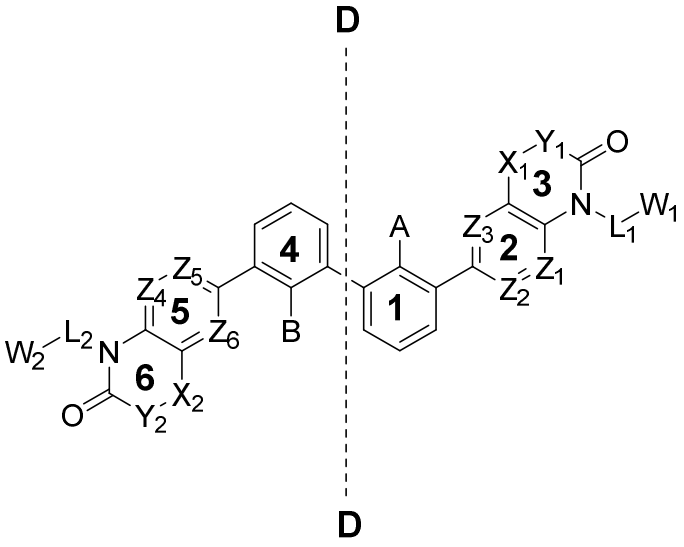
Claims

1. A compound of formula (I):



(I)

or a pharmaceutically acceptable salt, stereoisomer, mixture of stereoisomers, solvate, or tautomer thereof, wherein,

A and B each is independently selected from halogen, cyano, -N_3, alkyl and substituted alkyl, amine, alkylamine, alkoxy;

Z_1 is –CR^1= or –N=;

Z_2 is –CR^2=;

Z_3 is –CR^3= or –N=;

Z_4 is –CR^4= or –N=,

Z_5 is –CR^5=;

Z_6 is –CR^6= or –N=;

R^1 and R^4 each is independently –H, halogen, cyano, alkyl, cycloalkyl, substituted alkyl, alkenyl, alkynyl, aryl, amine, alkylamine, alkoxy;

R^2 and R^5 each is independently –H, halogen, cyano, alkyl, cycloalkyl, substituted alkyl, alkenyl, alkynyl, aryl, amine, alkylamine, alkoxy;

R^3 and R^6 each is independently –H, halogen, cyano, alkyl, cycloalkyl, substituted alkyl , alkenyl, alkynyl, aryl, amine, alkylamine, alkoxy;

Y_1 and Y_2 each is independently –$C(R^7)(R^8)$–, –CR^9=, –NR^{10}–, –O–, or –S–;

X_1 and X_2 each is independently –$C(R^{11})(R^{12})$–, –N=, –NR^{13}–, –S– or –O–;

R^7, R^8, R^9, R^{11}, and R^{12} each is independently –H, halogen, cyano, alkyl, cycloalkyl, substituted alkyl, alkenyl, alkynyl, aryl, amine, alkylamine, alkoxy;

R^{10} and R^{13} each is independently –H, alkyl, cycloalkyl, substituted alkyl, alkenyl, alkynyl, aryl, alkylamine, alkoxy;

L_1 and L_2 each is an alkyl, substituted alkyl or hetereoatom chain, containing m atoms between Ring 3 and W_1, and Ring 6 and W_2, wherein m = 0, 1, 2, 3, 4, 5 or 6; when m is 0, W_1 or W_2 is directly linked to the corresponding nitrogen in ring 3 or ring 6, respectively;

W_1 and W_2 each is independently hydrogen, a five member heterocyclic ring or substituted five member heterocyclic ring, a six member heterocyclic ring or substituted six member heterocyclic ring, a carboxylalkyl group or substituted carboxylalkyl group, a cyanoalkyl group or substituted cyanoalkyl group, an aminoalkyl group or substituted aminoalkyl group, a hydroxyalkyl group or substituted hydroxyalkyl group, an amino acid, an ester of amino acid, an amide of amino acid, a unnatural amino acid, an ester of unnatural amino acid or an amide of unnatural amino acid.

2. The compounds of claim 1, wherein

A and B each is independently selected from halogen, alkyl and substituted alkyl, cyano, and $–N_3$,

Z_1 is $–CR^1=$ or –N=;

Z_2 is $–CR^2=$;

Z_3 is $–CR^3=$ or –N=;

Z_4 is $–CR^4=$ or –N=,

Z_5 is $–CR^5=$;

Z_6 is $–CR^6=$ or –N=;

R^1 and R^4 each is independently –H or –F, –Cl, or $–CH_3$;

R^2 and R^5 each is independently, –H, –Cl, –F, $–CH_3$, or $–NH_2$;

R^3 and R^6 each is independently –H, –Cl, –F, $–CH_3$, or $–NH_2$;

X_1 and X_2 each is independently $–C(R^{11})(R^{12})–$, –N=, –NH–, $–N(R^{13})–$ or –O–;

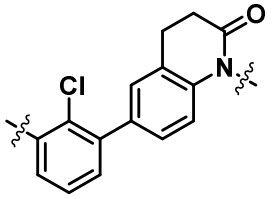
Y_1 and Y_2 each is independently $–CH_2–$, –CH=, –NH–, –O–, $–C(R^7)(R^8)–$;

R^7, R^8, R^{11}, and R^{12} each is independently –H, –F, –Cl, or $–CH_3$;

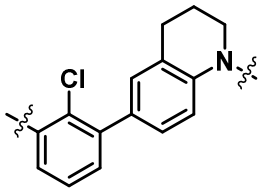
L_1 and L_2 each is an alkyl or substituted alkyl containing m carbon atoms, wherein m = 0, 1, 2, 3, 4, 5 or 6; when m is 0, W_1 or W_2 is directly linked to the corresponding nitrogen in ring 3 or ring 6, respectively;

W_1 and W_2 each is independently hydrogen, a five member heterocyclic ring or substituted five member heterocyclic ring, a six member heterocyclic ring or substituted six member heterocyclic ring, a carboxylalkyl group or substituted carboxylalkyl group, a cyanoalkyl group or substituted cyanoalkyl group, an aminoalkyl group or substituted aminoalkyl group, a hydroxyalkyl group or substituted hydroxyalkyl group, an amino acid, an ester of amino acid, an amide of amino acid, a unnatural amino acid, an ester of unnatural amino acid or an amide of unnatural amino acid.

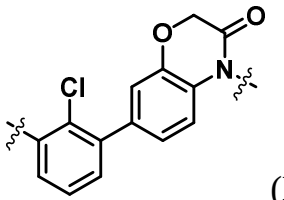
3. The compound of claim 1, wherein the compound comprises a core structure selected from the group consisting of formulas (II) to (XXIII):



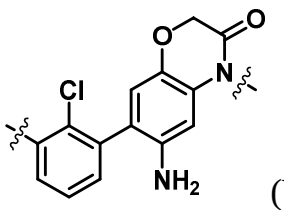
(II)



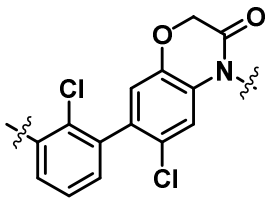
(III)



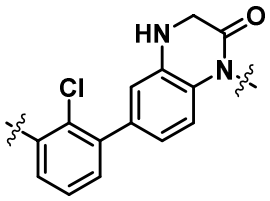
(IV)



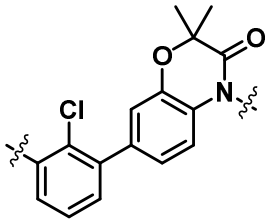
(V)



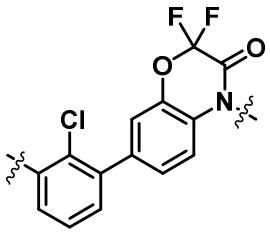
(VI)



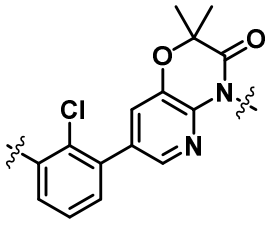
（VII）



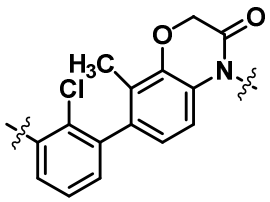
(VIII)



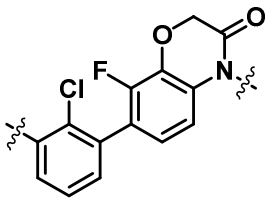
(IX)



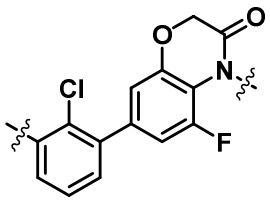
(X)



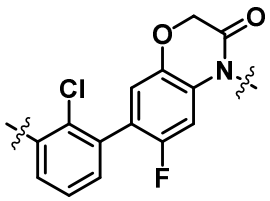
(XI)



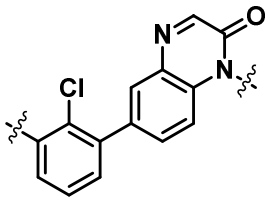
(XII)



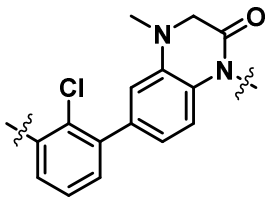
(XIII)



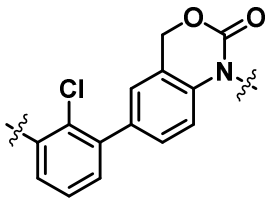
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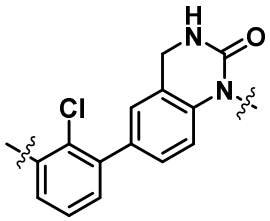
(XV)



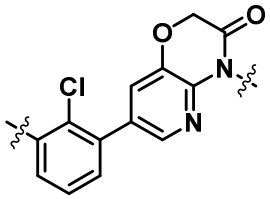
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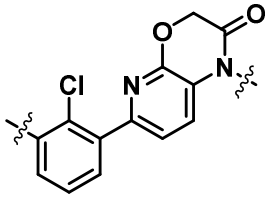
(XVII)



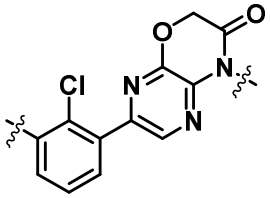
(XVIII)



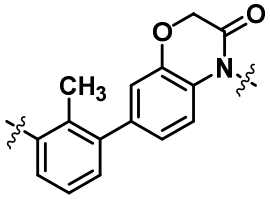
(XIX)



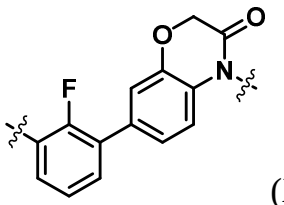
(XX)



(XXI)

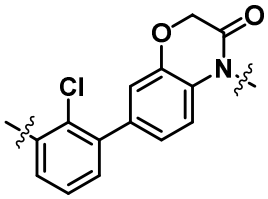


(XXII)

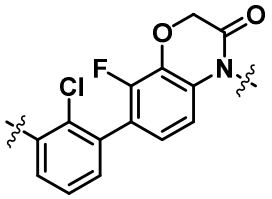


(XXIII);

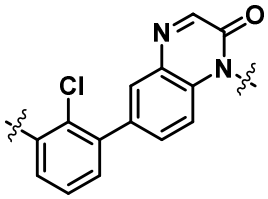
preferably, wherein the compound comprises the core structures of:



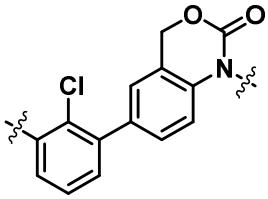
(IV),



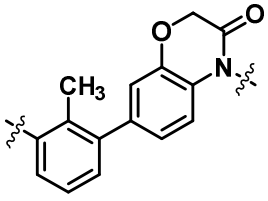
(XII),



(XV),



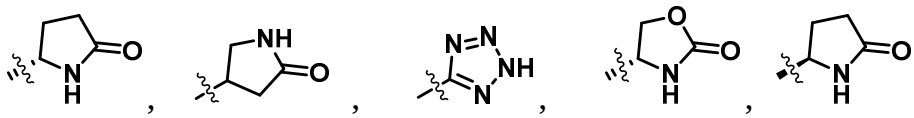
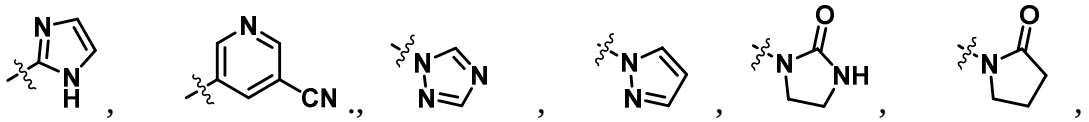
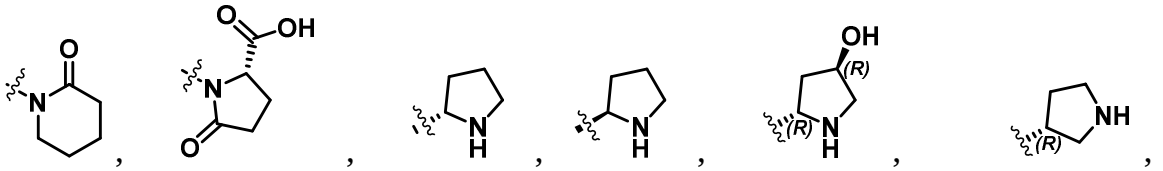
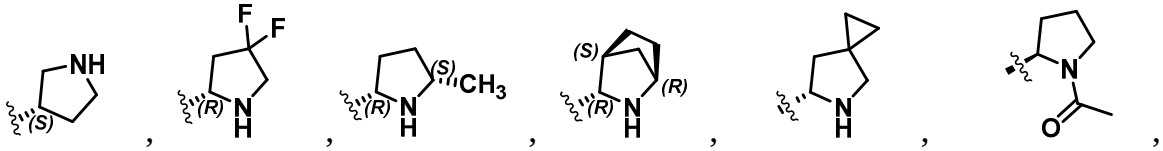
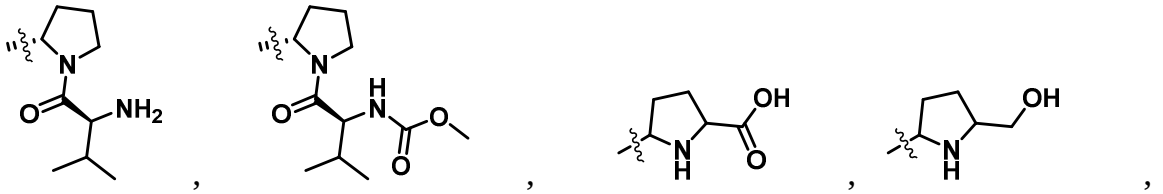
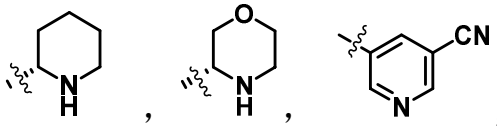
(XVII), or



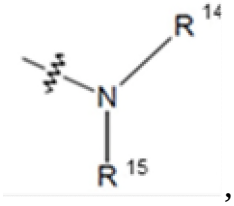
(XXII);

preferably, wherein L_1 and L_2 each is independently C_1-C_3 alkyl.

4. The compound of any one of claims 1-3, wherein W_1 and W_2 each is independently a type I side chain, wherein type I side chains consist of

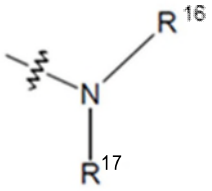






, –C(O)ONa, –CN, –CH_2OH and –CH_2NH_2.

5. The compound of any one of claims 1-3, wherein W_1 and W_2 each is independently a type II side chain, wherein type II side chains for W_1 have the general formula of:


,

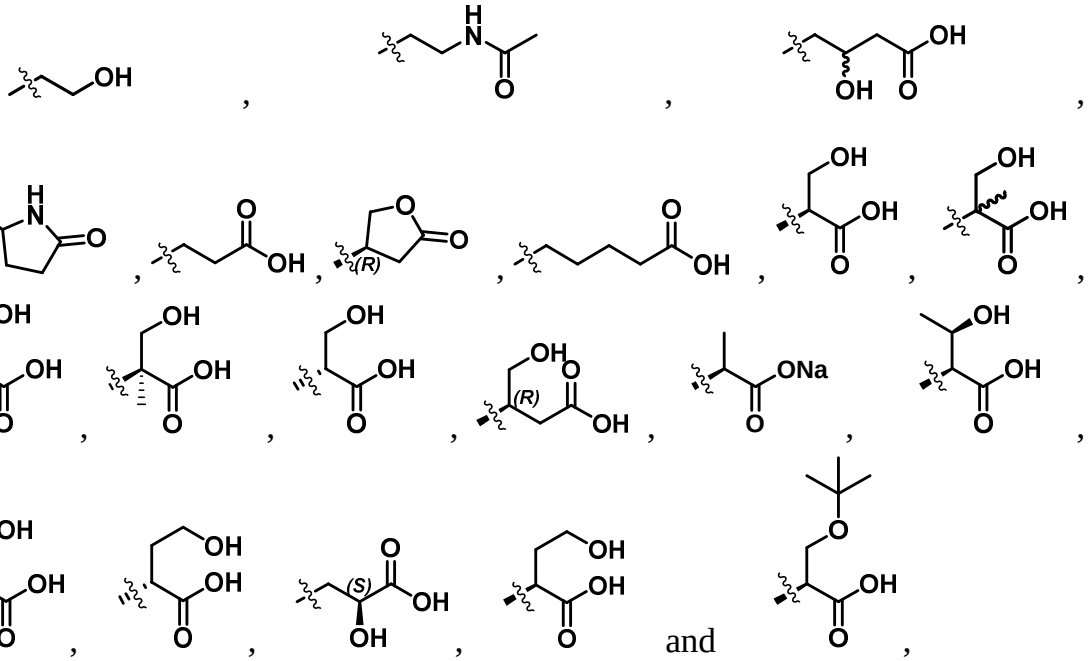
wherein R^{14} and R^{15} are independently –H, alkyl, or substituted alkyl,

wherein type II side chains for W_2 have the general formula of:



wherein R^{16} and R^{17} are independently –H, alkyl, or substituted alkyl;

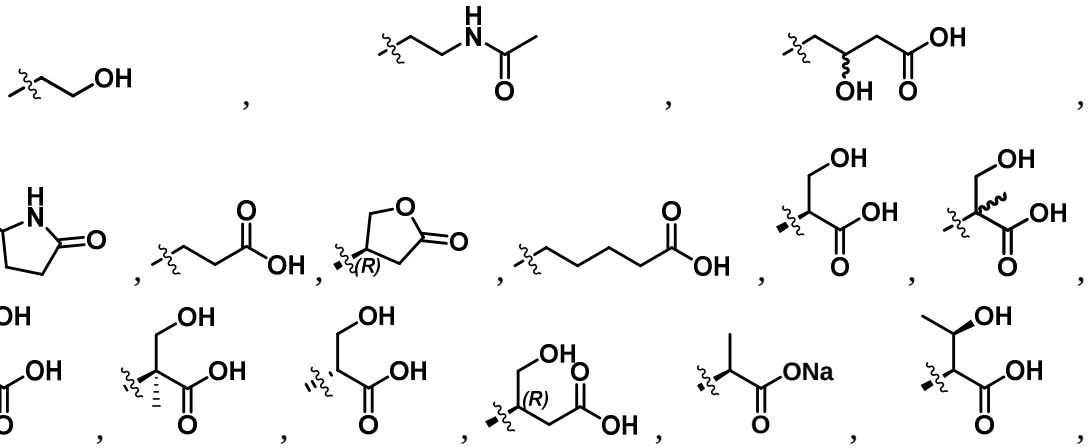
preferably, wherein R^{14} is one of

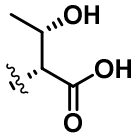
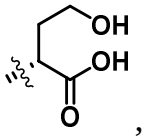
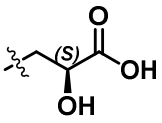
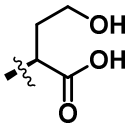
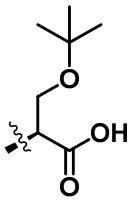


and

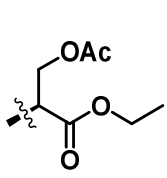
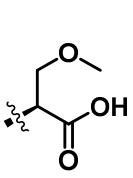
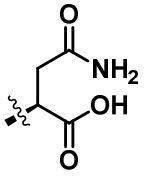
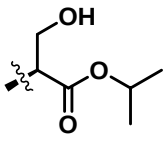
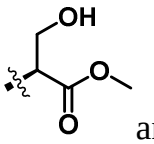
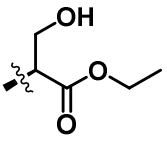
R^{15} is independently –H, alkyl, or substituted alkyl,

wherein R^{16} is one of







and , and R^{17} is independently –H, alkyl, or substituted alkyl;

preferably, wherein R^{14} and R^{16} each is independently selected from the group of






and ;

preferably, wherein W_1 or W_2 is L-serine;

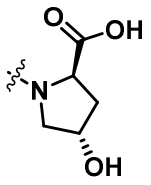
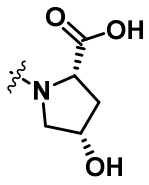
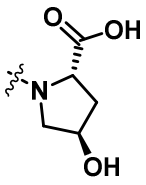
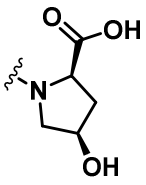
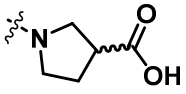
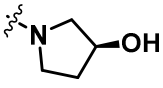
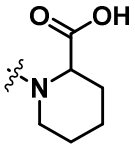
preferably, wherein both W_1 and W_2 are L-serine;

preferably, wherein W_1 or W_2 is an ester of L-serine;

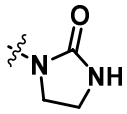
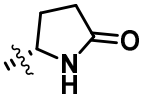
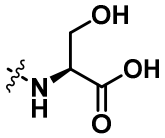
preferably, wherein both W_1 and W_2 are ester of L-serine;

preferably, wherein W_1 and/or W_2 is an ester of L-serine;

preferably, wherein W_1 and W_2 is independently selected from the group consisting of:

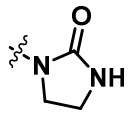
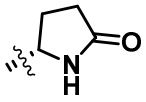
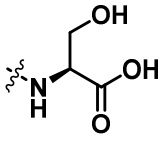







and ;

preferably, wherein

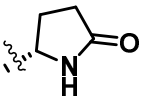
W_1 is ,  or , and

W_2 is H, and L_2 is absent (i.e., m = 0);

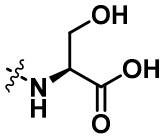
preferably, wherein

W_1 is ,  or , and W_2 is a type I or type II side chain;

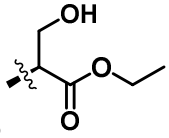
preferably, wherein

W_1 is  and W_2 is a type I or type II side chain;

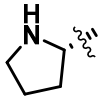
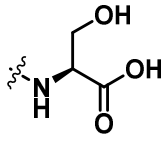
preferably, wherein

W_1 is  and W_2 is a type I or type II side chain;

preferably, wherein

W_1 is  and W_2 is a type I or type II side chain;

preferably, wherein

W_1 is  and W_2 is ;

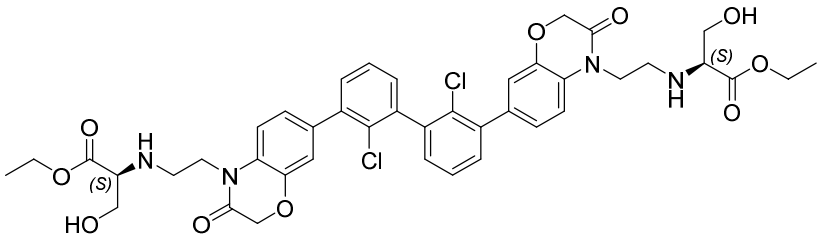
preferably, wherein L_1 and L_2 each is independently a C_1-C_3 alkyl.

6. The compound of claim 1, wherein the compound is selected from the group consisting of Compound Nos. 281, 303, 448, 338, 354, 361, 363, 372, 376, 381, 382, 388, 395, 396, 401, 402, 457, 466, 481, 445, 449, 454, 460, 461, 465, 468, 469, 470, 471, 475, 476, 478, 482, 483, 484, 490, 491, 493, 513, 527, 528, 536, 537, 541, 545, 551, 552, 553, 560, 566, 570, 571, 573, 588, 479, 480, 563, 550, 554, 589, 561, 557, 586, 585, 514, 373, 374, 375, 378, 384, 386, 427, 394, 397, 408, 411, 503, 530, 531, 535, 539, 540, 412, 413, 415, 459, 422, 430, 472, 567, 529, 558, 559, 538, 429, 385, 533, 516, 515, 542, 488, 489, 492, 450, 517 of Table 1, or pharmaceutically acceptable salts thereof, stereoisomers thereof, mixtures of stereoisomers thereof, or tautomers thereof;

preferably, wherein the compound is selected from the group consisting of

Compound Nos. 338, 361, 411, 465, 475, 483, 529, 533, 537, 541, 554, 585, 613, 614, 619, 620, 628, 633, 648, 649 of Table 1, or pharmaceutically acceptable salts thereof, stereoisomers thereof, mixtures of stereoisomers thereof, or tautomer thereof.

7. The compound of any one of claims 1-3, wherein the compound is



.

8. A pharmaceutical composition which contain the compound of any one of claims 1-7, or a pharmaceutically acceptable salt, stereoisomer, mixture of stereoisomers, solvate, or tautomer thereof.

9. The compound of any one of claims 1-7, or a pharmaceutically acceptable salt, stereoisomer, mixture of stereoisomers, solvate, or tautomer thereof, or or the pharmaceutical composition of claim 8, for use in the treatment of a disease or condition relating to the interaction between PD-L1 and PD-1.

10. The compound of Claim 9, wherein the disease is cancer.