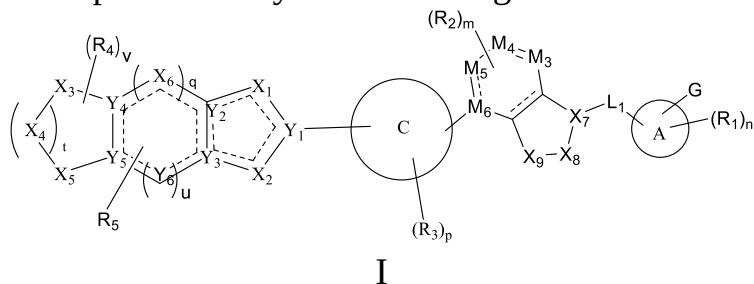
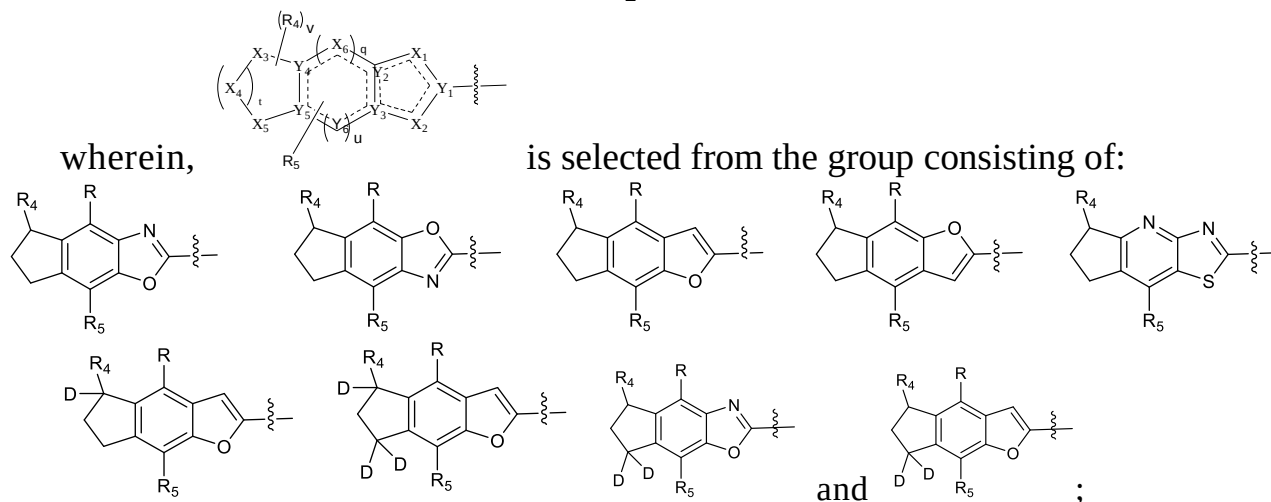


Claims

1. A compound represented by the following formula I:



5



10 n, m, p, v are each independently selected from the group consisting of 0, 1, 2, 3, 4, and 5;

X_7 is CR;

X_8 and X_9 are each independently $C(R)_2$;

$M_3, M_4,$ and M_5 are each independently CR;

R is H;

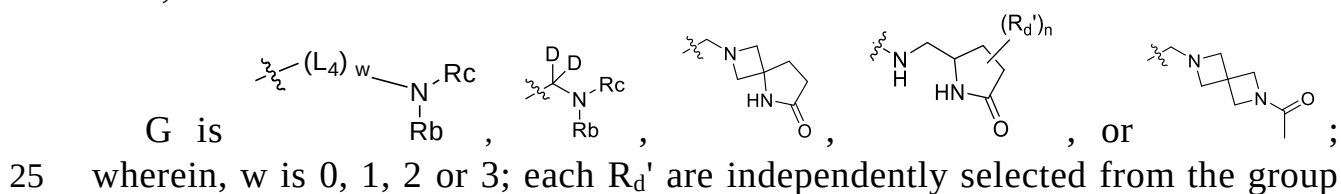
15 M_6 is C;

and --- represents single bond or double bond;

C is each independently selected from the group consisting of substituted or unsubstituted C6 arylene, and substituted or unsubstituted 5-6 membered heteroarylene having 1-3 heteroatoms;

20 A is selected from the group consisting of substituted or unsubstituted 5-6 membered heteroaryl, and substituted or unsubstituted C6 aryl;

L_1 is selected from the group consisting of C1-C4 alkylene, -S-, -O-, and -NH-;



25 wherein, w is 0, 1, 2 or 3; each R_d' are independently selected from the group

consisting of H, substituted or unsubstituted C₁-C₆ alkyl, substituted or unsubstituted C₃-C₁₀ cycloalkyl, and substituted or unsubstituted C₆-C₁₀ aryl;

each L₄ is substituted or unsubstituted C₁-C₄ alkylene, or NR_f; wherein, a hydrogen on a carbon atom of the substituted or unsubstituted C₁-C₄ alkylene may be each independently substituted by deuterium, provided that a structure formed by each L₄ is chemically stable; R_g is selected from the group consisting of H, substituted or unsubstituted C₁-C₆ alkyl;

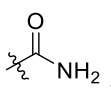
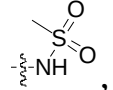
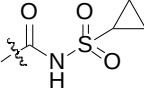
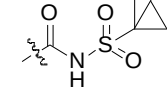
R_b and R_c are each independently selected from the group consisting of H and substituted or unsubstituted C₁-C₈ alkyl; or R_b and R_c together with the adjacent N atom form substituted or unsubstituted 3-10 membered heterocyclyl having 1-3 heteroatoms selected from N, S and O;

R₁, R₂, R₃ and R₅ are each independently selected from the group consisting of H, -CN, trifluoromethyl, -CHF₂, -OCF₃, -OCHF₂, sulfonamido, nitro, hydroxyl, halogen, substituted or unsubstituted C₁-C₁₀ alkyl, substituted or unsubstituted C₁-C₆ alkoxy, substituted or unsubstituted C₃-C₈ cycloalkyl, -CN, hydroxyl, and substituted or unsubstituted C₁-C₆ amino;

R₄ is selected from the group selected from NR_dR_e;

R_d and R_e are each independently selected from the group consisting of H, substituted or unsubstituted C₁-C₆ alkyl, and substituted or unsubstituted C₃-C₁₀ cycloalkyl; or R_d and R_e together with the adjacent N atom form substituted or unsubstituted 3-10 membered heterocyclyl having 1-3 heteroatoms selected from N, S and O;

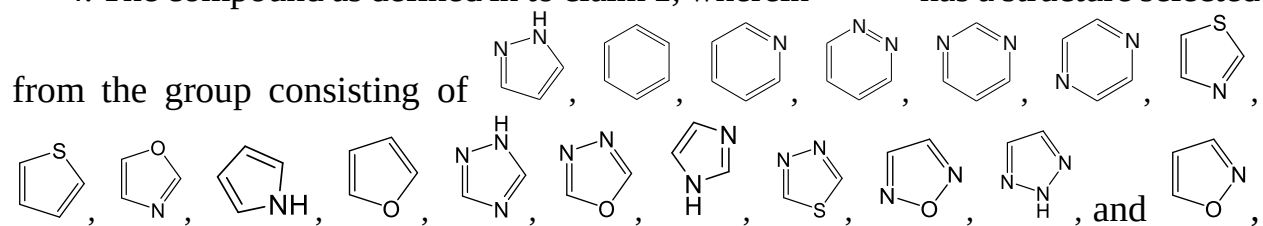
unless otherwise specified, the "substituted" refers to substitution with one or more substituents selected from the group consisting of halogen -CH₂Cl, -CHCl₂, -CCl₃, -CH₂F, -CHF₂, -CF₃, oxo, -CN, hydroxyl, amino, C₁-C₆

alkylamino, carboxyl, -NHAc, , , , , and a group unsubstituted or substituted by R_z, wherein the group is selected from C₁-C₆ alkyl, C₁-C₆ alkoxy, C₃-C₈ cycloalkyl, and 5-10 membered heterocyclyl with 1-3 heteroatoms selected from N, S and O; the R_z substituent is selected from the group consisting of halogen, hydroxyl, carboxyl, cyano, C₁-C₆ alkoxy, and C₁-C₆ alkylamino;

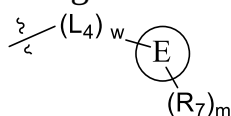
in the above formulas, any one of the heteroatom is selected from the group consisting of B, P, N, S and O.

2. The compound as defined in claim 1, or the optical isomer, hydrate, solvate thereof, or the pharmaceutically acceptable salt thereof, wherein  is benzene ring.

3. The compound as defined in claim 2, wherein R₃ is methyl, C₁-C₆ alkyl or alkoxy; C₃-C₆ cycloalkyl, -F, Cl, Br, -CH₂Cl, -CH₂Br, -CHCl₂, -CCl₃, -CH₂F, -CHF₂, -CF₃, -CN, hydroxyl, amino or alkyl substituted amino.

4. The compound as defined in to claim 1, wherein $\textcircled{\text{A}}$ has a structure selected from the group consisting of , wherein the bonding position of the ring is N or C.

5. The compound as defined in claim 1, or the optical isomer, hydrate, solvate thereof, or the pharmaceutically acceptable salt thereof, wherein $\textcircled{\text{A}}$ ring has a substituent as shown in the following formula IV:



IV

wherein, w is 0, 1, 2, or 3;
each L_4 is independently selected from the group consisting of substituted or unsubstituted C1-C4 alkylene, and NR_f ; R_f is selected from the group consisting of H, substituted or unsubstituted C₁-C₆ alkyl; wherein, a hydrogen on a carbon atom of the substituted or unsubstituted C1-C4 alkylene is each independently optionally substituted by deuterium, provided that a structure formed by each L_4 is chemically stable;

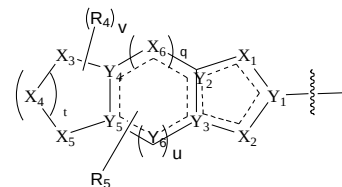
$\textcircled{\text{E}}$ is selected from the group consisting of substituted or unsubstituted C3-C10 cycloalkyl, and substituted or unsubstituted 3-10 membered heterocyclyl having 1-3 heteroatoms selected from B, P, N, S and O;

each R_7 is independently selected from the group consisting of substituted or unsubstituted C1-C6 alkyl, -CN, hydroxy, amino, carboxyl; R_f is defiend as above; wherein a hydrogen on a carbon atom of R_f is optionally independently substituted by deuterium; wherein, the substituted means being substituted by a group selected from halogen, hydroxyl, carboxyl, cyano, and C1- C6 alkoxy.

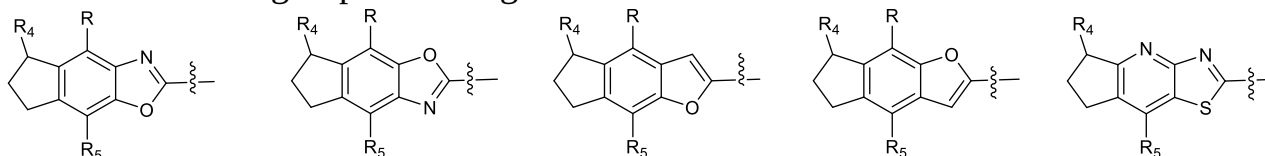
6. The compound as defined in claim 5, wherein w is 1, L_4 is C1-C4 alkylene, and $\textcircled{\text{E}}$ is 3-8 membered nitrogen-containing heterocyclyl, or substituted or unsubstituted 4-10 membered cyclic amido, wherein a hydrogen on the ring-forming carbon atom of 3-8 membered nitrogen-containing heterocyclyl, and substituted or unsubstituted 4-10 membered cyclic amido is optionally independently substituted by deuterium.

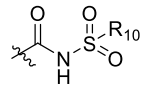
7. The compound as defined in claim 5, wherein $(L_4)_w$ is -CH₂-NH-CH₂-, and $\textcircled{\text{E}}$ is 3-8 membered nitrogen-containing heterocyclyl, or substituted or unsubstituted 4-10 membered cyclic amido, wherein a hydrogen on the ring-forming

carbon atom of 3-8 membered nitrogen-containing heterocyclyl, and substituted or unsubstituted 4-10 membered cyclic amido is optionally independently substituted by deuterium.

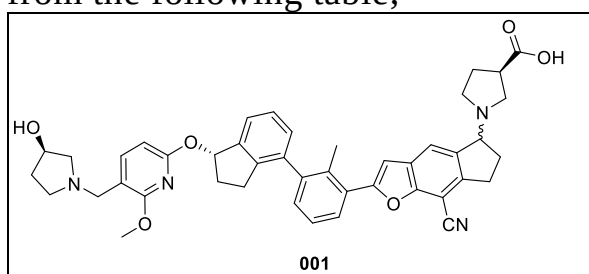
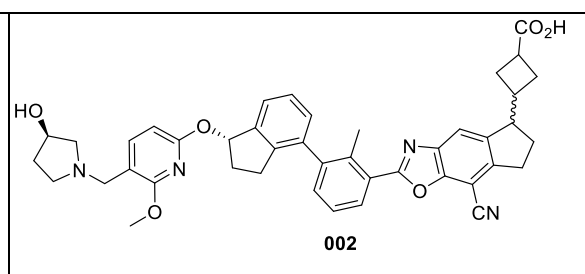
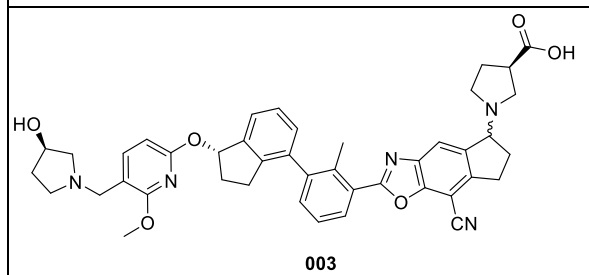
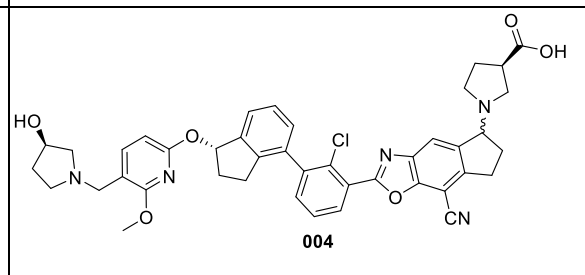


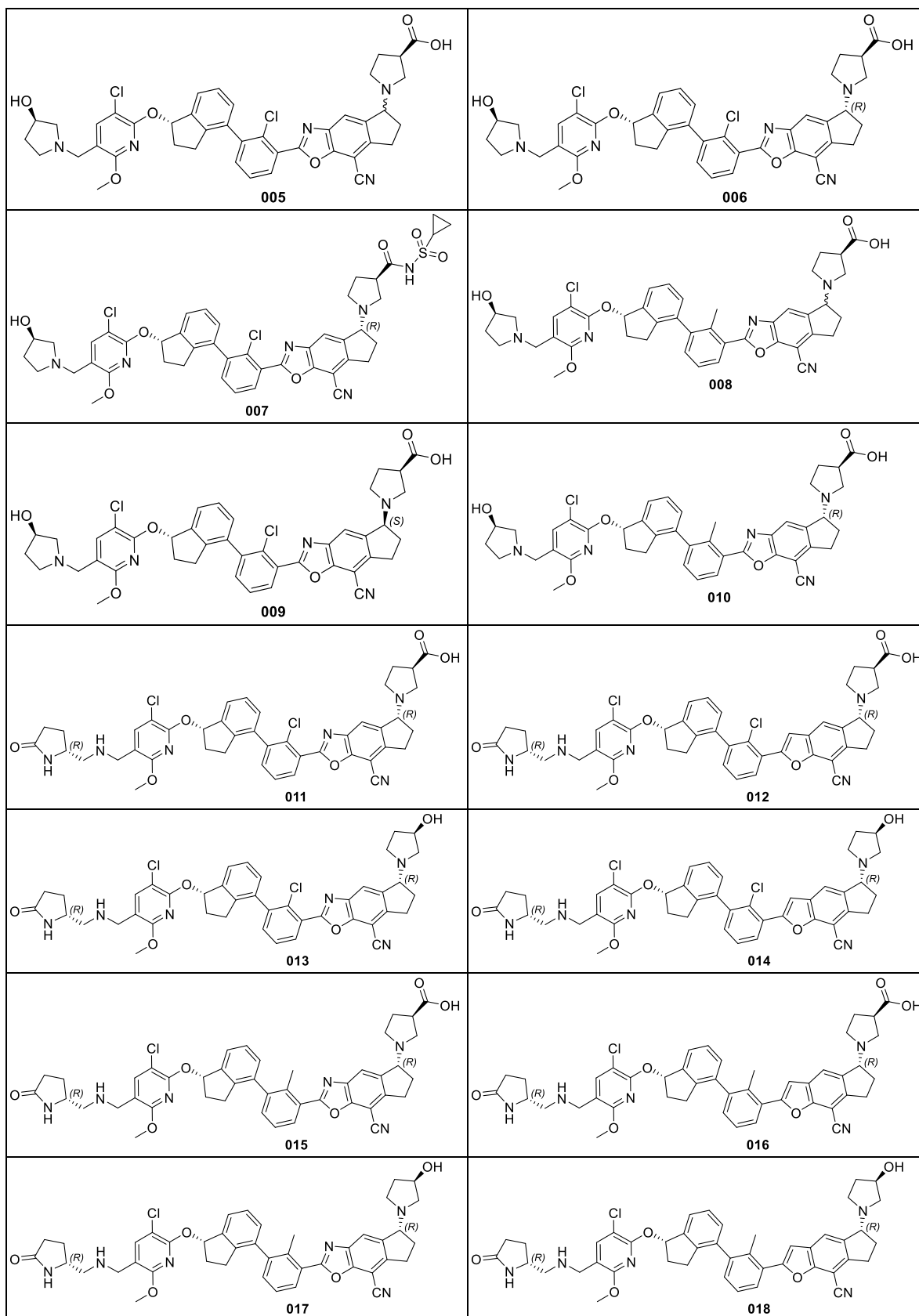
- 5 8. The compound as defined in claim 1, wherein
selected from the group consisting of:

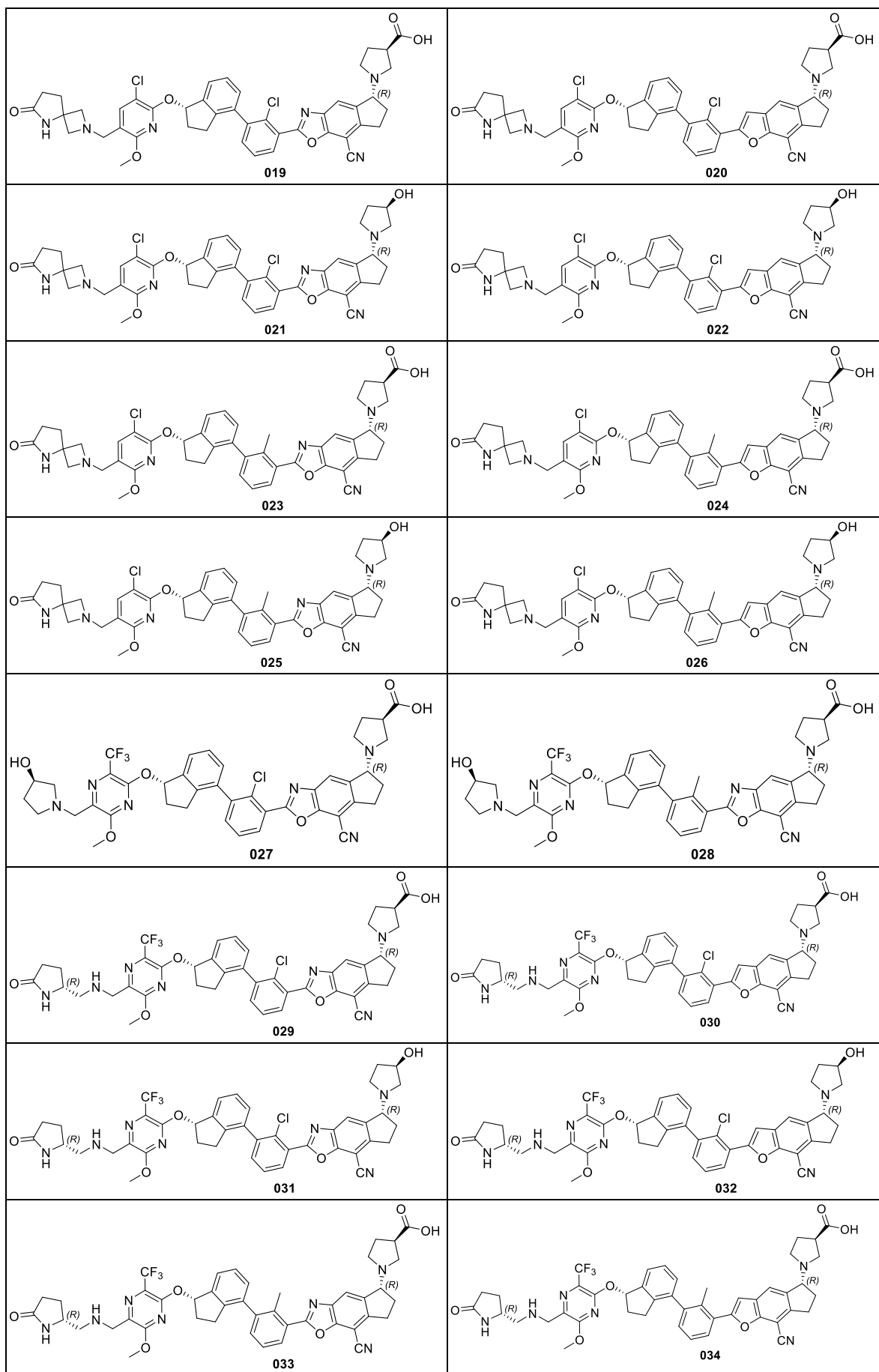


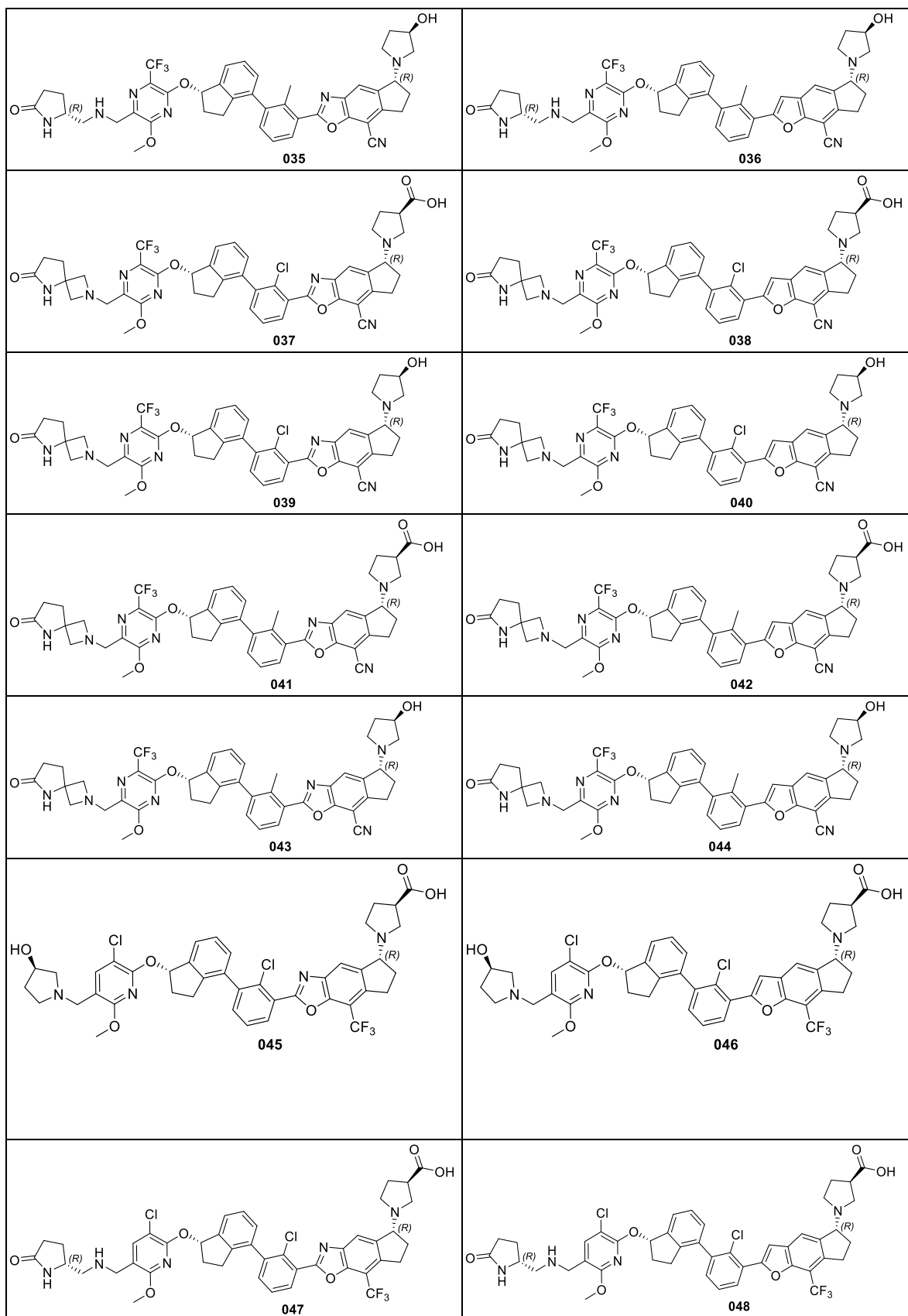
- 10 9. The compound as defined in claim 1, wherein R₄ is selected from the group
consisting of -NR_dR_e; R_d and R_e are each independently selected from the group
consisting of H, substituted or unsubstituted C₁-C₆ alkyl, and substituted or
unsubstituted C₃-C₁₀ cycloalkyl; or R_d and R_e together form substituted or
unsubstituted 3-10 membered heterocyclyl having 1-3 heteroatoms selected
from N, S and O; wherein the substituted means being substituted by a
15 substituent selected from carboxyl, hydroxyl, , , , and
; R₁₀ is substituted or unsubstituted C₃-C₁₀ cycloalkyl, wherein a
hydrogen on a carbon atom of R_d, R_e and R₁₀ is optionally independently
substituted by deuterium.

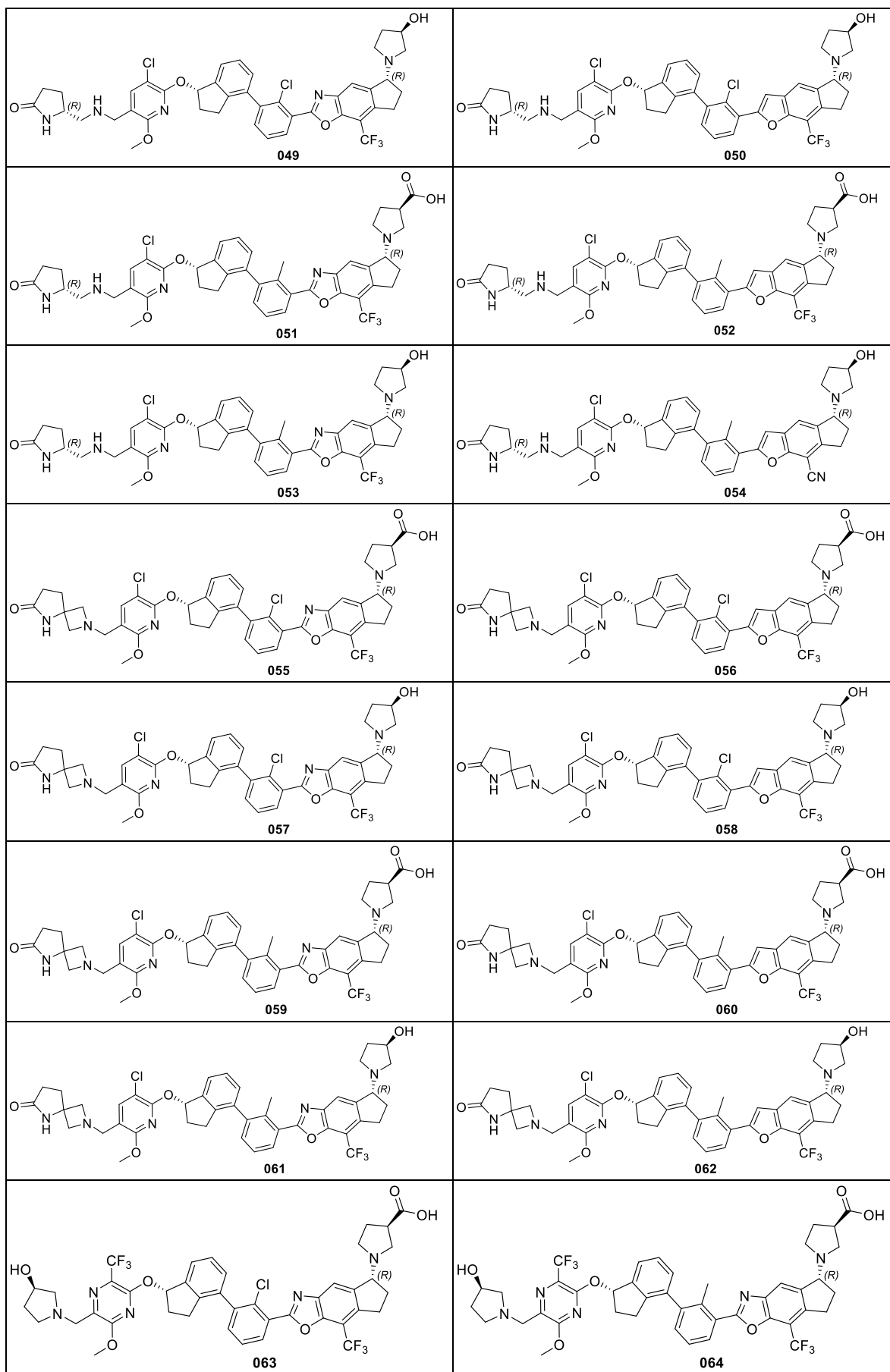
- 20 10. The compound as defined in claim 1, wherein the compound is selected
from the following table;

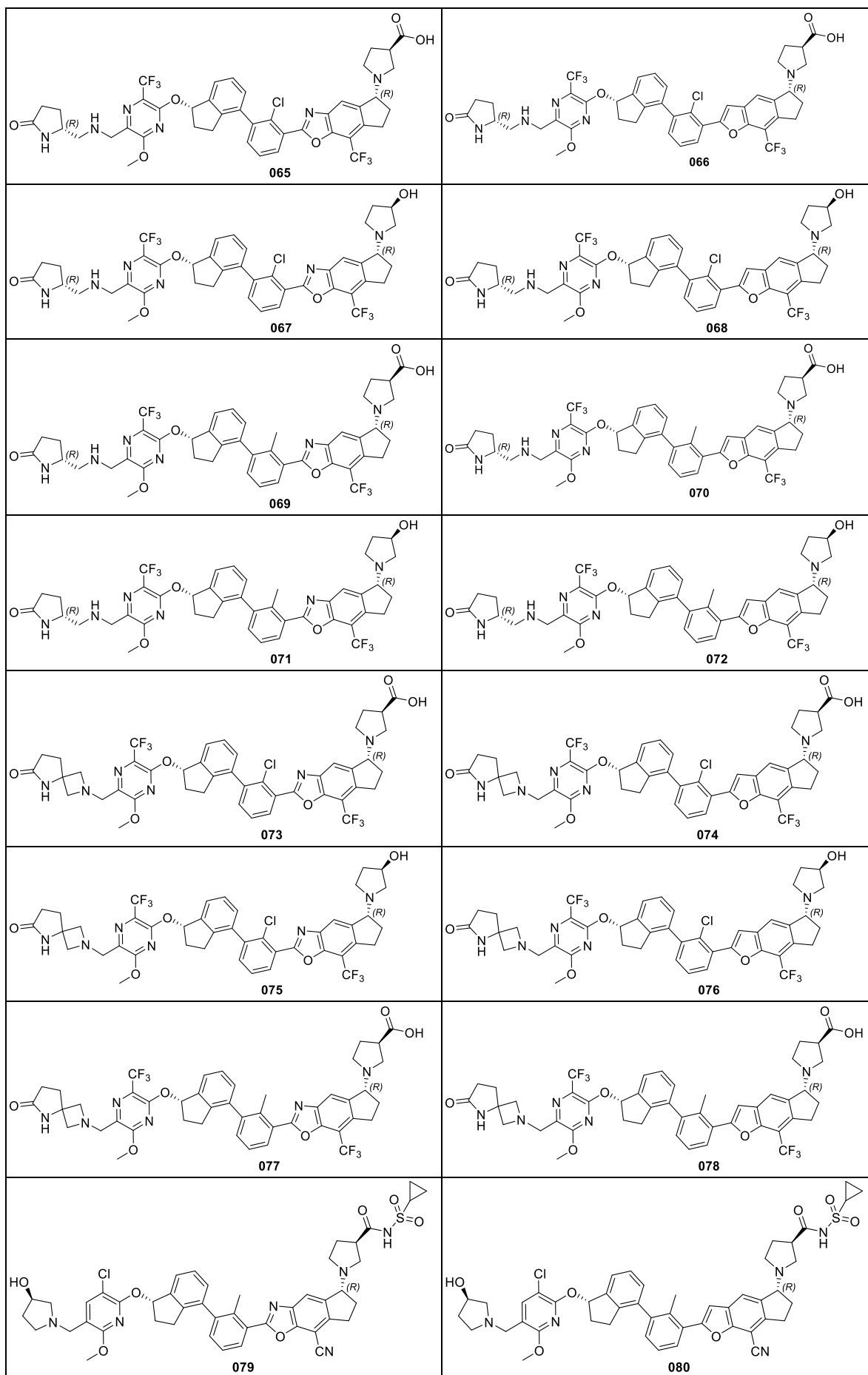
 001	 002
 003	 004

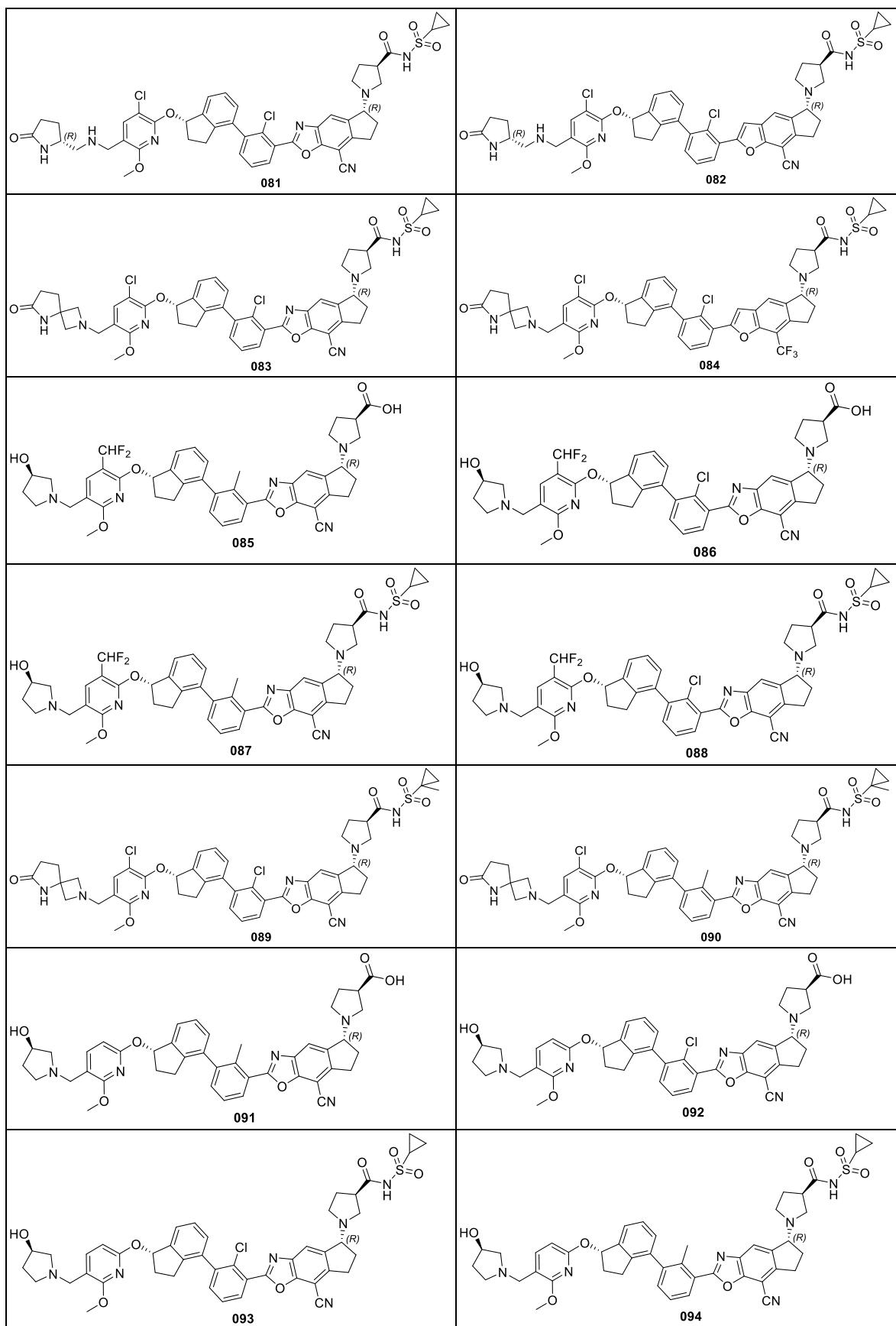


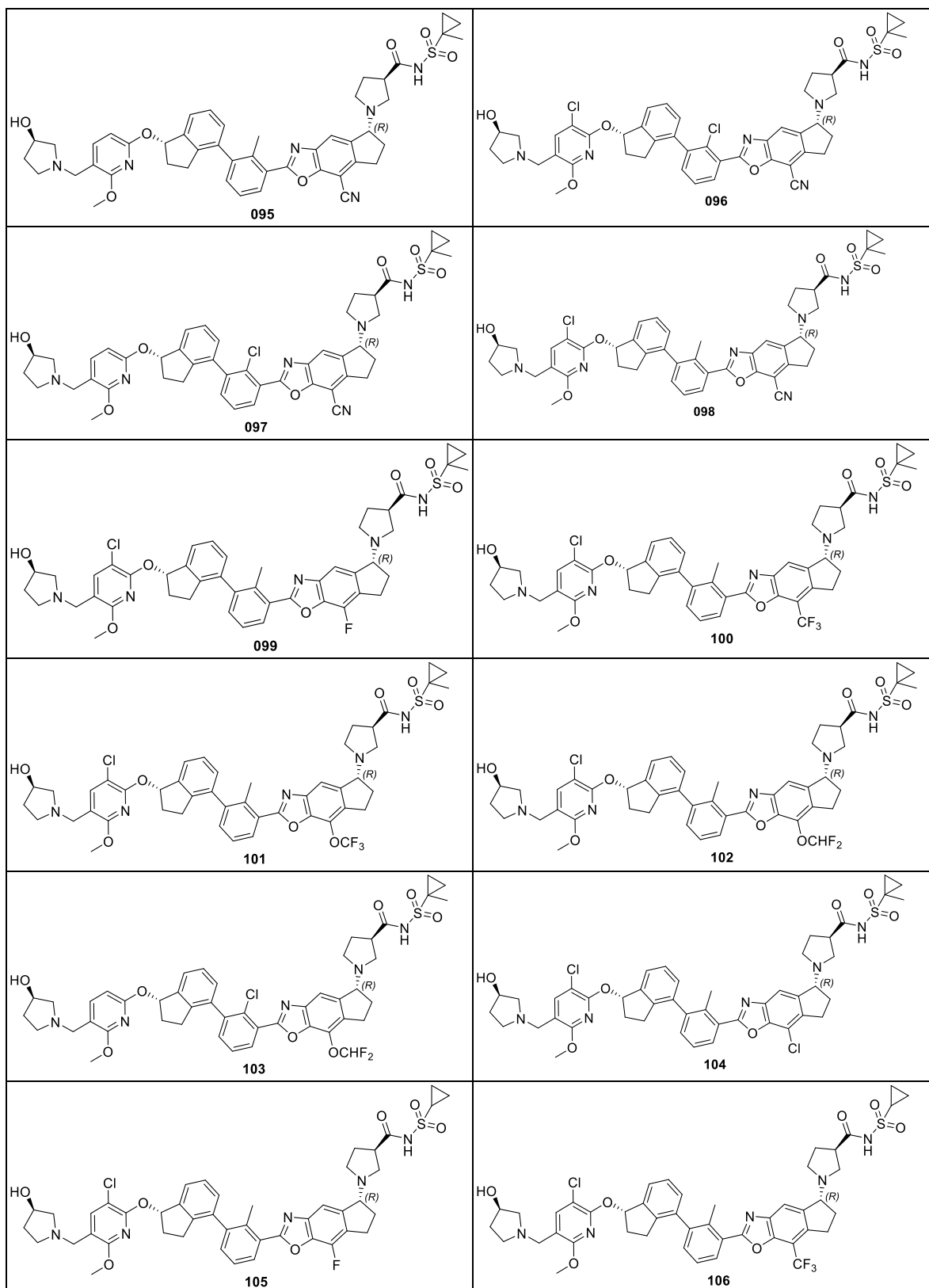


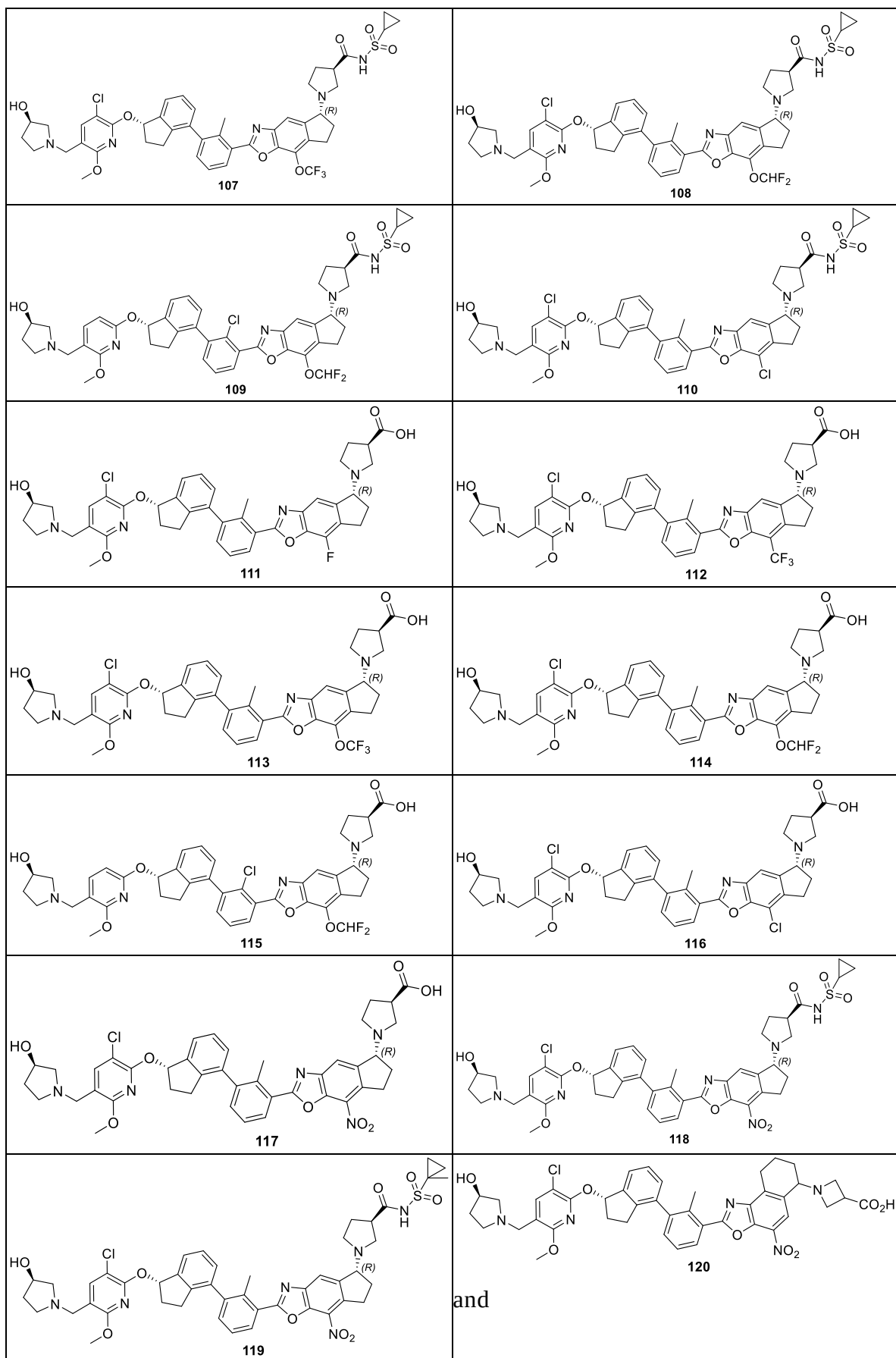




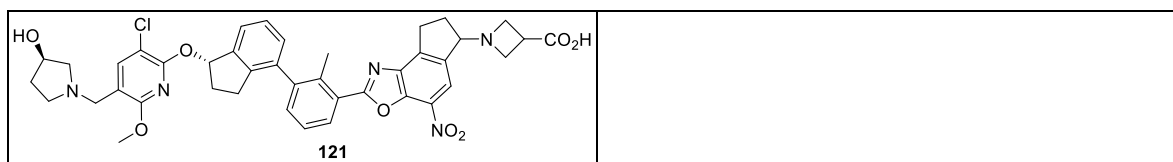






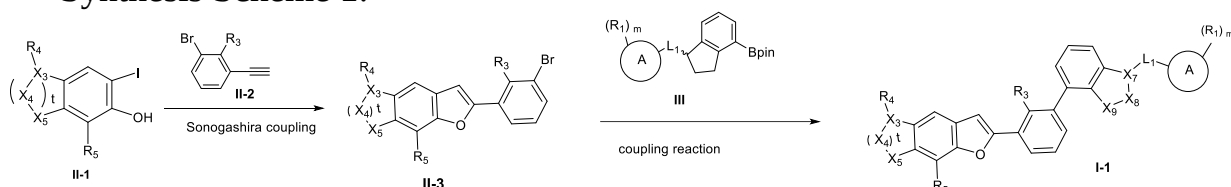


and



11. A preparation method of a compound of formula I as defined in claim 1, wherein the compound of formula I is the compound of formula I-1 and I-2, and the method comprises steps selected from the steps shown in Synthesis Scheme 1 or 2:

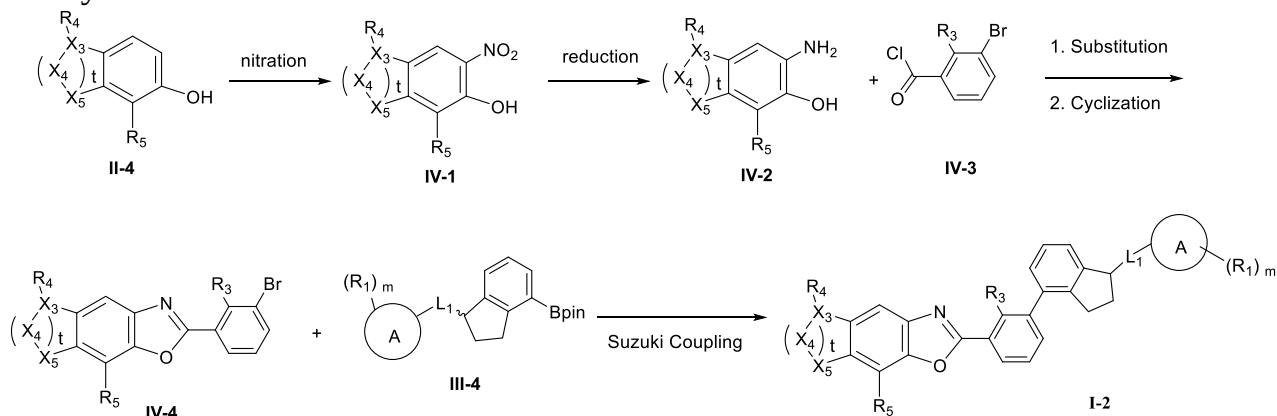
5 Synthesis Scheme 1:



(a) subjecting intermediates II-1 and II-2 as raw materials to Sonogashira coupling reaction catalyzed by palladium catalyst to obtain intermediate II-3;

10 (b) subjecting II-3 and III as raw materials to a coupling reaction in the presence of palladium catalyst and ligand to obtain intermediate I-1;

Synthesis Scheme 2:



(a) reacting compound II-4 as a raw material with a nitrifying agent to form intermediate IV-1;

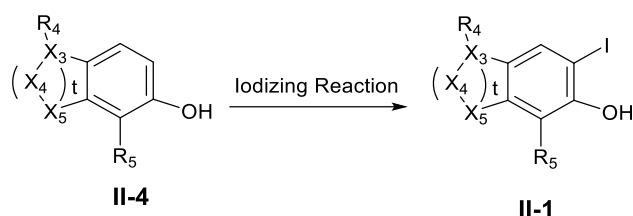
15 (b) subjecting IV-1 as a raw material to a reduction reaction under reducing condition to form intermediate IV-2;

(c) subjecting IV-2 and IV-3 as raw materials to an affinity substitution reaction under alkaline condition to obtain amide intermediate; and then subjecting to a cyclization reaction in the presence of suitable dehydration reagent to obtain an intermediate IV-4;

(d) subjecting IV-4 and III-4 as raw materials to a coupling reaction under the conditions of catalyst and ligand to form target product I-2;

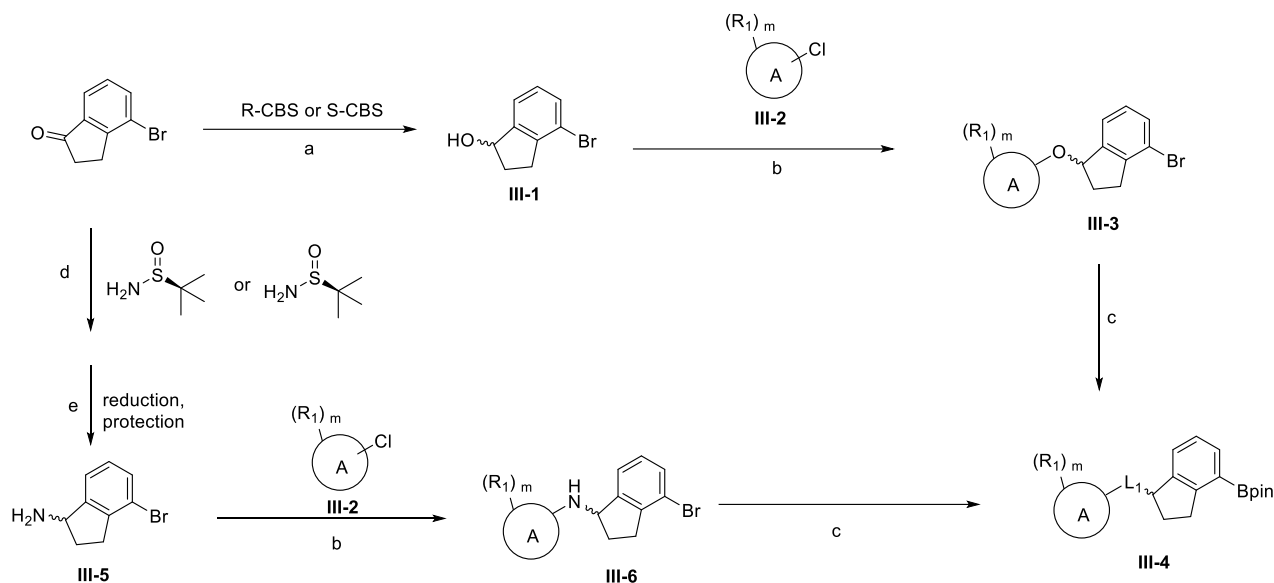
above X_1 - X_{10} , R_1 - R_{10} , t , and m are defined as above.

25 12. The method as defined in claim 11, wherein the preparation method of intermediate II-1 is as follows:



subjecting II-4 as raw material to a halogenation reaction catalyzed by Lewis acid to obtain intermediate II-1.

13. The method as defined in claim 12, wherein the preparation method of intermediate III-1 is as follows:



(a) reacting compound 4-bromoindanone as a raw material under the action of chiral auxiliary (such as R/S-CBS) and reducing agent (such as borane) to form chiral alcohol **1-2**;

10 (b) subjecting **III-1** (or **III-5**) and **III-2** as raw materials to an affinity substitution reaction under basic condition to obtain intermediate **III-3** (or **III-6**);

(c) subjecting **III-3** (or **III-6**) and bis(pinacolato)diboron as raw materials to a boronation reaction under the presence of palladium catalyst and ligand to obtain intermediate **III-1**;

15 (d), (e) reacting compound 4-bromoindanone and R/S-tert-butylsulfonimide as raw materials under the action of Lewis acid and reducing agent to form a protected chiral amino compound, and then the protective group is removed under acidic condition to obtain a chiral amino compound **III-5**.

20 14. A pharmaceutical composition comprising (1) the compound as defined in claim 1; and (2) a pharmaceutically acceptable carrier; wherein the pharmaceutically acceptable carrier is selected from cellulose and the derivatives thereof, gelatin, talc, solid lubricants, calcium sulfate, vegetable oils, polyols, emulsifiers, wetting agent, coloring agents, flavoring agents, stabilizers, antioxidants, preservatives, pyrogen-free water.

25 15. Use of the compound as defined in claim 1, or the pharmaceutical

composition as defined in claim 14, for the preparation of a pharmaceutical composition for preventing and/or treating diseases related to the activity or expression of PD-1/PD-L1, wherein the diseases are selected from the group consisting of cancer, infectious disease, and autoimmune disease.

5 16. The use as defined in claim 15, wherein the cancer is selected from the group consisting of pancreatic cancer, bladder cancer, colorectal cancer, breast cancer, prostate cancer, kidney cancer, hepatocellular carcinoma, lung cancer, ovary cancer, cervical cancer, stomach cancer, esophageal cancer, melanoma, neuroendocrine cancer, central nervous system cancer, brain cancer, bone cancer, soft tissue sarcoma,
10 non-small cell lung cancer, small cell lung cancer or colon cancer, skin cancer, lung cancer, urinary system tumor, blood tumor, glioma, digestive system tumor, reproductive system tumor, lymphoma, nervous system tumor, brain tumor, head and neck cancer.

15 17. The use as defined in claim 15, wherein the infectious disease is selected from bacterial infection and viral infection.

18. The use as defined in claim 15, wherein the autoimmune disease is selected from the group consisting of organ-specific autoimmune disease and systemic autoimmune disease.

20 19. The use as defined in claim 15, wherein the pharmaceutical composition further comprises at least one therapeutic agent selected from the group consisting of nivolumab, pembrolizumab, atezolizumab and ipilimumab.