

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property

Organization

International Bureau

(43) International Publication Date

02 September 2021 (02.09.2021)



(10) International Publication Number

WO 2021/172886 A1

(51) International Patent Classification:

C07D 471/04 (2006.01) A61P 29/00 (2006.01)

A61K 31/4545 (2006.01) A61P 37/00 (2006.01)

A61K 31/496 (2006.01) A61P 25/00 (2006.01)

A61P 35/00 (2006.01)

(21) International Application Number:

PCT/KR2021/002362

(22) International Filing Date:

25 February 2021 (25.02.2021)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

10-2020-0023249 25 February 2020 (25.02.2020) KR

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: 1,3,4-OXADIAZOLE DERIVATIVE COMPOUNDS AS HISTONE DEACETYLASE 6 INHIBITOR, AND THE PHARMACEUTICAL COMPOSITION COMPRISING THE SAME

(57) Abstract: The present invention relates to a novel compound having a histone deacetylase 6 (HDAC6) inhibitory activity, an isomer thereof or a pharmaceutically acceptable salt thereof, the use thereof for preparing a therapeutic medicament; a pharmaceutical composition containing the same, and a treatment method using the composition; and a preparation method thereof. The novel compound, the isomer thereof, or the pharmaceutically acceptable salt thereof according to the present invention has the HDAC6 inhibitory activity, which is effective in the prevention or treatment of HDAC6-mediated diseases including cancer, inflammatory diseases, autoimmune diseases, neurological or neurodegenerative diseases.



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Description

Title of Invention: 1,3,4-OXADIAZOLE DERIVATIVE COMPOUNDS AS HISTONE DEACETYLASE 6 INHIBITOR, AND THE PHARMACEUTICAL COMPOSITION COMPRISING THE SAME

Technical Field

- [1] The present invention relates to a 1,3,4-oxadiazole derivative compound having a histone deacetylase 6 (HDAC6) inhibitory activity, an optical isomer thereof, a pharmaceutically acceptable salt thereof; the use for preparing a therapeutic medicament; a treatment method using the same; a pharmaceutical composition containing the same; and a preparation method thereof.

Background Art

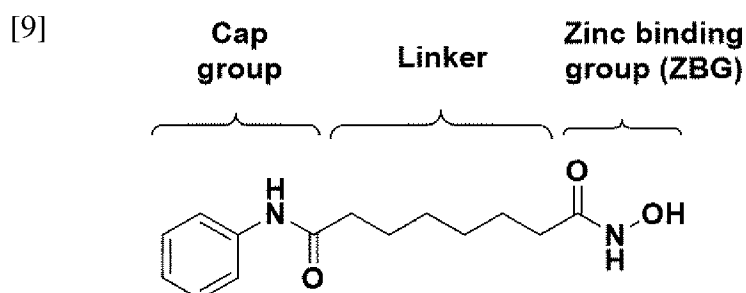
- [2] Post-translational modifications such as acetylation in cells are very important regulatory modules at the center of biological processes and are strictly controlled by a number of enzymes. Histones are core proteins that make up the chromatin, acting as spools around which DNA winds to help condensation of DNA. In addition, the balance between acetylation and deacetylation of histones plays a very important role in gene expression.
- [3] Histone deacetylases (HDACs) are enzymes that remove the acetyl group of the histone protein lysine residues constituting the chromatin, which are known to be associated with gene silencing and to induce cell cycle arrest, angiogenesis inhibition, immune regulation, cell death, and the like (Hassig et al., Curr. Opin. Chem. Biol. 1997, 1, 300-308). Further, it has been reported that inhibition of HDAC enzyme function induces cancer cell death by reducing the activity of cancer cell survival-related factors and activating cancer cell death-related factors in vivo (Warrell et al, J. Natl. Cancer Inst. 1998, 90, 1621-1625).
- [4] In humans, 18 HDACs are known and are classified into 4 groups depending on their homology with yeast HDACs. Here, 11 HDACs using zinc as a cofactor can be divided into three groups of Class I (HDACs 1, 2, 3, and 8), Class II (IIa: HDACs 4, 5, 7, and 9; IIb: HDACs 6 and 10) and Class IV (HDAC11). Further, 7 HDACs of Class III (SIRT 1-7) employ NAD⁺ as a cofactor instead of zinc (Bolden et al., Nat. Rev. Drug. Discov. 2006, 5(9), 769-784).
- [5] Various HDAC inhibitors are in the preclinical or clinical development stage. However, until now, only non-selective HDAC inhibitors are known as anticancer agents, wherein vorinostat (SAHA) and romidepsin (FK228) have been approved as

treatments for cutaneous T-cell lymphoma, and panobinostat (LBH-589) has been approved as a treatment for multiple myeloma. However, non-selective HDACs inhibitors are generally known to cause side effects such as fatigue and nausea, and the like, at high doses (Piekarz et al., *Pharmaceuticals* 2010, 3, 2751-2767). These side effects are reported to be caused by inhibition of Class I HDACs, and due to these side effects, non-selective HDACs inhibitors have been limited in drug development in fields other than anticancer agents (Witt et al., *Cancer Letters* 277 (2009) 8.21).

[6] Meanwhile, it has been reported that selective Class II HDAC inhibition may not show the toxicity seen in Class I HDAC inhibition, and if a selective Class II HDAC inhibitor is developed, side effects such as toxicity caused by the non-selective HDAC inhibition may be solved, and thus the selective HDAC inhibitor has the potential to be developed as effective therapeutic agent for various diseases (Matthias et al., *Mol. Cell. Biol.* 2008, 28, 1688-1701).

[7] HDAC6, one of the Class IIb HDACs, is mainly present in the cytoplasm and is known to be involved in deacetylation of a number of non-histone substrates (HSP90, cortactin, and the like) including tubulin proteins (Yao et al., *Mol. Cell* 2005, 18, 601-607). The HDAC6 has two catalytic domains, and the C-terminal of zinc-finger domain may bind to ubiquitinated proteins. Since the HDAC6 has a large number of non-histone proteins as substrates, it is known to play an important role in various diseases such as cancer, inflammatory diseases, autoimmune diseases, neurological diseases, and neurodegenerative disorders, and the like (Santo et al., *Blood* 2012 119: 2579-258; Vishwakarma et al., *International Immunopharmacology* 2013, 16, 72-78; Hu et al., *J. Neurol. Sci.* 2011, 304, 1-8).

[8] A common structural feature of various HDAC inhibitors is that they consist of a cap group, a linker group, and a zinc-binding group (ZBG), as shown in the structure of vorinostat below. Many researchers have studied the inhibitory activity and selectivity for enzymes through structural modifications of the cap group and linker group. Among the groups, the zinc-binding group is known to play a more important role in the enzyme inhibitory activity and selectivity (Wiest et al., *J. Org. Chem.* 2013 78: 5051-5065; Methot et al., *Bioorg. Med. Chem. Lett.* 2008, 18, 973-978).



[10] Most of the zinc-binding groups are hydroxamic acid or benzamide, and among

them, hydroxamic acid derivatives exhibit a strong HDAC inhibitory effect, but have problems such as low bioavailability and severe off-target activity. Since benzamide contains aniline, there is a problem that toxic metabolites may be caused in vivo (Woster et al., Med. Chem. Commun. 2015, online publication).

- [11] Therefore, for the treatment of cancer, inflammatory diseases, autoimmune diseases, neurological diseases, and neurodegenerative disorders, and the like, there is a need to develop a selective HDAC6 inhibitor having a zinc-binding group with improved bioavailability without side effects, unlike non-selective inhibitors with side effects.

Disclosure of Invention

Technical Problem

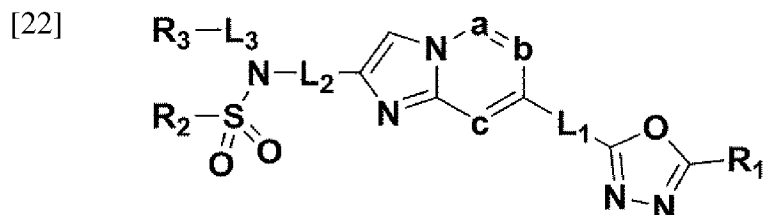
- [12] An object of the present invention is to provide a 1,3,4-oxadiazole derivative compound having a selective histone deacetylase 6 (HDAC6) inhibitory activity, an optical isomer thereof, or a pharmaceutically acceptable salt thereof.
- [13] Another object of the present invention is to provide a pharmaceutical composition including a 1,3,4-oxadiazole derivative compound having a selective HDAC6 inhibitory activity, an optical isomer thereof, or a pharmaceutically acceptable salt thereof.
- [14] Still another object of the present invention is to provide a preparation method thereof.
- [15] Still another object of the present invention is to provide a pharmaceutical composition including the compounds for preventing or treating histone deacetylase 6(HDAC6)-mediated diseases including infectious diseases; neoplasm; endocrine, nutritional and metabolic diseases; mental and behavioral disorders; neurological diseases; diseases of eyes and adnexa; circulatory diseases; respiratory diseases; digestive diseases; skin and subcutaneous tissue diseases; musculoskeletal and connective tissue diseases; or congenital malformations, alterations, or chromosomal abnormalities.
- [16] Still another object of the present invention is to provide the use of the compounds for preparing a medicament for preventing or treating HDAC6-mediated diseases.
- [17] Still another object of the present invention is to provide a method for preventing or treating HDAC6-mediated diseases including administering a therapeutically effective amount of the composition including the compounds as described above.

Solution to Problem

- [18] The present inventors found a 1,3,4-oxadiazole derivative compound having a histone deacetylase 6 (HDAC6) inhibitory activity to inhibit or treat HDAC6-mediated diseases, and completed the present invention.
- [19] **1,3,4-Oxadiazole Derivative Compound**

[20] In one general aspect, the present invention provides a 1,3,4-oxadiazole derivative compound represented by Chemical Formula I below, an optical isomer thereof, or a pharmaceutically acceptable salt thereof:

[21] [Chemical Formula I]



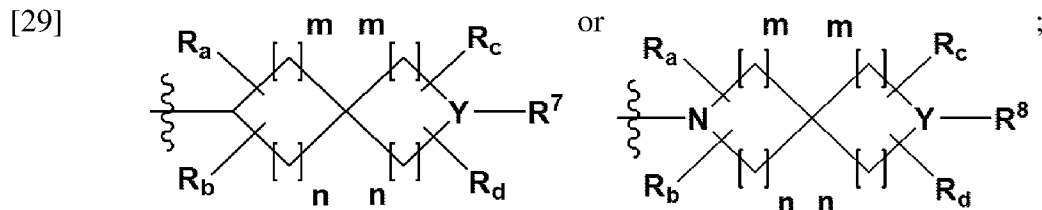
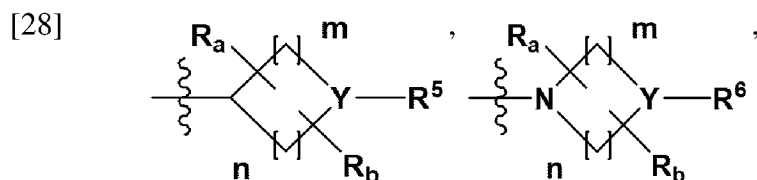
[23] in the Chemical Formula I above,

[24] L_1 , L_2 and L_3 are each independently $-(C_0-C_2\text{alkyl})-$;

[25] a, b and c are each independently N or CR^4 , wherein a, b and c cannot be N at the same time, and R^4 is -H, -X or $-O(C_1-C_4\text{alkyl})$;

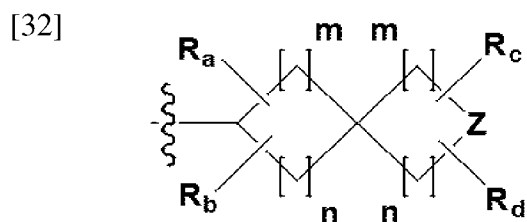
[26] R_1 is $-CH_2X$ or $-CX_3$;

[27] R_2 is $-(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-O-(C_1-C_4\text{alkyl})$, $-NR^A R^B$, aryl, heteroaryl,



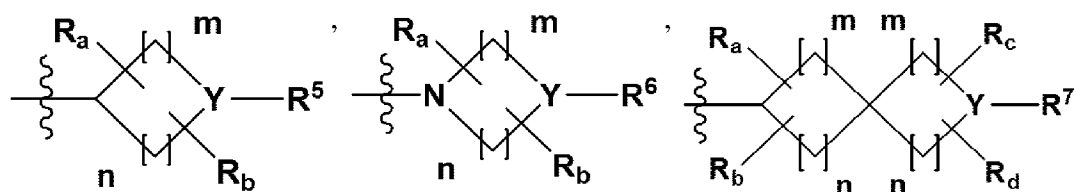
[30] Y is -N-, -CH-, -O- or $-S(=O)_2-$;

[31] when Y is -N- or -CH-, R_5 , R_6 , R_7 and R_8 are each independently -H, -X, -OH, $-(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-O(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-O(C_1-C_4\text{alkyl})$, $-NR^C R^D$, $-CF_3$, $-CF_2H$, -CN, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^C R^D$, $-C(=O)-(C_1-C_4\text{alkyl})-NR^C R^D$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, -aryl, heteroaryl, $-(C_1-C_4\text{alkyl})$ -aryl, $-(C_1-C_4\text{alkyl})$ -heteroaryl, an amine protecting group or

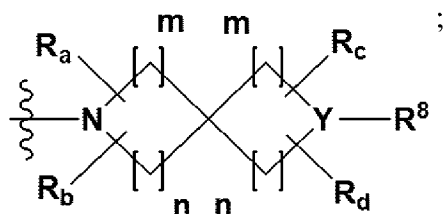


[33] wherein at least one H of $-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$

- and -C(=O)-(C₃-C₇cycloalkyl) may be substituted with -X, -OH, -O(C₁-C₄alkyl), -C(=O)-(C₁-C₄alkyl), -C(=O)-O(C₁-C₄alkyl), -CF₃ or -CF₂H; at least one H of -aryl, -heteroaryl, -(C₁-C₄alkyl)-aryl and -(C₁-C₄alkyl)heteroaryl may be substituted with -X, -OH, -(C₁-C₄alkyl), -O(C₁-C₄alkyl), -C(=O)-(C₁-C₄alkyl), -C(=O)-O(C₁-C₄alkyl), -CF₃ or -CF₂H; -(C₂-C₆heterocycloalkyl), -heteroaryl or -(C₁-C₄alkyl)heteroaryl may contain N, O or S atom in the ring; and Z is -NH-, -CH₂- or -O-;
- [34] when Y is -O- or -S(=O)₂-, R₅, R₆, R₇ and R₈ are nothing (null);
- [35] R^A to R^D are each independently -H, -(C₁-C₄alkyl), -(C₃-C₇cycloalkyl), -(C₂-C₆heterocycloalkyl), -(C₁-C₄alkyl)-(C₂-C₆heterocycloalkyl), aryl, heteroaryl or -(C₁-C₄alkyl)-aryl, wherein at least one H of -(C₃-C₇cycloalkyl), -(C₂-C₆heterocycloalkyl), -(C₁-C₄alkyl)-(C₂-C₆heterocycloalkyl), aryl, heteroaryl and -(C₁-C₄alkyl)-aryl may be substituted with -(C₁-C₄alkyl), -C(=O)-(C₁-C₄alkyl), -S(=O)₂-(C₁-C₄alkyl) or -(C₂-C₆heterocycloalkyl);
- [36] m and n are each independently an integer of 1, 2 or 3;
- [37] R_a to R_d are each independently -H or -(C₁-C₄alkyl);
- [38] R³ is -H, -(C₁-C₄alkyl), -(C₁-C₄alkyl)-O(C₁-C₄alkyl), -(C₁-C₄alkyl)-C(=O)-O(C₁-C₄alkyl), -C(=O)-O(C₁-C₄alkyl), -(C₃-C₇cycloalkyl), -(C₂-C₆heterocycloalkyl), -aryl or -heteroaryl, wherein at least one H of -(C₁-C₄alkyl), -(C₃-C₇cycloalkyl), -(C₂-C₆heterocycloalkyl), -aryl and -heteroaryl may each independently be substituted with -X, -OH, -O(C₁-C₄alkyl), -C(=O)-O(C₁-C₄alkyl), -C(=O)-(C₁-C₄alkyl), -CF₃, -CF₂H, -OCF₃, -S(=O)₂-(C₁-C₄alkyl), -aryl, -O-aryl, -heteroaryl or -NR^{ER}, and the R^E and R^F are each independently -H or -(C₁-C₄alkyl); and
- [39] X is F, Cl, Br or I.
- [40] According to an embodiment of the present invention,
- [41] in the Chemical Formula I above,
- [42] L₁ to L₃ are each independently -(C₀-C₁alkyl)-;
- [43] a, b and c are each independently N or CR⁴, wherein a, b and c cannot be N at the same time, and R⁴ is -H or -X;
- [44] R₁ is -CH₂XH or -CX₃;
- [45] R₂ is -(C₁-C₄alkyl), -NR^{AR},
 [46]



[47]



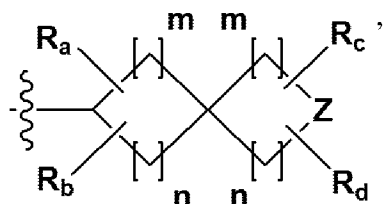
[48] m and n are each independently an integer of 1 or 2;

[49] R_a to R_d are each independently -H or $-(C_1-C_4\text{alkyl})$;

[50] Y is -N-, -O- or $-S(=O)_2$;

[51] when Y is -N-, R_5 , R_6 , R_7 and R_8 are each independently -H, $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^cR^d$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, -heteroaryl or

[52]



[53] wherein at least one -H of $-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$ and $-(C_3-C_7\text{cycloalkyl})$ may be substituted with -X or -OH; $-(C_2-C_6\text{heterocycloalkyl})$ or -heteroaryl may contain N, O or S atoms in the ring; and Z is -NH-, $-CH_2$ - or -O-;

[54] when Y is -O- or $-S(=O)_2$, R_5 , R_6 , R_7 and R_8 are nothing (null);

[55] R^A to R^D are each independently -H or $-(C_1-C_4\text{alkyl})$;

[56] R^3 is -aryl or -heteroaryl, wherein at least one H of -aryl and -heteroaryl may each independently be substituted with -X; and

[57] X may be F, Cl or Br.

[58] Further, according to another embodiment of the present invention,

[59] in the Chemical Formula I above,

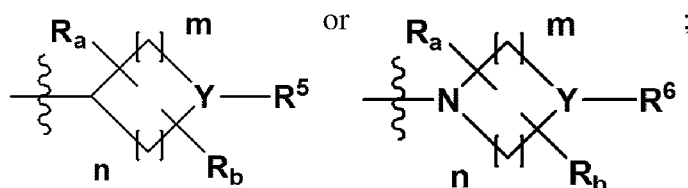
[60] L_1 and L_3 are each independently $-(C_6\text{alkyl})$;

[61] L_2 is $-(C_1\text{alkyl})$;

[62] a , b and c are each independently CR^4 , wherein R^4 is -H or -X;

[63] R_1 is $-CH_2XH$ or $-CX_3$;

[64] R_2 is

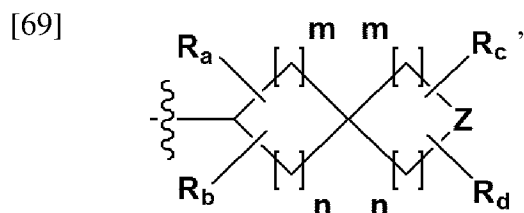


[65] m and n are each independently an integer of 1 or 2;

[66] R_a and R_b are each independently -H or $-(C_1-C_4\text{alkyl})$;

[67] Y is -N-,

[68] R_5 and R_6 are each independently -H, $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^cR^d$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, -heteroaryl or



[70] wherein at least one -H of $-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$ and $-(C_3-C_7\text{cycloalkyl})$ may be substituted with -X or -OH; $-(C_2-C_6\text{heterocycloalkyl})$ or -heteroaryl may contain N, O or S atoms in the ring; and Z is $-CH_2-$ or $-O-$;

[71] R^c and R^d are each independently -H or $-(C_1-C_4\text{alkyl})$;

[72] R^3 is -aryl, wherein at least one H of -aryl may each independently be substituted with -X; and

[73] X may be F or Cl.

[74] Further, according to still another embodiment of the present invention,

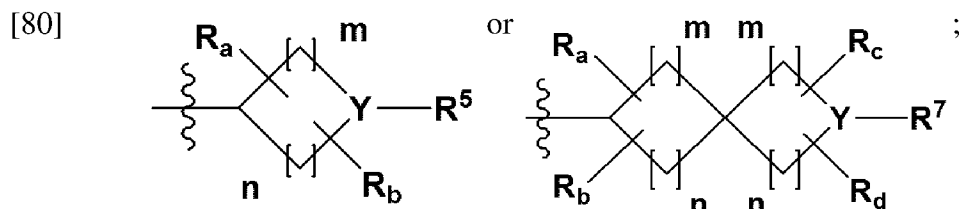
[75] in the Chemical Formula I above,

[76] L_1 to L_3 are each independently $-(C_0-C_1\text{alkyl})-$;

[77] a, b and c are each independently N or CR^4 , wherein a, b and c cannot be N at the same time, and R^4 is -H or -X;

[78] R_1 is $-CH_2XH$ or $-CX_3$;

[79] R_2 is $-(C_1-C_4\text{alkyl})$,



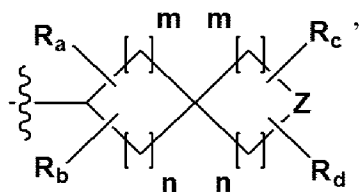
[81] m and n are each independently an integer of 1 or 2;

[82] R_a to R_d are each independently -H or $-(C_1-C_4\text{alkyl})$;

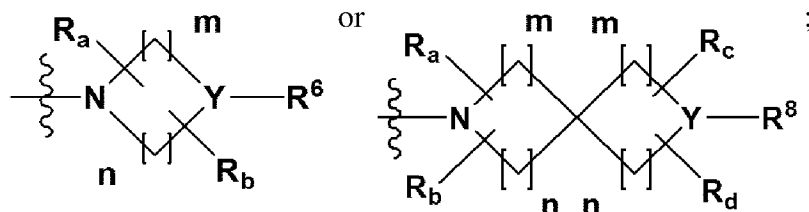
[83] Y is -N-, -O- or $-S(=O)_2-$;

[84] when Y is -N-, R_5 , R_6 , R_7 and R_8 are each independently -H, $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^cR^d$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, -heteroaryl or

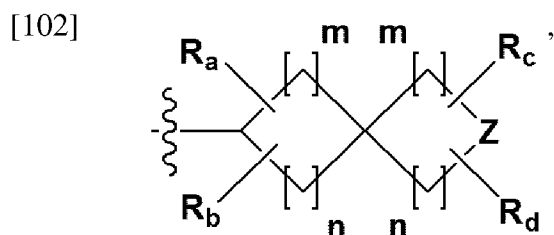
[85]



- [86] wherein at least one -H of $-(C_1-C_4\text{alkyl})$, $-(C=O)-(C_1-C_4\text{alkyl})$ and $-(C_3-C_7\text{ cycloalkyl})$ may be substituted with -X or -OH; $-(C_2-C_6\text{heterocycloalkyl})$ or -heteroaryl may contain N, O or S atoms in the ring; and Z is -NH-, $-CH_2-$ or -O-;
- [87] when Y is -O- or $-S(=O)_2$, R_5 , R_6 , R_7 and R_8 are nothing (null);
- [88] R^C and R^D are each independently -H or $-(C_1-C_4\text{alkyl})$;
- [89] R^3 is -aryl or -heteroaryl, wherein at least one H of -aryl or -heteroaryl may each independently be substituted with -X; and
- [90] X may be F, Cl or Br.
- [91] Further, according to still another embodiment of the present invention,
- [92] in the Chemical Formula I above,
- [93] L_1 to L_3 are each independently $-(C_0-C_1\text{alkyl})$;
- [94] a, b and c are each independently N or CR^4 , wherein a, b and c cannot be N at the same time, and R^4 is -H or -X;
- [95] R_1 is $-CH_2XH$ or $-CX_3$;
- [96] R_2 is $-NR^A R^B$,
- [97]



- [98] m and n are each independently an integer of 1 or 2;
- [99] R_a to R_d are each independently -H or $-(C_1-C_4\text{alkyl})$;
- [100] Y is -N-, -O- or $-S(=O)_2$;
- [101] when Y is -N-, R_5 , R_6 , R_7 and R_8 are each independently -H, $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{ cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{ cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^C R^D$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, -heteroaryl or



- [103] wherein at least one -H of $-(C_1-C_4\text{alkyl})$, $-(C=O)-(C_1-C_4\text{alkyl})$ and $-(C_3-C_7\text{ cycloalkyl})$

cloalkyl) may be substituted with -X or -OH; -(C₂-C₆heterocycloalkyl) or -heteroaryl may contain N, O or S atoms in the ring; and Z is -NH-, -CH₂- or -O-;

[104] when Y is -O- or -S(=O)₂-, R₅, R₆, R₇ and R₈ are nothing (null);

[105] R^A to R^D are each independently -H or -(C₁-C₄alkyl);

[106] R³ is -aryl or -heteroaryl, wherein at least one H of -aryl and -heteroaryl may each independently be substituted with -X; and

[107] X may be F, Cl or Br.

[108] Specific compounds represented by Chemical Formula I of the present invention are shown in Table 1 below.

[109] [Table 1]

[110]

Ex	Comp	Structure	Ex	Comp	Structure
1	3778		2	3779	
3	4214		4	4215	
5	4216		6	4217	
7	4218		8	4219	
9	4220		10	4221	

[111]

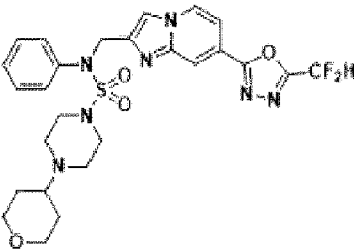
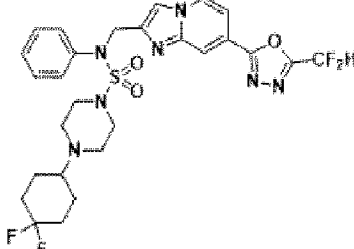
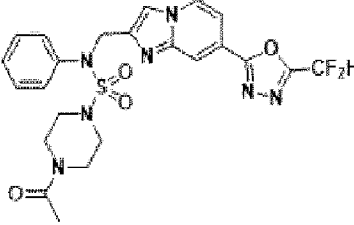
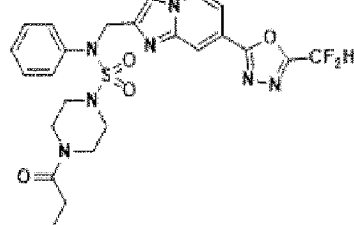
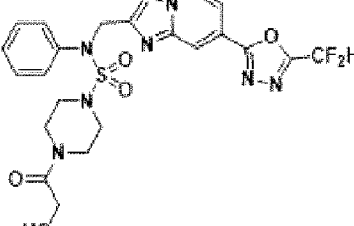
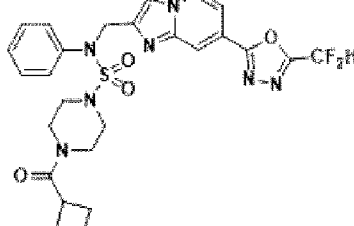
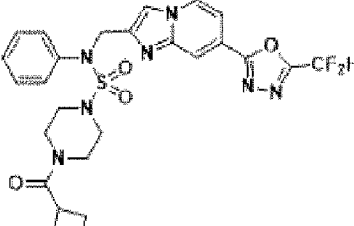
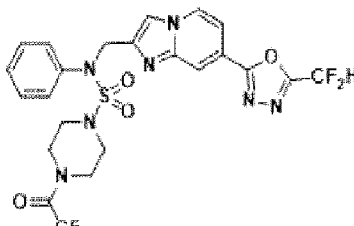
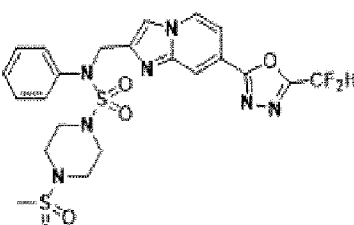
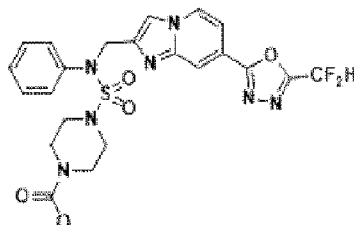
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17	4228		18	4236	
19	4237		20	4238	
21	4239		22	4240	

[112]

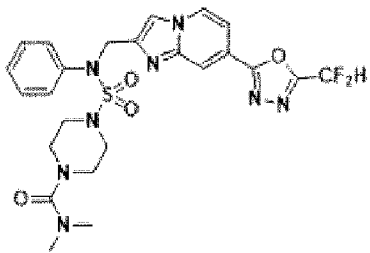
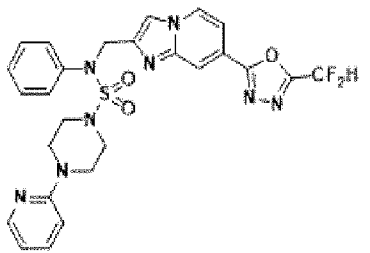
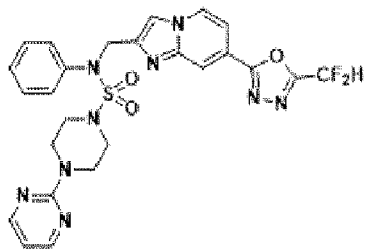
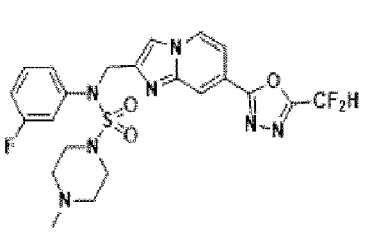
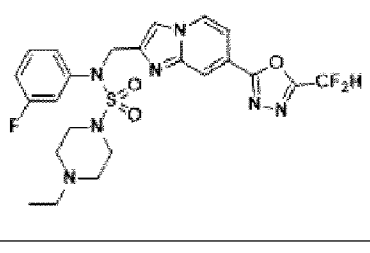
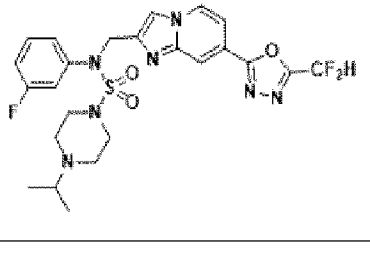
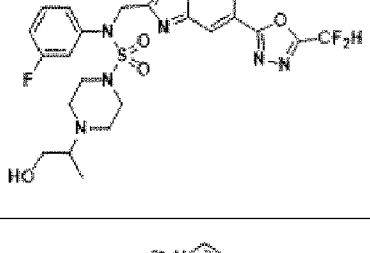
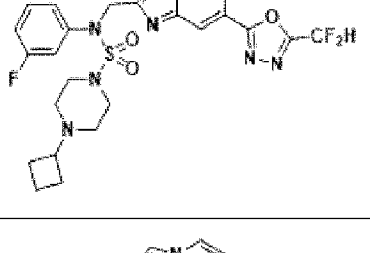
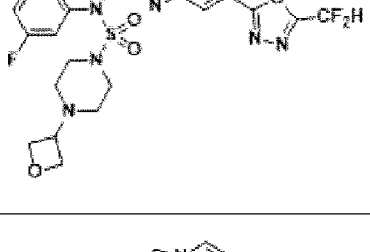
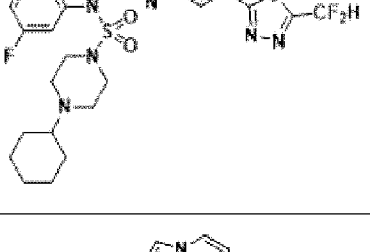
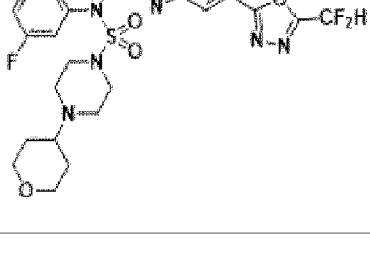
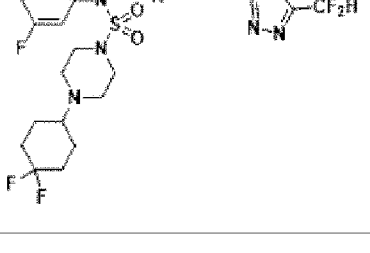
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29	4247		30	4248	
31	4249		32	4250	

[113]

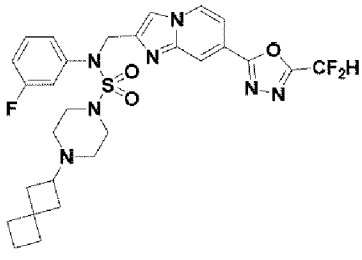
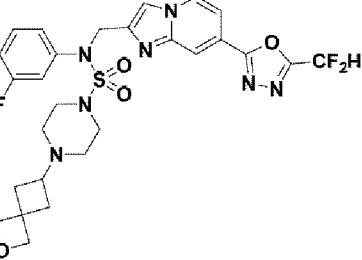
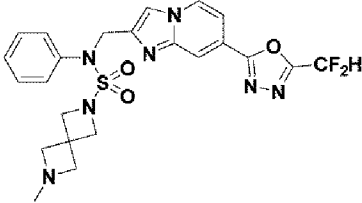
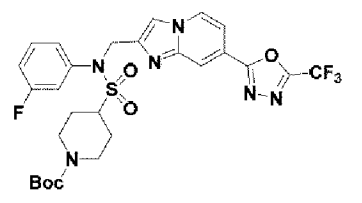
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35	4253		36	4254	
37	4255		38	4256	
39	4257		40	4258	
41	4259		42	4260	
43	4261		44	4262	

45	4263		46	4264	
47	4265		48	4266	
49	4267		50	4268	
51	4269		52	4270	
53	4271		54	4272	

[115]

55	4273		56	4274	
57	4275		58	4297	
59	4298		60	4299	
61	4300		62	4301	
63	4302		64	4303	
65	4304		66	4305	

[117]

79	4622		80	4623	
81	4624		82	6893	

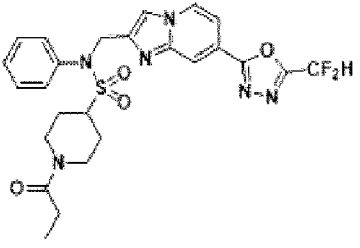
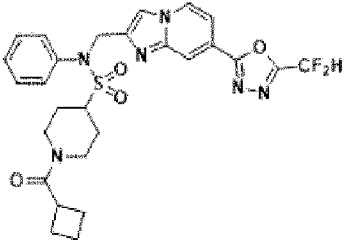
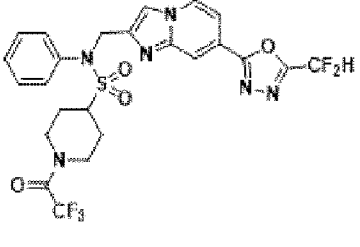
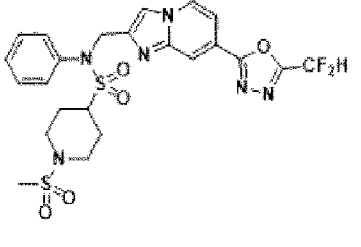
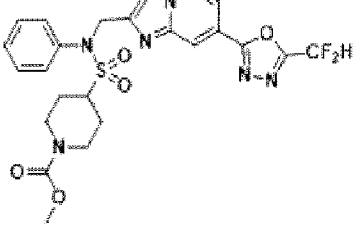
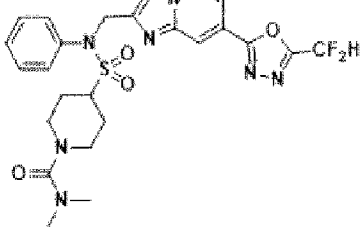
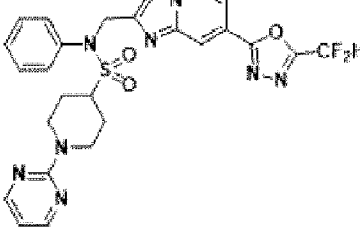
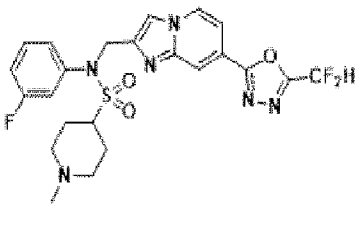
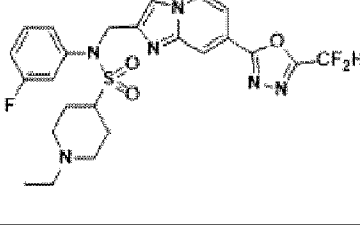
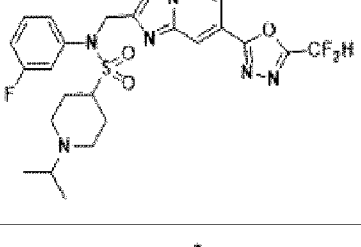
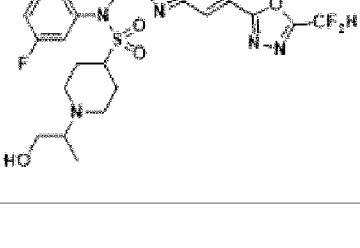
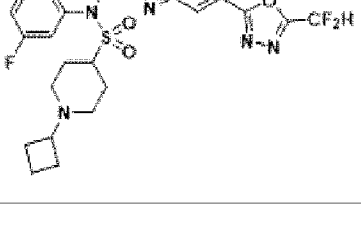
[118] According to an embodiment of the present invention, it may be a specific compound represented by Chemical Formula I of the present invention:

[119] [Table 2]

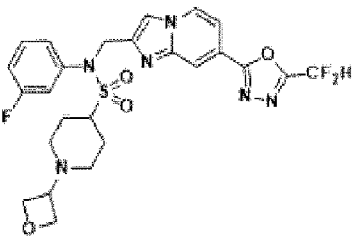
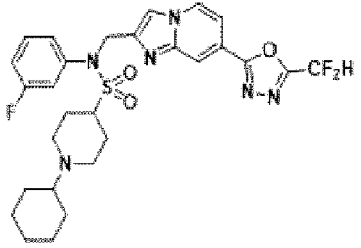
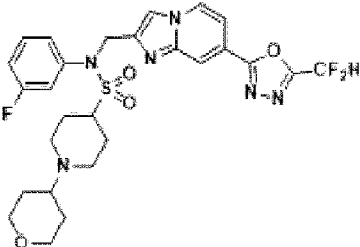
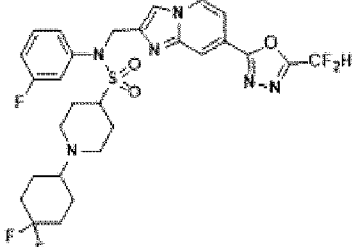
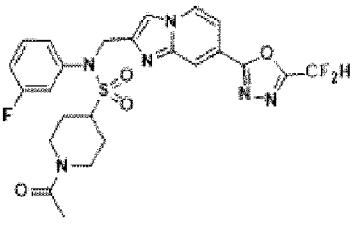
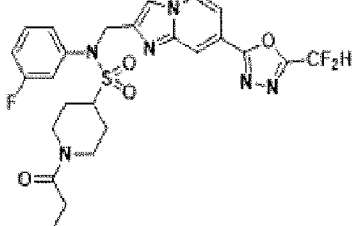
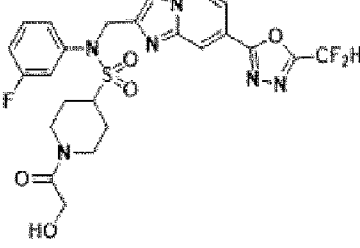
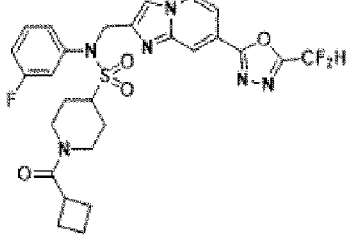
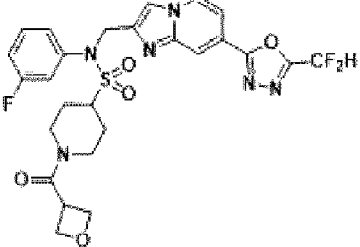
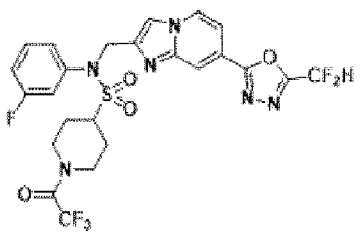
[120]

Ex	Comp	Structure	Ex	Comp	Structure
1	3778		2	3779	
3	4214		4	4215	
5	4216		6	4217	
7	4218		8	4219	
9	4220		10	4221	

[121]

11	4222		12	4223	
13	4224		14	4225	
15	4226		16	4227	
17	4228		18	4236	
19	4237		20	4238	
21	4239		22	4240	

[122]

23	4241		24	4242	
25	4243		26	4244	
27	4245		28	4246	
29	4247		30	4248	
31	4249		32	4250	

[123]

33	4251		34	4252	
35	4253		36	4254	
37	4255		77	4616	
78	4617		82	6893	

[124] According to an embodiment of the present invention, it may be a specific compound represented by Chemical Formula I of the present invention:

[125] [Table 3]

[126]

Ex	Comp	Structure	Ex	Comp	Structure
38	4256		39	4257	
40	4258		41	4259	
42	4260		43	4261	
44	4262		45	4263	
46	4264		47	4265	
48	4266		49	4267	

[127]

50	4268		51	4269	
52	4270		53	4271	
54	4272		55	4273	
56	4274		57	4275	
58	4297		59	4298	
60	4299		61	4300	

[128]

[129]

74	4313		75	4314	
76	4315		79	4622	
80	4623		81	4624	

[130] In the present invention, the pharmaceutically acceptable salt refers to a salt commonly used in the pharmaceutical industry, for example, may include inorganic ionic salts prepared from calcium, potassium, sodium, and magnesium, and the like, inorganic acid salts prepared from hydrochloric acid, nitric acid, phosphoric acid, bromic acid, iodic acid, perchloric acid, and sulfuric acid, and the like; organic acid salts prepared from acetic acid, trifluoroacetic acid, citric acid, maleic acid, succinic acid, oxalic acid, benzoic acid, tartaric acid, fumaric acid, mandelic acid, propionic acid, lactic acid, glycolic acid, gluconic acid, galacturonic acid, glutamic acid, glutaric acid, glucuronic acid, aspartic acid, ascorbic acid, carbonic acid, vanillic acid, hydroiodic acid, and the like; sulfonic acid salts prepared from methanesulfonic acid, ethanesulfonic acid, benzenesulfonic acid, p-toluenesulfonic acid, and naphthalene-sulfonic acid, and the like; amino acid salts prepared from glycine, arginine, lysine, and the like; and amine salts prepared with trimethylamine, triethylamine, ammonia, pyridine, picoline, and the like, but types of salts referred to in the present invention are not limited by these salts listed above.

[131] Preferred salts in the present invention include hydrochloride, phosphate, sulfate, trifluoroacetate, citrate, bromate, maleate, or tartrate.

[132] The compound represented by Chemical Formula I of the present invention may contain one or more asymmetric carbons, thereby being able to exist as a racemate, a racemic mixture, a single enantiomer, a diastereomeric mixture, and each diastereomer. These isomers may be separated using conventional techniques, for example, by par-

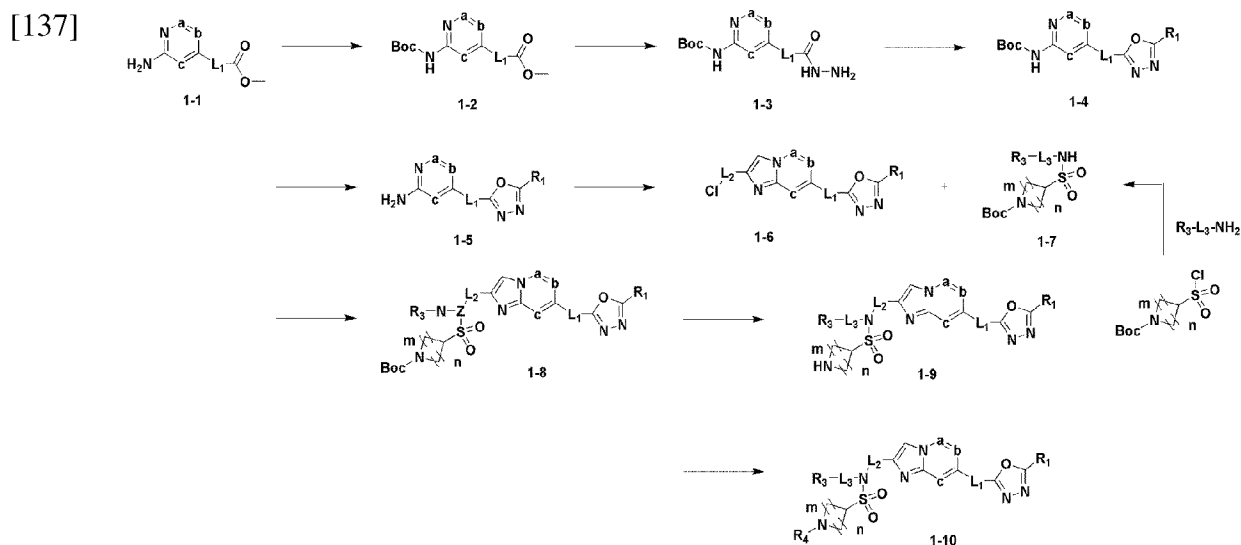
tioning, such as by column chromatography, HPLC, or the like, the compound represented by Chemical Formula I. Alternatively, stereoisomers of each of the compounds represented by Chemical Formula I may be stereospecifically synthesized using optically pure starting materials and/or reagents with known arrangement.

[133] **Method for preparing 1,3,4-oxadiazole derivative compound**

[134] The present invention provides a method for preparing a 1,3,4-oxadiazole derivative compound represented by Chemical Formula I, an optical isomer thereof, or a pharmaceutically acceptable salt thereof.

[135] In the present invention, a preferred method for preparing the 1,3,4-oxadiazole derivative compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof is the same as Reaction Schemes 1 and 2 below, which also includes preparation methods that are modified to a level obvious to those skilled in the art.

[136] [Reaction Scheme 1]

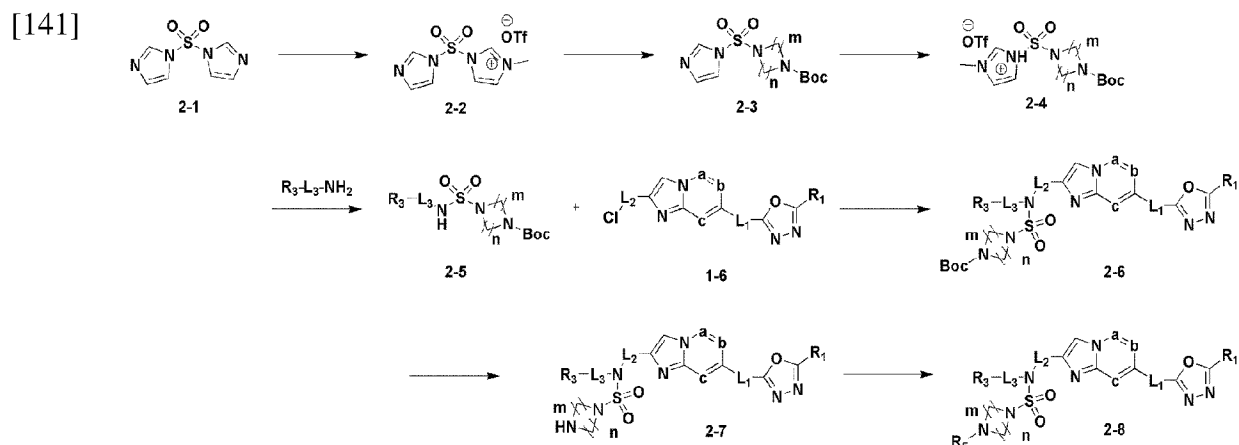


[138] Reaction Scheme 1 shows a method for synthesizing a compound having a sulfonamide structure, wherein Compound 1-2 in which a protecting group is introduced into Compound 1-1 is synthesized, and then reacted with hydrazine to synthesize hydrazide Compounds 1-3. A cyclization reaction with difluoroacetic anhydride is performed to synthesize Compound 1-4, and then the protecting group is removed under an acidic condition to synthesize Compound 1-5. By reacting with 1,3-dichloropropan-2-one, bicyclic Compound 1-6 is synthesized and reacted with a sulfonamide functional group to synthesize Compound 1-8. Compound 1-9 from which the protecting group is removed under an acid condition is synthesized, and title Compound 1-10 is synthesized by introducing various functional groups.

[139] Compounds prepared by the above Reaction Scheme are **Compounds 3778, 3779, 4214, 4215, 4216, 4217, 4218, 4219, 4220, 4221, 4222, 4223, 4224, 4225, 4226, 4227,**

4228, 4236, 4237, 4238, 4239, 4240, 4241, 4242, 4243, 4244, 4245, 4246, 4247, 4248, 4249, 4250, 4251, 4252, 4253, 4254, 4255, 4616, 4617 and 6893.

[140] [Reaction Scheme 2]



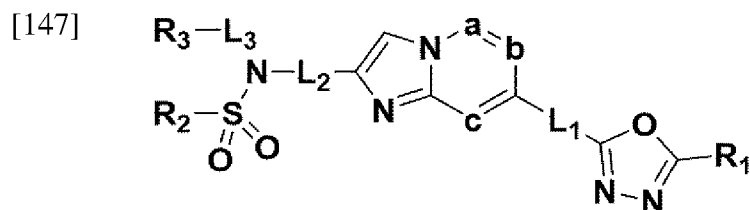
[142] Reaction Scheme 2 shows a method for synthesizing a compound having a sulfamide structure, wherein Compound 2-2 in which a leaving group is introduced into 1,1'-sulfonylbis(1-H-imidazole) is synthesized. The synthesized Compound 2-2 is reacted with an amine compound to synthesize Compound 2-3, and the leaving group is introduced again to synthesize Compound 2-4. By reacting with an amine compound, Compound 2-5 is synthesized and reacted with Compound 1-6 synthesized in Reaction Scheme 1 to synthesize Sulfamide Compound 2-6. Compound 2-7 from which the protecting group is removed under an acid condition is synthesized, and title Compound 2-8 is synthesized by introducing various functional groups.

[143] Compounds prepared by the above Reaction Scheme are **Compounds 4256, 4257, 4258, 4259, 4260, 4261, 4262, 4263, 4264, 4265, 4266, 4267, 4268, 4269, 4270, 4271, 4272, 4273, 4274, 4275, 4297, 4298, 4299, 4300, 4301, 4302, 4303, 4304, 4305, 4306, 4307, 4308, 4309, 4310, 4311, 4312, 4313, 4314, 4315, 4622, 4623, and 4624.**

[144] **Composition comprising 1,3,4-oxadiazole derivative compounds, use thereof, and treatment method using the same**

[145] The present invention provides a pharmaceutical composition for preventing or treating histone deacetylase 6-mediated diseases containing the compound represented by Chemical Formula I below, the optical isomer thereof, or the pharmaceutically acceptable salt thereof as an active ingredient:

[146] [Chemical Formula I]



- [148] The Chemical Formula I is the same as defined above.
- [149] The pharmaceutical composition of the present invention exhibits a remarkable effect in the prevention or treatment of histone deacetylase 6-mediated diseases by selectively inhibiting a histone deacetylase 6.
- [150] The histone deacetylase 6-mediated diseases include infectious diseases such as prion disease; neoplasm such as benign tumors (e.g. myelodysplastic syndrome) or malignant tumors (e.g. multiple myeloma, lymphoma, leukemia, lung cancer, colorectal cancer, colon cancer, prostate cancer, urinary tract epithelial cell carcinoma, breast cancer, melanoma, skin cancer, liver cancer, brain cancer, stomach cancer, ovarian cancer, pancreatic cancer, head and neck cancer, oral cancer or glioma); endocrine, nutritional and metabolic diseases such as Wilson's disease, amyloidosis or diabetes; mental and behavioral disorders such as depression or Rett syndrome; neurological diseases such as central nervous system atrophy (e.g. Huntington's disease, spinal muscular atrophy (SMA), spinal cerebellar ataxia (SCA)), neurodegenerative diseases (e.g. Alzheimer's disease), movement disorders (e.g. Parkinson's disease), neuropathy (e.g. hereditary neuropathy (Charcot-Marie-Tooth disease), sporadic neuropathy, inflammatory neuropathy, drug-induced neuropathy), motor neuropathy (e.g. amyotrophic lateral sclerosis (ALS)), or central nervous system demyelination (e.g. multiple sclerosis (MS)); diseases of eyes and adnexa such as uveitis; circulatory diseases such as atrial fibrillation, stroke, and the like; respiratory diseases such as asthma; digestive diseases such as alcoholic liver disease, inflammatory bowel disease, Crohn's disease, ulcerative bowel disease, and the like; skin and subcutaneous tissue diseases such as psoriasis; musculoskeletal and connective tissue diseases such as rheumatoid arthritis, osteoarthritis, systemic lupus erythematosus (SLE), and the like; or congenital malformations, alterations, and chromosomal abnormalities such as autosomal dominant polycystic kidney disease, and also include symptoms or diseases related to abnormal functions of histone deacetylase.
- [151] The pharmaceutically acceptable salt is the same as described above in the pharmaceutically acceptable salt of the compound represented by Chemical Formula I of the present invention.
- [152] The pharmaceutical composition of the present invention may further include one or more pharmaceutically acceptable carriers for administration, in addition to the compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof. The pharmaceutically acceptable carrier may be used by mixing saline, sterile water, Ringer's solution, buffered saline, dextrose solution, maltodextrin solution, glycerol, ethanol and one or more of these ingredients, and if necessary, other conventional additives such as antioxidants, buffers, bacteriostatic agents, and the like, may be added. Further, injectable formulations such as

aqueous solutions, suspensions, emulsions, and the like, pills, capsules, granules or tablets may be formulated by further adding diluents, dispersants, surfactants, binders and lubricants. Accordingly, the composition of the present invention may be a patch, liquid, pill, capsule, granule, tablet, suppository, or the like. These formulations may be prepared by a conventional method used for formulation in the art or by a method disclosed in Remington's Pharmaceutical Science (latest edition), Mack Publishing Company, Easton PA, and formulated into various formulations depending on respective diseases or ingredients.

- [153] The composition of the present invention may be administered orally or parenterally (for example, intravenously, subcutaneously, intraperitoneally or topically) depending on the desired method, and the dosage range varies depending on the patient's weight, age, sex, health condition, diet, administration time, administration method, excretion rate, and severity of disease, and the like. The daily dose of the compound represented by Chemical Formula I of the present invention may be about 1 to 1000 mg/kg, preferably 5 to 100 mg/kg, and may be administered once a day or divided into several times a day.
- [154] The pharmaceutical composition of the present invention may further include one or more active ingredients exhibiting the same or similar medicinal effects in addition to the compound represented by Chemical Formula I above, the optical isomer thereof, or the pharmaceutically acceptable salt thereof.
- [155] The present invention provides a method for preventing or treating histone deacetylase 6-mediated diseases including administering a therapeutically effective amount of the compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof.
- [156] The term "therapeutically effective amount" used in the present invention refers to an amount of the compound represented by Chemical Formula I that is effective for preventing or treating the histone deacetylase 6-mediated diseases.
- [157] In addition, the present invention provides a method for selectively inhibiting HDAC6 by administering the compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof to a mammal including humans.
- [158] The method for preventing or treating the histone deacetylase 6-mediated diseases of the present invention also includes administering the compound represented by Chemical Formula I to treat the disease itself before the onset of the symptom, but also to inhibit or avoid the symptom thereof. In the management of the disease, prophylactic or therapeutic dose of a specific active ingredient will vary depending on the nature and severity of the disease or condition, and the route to which the active ingredient is administered. The dose and frequency of dose will vary depending on the

age, weight and response of the individual patients. A suitable dosage regimen may be readily selected by a person having ordinary knowledge in the art considering these factors for granted. In addition, the method for preventing or treating histone deacetylase 6-mediated diseases of the present invention may further include administering a therapeutically effective amount of an additional active agent useful for the treatment of the disease together with the compound represented by Chemical Formula I, wherein the additional active agent may exhibit synergistic or auxiliary effects together with the compound represented by Chemical Formula I.

[159] The present invention also aims to provide the use of the compound represented by Chemical Formula I above, the optical isomer thereof, or the pharmaceutically acceptable salt thereof for preparing a medicament for treating histone deacetylase 6-mediated diseases. The compound represented by Chemical Formula I above for preparing the medicament may be mixed with acceptable adjuvants, diluents, carriers, and the like, and may be prepared as a complex formulation with other active agents to have a synergistic effect of active ingredients.

[160] Matters mentioned in the uses, compositions and treatment methods of the present invention are applied equally as long as they are inconsistent with each other.

[161]

Advantageous Effects of Invention

[162] The compound represented by Chemical Formula I above of the present invention, the optical isomer thereof, or the pharmaceutically acceptable salt thereof, is able to selectively inhibit histone deacetylase 6 (HDAC6), thereby having remarkably excellent preventive or therapeutic effects on HDAC6-mediated diseases.

Best Mode for Carrying out the Invention

[163] Hereinafter, the present invention will be described in more detail through Examples and Experimental Examples. However, they are only examples of the present invention, and the scope of the present invention is not limited thereto.

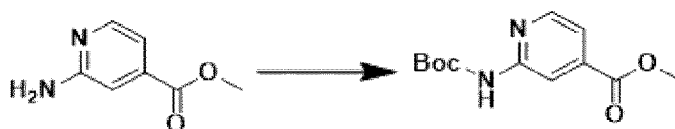
[164] **Preparation of 1,3,4-oxadiazole derivative compound of the present invention**

[165] A specific method for preparing the compounds represented by Chemical Formula I is the same as follows.

[166] **Example 1: Synthesis of Compound 3778, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-1-methyl- *N*- phenylpiperidine-4-sulfonamide**

[167] **[Step 1] Synthesis of methyl 2-((tert-butoxycarbonyl)amino)isonicotinate**

[168]



[169] Methyl 2-aminoisonicotinate (20.000 g, 131.449 mmol) and di-tert-butyl dicarbonate (37.295 g, 170.884 mmol) were dissolved in tert-butanol (800 mL) at room temperature. The resulting solution was stirred at 60°C for 16 hours, and then the temperature was lowered to room temperature to terminate the reaction. The precipitated solid was filtered, washed with ethanol, and dried to obtain the title compound (26.000 g, 78.4 %) as a white solid.

[170] [Step 2] Synthesis of tert-butyl (4-(hydrazinecarbonyl)pyridin-2-yl)carbamate

[171]



[172] Methyl 2-((tert-butoxycarbonyl)amino)isonicotinate (26.000 g, 103.064 mmol) prepared in step 1 and hydrazine monohydrate (100.182 mL, 2.061 mol) were dissolved in methanol (800 mL) at room temperature. The resulting solution was stirred at the same temperature for 16 hours. Methanol (500 mL) was added to the obtained product, followed by filtration through a plastic filter to obtain an organic layer, and the organic layer was concentrated to obtain the title compound (25.000 g, 96.2 %) as a white solid.

[173] [Step 3] Synthesis of tert-butyl

(4-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-yl)carbamate

[174]



[175] Tert-butyl (4-(hydrazinecarbonyl)pyridin-2-yl)carbamate (20.000 g, 79.280 mmol) prepared in step 2 and triethylamine (55.250 mL, 396.401 mmol) were dissolved in tetrahydrofuran (600 mL), and 2,2-difluoroacetic anhydride (49.281 mL, 396.401 mmol) was added at room temperature and heated to reflux for 16 hours, and then the temperature was lowered to room temperature to terminate the reaction. A saturated aqueous ammonium chloride solution was added to the reaction mixture, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. Ethyl acetate (40 mL) and hexane (200 mL) were poured into the concentrate, suspended, and filtered to obtain a solid, and the obtained solid was washed with hexane and dried to obtain the title compound (11.500 g, 46.5 %) as a white solid.

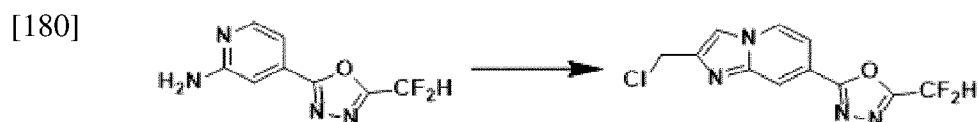
[176] [Step 4] Synthesis of 4-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-amine

[177]



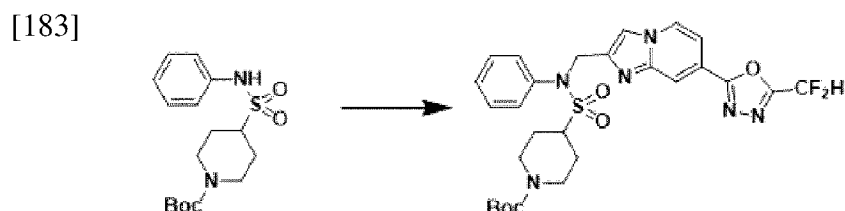
[178] Tert-butyl 4-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-ylcarbamate (11.500 g, 36.826 mmol) prepared in step 3 was dissolved in dichloromethane (300 mL), and trifluoroacetic acid (28.199 mL, 368.259 mmol) was added at 0°C. The resulting solution was stirred at room temperature for 4 hours. After removing the solvent from the reaction mixture under reduced pressure, a saturated aqueous sodium hydrogen carbonate solution (150 mL) was poured into the concentrate and suspended, followed by filtration to obtain a solid. The obtained solid was washed with water and dried to obtain the title compound (7.500 g, 96.0%) as a white solid.

[179] [Step 5] Synthesis of
2-(2-(chloromethyl)imidazo[1,2-a]pyridin-7-yl)-5-(difluoromethyl)-1,3,4-oxadiazole



[181] 4-(5-(Difluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-amine (7.500 g, 35.351 mmol) prepared in step 4, 1,3-dichloropropan-2-one (6.732 g, 53.026 mmol), and sodium hydrogen carbonate (14.848 g, 176.753 mmol) were dissolved in 1,4-dioxane (250 mL) at room temperature. The resulting solution was heated to reflux for 16 hours, and then the temperature was lowered to room temperature to terminate the reaction. The reaction mixture was filtered through a plastic filter to remove solids, and the filtrate was purified by column chromatography (SiO₂, 80 g cartridge; ethyl acetate/hexane = 10% to 90%) and concentrated to obtain the title compound (7.000 g, 69.6%) as a beige solid.

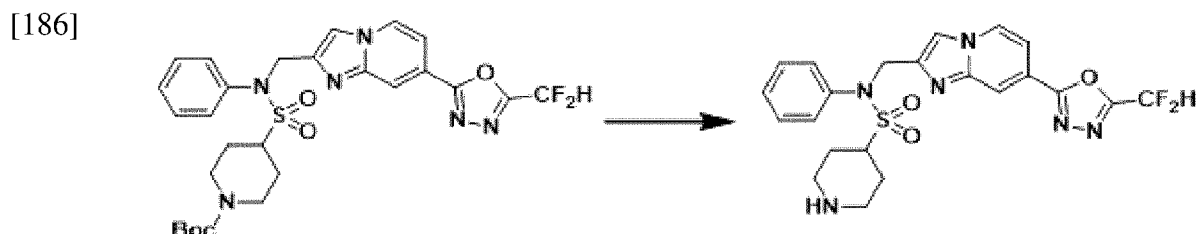
[182] [Step 6] Synthesis of tert-butyl 4-(N-
((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)- N-
phenylsulfamoyl)piperidine-1-carboxylate



[184] Tert-butyl 4-(N-phenylsulfamoyl)piperidine-1-carboxylate (0.050 g, 0.147 mmol), 2-(2-(chloromethyl)imidazo[1,2-a]pyridin-7-yl)-5-(difluoromethyl)-1,3,4-oxadiazole (0.040 g, 0.140 mmol) prepared in step 5, potassium carbonate (0.041 g, 0.294 mmol), and potassium iodide (0.002 g, 0.015 mmol) were dissolved in *N,N*-dimethylformamide (3 mL) at room temperature, and the resulting solution was stirred at the

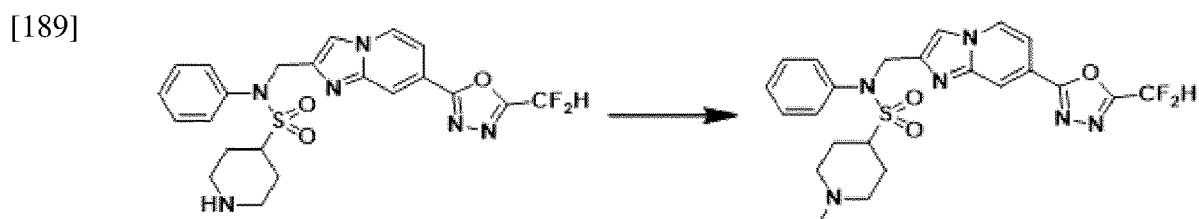
same temperature for 16 hours. Water (5 mL) was added to the reaction mixture and stirred to precipitate a solid. The precipitated solid was filtered, washed with water, and dried to obtain the title compound (0.055 g, 63.6%) as a beige solid.

[185] [Step 7] Synthesis of *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide



[187] Tert-butyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)piperidine-1-carboxylate (0.100 g, 0.170 mmol) prepared in step 6 and trifluoroacetic acid (0.260 mL, 3.398 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, and filtered. After concentration under reduced pressure, the title compound (0.083 g, 100.0 %) was obtained as a brown gel without further purification.

[188] [Step 8] Synthesis of Compound 3778



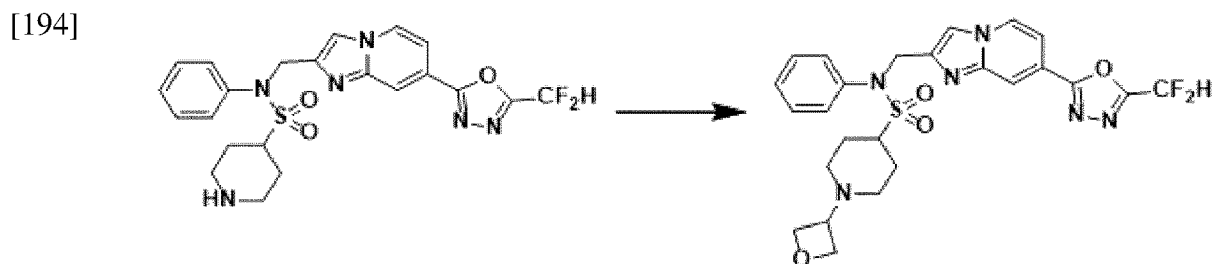
[190] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.040 g, 0.082 mmol) prepared in step 7, formaldehyde (0.005 g, 0.164 mmol), acetic acid (0.005 mL, 0.082 mmol), and sodium triacetoxyborohydride (0.052 g, 0.246 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The

concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.016 g, 38.9 %) as a white solid.

[191] ¹H NMR (400 MHz, CDCl₃) δ 8.26 (s, 1H), 8.24-8.19 (m, 1H), 7.80 (s, 1H), 7.55-7.50 (m, 1H), 7.47 (d, *J* = 7.8 Hz, 2H), 7.35 (d, *J* = 9.2 Hz, 2H), 7.30 (d, *J* = 5.1 Hz, 1H), 7.10-6.78 (m, 1H), 5.16 (d, *J* = 3.0 Hz, 2H), 3.00 (d, *J* = 10.2 Hz, 3H), 2.31 (s, 3H), 2.14 (s, 2H), 2.01 (s, 4H);

[192] LRMS (ES) *m/z* 503.2 (*M* + 1).

[193] **Example 2:** Synthesis of Compound 3779, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-1-(oxetan-3-yl)-*N*-phenylpiperidine-4-sulfonamide



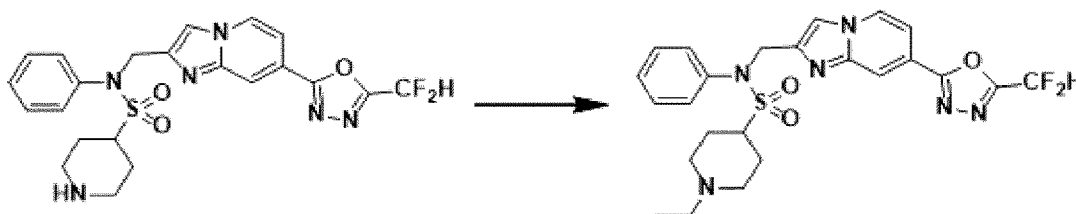
[195] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.040 g, 0.082 mmol) prepared in step 7 of Example 1, oxetan-3-one (0.012 g, 0.164 mmol), acetic acid (0.005 mL, 0.082 mmol), and sodium triacetoxyborohydride (0.052 g, 0.246 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.024 g, 53.8 %) as a white solid.

[196] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (s, 1H), 8.22 (d, *J* = 6.9 Hz, 1H), 7.79 (s, 1H), 7.53 (d, *J* = 7.2 Hz, 1H), 7.46 (d, *J* = 7.8 Hz, 2H), 7.37 (t, *J* = 7.9 Hz, 2H), 7.30 (s, 1H), 6.95 (td, *J* = 52.7, 51.7, 2.5 Hz, 1H), 5.16 (s, 2H), 4.70-4.55 (m, 4H), 3.50 (s, 1H), 3.09 (s, 1H), 2.89 (s, 2H), 2.16 (s, 2H), 2.03 (s, 2H), 1.85 (s, 2H);

[197] LRMS (ES) *m/z* 545.3 (*M* + 1).

[198] **Example 3:** Synthesis of Compound 4214, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-1-ethyl-*N*-phenylpiperidine-4-sulfonamide

[199]



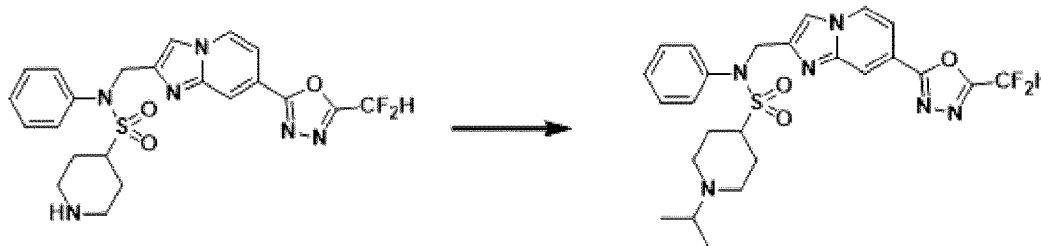
[200] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, acetaldehyde (0.009 g, 0.205 mmol) and sodium triacetoxyborohydride (0.065 g, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 4 g cartridge; methanol/dichloromethane = 0% to 3 %) and concentrated to obtain the title compound (0.014 g, 26.5 %) as an ivory solid.

[201] ¹H NMR (400 MHz, CDCl₃) δ 8.25 (s, 1H), 8.22 (dd, 1H, *J* = 7.1, 0.8 Hz), 7.80 (s, 1H), 7.52 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.49-7.45 (m, 2H), 7.38-7.34 (m, 2H), 7.30-7.26 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.17 (s, 2H), 3.06-2.96 (m, 3H), 2.29 (s, 3H), 2.15-2.08 (m, 2H), 2.05-1.89 (m, 4H);

[202] LRMS (ES) *m/z* 517.4 (*M* + 1).

[203] **Example 4:** Synthesis of Compound 4215, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-1-*iso* propyl-*N*-phenylpiperidine-4-sulfonamide

[204]



[205] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, propan-2-one (0.012 g, 0.205 mmol) and sodium triacetoxyborohydride (0.065 g, 0.307 mmol) in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The con-

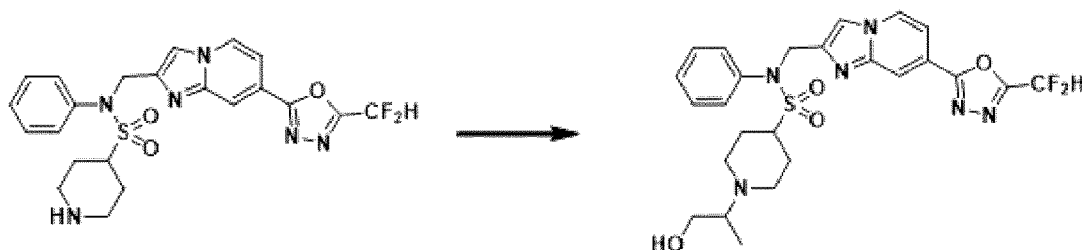
centrate was purified by column chromatography (SiO_2 , 4 g cartridge; methanol/dichloromethane = 0% to 3 %) and concentrated to obtain the title compound (0.011 g, 20.3 %) as an ivory solid.

[206] ^1H NMR (400 MHz, CDCl_3) δ 8.26 (s, 1H), 8.22 (dd, 1H, $J = 7.1, 0.8$ Hz), 7.81 (s, 1H), 7.52 (dd, 1H, $J = 7.1, 1.7$ Hz), 7.49-7.45 (m, 2H), 7.38-7.34 (m, 2H), 7.30-7.26 (m, 1H), 6.95 (t, 1H, $J = 51.7$ Hz), 5.17 (s, 2H), 3.09-2.99 (m, 3H), 2.45-2.39 (m, 1H), 2.15-2.04 (m, 3H), 2.04-1.88 (m, 3H), 1.05 (s, 3H), 1.03 (s, 3H);

[207] LRMS (ES) m/z 531.4 ($\text{M}^+ + 1$).

[208] **Example 5:** Synthesis of Compound 4216, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-1-(1-hydroxypropan-2-yl)-*N*-phenylpiperidine-4-sulfonamide

[209]



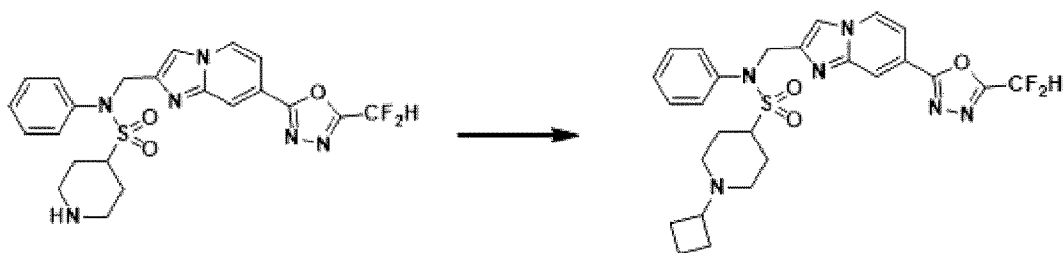
[210] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, 1-hydroxypropan-2-one (0.015 g, 0.205 mmol), and sodium triacetoxymethylborohydride (0.065 g, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO_2 , 4 g cartridge; methanol/dichloromethane = 0% to 3 %) and concentrated to obtain the title compound (0.009 g, 16.1 %) as an ivory solid.

[211] ^1H NMR (400 MHz, CDCl_3) δ 8.26 (s, 1H), 8.22 (dd, 1H, $J = 7.1, 0.8$ Hz), 7.78 (s, 1H), 7.53 (dd, 1H, $J = 7.1, 1.7$ Hz), 7.48-7.44 (m, 2H), 7.38-7.34 (m, 2H), 7.30-7.26 (m, 1H), 6.95 (t, 1H, $J = 51.7$ Hz), 5.16 (s, 2H), 3.43-3.39 (m, 1H), 3.33 (t, 1H, $J = 10.4$ Hz), 3.12-3.04 (m, 1H), 2.84-2.30 (m, 3H), 2.58-2.52 (m, 1H), 2.20-2.15 (m, 2H), 2.11-1.83 (m, 4H), 0.89 (d, 3H, $J = 6.7$ Hz);

[212] LRMS (ES) m/z 547.0 ($\text{M}^+ + 1$).

[213] **Example 6:** Synthesis of Compound 4217, 1-cyclobutyl-*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide

[214]



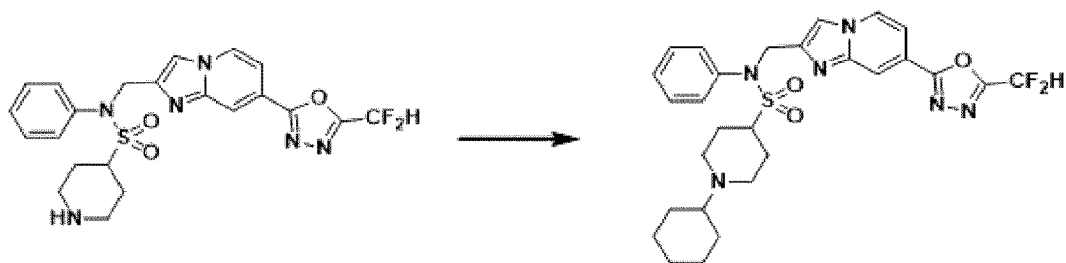
[215] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, cyclobutanone (0.014 g, 0.205 mmol), and sodium triacetoxyborohydride (0.065 g, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 4 g cartridge; methanol/dichloromethane = 0% to 3 %) and concentrated to obtain the title compound (0.015 g, 27.0 %) as an ivory solid.

[216] ¹H NMR (400 MHz, CDCl₃) δ 8.25 (s, 1H), 8.21 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.80 (s, 1H), 7.52 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.48-7.44 (m, 2H), 7.38-7.33 (m, 2H), 7.30-7.26 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.16 (s, 2H), 3.08-2.98 (m, 3H), 2.74-2.66 (m, 1H), 2.15-2.11 (m, 2H), 2.06-1.83 (m, 8H), 1.74-1.53 (m, 2H);

[217] **LRMS** (ES) *m/z* 543.4 (*M* + 1).

[218] **Example 7:** Synthesis of Compound 4218, 1-cyclohexyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide

[219]



[220] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, cyclohexanone (0.020 g, 0.205 mmol), and sodium triacetoxyborohydride (0.065 g, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried

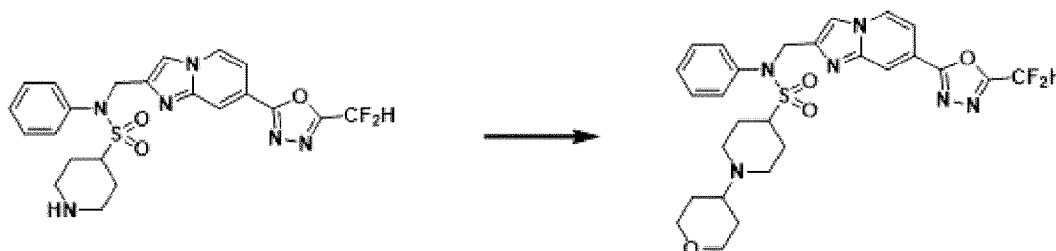
over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 4 g cartridge; methanol/dichloromethane = 0% to 3 %) and concentrated to obtain the title compound (0.014 g, 24.0 %) as an ivory solid.

[221] ¹H NMR (400 MHz, CDCl₃) δ 8.25 (s, 1H), 8.21 (dd, 1H, *J* = 7.1, 0.8 Hz), 7.81 (s, 1H), 7.52 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.48-7.46 (m, 2H), 7.38-7.34 (m, 2H), 7.30-7.26 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.17 (s, 2H), 3.05-3.02 (m, 3H), 2.32 (m, 1H), 2.23-2.10 (m, 4H), 1.99-1.91 (m, 2H), 1.81 (m, 3H), 1.66-1.62 (m, 1H), 1.29-1.07 (m, 6H);

[222] **LRMS** (ES) *m/z* 571.4 (*M* + 1).

[223] **Example 8:** Synthesis of Compound 4219, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-1-(tetrahydro-2H-pyran-4-yl)piperidine-4-sulfonamide

[224]



[225] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, tetrahydro-4H-pyran-4-one (0.020 g, 0.205 mmol), and sodium triacetoxyborohydride (0.065 g, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 4 g cartridge; methanol/dichloromethane = 0% to 3 %) and concentrated to obtain the title compound (0.012 g, 20.5 %) as an ivory solid.

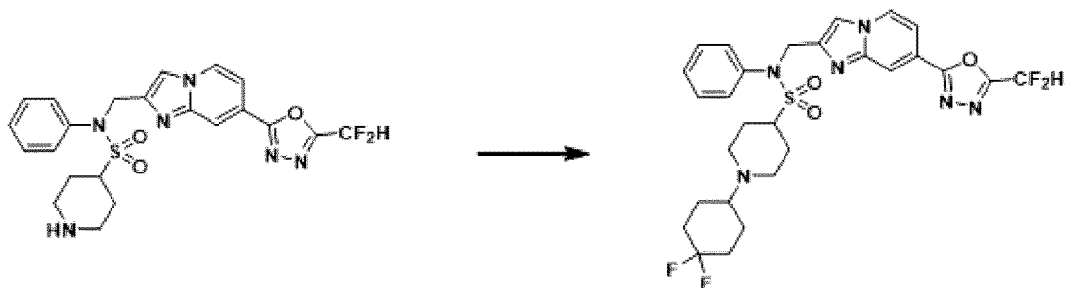
[226] ¹H NMR (400 MHz, CDCl₃) δ 8.26 (s, 1H), 8.21 (dd, 1H, *J* = 7.1, 0.8 Hz), 7.80 (s, 1H), 7.52 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.48-7.45 (m, 2H), 7.38-7.34 (m, 2H), 7.30-7.25 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.17 (s, 2H), 4.04-3.99 (m, 2H), 3.41-3.34 (m, 2H), 3.09-3.02 (m, 3H), 2.53-2.48 (m, 1H), 2.19-2.13 (m, 4H), 2.01-1.92 (m, 2H), 1.72-1.69 (m, 2H), 1.63-1.54 (m, 2H);

[227] **LRMS** (ES) *m/z* 573.4 (*M* + 1).

[228] **Example 9:** Synthesis of Compound 4220, 1-(4,4-difluorocyclohexyl)-*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-

phenylpiperidine-4-sulfonamide

[229]



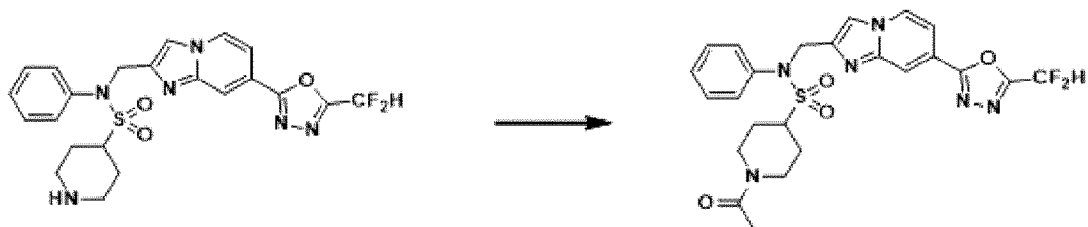
[230] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, 4,4-difluorocyclohexan-1-one (0.027 g, 0.205 mmol), and sodium triacetoxyborohydride (0.065 g, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 4 g cartridge; methanol/dichloromethane = 0% to 3 %) and concentrated to obtain the title compound (0.009 g, 14.5 %) as an ivory solid.

[231] ¹H NMR (400 MHz, CDCl₃) δ 8.24 (s, 1H), 8.21 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.78 (s, 1H), 7.50 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.47-7.43 (m, 2H), 7.37-7.32 (m, 2H), 7.29-7.24 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.15 (s, 2H), 3.07-2.96 (m, 3H), 2.46-2.41 (m, 1H), 2.21-2.08 (m, 6H), 1.98-1.88 (m, 2H), 1.80-1.73 (m, 3H), 1.69-1.60 (m, 3H);

[232] **LRMS** (ES) *m/z* 607.1 (*M* + 1).

[233] **Example 10:** Synthesis of Compound 4221, 1-acetyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-phenylpiperidine-4-sulfonamide

[234]



[235] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, acetyl chloride (0.015 mL, 0.205 mmol), and triethylamine (0.043 mL, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic

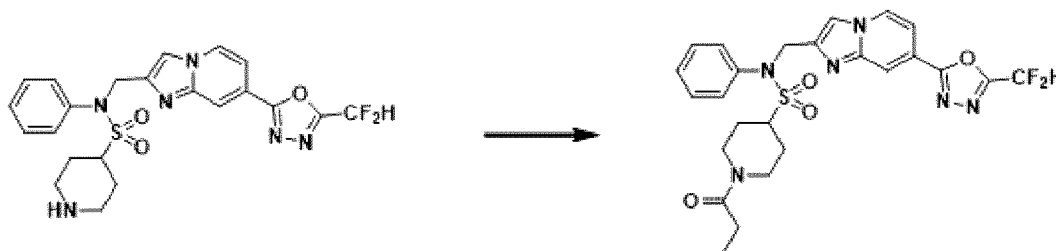
layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.014 g, 25.8 %) as an ivory solid.

[236] ¹H NMR (400 MHz, CDCl₃) δ 8.26 (t, 1H, *J* = 0.8 Hz), 8.22 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.73 (s, 1H), 7.53 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.46-7.42 (m, 2H), 7.38-7.34 (m, 2H), 7.34-7.27 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.13 (s, 2H), 4.72 (d, 1H, *J* = 13.5 Hz), 3.95 (d, 1H, *J* = 13.8 Hz), 3.67-3.29 (m, 1H), 3.11-3.03 (m, 1H), 2.58 (td, 1H, *J* = 12.8, 2.5 Hz), 2.27-2.16 (m, 2H), 2.11 (s, 3H), 1.94-1.76 (m, 2H);

[237] **LRMS** (ES) *m/z* 531.3 (*M* + 1).

[238] **Example 11:** Synthesis of Compound 4222, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-1-propionylpiperidine-4-sulfonamide

[239]



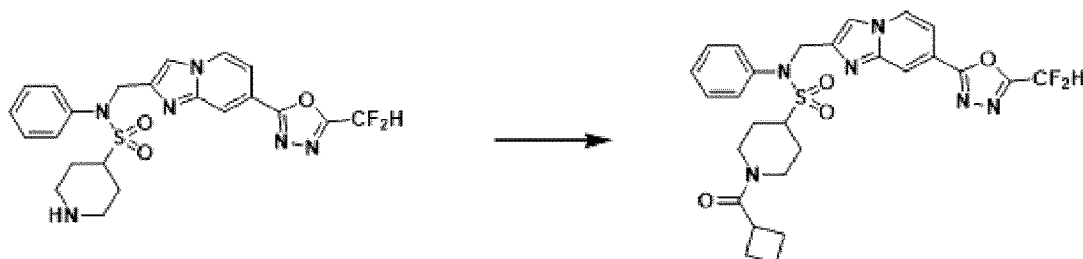
[240] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, propionyl chloride (0.019 g, 0.205 mmol), and triethylamine (0.043 mL, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.013 g, 23.3 %) as an ivory solid.

[241] ¹H NMR (400 MHz, CDCl₃) δ 8.26 (s, 1H), 8.22 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.73 (s, 1H), 7.53 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.46-7.42 (m, 2H), 7.38-7.34 (m, 2H), 7.32-7.27 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.13 (s, 2H), 4.75 (d, 1H, *J* = 13.4 Hz), 4.00 (d, 1H, *J* = 13.5 Hz), 3.68-3.29 (m, 1H), 3.03 (t, 1H, *J* = 12.1 Hz), 2.58 (t, 1H, *J* = 11.9 Hz), 2.36 (q, 2H, *J* = 7.4 Hz), 2.20 (t, 2H, *J* = 15.4 Hz), 1.90-1.76 (m, 2H), 1.15 (t, 3H, *J* = 7.4 Hz);

[242] **LRMS** (ES) *m/z* 545.4 (*M* + 1).

[243] **Example 12:** Synthesis of Compound 4223, 1-(cyclobutanecarbonyl)- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridine-2-yl)methyl)- *N*-phenylpiperidine-4-sulfonamide

[244]



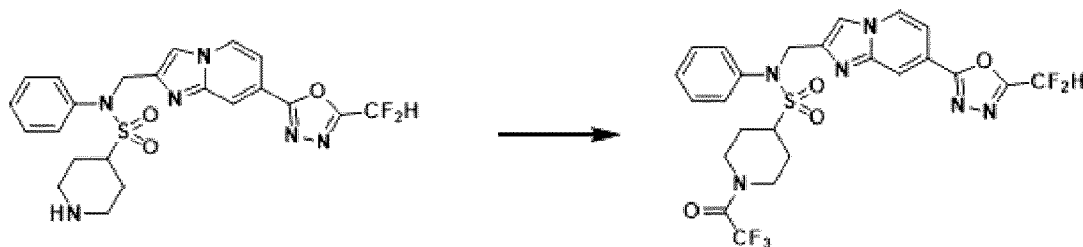
[245] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, cyclobutanecarbonyl chloride (0.024 g, 0.205 mmol), and triethylamine (0.043 mL, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.010 g, 17.1 %) as an ivory solid.

[246] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (t, 1H, *J* = 0.8 Hz), 8.22 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.74 (s, 1H), 7.54 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.46-7.42 (m, 2H), 7.38-7.34 (m, 2H), 7.32-7.27 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.13 (s, 2H), 4.78-4.76 (m, 1H), 3.84 (d, 1H, *J* = 13.6 Hz), 3.50 (s, 1H), 3.33-3.24 (m, 2H), 3.23-2.90 (m, 1H), 2.61-2.54 (m, 1H), 2.40-2.33 (m, 2H), 2.19-2.12 (m, 4H), 2.06-1.74 (m, 3H);

[247] **LRMS** (ES) *m/z* 571.0 (*M* + 1).

[248] **Example 13:** Synthesis of Compound 4224, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-phenyl-1-(2,2,2-trifluoroacetyl)piperidine-4-sulfonamide

[249]



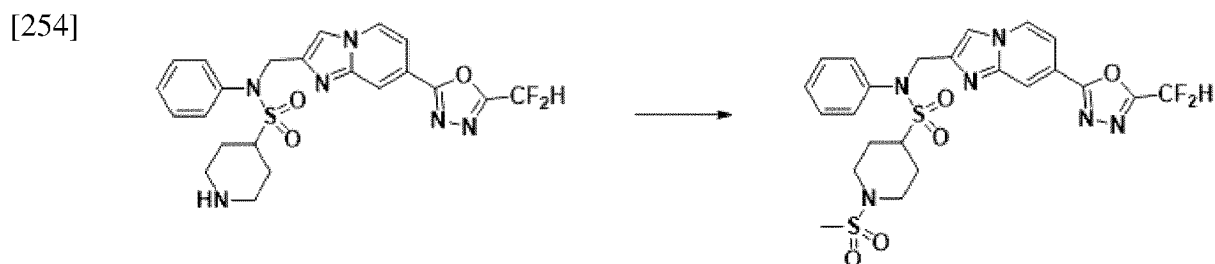
[250] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, 2,2,2-trifluoroacetic anhydride (0.043 g, 0.205 mmol), and triethylamine

(0.043 mL, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.012 g, 20.1 %) as an ivory solid.

[251] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (s, 1H), 8.22 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.70 (s, 1H), 7.55 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.45-7.41 (m, 2H), 7.39-7.34 (m, 2H), 7.33-7.29 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.12 (s, 2H), 4.60 (d, 1H, *J* = 13.6 Hz), 4.16-4.12 (m, 1H), 3.48-3.40 (m, 1H), 3.23-3.16 (m, 1H), 2.93-2.86 (m, 1H), 2.33-2.27 (m, 2H), 2.21-1.91 (m, 2H);

[252] LRMS (ES) *m/z* 585.1 (*M* + 1).

[253] **Example 14:** Synthesis of Compound 4225, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-1-(methanesulfonyl)-*N*-phenylpiperidine-4-sulfonamide



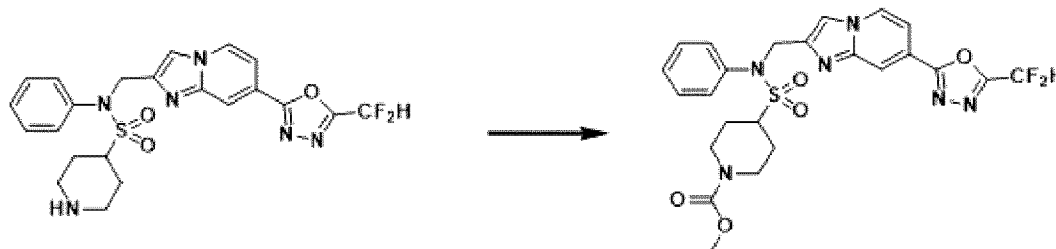
[255] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, methanesulfonyl chloride (0.016 mL, 0.205 mmol), and triethylamine (0.043 mL, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.012 g, 20.7 %) as an ivory solid.

[256] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (s, 1H), 8.23 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.73 (s, 1H), 7.55 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.45-7.42 (m, 2H), 7.39-7.34 (m, 2H), 7.33-7.28 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.13 (s, 2H), 3.90 (dt, 2H, *J* = 12.6, 3.5 Hz), 3.28-3.20 (m, 1H), 2.86-2.76 (m, 5H), 2.30-2.25 (m, 2H), 2.21-2.00 (m, 2H);

[257] **LRMS** (ES) m/z 567.0 ($M + 1$).

[258] **Example 15:** Synthesis of Compound 4226, methyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)piperidine-1-carboxylate

[259]



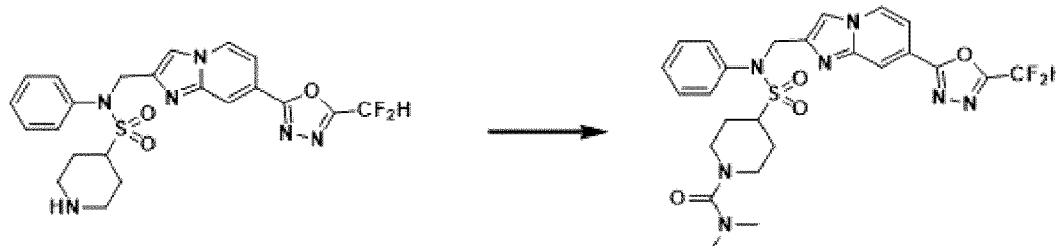
[260] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, methyl carbonochloridate (0.019 g, 0.205 mmol), and triethylamine (0.043 mL, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO_2 , 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.015 g, 26.8 %) as an ivory solid.

[261] ^1H NMR (400 MHz, CDCl_3) δ 8.27 (s, 1H), 8.22 (dd, 1H, $J = 7.2, 0.9$ Hz), 7.75 (s, 1H), 7.54 (dd, 1H, $J = 7.1, 1.7$ Hz), 7.46-7.43 (m, 2H), 7.39-7.34 (m, 2H), 7.32-7.28 (m, 1H), 6.95 (t, 1H, $J = 51.7$ Hz), 5.14 (s, 2H), 4.28 (s, 2H), 3.72 (s, 3H), 3.28-3.22 (m, 1H), 2.78 (m, 2H), 2.18-2.14 (m, 2H), 1.91-1.80 (m, 2H);

[262] **LRMS** (ES) m/z 547.1 ($M + 1$).

[263] **Example 16:** Synthesis of Compound 4227, 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)-*N,N*-dimethylpiperidine-1-carboxamide

[264]



[265] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, dimethylcarbamic chloride (0.022 g, 0.205 mmol), and triethylamine

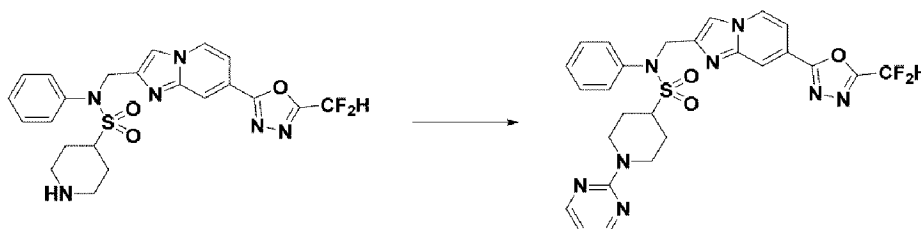
(0.043 mL, 0.307 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.013 g, 22.7 %) as an ivory solid.

[266] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (s, 1H), 8.22 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.76 (s, 1H), 7.54 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.47-7.44 (m, 2H), 7.39-7.34 (m, 2H), 7.32-7.27 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 5.15 (s, 2H), 3.78 (d, 2H, *J* = 13.3 Hz), 3.27-3.19 (m, 1H), 2.84-2.80 (m, 6H), 2.76-2.67 (m, 2H), 2.18-2.15 (m, 2H), 1.98-1.87 (m, 2H);

[267] LRMS (ES) *m/z* 560.1 (*M* + 1).

[268] **Example 17:** Synthesis of Compound 4228, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-1-(pyrimidin-2-yl)piperidine-4-sulfonamide

[269]



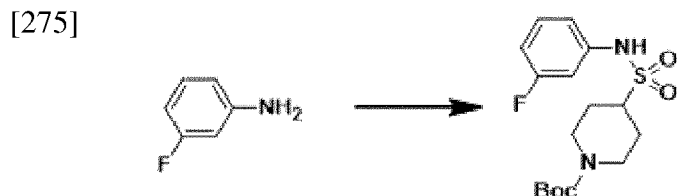
[270] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperidine-4-sulfonamide (0.050 g, 0.102 mmol) prepared in step 7 of Example 1, 2-chloropyrimidine (0.023 g, 0.205 mmol), and potassium carbonate (0.042 g, 0.307 mmol) were dissolved in acetonitrile (1 mL)/ *N,N*-dimethylformamide (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 12 g cartridge; ethyl acetate/hexane = 70% to 100 %) and concentrated to obtain the title compound (0.014 g, 24.1 %) as an ivory solid.

[271] ¹H NMR (400 MHz, CDCl₃) δ 8.33 (d, 2H, *J* = 4.8 Hz), 8.26 (s, 1H), 8.22 (dd, 1H, *J* = 7.1, 0.9 Hz), 7.77 (s, 1H), 7.54 (dd, 1H, *J* = 7.1, 1.7 Hz), 7.48-7.45 (m, 2H), 7.39-7.35 (m, 2H), 7.31-7.29 (m, 1H), 6.95 (t, 1H, *J* = 51.7 Hz), 6.53 (t, 1H, *J* = 4.7 Hz), 5.17 (s, 2H), 4.94 (d, 2H, *J* = 13.5 Hz), 3.41-3.34 (m, 1H), 2.89 (td, 2H, *J* = 12.9, 4.3 Hz), 2.24-2.21 (m, 2H), 1.97-1.86 (m, 2H);

[272] **LRMS** (ES) m/z 566.8 ($M + 1$).

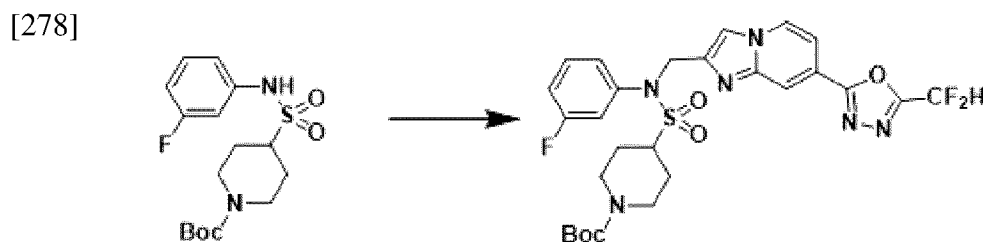
[273] **Example 18:** Synthesis of Compound 4236, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-methylpiperidine-4-sulfonamide

[274] [Step 1] Synthesis of tert-butyl 4-(*N*-(3-fluorophenyl)sulfamoyl)piperidine-1-carboxylate



[276] Tert-butyl 4-(chlorosulfonyl)piperidine-1-carboxylate (5.000 g, 17.620 mmol), 3-fluoroaniline (2.937 g, 26.430 mmol), and triethylamine (2.947 mL, 21.144 mmol) were dissolved in dichloromethane (50 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 40 g cartridge; ethyl acetate/hexane = 0 % to 30 %) and concentrated to obtain the title compound (3.200 g, 50.7 %) as a white solid.

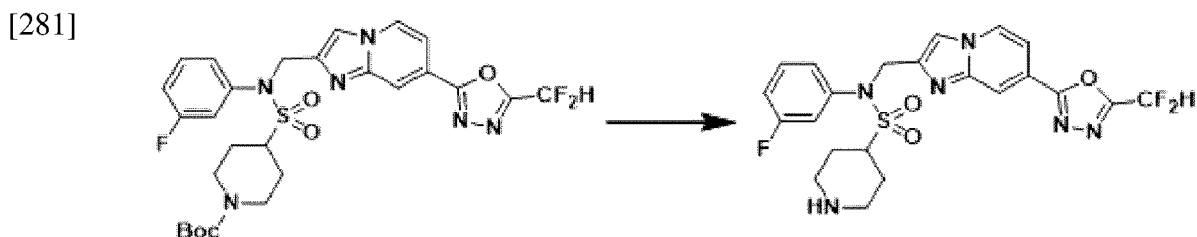
[277] [Step 2] Synthesis of tert-butyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)sulfamoyl)piperidine-1-carboxylate



[279] Tert-butyl 4-(*N*-(3-fluorophenyl)sulfamoyl)piperidine-1-carboxylate (2.680 g, 7.477 mmol) prepared in step 1, 2-(2-(chloromethyl)imidazo[1,2-*a*]pyridin-7-yl)-5-(difluoromethyl)-1,3,4-oxadiazole (2.554 g, 8.972 mmol) prepared in step 5 of Example 1, potassium carbonate (1.550 g, 11.216 mmol), and potassium iodide (0.621 g, 3.739 mmol) were dissolved in *N,N*-dimethylformamide (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous ammonium chloride solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. The

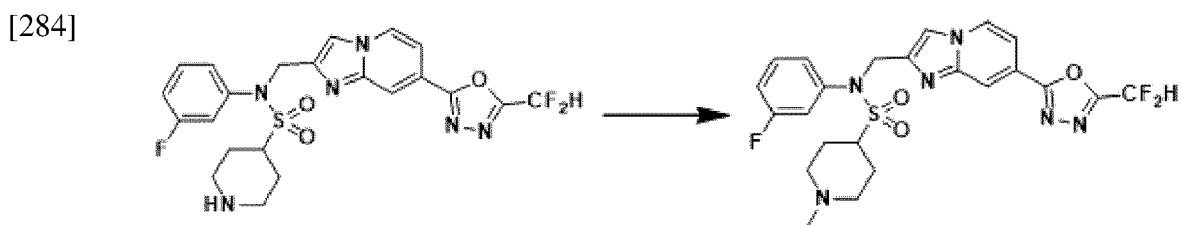
organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 40 g cartridge; ethyl acetate/hexane = 0 % to 90 %) and concentrated to obtain the title compound (3.600 g, 79.4 %) as a yellow solid.

[280] [Step 3] Synthesis of *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide



[282] Tert-butyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)sulfamoyl)piperidine-1-carboxylate (1.200 g, 1.978 mmol) prepared in step 2 and trifluoroacetic acid (3.030 mL, 39.563 mmol) were dissolved in dichloromethane (18 mL) at 0°C, and the resulting solution was stirred at room temperature for 4 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and then filtered through a plastic filter to remove a solid residue and an aqueous layer. After concentration under reduced pressure, the title compound (0.990g, 100.1%) was obtained as a yellow solid without further purification.

[283] [Step 4] Synthesis of Compound 4236



[285] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3, formaldehyde (0.006 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an

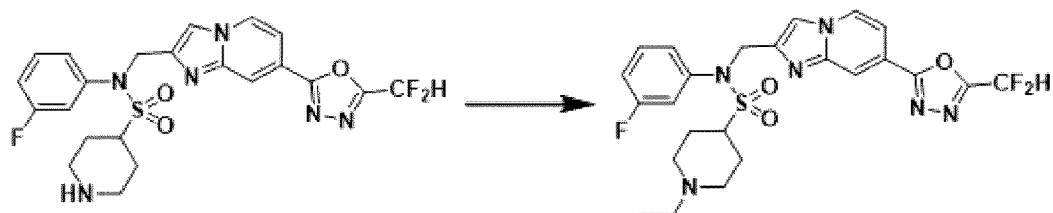
aqueous layer, and then concentrated under reduced pressure. Dichloromethane (3 mL) was added to the concentrate, followed by stirring, and the precipitated solid was filtered, washed with dichloromethane, and dried to obtain the title compound (0.028 g, 54.1 %) as a white solid.

[286] ^1H NMR (400 MHz, CDCl_3) δ 8.27 (p, $J = 0.7$ Hz, 1H), 8.23 (dd, $J = 1.0, 7.1$ Hz, 1H), 7.78 (s, 1H), 7.54 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.36-7.23 (m, 3H), 7.10-6.80 (m, 2H), 5.15 (s, 2H), 3.09-2.90 (m, 3H), 2.28 (s, 3H), 2.10 (d, $J = 11.3$ Hz, 2H), 2.03-1.86 (m, 4H);

[287] **LRMS** (ES) m/z 521.2 ($M + + 1$).

[288] **Example 19:** Synthesis of Compound 4237, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-1-ethyl-*N*-(3-fluorophenyl)-piperidine-4-sulfonamide

[289]

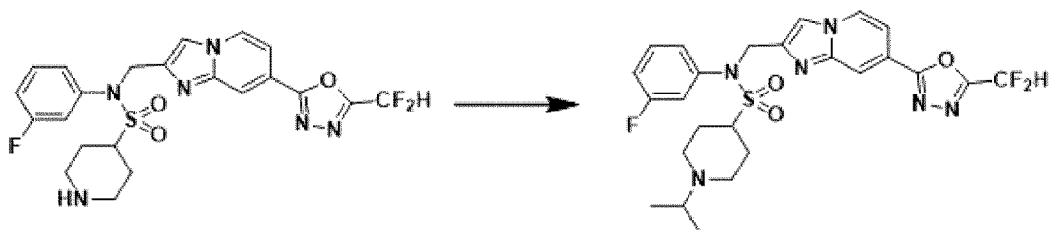


[290] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, acetaldehyde (0.009 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol) and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10 %) and concentrated to obtain the title compound (0.027 g, 51.9 %) as a yellow solid.

[291] ^1H NMR (400 MHz, CDCl_3) δ 8.27 (s, 1H), 8.22 (d, $J = 7.1$ Hz, 1H), 7.78 (s, 1H), 7.53 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.34 - 7.24 (m, 3H), 7.09 - 6.80 (m, 2H), 5.15 (s, 2H), 3.12 - 2.99 (m, 3H), 2.42 (q, $J = 7.2$ Hz, 2H), 2.11 (d, $J = 11.7$ Hz, 2H), 2.05 - 1.85 (m, 4H), 1.08 (t, $J = 7.2$ Hz, 3H); **LRMS** (ES) m/z 535.1 ($M + + 1$).

[292] **Example 20:** Synthesis of Compound 4238, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-isopropylpiperidine-4-sulfonamide

[293]



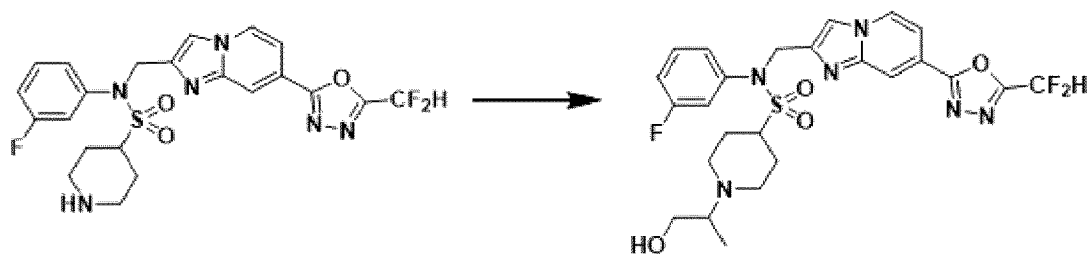
[294] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, propan-2-one (0.011 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10 %) and concentrated to obtain the title compound (0.018 g, 33.2 %) as a white solid.

[295] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (s, 1H), 8.23 (d, *J* = 7.1 Hz, 1H), 7.79 (s, 1H), 7.53 (dd, *J* = 1.8, 7.1 Hz, 1H), 7.36-7.24 (m, 3H), 7.09-6.81 (m, 2H), 5.15 (s, 2H), 3.01 (d, *J* = 11.4 Hz, 3H), 2.85-2.72 (m, 1H), 2.12 (d, *J* = 13.4 Hz, 4H), 2.02-1.87 (m, 2H), 1.04 (d, *J* = 6.6 Hz, 6H);

[296] **LRMS** (ES) *m/z* 549.4 (*M* + 1).

[297] **Example 21:** Synthesis of Compound 4239, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(1-hydroxypropan-2-yl)piperidine-4-sulfonamide

[298]



[299] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, 1-hydroxypropan-2-one (0.015 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours.

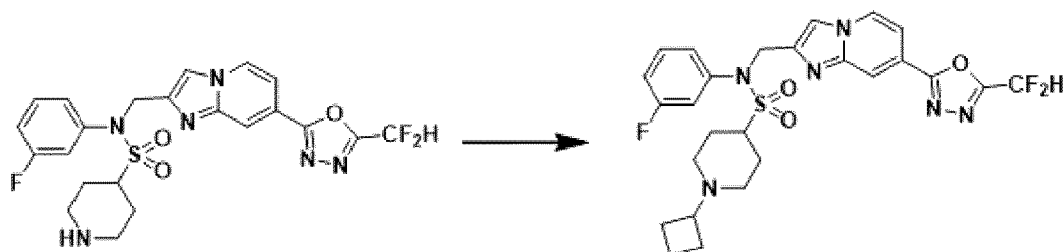
An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10 %) and concentrated to obtain the title compound (0.019 g, 33.7 %) as a yellow solid.

[300] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (s, 1H), 8.23 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.77 (s, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.37-7.22 (m, 3H), 7.11-6.80 (m, 2H), 5.15 (s, 2H), 3.42 (dd, *J* = 10.8, 5.0 Hz, 1H), 3.33 (t, *J* = 10.4 Hz, 1H), 3.09 (tt, *J* = 11.9, 3.8 Hz, 1H), 2.96-2.80 (m, 3H), 2.55 (td, *J* = 11.6, 2.4 Hz, 1H), 2.21-1.81 (m, 5H), 0.89 (d, *J* = 6.7 Hz, 3H);

[301] **LRMS** (ES) *m/z* 565.4 (*M* + 1).

[302] **Example 22:** Synthesis of Compound 4240, 1-cyclobutyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)piperidine-4-sulfonamide

[303]



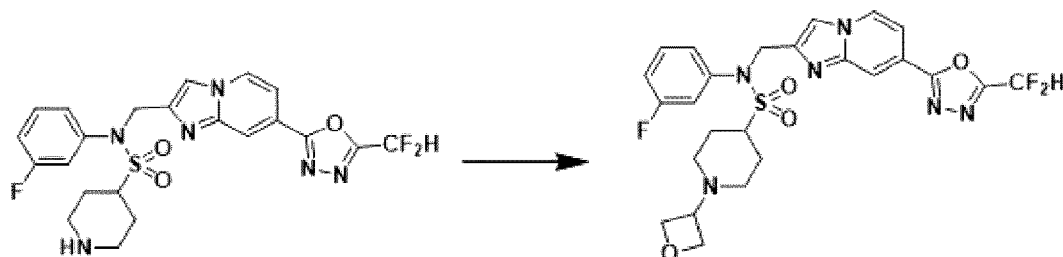
[304] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, cyclobutanone (0.014 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10 %) and concentrated to obtain the title compound (0.023 g, 41.9 %) as a white solid.

[305] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (d, *J* = 1.5 Hz, 1H), 8.22 (d, *J* = 7.1 Hz, 1H), 7.78 (s, 1H), 7.53 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.36-7.23 (m, 3H), 7.10-6.80 (m, 2H), 5.14 (s, 2H), 3.03 (ddt, *J* = 3.6, 12.1, 26.5 Hz, 3H), 2.70 (p, *J* = 7.8 Hz, 1H), 2.15-1.82 (m, 8H), 1.79-1.59 (m, 4H);

[306] **LRMS** (ES) *m/z* 561.1 (*M* + 1).

[307] **Example 23:** Synthesis of Compound 4241, *N*-
 ((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-
 (3-fluorophenyl)-1-oxetan-3-yl)piperidine-4-sulfonamide

[308]



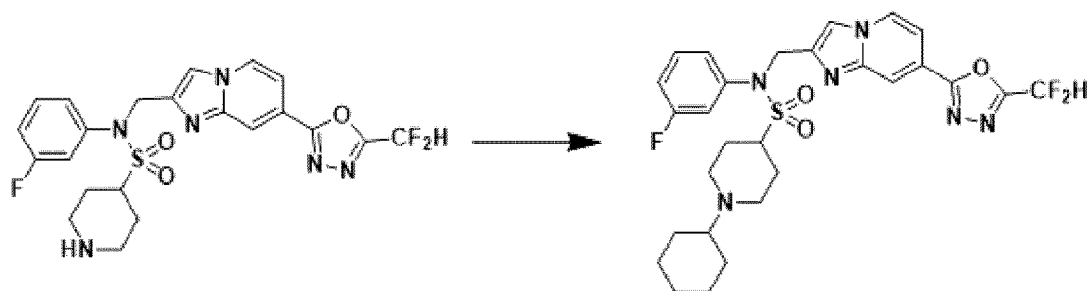
[309] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, oxetan-3-one (0.014 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10 %) and concentrated to obtain the title compound (0.027 g, 48.8 %) as a white solid.

[310] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.23 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.76 (s, 1H), 7.53 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.36-7.23 (m, 3H), 7.10-6.81 (m, 2H), 5.14 (s, 2H), 4.62 (dt, *J* = 6.4, 21.5 Hz, 4H), 3.53-3.43 (m, 1H), 3.09 (tt, *J* = 3.9, 11.7 Hz, 1H), 2.87 (dt, *J* = 3.4, 11.8 Hz, 2H), 2.17-2.09 (m, 2H), 1.99 (qd, *J* = 3.8, 12.1 Hz, 2H), 1.88-1.78 (m, 2H);

[311] **LRMS** (ES) *m/z* 563.1 (*M*⁺ + 1).

[312] **Example 24:** Synthesis of Compound 4242, 1-cyclohexyl-*N*-
 ((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-
 (3-fluorophenyl)piperidine-4-sulfonamide

[313]



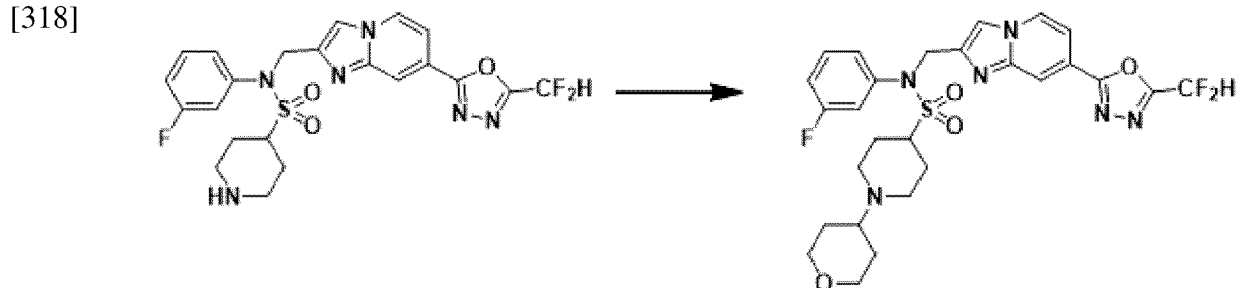
[314] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-

N-phenylpiperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, cyclohexanone (0.019 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10 %) and concentrated to obtain the title compound (0.030 g, 51.6 %) as a white solid.

[315] ¹H NMR (400 MHz, CDCl₃) δ 8.29-8.25 (m, 1H), 8.22 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.78 (s, 1H), 7.53 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.35-7.23 (m, 3H), 7.11-6.79 (m, 2H), 5.15 (s, 2H), 3.05 (dq, *J* = 4.0, 11.9 Hz, 3H), 2.40-1.87 (m, 7H), 1.80 (dd, *J* = 5.6, 10.2 Hz, 4H), 1.68-1.59 (m, 1H), 1.33-1.15 (m, 5H);

[316] LRMS (ES) *m/z* 589.2 (*M*⁺ + 1).

[317] **Example 25:** Synthesis of Compound 4243, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(tetrahydro-2H-pyran-4-yl)piperidine-4-sulfonamide



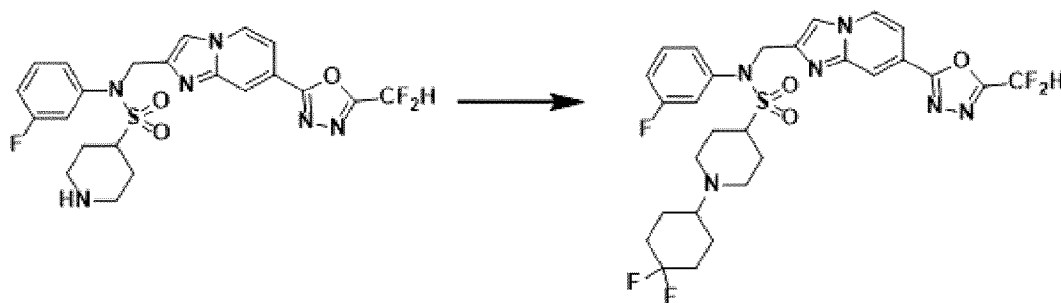
[319] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, tetrahydro-4H-pyran-4-one (0.020 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10 %) and concentrated to obtain the title compound (0.023 g, 40.1 %) as a yellow gel.

[320] ^1H NMR (400 MHz, CDCl_3) δ 8.29-8.26 (m, 1H), 8.23 (dd, $J = 1.0, 7.1$ Hz, 1H), 7.77 (s, 1H), 7.53 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.37-7.23 (m, 3H), 7.09-6.80 (m, 2H), 5.15 (s, 2H), 4.06-3.97 (m, 2H), 3.37 (td, $J = 2.0, 11.8$ Hz, 2H), 3.12-3.02 (m, 3H), 2.56-2.46 (m, 1H), 2.20-2.06 (m, 4H), 2.00-1.89 (m, 2H), 1.71 (dd, $J = 3.5, 12.4$ Hz, 2H), 1.64-1.52 (m, 2H);

[321] **LRMS** (ES) m/z 591.1 ($M + 1$).

[322] **Example 26:** Synthesis of Compound 4244, 1-(4,4-difluorocyclohexyl)- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)piperidine-4-sulfonamide

[323]



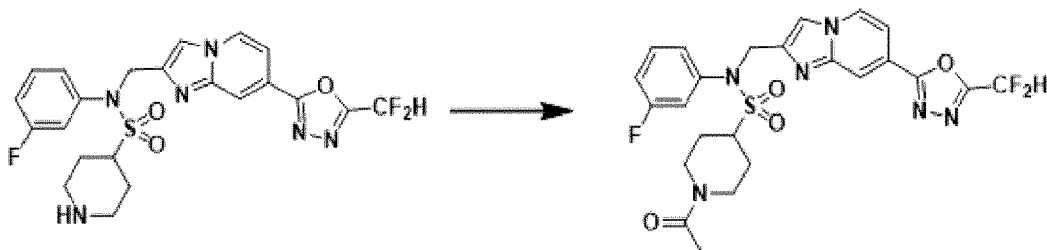
[324] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, 4,4-difluorocyclohexan-1-one (0.026 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 10%) and concentrated, and then the obtained product was again purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 0% to 7%) and concentrated to obtain the title compound (0.017 g, 27.9%) as a yellow gel.

[325] ^1H NMR (400 MHz, CDCl_3) δ 8.28 (s, 1H), 8.23 (d, $J = 7.5$ Hz, 1H), 7.77 (s, 1H), 7.54 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.36-7.23 (m, 3H), 7.09-6.79 (m, 2H), 5.15 (s, 2H), 3.03 (t, $J = 9.3$ Hz, 2H), 2.45 (s, 1H), 2.16 (dt, $J = 11.7, 22.3$ Hz, 6H), 2.00-1.56 (m, 9H);

[326] **LRMS** (ES) m/z 625.2 ($M + 1$).

[327] **Example 27:** Synthesis of Compound 4245, 1-acetyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)piperidine-4-sulfonamide

[328]

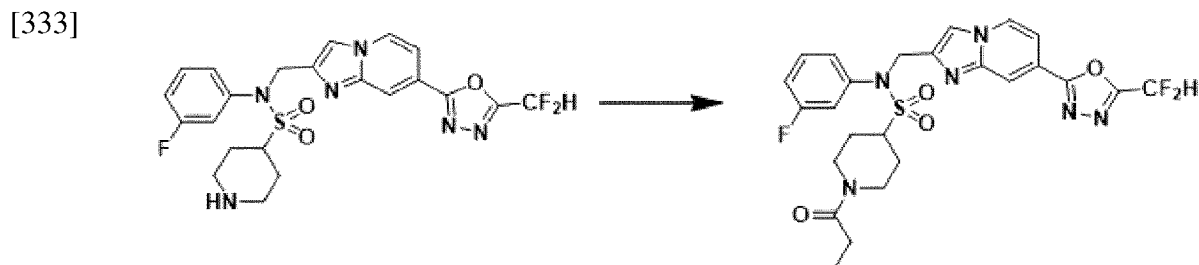


[329] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, acetyl chloride (0.014 mL, 0.197 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated to obtain the title compound (0.020 g, 37.7%) as a white gel.

[330] ¹H NMR (400 MHz, CDCl₃) δ 8.30-8.27 (m, 1H), 8.24 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.73 (s, 1H), 7.55 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.37-7.22 (m, 3H), 7.10-6.81 (m, 2H), 5.12 (s, 2H), 4.72 (d, *J* = 13.3 Hz, 1H), 3.95 (d, *J* = 13.6 Hz, 1H), 3.33 (tt, *J* = 3.8, 11.7 Hz, 1H), 3.07 (ddd, *J* = 2.8, 12.2, 14.0 Hz, 1H), 2.57 (td, *J* = 2.9, 12.9 Hz, 1H), 2.22 (d, *J* = 12.6 Hz, 1H), 2.11 (s, 3H), 1.83 (dtt, *J* = 6.1, 12.3, 24.8 Hz, 3H);

[331] **LRMS** (ES) *m/z* 548.9 (*M* + 1).

[332] **Example 28:** Synthesis of Compound 4246, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-propionylpiperidine-4-sulfonamide



[334] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, propionyl chloride (0.018 g, 0.197 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted

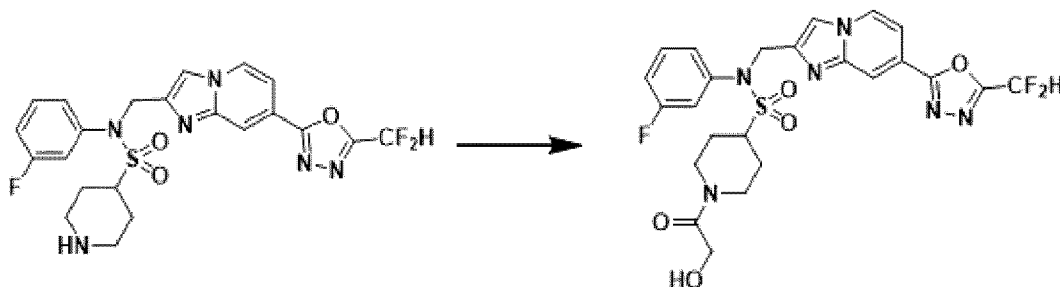
with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.017 g, 29.9 %) as a yellow solid.

[335] ¹H NMR (400 MHz, CDCl₃) δ 8.30-8.28 (m, 1H), 8.24 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.76-7.71 (m, 1H), 7.56 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.38-7.22 (m, 3H), 7.11-6.82 (m, 2H), 5.13 (s, 2H), 4.75 (d, *J* = 13.5 Hz, 1H), 4.00 (d, *J* = 13.8 Hz, 1H), 3.33 (tt, *J* = 3.8, 11.7 Hz, 1H), 3.03 (t, *J* = 12.9 Hz, 1H), 2.57 (t, *J* = 12.8 Hz, 1H), 2.36 (q, *J* = 7.4 Hz, 2H), 2.18 (dd, *J* = 13.1, 25.6 Hz, 2H), 1.90-1.70 (m, 2H), 1.16 (t, *J* = 7.4 Hz, 3H);

[336] **LRMS** (ES) *m/z* 563.0 (*M* + 1).

[337] **Example 29:** Synthesis of Compound 4247, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(2-hydroxyacetyl)piperidine-4-sulfonamide

[338]



[339] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, 2-hydroxyacetic acid (0.015 g, 0.197 mmol), triethylamine (0.028 mL, 0.197 mmol), and 1-[bis(dimethylamino)methylene]-1*H*-1,2,3-triazolo[4,5-*b*]pyridinium 3-oxide hexafluorophosphate (HATU, 0.056 g, 0.148 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated, and then the obtained product was again purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 5 % to 7%) and concentrated to obtain the title compound (0.017 g, 31.2 %) as a white gel.

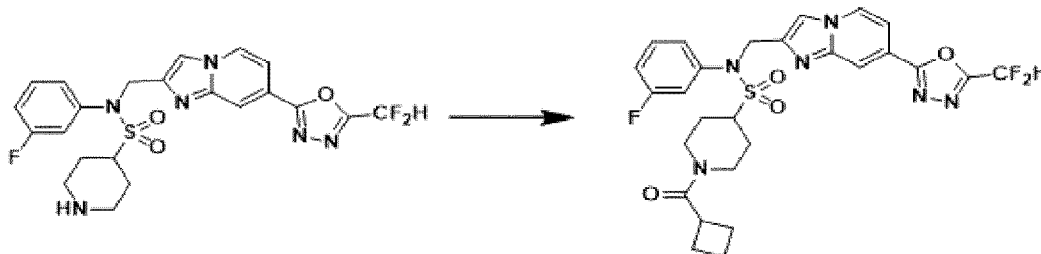
[340] ¹H NMR (400 MHz, CDCl₃) δ 8.30 (dd, *J* = 0.9, 1.7 Hz, 1H), 8.24 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.71 (s, 1H), 7.57 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.34 (td, *J* = 6.2, 8.0 Hz, 1H),

7.30-7.22 (m, 2H), 7.10-6.81 (m, 2H), 5.11 (s, 2H), 4.68 (d, $J = 13.5$ Hz, 1H), 4.18 (d, $J = 1.2$ Hz, 2H), 3.65 (d, $J = 13.7$ Hz, 1H), 3.39 (tt, $J = 3.8, 11.5$ Hz, 1H), 3.07-2.96 (m, 1H), 2.77 (t, $J = 12.2$ Hz, 1H), 2.23 (t, $J = 14.2$ Hz, 2H), 1.87 (qd, $J = 4.3, 12.4$ Hz, 2H);

[341] **LRMS** (ES) m/z 565.0 ($M + 1$).

[342] **Example 30:** Synthesis of Compound 4248, 1-(cyclobutanecarbonyl)- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridine-2-yl)methyl)- *N*-(3-fluorophenyl)piperidine-4-sulfonamide

[343]



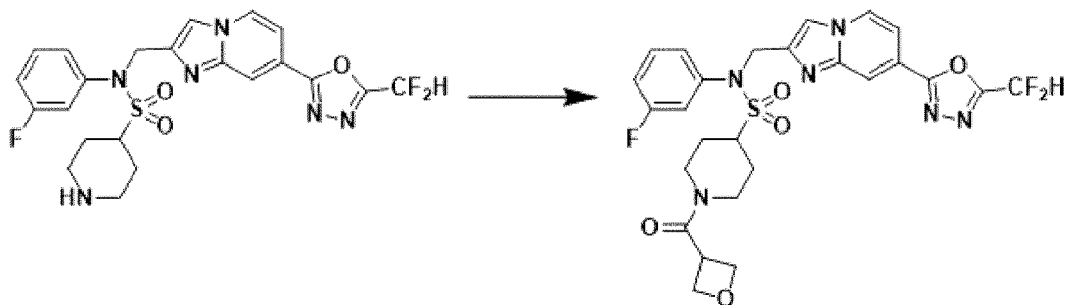
[344] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, cyclobutanecarbonyl chloride (0.023 g, 0.197 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated, and then the obtained product was again purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 0 % to 7%) and concentrated to obtain the title compound (0.010 g, 17.2 %) as a white solid.

[345] ^1H NMR (400 MHz, CDCl_3) δ 8.31-8.28 (m, 1H), 8.24 (dd, $J = 1.0, 7.1$ Hz, 1H), 7.73 (s, 1H), 7.57 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.38-7.22 (m, 3H), 7.10-6.81 (m, 2H), 5.13 (s, 2H), 4.72 (d, $J = 13.4$ Hz, 1H), 3.84 (d, $J = 13.7$ Hz, 1H), 3.37-3.17 (m, 2H), 2.95 (t, $J = 12.8$ Hz, 1H), 2.57 (t, $J = 12.8$ Hz, 1H), 2.42-2.27 (m, 2H), 2.16 (tt, $J = 4.8, 8.8$ Hz, 4H), 2.05-1.68 (m, 4H);

[346] **LRMS** (ES) m/z 588.9 ($M + 1$).

[347] **Example 31:** Synthesis of Compound 4249, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)-1-(oxetan-3-carbonyl)piperidine-4-sulfonamide

[348]



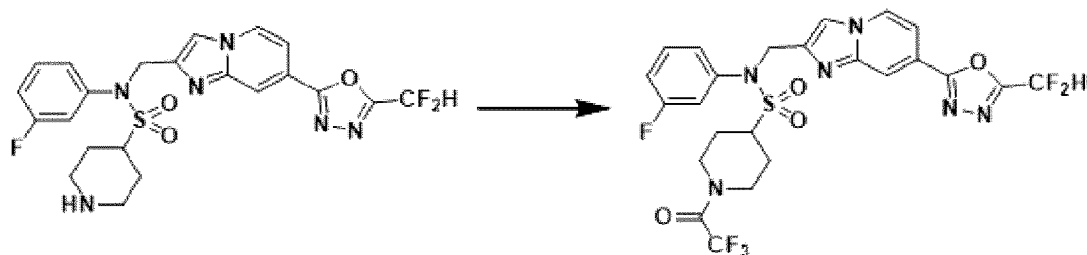
[349] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, oxetane-3-carboxylic acid (0.020 g, 0.197 mmol), 1-[bis(dimethylamino)methylene]-1*H*-1,2,3-triazolo[4,5-*b*]pyridinium 3-oxide hexafluorophosphate (HATU, 0.056 g, 0.148 mmol), and triethylamine (0.028 mL, 0.197 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.013 g, 21.8 %) as a yellow solid.

[350] ¹H NMR (400 MHz, CDCl₃) δ 8.33-8.28 (m, 1H), 8.24 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.71 (s, 1H), 7.57 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.38-7.20 (m, 3H), 7.10-6.81 (m, 2H), 5.11 (s, 2H), 4.92 (ddd, *J* = 5.8, 7.1, 16.4 Hz, 2H), 4.81 (dd, *J* = 5.9, 8.7 Hz, 2H), 4.72 (d, *J* = 13.8 Hz, 1H), 4.00 (tt, *J* = 7.1, 8.7 Hz, 1H), 3.47 (d, *J* = 13.8 Hz, 1H), 3.35 (tt, *J* = 3.8, 11.6 Hz, 1H), 2.98 (ddd, *J* = 2.8, 12.2, 14.2 Hz, 1H), 2.66 (td, *J* = 2.9, 12.9, 13.7 Hz, 1H), 2.20 (d, *J* = 13.0 Hz, 1H), 1.81 (dtt, *J* = 6.1, 13.0, 20.0 Hz, 3H);

[351] **LRMS** (ES) *m/z* 591.0 (*M*⁺ + 1).

[352] **Example 32:** Synthesis of Compound 4250, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(2,2,2-trifluoroacetyl)piperidine-4-sulfonamide

[353]



[354] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3

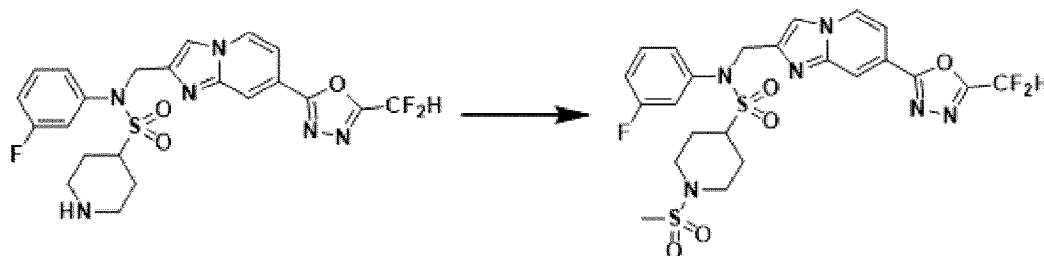
of Example 18, 2,2,2-trifluoroacetic anhydride (0.041 g, 0.197 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.025 g, 41.9 %) as a yellow solid.

[355] ¹H NMR (400 MHz, CDCl₃) δ 8.30 (s, 1H), 8.27-8.21 (m, 1H), 7.71 (s, 1H), 7.57 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.38-7.19 (m, 3H), 7.11-6.81 (m, 2H), 5.11 (s, 2H), 4.60 (d, *J* = 13.5 Hz, 1H), 4.13 (d, *J* = 14.2 Hz, 1H), 3.45 (ddt, *J* = 4.1, 7.3, 11.3 Hz, 1H), 3.20 (ddd, *J* = 2.8, 11.8, 14.4 Hz, 1H), 2.93-2.81 (m, 1H), 2.27 (d, *J* = 13.6 Hz, 2H), 2.04-1.88 (m, 2H);

[356] **LRMS** (ES) *m/z* 602.7 (*M* + 1).

[357] **Example 33:** Synthesis of Compound 4251, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(methylsulfonyl)piperidine-4-sulfonamide

[358]



[359] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, methanesulfonyl chloride (0.015 mL, 0.197 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.004 g, 6.2 %) as a white solid.

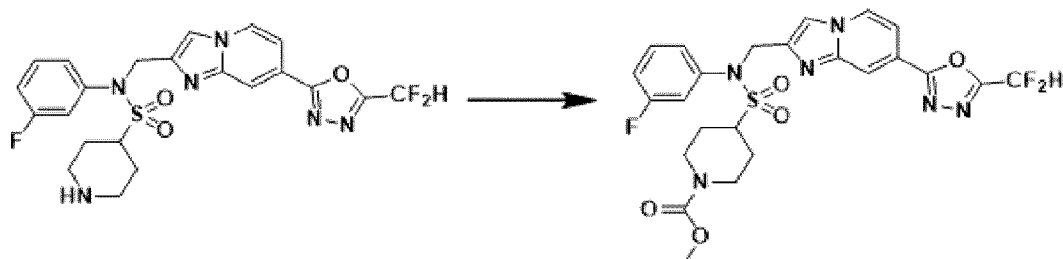
[360] ¹H NMR (400 MHz, CDCl₃) δ 8.29 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.24 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.75-7.71 (m, 1H), 7.56 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.38-7.21 (m, 3H), 7.09-6.80 (m, 2H), 5.12 (s, 2H), 3.89 (dt, *J* = 4.2, 13.3 Hz, 2H), 3.24 (ddt, *J* = 3.8, 7.7,

11.1 Hz, 1H), 2.85-2.73 (m, 5H), 2.30-2.17 (m, 2H), 2.07-1.95 (m, 2H);

[361] **LRMS** (ES) m/z 584.7 ($M + 1$).

[362] **Example 34:** Synthesis of Compound 4252, methyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)sulfamoyl)piperidine-1-carboxylate

[363]



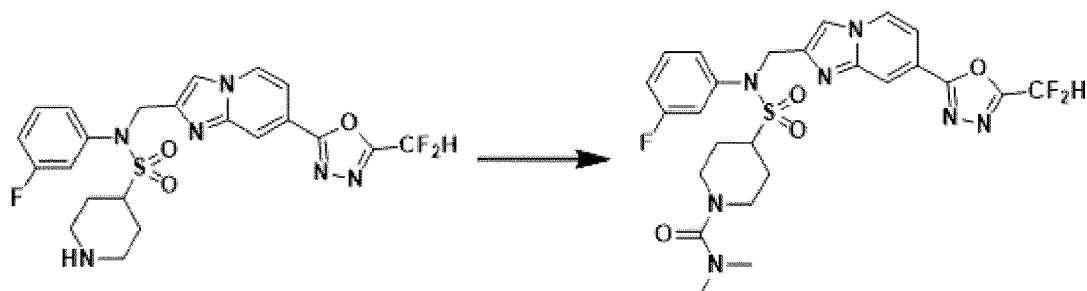
[364] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, methyl carbonochloridate (0.019 g, 0.197 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.025 g, 45.6 %) as a yellow solid.

[365] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.23 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.74 (s, 1H), 7.55 (dd, *J* = 1.7, 7.2 Hz, 1H), 7.36-7.23 (m, 3H), 7.09-6.81 (m, 2H), 5.12 (s, 2H), 4.28 (s, 2H), 3.71 (s, 3H), 3.26 (ddd, *J* = 3.7, 8.1, 11.8 Hz, 1H), 2.77 (s, 2H), 2.18-2.07 (m, 2H), 1.82 (qd, *J* = 4.5, 12.4 Hz, 2H);

[366] **LRMS** (ES) m/z 565.4 ($M + 1$).

[367] **Example 35:** Synthesis of Compound 4253, 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)sulfamoyl)-*N,N*-dimethylpiperidine-1-carboxamide

[368]



[369] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-

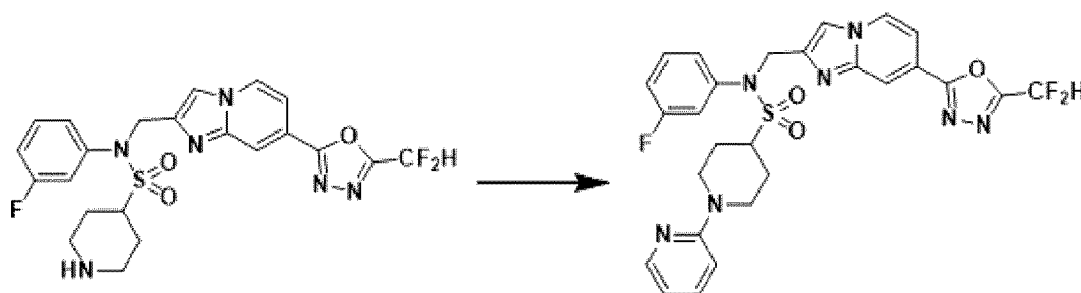
N-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, dimethylcarbamic chloride (0.021 g, 0.197 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.022 g, 38.4 %) as a white solid.

[370] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.23 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.75 (s, 1H), 7.55 (dd, *J* = 1.7, 7.2 Hz, 1H), 7.36-7.24 (m, 3H), 7.10-6.81 (m, 2H), 5.13 (s, 2H), 3.77 (dt, *J* = 3.4, 13.9 Hz, 2H), 3.23 (tt, *J* = 3.8, 11.9 Hz, 1H), 2.84 (s, 6H), 2.71 (td, *J* = 2.5, 12.9, 13.4 Hz, 2H), 2.19-2.06 (m, 2H), 1.89 (qd, *J* = 4.1, 12.4 Hz, 2H);

[371] LRMS (ES) *m/z* 578.4 (*M* + 1).

[372] **Example 36:** Synthesis of Compound 4254, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(pyridin-2-yl)piperidine-4-sulfonamide

[373]



[374] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, 2-bromopyridine (0.031 g, 0.197 mmol), RuPhos palladium G2 (0.004 g, 0.005 mmol) and cesium carbonate (0.064 g, 0.197 mmol) were dissolved in 1,4-dioxane (1 mL) at room temperature, and the resulting solution was stirred at 120°C for 18 hours. Then, the temperature was lowered to room temperature to terminate the reaction. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated, and then the obtained product was again purified by chromatography (SiO₂ plate, 20 x 20 x 1

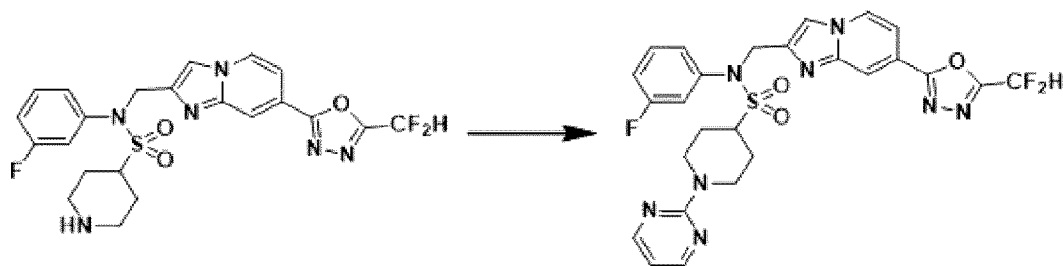
mm; methanol/1%-dichloromethane aqueous solution = 0 % to 7%) and concentrated to obtain the title compound (0.005 g, 8.0 %) as a yellow solid.

[375] ^1H NMR (400 MHz, CDCl_3) δ 8.30-8.26 (m, 1H), 8.23 (dd, $J = 1.0, 7.1$ Hz, 1H), 8.20 (ddd, $J = 0.9, 2.0, 5.0$ Hz, 1H), 7.76 (d, $J = 0.7$ Hz, 1H), 7.55 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.51 (t, $J = 8.2$ Hz, 1H), 7.37-7.24 (m, 3H), 7.10-6.81 (m, 2H), 6.67 (dd, $J = 7.3, 12.1$ Hz, 2H), 5.16 (s, 2H), 4.46 (d, $J = 13.3$ Hz, 2H), 3.35 (ddd, $J = 3.8, 8.2, 12.0$ Hz, 1H), 2.86 (t, $J = 12.7$ Hz, 2H), 2.21 (d, $J = 12.8$ Hz, 2H), 1.95 (qd, $J = 4.2, 12.3$ Hz, 2H);

[376] **LRMS** (ES) m/z 584.1 ($M + 1$).

[377] **Example 37:** Synthesis of Compound 4255, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(pyrimidin-2-yl)piperidine-4-sulfonamide

[378]



[379] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 18, 2-chloropyrimidine (0.023 g, 0.197 mmol), and potassium carbonate (0.041 g, 0.296 mmol) were dissolved in *N,N*-dimethylformamide (0.5 mL)/acetonitrile (0.5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. Next, the obtained product was filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. Dichloromethane (3 mL) was added to the concentrate, followed by stirring, and the precipitated solid was filtered, washed with dichloromethane, and dried to obtain the title compound (0.012 g, 21.5 %) as a yellow solid.

[380] ^1H NMR (400 MHz, CDCl_3) δ 8.32 (d, $J = 4.7$ Hz, 2H), 8.27 (dt, $J = 0.8, 1.7$ Hz, 1H), 8.23 (dd, $J = 1.0, 7.1$ Hz, 1H), 7.76 (d, $J = 0.7$ Hz, 1H), 7.55 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.37-7.25 (m, 4H), 7.10-6.81 (m, 2H), 6.53 (t, $J = 4.7$ Hz, 1H), 5.15 (s, 2H), 4.99-4.86 (m, 2H), 3.38 (ddt, $J = 3.7, 7.5, 11.9$ Hz, 1H), 2.95-2.82 (m, 2H), 2.26-2.18 (m, 2H), 1.89 (qd, $J = 4.4, 12.4$ Hz, 2H);

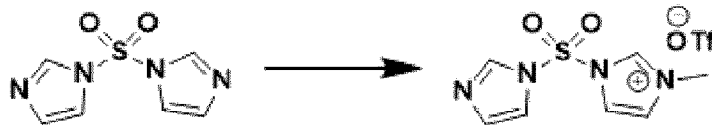
[381] **LRMS** (ES) m/z 585.1 ($M + 1$).

[382] **Example 38:** Synthesis of Compound 4256, *N*-

((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-4-methyl- *N*-phenylpiperazine-1-sulfonamide

[383] [Step 1] Synthesis of 1-((1H-imidazol-1-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium trifluoromethanesulfonate

[384]



[385] 1,1'-sulfonylbis (1H-imidazole, 10.000 g, 50.454 mmol) and methyl trifluoromethanesulfonate (4.981 mL, 45.409 mmol) were dissolved in dichloromethane (150 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. After removing the solvent from the reaction mixture under reduced pressure, the title compound (18.280 g, 100.0 %) was obtained as a white solid without further purification.

[386] [Step 2] Synthesis of tert-butyl 4-((1H-imidazol-1-yl)sulfonyl)piperazine-1-carboxylate

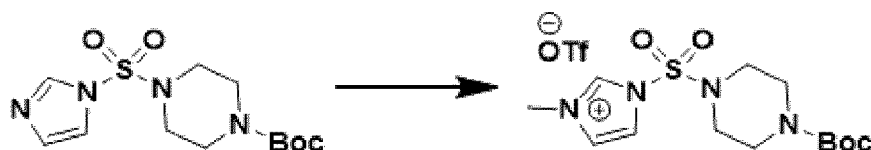
[387]



[388] 1-((1H-imidazol-1-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium trifluoromethanesulfonate (18.000 g, 49.684 mmol) prepared in step 1 and tert-butyl piperazine-1-carboxylate (10.642 g, 57.137 mmol) were dissolved in acetonitrile (100 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous ammonium chloride solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 80 g cartridge; hexane/ethyl acetate = 0 % to 100 %) and concentrated to obtain the title compound (5.830 g, 37.1 %) as a white solid.

[389] [Step 3] Synthesis of 1-((4-(tert-butoxycarbonyl)piperazine-1-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium trifluoromethanesulfonate

[390]

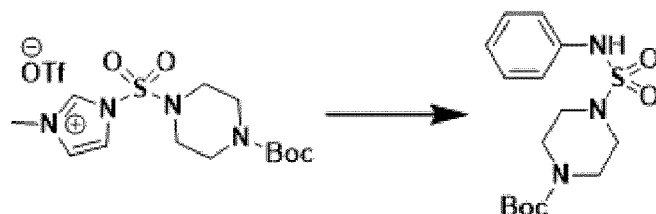


[391] Tert-butyl 4-((1H-imidazol-1-yl)sulfonyl)piperazine-1-carboxylate (5.830 g, 18.427

mmol) prepared in step 2 and methyl trifluoromethanesulfonate (2.223 mL, 20.270 mmol) were dissolved in dichloromethane (150 mL) at 0°C, and the resulting solution was stirred at room temperature for 3 hours. After removing the solvent from the reaction mixture under reduced pressure, the title compound (8.850 g, 100.0 %) was obtained as a white solid without further purification.

[392] [Step 4] Synthesis of tert-butyl 4-(*N*-(phenylsulfamoyl)piperazine-1-carboxylate

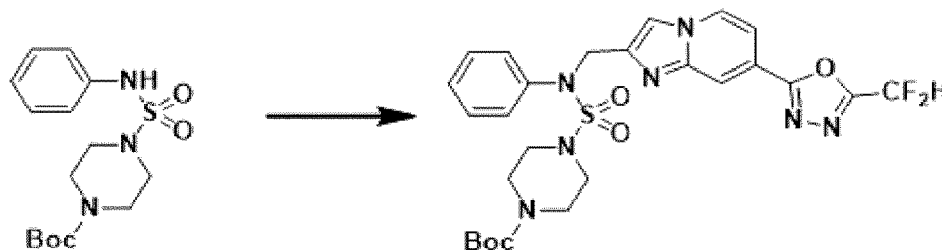
[393]



[394] 1-((4-(Tert-butoxycarbonyl)piperazine-1-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium trifluoromethanesulfonate (4.400 g, 9.158 mmol) prepared in step 3 and aniline (1.003 mL, 10.989 mmol) were dissolved in acetonitrile (50 mL) at room temperature, and the resulting solution was heated to reflux for 18 hours. Then, the temperature was lowered to room temperature to terminate the reaction. A saturated aqueous ammonium chloride solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 24 g cartridge; ethyl acetate/hexane = 0 % to 20 %) and concentrated to obtain the title compound (1.200 g, 38.4 %) as a beige solid.

[395] [Step 5] Synthesis of tert-butyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)piperazine-1-carboxylate

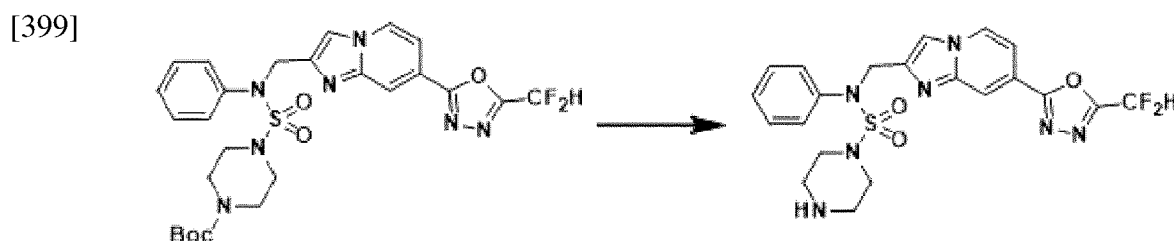
[396]



[397] Tert-butyl 4-(*N*-phenylsulfamoyl)piperazine-1-carboxylate (0.300 g, 0.879 mmol) prepared in step 4, 2-(2-(chloromethyl)imidazo[1,2-*a*]pyridin-7-yl)-5-(difluoromethyl)-1,3,4-oxadiazole (0.300 g, 1.054 mmol) prepared in step 5 of Example 1, potassium carbonate (0.182 g, 1.318 mmol), and potassium iodide (0.073 g, 0.439 mmol) were dissolved in *N,N*-dimethylformamide (10 mL) at room temperature, and the resulting solution was

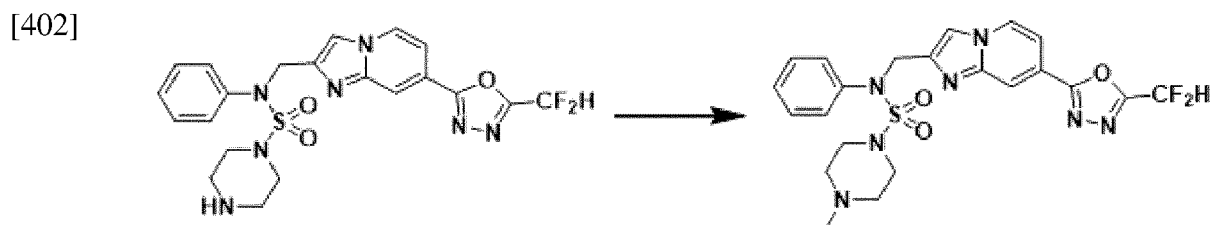
stirred at the same temperature for 3 hours. A saturated aqueous ammonium chloride solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 40 g cartridge; ethyl acetate/hexane = 0 % to 70 %) and concentrated to obtain the title compound (0.450 g, 86.9 %) as a white solid.

[398] [Step 6] Synthesis of *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide



[400] Tert-butyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl) piperazine-1-carboxylate (0.470 g, 0.797 mmol) prepared in step 5, and trifluoroacetic acid (1.221 mL, 15.942 mmol) were dissolved in dichloromethane (10 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, and filtered. After concentration under reduced pressure, the title compound (0.390g, 100.0%) was obtained as a brown gel without further purification.

[401] [Step 7] Synthesis of Compound 4256



[403] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6, formaldehyde (0.006 g, 0.204 mmol), acetic acid (0.006 mL, 0.102 mmol), and sodium triacetoxyborohydride (0.065 g, 0.306 mmol) were dissolved in dichloromethane (3

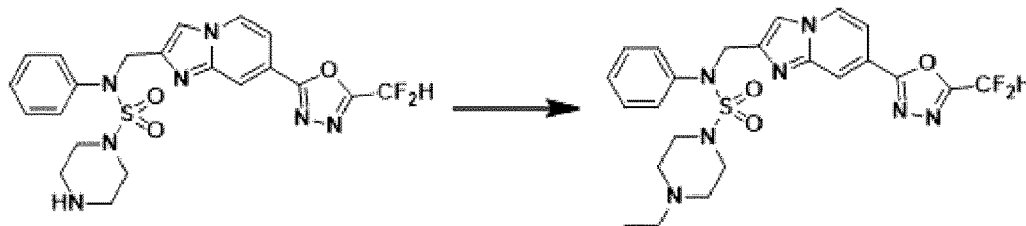
mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.020 g, 38.9 %) as a yellow solid.

[404] ¹H NMR (700 MHz, CDCl₃) δ 8.30 (s, 1H), 8.23 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.76 (s, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.48 (d, *J* = 7.9 Hz, 2H), 7.36 (t, *J* = 7.8 Hz, 2H), 7.30 (s, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.11 (s, 2H), 3.39 (s, 4H), 2.71-2.28 (m, 7H);

[405] **LRMS** (ES) *m/z* 504.3 (*M* + 1).

[406] **Example 39:** Synthesis of Compound 4257, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-4-ethyl-*N*-phenylpiperazine-1-sulfonamide

[407]



[408] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, acetaldehyde (0.009 g, 0.204 mmol), acetic acid (0.006 mL, 0.102 mmol), and sodium triacetoxyborohydride (0.065 g, 0.306 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.024 g, 45.4 %) as a yellow solid.

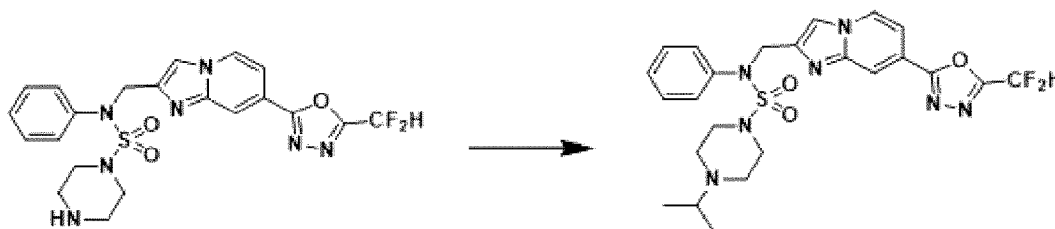
[409] ¹H NMR (700 MHz, CDCl₃) δ 8.28 (d, *J* = 1.7 Hz, 1H), 8.22 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.79 (s, 1H), 7.52 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.51-7.47 (m, 2H), 7.38-7.33 (m, 2H), 7.28-7.25 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.12 (s, 2H), 3.31 (s, 4H), 2.45 (s, 6H), 1.10 (s, 3H);

[410] **LRMS** (ES) *m/z* 518.2 (*M* + 1).

[411] **Example 40:** Synthesis of Compound 4258, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-4-iso

propyl- *N*-phenylpiperazine-1-sulfonamide

[412]



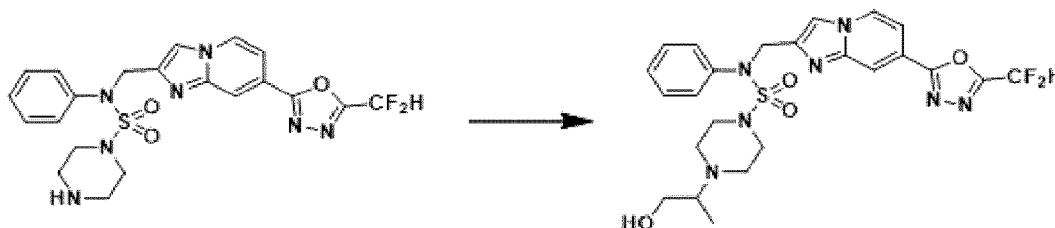
[413] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, propan-2-one (0.012 g, 0.204 mmol), acetic acid (0.006 mL, 0.102 mmol), and sodium triacetoxyborohydride (0.065 g, 0.306 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.032 g, 58.9 %) as a yellow solid.

[414] ¹H NMR (700 MHz, CDCl₃) δ 8.28 (s, 1H), 8.22 (d, *J* = 7.1 Hz, 1H), 7.80 (d, *J* = 0.8 Hz, 1H), 7.52 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.51-7.48 (m, 2H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.28-7.25 (m, 1H), 7.03-6.86 (m, 1H), 5.12 (s, 2H), 3.27 (s, 4H), 2.70 (s, 1H), 2.48 (s, 4H), 1.02 (s, 6H);

[415] LRMS (ES) *m/z* 532.3 (*M*⁺ + 1).

[416] **Example 41:** Synthesis of Compound 4259, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-4-(1-hydroxypropan-2-yl)-*N*-phenylpiperazine-1-sulfonamide

[417]



[418] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, 1-hydroxypropan-2-one (0.015 g, 0.204 mmol), acetic acid (0.006 mL, 0.102 mmol), and sodium triacetoxyborohydride (0.065 g, 0.306 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and

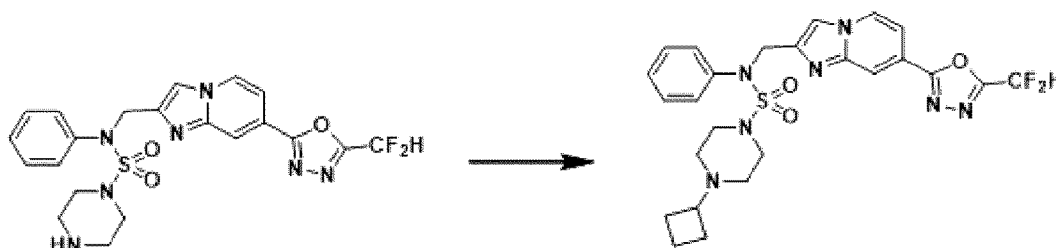
filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.019 g, 34.0 %) as a yellow solid.

[419] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (dt, *J* = 1.7, 0.8 Hz, 1H), 8.21 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.76 (d, *J* = 0.7 Hz, 1H), 7.52 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.51-7.46 (m, 2H), 7.39-7.32 (m, 2H), 7.30-7.25 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.11 (d, *J* = 0.7 Hz, 2H), 3.45 (d, *J* = 12.0 Hz, 1H), 3.41-3.20 (m, 5H), 2.85 (s, 1H), 2.66 (s, 2H), 2.44 (s, 2H), 0.92-0.87 (m, 3H);

[420] LRMS (ES) *m/z* 548.3 (*M* + 1).

[421] **Example 42:** Synthesis of Compound 4260, 4-cyclobutyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide

[422]



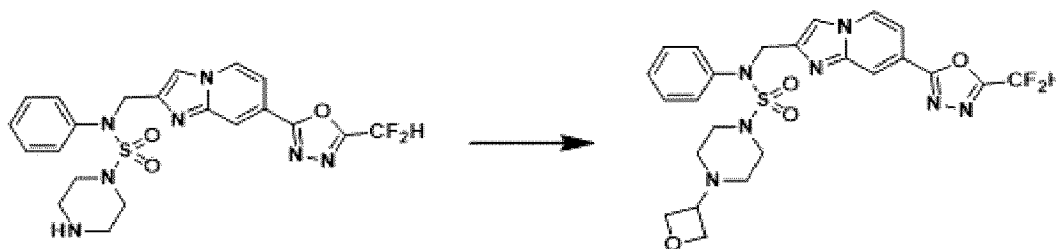
[423] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, cyclobutanone (0.014 g, 0.204 mmol), acetic acid (0.006 mL, 0.102 mmol), and sodium triacetoxyborohydride (0.065 g, 0.306 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.022 g, 39.6 %) as a yellow solid.

[424] ¹H NMR (700 MHz, CDCl₃) δ 8.28 (s, 1H), 8.22 (d, *J* = 7.1 Hz, 1H), 7.78 (s, 1H), 7.52 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.49 (d, *J* = 7.9 Hz, 2H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.28-7.25 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.12 (s, 2H), 3.27 (s, 4H), 2.71 (s, 1H), 2.29 (s, 4H), 2.03 (s, 2H), 1.83 (s, 2H), 1.70 (s, 2H);

[425] LRMS (ES) *m/z* 544.1 (*M* + 1).

[426] **Example 43:** Synthesis of Compound 4261, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-4-(oxetan-3-yl)-*N*-phenylpiperazine-1-sulfonamide

[427]



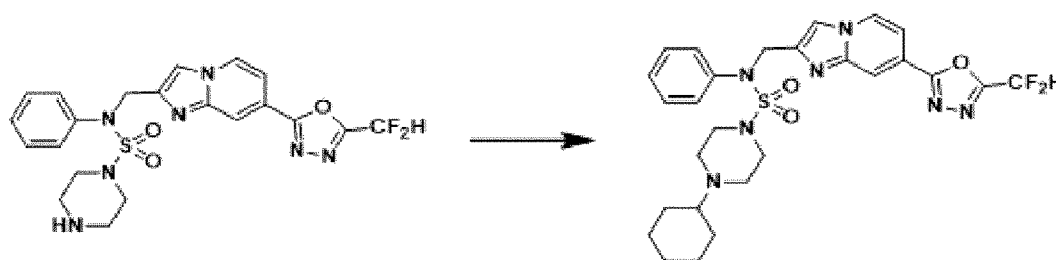
[428] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, oxetan-3-one (0.015 g, 0.204 mmol), acetic acid (0.006 mL, 0.102 mmol), and sodium triacetoxyborohydride (0.065 g, 0.306 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.022 g, 39.5 %) as a yellow solid.

[429] ¹H NMR (700 MHz, CDCl₃) δ 8.29 (s, 1H), 8.22 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.76 (s, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.50-7.47 (m, 2H), 7.38-7.35 (m, 2H), 7.29 (s, 1H), 7.04-6.86 (m, 1H), 5.11 (s, 2H), 4.67 (t, *J* = 6.5 Hz, 4H), 3.54 (s, 1H), 3.36 (s, 4H), 2.37 (s, 4H);

[430] **LRMS** (ES) *m/z* 545.9 (*M*⁺ + 1).

[431] **Example 44:** Synthesis of Compound 4262, 4-cyclohexyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide

[432]



[433] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, cyclohexanone (0.020 g, 0.204 mmol), acetic acid (0.006 mL, 0.102 mmol), and sodium triacetoxyborohydride (0.065 g, 0.306 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and

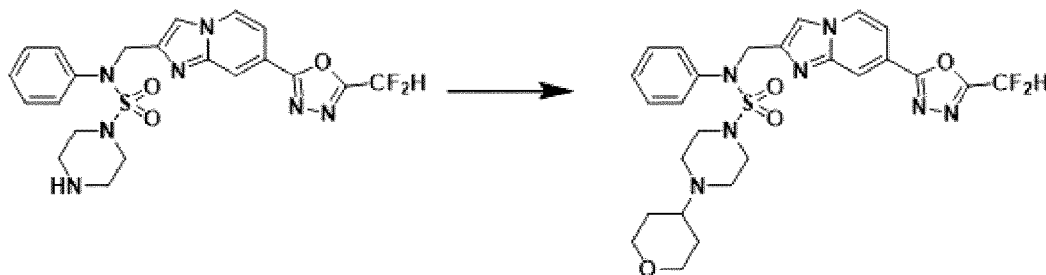
filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.029 g, 49.7 %) as a yellow solid.

[434] ¹H NMR (700 MHz, CDCl₃) δ 8.28 (s, 1H), 8.24-8.20 (m, 1H), 7.80 (d, *J* = 0.7 Hz, 1H), 7.53 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.49 (d, *J* = 7.9 Hz, 2H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.28-7.24 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.12 (s, 2H), 3.25 (s, 4H), 2.53 (s, 4H), 2.31-2.20 (m, 1H), 1.80 (s, 4H), 1.17 (d, *J* = 86.7 Hz, 6H);

[435] **LRMS** (ES) *m/z* 572.2 (*M* + 1).

[436] **Example 45:** Synthesis of Compound 4263, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-1-(tetrahydro-2H-pyran-4-yl)piperazine-1-sulfonamide

[437]



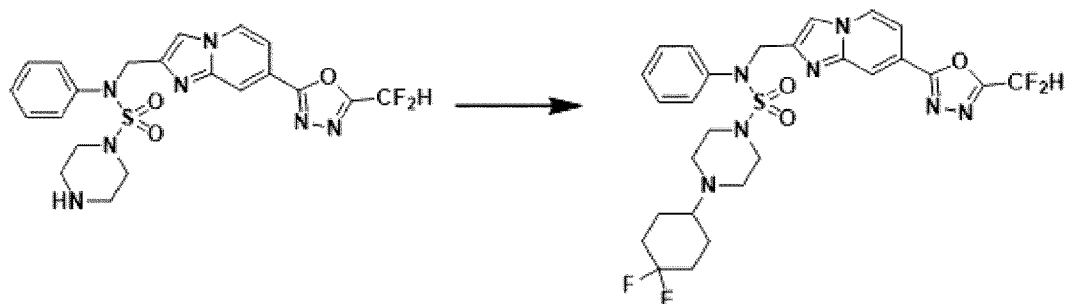
[438] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, tetrahydro-4H-pyran-4-one (0.015 g, 0.153 mmol), acetic acid (0.006 mL, 0.102 mmol), sodium triacetoxyborohydride (0.065 g, 0.306 mmol), and triethylamine (0.014 mL, 0.102 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated, and then the obtained product was again purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 0 % to 7%) and concentrated to obtain the title compound (0.017 g, 29.5 %) as a white solid.

[439] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (s, 1H), 8.21 (d, *J* = 7.1 Hz, 1H), 7.77 (s, 1H), 7.55-7.45 (m, 3H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.26 (t, *J* = 8.1 Hz, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.12 (s, 2H), 4.02 (dd, *J* = 4.3, 11.3 Hz, 2H), 3.36 (td, *J* = 1.9, 11.9 Hz, 2H), 3.27 (t, *J* = 4.9 Hz, 4H), 2.53 (t, *J* = 4.9 Hz, 4H), 2.43 (d, *J* = 12.9 Hz, 2H), 1.70 (d, *J* = 12.7 Hz, 1H), 1.53 (qd, *J* = 4.5, 12.0 Hz, 2H);

[440] **LRMS** (ES) m/z 574.4 ($M + 1$).

[441] **Example 46:** Synthesis of Compound 4264, 4-(4,4-difluorocyclohexyl)- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-phenylpiperazine-1-sulfonamide

[442]



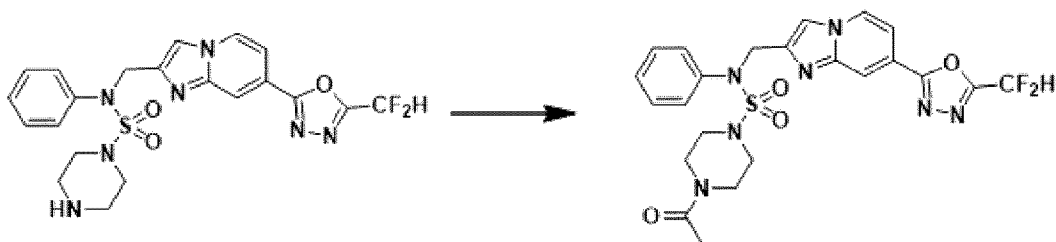
[443] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, 4,4-difluorocyclohexan-1-one (0.021 g, 0.153 mmol), acetic acid (0.006 mL, 0.102 mmol), sodium triacetoxyborohydride (0.065 g, 0.306 mmol), and triethylamine (0.014 mL, 0.102 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated, and then the obtained product was again purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 0 % to 7%) and concentrated to obtain the title compound (0.011 g, 18.2 %) as a white solid.

[444] ^1H NMR (400 MHz, CDCl_3) δ 8.27 (s, 1H), 8.21 (d, $J = 7.1$ Hz, 1H), 7.77 (s, 1H), 7.50 (ddd, $J = 1.7, 7.5, 13.0$ Hz, 3H), 7.35 (dd, $J = 6.9, 8.6$ Hz, 2H), 7.26 (d, $J = 7.4$ Hz, 1H), 6.95 (t, $J = 51.7$ Hz, 1H), 5.11 (s, 2H), 3.25 (s, 4H), 2.51 (s, 4H), 2.39 (s, 1H), 2.13 (d, $J = 10.7$ Hz, 2H), 1.83-1.53 (m, 6H);

[445] **LRMS** (ES) m/z 608.5 ($M + 1$).

[446] **Example 47:** Synthesis of Compound 4265, 4-acetyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-phenylpiperazine-1-sulfonamide

[447]

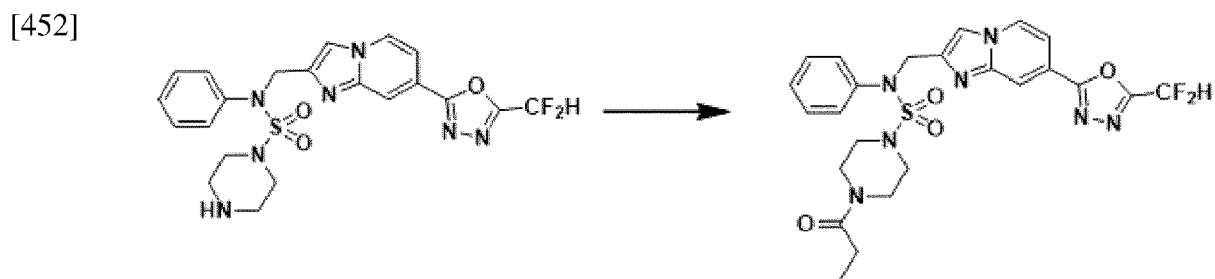


[448] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, acetyl chloride (0.011 mL, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 4 g cartridge; methanol/dichloromethane = 0% to 5 %) and concentrated to obtain the title compound (0.024 g, 43.5 %) as a white solid.

[449] ¹H NMR (400 MHz, CDCl₃) δ 8.29 (dd, *J* = 0.9, 1.8 Hz, 1H), 8.21 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.73 (s, 1H), 7.53 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.49-7.43 (m, 2H), 7.36 (ddd, *J* = 1.4, 6.8, 7.8 Hz, 2H), 7.31-7.26 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.08 (s, 2H), 3.59 (t, *J* = 5.2 Hz, 2H), 3.42 (t, *J* = 5.1 Hz, 2H), 3.22 (dt, *J* = 5.2, 10.9 Hz, 4H), 2.08 (s, 3H);

[450] **LRMS** (ES) *m/z* 532.4 (*M* + 1).

[451] **Example 48:** Synthesis of Compound 4266, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-4-propionylpiperazine-1-sulfonamide



[453] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, propionyl chloride (0.014 g, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an

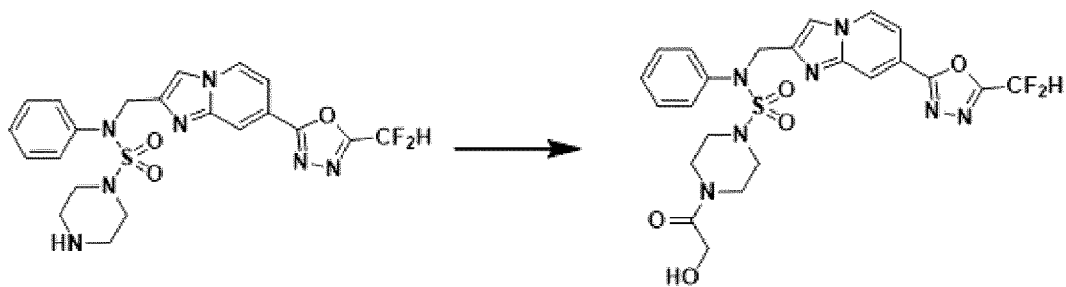
aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.017 g, 30.9 %) as a white solid.

[454] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.21 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.73 (d, *J* = 0.7 Hz, 1H), 7.53 (dd, *J* = 1.7, 7.2 Hz, 1H), 7.50-7.42 (m, 2H), 7.40-7.24 (m, 3H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.11-5.06 (m, 2H), 3.60 (t, *J* = 5.2 Hz, 2H), 3.42 (t, *J* = 5.1 Hz, 2H), 3.22 (q, *J* = 5.6 Hz, 4H), 2.32 (q, *J* = 7.4 Hz, 2H), 1.14 (t, *J* = 7.4 Hz, 3H);

[455] **LRMS** (ES) *m/z* 546.0 (*M* + 1).

[456] **Example 49:** Synthesis of Compound 4267, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-4-(2-hydroxyacetyl)-*N*-phenylpiperazine-1-sulfonamide

[457]



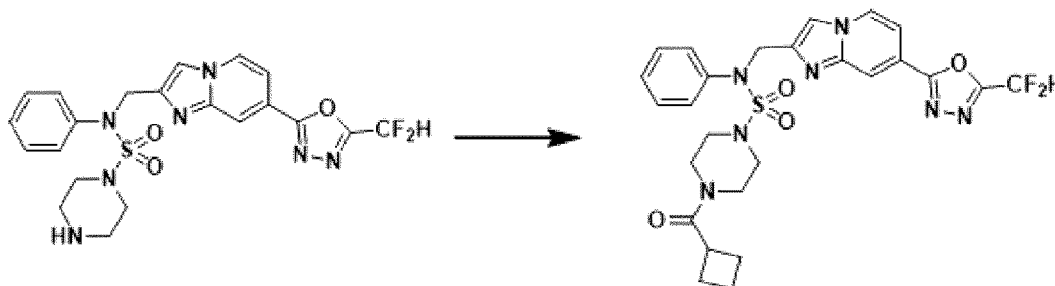
[458] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, 2-hydroxyacetic acid (0.012 g, 0.153 mmol), 1-[bis(dimethylamino)methylene]-1*H*-1,2,3-triazolo[4,5-*b*]pyridinium 3-oxide hexafluorophosphate (HATU, 0.058 g, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.017 g, 30.9 %) as a white solid.

[459] ¹H NMR (400 MHz, CDCl₃) δ 8.29 (dt, *J* = 1.7, 0.8 Hz, 1H), 8.21 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.70 (s, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.48-7.42 (m, 2H), 7.40-7.33 (m, 2H), 7.32-7.28 (m, 1H), 6.96 (t, *J* = 51.7 Hz, 1H), 5.07 (s, 2H), 4.15 (s, 2H), 3.66 (t, *J* = 5.2 Hz, 2H), 3.26 (d, *J* = 6.5 Hz, 6H);

[460] **LRMS** (ES) *m/z* 546.0 (*M* + 1).

[461] **Example 50:** Synthesis of Compound 4268, 4-(cyclobutanecarbonyl)- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridine-2-yl)methyl)- *N*-phenylpiperazine-1-sulfonamide

[462]



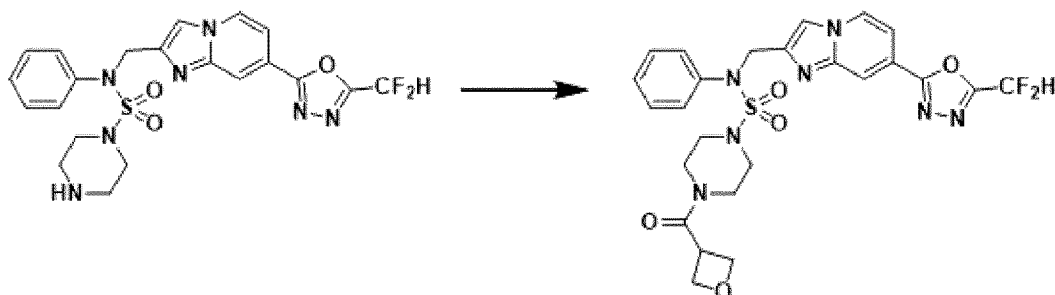
[463] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, cyclobutanecarbonyl chloride (0.018 g, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated, and then the obtained product was again purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 0 % to 7%) and concentrated to obtain the title compound (0.010 g, 17.6 %) as a white solid.

[464] ¹H NMR (400 MHz, CDCl₃) δ 8.30 (s, 1H), 8.22 (dd, *J* = 0.9, 7.1 Hz, 1H), 7.73 (s, 1H), 7.55 (dd, *J* = 1.7, 7.2 Hz, 1H), 7.46 (dd, *J* = 1.8, 7.5 Hz, 2H), 7.35 (t, *J* = 7.7 Hz, 2H), 7.29 (d, *J* = 7.6 Hz, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.09 (s, 2H), 3.59 (t, *J* = 5.1 Hz, 2H), 3.31 (t, *J* = 5.0 Hz, 2H), 3.20 (ddd, *J* = 3.1, 5.5, 10.8 Hz, 5H), 2.33 (dq, *J* = 9.1, 11.5 Hz, 2H), 2.14 (qd, *J* = 4.6, 8.8 Hz, 2H), 2.03-1.81 (m, 2H);

[465] **LRMS** (ES) *m/z* 571.9 (*M* + 1).

[466] **Example 51:** Synthesis of Compound 4269, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-4-(oxetan-3-carbonyl)- *N*-phenylpiperazine-1-sulfonamide

[467]



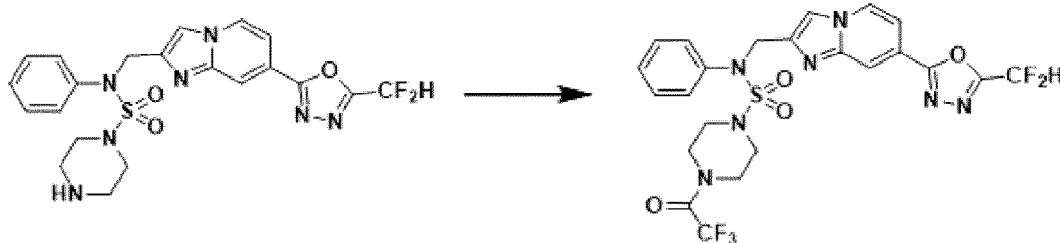
[468] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, oxetane-3-carboxylic acid (0.016 g, 0.153 mmol), 1-[bis(dimethylamino)methylene]-1*H*-1,2,3-triazolo[4,5-*b*]pyridinium 3-oxide hexafluorophosphate (HATU, 0.058 g, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂ plate, 4 g cartridge; methanol/dichloromethane = 0% to 5%) and concentrated, and then the obtained product was again purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 0% to 7%) and concentrated to obtain the title compound (0.006 g, 10.2 %) as a white solid.

[469] ¹H NMR (400 MHz, CDCl₃) δ 8.32 (s, 1H), 8.22 (dd, *J* = 0.9, 7.2 Hz, 1H), 7.71 (s, 1H), 7.56 (dd, *J* = 1.7, 7.2 Hz, 1H), 7.49-7.42 (m, 2H), 7.40-7.33 (m, 2H), 7.35-7.27 (m, 1H), 6.96 (t, *J* = 51.7 Hz, 1H), 5.08 (s, 2H), 4.89 (dd, *J* = 5.9, 7.1 Hz, 2H), 4.79 (dd, *J* = 5.9, 8.7 Hz, 2H), 3.97 (tt, *J* = 7.0, 8.7 Hz, 1H), 3.64 (t, *J* = 5.2 Hz, 2H), 3.28-3.10 (m, 6H);

[470] **LRMS** (ES) *m/z* 574.1 (*M* + 1).

[471] **Example 52:** Synthesis of Compound 4270, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-4-(2,2,2-trifluoroacetyl)piperazine-1-sulfonamide

[472]



[473] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, 2,2,2-trifluoroacetic anhydride (0.026 g, 0.123 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The

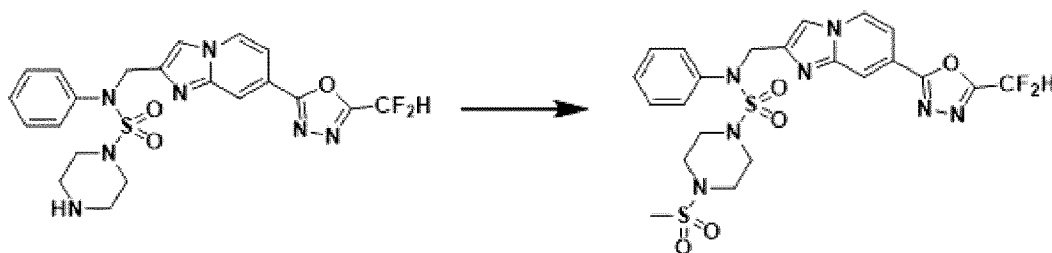
concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.021 g, 35.3 %) as a yellow solid.

[474] ¹H NMR (400 MHz, CDCl₃) δ 8.29 (dd, *J* = 1.0, 1.9 Hz, 1H), 8.21 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.69 (s, 1H), 7.55 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.49-7.26 (m, 5H), 6.96 (t, *J* = 51.7 Hz, 1H), 5.07 (s, 2H), 3.71-3.64 (m, 2H), 3.59 (t, *J* = 5.0 Hz, 2H), 3.37-3.29 (m, 4H);

[475] **LRMS** (ES) *m/z* 585.8 (*M* + 1).

[476] **Example 53:** Synthesis of Compound 4271, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-4-(methylsulfonyl)-*N*-phenylpiperazine-1-sulfonamide

[477]



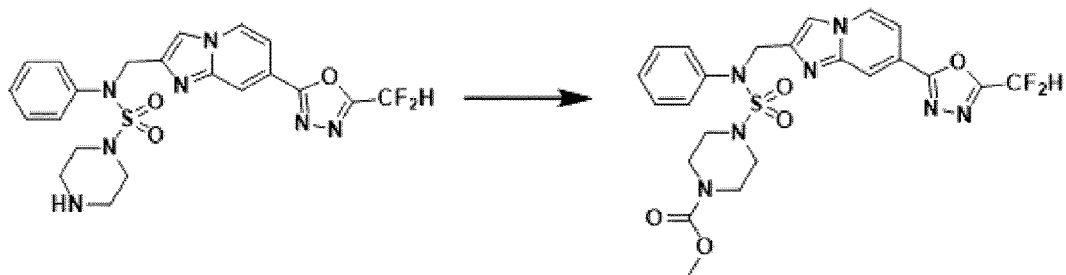
[478] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, methanesulfonyl chloride (0.012 mL, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated, and then the obtained product was again purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/1%-dichloromethane aqueous solution = 0 % to 5 %) and concentrated to obtain the title compound (0.002 g, 2.9 %) as a yellow solid.

[479] ¹H NMR (400 MHz, CDCl₃) δ 8.37 (s, 1H), 8.25 (d, *J* = 7.0 Hz, 1H), 7.74 (s, 1H), 7.62 (d, *J* = 6.9 Hz, 1H), 7.49 (d, *J* = 7.8 Hz, 2H), 7.39 (t, *J* = 7.6 Hz, 2H), 7.33 (d, *J* = 7.2 Hz, 1H), 7.10-6.82 (m, 1H), 5.12 (s, 2H), 3.41-3.29 (m, 4H), 3.22 (t, *J* = 5.0 Hz, 4H), 2.78 (s, 3H);

[480] **LRMS** (ES) *m/z* 567.9 (*M* + 1).

[481] **Example 54:** Synthesis of Compound 4272, methyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)piperazine-1-carboxylate

[482]



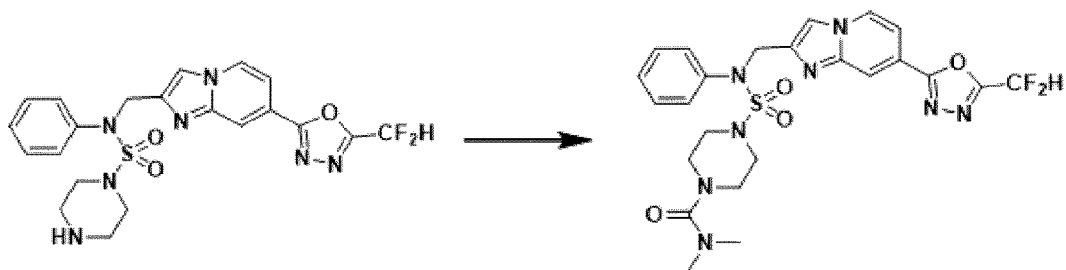
[483] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, methyl carbonochloridate (0.014 g, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.012 g, 21.8 %) as a white solid.

[484] ¹H NMR (400 MHz, CDCl₃) δ 8.29 (dt, *J* = 0.9, 1.8 Hz, 1H), 8.22 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.74 (d, *J* = 0.7 Hz, 1H), 7.54 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.51-7.43 (m, 2H), 7.41-7.31 (m, 2H), 7.29 (d, *J* = 7.1 Hz, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.10 (d, *J* = 0.7 Hz, 2H), 3.71 (s, 3H), 3.45 (t, *J* = 5.1 Hz, 4H), 3.20 (t, *J* = 5.1 Hz, 4H);

[485] **LRMS** (ES) *m/z* 547.8 (*M* + 1).

[486] **Example 55:** Synthesis of Compound 4273, 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)-*N,N*-dimethylpiperazine-1-carboxamide

[487]



[488] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, dimethylcarbamic chloride (0.016 g, 0.153 mmol), and triethylamine (0.043 mL, 0.306 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction

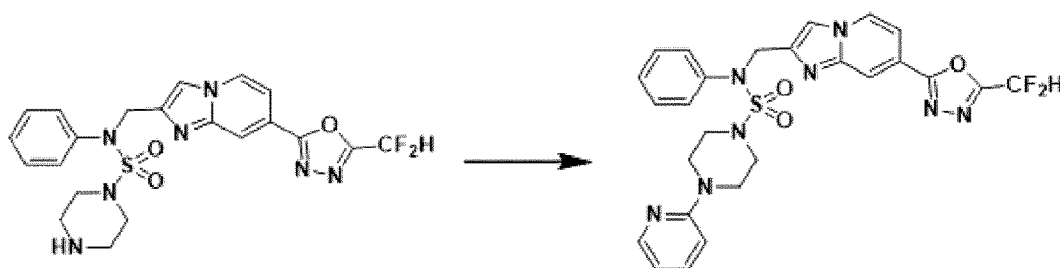
mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.020 g, 35.3 %) as a white solid.

[489] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.21 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.74 (s, 1H), 7.51 (dd, *J* = 1.7, 7.2 Hz, 1H), 7.48-7.42 (m, 2H), 7.39-7.29 (m, 2H), 7.34-7.22 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 5.09 (s, 2H), 3.29-3.15 (m, 8H), 2.82 (s, 6H);

[490] **LRMS** (ES) *m/z* 547.8 (*M* + 1).

[491] **Example 56:** Synthesis of Compound 4274, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-4-(pyridin-2-yl)piperazine-1-sulfonamide

[492]



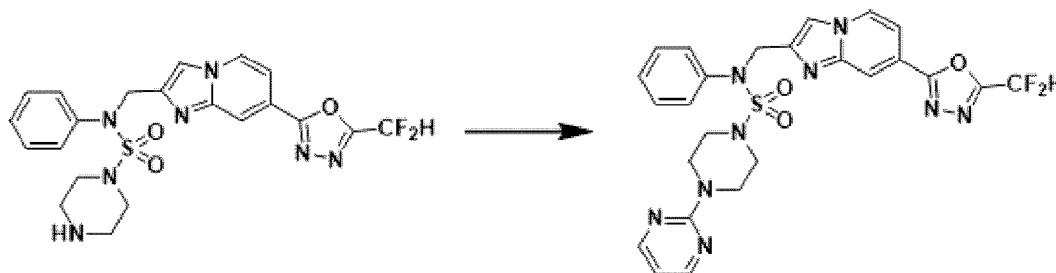
[493] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, 2-chloropyridine (0.032 g, 0.204 mmol), RuPhos palladium G2 (0.004 g, 0.005 mmol), and cesium carbonate (0.067 g, 0.204 mmol) were dissolved in 1,4-dioxane (1 mL) at room temperature, and the resulting solution was stirred at 120°C for 18 hours. Then, the temperature was lowered to room temperature to terminate the reaction. An aqueous *N*-sodium hydrogen carbonate solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. Next, the obtained product was filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.003 g, 5.7 %) as a white solid.

[494] ¹H NMR (400 MHz, CDCl₃) δ 8.27 (dd, *J* = 1.7, 0.9 Hz, 1H), 8.24 - 8.18 (m, 2H), 7.77 (d, *J* = 0.7 Hz, 1H), 7.55 - 7.47 (m, 4H), 7.38 - 7.30 (m, 2H), 7.27 - 7.23 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 6.71 - 6.60 (m, 2H), 5.13 (s, 2H), 3.53 (q, *J* = 4.6, 4.0 Hz, 4H), 3.35 (dd, *J* = 6.4, 3.9 Hz, 4H);

[495] **LRMS** (ES) *m/z* 567.5 (*M* + 1).

[496] **Example 57:** Synthesis of Compound 4275, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-4-(pyrimidin-2-yl)piperazine-1-sulfonamide

[497]



[498] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylpiperazine-1-sulfonamide (0.050 g, 0.102 mmol) prepared in step 6 of Example 38, 2-chloropyrimidine (0.023 g, 0.204 mmol), and potassium carbonate (0.042 g, 0.306 mmol) were dissolved in *N,N*-dimethylformamide (0.5 mL)/acetonitrile (0.5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. Next, the obtained product was filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7%) and concentrated to obtain the title compound (0.023 g, 39.2%) as a white solid.

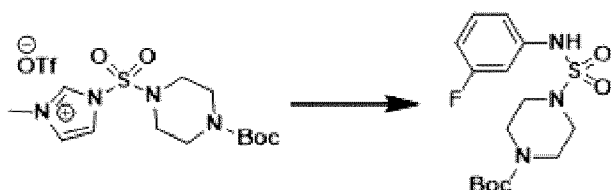
[499] ¹H NMR (400 MHz, CDCl₃) δ 8.31 (d, *J* = 4.7 Hz, 2H), 8.28-8.25 (m, 1H), 8.21 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.77 (s, 1H), 7.55-7.47 (m, 3H), 7.37-7.31 (m, 2H), 7.28-7.23 (m, 1H), 6.95 (t, *J* = 51.7 Hz, 1H), 6.54 (t, *J* = 4.7 Hz, 1H), 5.12 (s, 2H), 3.83-3.77 (m, 4H), 3.32-3.23 (m, 4H);

[500] **LRMS** (ES) *m/z* 568.0 (*M* + 1).

[501] **Example 58:** Synthesis of Compound 4297, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-methylpiperazine-1-sulfonamide

[502] [Step 1] Synthesis of tert-butyl 4-(*N*-(3-fluorophenyl)sulfamoyl)piperazine-1-carboxylate

[503]

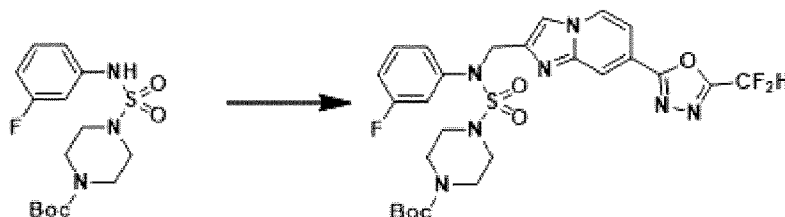


[504] 1-((4-(Tert-butoxycarbonyl)piperazine-1-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium

trifluoromethanesulfonate (4.400 g, 9.158 mmol) prepared in step 3 of Example 38 and 3-fluoroaniline (1.221 g, 10.989 mmol) were dissolved in acetonitrile (50 mL) at room temperature, and the resulting solution was heated to reflux for 18 hours. Then, the temperature was lowered to room temperature to terminate the reaction. A saturated aqueous ammonium chloride solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 24 g cartridge; ethyl acetate/hexane = 0 % to 20 %) and concentrated to obtain the title compound (2.400 g, 72.9 %) as a beige solid.

[505] [Step 2] Synthesis of tert-butyl 4-(N-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)- N-(3-fluorophenyl)sulfamoyl)piperazine-1-carboxylate

[506]

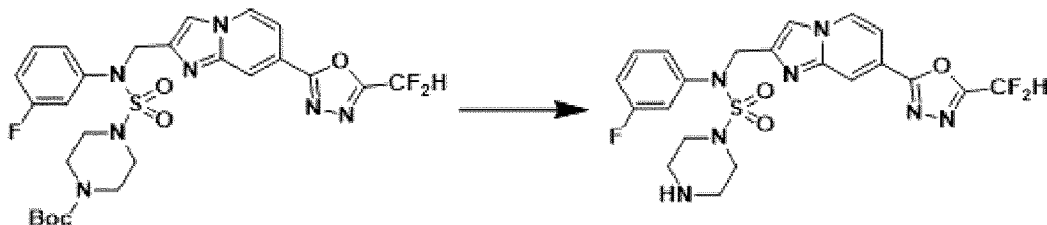


[507] Tert-butyl 4-(N-(3-fluorophenyl)sulfamoyl)piperazine-1-carboxylate (0.300 g, 0.835 mmol) prepared in step 1,

2-(2-(chloromethyl)imidazo[1,2-a]pyridin-7-yl)-5-(difluoromethyl)-1,3,4-oxadiazole (0.285 g, 1.002 mmol) prepared in step 5 of Example 1, potassium carbonate (0.173 g, 1.252 mmol), and potassium iodide (0.069 g, 0.417 mmol) were dissolved in *N,N*-dimethylformamide (10 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous ammonium chloride solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 40 g cartridge; ethyl acetate/hexane = 0 % to 70 %) and concentrated to obtain the title compound (0.400 g, 78.9 %) as a white solid.

[508] [Step 3] Synthesis of N-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)- N-(3-fluorophenyl)piperazine-1-sulfonamide

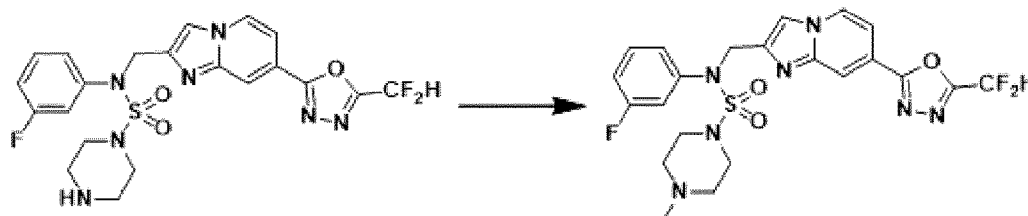
[509]



[510] Tert-butyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)sulfamoyl)piperazine-1-carboxylate (0.450 g, 0.741 mmol) prepared in step 2 and trifluoroacetic acid (1.134 mL, 4.812 mmol) were dissolved in dichloromethane (10 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, and filtered. After concentration under reduced pressure, the title compound (0.376g, 100.0%) was obtained as a brown gel without further purification.

[511] [Step 4] Synthesis of Compound 4297

[512]



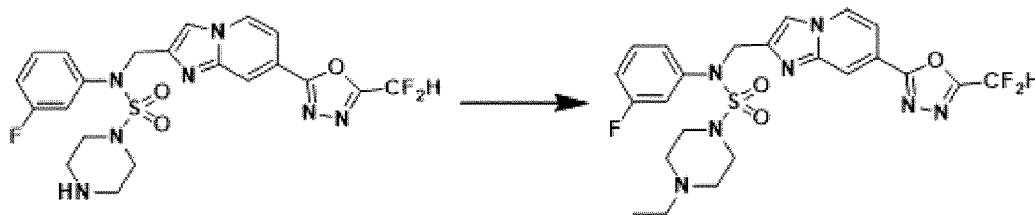
[513] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3, formaldehyde (0.006 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), and sodium triacetoxyborohydride (0.063 g, 0.296 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.024 g, 46.7 %) as a yellow solid.

[514] ¹H NMR (700 MHz, CDCl₃) δ 8.31 (s, 1H), 8.24 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.77 (s, 1H), 7.55 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.35-7.28 (m, 3H), 7.05-6.84 (m, 2H), 5.09 (s, 2H), 3.38 (s, 4H), 2.39 (s, 7H);

[515] **LRMS** (ES) *m/z* 523.1 (*M*⁺ + 1).

- [516] **Example 59:** Synthesis of Compound 4298, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-4-ethyl-*N*-(3-fluorophenyl)piperazine-1-sulfonamide

[517]



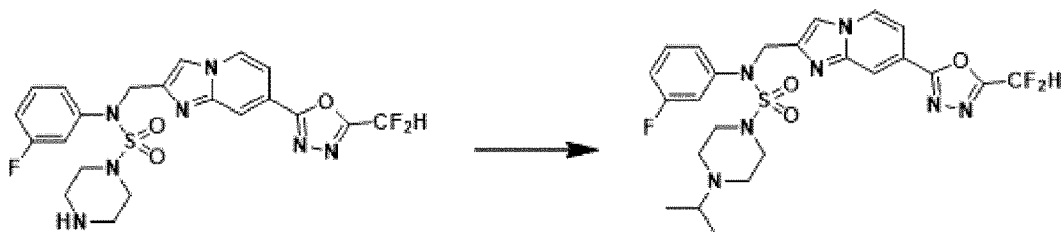
- [518] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, acetaldehyde (0.009 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), and sodium triacetoxyborohydride (0.063 g, 0.296 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.019 g, 36.0 %) as a yellow solid.

- [519] ¹H NMR (700 MHz, CDCl₃) δ 8.30 (s, 1H), 8.26-8.22 (m, 1H), 7.79-7.76 (m, 1H), 7.55 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.34-7.29 (m, 3H), 7.06-6.84 (m, 2H), 5.10 (s, 2H), 3.32 (s, 4H), 2.46 (s, 6H), 1.12 (s, 3H);

- [520] **LRMS** (ES) *m/z* 536.3 (*M* + 1).

- [521] **Example 60:** Synthesis of Compound 4299, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-isopropylpiperazine-1-sulfonamide

[522]



- [523] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, propan-2-one (0.011 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), and sodium triacetoxyborohydride (0.063 g, 0.296 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate

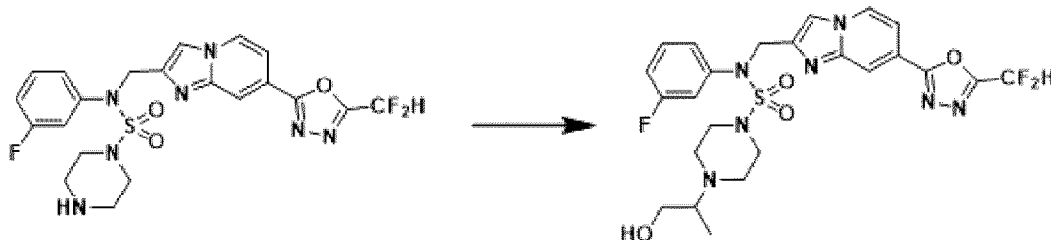
solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.024 g, 44.3 %) as a yellow solid.

[524] ¹H NMR (700 MHz, CDCl₃) δ 8.31-8.28 (m, 1H), 8.25-8.21 (m, 1H), 7.79 (d, *J* = 0.8 Hz, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.34-7.28 (m, 3H), 7.04-6.80 (m, 2H), 5.11 (s, 2H), 3.27 (s, 4H), 2.71 (s, 1H), 2.49 (s, 4H), 1.03 (s, 6H);

[525] **LRMS** (ES) *m/z* 549.9 (*M* + 1).

[526] **Example 61:** Synthesis of Compound 4300, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(1-hydroxypropan-2-yl)piperazine-1-sulfonamide

[527]



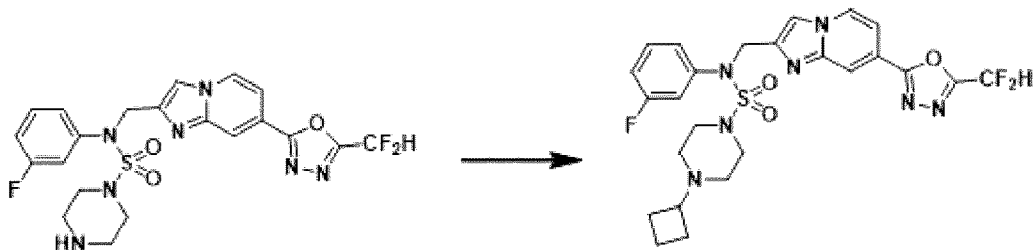
[528] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, 1-hydroxypropan-2-one (0.015 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), and sodium triacetoxyborohydride (0.063 g, 0.296 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.032 g, 57.4 %) as a yellow solid.

[529] ¹H NMR (400 MHz, CDCl₃) δ 8.30 (dt, *J* = 1.7, 0.9 Hz, 1H), 8.23 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.76 (d, *J* = 0.7 Hz, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.35-7.29 (m, 3H), 7.11-6.77 (m, 2H), 5.09 (d, *J* = 0.7 Hz, 2H), 3.46 (d, *J* = 11.5 Hz, 1H), 3.33 (d, *J* = 18.2 Hz, 5H), 2.86 (s, 1H), 2.67 (s, 2H), 2.44 (s, 2H), 0.91 (d, *J* = 6.6 Hz, 3H);

[530] **LRMS** (ES) *m/z* 566.4 (*M* + 1).

[531] **Example 62:** Synthesis of Compound 4301, 4-cyclobutyl-*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide

[532]



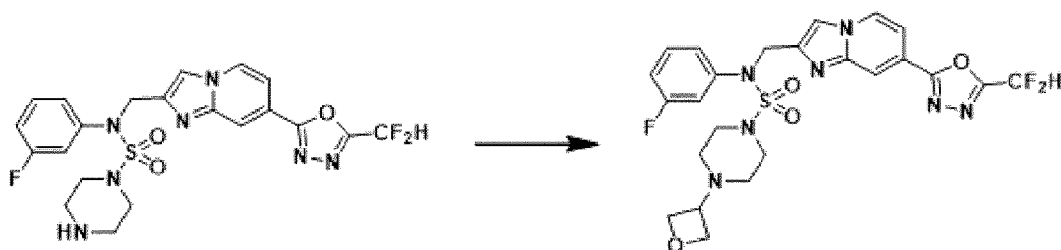
[533] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, cyclobutanone (0.014 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), and sodium triacetoxyborohydride (0.063 g, 0.296 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.022 g, 39.8 %) as a yellow solid.

[534] ¹H NMR (700 MHz, CDCl₃) δ 8.29 (s, 1H), 8.23 (d, *J* = 7.1 Hz, 1H), 7.78 (d, *J* = 0.7 Hz, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.33-7.29 (m, 3H), 7.05-6.86 (m, 2H), 5.10 (s, 2H), 3.27 (s, 4H), 2.71 (s, 1H), 2.29 (s, 4H), 2.03 (s, 2H), 1.83 (s, 2H), 1.70 (s, 2H);

[535] **LRMS** (ES) *m/z* 562.2 (*M*⁺ + 1).

[536] **Example 63:** Synthesis of Compound 4302, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-oxetan-3-yl)piperazine-1-sulfonamide

[537]



[538] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, oxetan-3-one (0.014 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), and sodium triacetoxyborohydride (0.063 g, 0.296 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then

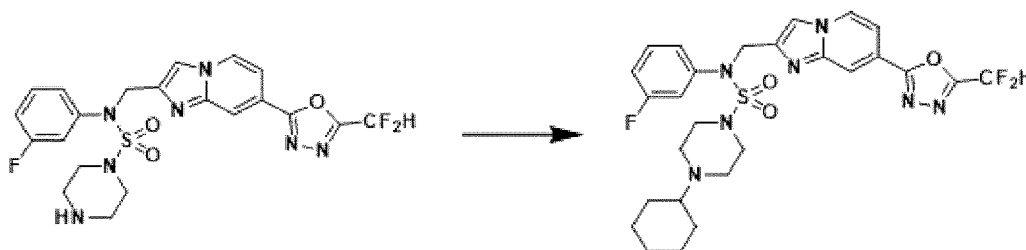
concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.017 g, 30.6 %) as a yellow solid.

[539] ¹H NMR (700 MHz, CDCl₃) δ 8.31 (dt, *J* = 1.8, 0.8 Hz, 1H), 8.24 (dd, *J* = 7.1, 1.0 Hz, 1H), 7.78-7.74 (m, 1H), 7.55 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.36-7.29 (m, 3H), 7.05-6.83 (m, 2H), 5.11-5.07 (m, 2H), 4.71-4.55 (m, 4H), 3.53 (s, 1H), 3.35 (s, 4H), 2.36 (s, 4H);

[540] **LRMS** (ES) *m/z* 564.5 (*M* + 1).

[541] **Example 64:** Synthesis of Compound 4303, 4-cyclohexyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)piperazine-1-sulfonamide

[542]



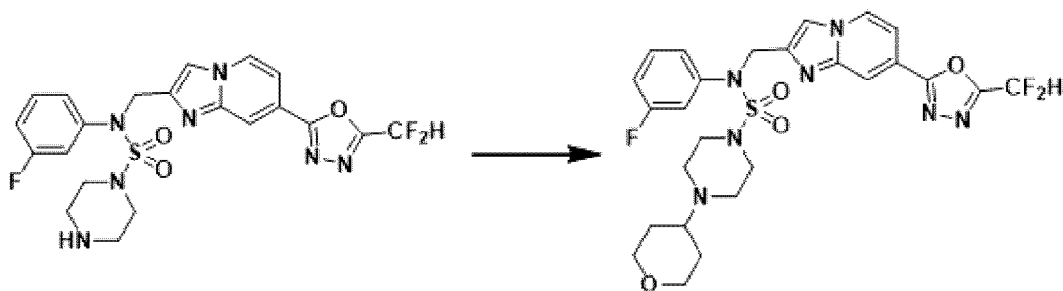
[543] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, cyclohexanone (0.019 g, 0.197 mmol), acetic acid (0.006 mL, 0.099 mmol), and sodium triacetoxyborohydride (0.063 g, 0.296 mmol) were dissolved in dichloromethane (3 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.029 g, 49.9 %) as a yellow solid.

[544] ¹H NMR (700 MHz, CDCl₃) δ 8.29 (dt, *J* = 1.8, 0.8 Hz, 1H), 8.23 (d, *J* = 7.1 Hz, 1H), 7.80-7.78 (m, 1H), 7.54 (dd, *J* = 7.1, 1.7 Hz, 1H), 7.33-7.29 (m, 3H), 7.05-6.86 (m, 2H), 5.10 (s, 2H), 3.25 (s, 4H), 2.53 (s, 4H), 2.31-2.18 (m, 1H), 1.80 (s, 4H), 1.25-1.06 (m, 6H);

[545] **LRMS** (ES) *m/z* 590.0 (*M* + 1).

[546] **Example 65:** Synthesis of Compound 4304, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)- *N*-(3-fluorophenyl)-4-(tetrahydro-2H-pyran-4-yl)piperazine-1-sulfonamide

[547]



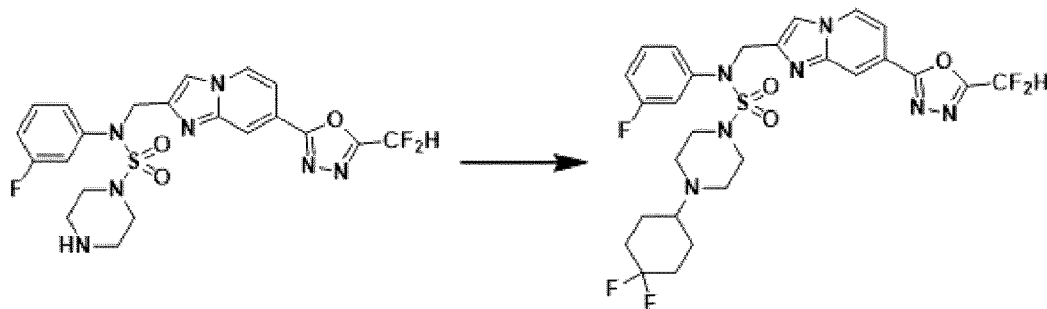
[548] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, tetrahydro-4H-pyran-4-one (0.015 g, 0.148 mmol), acetic acid (0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.021 g, 35.7 %) as a white solid.

[549] ¹H NMR (400 MHz, CDCl₃) δ 8.30 - 8.27 (m, 1H), 8.22 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.77 (s, 1H), 7.53 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.33 - 7.25 (m, 4H), 7.10 - 6.80 (m, 2H), 5.10 (s, 2H), 4.06 - 3.97 (m, 2H), 3.36 (td, *J* = 2.0, 11.8 Hz, 2H), 3.27 (t, *J* = 4.9 Hz, 4H), 2.53 (t, *J* = 4.8 Hz, 4H), 2.44 (s, 1H), 1.69 (d, *J* = 12.0 Hz, 2H), 1.53 (qd, *J* = 4.6, 12.0 Hz, 2H);

[550] **LRMS** (ES) *m/z* 592.2 (*M* + 1).

[551] **Example 66:** Synthesis of Compound 4305, 4-(4,4-difluorocyclohexyl)-*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide

[552]



[553] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, 4,4-difluorocyclohexan-1-one (0.020 g, 0.148 mmol), acetic acid

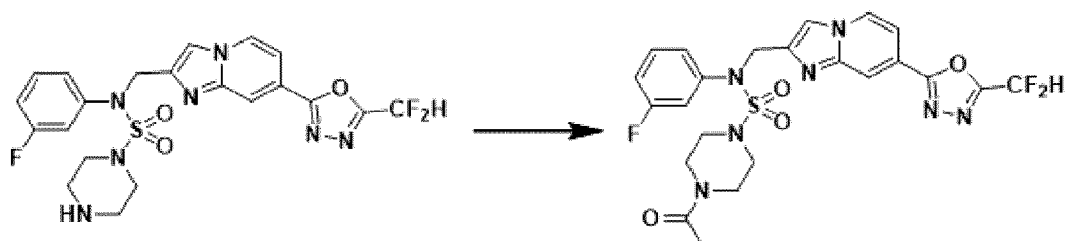
(0.006 mL, 0.099 mmol), sodium triacetoxyborohydride (0.063 g, 0.296 mmol), and triethylamine (0.014 mL, 0.099 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.020 g, 31.8 %) as a white solid.

[554] ¹H NMR (400 MHz, CDCl₃) δ 8.31-8.27 (m, 1H), 8.23 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.77 (s, 1H), 7.54 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.33-7.25 (m, 3H), 7.09-6.81 (m, 2H), 5.10 (s, 2H), 3.25 (t, *J* = 4.7 Hz, 4H), 2.51 (t, *J* = 4.9 Hz, 4H), 2.38 (d, *J* = 11.2 Hz, 1H), 2.13 (q, *J* = 10.2, 10.8 Hz, 2H), 1.84-1.53 (m, 6H);

[555] LRMS (ES) *m/z* 626.0 (*M* + 1).

[556] **Example 67:** Synthesis of Compound 4306, 4-acetyl- *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide

[557]



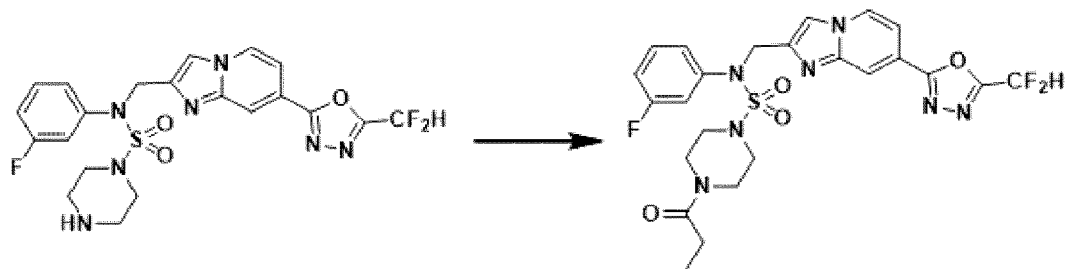
[558] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, acetyl chloride (0.011 mL, 0.148 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.020 g, 36.2 %) as a white solid.

[559] ¹H NMR (400 MHz, CDCl₃) δ 8.30 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.23 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.73 (d, *J* = 0.7 Hz, 1H), 7.55 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.38-7.22 (m, 3H), 7.11-6.80 (m, 2H), 5.07 (s, 2H), 3.59 (t, *J* = 5.2 Hz, 2H), 3.43 (t, *J* = 5.1 Hz, 2H), 3.29-3.17 (m, 4H), 2.09 (s, 3H);

[560] **LRMS** (ES) m/z 550.4 ($M + 1$).

[561] **Example 68:** Synthesis of Compound 4307, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-propionylpiperazine-1-sulfonamide

[562]



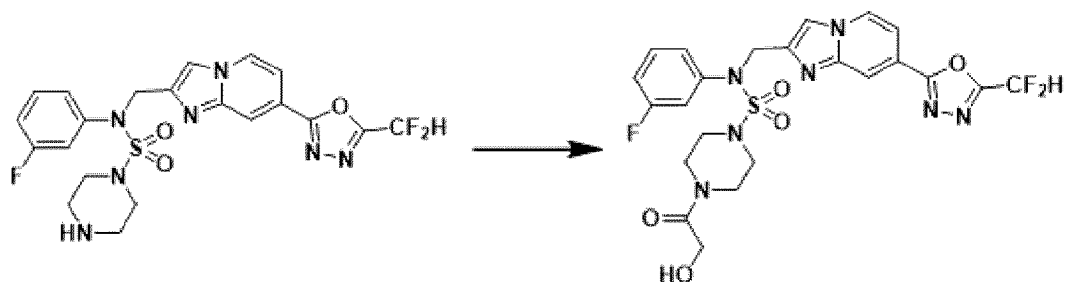
[563] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, propionyl chloride (0.014 g, 0.148 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.013 g, 23.8 %) as a white solid.

[564] ^1H NMR (400 MHz, CDCl_3) δ 8.34-8.28 (m, 1H), 8.23 (dd, $J = 1.0, 7.1$ Hz, 1H), 7.74 (d, $J = 0.7$ Hz, 1H), 7.56 (dd, $J = 1.7, 7.1$ Hz, 1H), 7.38-7.23 (m, 3H), 7.11-6.80 (m, 2H), 5.07 (s, 2H), 3.61 (t, $J = 5.2$ Hz, 2H), 3.48-3.40 (m, 2H), 3.23 (dt, $J = 5.1, 11.2$ Hz, 4H), 2.33 (q, $J = 7.4$ Hz, 2H), 1.15 (t, $J = 7.4$ Hz, 3H);

[565] **LRMS** (ES) m/z 563.9 ($M + 1$).

[566] **Example 69:** Synthesis of Compound 4308, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(2-hydroxyacetyl)piperazine-1-sulfonamide

[567]



[568] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3

of Example 58, 2-hydroxyacetic acid (0.011 g, 0.148 mmol), triethylamine (0.041 mL, 0.296 mmol), and

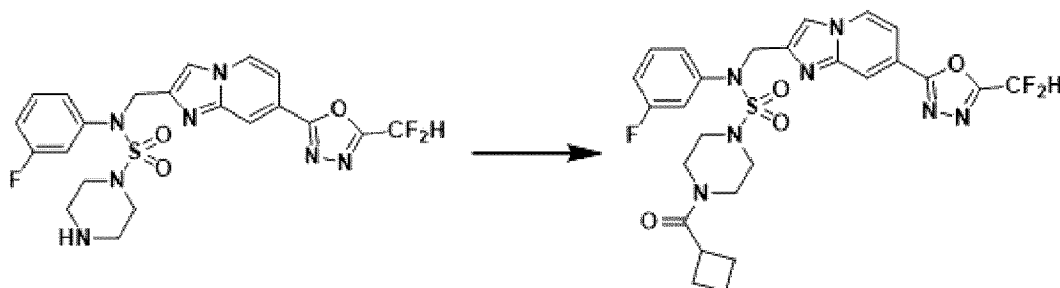
1-[bis(dimethylamino)methylene]-1H-1,2,3-triazolo[4,5-b]pyridinium 3-oxide hexafluorophosphate (HATU, 0.056 g, 0.148 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.019 g, 33.4 %) as a white solid.

[569] ¹H NMR (400 MHz, CDCl₃) δ 8.33-8.28 (m, 1H), 8.23 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.71 (s, 1H), 7.56 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.39-7.22 (m, 3H), 7.12-6.81 (m, 2H), 5.05 (s, 2H), 4.15 (s, 2H), 3.66 (t, *J* = 5.1 Hz, 2H), 3.28 (d, *J* = 7.3 Hz, 6H);

[570] **LRMS** (ES) *m/z* 566.3 (*M* + 1).

[571] **Example 70:** Synthesis of Compound 4309, 4-(cyclobutanecarbonyl)-*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridine-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide

[572]



[573] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, cyclobutanecarbonyl chloride (0.018 g, 0.148 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.014 g, 23.4 %) as a white solid.

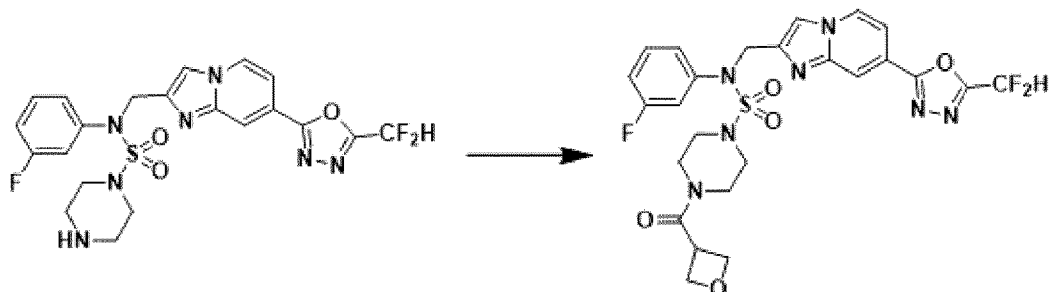
[574] ¹H NMR (400 MHz, CDCl₃) δ 8.31 (s, 1H), 8.23 (d, *J* = 7.1 Hz, 1H), 7.73 (s, 1H), 7.56 (dd, *J* = 1.6, 7.1 Hz, 1H), 7.36-7.23 (m, 3H), 7.10-6.81 (m, 2H), 5.08 (s, 2H), 3.59

(t, $J = 5.2$ Hz, 2H), 3.32 (t, $J = 5.0$ Hz, 2H), 3.22-3.15 (m, 4H), 2.32 (td, $J = 2.7, 9.0$ Hz, 3H), 2.18-2.09 (m, 2H), 2.03-1.84 (m, 2H);

[575] **LRMS** (ES) m/z 590.0 ($M + 1$).

[576] **Example 71:** Synthesis of Compound 4310, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(oxetane-3-carbonyl)piperazine-1-sulfonamide

[577]



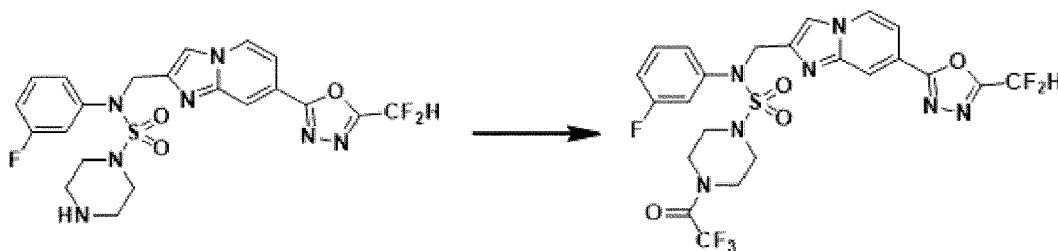
[578] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, oxetane-3-carboxylic acid (0.015 g, 0.148 mmol), triethylamine (0.041 mL, 0.296 mmol), and 1-[bis(dimethylamino)methylene]-1*H*-1,2,3-triazolo[4,5-*b*]pyridinium 3-oxide hexafluorophosphate (HATU, 0.056 g, 0.148 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO_2 plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.006 g, 10.8 %) as a white solid.

[579] ^1H NMR (400 MHz, CDCl_3) δ 8.32 (s, 1H), 8.23 (d, $J = 7.1$ Hz, 1H), 7.71 (s, 1H), 7.57 (d, $J = 7.1$ Hz, 1H), 7.36-7.22 (m, 3H), 7.11-6.81 (m, 2H), 5.06 (s, 2H), 4.89 (t, $J = 6.6$ Hz, 2H), 4.79 (dd, $J = 6.2, 8.5$ Hz, 2H), 3.97 (p, $J = 7.7, 8.2$ Hz, 1H), 3.64 (t, $J = 5.0$ Hz, 2H), 3.24 (dt, $J = 4.8, 10.2$ Hz, 4H), 3.16 (d, $J = 5.4$ Hz, 2H);

[580] **LRMS** (ES) m/z 592.5 ($M + 1$).

[581] **Example 72:** Synthesis of Compound 4311, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(2,2,2-trifluoroacetyl)piperazine-1-sulfonamide

[582]



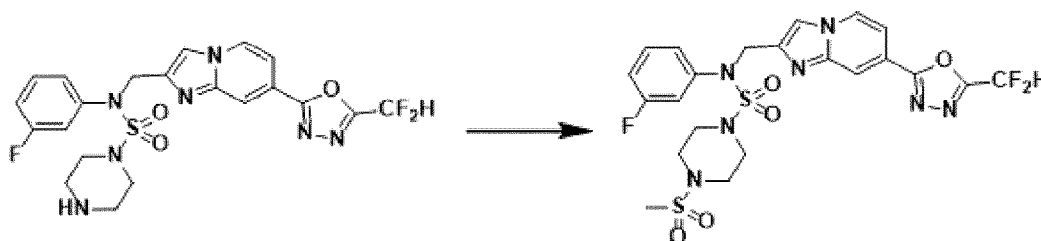
[583] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, 2,2,2-trifluoroacetic anhydride (0.031 g, 0.148 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.016 g, 26.7 %) as a white solid.

[584] ¹H NMR (400 MHz, CDCl₃) δ 8.31 (s, 1H), 8.23 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.70 (s, 1H), 7.57 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.38-7.23 (m, 3H), 7.11-6.81 (m, 2H), 5.05 (s, 2H), 3.69 (t, *J* = 5.2 Hz, 2H), 3.60 (t, *J* = 5.0 Hz, 2H), 3.34 (dq, *J* = 2.5, 7.8 Hz, 4H);

[585] **LRMS** (ES) *m/z* 604.0 (*M*⁺ + 1).

[586] **Example 73:** Synthesis of Compound 4312, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(methylsulfonyl)piperazine-1-sulfonamide

[587]



[588] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.040 g, 0.079 mmol) prepared in step 3 of Example 58, methanesulfonyl chloride (0.009 mL, 0.118 mmol), and triethylamine (0.033 mL, 0.236 mmol) were dissolved in dichloromethane (1 mL) at 0°C, and the resulting solution was stirred at room temperature for 10 minutes. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was

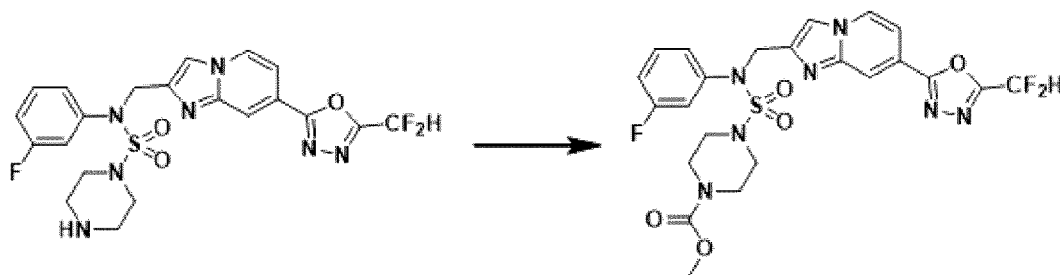
purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.015 g, 33.1 %) as a white solid.

[589] ¹H NMR (400 MHz, CDCl₃) δ 8.31 (dt, *J* = 0.8, 1.7 Hz, 1H), 8.23 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.74-7.69 (m, 1H), 7.56 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.40-7.24 (m, 3H), 7.11-6.80 (m, 2H), 5.06 (s, 2H), 3.40-3.32 (m, 4H), 3.22 (dd, *J* = 3.6, 6.3 Hz, 4H), 2.78 (s, 3H);

[590] **LRMS** (ES) *m/z* 586.0 (*M* + 1).

[591] **Example 74:** Synthesis of Compound 4313, methyl 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)sulfamoyl)piperazine-1-carboxylate

[592]



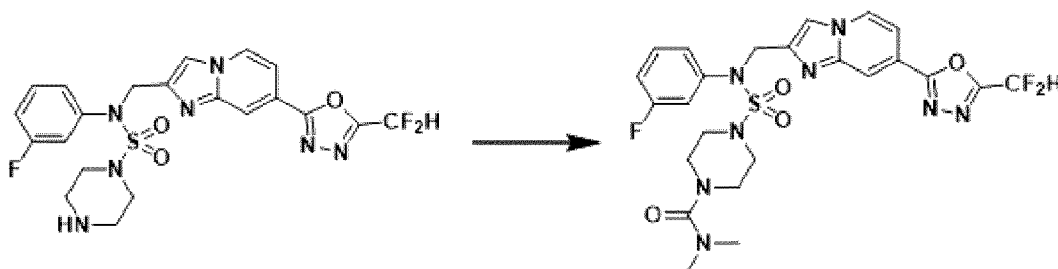
[593] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, methyl carbonochloridate (0.014 g, 0.148 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.014 g, 24.4 %) as a white solid.

[594] ¹H NMR (400 MHz, CDCl₃) δ 8.33-8.27 (m, 1H), 8.23 (dd, *J* = 1.0, 7.1 Hz, 1H), 7.77-7.72 (m, 1H), 7.55 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.38-7.24 (m, 3H), 7.11-6.80 (m, 2H), 5.07 (s, 2H), 3.71 (s, 3H), 3.45 (t, *J* = 5.0 Hz, 4H), 3.21 (dd, *J* = 4.0, 6.3 Hz, 4H);

[595] **LRMS** (ES) *m/z* 566.4 (*M* + 1).

[596] **Example 75:** Synthesis of Compound 4314, 4-(*N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)sulfamoyl)-*N,N*-dimethylpiperazine-1-carboxamide

[597]



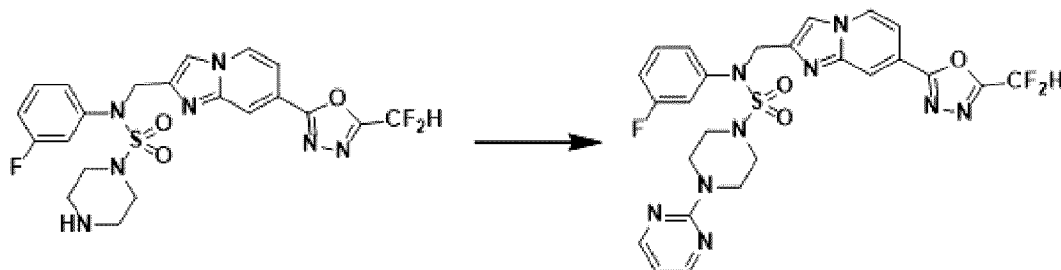
[598] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, cyclobutanecarbonyl chloride (0.016 g, 0.148 mmol), and triethylamine (0.041 mL, 0.296 mmol) were dissolved in dichloromethane (1 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.016 g, 27.5 %) as a white solid.

[599] ¹H NMR (400 MHz, CDCl₃) δ 8.32-8.27 (m, 1H), 8.23 (dd, *J* = 1.0, 7.2 Hz, 1H), 7.74 (s, 1H), 7.54 (dd, *J* = 1.7, 7.2 Hz, 1H), 7.37-7.21 (m, 3H), 7.11-6.79 (m, 2H), 5.08 (s, 2H), 3.30-3.22 (m, 4H), 3.24-3.16 (m, 4H), 2.83 (s, 6H);

[600] LRMS (ES) *m/z* 579.3 (*M*⁺ + 1).

[601] **Example 76:** Synthesis of Compound 4315, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(pyrimidin-2-yl)piperazine-1-sulfonamide

[602]



[603] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.050 g, 0.099 mmol) prepared in step 3 of Example 58, 2-chloropyrimidine (0.023 g, 0.197 mmol), and potassium carbonate (0.041 g, 0.296 mmol) were dissolved in *N,N*-dimethylformamide (0.5 mL)/acetonitrile (0.5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 18 hours. An aqueous *N*-sodium hydrogen carbonate solution was poured into the concentrate obtained by removing the solvent from the reaction

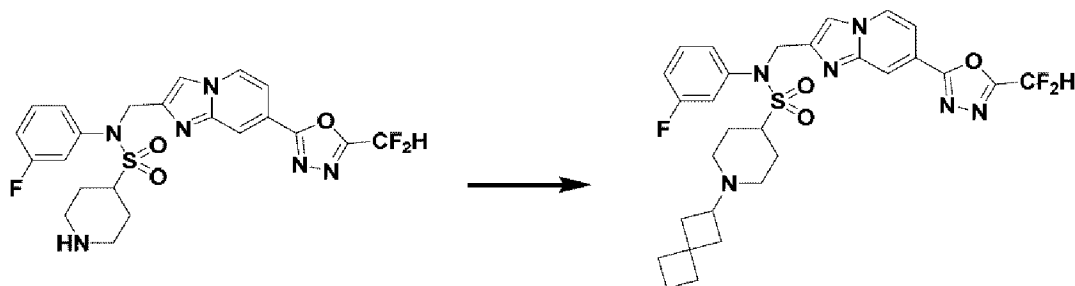
mixture under reduced pressure, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; methanol/dichloromethane = 0% to 7 %) and concentrated to obtain the title compound (0.012 g, 20.3 %) as a white solid.

[604] ¹H NMR (400 MHz, CDCl₃) δ 8.32 (d, *J* = 4.7 Hz, 2H), 8.28 (s, 1H), 8.23 (dd, *J* = 0.9, 7.2 Hz, 1H), 7.77 (s, 1H), 7.55 (dd, *J* = 1.7, 7.1 Hz, 1H), 7.37-7.25 (m, 3H), 7.11-6.80 (m, 2H), 6.55 (t, *J* = 4.8 Hz, 1H), 5.11 (s, 2H), 3.86-3.78 (m, 4H), 3.30 (t, *J* = 5.1 Hz, 4H);

[605] **LRMS** (ES) *m/z* 586.5 (*M* + 1).

[606] **Example 77:** Synthesis of Compound 4616, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(spiro[3.3]heptan-2-yl)piperidine-4-sulfonamide

[607]



[608] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.100 g, 0.197 mmol) prepared in step 3 of Example 18, spiro[3.3]heptan-2-one (0.043 g, 0.395 mmol), acetic acid (0.011 mL, 0.197 mmol), and sodium triacetoxyborohydride (0.126 g, 0.592 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.100 g, 84.3 %) as a white solid.

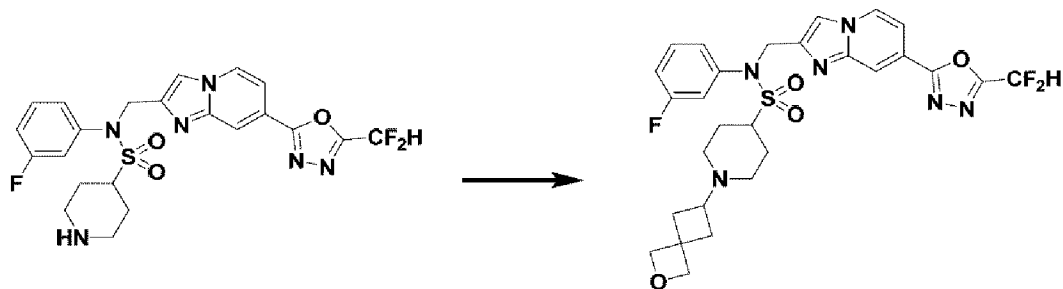
[609] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (s, 1H), 8.23 (d, *J* = 7.1 Hz, 1H), 7.78 (s, 1H), 7.54 (dd, *J* = 7.1, 1.5 Hz, 1H), 7.36-7.23 (m, 3H), 7.10-6.79 (m, 2H), 5.14 (s, 2H), 3.12-2.87 (m, 3H), 2.49 (d, *J* = 39.3 Hz, 1H), 2.41 (ddd, *J* = 9.2, 6.1, 2.7 Hz, 1H), 2.19-2.04 (m, 4H), 2.04-1.61 (m, 11H);

[610] **LRMS** (ES) *m/z* 601.1 (*M* + 1).

[611] **Example 78:** Synthesis of Compound 4617, *N*-

((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-1-(2-oxaspiro[3.3]heptan-6-yl)piperidine-4-sulfonamide

[612]



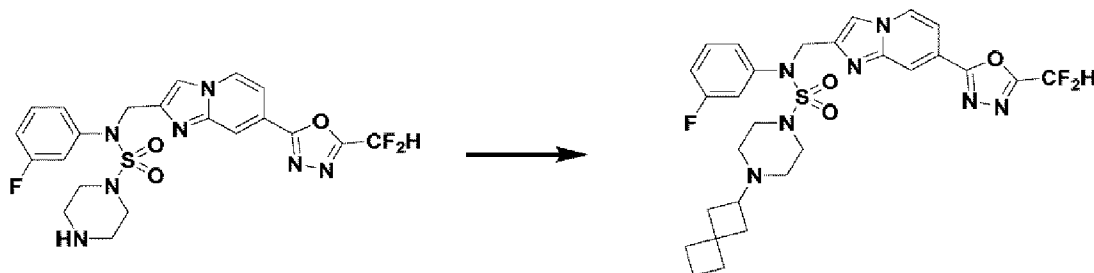
[613] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperidine-4-sulfonamide (0.100 g, 0.197 mmol) prepared in step 3 of Example 18, 2-oxaspiro[3.3]heptan-6-one (0.044 g, 0.395 mmol), acetic acid (0.011 mL, 0.197 mmol), and sodium triacetoxyborohydride (0.126 g, 0.592 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.100 g, 84.0 %) as a white solid.

[614] ¹H NMR (400 MHz, CDCl₃) δ 8.28 (s, 1H), 8.23 (d, J = 7.1 Hz, 1H), 7.77 (s, 1H), 7.54 (d, J = 7.2 Hz, 1H), 7.36-7.21 (m, 3H), 7.11-6.79 (m, 2H), 5.14 (s, 2H), 4.75-4.64 (m, 2H), 4.61 (s, 2H), 3.13-2.88 (m, 3H), 2.59-2.31 (m, 3H), 2.08 (ddd, J = 49.8, 24.9, 14.0 Hz, 4H), 1.89 (d, J = 35.1 Hz, 2H), 1.70 (d, J = 12.6 Hz, 2H);

[615] **LRMS** (ES) *m/z* 603.3 (*M* +1).

[616] **Example 79:** Synthesis of Compound 4622, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(spiro[3.3]heptan-2-yl)piperazine-1-sulfonamide

[617]



[618] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.090 g, 0.177 mmol) prepared in step 3 of Example 58, spiro[3.3]heptan-2-one (0.039 g, 0.355 mmol), acetic acid (0.010 mL,

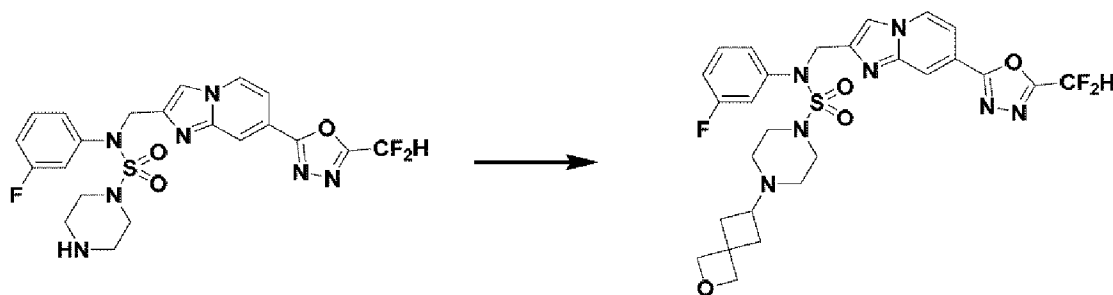
0.177 mmol), and sodium triacetoxyborohydride (0.113 g, 0.532 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.050 g, 46.9 %) as a white solid.

[619] ¹H NMR (400 MHz, CDCl₃) δ 8.29 (s, 1H), 8.23 (d, J = 7.1 Hz, 1H), 7.78 (s, 1H), 7.54 (dd, J = 7.1, 1.7 Hz, 1H), 7.35-7.23 (m, 3H), 7.09-6.80 (m, 2H), 5.09 (s, 2H), 3.28 (s, 4H), 2.57 (s, 1H), 2.39-2.18 (m, 3H), 2.13 (s, 2H), 2.04-1.77 (m, 9H);

[620] LRMS (ES) m/z 602.4 (M⁺+1).

[621] **Example 80:** Synthesis of Compound 4623, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)-4-(2-oxaspiro[3.3]heptan-6-yl)piperazine-1-sulfonamide

[622]



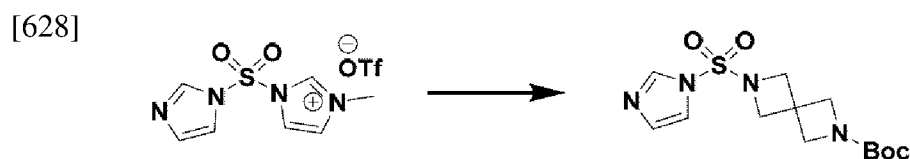
[623] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-a]pyridin-2-yl)methyl)-*N*-(3-fluorophenyl)piperazine-1-sulfonamide (0.090 g, 0.177 mmol) prepared in step 3 of Example 58, 2-oxaspiro[3.3]heptan-6-one (0.040 g, 0.355 mmol), acetic acid (0.010 mL, 0.177 mmol), and sodium triacetoxyborohydride (0.113 g, 0.532 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.050 g, 46.7 %) as a white solid.

[624] ¹H NMR (400 MHz, CDCl₃) δ 8.29 (s, 1H), 8.23 (d, J = 7.1 Hz, 1H), 7.76 (s, 1H), 7.54 (dd, J = 7.1, 1.6 Hz, 1H), 7.36-7.23 (m, 3H), 7.10-6.81 (m, 2H), 5.08 (s, 2H), 4.71 (s, 2H), 4.60 (s, 2H), 3.24 (s, 4H), 2.50 (s, 1H), 2.39 (s, 2H), 2.26 (s, 4H), 1.99 (s, 2H);

[625] LRMS (ES) m/z 604.2 (M⁺+1).

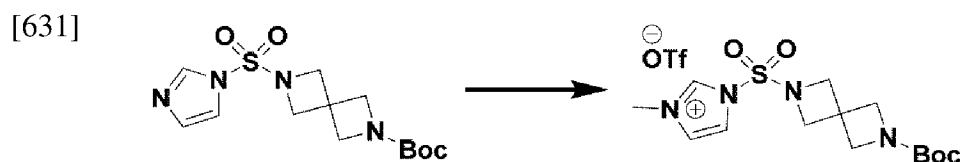
[626] **Example 81:** Synthesis of Compound 4624, *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-6-methyl-*N*-phenyl-2,6-diazaspiro[3.3]heptan-2-sulfonamide

[627] [Step 1] Synthesis of tert-butyl 6-((1H-imidazol-1-yl)sulfonyl)-2,6-diazaspiro[3.3]heptan-2-carboxylate



[629] 1-((1H-imidazol-1-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium trifluoromethanesulfonate (3.600 g, 9.937 mmol) prepared in step 1 of Example 38 was dissolved in acetonitrile (25 mL). Then, tert-butyl 2,6-diazaspiro[3.3]heptan-2-carboxylate oxalate (2.659 g, 5.465 mmol) and *N,N*-diisopropylethylamine (8.654 mL, 49.683 mmol) were added at 0°C, stirred at the same temperature for 0.2 hours, and further stirred at room temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 24 g cartridge; ethyl acetate/hexane = 10 % to 80 %) and concentrated to obtain the title compound (1.300 g, 39.8 %) as a white solid.

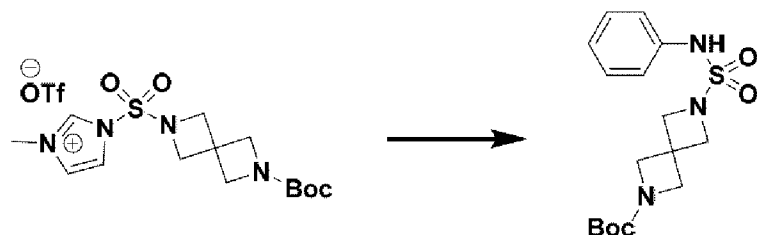
[630] [Step 2] Synthesis of (1-((6-(tert-butoxycarbonyl)-2,6-diazaspiro[3.3]heptan-2-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium trifluoromethanesulfonate



[632] Tert-butyl 6-((1H-imidazol-1-yl)sulfonyl)-2,6-diazaspiro[3.3]heptan-2-carboxylate (1.300 g, 3.959 mmol) prepared in step 1 was dissolved in dichloromethane (20 mL). Then, methyl trifluoromethanesulfonate (0.499 mL, 4.553 mmol) was added at 0°C, stirred at the same temperature for 0.2 hours, and further stirred at room temperature for 3 hours. After removing the solvent from the reaction mixture under reduced pressure, the title compound (1.850 g, 94.9 %) was obtained as a white solid without further purification.

[633] [Step 3] Synthesis of tert-butyl 6-(*N*-(phenylsulfamoyl)-2,6-diazaspiro[3.3]heptan-2-carboxylate

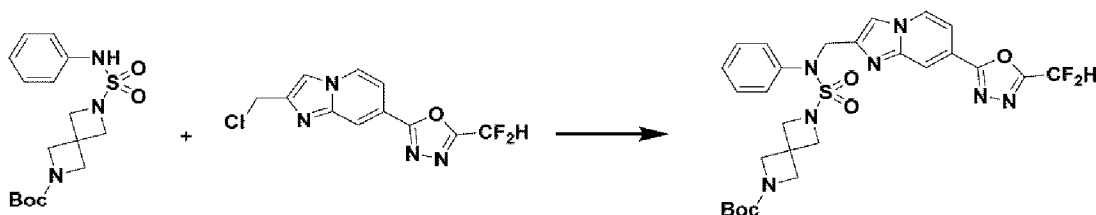
[634]



- [635] (1-((6-(Tert-butoxycarbonyl)-2,6-diazaspiro[3.3]heptan-2-yl)sulfonyl)-3-methyl-1H-imidazol-3-ium trifluoromethanesulfonate (1.140 g, 2.315 mmol) prepared in step 2 and aniline (0.254 mL, 2.778 mmol) were dissolved in acetonitrile (15 mL) at room temperature, and stirred at 85°C for 18 hours. Then, the temperature was lowered to room temperature to terminate the reaction. Water was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous sodium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 24 g cartridge; ethyl acetate/hexane = 0 % to 30 %) and concentrated to obtain the title compound (0.500 g, 61.1 %) as a yellow solid.

- [636] [Step 4] Synthesis of tert-butyl 6-(*N*-(7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)-2,6-diazaspiro[3.3]heptan-2-carboxylate

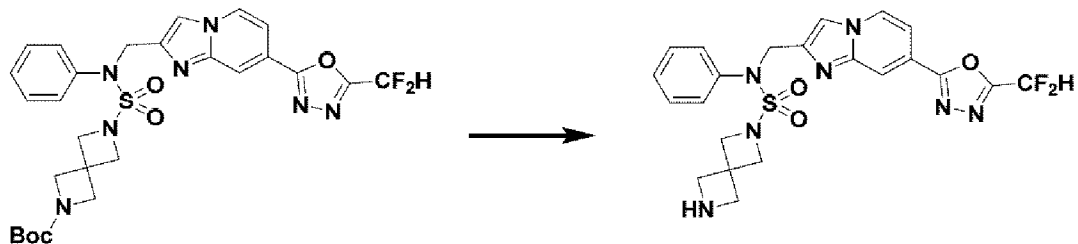
[637]



- [638] Tert-butyl 6-(*N*-phenylsulfamoyl)-2,6-diazaspiro[3.3]heptan-2-carboxylate (0.100 g, 0.283 mmol) prepared in step 3, 2-(2-(chloromethyl)imidazo[1,2-*a*]pyridin-7-yl)-5-(difluoromethyl)-1,3,4-oxadiazole (0.097 g, 0.340 mmol), potassium carbonate (0.059 g, 0.424 mmol), and potassium iodide (0.023 g, 0.141 mmol) were dissolved in *N,N*-dimethylformamide (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous ammonium chloride solution was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 40 g cartridge; ethyl acetate/hexane = 0 % to 70 %) and concentrated to obtain the title compound (0.120 g, 70.5 %) as a white solid.

[639] [Step 5] Synthesis of *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-2,6-diazaspiro[3.3]heptan-2-sulfonamide

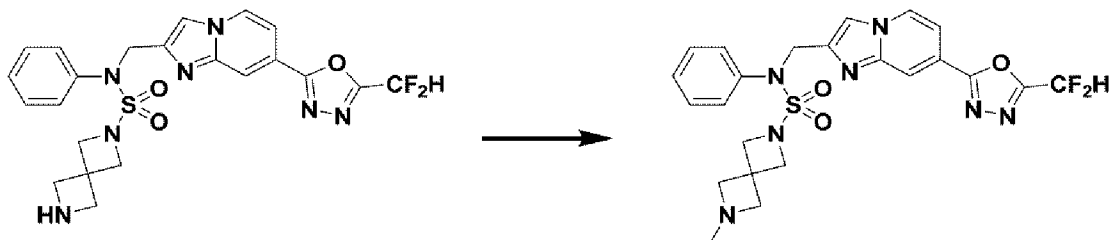
[640]



[641] Tert-butyl 6-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenylsulfamoyl)-2,6-diazaspiro[3.3]heptan-2-carboxylate (0.120 g, 0.199 mmol) prepared in step 4, and trifluoroacetic acid (0.305 mL, 3.989 mmol) were dissolved in dichloromethane (10 mL) at room temperature, and the resulting solution was stirred at the same temperature for 2 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, followed by extraction with dichloromethane. The organic layer was washed with a saturated aqueous water solution, dried over anhydrous magnesium sulfate, and filtered. After concentration under reduced pressure, the title compound (0.100 g, 100.0 %) was obtained as a yellow gel without further purification.

[642] [Step 6] Synthesis of Compound 4624

[643]



[644] *N*-((7-(5-(difluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)-*N*-phenyl-2,6-diazaspiro[3.3]heptan-2-sulfonamide (0.100 g, 0.199 mmol) prepared in step 5, formaldehyde (0.012 g, 0.399 mmol), acetic acid (0.011 mL, 0.199 mmol), and sodium triacetoxyborohydride (0.127 g, 0.598 mmol) were dissolved in dichloromethane (5 mL) at room temperature, and the resulting solution was stirred at the same temperature for 3 hours. A saturated aqueous sodium hydrogen carbonate solution was poured into the reaction mixture, extracted with dichloromethane, and filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by chromatography (SiO₂ plate, 20 x 20 x 1 mm; dichloromethane/methanol = 0% to 10 %) and concentrated to obtain the title compound (0.080 g, 77.8 %) as a white solid.

[645] ^1H NMR (400 MHz, CDCl_3) δ 8.28 (s, 1H), 8.21 (d, $J = 7.1$ Hz, 1H), 7.75 (s, 1H), 7.52 (dd, $J = 7.1, 1.7$ Hz, 1H), 7.47-7.41 (m, 2H), 7.38-7.31 (m, 2H), 7.30-7.25 (m, 1H), 7.09-6.80 (m, 1H), 5.07 (s, 2H), 4.00 (s, 4H), 3.33 (s, 4H), 2.31 (s, 3H);

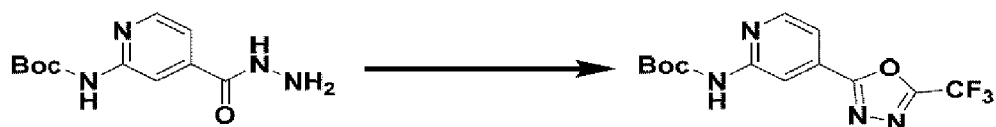
[646] **LRMS** (ES) m/z 516.2 ($M + 1$).

[647] **Example 82:** Synthesis of Compound 6893, tert-butyl 4-(*N*-(3-fluorophenyl)-*N*-((7-(5-(trifluoromethyl)-1,3,4-oxadiazol-2-yl)imidazo[1,2-*a*]pyridin-2-yl)methyl)sulfa moyl)piperidine-1-carboxylate

[648] [Step 1] Synthesis of tert-butyl

(4-(5-(trifluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-yl)carbamate

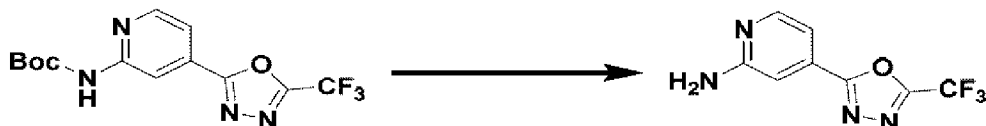
[649]



[650] Tert-butyl (4-(hydrazinecarbonyl)pyridin-2-yl)carbamate (2.600 g, 10.306 mmol) prepared in step 2 of Example 1 and triethylamine (14.365 mL, 103.064 mmol) were dissolved in tetrahydrofuran (150 mL), and trifluoroacetic anhydride (7.279 mL, 51.532 mmol) was added at room temperature and heated to reflux for 16 hours. Then, the temperature was lowered to room temperature to terminate the reaction. A saturated aqueous ammonium chloride solution was added to the reaction mixture, followed by extraction with ethyl acetate. The organic layer was washed with a saturated aqueous sodium chloride solution, dried over anhydrous magnesium sulfate, filtered, and concentrated under reduced pressure. Ethyl acetate (30 mL) and hexane (100 mL) were poured into the concentrate, suspended, and filtered to obtain a solid, and the obtained solid was washed with hexane and dried to obtain the title compound (1.500 g, 44.1 %) as a white solid.

[651] [Step 2] Synthesis of 4-(5-(trifluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-amine

[652]

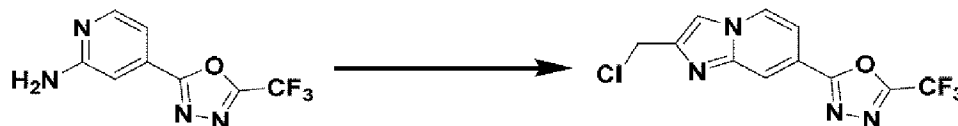


[653] Tert-butyl (4-(5-(trifluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-yl)carbamate (1.500 g, 4.542 mmol) prepared in step 1 was dissolved in dichloromethane (70 mL). Then, trifluoroacetic acid (6.956 mL, 90.835 mmol) was added at 0°C , and the resulting solution was stirred at room temperature for 4 hours. After removing the solvent from the reaction mixture under reduced pressure, a saturated aqueous sodium hydrogen carbonate solution (50 mL) was poured into the concentrate and suspended, followed by filtration to obtain a solid. The obtained solid was washed with water and dried to obtain the title compound (1.030 g, 98.5 %) as a yellow solid.

[654] [Step 3] Synthesis of

2-(2-(chloromethyl)imidazo[1,2-a]pyridin-7-yl)-5-(trifluoromethyl)-1,3,4-oxadiazole

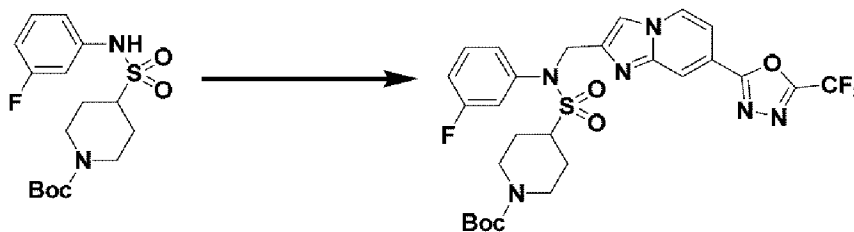
[655]



[656] 4-(5-(Trifluoromethyl)-1,3,4-oxadiazol-2-yl)pyridin-2-amine (1.100 g, 4.779 mmol) prepared in step 2, 1,3-dichloropropan-2-one (1.214 g, 9.559 mmol), and sodium hydrogen carbonate (2.008 g, 23.897 mmol) were dissolved in 1,4-dioxane (60 mL) at room temperature. The resulting solution was heated to reflux for 16 hours, and then the temperature was lowered to room temperature to terminate the reaction. The reaction mixture was filtered through a plastic filter to remove solids, and the filtrate was purified by column chromatography (SiO₂, 40 g cartridge; ethyl acetate/hexane = 5 % to 70 %) and concentrated to obtain the title compound (0.850 g, 58.8 %) as a beige solid.

[657] [Step 4] Synthesis of Compound 6893

[658]



[659] Tert-butyl 4-(*N*-(3-fluorophenyl)sulfamoyl)piperidine-1-carboxylate (0.250 g, 0.697 mmol) prepared in step 1 of Example 18, 2-(2-(chloromethyl)imidazo[1,2-a]pyridin-7-yl)-5-(trifluoromethyl)-1,3,4-oxadiazole (0.201 g, 0.663 mmol) prepared in step 3, potassium carbonate (0.193 g, 1.395 mmol), and potassium iodide (0.012 g, 0.070 mmol) were dissolved in *N,N*-dimethylformamide (6 mL) at room temperature, and the resulting solution was stirred at 60°C for 16 hours. Then, the temperature was lowered to room temperature to terminate the reaction. Water was poured into the concentrate obtained by removing the solvent from the reaction mixture under reduced pressure, followed by extraction with dichloromethane. Next, the obtained product was filtered through a plastic filter to remove a solid residue and an aqueous layer, and then concentrated under reduced pressure. The concentrate was purified by column chromatography (SiO₂, 24 g cartridge; ethyl acetate/hexane = 10 % to 90 %) and concentrated to obtain the title compound (0.150 g, 34.4 %) as a colorless oil.

[660] ¹H NMR (400 MHz, CDCl₃) δ 8.08 (s, 1H), 7.98 (m, 1H), 7.59 (s, 1H), 7.28 - 7.15 (m, 4H), 6.87 (m, 1H), 5.11 (s, 2H), 4.19 (m, 2H), 3.21 (m, 1H), 2.67 (m, 2H), 2.05 (m, 2H), 1.75 (m, 2H), 1.41 (s, 9H).

[661] **Activity measurement and analysis protocol of the compounds of the present**

invention

[662] **<Experimental Example 1> In vitro HDAC enzyme activity inhibition assay**

[663] In order to confirm the selectivity of the compounds represented by Chemical Formula I of the present invention to HDAC6 through HDAC1 and HDAC6 enzyme activity inhibition experiments, a comparison experiment was performed using the material that has already been developed as a control group.

[664] HDAC enzyme activity was measured using the HDAC Fluorimetric Drug Discovery Kit (Enzo Life Sciences, Inc., BML-AK511, 516). For the HDAC1 enzyme activity test, human recombinant HDAC1 (BML-SE456) was used as an enzyme source and Fluor de Lys[®]-SIRT1 (BNL-KI177) was used as a substrate. After dispensing 5-fold diluted compounds into a 96-well plate, 0.3 µg of enzyme and 10 µM substrate were added to each well of the plate and allowed to react at 30°C for 60 minutes. Next, Fluor de Lys[®] Developer II (BML-KI176) was added and reacted for 30 minutes to complete the reaction, and then the fluorescence values (Ex 360, Em 460) were measured using a multi-plate reader (Flexstation 3, Molecular Device). The HDAC6 enzymes were tested using human recombinant HDAC6 (382180) from Calbiochem Inc., according to the same protocol as the HDAC1 enzyme activity test method. With respect to the final result values, respective IC₅₀ values were calculated using GraphPad Prism 4.0 program, and results thereof were summarized in Table 4 below.

[665] [Table 4] Results of HDAC enzyme activity inhibition assay

[666]

Example	Compound	HDAC1 (nM)	HDAC6 (nM)	HDAC6 selectivity (fold)
1	3778	>50,000	91.0	549
2	3779	>50,000	156.0	321
3	4214	>50,000	179.8	278
4	4215	>50,000	182.0	275
5	4216	>50,000	119.0	420
6	4217	>50,000	122.1	410
7	4218	>50,000	115.6	433
8	4219	>50,000	103.7	482
9	4220	>50,000	156.3	320
10	4221	>50,000	137.2	364
11	4222	>50,000	218.0	229
12	4223	>50,000	127.5	392
13	4224	>50,000	141.3	354
14	4225	>50,000	94.4	530
15	4226	>50,000	115.7	432
16	4227	>50,000	207.5	241
17	4228	>50,000	102.9	486
18	4236	>50,000	73.8	678
19	4237	>50,000	60.9	821
20	4238	>50,000	76.6	653
21	4239	>50,000	78.8	635
22	4240	>50,000	53.4	936
23	4241	>50,000	69.9	715
24	4242	>50,000	62.5	800
25	4243	>50,000	94.3	530
26	4244	>50,000	95.3	525
27	4245	>50,000	47.4	1055
28	4246	>50,000	75.8	660
29	4247	>50,000	51.0	980

[667]

30	4248	>50,000	92.2	542
31	4249	>50,000	73.1	684
32	4250	>50,000	115.9	431
33	4251	>50,000	95.2	525
34	4252	>50,000	109.8	455
35	4253	>50,000	99.4	503
36	4254	>50,000	116.2	430
37	4255	>50,000	107.9	463
38	4256	>50,000	79.4	630
39	4257	>50,000	74.2	674
40	4258	>50,000	100.1	500
41	4259	>50,000	82.6	605
42	4260	>50,000	87.3	573
43	4261	>50,000	85.0	588
44	4262	>50,000	299.3	167
45	4263	>50,000	126.1	397
46	4264	>50,000	203.0	246
47	4265	>50,000	85.5	585
48	4266	>50,000	116.0	431
49	4267	>50,000	95.5	524
50	4268	>50,000	128.7	389
51	4269	>50,000	193.1	259
52	4270	>50,000	152.7	327
53	4271	>50,000	232.4	215
54	4272	>50,000	168.0	298
55	4273	>50,000	121.0	413
56	4274	>50,000	150.0	333
57	4275	>50,000	142.3	351
58	4297	>50,000	89.2	561
59	4298	>50,000	79.2	631
60	4299	>50,000	102.4	488

[668]

61	4300	>50,000	122.0	410
62	4301	>50,000	84.1	595
63	4302	>50,000	67.8	737
64	4303	>50,000	167.4	299
65	4304	>50,000	60.1	832
66	4305	>50,000	114.5	437
67	4306	>50,000	81.0	617
68	4307	>50,000	136.8	365
69	4308	>50,000	69.1	724
70	4309	>50,000	114.5	437
71	4310	>50,000	73.4	681
72	4311	>50,000	98.0	510
73	4312	>50,000	94.3	530
74	4313	>50,000	134.9	371
75	4314	>50,000	108.3	462
76	4315	>50,000	162.0	309
77	4616	>50,000	205	243
78	4617	>50,000	75	666
79	4622	>50,000	182	274
80	4623	>50,000	62	806
81	4624	>50,000	84	595
82	6893	>50,000	3118	16

[669] As shown in Table 4 above, it was found from the results of the activity inhibition assay for HDAC1 and HDAC6 that the 1,3,4-oxadiazole derivative compounds of the present invention, the optical isomers thereof, or the pharmaceutically acceptable salts thereof exhibited about 16 to about 1055 times higher selective HDAC6 inhibitory activity than that of HDAC1.

[670] **<Experimental Example 2> In vitro Analysis of Effect of HDAC6-Specific Inhibitors on Mitochondrial Axonal Transport**

[671] The effects of the HDAC6-specific inhibitors on mitochondrial axonal transport were analyzed. Specifically, in order to confirm whether the compounds represented by Chemical Formula I of the present invention selectively inhibit the HDAC6 activity and increase the acetylation of tubulin, which is a major substrate of HDAC6, thereby improving the mitochondrial axonal transport rates reduced by amyloid-beta treatment in neuronal axons, a comparison experiment was performed using the material that has already been developed as a control group.

[672] Hippocampal neurons from Sprague-Dawley (SD) rat embryos at embryonic day 17-18 (E17-18) were cultured for 7 days in an extracellular matrix-coated culture dish

for imaging, and then treated with 1M of amyloid-beta peptide fragments. After 24 hours, the compound was treated on the 8th day of in vitro culture, and 3 hours later, treated with MitoTracker Red CMXRos (Life Technologies, NY, USA) for the last 5 minutes to stain the mitochondria. With regard to the axonal transport of the stained neuron mitochondria, the transport rates of each mitochondrion were determined using the IMARIS analysis software (BITPLANE, Zurich, Switzerland) by taking images using a confocal microscope (Leica 5P8; Leica Microsystems, UK) at 1-second intervals for 1 minute.

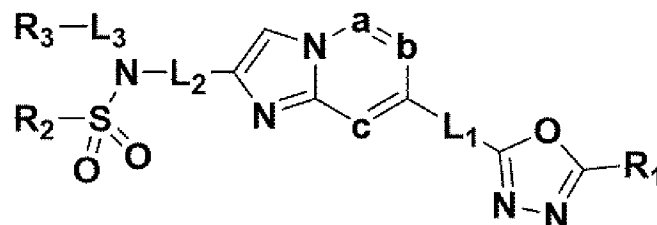
[673] As a result, it was confirmed that the 1,3,4-oxadiazole derivative compounds of the present invention, the optical isomers thereof or the pharmaceutically acceptable salts thereof showed an improvement effect on the rates of mitochondrial axonal transport.

Claims

[Claim 1]

A 1,3,4-oxadiazole derivative compound represented by Chemical Formula I below, an optical isomer thereof, or a pharmaceutically acceptable salt thereof:

[Chemical Formula I]



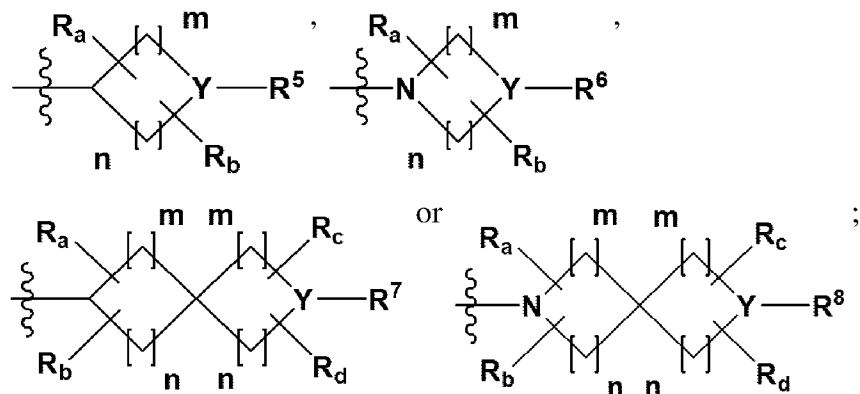
in the Chemical Formula I above,

L_1 , L_2 and L_3 are each independently $-(C_0-C_2\text{alkyl})-$;

a , b and c are each independently N or CR^4 {wherein a , b and c cannot be N at the same time, and R^4 is $-H$, $-X$ or $-O(C_1-C_4\text{alkyl})$ };

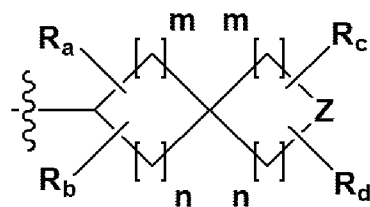
R_1 is $-CH_2X$ or $-CX_3$;

R_2 is $-(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-O-(C_1-C_4\text{alkyl})$, $-NR^A R^B$, aryl, heteroaryl,



Y is $-N-$, $-CH-$, $-O-$ or $-S(=O)_2-$;

when Y is $-N-$ or $-CH-$, R_5 , R_6 , R_7 and R_8 are each independently $-H$, $-X$, $-OH$, $-(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-O-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-O(C_1-C_4\text{alkyl})$, $-NR^C R^D$, $-CF_3$, $-CF_2H$, $-CN$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^C R^D$, $-C(=O)-(C_1-C_4\text{alkyl})-NR^C R^D$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, aryl, heteroaryl, $-(C_1-C_4\text{alkyl})$ -aryl, $-(C_1-C_4\text{alkyl})$ heteroaryl, an amine protecting group or



{ wherein at least one H of $-(C_1-C_4\text{alkyl})$, $-(C=O)-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$ and $-(C=O)-(C_3-C_7\text{cycloalkyl})$ may be substituted with $-X$, $-OH$, $-O(C_1-C_4\text{alkyl})$, $-(C=O)-(C_1-C_4\text{alkyl})$, $-(C=O)-O(C_1-C_4\text{alkyl})$, $-CF_3$ or $-CF_2H$; at least one H of $-aryl$, $-heteroaryl$, $-(C_1-C_4\text{alkyl})-aryl$ and $-(C_1-C_4\text{alkyl})heteroaryl$ may be substituted with $-X$, $-OH$, $-(C_1-C_4\text{alkyl})$, $-O(C_1-C_4\text{alkyl})$, $-(C=O)-(C_1-C_4\text{alkyl})$, $-(C=O)-O(C_1-C_4\text{alkyl})$, $-CF_3$ or $-CF_2H$; $-(C_2-C_6\text{heterocycloalkyl})$, $-heteroaryl$ or $-(C_1-C_4\text{alkyl})heteroaryl$ may contain N, O or S atom in the ring; and Z is $-NH-$, $-CH_2-$ or $-O-$ };

when Y is $-O-$ or $-S(=O)_2-$, R_5 , R_6 , R_7 and R_8 are nothing (null);

R^A to R^D are each independently $-H$, $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-(C_1-C_4\text{alkyl})-(C_2-C_6\text{heterocycloalkyl})$, $aryl$, $heteroaryl$ or $-(C_1-C_4\text{alkyl})-aryl$ { wherein at least one H of $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-(C_1-C_4\text{alkyl})-(C_2-C_6\text{heterocycloalkyl})$, $aryl$, $heteroaryl$ and $-(C_1-C_4\text{alkyl})-aryl$ may be substituted with $-(C_1-C_4\text{alkyl})$, $-(C=O)-(C_1-C_4\text{alkyl})$, $-S(=O)_2-(C_1-C_4\text{alkyl})$ or $-(C_2-C_6\text{heterocycloalkyl})$ };

m and n are each independently an integer of 1, 2 or 3;

R_a to R_d are each independently $-H$ or $-(C_1-C_4\text{alkyl})$;

R^3 is $-H$, $-(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-O(C_1-C_4\text{alkyl})$, $-(C_1-C_4\text{alkyl})-C(=O)-O(C_1-C_4\text{alkyl})$, $-(C=O)-O(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-aryl$ or $-heteroaryl$ { wherein at least one H of $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-aryl$ and $-heteroaryl$ may each independently be substituted with $-X$, $-OH$, $-O(C_1-C_4\text{alkyl})$, $-(C=O)-O(C_1-C_4\text{alkyl})$, $-(C=O)-(C_1-C_4\text{alkyl})$, $-CF_3$, $-CF_2H$, $-OCF_3$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, $-aryl$, $-O-aryl$, $-heteroaryl$ or $-NR^E R^F$, and the R^E and R^F are each independently $-H$ or $-(C_1-C_4\text{alkyl})$ }; and

X is F, Cl, Br or I.

[Claim 2]

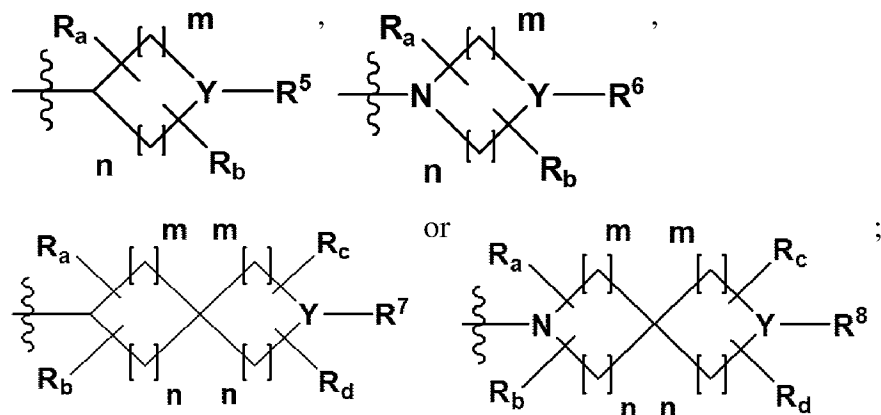
The 1,3,4-oxadiazole derivative compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof according to claim 1, wherein in the Chemical Formula I above,

L_1 to L_3 are each independently $-(C_0-C_1\text{alkyl})-$;

a , b and c are each independently N or CR^4 {wherein a , b and c cannot be N at the same time, and R^4 is $-H$ or $-X$ };

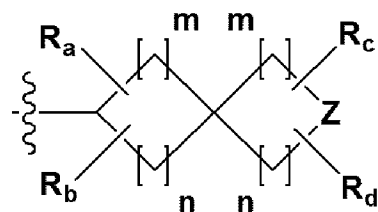
R_1 is $-CH_2XH$ or $-CX_3$;

R_2 is $-(C_1-C_4\text{alkyl})$, $-NR^A R^B$,



Y is $-N-$, $-O-$ or $-S(=O)_2-$;

when Y is $-N-$, R_5 , R_6 , R_7 and R_8 are each independently $-H$, $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^C R^D$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, $-heteroaryl$ or



{wherein at least one $-H$ of $-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$ and $-(C_3-C_7\text{cycloalkyl})$ may be substituted with $-X$ or $-OH$; $-(C_2-C_6\text{heterocycloalkyl})$ or $-heteroaryl$ may contain N, O or S atoms in the ring; and Z is $-NH-$, $-CH_2-$ or $-O-$ };

when Y is $-O-$ or $-S(=O)_2-$, R_5 , R_6 , R_7 and R_8 are nothing (null);

R^A to R^D are each independently $-H$ or $-(C_1-C_4\text{alkyl})$;

m and n are each independently an integer of 1 or 2;

R_a to R_d are each independently $-H$ or $-(C_1-C_4\text{alkyl})$;

R^3 is $-aryl$ or $-heteroaryl$ {wherein at least one H of $-aryl$ and $-heteroaryl$ may each independently be substituted with $-X$ }; and

X is F, Cl or Br.

[Claim 3]

The 1,3,4-oxadiazole derivative compound represented by Chemical

Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof according to claim 2, wherein in the Chemical Formula I above,

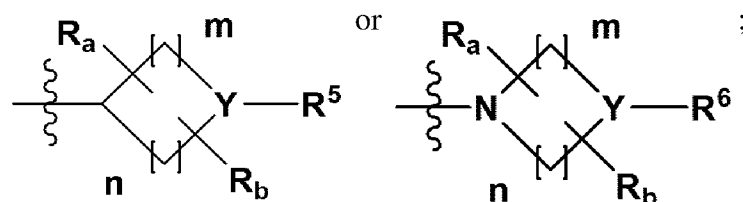
L_1 and L_3 are each independently $-(C_0\text{alkyl})-$;

L_2 is $-(C_1\text{alkyl})-$;

a , b and c are each independently CR^4 {wherein R^4 is $-H$ or $-X$ };

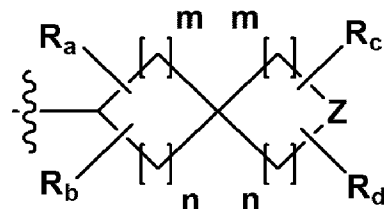
R_1 is $-CH_2XH$ or $-CX_3$;

R_2 is



Y is $-N-$,

R_5 and R_6 are each independently $-H$, $-(C_1-C_4\text{alkyl})$, $-(C_3-C_7\text{cycloalkyl})$, $-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_3-C_7\text{cycloalkyl})$, $-C(=O)-(C_2-C_6\text{heterocycloalkyl})$, $-C(=O)-O(C_1-C_4\text{alkyl})$, $-C(=O)-NR^cR^d$, $-S(=O)_2-(C_1-C_4\text{alkyl})$, $-\text{heteroaryl}$ or



{wherein at least one $-H$ of $-(C_1-C_4\text{alkyl})$, $-C(=O)-(C_1-C_4\text{alkyl})$ and $-(C_3-C_7\text{cycloalkyl})$ may be substituted with $-X$ or $-OH$; $-(C_2-C_6\text{heterocycloalkyl})$ or $-\text{heteroaryl}$ may contain N , O or S atoms in the ring; and Z is $-CH_2-$ or $-O-$ };

R^c and R^d are each independently $-H$ or $-(C_1-C_4\text{alkyl})$;

m and n are each independently an integer of 1 or 2;

R_a and R_b are each independently $-H$ or $-(C_1-C_4\text{alkyl})$;

R^3 is $-\text{aryl}$ {wherein at least one H of $-\text{aryl}$ may each independently be substituted with $-X$ }; and

X is F or Cl .

[Claim 4]

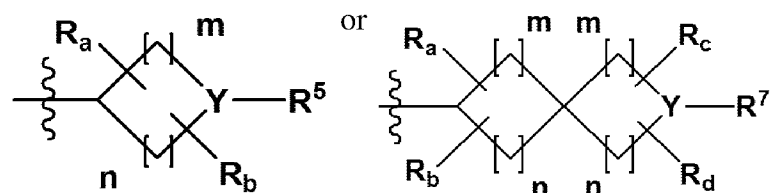
The 1,3,4-oxadiazole derivative compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof according to claim 2, wherein in the Chemical Formula I above,

L_1 to L_3 are each independently $-(C_0-C_1\text{alkyl})-$;

a, b and c are each independently N or CR⁴ {wherein a, b and c cannot be N at the same time, and R⁴ is -H or -X};

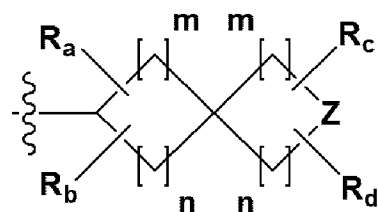
R₁ is -CH₂XH or -CX₃;

R₂ is -(C₁-C₄alkyl),



Y is -N-, -O- or -S(=O)₂-;

when Y is -N-, R₅, R₆, R₇ and R₈ are each independently -H, -(C₁-C₄alkyl), -(C₃-C₇cycloalkyl), -(C₂-C₆heterocycloalkyl), -C(=O)-(C₁-C₄alkyl), -C(=O)-(C₃-C₇cycloalkyl), -C(=O)-(C₂-C₆heterocycloalkyl), -C(=O)-O(C₁-C₄alkyl), -C(=O)-NR^cR^d, -S(=O)₂-(C₁-C₄alkyl), -heteroaryl or



{wherein at least one -H of -(C₁-C₄alkyl), -C(=O)-(C₁-C₄alkyl) and -(C₃-C₇cycloalkyl) may be substituted with -X or -OH; -(C₂-C₆heterocycloalkyl) or -heteroaryl may contain N, O or S atoms in the ring; and Z is -NH-, -CH₂- or -O-};

when Y is -O- or -S(=O)₂-, R₅, R₆, R₇ and R₈ are nothing (null);

R^c and R^d are each independently -H or -(C₁-C₄alkyl);

m and n are each independently an integer of 1 or 2;

R_a to R_d are each independently -H or -(C₁-C₄alkyl);

R³ is -aryl or -heteroaryl {wherein at least one H of -aryl and -heteroaryl may each independently be substituted with -X}; and

X is F, Cl or Br.

[Claim 5]

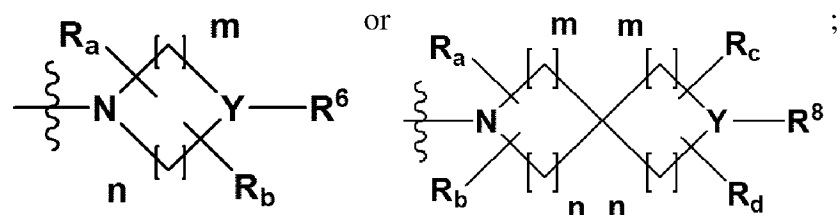
The 1,3,4-oxadiazole derivative compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof according to claim 2, wherein in the Chemical Formula I above,

L₁ to L₃ are each independently -(C₀-C₁alkyl)-;

a, b and c are each independently N or CR⁴ {wherein a, b and c cannot be N at the same time, and R⁴ is -H or -X};

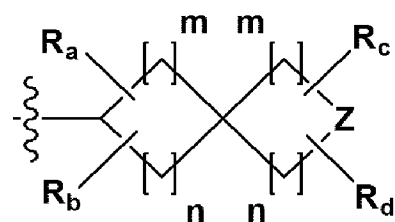
R_1 is $-\text{CH}_2\text{XH}$ or $-\text{CX}_3$;

R_2 is $-\text{NR}^{\text{A}}\text{R}^{\text{B}}$,



Y is $-\text{N}-$, $-\text{O}-$ or $-\text{S}(=\text{O})_2-$;

when Y is $-\text{N}-$, R_5 , R_6 , R_7 and R_8 are each independently $-\text{H}$, $-(\text{C}_1\text{-C}_4\text{alkyl})$, $-(\text{C}_3\text{-C}_7\text{cycloalkyl})$, $-(\text{C}_2\text{-C}_6\text{heterocycloalkyl})$, $-\text{C}(=\text{O})-(\text{C}_1\text{-C}_4\text{alkyl})$, $-\text{C}(=\text{O})-(\text{C}_3\text{-C}_7\text{cycloalkyl})$, $-\text{C}(=\text{O})-(\text{C}_2\text{-C}_6\text{heterocycloalkyl})$, $-\text{C}(=\text{O})-\text{O}(\text{C}_1\text{-C}_4\text{alkyl})$, $-\text{C}(=\text{O})-\text{NR}^{\text{C}}\text{R}^{\text{D}}$, $-\text{S}(=\text{O})_2-(\text{C}_1\text{-C}_4\text{alkyl})$, $-\text{heteroaryl}$ or



{ wherein at least one $-\text{H}$ of $-(\text{C}_1\text{-C}_4\text{alkyl})$, $-\text{C}(=\text{O})-(\text{C}_1\text{-C}_4\text{alkyl})$ and $-(\text{C}_3\text{-C}_7\text{cycloalkyl})$ may be substituted with $-\text{X}$ or $-\text{OH}$; $-(\text{C}_2\text{-C}_6\text{heterocycloalkyl})$ or $-\text{heteroaryl}$ may contain N , O or S atoms in the ring; and Z is $-\text{NH}-$, $-\text{CH}_2-$ or $-\text{O}-$ };

when Y is $-\text{O}-$ or $-\text{S}(=\text{O})_2-$, R_5 , R_6 , R_7 and R_8 are nothing (null);

R^{A} to R^{D} are each independently $-\text{H}$ or $-(\text{C}_1\text{-C}_4\text{alkyl})$;

m and n are each independently an integer of 1 or 2;

R_{a} to R_{d} are each independently $-\text{H}$ or $-(\text{C}_1\text{-C}_4\text{alkyl})$;

R^3 is $-\text{aryl}$ or $-\text{heteroaryl}$ { wherein at least one H of $-\text{aryl}$ and $-\text{heteroaryl}$ may each independently be substituted with $-\text{X}$ }; and

X is F , Cl or Br .

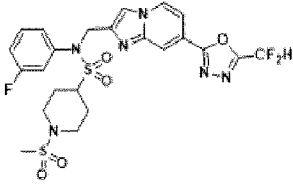
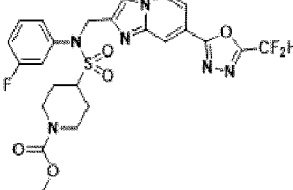
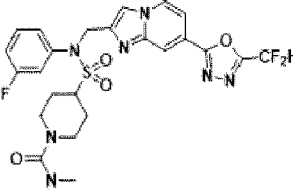
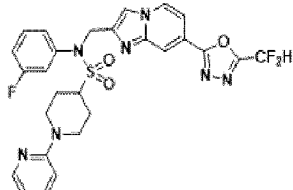
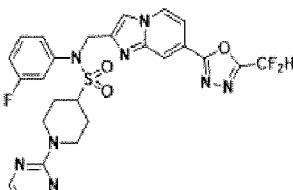
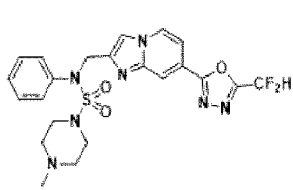
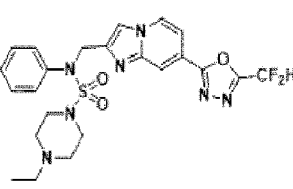
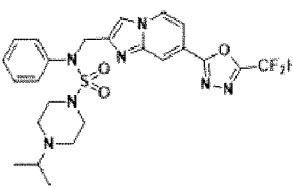
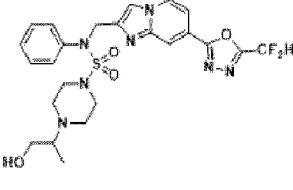
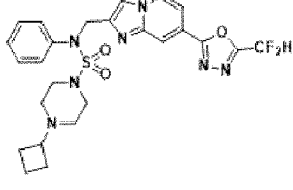
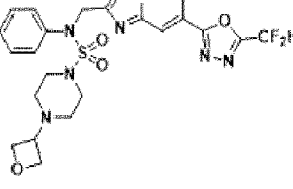
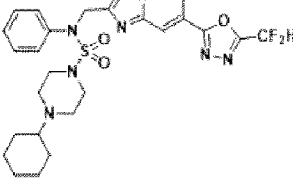
[Claim 6]

The 1,3,4-oxadiazole derivative compound, the optical isomer thereof or the pharmaceutically acceptable salt thereof according to claim 1, wherein it is any one of compounds listed in the following table:

Ex	Comp	Structure	Ex	Comp	Structure
1	3778		2	3779	
3	4214		4	4215	
5	4216		6	4217	
7	4218		8	4219	
9	4220		10	4221	

11	4222		12	4223	
13	4224		14	4225	
15	4226		16	4227	
17	4228		18	4236	
19	4237		20	4238	
21	4239		22	4240	

23	4241		24	4242	
25	4243		26	4244	
27	4245		28	4246	
29	4247		30	4248	
31	4249		32	4250	

33	4251		34	4252	
35	4253		36	4254	
37	4255		38	4256	
39	4257		40	4258	
41	4259		42	4260	
43	4261		44	4262	

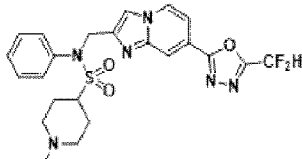
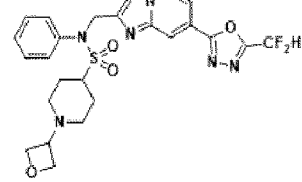
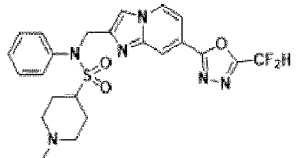
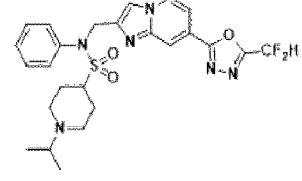
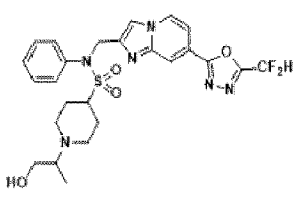
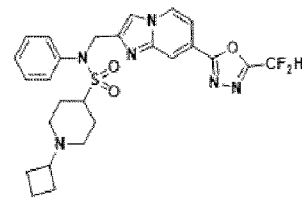
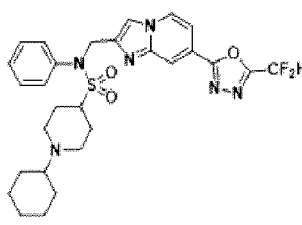
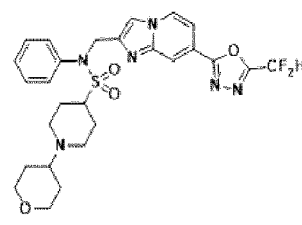
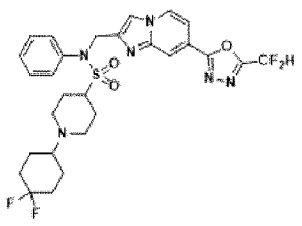
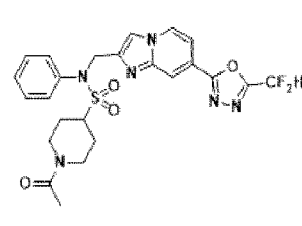
45	4263		46	4264	
47	4265		48	4266	
49	4267		50	4268	
51	4269		52	4270	
53	4271		54	4272	

55	4273		56	4274	
57	4275		58	4297	
59	4298		60	4299	
61	4300		62	4301	
63	4302		64	4303	
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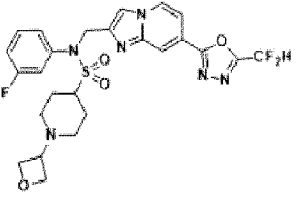
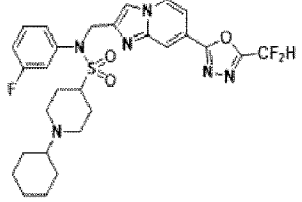
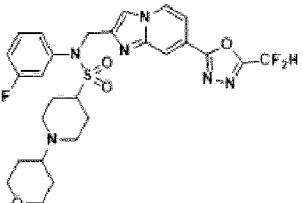
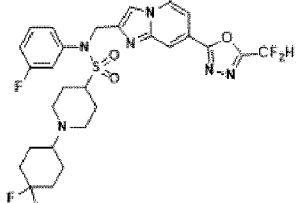
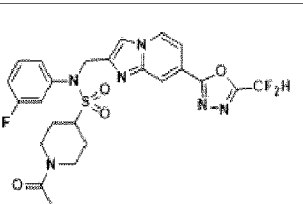
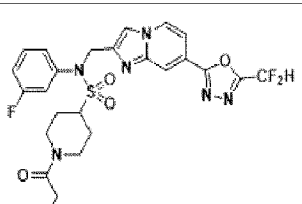
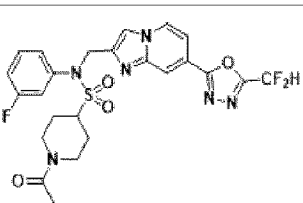
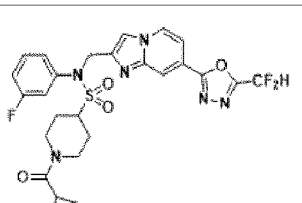
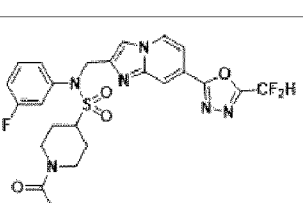
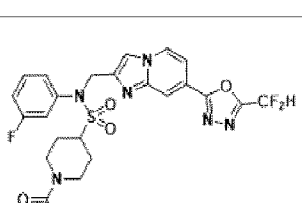
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69	4308		70	4309	
71	4310		72	4311	
73	4312		74	4313	
75	4314		76	4315	
77	4616		78	4617	
79	4622		80	4623	
81	4624		82	6893	

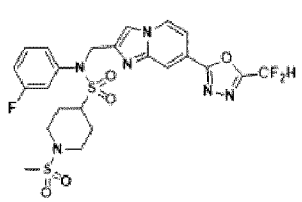
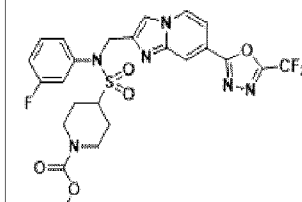
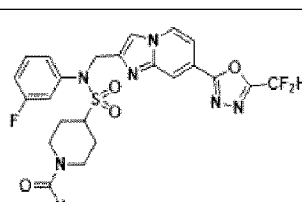
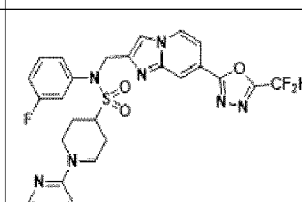
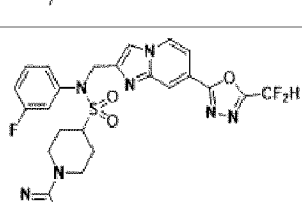
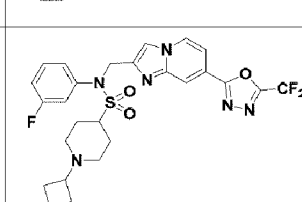
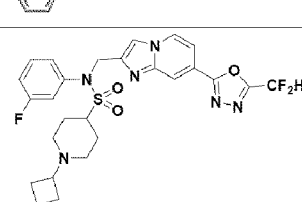
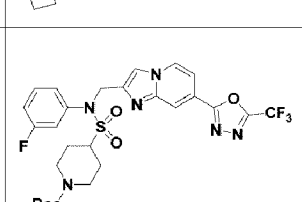
[Claim 7]

The 1,3,4-oxadiazole derivative compound, the optical isomer thereof or the pharmaceutically acceptable salt thereof according to claim 6, wherein it is any one of compounds listed in the following table:

Ex	Comp	Structure	Ex	Comp	Structure
1	3778		2	3779	
3	4214		4	4215	
5	4216		6	4217	
7	4218		8	4219	
9	4220		10	4221	

11	4222		12	4223	
13	4224		14	4225	
15	4226		16	4227	
17	4228		18	4236	
19	4237		20	4238	
21	4239		22	4240	

23	4241		24	4242	
25	4243		26	4244	
27	4245		28	4246	
29	4247		30	4248	
31	4249		32	4250	

33	4251		34	4252	
35	4253		36	4254	
37	4255		77	4616	
78	4617		82	6893	

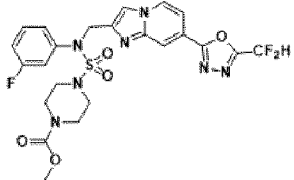
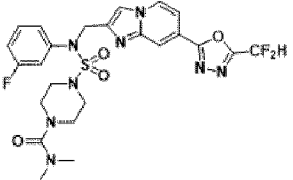
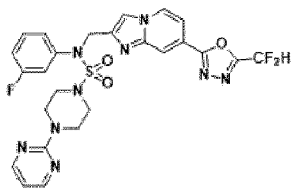
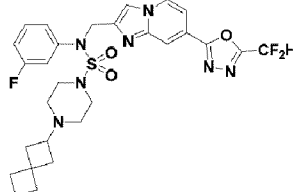
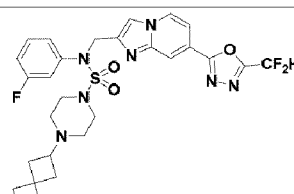
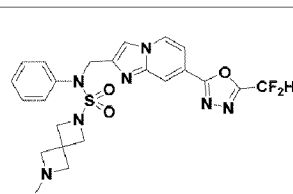
[Claim 8]

The 1,3,4-oxadiazole derivative compound, the optical isomer thereof or the pharmaceutically acceptable salt thereof according to claim 6, wherein it is any one of compounds listed in the following table:

Ex	Comp	Structure	Ex	Comp	Structure
38	4256		39	4257	
40	4258		41	4259	
42	4260		43	4261	
44	4262		45	4263	
46	4264		47	4265	
48	4266		49	4267	

50	4268		51	4269	
52	4270		53	4271	
54	4272		55	4273	
56	4274		57	4275	
58	4297		59	4298	
60	4299		61	4300	

62	4301		63	4302	
64	4303		65	4304	
66	4305		67	4306	
68	4307		69	4308	
70	4309		71	4310	
72	4311		73	4312	

74	4313		75	4314	
76	4315		79	4622	
80	4623		81	4624	

[Claim 9] A pharmaceutical composition for preventing or treating histone deacetylase 6-mediated diseases comprising the compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof according to any one of claims 1 to 8 as an active ingredient.

[Claim 10] The pharmaceutical composition for preventing or treating the histone deacetylase 6-mediated diseases according to claim 9, wherein the histone deacetylase 6-mediated diseases are infectious diseases; neoplasm; endocrine, nutritional and metabolic diseases; mental and behavioral disorders; neurological diseases; diseases of eyes and adnexa; circulatory diseases; respiratory diseases; digestive diseases; skin and subcutaneous tissue diseases; musculoskeletal and connective tissue diseases; or congenital malformations, alterations, or chromosomal abnormalities.

[Claim 11] A method for preventing or treating the histone deacetylase 6-mediated diseases comprising administering a therapeutically effective amount of the compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof according to any one of claims 1 to 8 as an active ingredient.

[Claim 12] Use of the compound represented by Chemical Formula I, the optical isomer thereof, or the pharmaceutically acceptable salt thereof according to any one of claims 1 to 8 for preparing a medicament for preventing or treating the histone deacetylase 6-mediated diseases.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2021/002362

A. CLASSIFICATION OF SUBJECT MATTER

C07D 471/04(2006.01)i; **A61K 31/4545**(2006.01)i; **A61K 31/496**(2006.01)i; **A61P 35/00**(2006.01)i; **A61P 29/00**(2006.01)i;
A61P 37/00(2006.01)i; **A61P 25/00**(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C07D 471/04(2006.01); A01N 43/50(2006.01); A01N 43/90(2006.01); A61K 31/437(2006.01); C07D 271/10(2006.01);
C07D 403/06(2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal), STN(Registry, CPlus) & Keywords:1,3,4-oxadiazole, histone deacetylase 6 (HDAC6), inhibitor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	YU, Y. et al., "Design, synthesis, and biological evaluation of imidazo [1, 2-a] pyridine derivatives as novel PI3K/mTOR dual inhibitors", Journal of medicinal chemistry, 18 February 2020, Vol. 63, pp. 3028-3046 abstract; table 1	1-10,12
A	US 2018-0230113 A1 (CHONG KUN DANG PHARMACEUTICAL CORP.) 16 August 2018 (2018-08-16) claims 1, 5, 8-10	1-10,12
A	KR 10-2012-0034635 A (E. I. DUPONT DE NEMOURS AND COMPANY) 12 April 2012 (2012-04-12) claim 1; paragraphs [0606]-[0609]; compound 197	1-10,12
A	US 2010-0120761 A1 (BERDINI, V. et al.) 13 May 2010 (2010-05-13) the whole document	1-10,12
A	WO 2011-038086 A2 (AMIRA PHARMACEUTICALS, INC.) 31 March 2011 (2011-03-31) the whole document	1-10,12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search

11 June 2021

Date of mailing of the international search report

11 June 2021

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2021/002362

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: **11**
because they relate to subject matter not required to be searched by this Authority, namely:
Claim 11 pertains to a method for treatment of the human body by surgery or therapy (PCT Article 17(2)(a) (i) and Rule 39.1(iv)).
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2021/002362

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)	
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				AU	2016-299486	B2	01 August 2019
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				CA	2987570	A1	02 February 2017
				CN	107980040	A	01 May 2018
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				RU	2695227	C9	04 March 2020
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				TW	I694074	B	21 May 2020
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				WO	2017-018805	A1	02 February 2017
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				CA	2757075	A1	11 November 2010
				CA	2757075	C	04 July 2017
				CL	2011002726	A1	25 May 2012
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				CN	102413693	B	15 January 2014
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				EP	2427058	A2	14 March 2012
				EP	2427058	B1	31 December 2014
				ES	2530268	T3	27 February 2015
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2021/002362

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				UY	32606	A	31 December 2010
				WO	2010-129500	A2	11 November 2010
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				AU	2007-337886	C1	16 October 2014
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				DK	2114941	T3	29 June 2015
				DK	2114941	T5	27 July 2015
				EP	2114941	A1	11 November 2009
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				ES	2541658	T3	23 July 2015
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Information on patent family members

International application No.

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		WO 2011-038086 A3	13 October 2011