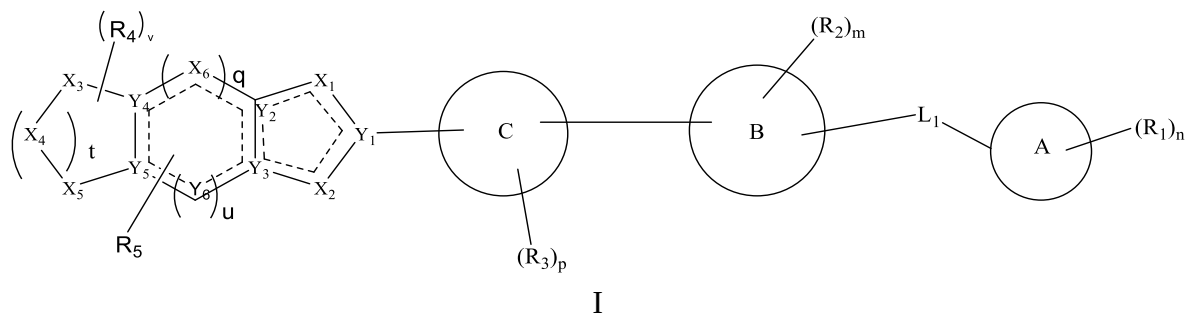


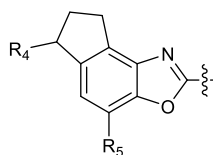
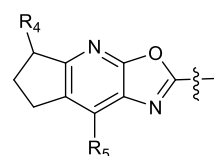
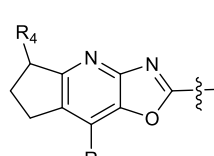
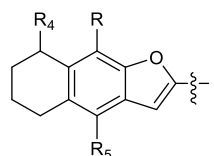
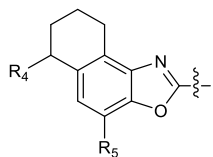
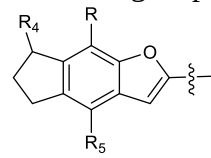
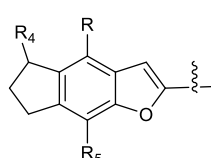
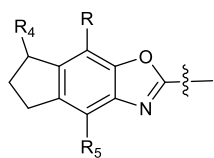
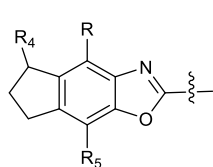
Claims

1. A compound represented by the following formula I, or an optical isomer, a hydrate, a solvate thereof, or a pharmaceutically acceptable salt thereof:



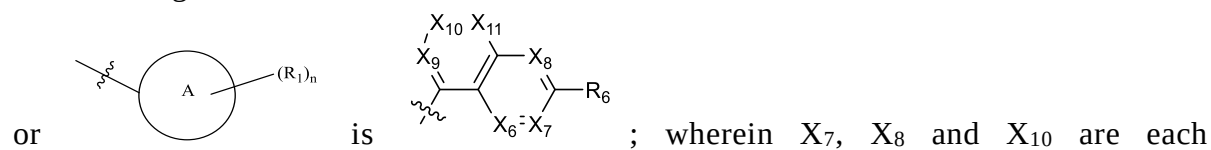
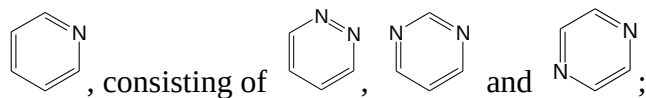
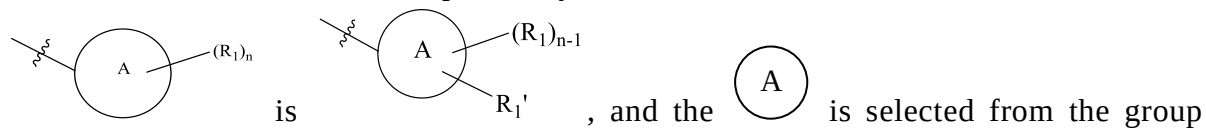
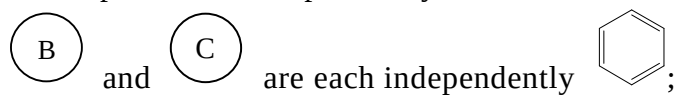
wherein the

is a structure selected from the group consisting of:



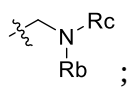
n is 0, 1, 2, 3 or 4;

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



independently CR; X₆ is N; X₉ and X₁₁ are each independently selected from the group consisting of N and CR; wherein each R are independently selected from the group consisting of H, -CN, trifluoromethyl, -CHF₂, -OCF₃, -OCHF₂, sulfonamido, nitro, hydroxyl, halogen, and substituted or unsubstituted C1-C10 alkyl;

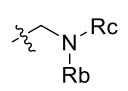
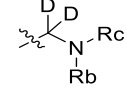
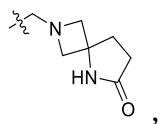
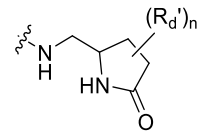
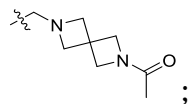
5 R₆ is selected from the group consisting of NR_dR_e, substituted or unsubstituted C1-C6

amino, substituted or unsubstituted -(C1-C6 alkylene)-NH-(C1-C6 alkyl), and  ;

L₁ is substituted or unsubstituted -NH-;

10 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 C2-C6 alkenyl, substituted or unsubstituted C1-C6 alkoxy, substituted or unsubstituted C3-C8 cycloalkyl, -CN, hydroxyl, C1-C6 amino, and carboxy;

R₁' and R₄ are each independently selected from the group consisting of NR_dR_e, substituted or unsubstituted C1-C6 amino, substituted or unsubstituted -(C1-C6 alkylene)-

15 NH-(C1-C6 alkylene), substituted or unsubstituted , , , , and  ;

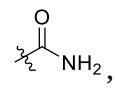
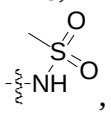
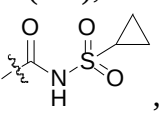
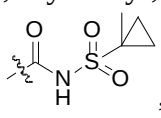
wherein, R_b and R_c are each independently selected from the group consisting of H and substituted or substituted C₁-C₈ alkyl; or R_b and R_c together with adjacent N atom form substituted or unsubstituted 3-10 membered heterocyclyl having 1-3 heteroatoms selected from N, S and O, or R_b and R_c together with adjacent N atom form substituted or unsubstituted 4-10 membered lactam;

R_d' is selected from the group consisting of H, substituted or substituted C₁-C₈ alkyl, substituted or unsubstituted C₃-C₁₀ cycloalkyl, and substituted or unsubstituted C₆-C₁₀ aryl;

20 wherein, a hydrogen on a carbon atom of R_b, R_c and R_d may be each independently substituted by deuterium;

25 R_d and R_e are each independently selected from the group consisting of H and substituted or unsubstituted C₁-C₆ alkyl; or R_d and R_e together with adjacent N atom form substituted or unsubstituted 4-10 membered heterocyclyl having 1-3 heteroatoms selected from N, S and O;

30 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 (=O), -CN, hydroxyl, amino, C1-C6 alkylamino, carboxyl, -NHAc,

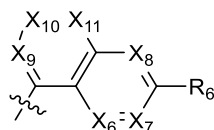
, , , , substituted or unsubstituted group selected from the group consisting of C1-C6 alkyl, C1-C6 alkoxy, C₆-C₁₀ aryl, C₃-C₈ cycloalkyl, halogenated C₆-C₁₀ aryl, 5-10 membered heteroaryl with 1-3 heteroatoms selected from N, S and O, and 5-10 membered heterocyclyl with 1-3 heteroatoms selected from N, S and O; wherein the substituent is selected from the group consisting of halogen, hydroxyl, carboxyl,

oxo, 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, or the

5 pharmaceutically acceptable salt thereof, wherein $\textcircled{\text{A}}$ has a structure shown in the following formula:



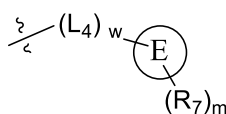
wherein each group are defined as claim 1.

10 3. The compound as defined in claim 1, or the optical isomer, hydrate, solvate thereof, or the pharmaceutically acceptable salt thereof, wherein $\textcircled{\text{A}}$ has a structure selected from the

group consisting of  and , wherein the bonding position of the ring can be N or C.

4. The compound as defined in claim 1, or the optical isomer, hydrate, solvate thereof, or the

15 pharmaceutically acceptable salt thereof, $\textcircled{\text{A}}$ has a substituent as shown in the following formula IV:



IV

wherein, w is 1, 2 or 3;

20 each L_4 is independently selected from the group consisting of substituted or unsubstituted C1-C4 alkylene and NR_f ; 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;

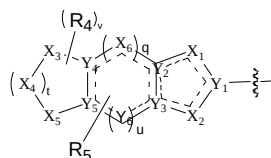
25 $\textcircled{\text{E}}$ is selected from the group consisting of substituted or unsubstituted C3-C10 cycloalkyl, and substituted or unsubstituted 3-10 membered heterocyclyl having 1-3 heteroatoms selected from B, P, N, S and O;

30 each R_7 is independently selected from the group consisting of substituted or unsubstituted C1-C6 alkyl, -CN, hydroxy, amino, carboxyl, $-\text{OR}_g$, $-\text{N}(\text{R}_g)_2$, $-\text{CO}-\text{NH}-\text{SO}_2-\text{R}_g$, $-\text{NH}-\text{SO}_2-\text{R}_g$, $-\text{SO}_2-\text{NH}-\text{CO}-\text{R}_g$, $-\text{CO}_2\text{R}_g$, $-\text{CON}(\text{R}_g)_2$, $-\text{CONHCOR}_g$, $\text{NR}_g-\text{CO}-\text{N}(\text{R}_g)_2$, and $-\text{NR}_g-\text{SO}_2-\text{N}(\text{R}_g)_2$; R_f and R_g are defined as above, wherein a hydrogen on a carbon atom of R_f and R_g may be independently substituted by deuterium; wherein, the substituents are selected from the group consisting of halogen, hydroxyl, carboxyl, cyano, and C1- C6 alkoxy.

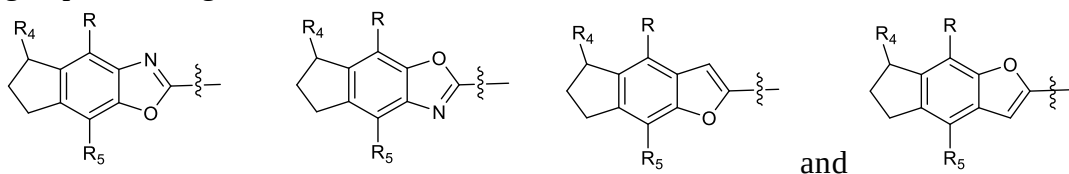
5. The compound as defined in claim 4, wherein w is 1, L_4 is C1-C4 alkylene, and $\textcircled{\text{E}}$ is

substituted or unsubstituted 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, substituted or unsubstituted 4-10 membered cyclic amido may be each independently substituted by deuterium.

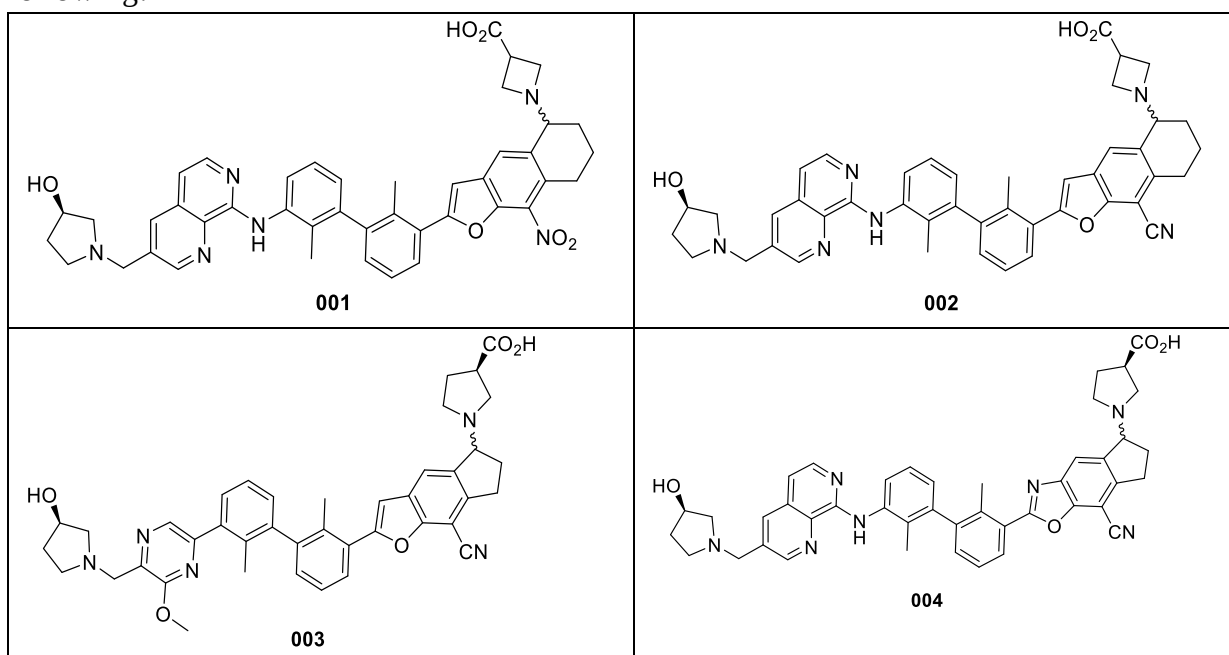
- 5 6. The compound as defined in claim 4, wherein $(L_4)_w$ is $-\text{CH}_2\text{-NH-CH}_2-$, and $\textcircled{\text{E}}$ is 3-8 membered nitrogen-containing heterocyclyl, or substituted or unsubstituted 4-10 membered cyclic amido, wherein a hydrogen on the ring-forming carbon atom of 3-8 membered nitrogen-containing heterocyclyl, substituted or unsubstituted 4-10 membered cyclic amido is optionally independently substituted by deuterium.

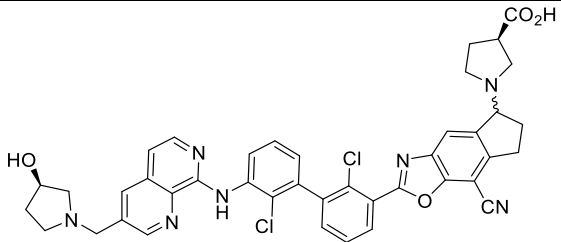
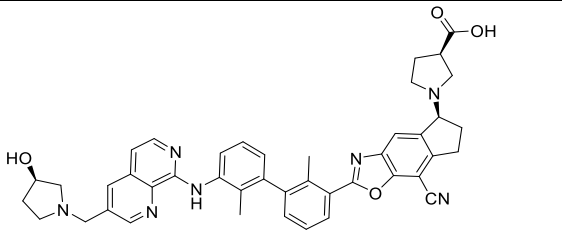
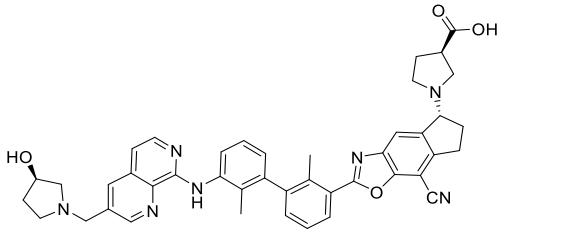
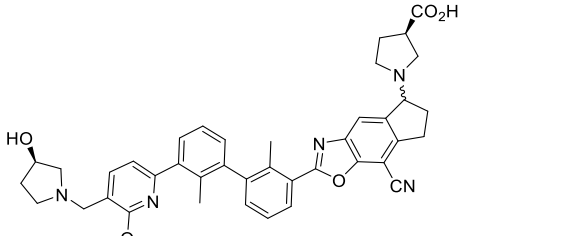
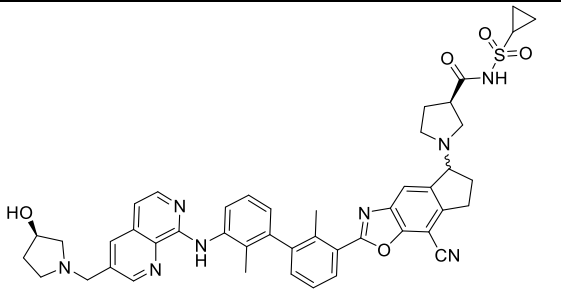
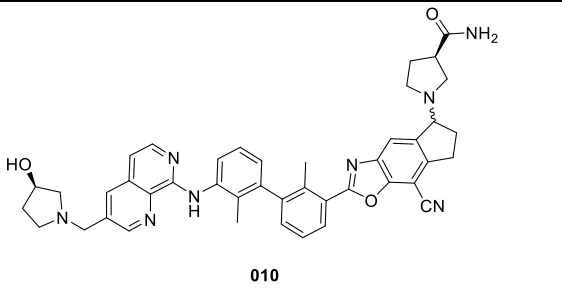
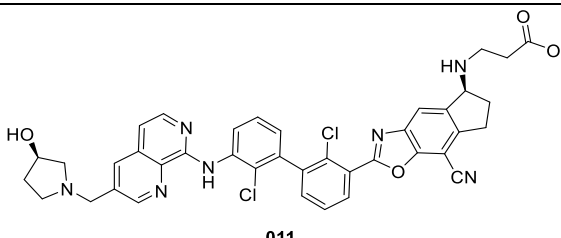
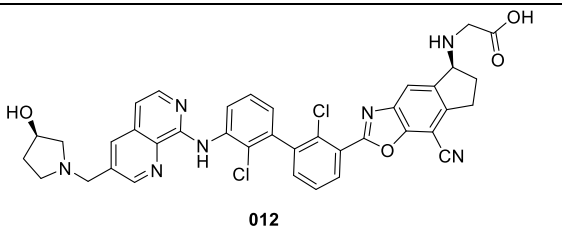
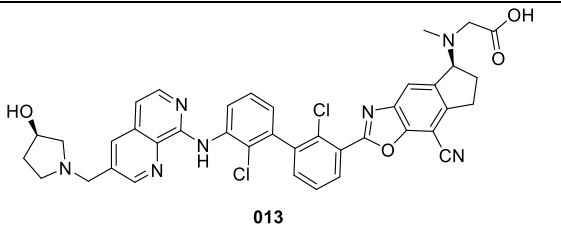
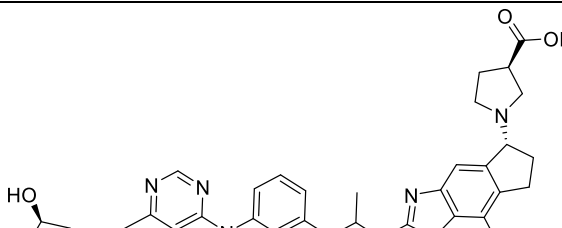
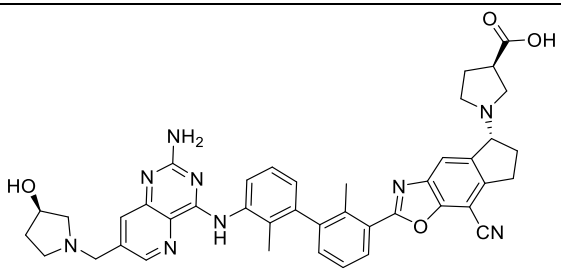
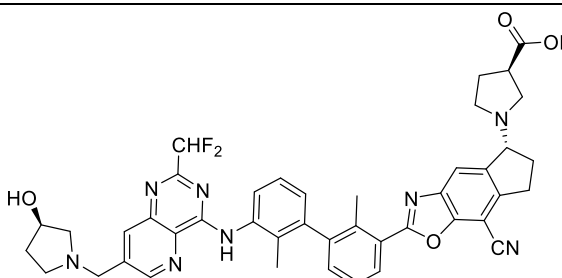


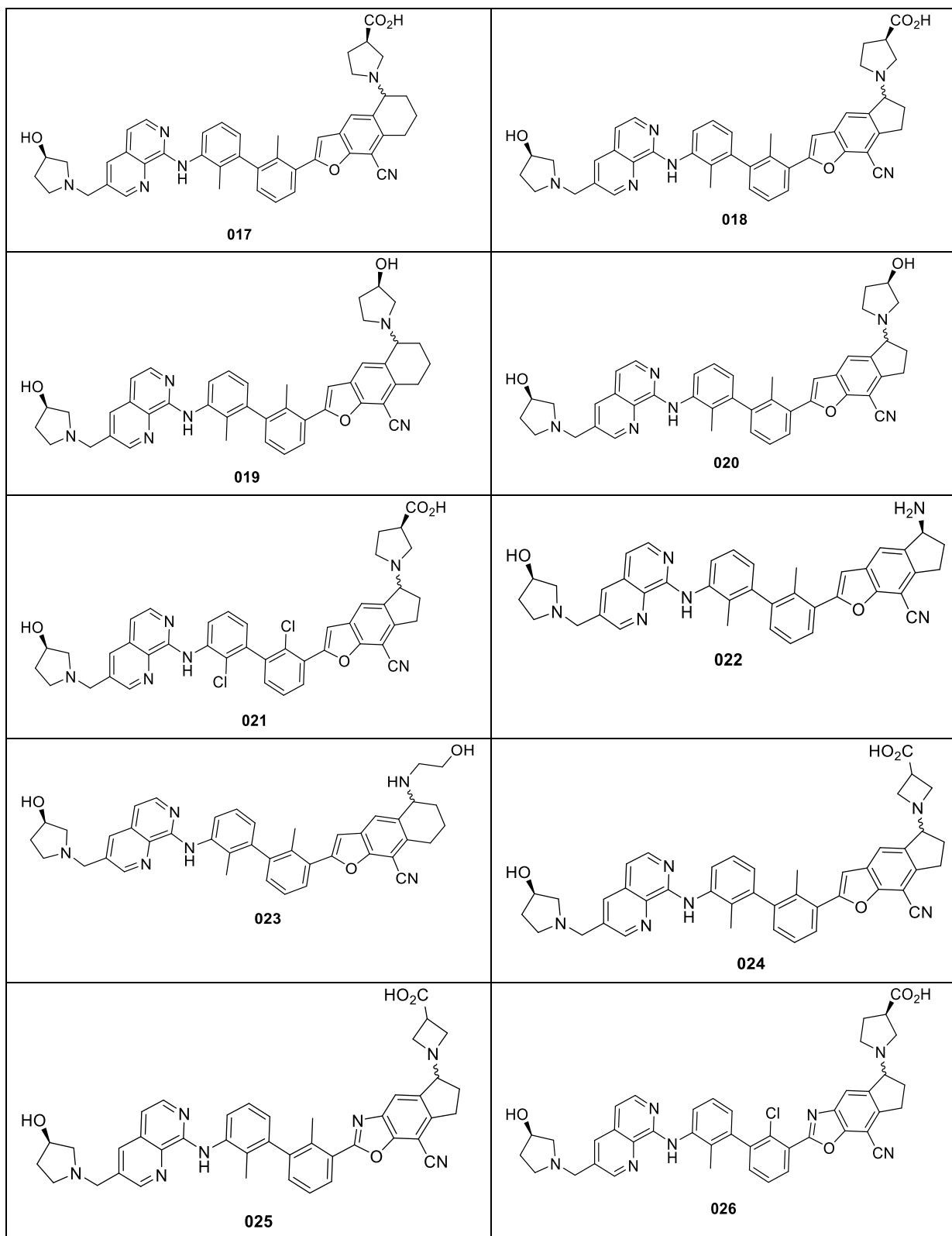
- 10 7. The compound as defined in claim 1, wherein $\textcircled{\text{E}}$ is selected from the group consisting of:

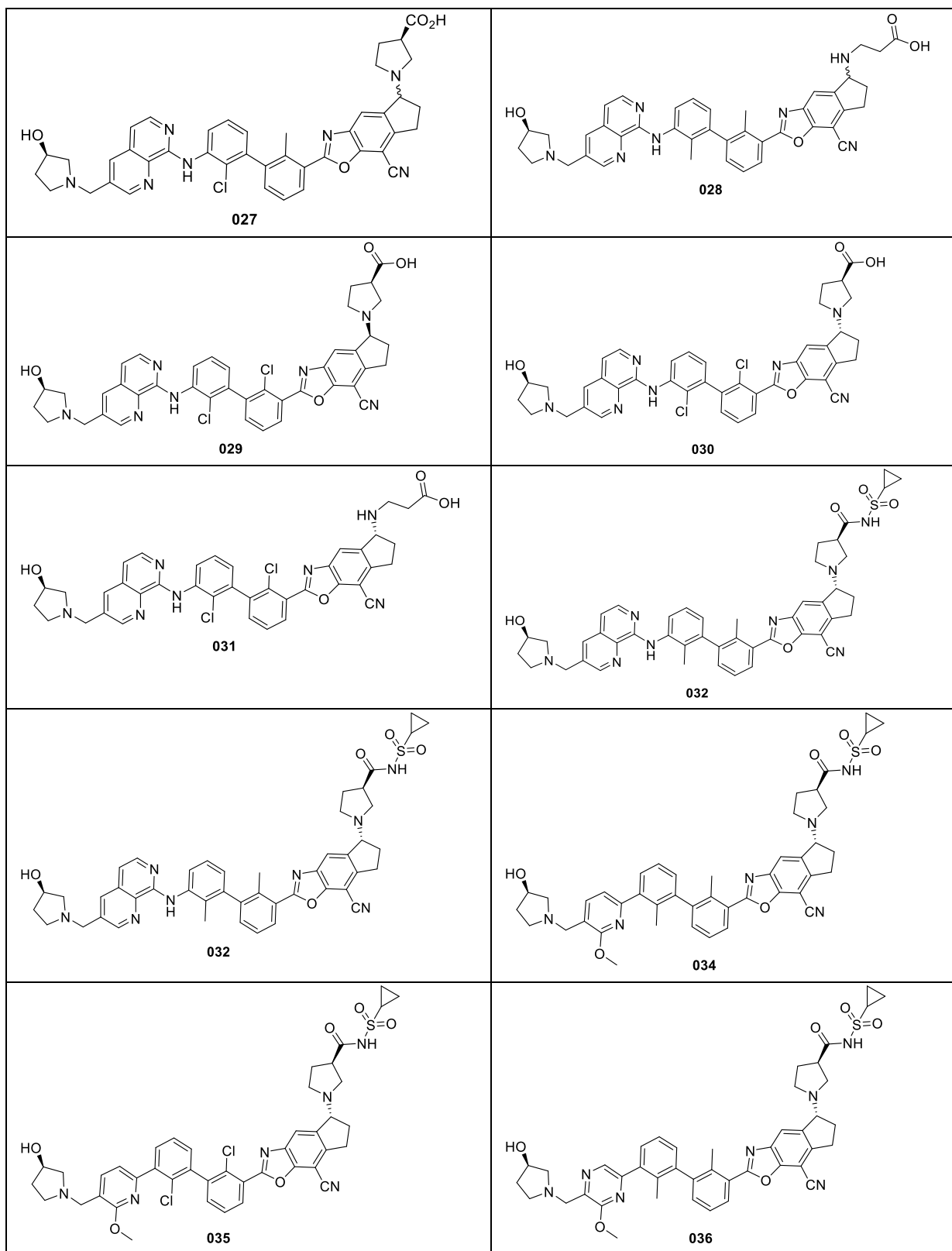


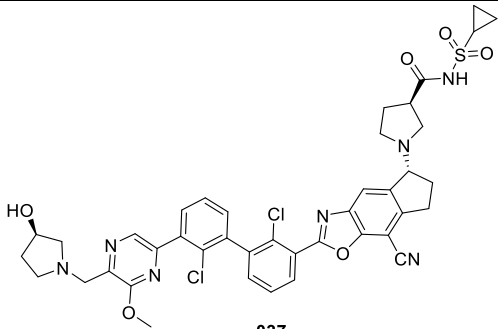
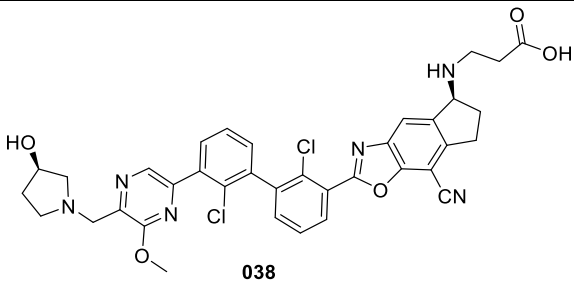
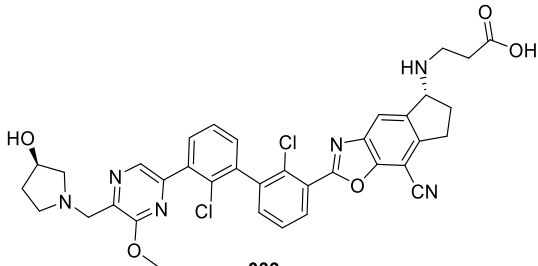
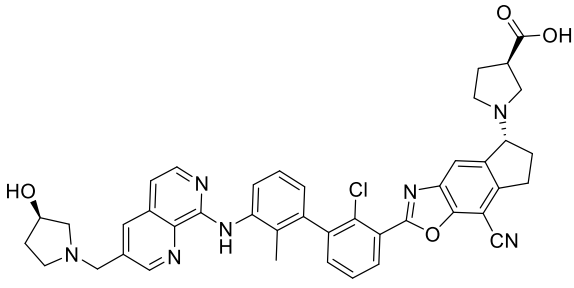
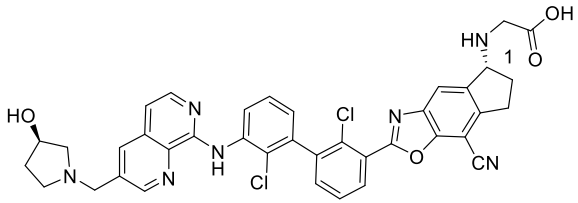
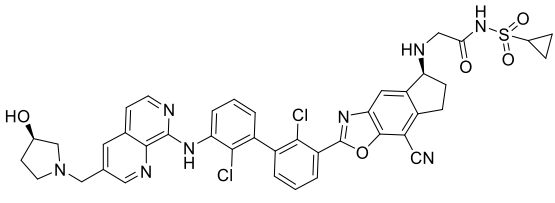
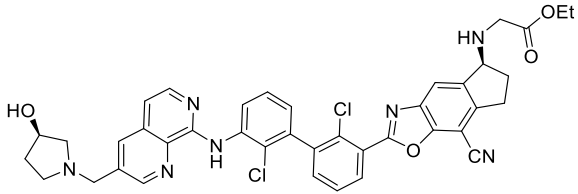
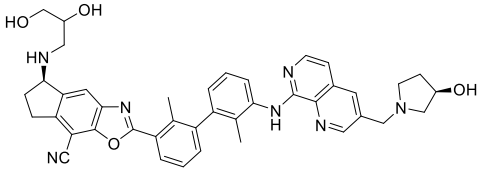
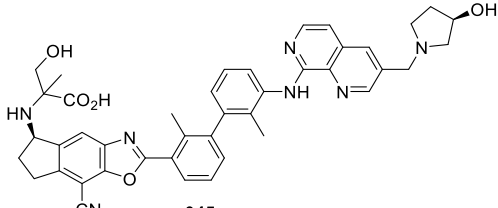
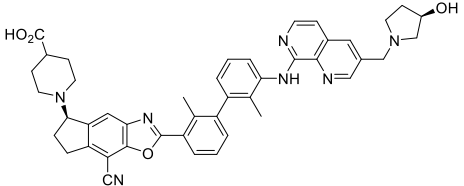
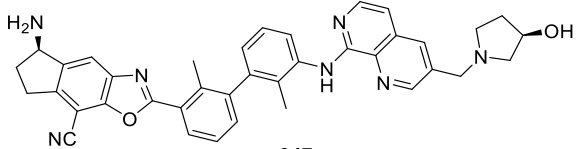
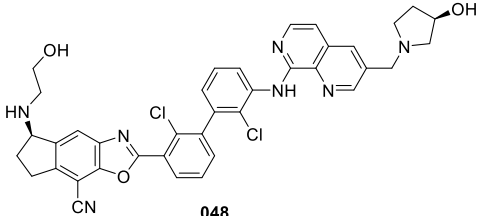
- 15 8. The compound as defined in claim 1, or the optical isomer, hydrate, solvate thereof, or the pharmaceutically acceptable salt thereof, wherein the compound is selected from the following:

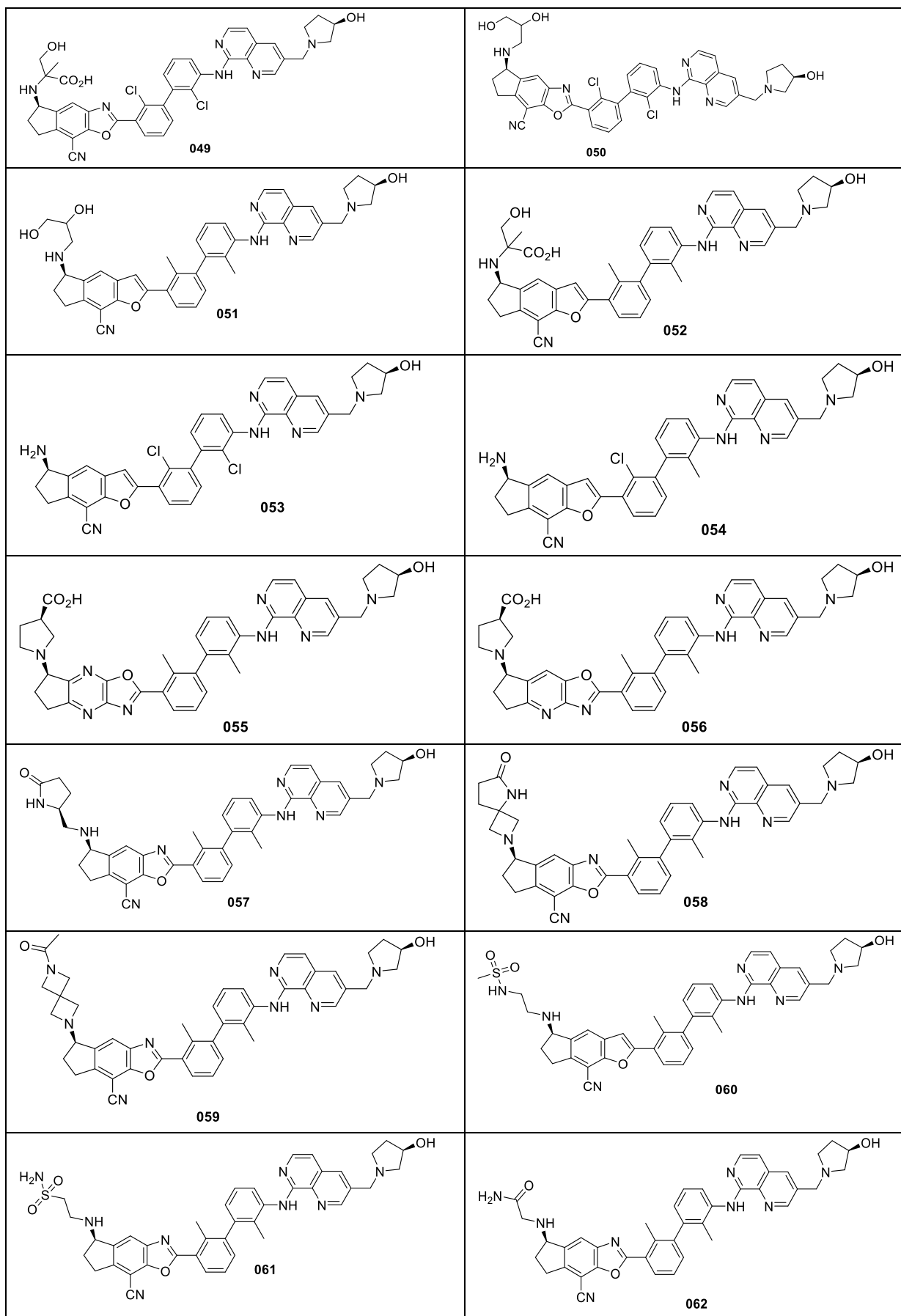


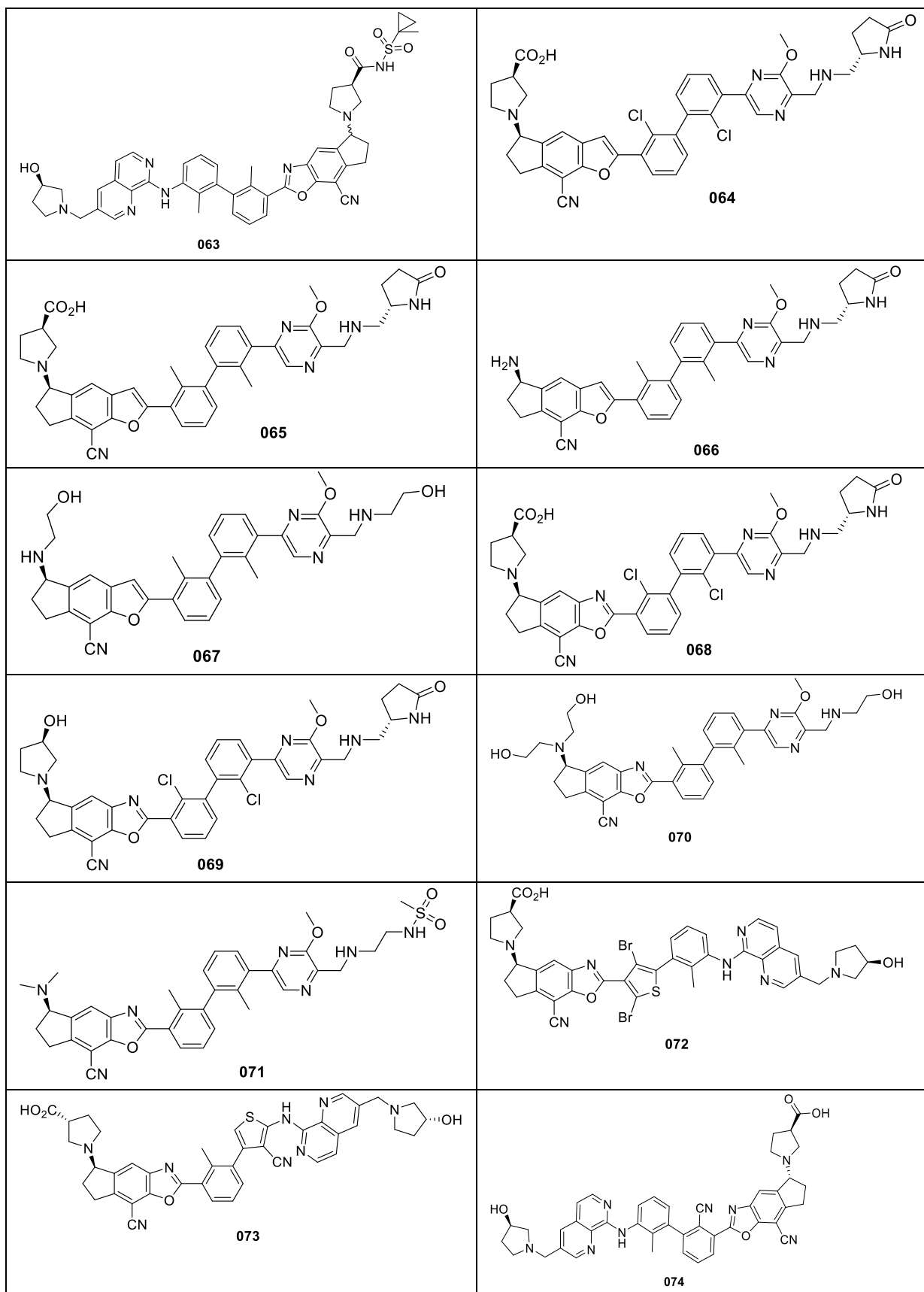
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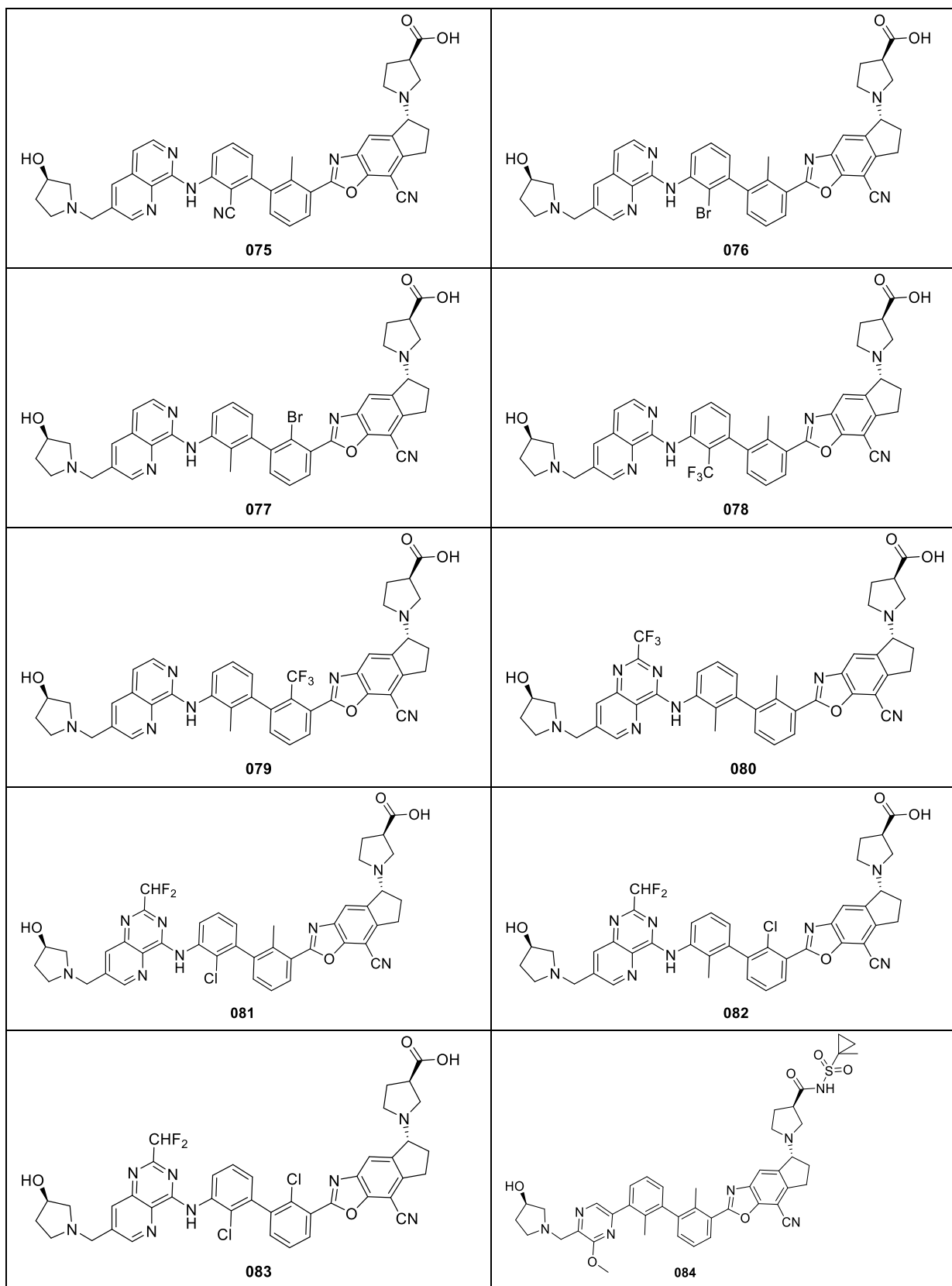


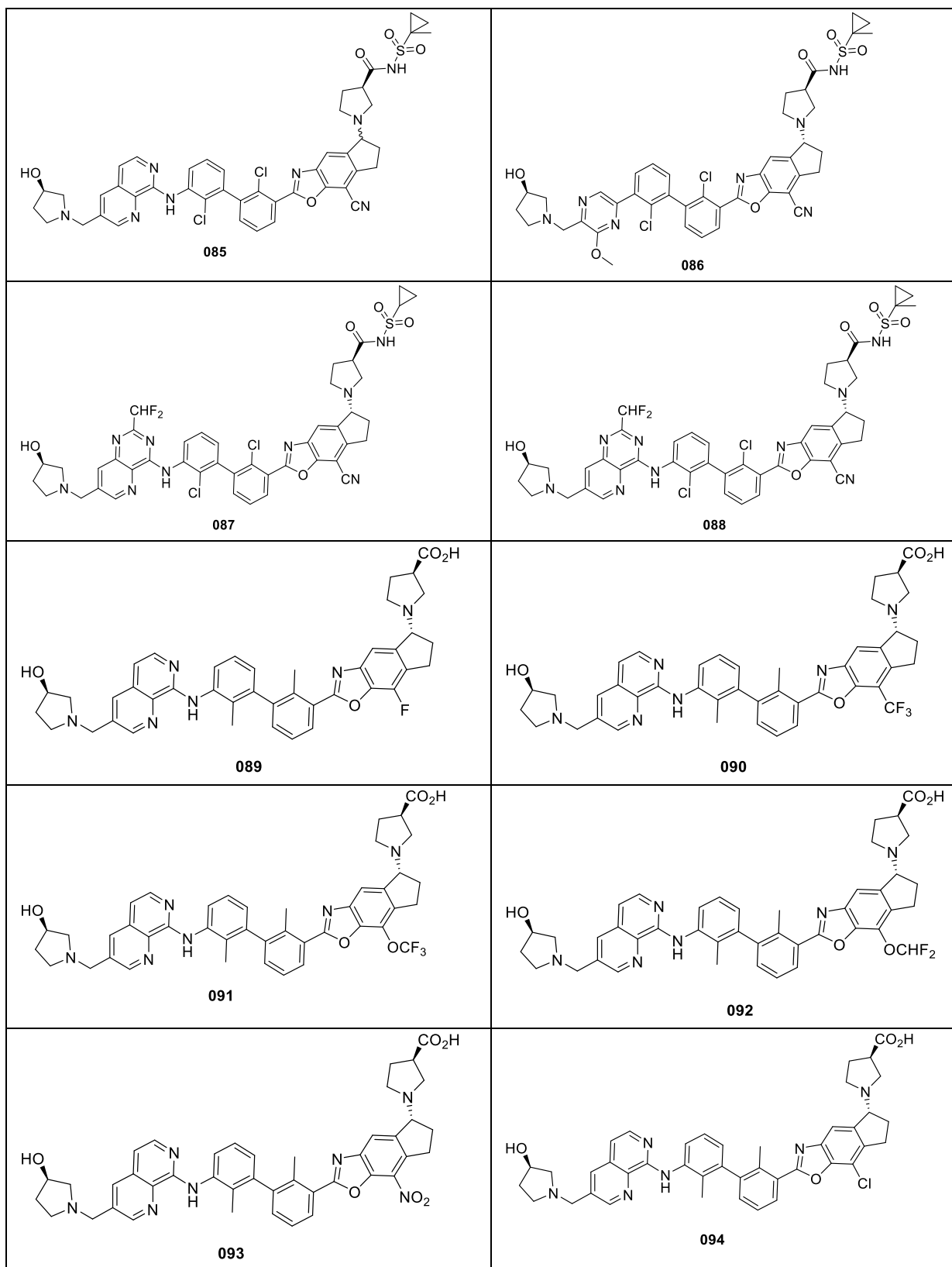


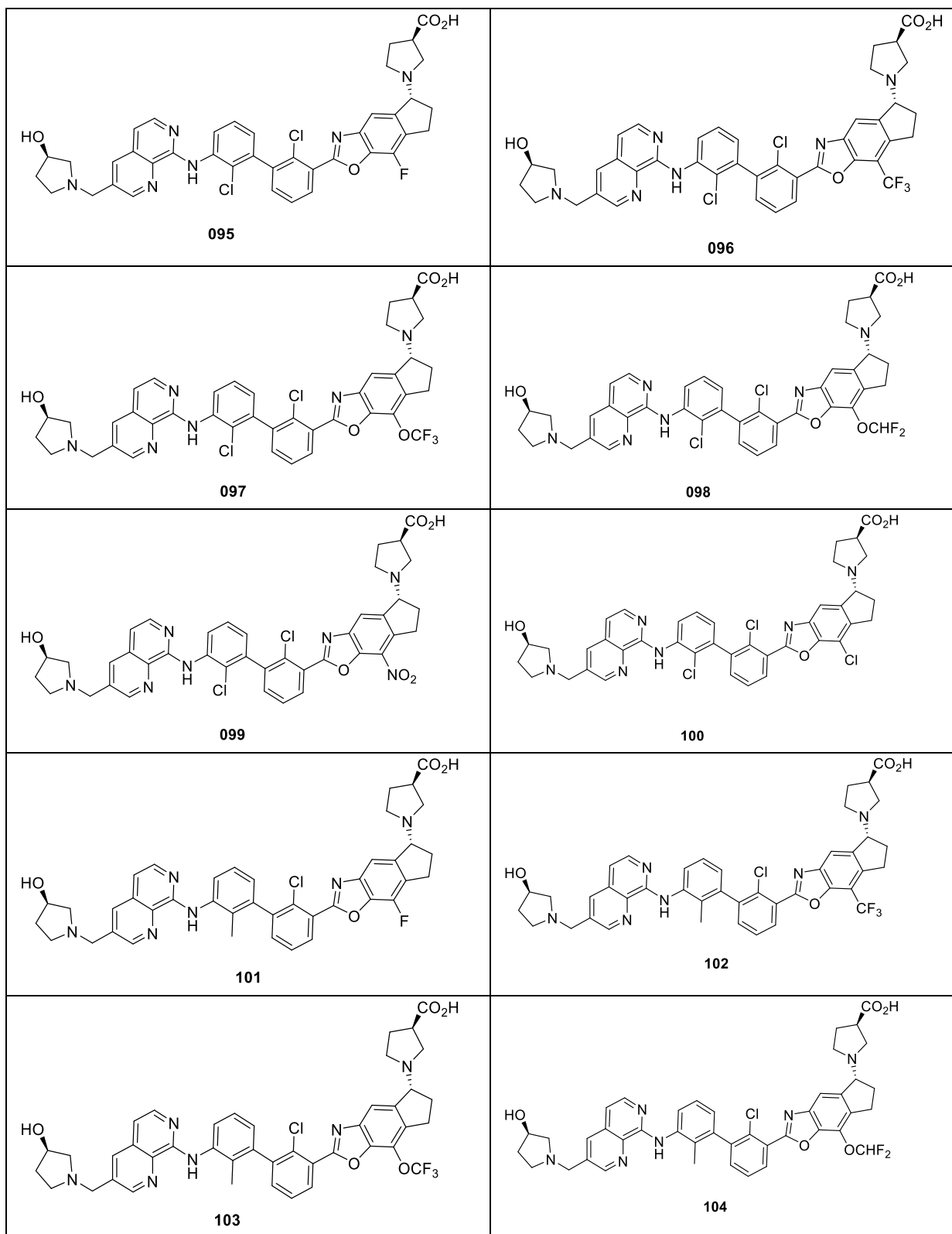
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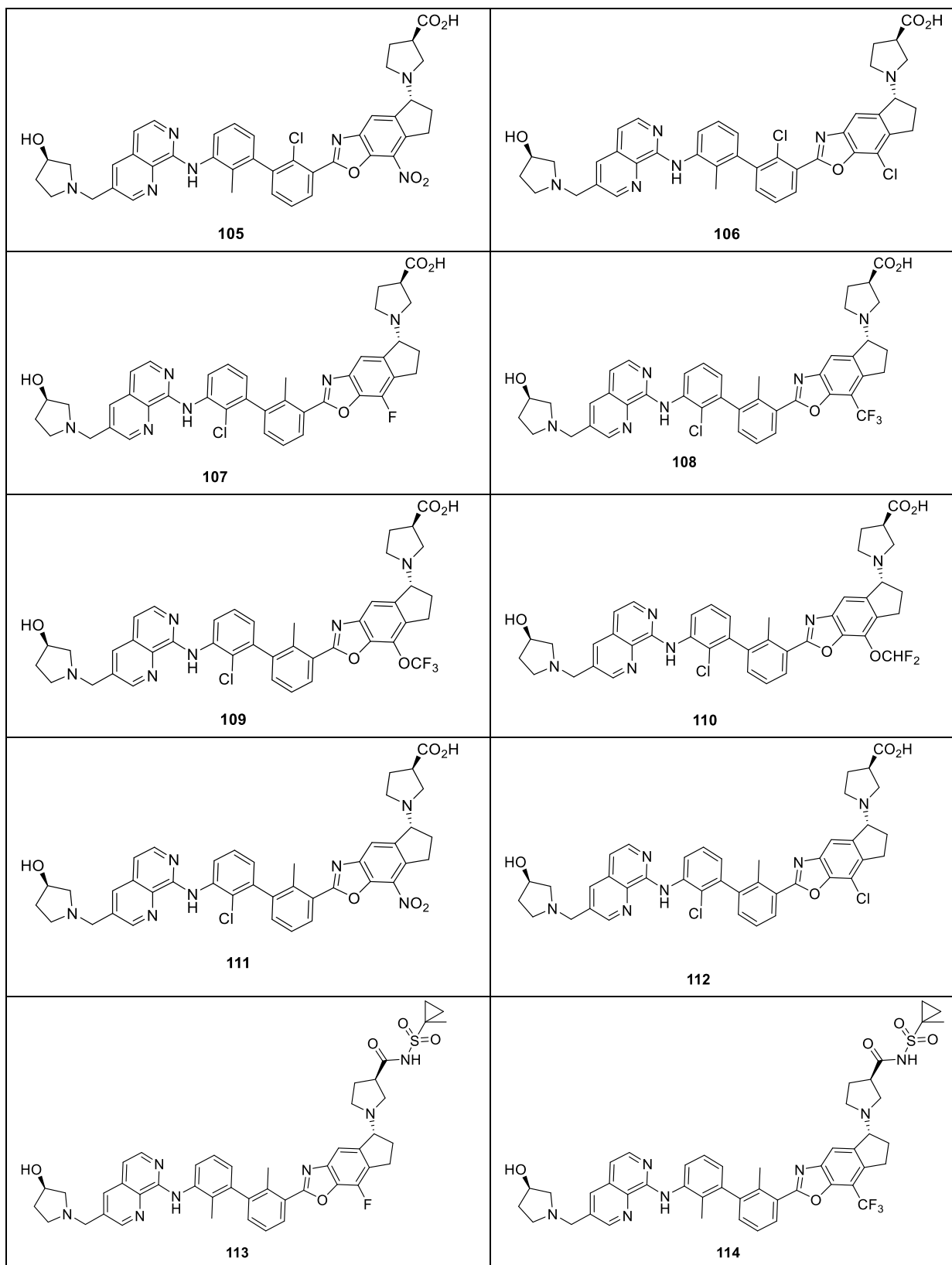


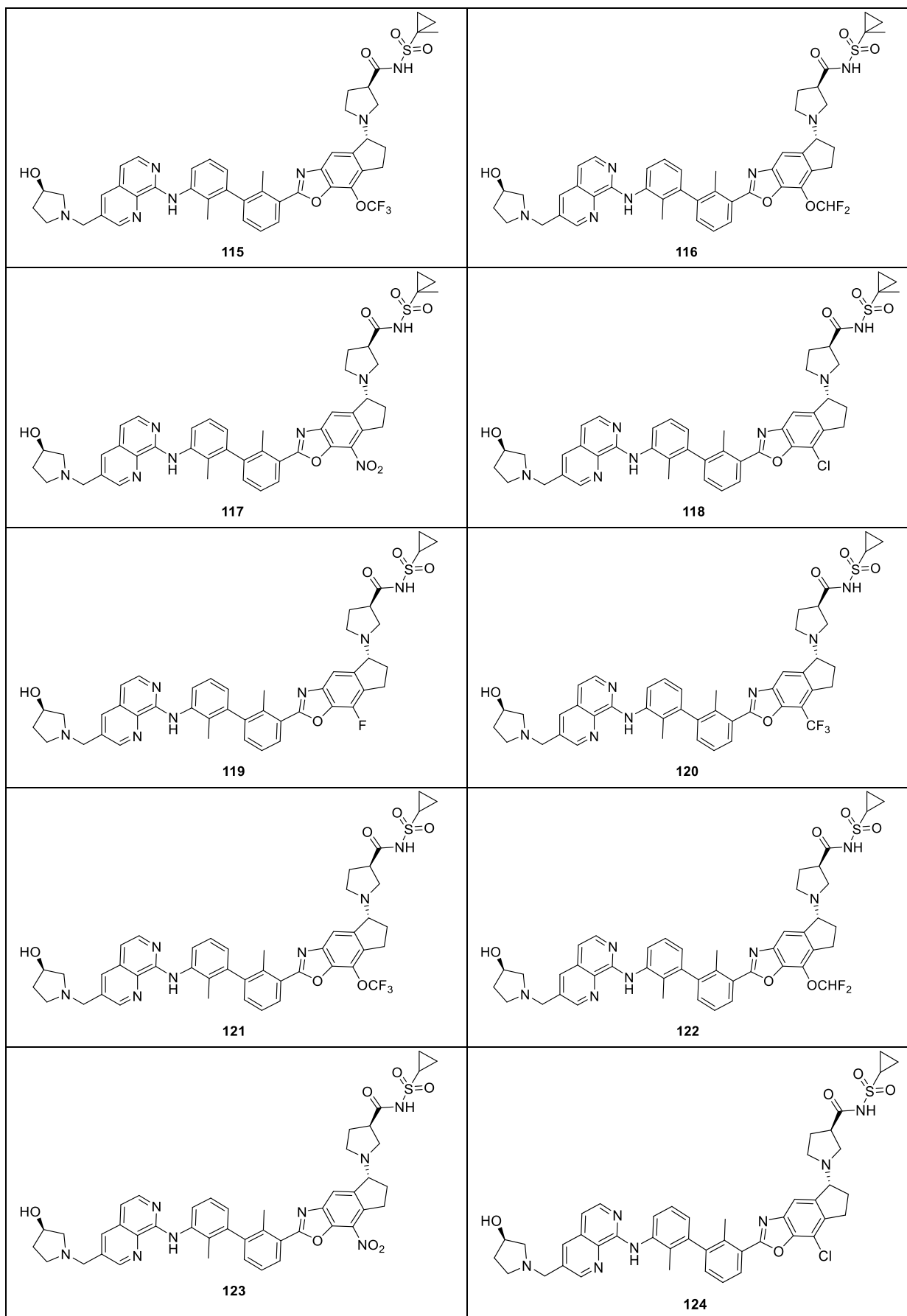


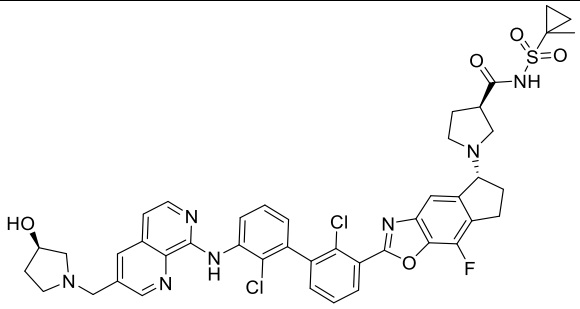
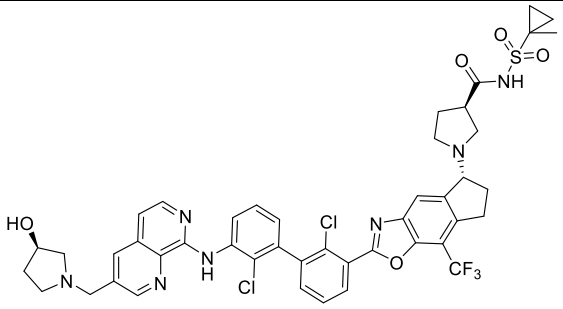
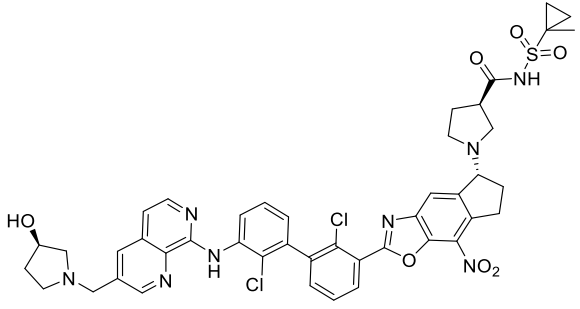
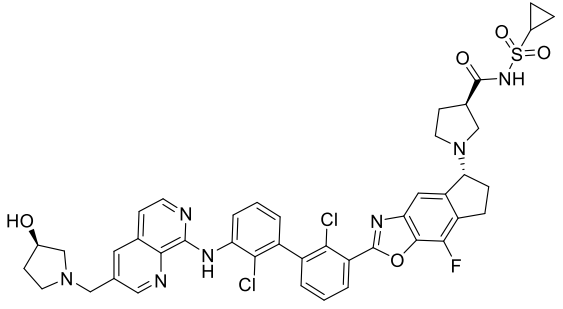
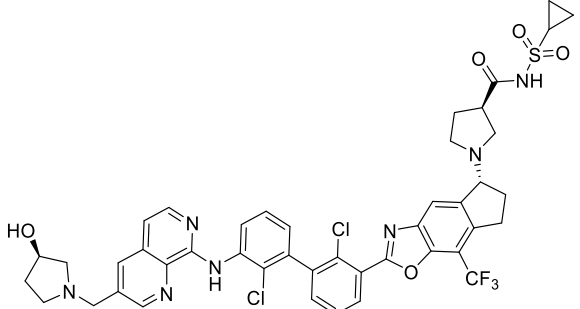
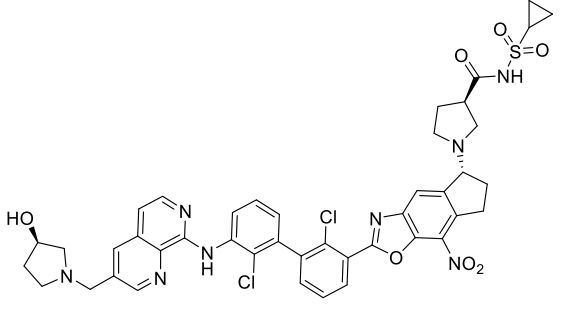
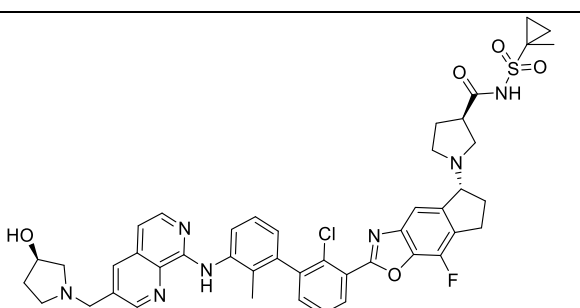
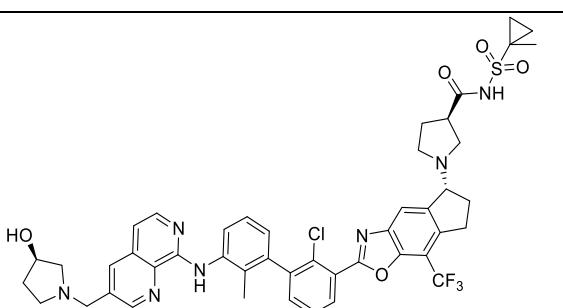
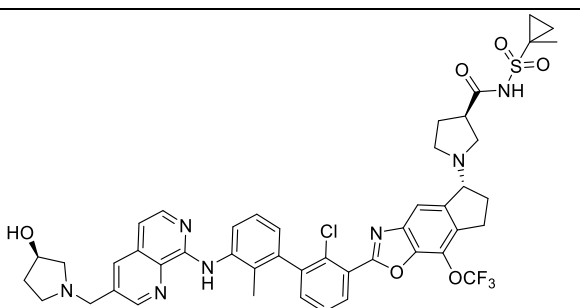
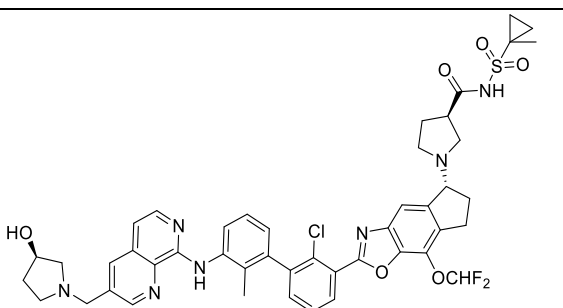


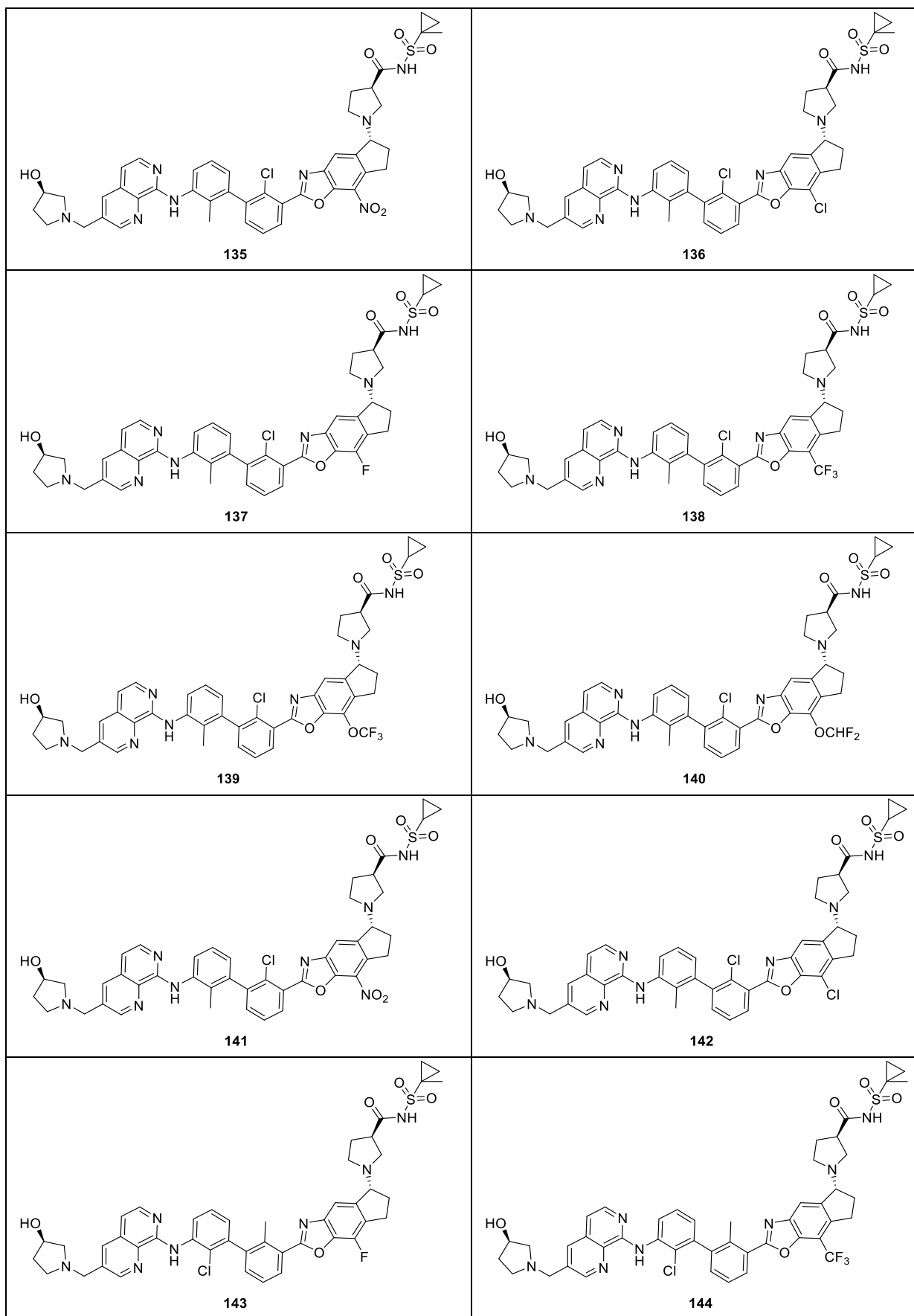


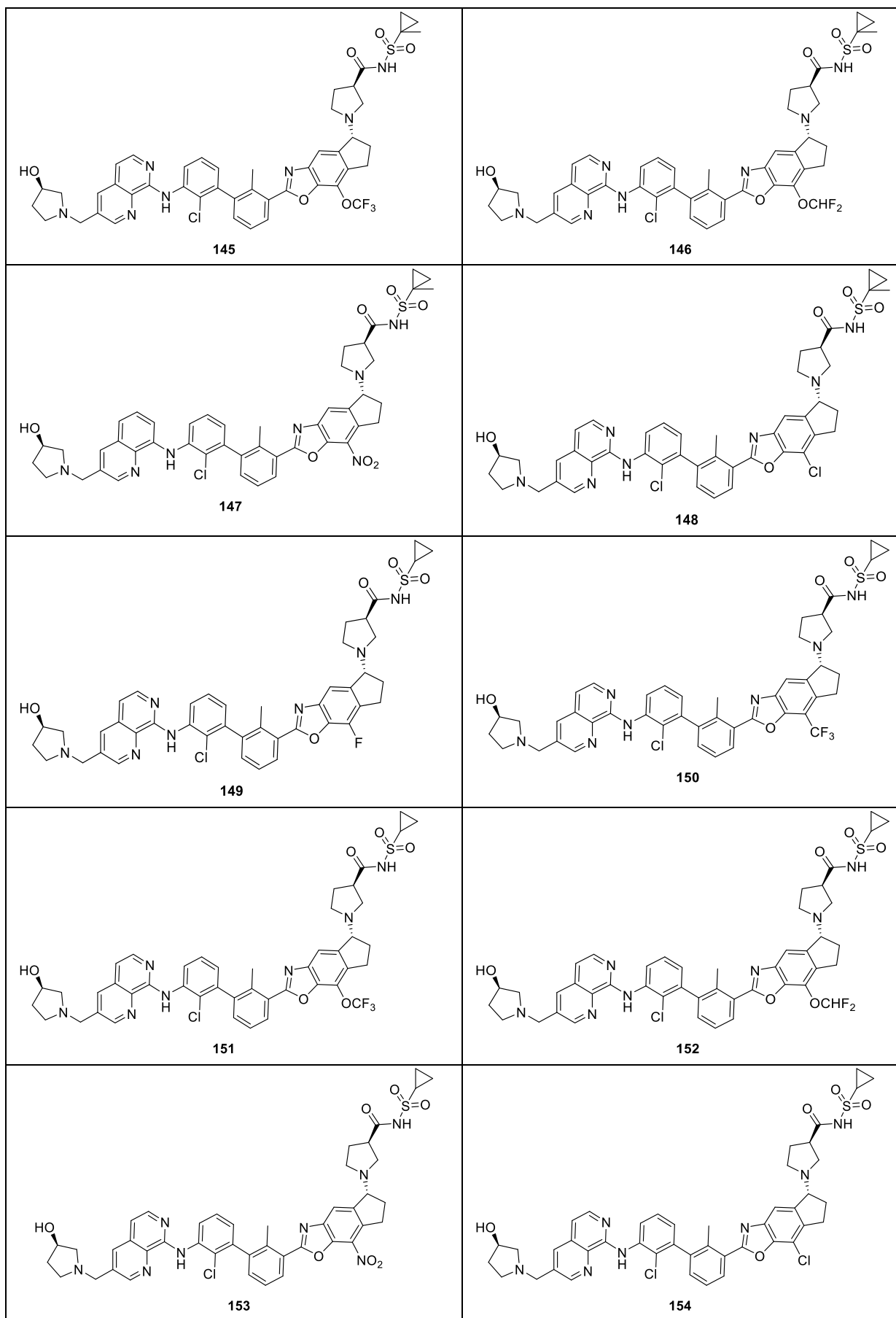


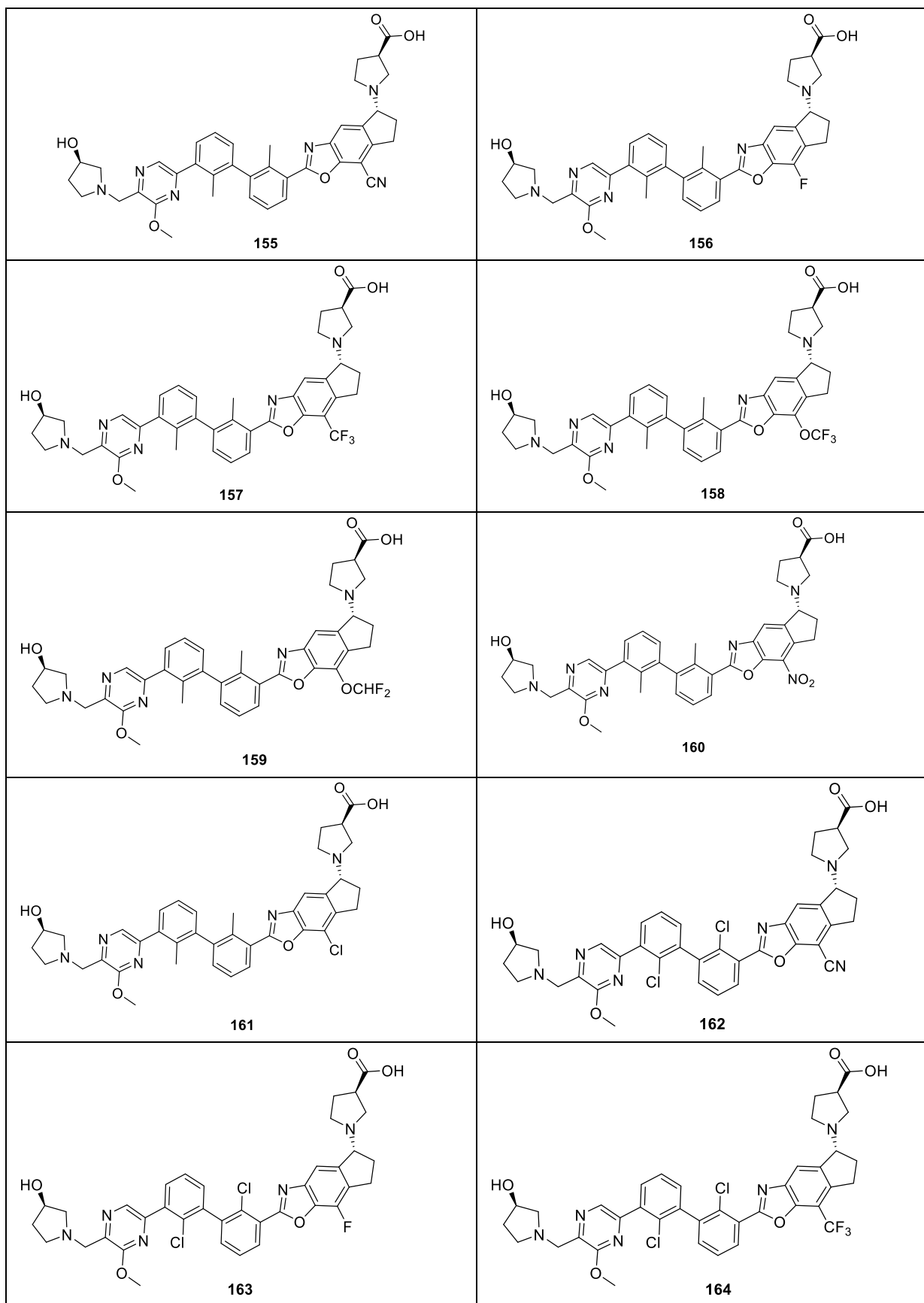


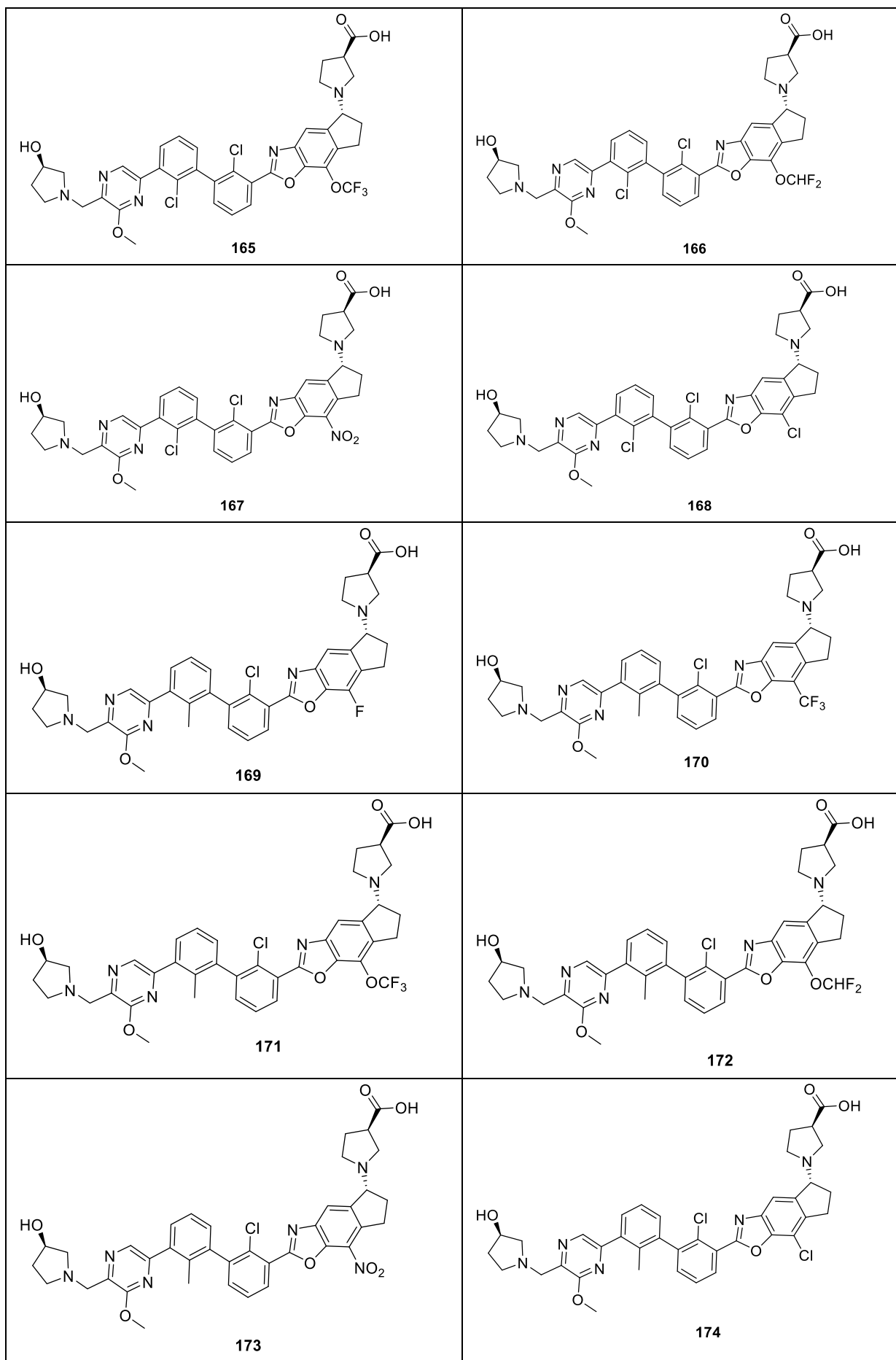


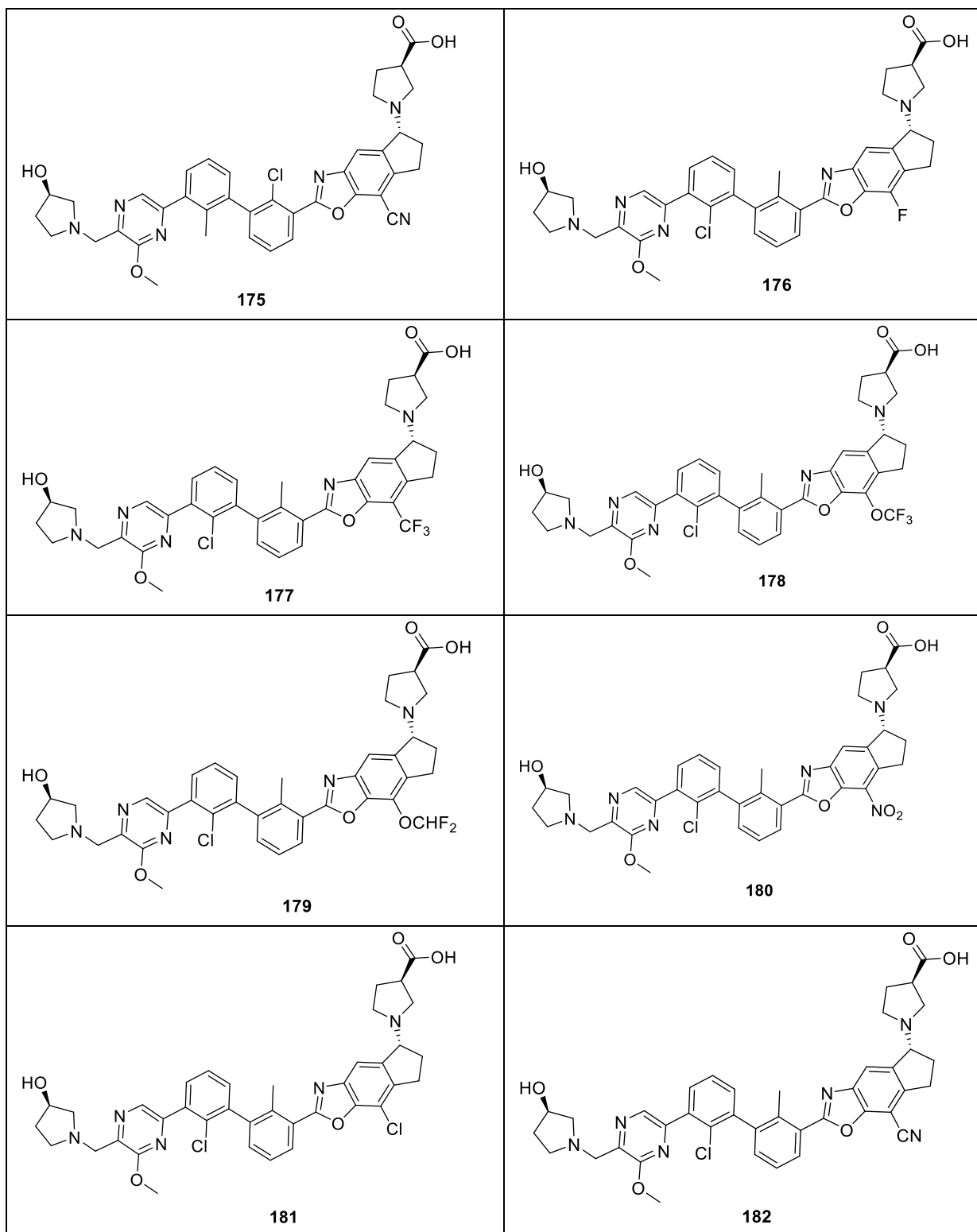
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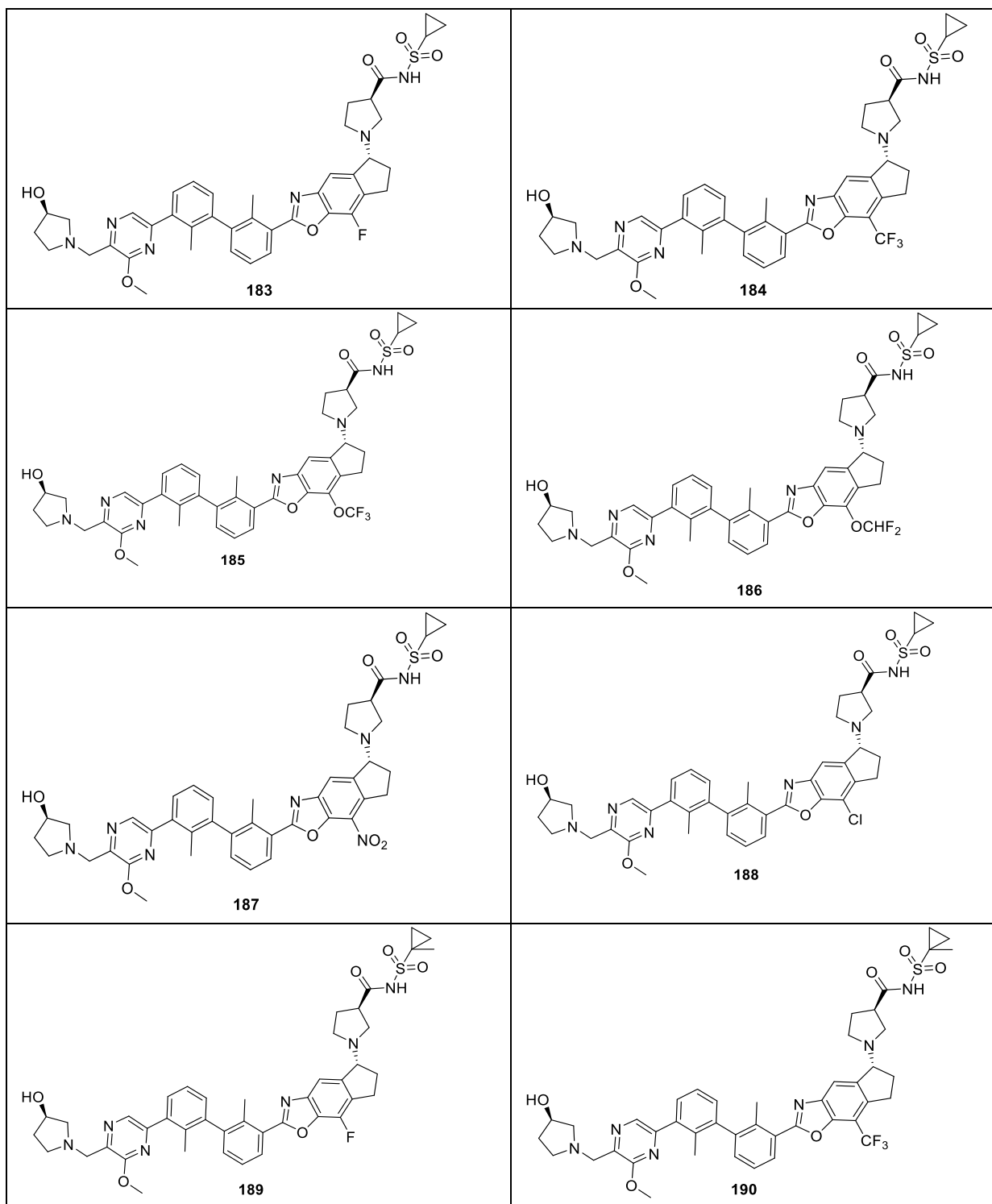


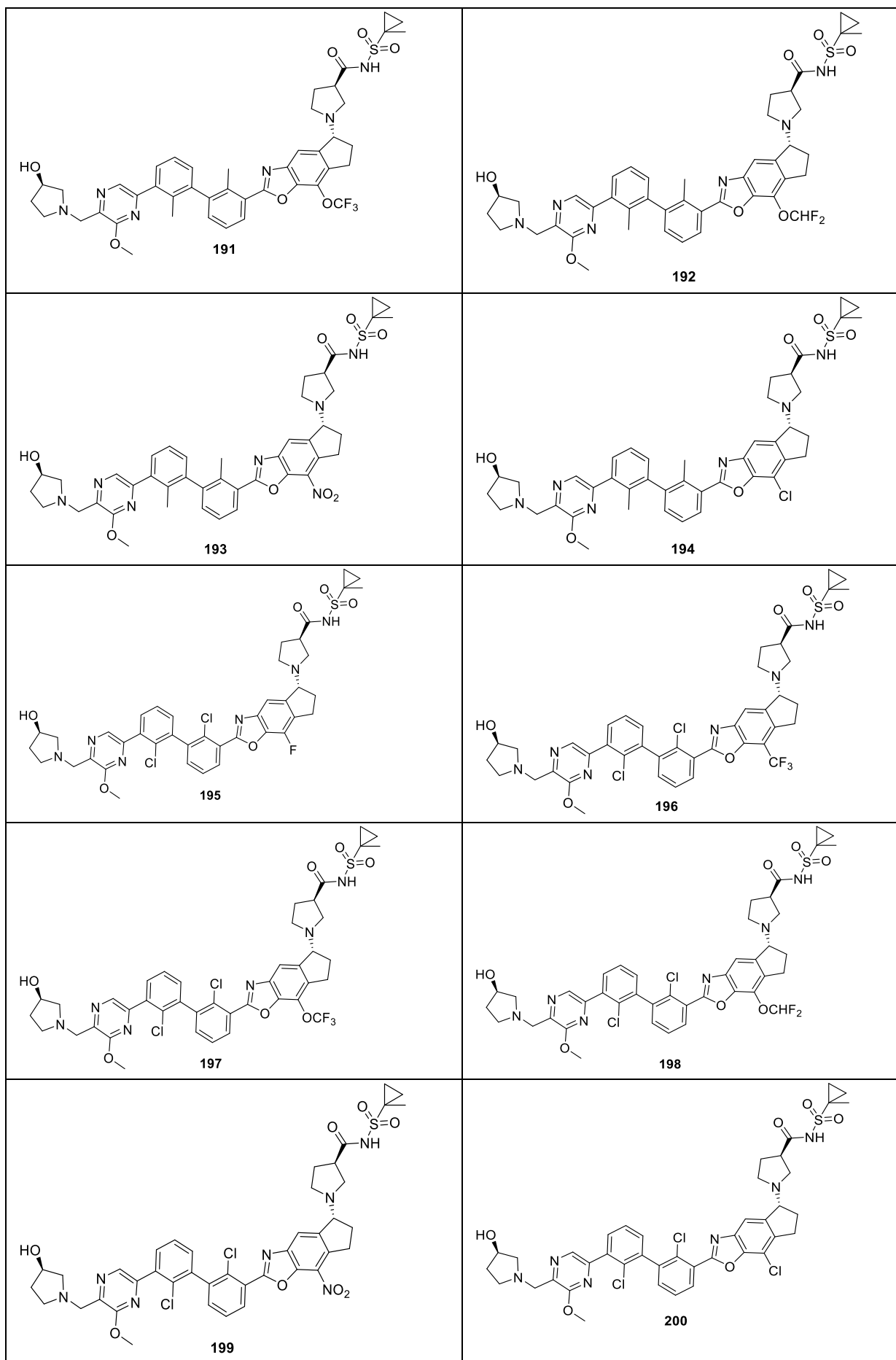


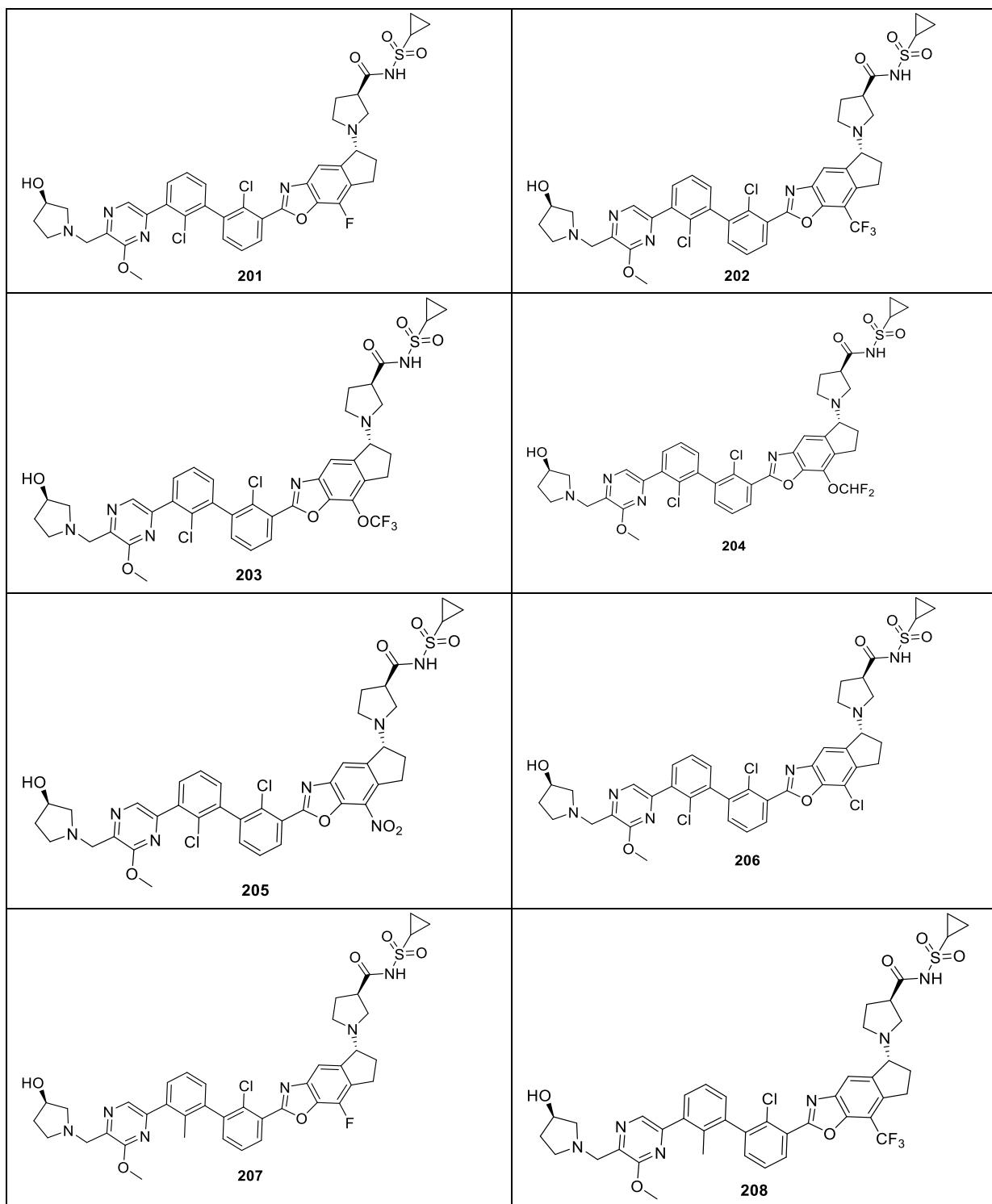


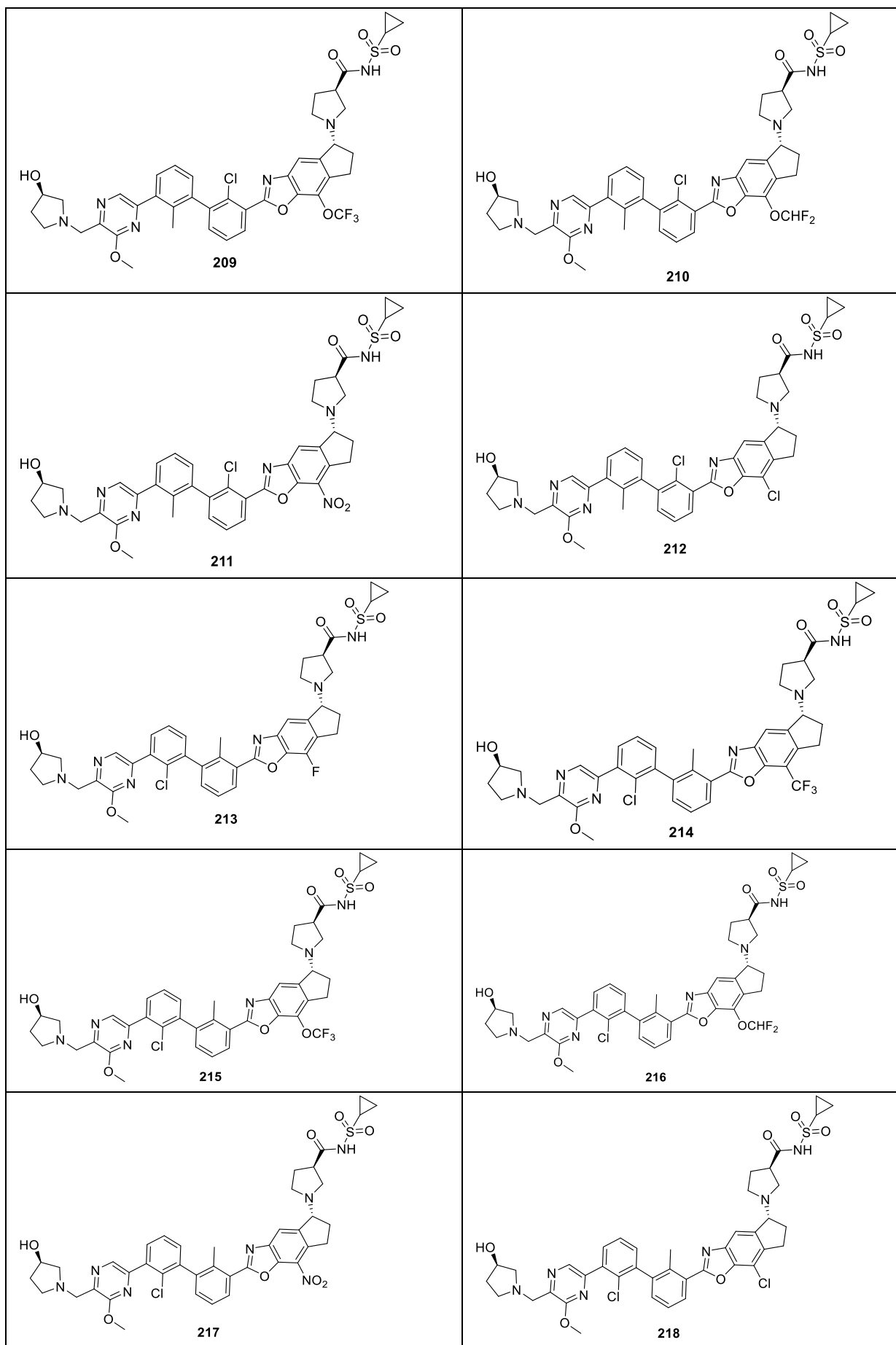


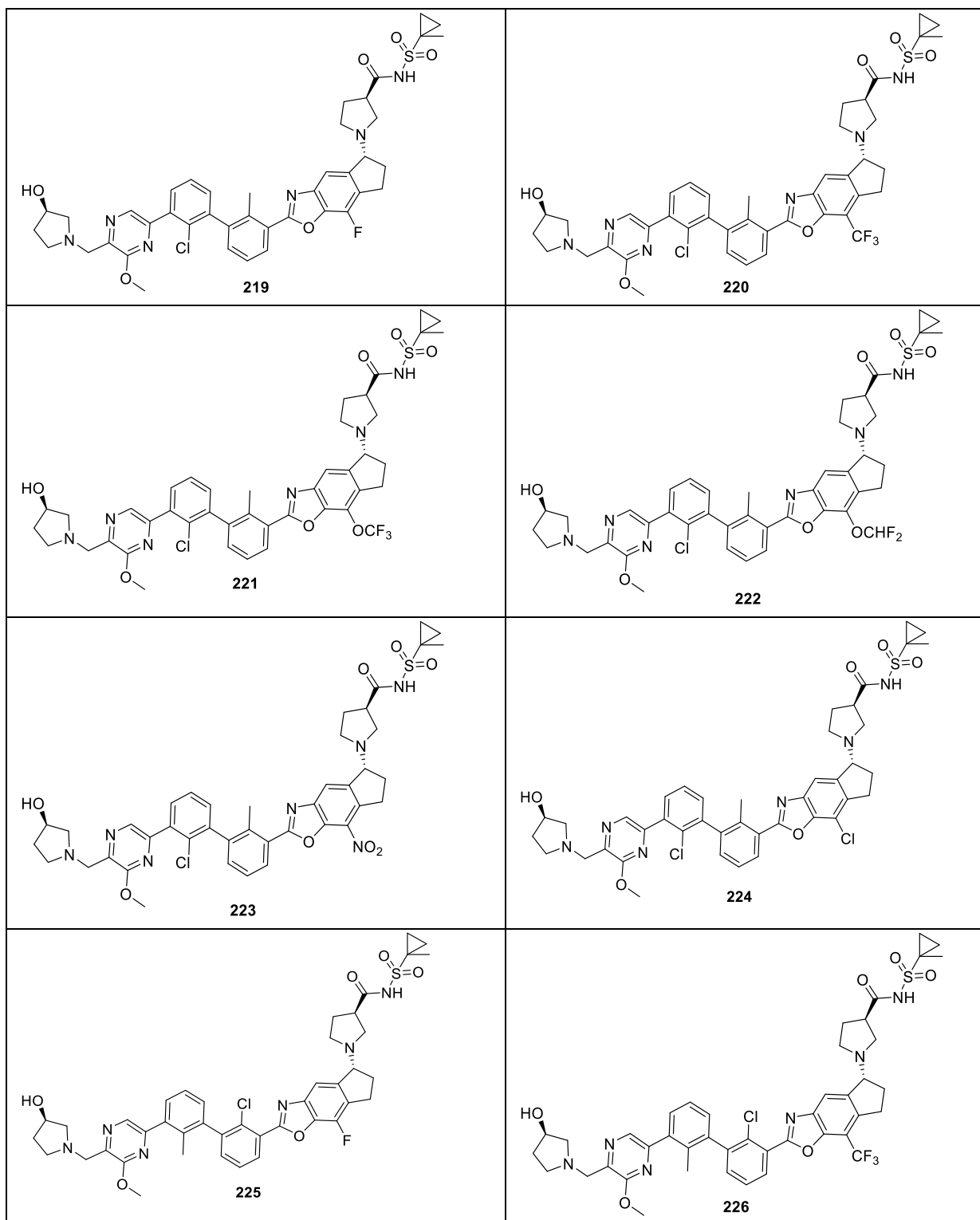


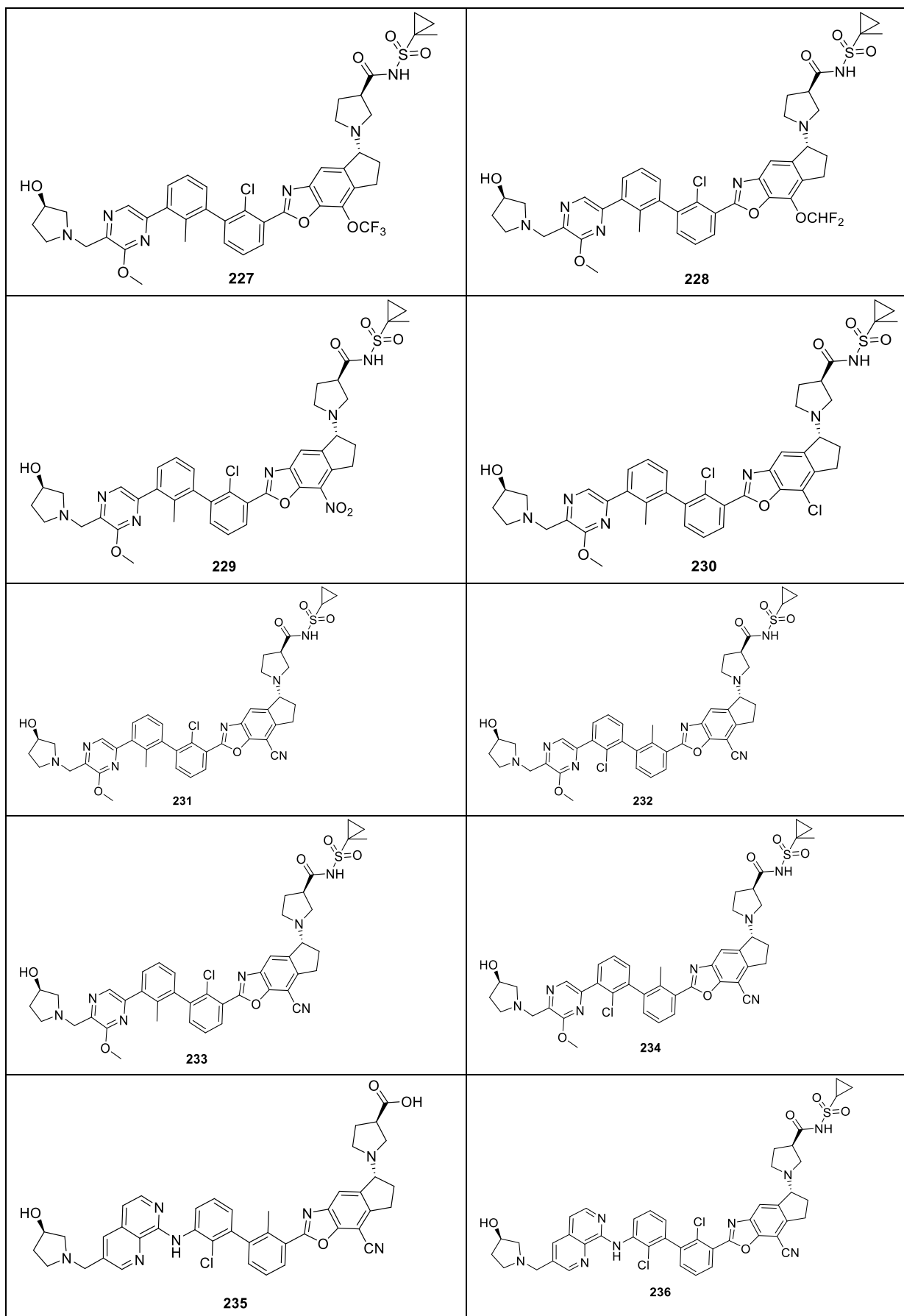


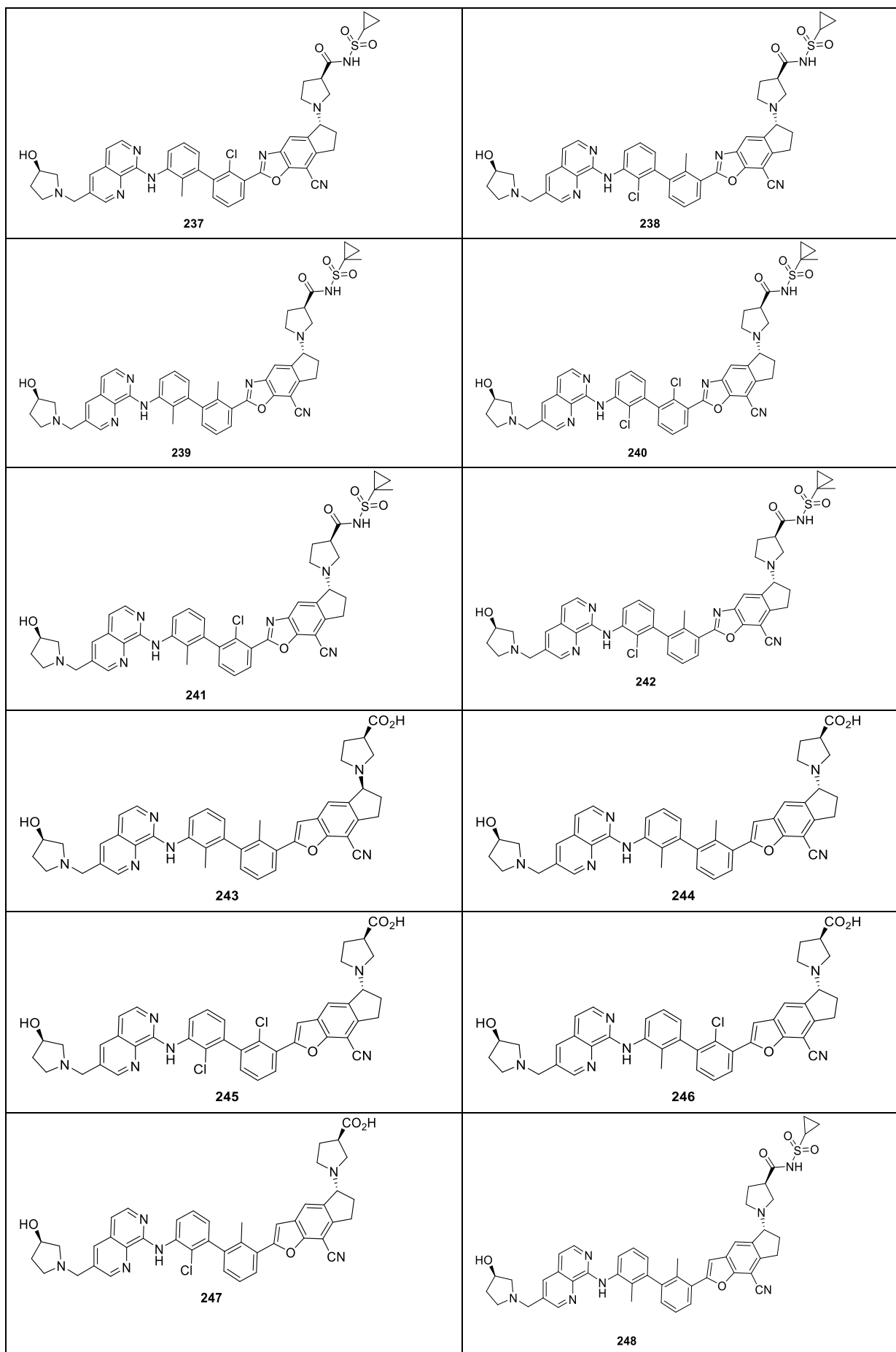


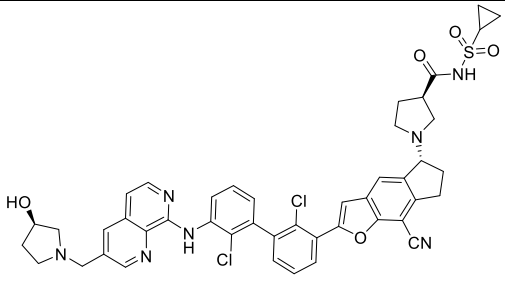
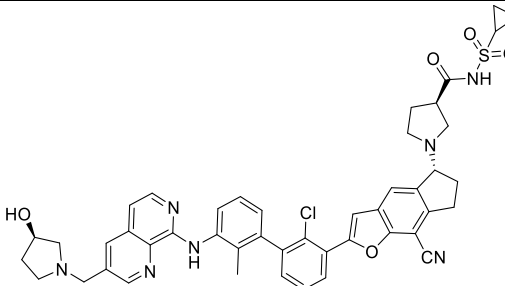
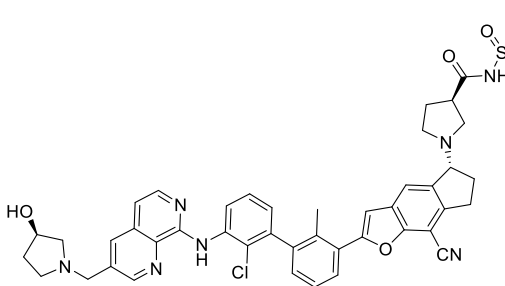
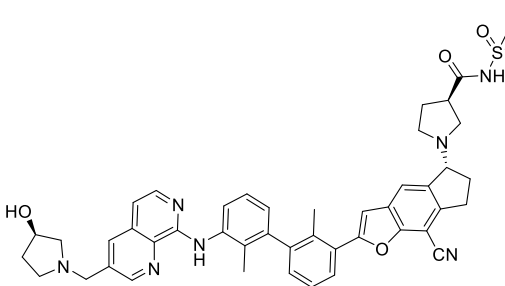
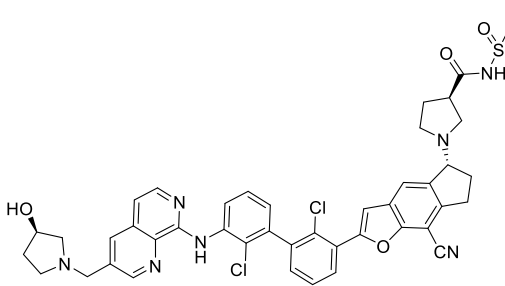
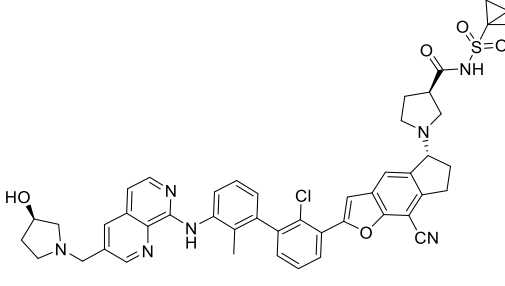
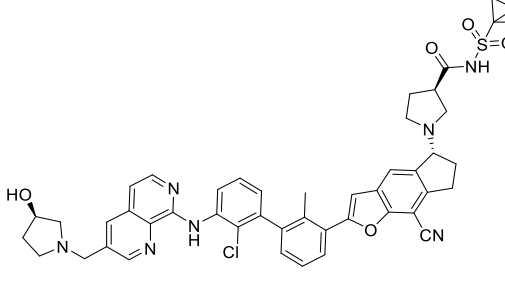
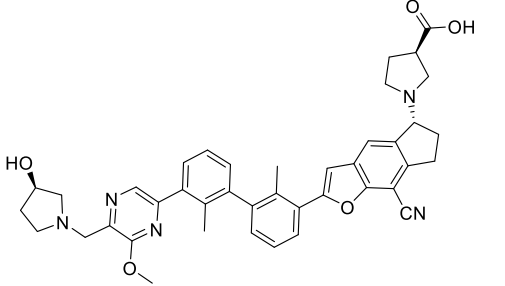
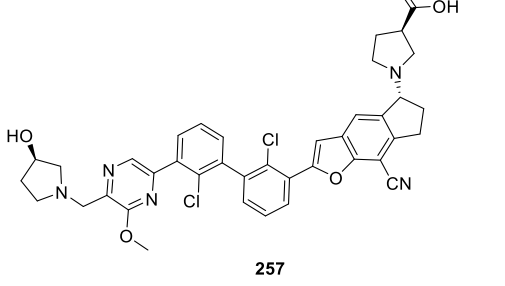
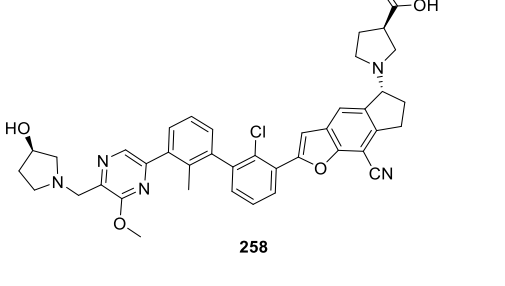


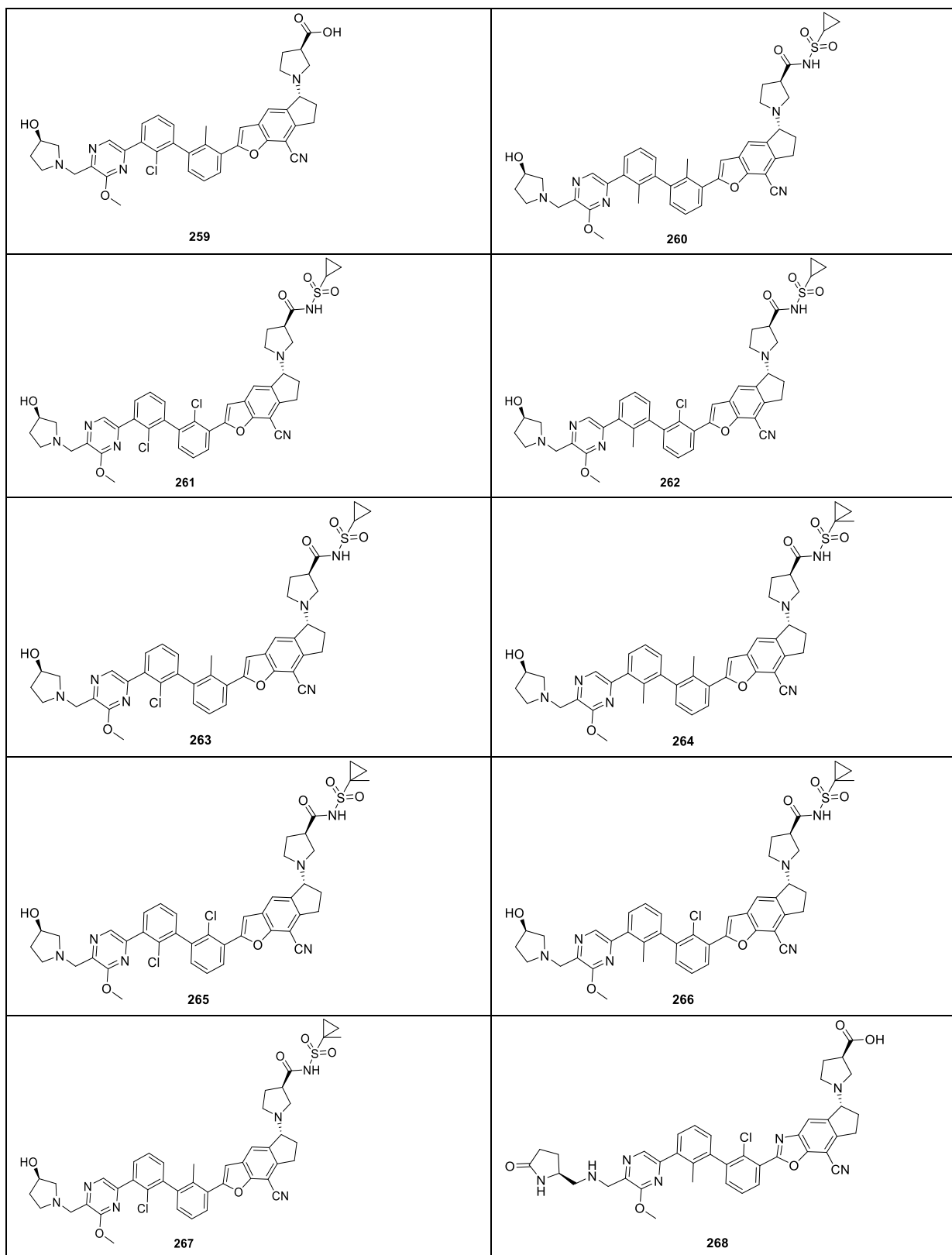


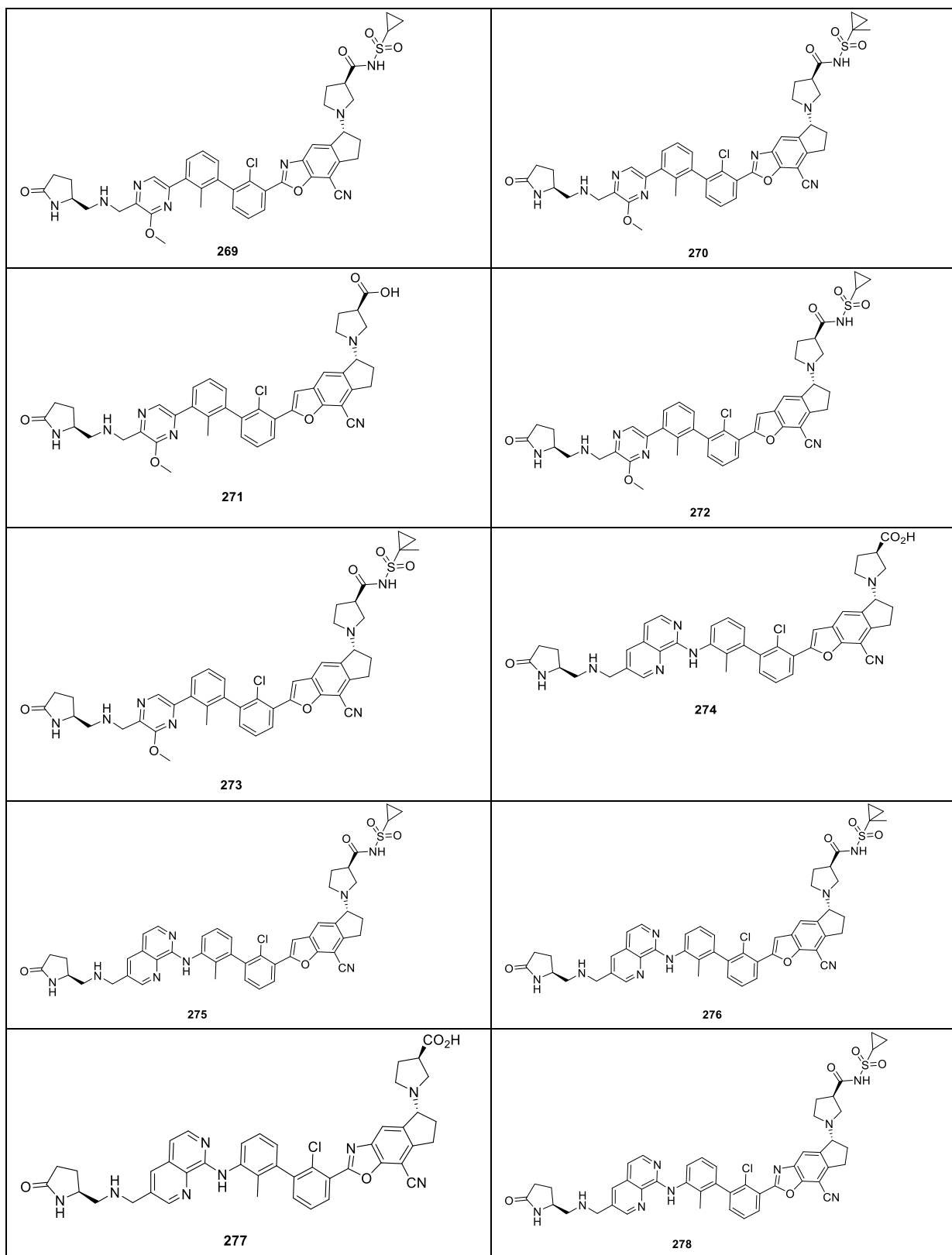


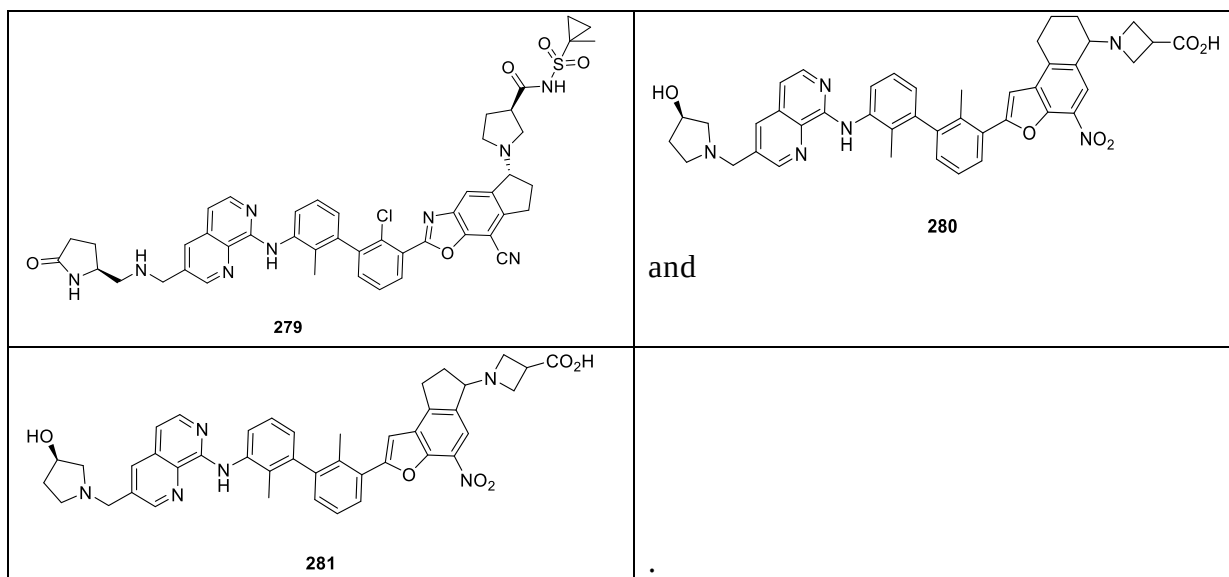




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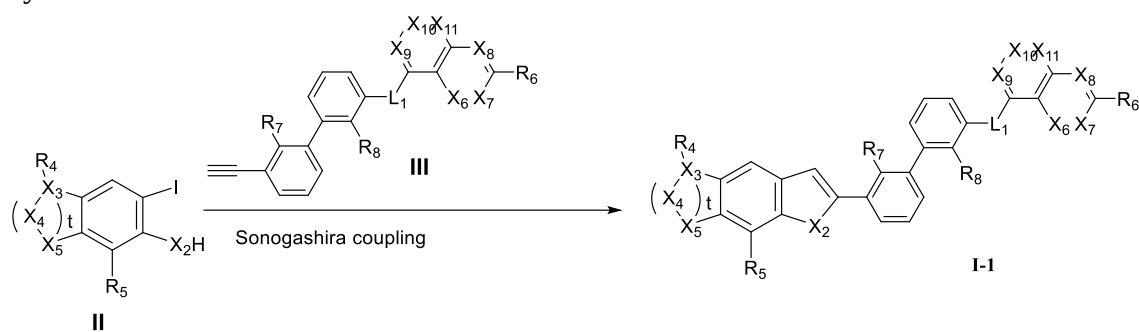






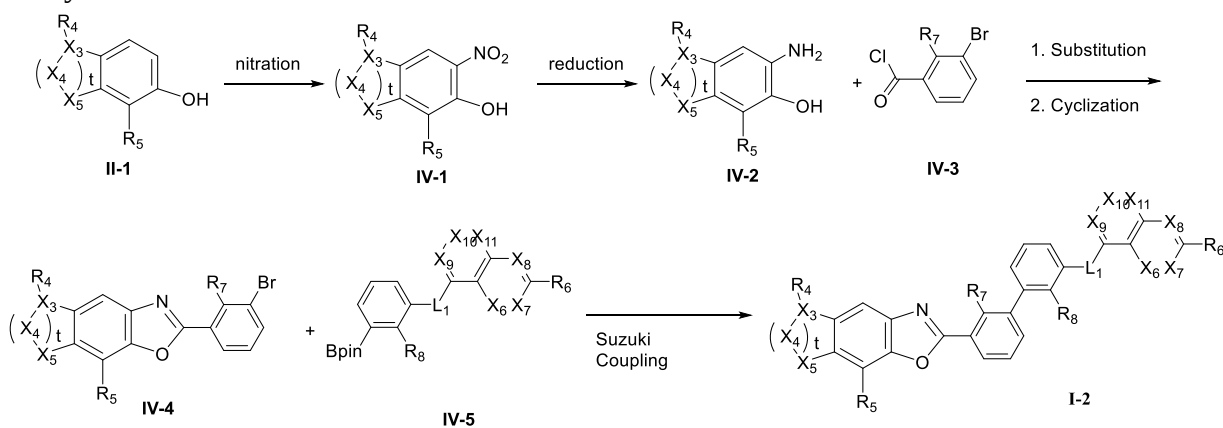
9. A preparation method of the compound of formula I as defined in claim 1, wherein the method comprises steps selected from the steps shown in Synthesis Scheme 1, 2 or 3:

Synthesis Scheme 1:



(a) subjecting intermediates **II** and **III** as raw materials to Sonogashira coupling reaction catalyzed by palladium catalyst to obtain target product **I-1**;

Synthesis Scheme 2:



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

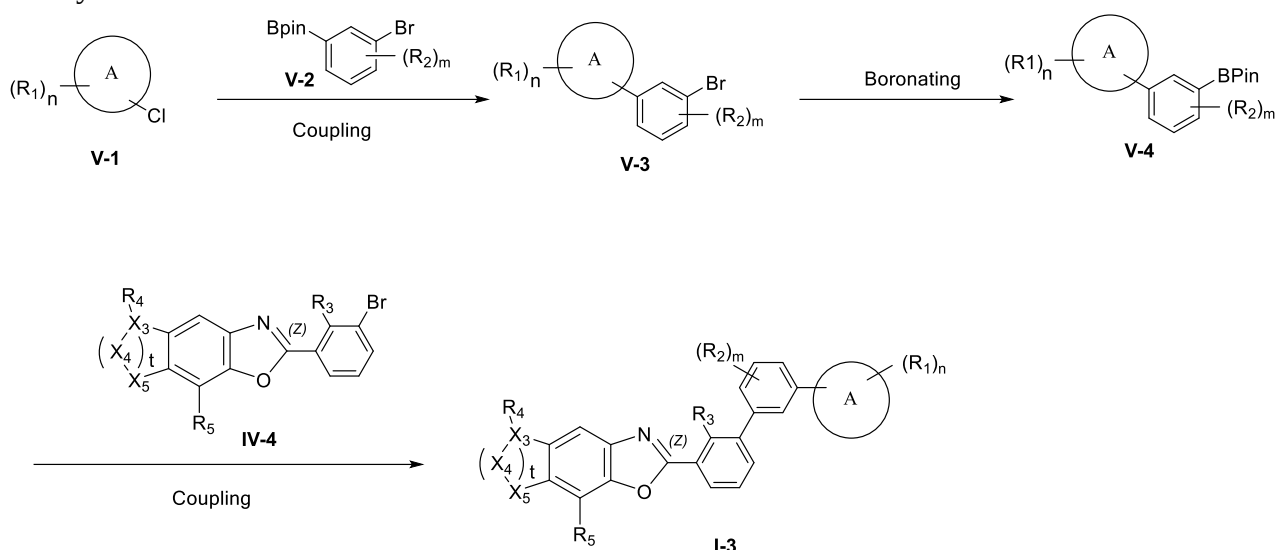
(b) subjecting **IV-1** as a raw material to a reduction reaction under reducing condition to form intermediate **IV-2**;

(c) subjecting **IV-2** and **IV-3** as raw materials to an affinity substitution reaction under alkaline

condition to obtain an amide intermediate; then to a cyclization reaction in the presence of a suitable dehydration reagent to obtain intermediate **IV-4**;

(d) subjecting **IV-4** and **IV-5** as raw materials to a coupling reaction under the conditions of catalyst and ligand to form target intermediate **I-2**;

5 Synthesis Scheme 3:



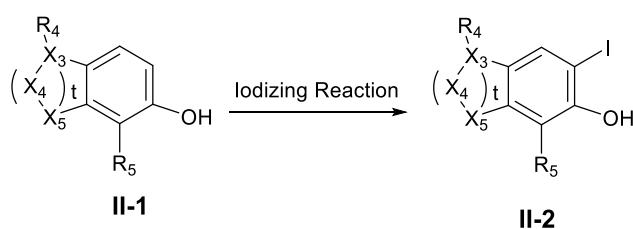
(a) subjecting **V-1** and **V-2** as raw materials to a coupling reaction under the conditions of catalyst and ligand to form intermediate **V-3**;

10 (d) subjecting **IV-4** and a suitable boron source as raw materials to a coupling reaction under the conditions of catalyst and ligand to form intermediate **V-4**;

(d) subjecting **V-4** and **IV-4** as raw materials to a coupling reaction under the conditions of catalyst and ligand to form target product **I-3**;

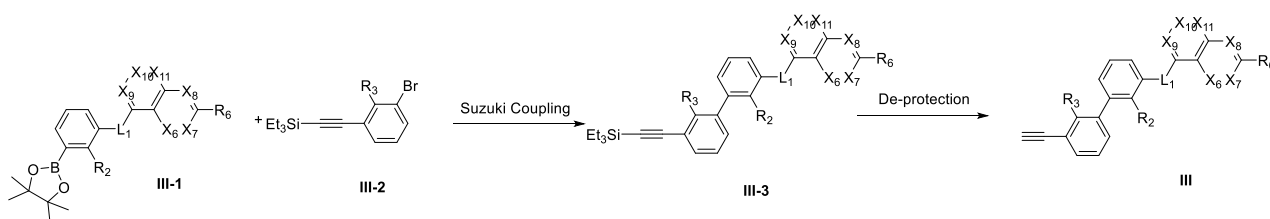
X_1 - X_{12} , R_1 - R_9 , t , m , and n in the above formula are defined as above.

15 10. The method as defined in claim 9, wherein the preparation method of intermediate **II-2** is as follows:



(a) subjecting **II-1** as a raw material to a halogenation reaction under the catalysis of Lewis acid to obtain intermediate **II-2**.

20 11. The method as defined in claim 9, wherein the preparation method of intermediate **III** is as follows:



(a) subjecting compound **III-1** and **III-2** as raw materials to a coupling reaction under the condition of palladium catalyst and ligand to obtain intermediate **III-3**;

(b) removing the silicon-based protecting group from **III-3** as a raw material by using a suitable reagent to obtain intermediate **III**.

12. A pharmaceutical composition comprising (1) the compound as defined in claim 1 or the stereoisomer or tautomer thereof, or the pharmaceutically acceptable salt, hydrate or solvate thereof; 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, and pyrogen-free water.

13. Use of the compound as defined in claim 1, or the pharmaceutical composition as defined in claim 12, 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.

14. The use as defined in claim 13, 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, 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, and head and neck cancer.

15. The use as defined in claim 13, wherein the infectious disease is selected from bacterial infection and viral infection.

16. The use as defined in claim 13, wherein the autoimmune disease is selected from the group consisting of organ-specific autoimmune disease and systemic autoimmune disease.

17. The use as defined in claim 13, wherein the pharmaceutical composition further comprises at least one therapeutic agent selected from the group consisting of nivolumab, pembrolizumab, atezolizumab, and ipilimumab.