkyl, 3- to 6-membered cycloalkyl, and -COOH, wherein the alkyl and cycloalkyl are optionally further substituted with 1-4 groups selected from halogen, OH, and NH_2.

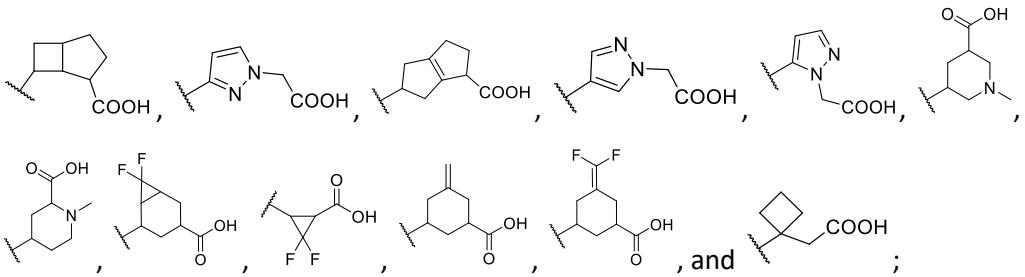
6. The compound as shown in formula (I-2), (I-2b) or (I-2c), or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 5, wherein rings A1, A1b, and A1c are each independently selected from one of the groups formed by the following structures optionally substituted with 1-4 R^A: , , ,

$L_{2\text{-}2}$ and $L_{2\text{-}2c}$ are each independently selected from , , , , , , , , , , , , , , , , , , , , , and .

7. The compound as shown in formula (I-2), (I-2a), (I-2b) or (I-2c), or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 6, wherein

rings A1, A1b, and A1c are each independently selected from the following structures:

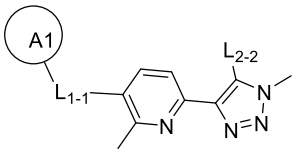
, , , , , , , , , , , , , , , , , , .



L_{1-1} and L_{1-1b} are each independently selected from a bond, $-OCH_2-$, $-OCH_2CH_2-$, -S-, $-OCH(CH_3)-$, $-OCH(CF_3)-$, , -O-, -C(=O)-, $-CH_2-$, $-CH=CH-CH_2-$, ethynyl, and -NHCO-;

each L_{1-1a} is independently selected from a bond, $-OCH_2-$, -S-, $-OCH(CH_3)-$, $-OCH(CF_3)-$, , -C(=O)-, $-CH_2-$, $-CH=CH-CH_2-$, ethynyl, -NHCO-, -NH-, $-N(CH_3)-$, and $-NHCH(CH_3)-$.

8. The compound as shown in formula (I), or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 1, having a structure of formula (I-6), wherein



(I-6)

L_{2-2} is selected from $-(CR^{L21}R^{L22})_p-OC(O)-N(CH_3)R^{L23}$, $-(CR^{L21}R^{L22})_p-OC(O)-NHR^{L23}$, and $-(CR^{L21}R^{L22})_p-N(R^{L26})C(O)O-R^{L23}$;

R^{L21}, R^{L22}, and R^{L26} are each independently selected from H and C_{1-4} alkyl;

R^{L23} is selected from $-(CH_2)_p-$(4- to 7-membered heterocyclyl) and $-(CH_2)_p-C_{3-10}$ cycloalkyl, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the cycloalkyl and heterocyclyl are further substituted with 1-4 groups selected from $=CH_2$, $=CF_2$, $=CH-CH_3$, and $=C-(CH_3)_2$;

ring A1 is selected from 3- to 12-membered carbocyclyl and 4- to 12-membered heterocyclyl, or is absent, wherein the heterocyclyl contains 1-3 heteroatoms selected from N, O and S; the carbocyclyl and heterocyclyl are optionally further substituted with 1-4 R^A;

when ring A1 is absent, L_{1-1} is $-OC_{1-6}$ alkyl substituted with one COOH;

L_{1-1} is selected from a bond, C_{1-6} alkyl, C_{2-6} alkenyl, C_{2-6} alkynyl, -O-, $-O-C_{1-6}$ alkyl-, -S-, $-S-C_{1-6}$ alkyl-, $-C(O)NR^{L1}-$, , $-NR^{L1}-$, and $-NR^{L1}-C_{1-6}$ alkyl-, wherein the alkyl, alkenyl, and alkynyl are optionally further substituted with 1-4 R^{L1};

R^A, R^{L1}, and p are as defined in claim 1.

9. The compound, or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to claim 1, wherein the compound is selected from one of the structures in Table 1 and Table 2.
10. A pharmaceutical composition or pharmaceutical preparation, comprising the compound, or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to any one of claims 1-9, and a pharmaceutically acceptable carrier and/or excipient.
11. The pharmaceutical composition or pharmaceutical preparation according to claim 10, comprising 1-1500 mg of the compound, or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to any one of claims 1-9, and a carrier and/or excipient.
12. Use of the compound, or the stereoisomer, the deuterated substance, or the pharmaceutically acceptable salt thereof according to any one of claims 1-9, or the composition according to claim 10 or 11 in the preparation of a medicament for treating/preventing an LPAR1-mediated disease.
13. The use according to claim 12, wherein the LPAR1-mediated disease is selected from idiopathic pulmonary fibrosis, progressive pulmonary fibrosis, systemic sclerosis, benign prostatic hyperplasia, multiple sclerosis, nerve injury, and neuralgia.