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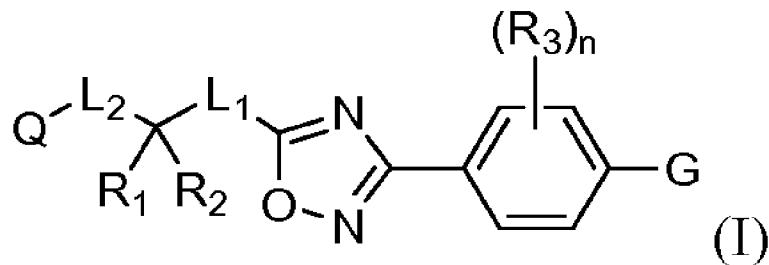
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(54) Title: SUBSTITUTED 3-PHENYL-1,2,4-OXADIAZOLE COMPOUNDS



(57) Abstract: Disclosed are compounds of Formula (I): (I) or stereoisomers, salts, or prodrugs thereof, wherein: (i) R1 and R2 are independently C<sub>1</sub>-C<sub>4</sub> alkyl, or (ii) R1 and R2 together with the carbon atom to which they are attached, form a cyclic group; and Q is H, C<sub>1</sub>-alkyl, phenyl or 5- to 6-membered heteroaryl substituted with zero to 3 substituents, and G is defined herein. Also disclosed are method of using such compounds as selective agonists for G protein-coupled receptor S1P1, and pharmaceutical compositions comprising such compounds. These compounds are useful in treating, preventing, or slowing the progression of diseases or disorders in a variety of therapeutic areas, such as autoimmune diseases and chronic inflammatory disease.

WO 2012/012477 A1

## SUBSTITUTED 3-PHENYL-1,2,4-OXADIAZOLE COMPOUNDS

## DESCRIPTION

[0001] The present invention generally relates to substituted 3-phenyl-1,2,4-oxadiazole compounds useful as S1P<sub>1</sub> agonists. Provided herein are 3-phenyl-1,2,4-oxadiazole compounds, compositions comprising such compounds, and methods of their use. The invention further pertains to pharmaceutical compositions comprising at least one compound according to the invention that are useful for the treatment of conditions related to S1P<sub>1</sub> agonism, such as autoimmune diseases and vascular disease.

[0002] Sphingosine-1-phosphate (S1P) has been demonstrated to induce many cellular effects, including those that result in platelet aggregation, cell proliferation, cell morphology, tumor cell invasion, endothelial cell and leukocyte chemotaxis, endothelial cell *in vitro* angiogenesis, and lymphocyte trafficking. S1P receptors are therefore good targets for a wide variety of therapeutic applications such as tumor growth inhibition, vascular disease, and autoimmune diseases. S1P signals cells in part via a set of G protein-coupled receptors named S1P<sub>1</sub> or S1P<sub>1</sub>, S1P<sub>2</sub> or S1P<sub>2</sub>, S1P<sub>3</sub> or S1P<sub>3</sub>, S1P<sub>4</sub> or S1P<sub>4</sub>, and S1P<sub>5</sub> or S1P<sub>5</sub> (formerly called EDG-1, EDG-5, EDG-3, EDG-6, and EDG-8, respectively).

[0003] S1P is important in the entire human body as it is also a major regulator of the vascular and immune systems. In the vascular system, S1P regulates angiogenesis, vascular stability, and permeability. In the immune system, S1P is recognized as a major regulator of trafficking of T- and B-cells. S1P interaction with its receptor S1P<sub>1</sub> is needed for the egress of immune cells from the lymphoid organs (such as thymus and lymph nodes) into the lymphatic vessels. Therefore, modulation of S1P receptors was shown to be critical for immunomodulation, and S1P receptor modulators are novel immunosuppressive agents.

[0004] The S1P<sub>1</sub> receptor is expressed in a number of tissues. It is the predominant family member expressed on lymphocytes and plays an important role in lymphocyte trafficking. Downregulation of the S1P<sub>1</sub> receptor disrupts lymphocyte migration and homing to various tissues. This results in sequestration of the lymphocytes in lymph organs thereby decreasing the number of circulating lymphocytes that are capable of migration to the affected tissues. Thus, development of an S1P<sub>1</sub> receptor agent that

suppresses lymphocyte migration to the target sites associated with autoimmune and aberrant inflammatory processes could be efficacious in a number of autoimmune and inflammatory disease states.

[0005] Among the five S1P receptors, S1P<sub>1</sub> has a widespread distribution and is highly abundant on endothelial cells where it works in concert with S1P<sub>3</sub> to regulate cell migration, differentiation, and barrier function. Inhibition of lymphocyte recirculation by non-selective S1P receptor modulation produces clinical immunosuppression preventing transplant rejection, but such modulation also results in transient bradycardia. Studies have shown that S1P<sub>1</sub> activity is significantly correlated with depletion of circulating lymphocytes. In contrast, S1P<sub>3</sub> receptor agonism is not required for efficacy. Instead, S1P<sub>3</sub> activity plays a significant role in the observed acute toxicity of nonselective S1P receptor agonists, resulting in the undesirable cardiovascular effects, such as bradycardia and hypertension. (See, e.g., Hale et al., *Bioorg. Med. Chem. Lett.*, 14:3501 (2004); Sanna et al., *J. Biol. Chem.*, 279:13839 (2004); Anliker et al., *J. Biol. Chem.*, 279:20555 (2004); Mandala et al., *J. Pharmacol. Exp. Ther.*, 309:758 (2004).)

[0006] An example of an S1P<sub>1</sub> agonist is FTY720. This immunosuppressive compound FTY720 (JPI 1080026-A) has been shown to reduce circulating lymphocytes in animals and humans, and to have disease modulating activity in animal models of organ rejection and immune disorders. The use of FTY720 in humans has been effective in reducing the rate of organ rejection in human renal transplantation and increasing the remission rates in relapsing remitting multiple sclerosis (see Brinkman et al., *J. Biol. Chem.*, 277:21453 (2002); Mandala et al., *Science*, 296:346 (2002); Fujino et al., *J. Pharmacol. Exp. Ther.*, 305:45658 (2003); Brinkman et al., *Am. J. Transplant.*, 4:1019 (2004); Webb et al., *J. Neuroimmunol.*, 153:108 (2004); Morris et al., *Eur. J. Immunol.*, 35:3570 (2005); Chiba, *Pharmacology & Therapeutics*, 108:308 (2005); Kahan et al., *Transplantation*, 76:1079 (2003); and Kappos et al., *N. Engl. J. Med.*, 335:1124 (2006)). Subsequent to its discovery, it has been established that FTY720 is a prodrug, which is phosphorylated *in vivo* by sphingosine kinases to a more biologically active agent that has agonist activity at the S1P<sub>1</sub>, S1P<sub>3</sub>, S1P<sub>4</sub>, and S1P<sub>5</sub> receptors. It is this activity on the S1P family of receptors that is largely responsible for the pharmacological effects of FTY720 in animals and humans.

[0007] Clinical studies have demonstrated that treatment with FTY720 results in bradycardia in the first 24 hours of treatment (Kappos et al., *N. Engl. J. Med.*, 335:1124 (2006)). The observed bradycardia is commonly thought to be due to agonism at the S1P<sub>3</sub> receptor. This conclusion is based on a number of cell based and animal experiments.

5 These include the use of S1P<sub>3</sub> knockout animals which, unlike wild type mice, do not demonstrate bradycardia following FTY720 administration and the use of S1P<sub>1</sub> selective compounds. (Hale et al., *Bioorg. Med. Chem. Lett.*, 14:3501 (2004); Sanna et al., *J. Biol. Chem.*, 279:13839 (2004); and Koyrakh et al., *Am. J. Transplant.*, 5:529 (2005)).

[0008] The following applications have described compounds as S1P<sub>1</sub> agonists: WO 10 03/061567 (U.S. Patent Publication No. 2005/0070506), WO 03/062248 (U.S. Patent No. 7,351,725), WO 03/062252 (U.S. Patent No. 7,479,504), WO 03/073986 (U.S. Patent No. 7,309,721), WO 03/105771, WO 05/058848, WO 05/000833, WO 05/082089 (U.S. Patent Publication No. 2007/0203100), WO 06/047195, WO 06/100633, WO 06/115188, WO 06/131336, WO 2007/024922, WO 07/109330, WO 07/116866, WO 08/023783 (U.S. Patent Publication No. 2008/0200535), WO 08/029370, WO 08/114157, WO 08/074820, WO 09/043889, WO 09/057079, and U.S. Patent No. 6,069,143. Also see Hale et al., *J. Med. Chem.*, 47:6662 (2004).

[0009] There still remains a need for compounds useful as S1P<sub>1</sub> agonists.

[0010] Applicants have found potent compounds that have activity as S1P<sub>1</sub> agonists.

20 These compounds are provided to be useful as pharmaceuticals with desirable stability, bioavailability, therapeutic index, and toxicity values that are important to their drugability.

#### SUMMARY OF THE INVENTION

25 [0011] The present invention provides 3-phenyl-1,2,4-oxadiazole compounds, which are useful as modulators of S1P<sub>1</sub> activity, including stereoisomers, salts, solvates, and prodrugs thereof.

[0012] The present invention also provides processes and intermediates for making the compounds of the present invention or stereoisomers, salts, or prodrugs thereof.

30 [0013] The present invention also provides pharmaceutical compositions comprising a compound of Formula (I), or stereoisomers, pharmaceutically acceptable salts, or prodrugs thereof; and a pharmaceutically acceptable carrier.

**[0014]** The present invention also provides a method of treating a disease or disorder associated with the activity of G protein-coupled receptor S1P<sub>1</sub>, the method comprising administering to a mammalian patient a compound of Formula (I) or stereoisomers, pharmaceutically acceptable salts, or prodrugs thereof.

5 **[0015]** The present invention also provides the compounds of the present invention or stereoisomers, pharmaceutically acceptable salts, or prodrugs thereof, for use in therapy.

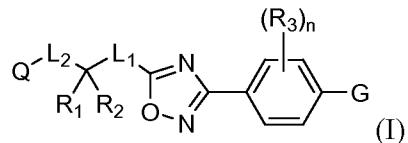
**[0016]** The present invention also provides the use of the compounds of the present invention or stereoisomers, pharmaceutically acceptable salts, or prodrugs thereof, for the manufacture of a medicament for the treatment or prophylaxis of S1P<sub>1</sub> receptor-related 10 conditions, such as autoimmune and vascular diseases.

**[0017]** The compounds of Formula (I) and compositions comprising the compounds are S1P<sub>1</sub> agonists. The compounds of Formula (I) and compositions comprising said compounds may be used in treating, preventing or curing various S1P<sub>1</sub> receptor-related conditions while reducing or minimizing the side effects due to S1P<sub>3</sub> activity.

15 Pharmaceutical compositions comprising these compounds are useful in treating, preventing, or slowing the progression of diseases or disorders in a variety of therapeutic areas, such as autoimmune and vascular diseases.

#### DETAILED DESCRIPTION

20 **[0018]** In a first aspect, the present invention provides compounds of Formula (I):



or a stereoisomer or a salt thereof, wherein:

(i) R<sub>1</sub> and R<sub>2</sub> are independently C<sub>1</sub>-C<sub>4</sub> alkyl; or

(ii) R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic

25 group selected from adamantanyl, bicyclo[2.2.1]heptanyl, bicyclo[2.2.2]octanyl, C<sub>3</sub>-cycloalkyl, and a 4- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>;

L<sub>1</sub> and L<sub>2</sub> are each independently:

(a) a bond,

30 (b) -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-,

- (c)  $-(CH_2)_{0-3}-CR_c=CR_c-(CH_2)_{0-3}$ , and/or
- (d)  $-(CH_2)_{0-3}O(CH_2)_{1-3}-$  or  $-(CH_2)_{0-3}S(CH_2)_{1-3}-$ ;

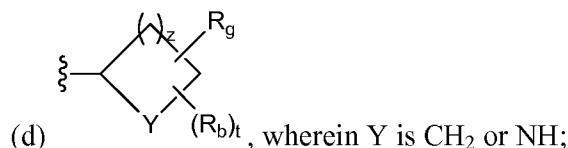
Q is:

- (a) H or  $C_{1-6}$ alkyl; or
- 5 (b) phenyl or 5- to 6-membered heteroaryl substituted with zero to 3 substituents independently selected from F, Cl,  $C_{1-3}$ alkyl, -CN,  $-NO_2$ ,  $-NH_2$ ,  $C_{1-2}$ fluoroalkyl,  $C_{1-3}$ alkoxy,  $C_{1-2}$ fluoroalkoxy,  $-NHC(O)(C_{1-3}alkyl)$ ,  $-NHC(O)O(C_{1-3}alkyl)$ ,  $-NHS(O)_2(C_{1-3}alkyl)$ , and/or  $-S(C_{1-3}alkyl)$ ;

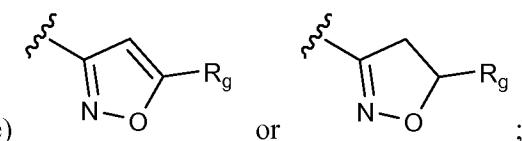
provided that if Q is H or  $C_{1-6}$ alkyl, then  $L_1$  is  $-(CR_bR_b)_{1-4}-$ ,  $L_2$  is a bond, and  $R_1$  and  $R_2$  together with the carbon atom to which they are attached form cyclohexanone; each  $R_3$  is independently F, Cl,  $C_{1-3}$ alkyl,  $C_{1-3}$ alkoxy,  $-CF_3$ ,  $-OCF_3$ ,  $-NHC(O)(C_{1-3}alkyl)$ , and/or  $-S(C_{1-3}alkyl)$ ;

10 G is:

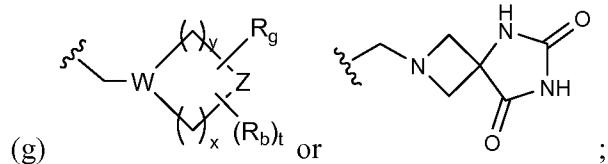
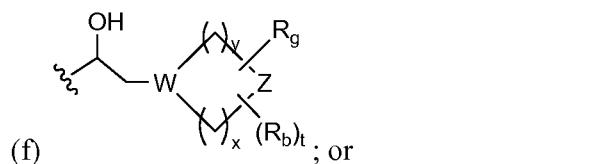
- (a)  $-(CR_eR_e)_aOH$ ,  $-(CR_eR_e)_aC(O)OH$ ,  $-(CR_eR_e)_aCN$ ,  $-(CR_eR_e)_aNH_2$ ,  $-$
- 15 (b)  $(CR_eR_e)_bCR_e(NH_2)(CR_eR_e)_aOH$ , or  $-(CR_eR_e)_bCR_e(NH_2)(CR_eR_e)_aOP(O)(OH)_2$ ;
- (c)  $-(CR_eR_e)_bNR_f(CR_eR_e)_bC(O)OH$ ,  $-(CR_eR_e)_bC(O)NR_f(CR_eR_e)_aC(O)OH$ , or  $-$
- (d)  $(CR_eR_e)_bS(O)_2NR_f(CR_eR_e)_aC(O)OH$ ;
- (e)  $-O(CR_eR_e)_aOH$ ,  $-O(CR_eR_e)_aNH_2$ , or  $-O(CR_eR_e)_aCH(NH_2)(CR_eR_e)_bC(O)OH$ ;



20 (e)



(f)



wherein one of W and Z is CH or N, and the other of W and Z is CH or C(OH), x is 1 or 2; and y is 1 or 2;

each R<sub>a</sub> is independently F, Cl, C<sub>1-3</sub>alkyl, and/or -S(O)<sub>2</sub>R<sub>d</sub>; and/or two R<sub>a</sub> attached to the same carbon atom form =O;

5 each R<sub>b</sub> is independently H, -CH<sub>3</sub>, F, Cl, -OH, and/or C<sub>1-3</sub>alkoxy, provided that if one R<sub>b</sub> is -OH, then the second R<sub>b</sub> attached to the same carbon is not -OH, F, or Cl;

each R<sub>c</sub> is independently H, F, and/or C<sub>1-2</sub>alkyl;

R<sub>d</sub> is phenyl substituted with zero to 2 substituents independently selected from F, Cl, -CH<sub>3</sub>, -CF<sub>3</sub>, -OCH<sub>3</sub>, and/or -OCF<sub>3</sub>;

10 each R<sub>e</sub> is independently H, -OH, -CH<sub>3</sub>, and/or -CH<sub>2</sub>OH, provided that if one R<sub>e</sub> is -OH, then the second R<sub>e</sub> attached to the same carbon is not -OH;

R<sub>f</sub> is H or -CH<sub>3</sub>;

R<sub>g</sub> is -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>OH, -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH, -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>CR<sub>e</sub>(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>OH, or -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>CR<sub>e</sub>(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>OP(O)(OH)<sub>2</sub>;

15 each a is independently 1, 2, 3, and/or 4;

each b is independently zero, 1, 2, 3, and/or 4;

n is zero, 1, 2, or 3;

t is zero, 1, or 2; and

z is 1, 2, or 3.

20 [0019] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein:

(i) R<sub>1</sub> is -CH<sub>3</sub> and R<sub>2</sub> is C<sub>1-C4</sub> alkyl; or

(ii) R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl, bicyclo[2.2.1]heptanyl, bicyclo[2.2.2]octanyl, C<sub>3-6</sub>cycloalkyl, and a 4- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>;

25 L<sub>1</sub> and L<sub>2</sub> are each independently:

(a) a bond,

(b) -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-,

30 (c) -(CH<sub>2</sub>)<sub>0-3</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-3</sub>, and/or

(d) -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-;

Q is:

(a) H or C<sub>1-4</sub>alkyl; or

(b) phenyl or 5- to 6-membered heteroaryl, each substituted with zero to 3 substituents independently selected from F, Cl, C<sub>1-3</sub>alkyl, C<sub>1-2</sub>fluoroalkyl, C<sub>1-3</sub>alkoxy, and/or C<sub>1-2</sub>fluoroalkoxy;

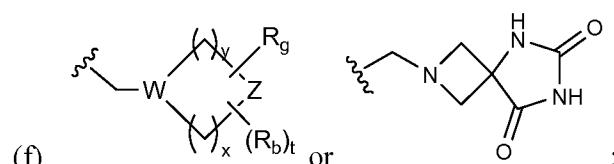
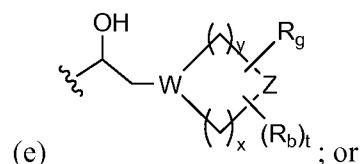
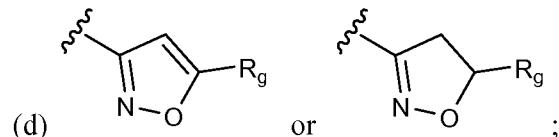
5 provided that if Q is H or C<sub>1-4</sub>alkyl, then L<sub>1</sub> is -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, L<sub>2</sub> is a bond, and R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached form cyclohexanone; each R<sub>3</sub> is independently F, Cl, -CH<sub>3</sub>, -OCH<sub>3</sub>, -CF<sub>3</sub>, and/or -OCF<sub>3</sub>;

G is:

(a) -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH or -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH;

10 (b) -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH, -C(O)NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH, or -S(O)<sub>2</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH;

(c) -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH, -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>NH<sub>2</sub>, or -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>CH(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH;



wherein one of W and Z is CH or N, and the other of W and Z is CH or C(OH), x is 1 or 2; and y is 1 or 2;

each R<sub>a</sub> is independently F, Cl, C<sub>1-3</sub>alkyl, and/or -S(O)<sub>2</sub>R<sub>d</sub>; and/or two R<sub>a</sub> attached to the same carbon atom form =O;

20 each R<sub>b</sub> is independently H, -CH<sub>3</sub>, F, Cl, -OH, and/or C<sub>1-3</sub>alkoxy, with the proviso that if one R<sub>b</sub> is -OH, then the second R<sub>b</sub> attached to the same carbon is not -OH, F, or Cl;

each R<sub>c</sub> is independently H and/or F;

R<sub>d</sub> is phenyl substituted with zero to 2 substituents independently selected from F, Cl, -CH<sub>3</sub>, -CF<sub>3</sub>, -OCH<sub>3</sub>, and/or -OCF<sub>3</sub>;

25 each R<sub>e</sub> is independently H, -OH, and/or -CH<sub>3</sub>, provided that if one R<sub>e</sub> is -OH, then the second R<sub>e</sub> attached to the same carbon is not -OH;

R<sub>f</sub> is H or -CH<sub>3</sub>;

R<sub>g</sub> is -(CR<sub>c</sub>R<sub>c</sub>)<sub>b</sub>OH or -(CR<sub>c</sub>R<sub>c</sub>)<sub>b</sub>C(O)OH;

each a is independently 1, 2, 3, and/or 4;

each b is independently zero, 1, 2, 3, and/or 4;

5 n is zero, 1, 2, or 3; and

t is zero, 1, or 2.

**[0020]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein:

(i) R<sub>1</sub> is -CH<sub>3</sub> and R<sub>2</sub> is C<sub>1</sub>-C<sub>3</sub> alkyl; or

10 (ii) R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl, C<sub>3</sub>-6cycloalkyl, and a 5- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>;

L<sub>1</sub> and L<sub>2</sub> are each independently:

15 (a) a bond,  
(b) -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-,  
(c) -(CH<sub>2</sub>)<sub>0-2</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-2</sub>, and/or  
(d) -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-;

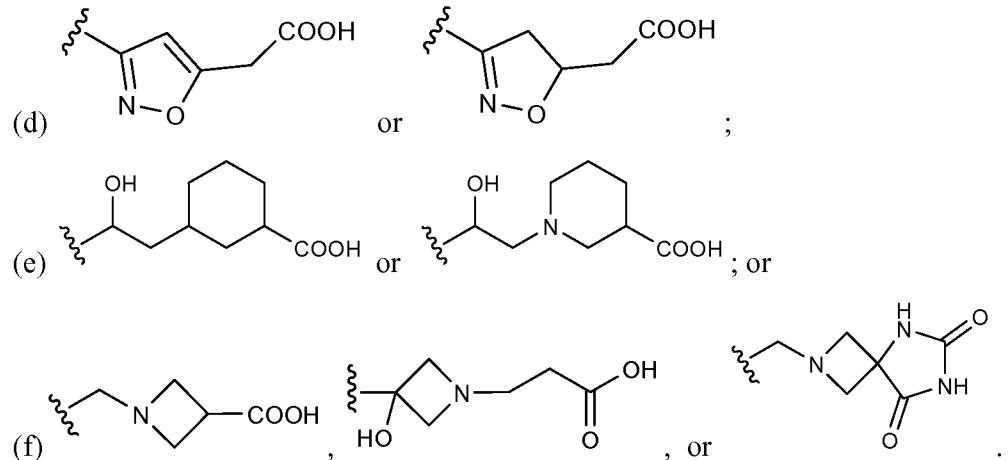
Q is:

20 (a) H or -CH<sub>3</sub>;  
(b) phenyl substituted with zero to 2 substituents independently selected from F, Cl, -CH<sub>3</sub>, -CF<sub>3</sub>, and/or -OCH<sub>3</sub>; or  
(c) pyridinyl;  
provided that if Q is H or -CH<sub>3</sub>, then L<sub>1</sub> is -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-, L<sub>2</sub> is a bond, and R<sub>1</sub> and R<sub>2</sub>  
25 together with the carbon atom to which they are attached form cyclohexanone;  
each R<sub>3</sub> is independently F, Cl, -CH<sub>3</sub>, and/or -CF<sub>3</sub>;  
n is zero, 1, or 2;  
each R<sub>a</sub> is independently -CH<sub>3</sub> and/or -S(O)<sub>2</sub>(methylphenyl); and/or two R<sub>a</sub> attached to the same carbon atom form =O;  
30 each R<sub>b</sub> is independently H, -CH<sub>3</sub>, F, -OH, and/or -OCH<sub>2</sub>CH<sub>3</sub>, with the proviso that if one R<sub>b</sub> is -OH, then the second R<sub>b</sub> attached to the same carbon is not -OH;  
each R<sub>c</sub> is independently H and/or F; and

G is:

(a) -CH<sub>2</sub>OH or -CH(OH)C(O)OH;  
 (b) -CH(OH)CH<sub>2</sub>NHCH<sub>2</sub>CH<sub>2</sub>C(O)OH, -C(O)NHCH<sub>2</sub>CH<sub>2</sub>C(O)OH, -C(O)NHCH(CH<sub>3</sub>)CH<sub>2</sub>C(O)OH, or -S(O)<sub>2</sub>NHCH<sub>2</sub>CH<sub>2</sub>C(O)OH;

5 (c) -OCH<sub>2</sub>CH(OH)CH<sub>2</sub>OH, -OCH<sub>2</sub>CH(NH<sub>2</sub>)CH<sub>2</sub>OH, or -OCH<sub>2</sub>CH(OH)CH<sub>2</sub>NH<sub>2</sub>;



10 [0021] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein R<sub>1</sub> and R<sub>2</sub> are independently C<sub>1</sub>-C<sub>4</sub> alkyl; preferably R<sub>1</sub> is -CH<sub>3</sub> and R<sub>2</sub> is C<sub>1</sub>-C<sub>4</sub> alkyl; and more preferably, R<sub>1</sub> is -CH<sub>3</sub> and R<sub>2</sub> is C<sub>1</sub>-C<sub>3</sub> alkyl. Included in this embodiment are compounds of Formula (I) in which R<sub>1</sub> is -CH<sub>3</sub> and R<sub>2</sub> is -CH<sub>3</sub>.

[0022] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl, bicyclo[2.2.1]heptanyl, bicyclo[2.2.2]octanyl, C<sub>3</sub>-<sub>6</sub>cycloalkyl, and a 4- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>; and preferably, R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl, C<sub>3</sub>-<sub>6</sub>cycloalkyl, and a 5- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>. Each R<sub>a</sub> is independently F, Cl, C<sub>1</sub>-<sub>3</sub>alkyl, and/or -S(O)<sub>2</sub>R<sub>d</sub>, and/or two R<sub>a</sub> attached to the same carbon atom form =O. Included in this embodiment are compounds of Formula (I) in which each R<sub>a</sub> is independently -CH<sub>3</sub> and/or -S(O)<sub>2</sub>(methylphenyl), and/or two R<sub>a</sub> attached to the same carbon atom form =O.

**[0023]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl, bicyclo[2.2.1]heptanyl, and bicyclo[2.2.2]octanyl.

5 **[0024]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from C<sub>3-6</sub>cycloalkyl and a 4- to 6-membered heterocycloalkyl, preferably a cyclic group selected from C<sub>3-6</sub>cycloalkyl and a 5- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is 10 substituted with zero to 4 R<sub>a</sub>.

**[0025]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a C<sub>3-6</sub>cycloalkyl substituted with zero to 4 R<sub>a</sub>. Examples of suitable cycloalkyl groups include cyclopropyl, cyclobutyl, cyclopentyl, and cyclohexyl groups.

15 Examples of C<sub>3-6</sub>cycloalkyl groups substituted with 1 to 4 R<sub>a</sub> include dimethyl cyclopropane, cyclopantanone, and cyclohexanone.

**[0026]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a 4- to 6-membered heterocycloalkyl, preferably a 5- to 6-membered heterocycloalkyl, substituted with zero to 4 R<sub>a</sub>. Examples of suitable heterocycloalkyl groups include pyrrolidine, piperidine, tetrahydrofuran, and tetrahydropyran. An example of a heterocyclalkyl group substituted with 1 to 4 R<sub>a</sub> is (4-methylphenyl)sulfonyl pyrrolidine.

25 **[0027]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein n is zero, 1, 2, or 3; and each R<sub>3</sub> is independently F, Cl, C<sub>1-3</sub>alkyl, C<sub>1-3</sub>alkoxy, -CF<sub>3</sub>, -OCF<sub>3</sub>, -NHC(O)(C<sub>1-3</sub>alkyl), and/or -S(C<sub>1-3</sub>alkyl). Preferably, each R<sub>3</sub> is independently F, Cl, -CH<sub>3</sub>, -OCH<sub>3</sub>, -CF<sub>3</sub>, and/or -OCF<sub>3</sub>. Included in this embodiment are compounds of Formula (I) in which n is zero, 1, or 2 and each R<sub>3</sub> is independently F, Cl, -CH<sub>3</sub>, and/or -CF<sub>3</sub>.

30 **[0028]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein L<sub>1</sub> and L<sub>2</sub> are each independently a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, -(CH<sub>2</sub>)<sub>0-3</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-3</sub>, and/or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-.

Included in this embodiment are

compounds in which L<sub>1</sub> and L<sub>2</sub> are each independently a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-, -(CH<sub>2</sub>)<sub>0-2</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-2</sub>, and/or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-. Also included in this embodiment are compounds in which L<sub>1</sub> and L<sub>2</sub> are independently a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-, -(CH<sub>2</sub>)<sub>0-1</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-1</sub>, and/or -(CH<sub>2</sub>)<sub>0-1</sub>O(CH<sub>2</sub>)<sub>0-1</sub>.

5 [0029] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein L<sub>1</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-, -(CH<sub>2</sub>)<sub>0-2</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-2</sub>, and/or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-. Included in this embodiment are compounds in which L<sub>1</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-, -(CH<sub>2</sub>)<sub>0-1</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-1</sub>, or -(CH<sub>2</sub>)<sub>0-1</sub>O(CH<sub>2</sub>)<sub>0-1</sub>.

10 [0030] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein L<sub>2</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-. Included in this embodiment are compounds in which L<sub>2</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-2</sub>-, or -(CH<sub>2</sub>)<sub>0-1</sub>O(CH<sub>2</sub>)<sub>1-2</sub>-. Also included in this embodiment are compounds in which L<sub>2</sub> is a bond, -CH<sub>2</sub>-, or -CH<sub>2</sub>OCH<sub>2</sub>-.

15 [0031] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein L<sub>1</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, -(CH<sub>2</sub>)<sub>0-3</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-3</sub>, or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-, and L<sub>2</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-. Included in this embodiment are compounds in which L<sub>1</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-, -(CH<sub>2</sub>)<sub>0-2</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-2</sub>, or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-2</sub>-, and L<sub>2</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-2</sub>-, or -(CH<sub>2</sub>)<sub>0-2</sub>O(CH<sub>2</sub>)<sub>1-2</sub>-. Also included are compounds in which L<sub>1</sub> is a bond, -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-3</sub>-, -(CH<sub>2</sub>)<sub>0-1</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-1</sub>, or -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-, and L<sub>2</sub> is a bond, -CH<sub>2</sub>-, and -CH<sub>2</sub>OCH<sub>2</sub>-.

20 [0032] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein Q is H or C<sub>1-6</sub>alkyl; L<sub>1</sub> is -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, L<sub>2</sub> is a bond; and R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached form cyclohexanone. Preferably, Q is H or C<sub>1-4</sub>alkyl; and more preferably H or -CH<sub>3</sub>.

25 [0033] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein Q is phenyl or 5- to 6-membered heteroaryl substituted with zero to 3 substituents independently selected from F, Cl, C<sub>1-3</sub>alkyl, -CN, -NO<sub>2</sub>, -NH<sub>2</sub>, C<sub>1-2</sub>fluoroalkyl, C<sub>1-3</sub>alkoxy, C<sub>1-2</sub>fluoroalkoxy, -NHC(O)(C<sub>1-3</sub>alkyl), -NHC(O)O(C<sub>1-3</sub>alkyl), -NHS(O)<sub>2</sub>(C<sub>1-3</sub>alkyl), and/or -S(C<sub>1-3</sub>alkyl). Preferably, Q is phenyl or 5- to 6-membered heteroaryl, each substituted with zero to 3 substituents independently selected from F, Cl, C<sub>1-3</sub>alkyl, C<sub>1-2</sub>fluoroalkyl, C<sub>1-3</sub>alkoxy, and/or C<sub>1-2</sub>fluoroalkoxy. Included in this

embodiment are compounds of Formula (I) in which Q is phenyl substituted with zero to 2 substituents independently selected from F, Cl, -CH<sub>3</sub>, -CF<sub>3</sub>, and/or -OCH<sub>3</sub>; or pyridinyl.

**[0034]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein Q is phenyl substituted with zero to 3 substituents

5 independently selected from F, Cl, C<sub>1-3</sub>alkyl, -CN, -NO<sub>2</sub>, -NH<sub>2</sub>, C<sub>1-2</sub>fluoroalkyl, C<sub>1-3</sub>alkoxy, C<sub>1-2</sub>fluoroalkoxy, -NHC(O)(C<sub>1-3</sub>alkyl), -NHC(O)O(C<sub>1-3</sub>alkyl), -NHS(O)<sub>2</sub>(C<sub>1-3</sub>alkyl), and/or -S(C<sub>1-3</sub>alkyl). Preferably, Q is phenyl substituted with zero to 3 substituents independently selected from F, Cl, C<sub>1-3</sub>alkyl, C<sub>1-2</sub>fluoroalkyl, C<sub>1-3</sub>alkoxy, and/or C<sub>1-2</sub>fluoroalkoxy. Included in this embodiment are compounds of Formula (I) in

10 which Q is phenyl substituted with zero to 2 substituents independently selected from F, Cl, -CH<sub>3</sub>, -CF<sub>3</sub>, and/or -OCH<sub>3</sub>.

**[0035]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH, -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH, -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>CN, or -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>NH<sub>2</sub>; preferably G is -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH or -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH. Included in this

15 embodiment are compounds of Formula (I) in which G is -CH<sub>2</sub>OH or -CH(OH)C(O)OH.

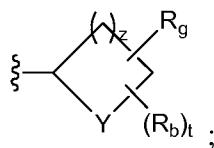
**[0036]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH, -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH, or -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>S(O)<sub>2</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH; preferably G is -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH, -C(O)NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH, or -

20 S(O)<sub>2</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH. Included in this embodiment are compounds of Formula (I) in which G is -CH(OH)CH<sub>2</sub>NHCH<sub>2</sub>CH<sub>2</sub>C(O)OH, -C(O)NHCH<sub>2</sub>CH<sub>2</sub>C(O)OH, -C(O)NHCH(CH<sub>3</sub>)CH<sub>2</sub>C(O)OH, or -S(O)<sub>2</sub>NHCH<sub>2</sub>CH<sub>2</sub>C(O)OH.

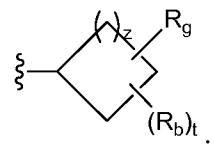
**[0037]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH, -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>NH<sub>2</sub>, or -

25 O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>CH(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH; preferably G is -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH, -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>NH<sub>2</sub>, or -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>CH(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH. Included in this embodiment are compounds of Formula (I) in which G is -OCH<sub>2</sub>CH(OH)CH<sub>2</sub>OH, -OCH<sub>2</sub>CH(NH<sub>2</sub>)CH<sub>2</sub>OH, or -OCH<sub>2</sub>CH(OH)CH<sub>2</sub>NH<sub>2</sub>.

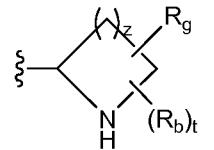
**[0038]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is:



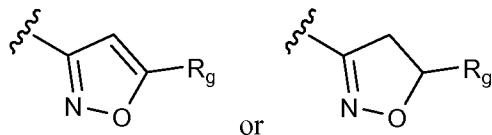
Y is  $\text{CH}_2$  or  $\text{NH}$ ; and  $z$  is 1, 2, or 3. Included in this embodiment are compounds in which Y is  $\text{CH}_2$ ; and G is:



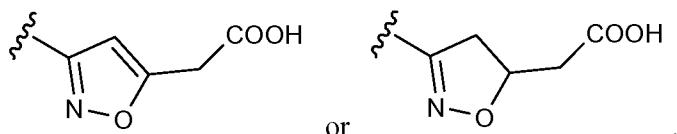
5 Also included in this embodiment are compounds in which Y is  $\text{NH}$ ; and G is:



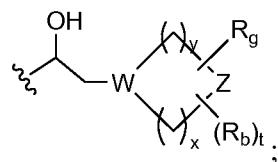
[0039] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is:



10 and  $R_g$  is  $-(\text{CR}_e\text{R}_e)_b\text{OH}$  or  $-(\text{CR}_e\text{R}_e)_b\text{C}(\text{O})\text{OH}$ ; each  $R_e$  is independently H, -OH, and/or  $-\text{CH}_3$ , provided that if one  $R_e$  is -OH, then the second  $R_e$  attached to the same carbon is not -OH; and each  $b$  is independently zero, 1, 2, 3, and/or 4. Included in this embodiment are compounds in which G is



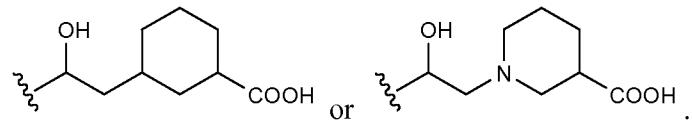
15 [0040] One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is:



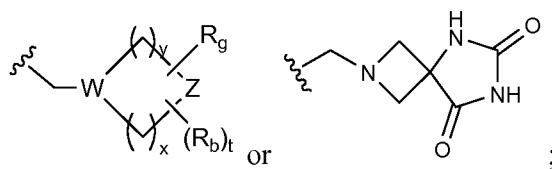
one of W and Z is  $\text{CH}$  or  $\text{N}$ , and the other of W and Z is  $\text{CH}$  or  $\text{C}(\text{OH})$ ;  $x$  is 1 or 2;  $y$  is 1 or 2;  $R_g$  is  $-(\text{CR}_e\text{R}_e)_b\text{OH}$  or  $-(\text{CR}_e\text{R}_e)_b\text{C}(\text{O})\text{OH}$ ; each  $R_e$  is independently H, -OH, and/or  $-\text{CH}_3$ .

CH<sub>3</sub>, provided that if one R<sub>e</sub> is -OH, then the second R<sub>e</sub> attached to the same carbon is not -OH; each R<sub>b</sub> is independently H, -CH<sub>3</sub>, F, Cl, -OH, and/or C<sub>1-3</sub>alkoxy, provided that if one R<sub>b</sub> is -OH, then the second R<sub>b</sub> attached to the same carbon is not -OH, F, or Cl; and t is zero, 1, or 2. Included in this embodiment are compounds in which G is

5

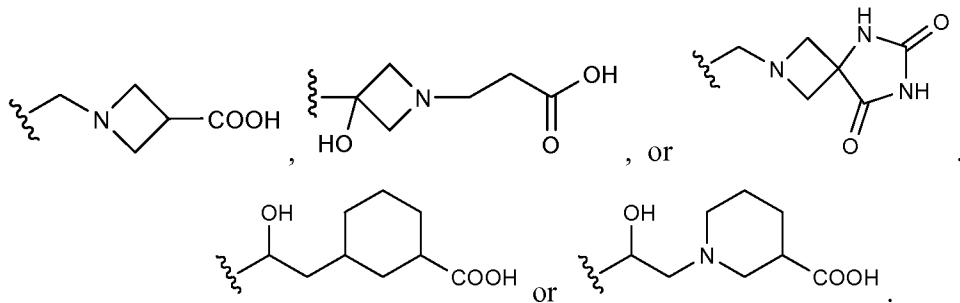


**[0041]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is:



one of W and Z is CH or N, and the other of W and Z is CH or C(OH); x is 1 or 2; and y is 10 1 or 2; R<sub>g</sub> is -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>OH or -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH; each R<sub>e</sub> is independently H, -OH, and/or -CH<sub>3</sub>, provided that if one R<sub>e</sub> is -OH, then the second R<sub>e</sub> attached to the same carbon is not -OH; each R<sub>b</sub> is independently H, -CH<sub>3</sub>, F, Cl, -OH, and/or C<sub>1-3</sub>alkoxy, provided that if one R<sub>b</sub> is -OH, then the second R<sub>b</sub> attached to the same carbon is not -OH, F, or Cl; and t is zero, 1, or 2. Included in this embodiment are compounds in which G is

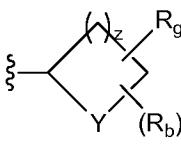
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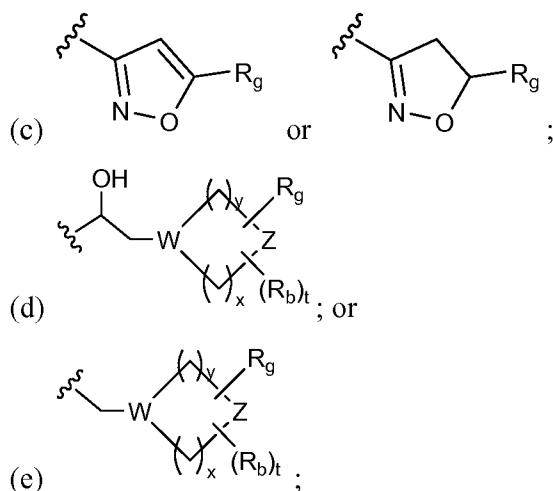


**[0042]** One embodiment provides compounds of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein G is:

(a) -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>CR<sub>e</sub>(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OP(O)(OH)<sub>2</sub>;

20

(b)  , wherein Y is CH<sub>2</sub> or NH;



wherein one of W and Z is CH or N, and the other of W and Z is CH or C(OH), x is 1

5 or 2; and y is 1 or 2;

each R<sub>b</sub> is independently H, -CH<sub>3</sub>, F, Cl, -OH, and/or C<sub>1-3</sub>alkoxy, provided that if one R<sub>b</sub> is -OH, then the second R<sub>b</sub> attached to the same carbon is not -OH, F, or Cl;

each R<sub>e</sub> is independently H, -OH, -CH<sub>3</sub>, and/or -CH<sub>2</sub>OH, provided that if one R<sub>e</sub> is -OH, then the second R<sub>e</sub> attached to the same carbon is not -OH;

10 R<sub>g</sub> is -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>CR<sub>e</sub>(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>OP(O)(OH)<sub>2</sub>;

each a is independently 1, 2, 3, and/or 4;

each b is independently zero, 1, 2, 3, and/or 4;

t is zero, 1, or 2; and

z is 1, 2, or 3.

15 [0043] One embodiment provides a compound of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein said compound is selected from: 1-(4-(5-(2-(1-

phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (1); 1-

(4-(5-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-

carboxylic acid (2); 2-(2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-

20 oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl)cyclohexanone (3); 2-(2-(3-(4-((S)-2,3-

dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl)

cyclohexanone (4); 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-

yl)benzyl)azetidine-3-carboxylic acid (5); (E)-1-(4-(5-(2-(1-(3,4-difluorophenyl)

cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (6); 1-(4-(5-(2-

25 (1-(3-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylic

acid (7); 1-(4-(5-(3-(1-(4-fluorophenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)

azetidine-3-carboxylic acid (8); 1-(4-(5-(3-(1-(4-fluorophenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (9); (S)-3-(2,6-dimethyl-4-(5-(3-(1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol (10); 1-(4-(5-(3-(2-oxo-1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (11); 2-(3-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)propyl)-2-phenylcyclohexanone (12); 1-(4-(5-(((1-(4-fluorophenyl)cyclohexyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (18); 2-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-2,5,7-triazaspiro[3.4]octane-6,8-dione (19); N-(2-hydroxy-2-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)ethyl)- $\beta$ -alanine (20); N-(2-(4-(5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)- $\beta$ -alanine (21); (3S)-1-(2-(4-(5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (22); (3S)-1-(2-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (23); 3-(3-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-3-hydroxy-1-azetidinyl)propanoic acid (24); N-(2-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)- $\beta$ -alanine (25); 2-(2-(3-(4-(hydroxymethyl)phenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-phenylcyclohexanone (26); (4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (27); (2S)-2-(2-(3-(4-(hydroxymethyl)phenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-methylcyclohexanone (28); (4-(5-(((1-phenylcyclohexyl)oxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (29); 2-((3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)methyl)-2-phenylcyclohexanone (30); (4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (31); 2-(2-(3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-phenylcyclohexanone (32); (2S)-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanediol (33); (2S)-3-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (35); (2S)-3-(4-(5-(2-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (37); (2S)-3-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-fluoroethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (40); 2-(2-(3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-



1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (67); 1-(4-(5-(2-(1-(3,5-  
5 difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid  
(68); 1-(4-(5-(2-(1-(3,4-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-  
azetidinecarboxylic acid (69); 1-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-  
10 oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (70); 1-(4-(5-(2-(1-(3-chlorophenyl)  
cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (71); 1-(4-(5-(  
2-(1-(2-chloro-6-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-  
azetidinecarboxylic acid (72); 1-(4-(5-(2-(1-(2-fluorophenyl)cyclohexyl)ethyl)-1,2,4-  
15 oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (73); 1-(4-(5-(2-(1-(4-chlorophenyl)  
cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (74); 1-(4-(5-(  
2-(1-(4-chlorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-  
azetidinecarboxylic acid (75); 1-(4-(5-(2-(1-(4-fluorophenyl)cyclopentyl)ethyl)-1,2,4-  
20 oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (76); 1-(4-(5-(2-(1-(3-fluorophenyl)  
cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (77); 1-(4-(5-(  
2-(1-(2-chloro-4-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-  
azetidinecarboxylic acid (78); 1-(4-(5-(2-(1-(2-fluorophenyl)cyclopentyl)ethyl)-1,2,4-  
25 oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (79); 1-(4-(5-(2-(1-(4-chlorophenyl)  
cyclobutyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (80); 1-(4-(5-(2-(  
1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic  
30 acid (81); 1-(4-(5-(2-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)ethyl)-1,2,4-oxadiazol-  
3-yl)benzyl)-3-azetidinecarboxylic acid (82); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-  
1,1-dimethylethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (83); 1-(4-(5-(  
2-(1-(4-chlorophenyl)cyclopropyl)-1-methylethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-  
azetidinecarboxylic acid (84); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1,1-difluoro-2-  
35 hydroxyethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (85); 1-(4-(5-(2-(1-(  
4-chlorophenyl)cyclopropyl)-1-ethoxyethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-  
azetidinecarboxylic acid (86); 1-(4-(5-((E)-2-(1-(3,5-difluorophenyl)cyclohexyl)vinyl)-  
1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (87); 1-(4-(5-((E)-2-(1-(4-  
40 trifluoromethyl)phenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-  
azetidinecarboxylic acid (88); 1-(4-(5-((E)-2-(1-(3,4-dichlorophenyl)cyclohexyl)vinyl)-  
1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (89); 1-(4-(5-((E)-2-(1-(3-  
45 chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid

(90); 1-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (91); 1-(4-(5-((E)-2-(1-(4-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (92); 1-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (93); 1-(4-(5-((E)-2-(1-(3-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (94); 1-(4-(5-((E)-2-(1-(2-chloro-4-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (95); 1-(4-(5-((E)-2-(1-(2-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (96); 1-(4-(5-((E)-2-(1-(4-chlorophenyl)cyclopropyl)-1-fluorovinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (97); 1-(4-(5-(3-(1-(4-chlorophenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (99); 1-(4-(5-((1E)-3-(1-(4-fluorophenyl)cyclohexyl)-1-propen-1-yl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (99); 1-(4-(5-((2E)-3-(1-(4-fluorophenyl)cyclohexyl)-2-propen-1-yl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (100); 1-(4-(5-(3-(1-(4-fluorophenyl)cyclopropyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (101); 1-(4-(5-(2-(1-benzylcyclobutyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (102); 1-(4-(5-((E)-2-(1-benzylcyclobutyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (103); 1-(4-(5-(1-(4-chlorophenyl)cyclopropyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (104); 1-(4-(5-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (105); 1-(4-(5-(2-(2-oxo-1-phenylcyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (106); 1-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (116); 1-(4-(5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (117); 1-(4-(5-(((1-((benzyloxy)methyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (118); 1-(4-(5-(((1-((benzyloxy)methyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (119); 1-(4-(5-(((1-benzylcyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (120); 1-(4-(5-(2-(2-oxo-1-(2-pyridinyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (121); (3S)-1-(2-(4-((5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (130); (R/S)-(3-(4-(5-(2-(1-

phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (131); (R)-(3-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (132); (S)-(3-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (133); (3-(4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (134); (3-(4-(5-(2-(1-(4-chlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (135); (3-(4-(5-(3-(1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (136); (3S)-1-(2-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (137); (3S)-1-(2-(4-(5-((E)-2-(1-(4-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (138); (3-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-5-isoxazolyl)acetic acid (139); hydroxy(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)acetic acid (140); 1-(3-chloro-4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (141); 1-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-3-(trifluoromethyl)benzyl)-3-azetidinecarboxylic acid (142); and 1-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-3-fluorobenzyl)-3-azetidinecarboxylic acid (143);

20 **[0044]** One embodiment provides a compound of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein said compound is selected from: 1-(4-(5-(2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (13); 1-(4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (14); (2S)-3-(2,6-dimethyl-4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol (15); 1-(4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (16); (2S)-3-(2,6-dimethyl-4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)methyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol (17); (2S)-3-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-

25 oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (34); (2S)-3-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (36); (2S)-3-(4-(5-(2-(3-(4-fluorophenyl)tetrahydro-3-

furanyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-panedol (38); (2S)-3-(4-(5-(2-(3-(4-chlorophenyl)-1-((4-methylphenyl)sulfonyl)-3-pyrrolidinyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanedol (39); (2S)-3-(4-(5-((E)-2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)vinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanedol (44); 1-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (107); 1-(4-(5-(2-(4-(3-pyridinyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (108); 1-(4-(5-((E)-2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (109); 1-(4-(5-(2-(4-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (110); 1-(4-(5-(2-(3-(4-fluorophenyl)tetrahydro-3-furanyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (111); 1-(4-(5-(2-(3-(4-chlorophenyl)-1-((4-methylphenyl)sulfonyl)-3-pyrrolidinyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (112); 1-(4-(5-(((4-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (113); 1-(4-(5-(((4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (114); and 1-(4-(5-(((4-(2,4-difluorophenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (115).

20 [0045] One embodiment provides a compound of Formula (I) or stereoisomers, salts, or prodrugs thereof, wherein said compound is selected from: (2S)-3-(2,6-dimethyl-4-(5-(3-methyl-3-phenylhexyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanedol (53); 1-(4-(5-((2-(4-chlorophenyl)-2-methylpropoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (122); 1-(4-(5-((3-(benzyloxy)-2,2-dimethylpropoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (123); 1-(4-(5-(3-methyl-3-(4-methylphenyl)butyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (124); 1-(4-(5-(3-(4-chlorophenyl)-3-methylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (125); 1-(4-(5-(3-methyl-3-phenylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (126); 1-(4-(5-(3-(4-chloro-3-fluorophenyl)-3-methylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (127); 1-(4-(5-(4-(4-fluorophenyl)-4-methylpentyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (128); and 1-(4-(5-

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(4-(4-chlorophenyl)-4-methylpentyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (129).

**[0046]** The compounds of Formula (I) have GTP $\gamma$ S S1P<sub>1</sub> EC<sub>50</sub> values of 15  $\mu$ M or less as measured by the S1P<sub>1</sub> Receptor GTP $\gamma$ S Binding Assay described herein below.

5 Preferably, the compounds of Formula (I) have GTP $\gamma$ S S1P<sub>1</sub> EC<sub>50</sub> values in the range of 0.1 nM to 5  $\mu$ M, and more preferably, in the range of from 0.1 nM to 1  $\mu$ M. Other preferred compounds of Formula (I) have GTP $\gamma$ S S1P<sub>1</sub> EC<sub>50</sub> values in the range of from 0.1 nM to 100 nM.

**[0047]** The compounds of Formula (I) are selective for S1P<sub>1</sub> activity over S1P<sub>3</sub> activity as measured by the selectivity ratio of the GTP $\gamma$ S S1P<sub>3</sub> EC<sub>50</sub> value to the GTP $\gamma$ S S1P<sub>1</sub> EC<sub>50</sub> value. The S1P<sub>1</sub> Receptor GTP $\gamma$ S Binding Assay and the S1P<sub>3</sub> Binding Assay are described herein below. The compounds of Formula (I) have selectivity ratios (GTP $\gamma$ S S1P<sub>3</sub>/S1P<sub>1</sub>) of at least 3.5 or greater, preferably at least 50 or greater, and more preferably at least 100 or greater. For example, suitable compounds of Formula (I) can have 15 selectivity ratios in the range of from 50 to 1,000. Other suitable compounds of Formula (I) can have selectivity ratios in the range of from 100 to 1,000.

**[0048]** In one embodiment, the compounds of Formula (I) are provided having GTP $\gamma$ S S1P<sub>1</sub> EC<sub>50</sub> values in the range of from 0.1 nM to 100 nM and selectivity ratios (GTP $\gamma$ S S1P<sub>3</sub>/S1P<sub>1</sub>) of at least 50, and more preferably, at least 100.

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## DEFINITIONS

**[0049]** The features and advantages of the invention may be more readily understood by those of ordinary skill in the art upon reading the following detailed description. It is to be appreciated that certain features of the invention that are, for clarity reasons, described 25 above and below in the context of separate embodiments, may also be combined to form a single embodiment. Conversely, various features of the invention that are, for brevity reasons, described in the context of a single embodiment, may also be combined so as to form sub-combinations thereof. Embodiments identified herein as exemplary or preferred are intended to be illustrative and not limiting.

**[0050]** Unless specifically stated otherwise herein, references made in the singular 30 may also include the plural. For example, "a" and "an" may refer to either one, or one or more.

[0051] Unless otherwise indicated, any heteroatom with unsatisfied valences is assumed to have hydrogen atoms sufficient to satisfy the valences.

[0052] The definitions set forth herein take precedence over definitions set forth in any patent, patent application, and/or patent application publication incorporated herein by reference.

[0053] Listed below are definitions of various terms used to describe the present invention. These definitions apply to the terms as they are used throughout the specification (unless they are otherwise limited in specific instances) either individually or as part of a larger group.

10 [0054] Throughout the specification, groups and substituents thereof may be chosen by one skilled in the field to provide stable moieties and compounds.

[0055] In accordance with a convention used in the art,

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is used in structural formulas herein to depict the bond that is the point of attachment of

15 the moiety or substituent to the core or backbone structure.

[0056] The terms “halo” and “halogen,” as used herein, refer to F, Cl, Br, and I.

[0057] The term “alkyl” as used herein, refers to both branched and straight-chain saturated aliphatic hydrocarbon groups containing, for example, from 1 to 12 carbon atoms, from 1 to 6 carbon atoms, and from 1 to 4 carbon atoms. Examples of alkyl groups include, but are not limited to, methyl (Me), ethyl (Et), propyl (e.g., n-propyl and i-propyl), butyl (e.g., n-butyl, i-butyl, sec-butyl, and t-butyl), and pentyl (e.g., n-pentyl, isopentyl, neopentyl), n-hexyl, 2-methylpentyl, 2-ethylbutyl, 3-methylpentyl, and 4-methylpentyl. When numbers appear in a subscript after the symbol “C”, the subscript defines with more specificity the number of carbon atoms that a particular group may contain. For example, “C<sub>1</sub>-C<sub>6</sub> alkyl” denotes straight and branched chain alkyl groups with one to six carbon atoms.

[0058] As used herein, “alkylene” refers to a bivalent alkyl radical having the general formula -(CH<sub>2</sub>)<sub>n</sub>-, where n is 1 to 10. Non-limiting examples include methylene, dimethylene, trimethylene, tetramethylene, pentamethylene, and hexamethylene. For

30 example, “C<sub>1</sub>-C<sub>6</sub> alkylene” denotes straight and branched chain alkylene groups with one to six carbon atoms. Further, for example, “C<sub>0</sub>-C<sub>4</sub> alkylene” denotes a bond and straight and branched chain alkylene groups with one to four carbon atoms.

**[0059]** The term “fluoroalkyl” as used herein is intended to include both branched and straight-chain saturated aliphatic hydrocarbon groups substituted with one or more fluorine atoms. For example, “C1-4 fluoroalkyl” is intended to include C1, C2, C3, and C4 alkyl groups substituted with one or more fluorine atoms. Representative examples of 5 fluoroalkyl groups include, but are not limited to, -CF3 and -CH2CF3.

**[0060]** The term “hydroxyalkyl” includes both branched and straight-chain saturated alkyl groups substituted with one or more hydroxyl groups. For example, “hydroxyalkyl” includes -CH2OH, -CH2CH2OH, and C1-4hydroxyalkyl.

**[0061]** The term “cyano” refers to the group -CN.

10 **[0062]** The term “cycloalkyl,” as used herein, refers to a group derived from a non-aromatic monocyclic or polycyclic hydrocarbon molecule by removal of one hydrogen atom from a saturated ring carbon atom. Representative examples of cycloalkyl groups include, but are not limited to, cyclopropyl, cyclopentyl, and cyclohexyl. When numbers appear in a subscript after the symbol “C”, the subscript defines with more specificity the 15 number of carbon atoms that a particular cycloalkyl group may contain. For example, “C<sub>3</sub>-C<sub>6</sub> cycloalkyl” denotes cycloalkyl groups with three to six carbon atoms.

**[0063]** The term “alkenyl” refers to a straight or branched chain hydrocarbon radical containing from 2 to 12 carbon atoms and at least one carbon-carbon double bond.

Exemplary such groups include ethenyl or allyl. For example, “C<sub>2</sub>-C<sub>6</sub> alkenyl” denotes 20 straight and branched chain alkenyl groups with two to six carbon atoms.

**[0064]** The term “alkoxy,” as used herein, refers to an alkyl group attached to the parent molecular moiety through an oxygen atom, for example, methoxy group (-OCH<sub>3</sub>).

**[0065]** “Fluoroalkoxy” and “-O(fluoroalkyl)” represent a fluoroalkyl group as defined above attached through an oxygen linkage (-O-). For example, “C<sub>1-4</sub>fluoroalkoxy” is 25 intended to include C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>, and C<sub>4</sub> fluoroalkoxy groups.

**[0066]** The term “aryl,” as used herein, refers to a group of atoms derived from a molecule containing aromatic ring(s) by removing one hydrogen that is bonded to the aromatic ring(s). Representative examples of aryl groups include, but are not limited to, phenyl, naphthyl, indanyl, indenyl, and 1,2,3,4-tetrahydronaphth-5-yl.

30 **[0067]** The term “benzyl” as used herein, refers to a methyl group in which one of the hydrogen atoms is replaced by a phenyl group.

**[0068]** The term “heteroatom” refers to oxygen (O), sulfur (S), and nitrogen (N).

**[0069]** The term “heterocyclo” or “heterocyclyl” may be used interchangeably and refer to non-aromatic 3- to 7-membered monocyclic groups and 6- to 11-membered bicyclic groups, in which at least one of the rings has at least one heteroatom (O, S or N), said heteroatom containing ring preferably having 1 to 3 heteroatoms independently

5 selected from O, S, and/or N. Each ring of such a group containing a heteroatom can contain one or two oxygen or sulfur atoms and/or from one to four nitrogen atoms provided that the total number of heteroatoms in each ring is four or less, and further provided that the ring contains at least one carbon atom. The nitrogen and sulfur atoms may optionally be oxidized and the nitrogen atoms may optionally be quaternized. The 10 fused rings completing the bicyclic group may contain only carbon atoms and may be saturated, partially saturated, or unsaturated. The heterocyclo group may be attached at any available nitrogen or carbon atom. The heterocyclo ring may be unsubstituted or may contain one or more substituents as valence allows.

**[0070]** Exemplary monocyclic heterocyclyl groups include oxetanyl, azetidinyl, 15 pyrrolidinyl, imidazolinyl, oxazolidinyl, isoxazolinyl, thiazolidinyl, isothiazolidinyl, tetrahydrofuranyl, piperidinyl, piperazinyl, 2-oxopiperazinyl, 2-oxopiperidinyl, 2-oxopyrrolodinyl, 2-oxoazepinyl, azepinyl, 4-piperidonyl, tetrahydropyranyl, morpholinyl, thiamorpholinyl, thiamorpholinyl sulfoxide, thiamorpholinyl sulfone, 1,3-dioxolane and tetrahydro-1,1-dioxothienyl.

**[0071]** The term “heteroaryl” refers to substituted and unsubstituted aromatic 5- or 6-membered monocyclic groups and 9- or 10-membered bicyclic groups which have at least one heteroatom (O, S or N) in at least one of the rings, said heteroatom-containing ring preferably having 1, 2, or 3 heteroatoms independently selected from O, S, and/or N. Each ring of the heteroaryl group containing a heteroatom can contain one or two oxygen 25 or sulfur atoms and/or from one to four nitrogen atoms provided that the total number of heteroatoms in each ring is four or less and each ring has at least one carbon atom. The fused rings completing the bicyclic group may contain only carbon atoms and may be saturated, partially saturated, or unsaturated. The nitrogen and sulfur atoms may optionally be oxidized and the nitrogen atoms may optionally be quaternized. Heteroaryl 30 groups which are bicyclic or tricyclic must include at least one fully aromatic ring but the other fused ring or rings may be aromatic or non-aromatic. The heteroaryl group may be

attached at any available nitrogen or carbon atom of any ring. The heteroaryl ring system may be unsubstituted or may contain one or more substituents.

[0072] Exemplary monocyclic heteroaryl groups include pyrrolyl, pyrazolyl, pyrazolinyl, imidazolyl, oxazolyl, isoxazolyl, thiazolyl, thiadiazolyl, isothiazolyl, furanyl, thiophenyl, oxadiazolyl, pyridinyl, pyrazinyl, pyrimidinyl, pyridazinyl, and triazinyl.

[0073] Exemplary bicyclic heteroaryl groups include indolyl, benzothiazolyl, benzodioxolyl, benzoxazolyl, benzothienyl, quinolinyl, tetrahydroisoquinolinyl, isoquinolinyl, benzimidazolyl, benzopyranyl, indolizinyl, benzofuranyl, chromonyl, coumarinyl, benzopyranyl, cinnolinyl, quinoxalinyl, indazolyl, pyrrolopyridyl, furopyridyl, dihydroisoindolyl, and tetrahydroquinolinyl.

[0074] The term “heterocyclalkyl,” as used herein, refers to an heterocyclyl group, as defined herein, appended to the parent molecular moiety through an alkylene group, as defined herein.

[0075] The phrase “pharmaceutically acceptable” is employed herein to refer to those compounds, materials, compositions, and/or dosage forms which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problem or complication, commensurate with a reasonable benefit/risk ratio.

[0076] As used herein, “pharmaceutically acceptable salts” refer to derivatives of the disclosed compounds wherein the parent compound is modified by making acid or base salts thereof. Examples of pharmaceutically acceptable salts include, but are not limited to, mineral or organic acid salts of basic residues such as amines; and alkali or organic salts of acidic residues such as carboxylic acids. The pharmaceutically acceptable salts include the conventional non-toxic salts or the quaternary ammonium salts of the parent compound formed, for example, from non-toxic inorganic or organic acids. The pharmaceutically acceptable salts of the present invention can be synthesized from the parent compound which contains a basic or acidic moiety by conventional chemical methods. Generally, such salts can be prepared by reacting the free acid or base forms of these compounds with a stoichiometric amount of the appropriate base or acid in water or in an organic solvent, or in a mixture of the two; generally, nonaqueous media like ether, ethyl acetate, ethanol, isopropanol, or acetonitrile are preferred. Lists of suitable salts are

found in *Remington's Pharmaceutical Sciences*, 17th ed., Mack Publishing Company, Easton, PA, p. 1418, (1985), the disclosure of which is hereby incorporated by reference.

**[0077]** Salt(s) of the Formula (I) compounds can be formed by, for example, reacting a Formula (I) compound with, for example, an equivalent amount of acid or base in a

5 medium that allows the newly formed salt to, for example, either be precipitated out, or be isolated via lyophilization. Exemplary acidic salt(s) that the compounds of Formula (I) can form with inorganic and/or organic acids include, but are not limited to, for example, include acetate, ascorbate, benzoate, benzenesulfonate, bisulfate, bitartrate, acid citrate, citrate, ethanesulfonate, formate, fumarate, gentisinate, gluconate, glucaronate, glutamate, 10 hydrochloride, hydrobromide, hydroiodide, isonicotinate, maleate, mesylate, methanesulfonate, nitrate, pantothenate, phosphate, acid phosphate, saccharate, salicylate, succinate, sulfate, tartrate, p-toluenesulfonate, trifluoroacetate, lactate, and pamoate [i.e., 1,1'-methylene-bis-(2-hydroxy-3-naphthoate)] salts. Such salts can be formed in accordance with methods known to a person of ordinary skill in the art.

15 **[0078]** Exemplary basic salt(s) that the compounds of Formula (I) can form with inorganic and/or organic bases include, but are not limited to, for example, ammonium salts; alkali metal salts, such as, for example, sodium, lithium and potassium salts; alkaline earth metal salts, such as, for example, calcium and magnesium salts; salts formed with organic bases, such as, for example, benzathines, dicyclohexylamines, 2-amino-2- 20 (hydroxymethyl)propane-1,3-diol (trisamine or tris), hydrabamines (such as, for example, N,N-bis(dehydroabietyl) ethylenediamine), N-methyl-D-glucamines, N-methyl-D-glycamides, and *t*-butyl amines; salts formed with amino acids, such as, for example, arginine and lysine; and salts formed by using agents, such as, for example, lower alkyl halides (e.g., methyl, ethyl, propyl, and butyl chlorides, bromides and iodides), dialkyl 25 sulfates (e.g., dimethyl, diethyl, dibutyl, and diamyl sulfates), long chain halides (e.g., decyl, lauryl, myristyl and stearyl chlorides, bromides and iodides), and aralkyl halides (e.g., benzyl and phenethyl bromides) to quaternize basic nitrogen-containing groups. Such salts can be formed in accordance with methods known to a person of ordinary skill in the art.

30 **[0079]** In addition, compounds of Formula (I) are, subsequent to their preparation, preferably isolated and purified to obtain a composition containing an amount by weight equal to or greater than 99% of a compound of Formula (I) ("substantially pure"), which is

then used or formulated as described herein. Such “substantially pure” compounds of Formula (I) are also contemplated herein as part of the present invention.

[0080] Any compound that can be converted in vivo to provide the bioactive agent (i.e., the compound of Formula (I)) is a prodrug within the scope and spirit of the invention.

[0081] The term “prodrugs” as employed herein includes esters and carbonates formed by reacting one or more hydroxyls of compounds of Formula (I) with alkyl, alkoxy, or aryl substituted acylating agents employing procedures known to those skilled in the art to generate acetates, pivalates, methylcarbonates, benzoates, and the like.

10 [0082] Various forms of prodrugs are well known in the art and are described in:

a) Wermuth, C.G. et al., *The Practice of Medicinal Chemistry*, Chapter 31, Academic Press (1996);

b) *Design of Prodrugs*, Bundgaard, H. ed., Elsevier (1985);

c) Bundgaard, H., Chapter 5, “Design and Application of Prodrugs,” *A*

15 *Textbook of Drug Design and Development*, pp. 113-191, Krosgaard-Larsen, P. et al., eds., Harwood Academic Publishers (1991); and

d) Testa, B. et al., *Hydrolysis in Drug and Prodrug Metabolism*, Wiley-VCH (2003).

20 [0083] In addition, compounds of the Formula (I) are, subsequent to their preparation, preferably isolated and purified to obtain a composition containing an amount by weight equal to or greater than 99% Formula (I) compound (“substantially pure” compound I), which is then used or formulated as described herein. Such “substantially pure” compounds of the Formula (I) are also contemplated herein as part of the present invention.

25 [0084] “Stable compound” and “stable structure” are meant to indicate a compound that is sufficiently robust to survive isolation to a useful degree of purity from a reaction mixture, and formulation into an efficacious therapeutic agent. The present invention is intended to embody stable compounds.

30 [0085] “Therapeutically effective amount” is intended to include an amount of a compound of the present invention alone or an amount of the combination of compounds claimed or an amount of a compound of the present invention in combination with other

active ingredients effective to act as an agonist to S1P<sub>1</sub>, or effective to treat or prevent vascular disease or autoimmune diseases.

**[0086]** As used herein, “treating” or “treatment” cover the treatment of a disease-state in a mammal, particularly in a human, and include: (a) preventing the disease-state from occurring in a mammal, in particular, when such mammal is predisposed to the disease-state but has not yet been diagnosed as having it; (b) inhibiting the disease-state, *i.e.*, arresting its development; and/or (c) relieving the disease-state, *i.e.*, causing regression of the disease state.

**[0087]** Compounds of the present invention may contain one or more additional asymmetric carbon atoms and therefore exist in two or more stereoisomeric forms. The present invention includes all of the possible individual stereoisomers, the individual tautomeric forms thereof, together with mixtures thereof. Separation of diastereoisomers may be achieved by conventional techniques, *e.g.*, by fractional crystallization, chromatography or HPLC of a stereoisomeric mixture of a compound of the present invention, or a suitable salt or derivative thereof. An individual enantiomer of the compound may also be prepared from a corresponding optically pure intermediate or by resolution, such as by HPLC of the corresponding racemate using a suitable chiral support or by fractional crystallization of the diastereoisomeric salts formed by reaction of the corresponding racemate with a suitable optically active acid or base, as appropriate. All stereoisomers of the compounds of the instant invention are contemplated, either in admixture or in pure or substantially pure form.

**[0088]** The compounds of the present invention are intended to include all isotopes of atoms occurring in the present compounds. Isotopes include those atoms having the same atomic number but different mass numbers. By way of general example and without limitation, isotopes of hydrogen include deuterium and tritium. Isotopes of carbon include <sup>13</sup>C and <sup>14</sup>C. Isotopically-labeled compounds of the invention can generally be prepared by conventional techniques known to those skilled in the art or by processes analogous to those described herein, using an appropriate isotopically-labeled reagent in place of the non-labeled reagent otherwise employed.

**[0089]** Also embraced within this invention is a class of pharmaceutical compositions comprising the compound of Formula (I) or a pharmaceutically acceptable salt thereof in association with one or more non-toxic, pharmaceutically-acceptable carriers and/or

diluents and/or adjuvants (collectively referred to herein as "carrier" materials) and, if desired, other active ingredients. The compounds of Formula (I) may be administered by any suitable route, preferably in the form of a pharmaceutical composition adapted to such a route, and in a dose effective for the treatment intended. The compounds and

5 compositions of the present invention may, for example, be administered orally, mucosally, or parentally including intravascularly, intravenously, intraperitoneally, subcutaneously, intramuscularly intrasternally and infusion techniques, in dosage unit formulations containing conventional pharmaceutically acceptable carriers, adjuvants, and vehicles. For example, the pharmaceutical carrier may contain a mixture of mannitol or  
10 lactose and microcrystalline cellulose. The mixture may contain additional components such as a lubricating agent, *e.g.*, magnesium stearate and a disintegrating agent such as crospovidone. The carrier mixture may be filled into a gelatin capsule or compressed as a tablet.

15 [0090] The pharmaceutically active compounds of this invention can be processed in accordance with conventional methods of pharmacy to produce medicinal agents for administration to patients, including humans and other mammals.

20 [0091] For oral administration, the pharmaceutical composition may be in the form of, for example, a tablet, capsule, suspension, or liquid. The pharmaceutical composition is preferably made in the form of a dosage unit containing a particular amount of the active ingredient. Examples of such dosage units are tablets or capsules. For example, these may contain an amount of active ingredient from about 0.5 to 2000 mg, preferably from about 0.5 to 500 mg, more preferably from about 0.5 to 150 mg. A suitable daily dose for a human or other mammal may vary widely depending on the condition of the patient and other factors, but, once again, can be determined using routine methods.

25 [0092] The amounts of compounds that are administered and the dosage regimen for treating a disease condition with the compounds and/or compositions of this invention depends on a variety of factors, including the age, weight, sex, the medical condition of the subject, the type of disease, the severity of the disease, the route and frequency of administration, and the particular compound employed. Thus, the dosage regimen may  
30 vary widely, but can be determined routinely using standard methods. A daily dose of about 0.01 to 1500 mg/kg body weight, preferably between about 0.5 and about 50 mg/kg

body weight and most preferably between about 0.1 to 20 mg/kg body weight, may be appropriate. The daily dose can be administered in one to four doses per day.

**[0093]** For therapeutic purposes, the active compounds of this invention are ordinarily combined with one or more adjuvants appropriate to the indicated route of administration.

5 If administered orally, the compounds may be admixed with lactose, sucrose, starch powder, cellulose esters of alkanoic acids, cellulose alkyl esters, talc, stearic acid, magnesium stearate, magnesium oxide, sodium and calcium salts of phosphoric and sulfuric acids, gelatin, acacia gum, sodium alginate, polyvinyl alcohol, and/or polyvinylpyrrolidone, and then tableted or encapsulated for convenient administration.

10 Such capsules or tablets may contain a controlled-release formulation as may be provided in a dispersion of active compound in hydroxypropylmethyl cellulose.

**[0094]** The oily phase of the emulsions comprising compounds of Formula (I) may be constituted from known ingredients in a known manner. While the phase may comprise merely an emulsifier, it may comprise a mixture of at least one emulsifier with a fat or an 15 oil or with both a fat and an oil. Preferably, a hydrophilic emulsifier is included together with a lipophilic emulsifier which acts as a stabilizer. It is also preferred to include both an oil and a fat. Together, the emulsifier(s) with or without stabilizer(s) make-up the so-called emulsifying wax, and the wax together with the oil and fat make up the so-called emulsifying ointment base which forms the oily dispersed phase of the cream

20 formulations. Emulsifiers and emulsion stabilizers suitable for use in the formulation of the present invention include Tween 60, Span 80, cetostearyl alcohol, myristyl alcohol, glyceryl monostearate, sodium lauryl sulfate, glyceryl distearate alone or with a wax, or other materials well known in the art.

**[0095]** The choice of suitable oils or fats for the formulation is based on achieving the 25 desired cosmetic properties, since the solubility of the active compound in most oils likely to be used in pharmaceutical emulsion formulations is very low. Thus, the cream should preferably be a non-greasy, non-staining and washable product with suitable consistency to avoid leakage from tubes or other containers. Straight or branched chain, mono- or dibasic alkyl esters such as di-isoadipate, isocetyl stearate, propylene glycol diester of 30 coconut fatty acids, isopropyl myristate, decyl oleate, isopropyl palmitate, butyl stearate, 2-ethylhexyl palmitate or a blend of branched chain esters may be used. These may be used alone or in combination depending on the properties required. Alternatively, high

melting point lipids such as white soft paraffin and/or liquid paraffin or other mineral oils can be used.

**[0096]** Formulations for parenteral administration may be in the form of aqueous or non-aqueous isotonic sterile injection solutions or suspensions. These solutions and

5 suspensions may be prepared from sterile powders or granules using one or more of the carriers or diluents mentioned for use in the formulations for oral administration or by using other suitable dispersing or wetting agents and suspending agents. The compounds may be dissolved in water, polyethylene glycol, propylene glycol, ethanol, corn oil, cottonseed oil, peanut oil, sesame oil, benzyl alcohol, sodium chloride, tragacanth gum, 10 and/or various buffers. Other adjuvants and modes of administration are well and widely known in the pharmaceutical art. The active ingredient may also be administered by injection as a composition with suitable carriers including saline, dextrose, or water, or with cyclodextrin (i.e., Captisol®), cosolvent solubilization (i.e., propylene glycol) or micellar solubilization (i.e., Tween 80).

15 **[0097]** The sterile injectable preparation may also be a sterile injectable solution or suspension in a non-toxic parenterally acceptable diluent or solvent, for example as a solution in propylene glycol. Among the acceptable vehicles and solvents that may be employed are water, Ringer's solution, and isotonic sodium chloride solution. In addition, sterile, fixed oils are conventionally employed as a solvent or suspending medium. For 20 this purpose any bland fixed oil may be employed, including synthetic mono- or diglycerides. In addition, fatty acids such as oleic acid find use in the preparation of injectables.

**[0098]** The pharmaceutical compositions may be subjected to conventional pharmaceutical operations such as sterilization and/or may contain conventional adjuvants, 25 such as preservatives, stabilizers, wetting agents, emulsifiers, and buffers. Tablets and pills can additionally be prepared with enteric coatings. Such compositions may also comprise adjuvants, such as wetting, sweetening, flavoring, and perfuming agents.

**[0099]** Pharmaceutical compositions of this invention comprise the compound of Formula (I), or a pharmaceutically acceptable salt thereof, and optionally an additional 30 agent selected from any pharmaceutically acceptable carrier, adjuvant, and vehicle.

Alternate compositions of this invention comprise a compound of the Formula (I)

described herein, or a pharmaceutically acceptable salt thereof, and a pharmaceutically acceptable carrier, adjuvant, or vehicle.

[0101] Pharmaceutically acceptable carriers, adjuvants, and vehicles that may be used in the pharmaceutical compositions of this invention include, but are not limited to, ion exchangers, alumina, aluminum stearate, lecithin, self-emulsifying drug delivery systems (SEDDS) such as d-alpha-tocopherol polyethyleneglycol 1000 succinate, surfactants used in pharmaceutical dosage forms such as Tweens or other similar polymeric delivery matrices, serum proteins, such as human serum albumin, buffer substances such as phosphates, glycine, sorbic acid, potassium sorbate, partial glyceride mixtures of saturated vegetable fatty acids, water, salts or electrolytes, such as protamine sulfate, disodium hydrogen phosphate, potassium hydrogen phosphate, sodium chloride, zinc salts, colloidal silica, magnesium trisilicate, polyvinyl pyrrolidone, cellulose-based substances, polyethylene glycol, sodium carboxymethylcellulose, polyacrylates, waxes, polyethylene-polyoxypropylene-block polymers, polyethylene glycol and wool fat. Cyclodextrins such as alpha-, beta-, and gamma-cyclodextrin, or chemically modified derivatives such as hydroxyalkylcyclodextrins, including 2- and 3-hydroxypropyl-cyclodextrins, or other solubilized derivatives may also be advantageously used to enhance delivery of compounds of the formulae described herein.

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## UTILITY

[0102] The human immune system has evolved to defend the body from micro-organisms, viruses, and parasites that can cause infection, disease or death. Complex regulatory mechanisms ensure that the various cellular components of the immune system target the foreign substances or organisms, while not causing permanent or significant damage to the individual. While the initiating events are not well understood at this time, in autoimmune disease states the immune system directs its inflammatory response to target organs in the afflicted individual. Different autoimmune diseases are typically characterized by the predominate or initial target organ or tissues affected; such as the joint in the case of rheumatoid arthritis, the thyroid gland in the case of Hashimoto's thyroiditis, the central nervous system in the case of multiple sclerosis, the pancreas in the case of type I diabetes, and the bowel in the case of inflammatory bowel disease. Thus it has been observed that therapeutic agents which act on the immune system or certain cell

types of the immune system (such as B-lymphocytes, and T lymphocytes, T cells) may have utility in more than one autoimmune disease.

**[0103]** It is well recognized in the art, including the literature references cited herein, that S1P receptors are good targets for a wide variety of therapeutic applications, including autoimmune diseases. S1P receptors make good drug targets, because individual receptors are both tissue- and response-specific. Tissue specificity of the S1P receptors is important, because development of an agonist or antagonist selective for one receptor localizes the cellular response to tissues containing that receptor, limiting unwanted side effects.

Response specificity of the S1P receptors is also important because it allows for development of agonists or antagonists that initiate or suppress certain cellular responses without affecting other processes. Therefore, compounds that act on some S1P receptor family members while having diminished or no activity at other family members are desirable and are expected to provide a therapeutic effect with an improved side effect profile (i.e., reduction or elimination of unwanted side effects).

**[0104]** As used herein, the term “agonist” in reference to S1P1 refers to an agent which exerts pharmacological effects such as decreased motility of T cells, decreased trafficking of T cells, or decreased egress of T cells from lymphoid tissues. (Rosen et al., *Trends in Immunology*, 28:102 (2007)).

**[0105]** By virtue of their S1P1 activity as agonists, the compounds of the present invention are immunoregulatory agents useful for treating or preventing autoimmune or chronic inflammatory diseases. The compounds of the present invention are useful to suppress the immune system in instances where immunosuppression is in order, such as in bone marrow, organ or transplant rejection, autoimmune and chronic inflammatory diseases, including systemic lupus erythematosis, chronic rheumatoid arthritis, type I diabetes mellitus, inflammatory bowel disease, biliary cirrhosis, uveitis, multiple sclerosis, Crohn’s disease, ulcerative colitis, bullous pemphigoid, sarcoidosis, psoriasis, autoimmune myositis, Wegener’s granulomatosis, ichthyosis, Graves ophthalmopathy, and asthma.

**[0106]** More particularly, the compounds of the present invention are useful to treat or prevent a disease or disorder selected from the group consisting of: transplantation of organs or tissue, graft-versus-host diseases brought about by transplantation, autoimmune syndromes including rheumatoid arthritis, systemic lupus erythematosus, Hashimoto’s thyroiditis, multiple sclerosis, myasthenia gravis, type I diabetes, uveitis, posterior uveitis,

allergic encephalomyelitis, glomerulonephritis, post-infectious autoimmune diseases including rheumatic fever and post-infectious glomerulonephritis, inflammatory and hyperproliferative skin diseases, psoriasis, psoriatic arthritis, atopic dermatitis, contact dermatitis, eczematous dermatitis, seborrhoeic dermatitis, lichen planus, pemphigus, 5 bullous pemphigoid, epidermolysis bullosa, urticaria, angioedemas, vasculitis, erythema, cutaneous eosinophilia, lupus erythematosus, acne, alopecia areata, keratoconjunctivitis, vernal conjunctivitis, uveitis associated with Behcet's disease, keratitis, herpetic keratitis, conical cornea, dystrophia epithelialis cornea, corneal leukoma, ocular pemphigus, Mooren's ulcer, scleritis, Graves' ophthalmopathy, Vogt-Koyanagi-Harada syndrome, 10 sarcoidosis, pollen allergies, reversible obstructive airway disease, bronchial asthma, allergic asthma, intrinsic asthma, extrinsic asthma, dust asthma, chronic or inveterate asthma, late asthma and airway hyper-responsiveness, bronchitis, gastric ulcers, vascular damage caused by ischemic diseases and thrombosis, ischemic bowel diseases, inflammatory bowel diseases, necrotizing enterocolitis, intestinal lesions associated with 15 thermal burns, coeliac diseases, proctitis, eosinophilic gastroenteritis, mastocytosis, Crohn's disease, ulcerative colitis, migraine, rhinitis, eczema, interstitial nephritis, Goodpasture's syndrome, hemolytic-uremic syndrome, diabetic nephropathy, multiple myositis, Guillain-Barre syndrome, Meniere's disease, polyneuritis, multiple neuritis, mononeuritis, radiculopathy, hyperthyroidism, Basedow's disease, pure red cell aplasia, 20 aplastic anemia, hypoplastic anemia, idiopathic thrombocytopenic purpura, autoimmune hemolytic anemia, agranulocytosis, pernicious anemia, megaloblastic anemia, anerythroplasia, osteoporosis, sarcoidosis, fibroid lung, idiopathic interstitial pneumonia, dermatomyositis, leukoderma vulgaris, ichthyosis vulgaris, photoallergic sensitivity, cutaneous T cell lymphoma, arteriosclerosis, atherosclerosis, aortitis syndrome, 25 polyarteritis nodosa, myocarditis, scleroderma, Wegener's granuloma, Sjögren's syndrome, adiposis, eosinophilic fascitis, lesions of gingiva, periodontium, alveolar bone, substantia ossea dentis, glomerulonephritis, male pattern alopecia or alopecia senilis by preventing epilation or providing hair germination and/or promoting hair generation and hair growth, muscular dystrophy, pyoderrna and Sezary's syndrome, Addison's disease, 30 ischemia-reperfusion injury of organs which occurs upon preservation, transplantation or ischemic disease, endotoxin-shock, pseudomembranous colitis, colitis caused by drug or radiation, ischemic acute renal insufficiency, chronic renal insufficiency, toxinosis caused

by lung-oxygen or drugs, lung cancer, pulmonary emphysema, cataracta, siderosis, retinitis pigmentosa, senile macular degeneration, vitreal scarring, corneal alkali burn, dermatitis erythema multiforme, linear IgA ballous dermatitis and cement dermatitis, gingivitis, periodontitis, sepsis, pancreatitis, diseases caused by environmental pollution, 5 aging, carcinogenesis, metastasis of carcinoma and hypobaropathy, disease caused by histamine or leukotriene-C4 release, Behcet's disease, autoimmune hepatitis, primary biliary cirrhosis, sclerosing cholangitis, partial liver resection, acute liver necrosis, necrosis caused by toxin, viral hepatitis, shock, or anoxia, B-virus hepatitis, non-A/non-B hepatitis, cirrhosis, alcoholic cirrhosis, hepatic failure, fulminant hepatic failure, late-onset 10 hepatic failure, "acute-on-chronic" liver failure, augmentation of chemotherapeutic effect, cytomegalovirus infection, HCMV infection, AIDS, cancer, senile dementia, trauma, neuropathic pain, and chronic bacterial infection.

**[0107]** One embodiment provides a method for treating autoimmune and/or inflammatory diseases, comprising administering to a mammal in need thereof at least one 15 compound of Formula (I) or a pharmaceutically acceptable salt thereof. Another embodiment provides the compounds of Formula (I) or pharmaceutically acceptable salts thereof, for use in therapy for the treatment of autoimmune and/or inflammatory diseases. In another embodiment, provided is the use of the compounds of Formula (I) or pharmaceutically acceptable salts thereof, for the manufacture of a medicament for the 20 treatment or prophylaxis of autoimmune and/or inflammatory disease. A therapeutically effective amount may be employed in these embodiments. Preferably, in these embodiments, the autoimmune and inflammatory diseases are selected from multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease (including Crohn's disease and ulcerative colitis), psoriasis, and as an agent to prevent the rejection of transplanted 25 organs. The method of the present embodiment includes administration of a therapeutically effect amount of a compound of Formula (I) or a pharmaceutically effective salt thereof.

**[0108]** In another embodiment, a method for treating vascular disease is provided comprising administering to a mammal in need thereof at least one compound of Formula 30 (I) or a pharmaceutically acceptable salt thereof. Another embodiment provides the compounds of Formula (I) or pharmaceutically acceptable salts thereof, for use in therapy for the treatment of vascular disease. In another embodiment, provided is the use of the

compounds of Formula (I) or pharmaceutically acceptable salts thereof, for the manufacture of a medicament for treatment of vascular disease. A therapeutically effective amount may be employed in these embodiments. Preferably, in these embodiments, the vascular disease is selected from atherosclerosis and ischemia reperfusion injury.

5 [0109] The methods of treating S1P1-associated conditions may comprise administering compounds of Formula (I) alone or in combination with each other and/or other suitable therapeutic agents useful in treating such conditions. Accordingly, “therapeutically effective amount” is also intended to include an amount of the 10 combination of compounds claimed that is effective to act as an agonist at the S1P1 receptor. The combination of compounds is preferably a synergistic combination. Synergy, as described, for example, by Chou et al., *Adv. Enzyme Regul.*, 22:27-55 (1984), occurs when the effect of the compounds when administered in combination is greater than the additive effect of the compounds when administered alone as a single agent. In 15 general, a synergistic effect is most clearly demonstrated at sub-optimal concentrations of the compounds. Synergy can be in terms of lower cytotoxicity, increased efficacy, or some other beneficial effect of the combination compared with the individual components.

15 [0110] Exemplary of such other therapeutic agents include corticosteroids or glucocorticoids such as dexamethasone, methylprednisolone, prednisolone, and 20 prednisone; PDE4 inhibitors such as rolipram, cilomilast, roflumilast, and oglemilast; cytokine-suppressive anti-inflammatory drugs (CSAIDs) and inhibitors of p38 kinase, 4- substituted imidazo [1,2-A]quinoxalines as disclosed in U.S. Patent No. 4,200,750; antibodies or fusion proteins directed to cell surface molecules such as CD2, CD3, CD4, CD8, CD20 such as RITUXAN®, CD25, CD30, CD40, CD69, CD80 (B7.1), CD86 25 (B7.2), CD90, CTLA, for example abatacept (ORENCIA®), belatacept, or their ligands including CD154 (GP39, or CD40L); antibodies to, fusion proteins, or soluble receptors of human cytokines or growth factors, for example, TNF such as, infliximab (REMICADE®), etanercept (Embrel), adalimumab (Humira®), LT, IL-1 such as anakinra (Kineret®) (an IL-1 receptor antagonist), IL-2, IL-4, IL-5, IL-6, such as CNTO 328 (a 30 chimeric anti-IL-6 antibody), IL-7, IL-8, IL-12, IL-15, IL-16, IL-17, IL-21, IL-23 such as Ustekinumab (a human anti-IL-12/23 monoclonal antibody), and interferons such as interferon beta 1a (Avonex®, Rebif®), interferon beta 1b (Betaseron®); integrin receptor

antagonists such as Tysabri®; polymeric agents such as glatiramer acetate (Copaxone®); sulfasalazine, mesalamine, hydroxychloroquine, non-steroidal antiinflammatory drugs (NSAIDs) such as salicylates including aspirin, salsalate, and magnesium salicylate, and non-salicylates such as, ibuprofen, naproxen, meloxicam, celecoxib and rofecoxib;

5 antiviral agents such as abacavir; antiproliferative agents such as methotrexate, mercaptopurine, leflunomide, cyclosporine, mycophenolate, FK506 (tacrolimus, PROGRAF®); cytotoxic drugs such as azathioprine and cyclophosphamide; nuclear translocation inhibitors, such as deoxyspergualin (DSG); gold containing products such as auronofin; penicillamine, and rapamycin (sirolimus or RAPAMUNE®) or derivatives

10 thereof.

[0111] The above other therapeutic agents, when employed in combination with the compounds of the present invention, may be used, for example, in those amounts indicated in the Physicians' Desk Reference (PDR) or as otherwise determined by one of ordinary skill in the art. In the methods of the present invention, such other therapeutic agent(s) 15 may be administered prior to, simultaneously with, or following the administration of the inventive compounds.

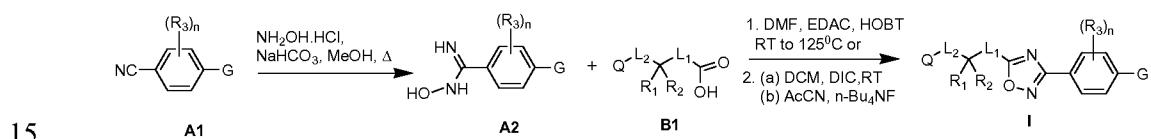
#### METHODS OF PREPARATION

[0112] The compounds of the present invention can be prepared in a number of ways 20 well known to one skilled in the art of organic synthesis. The compounds of the present invention can be synthesized using the methods described below, together with synthetic methods known in the art of synthetic organic chemistry, or variations thereon as appreciated by those skilled in the art. Preferred methods include, but are not limited to, those described below. All references cited herein are hereby incorporated in their entirety 25 by reference.

[0113] The compounds of this invention may be prepared using the reactions and 30 techniques described in this section. The reactions are performed in solvents appropriate to the reagents and materials employed and are suitable for the transformations being effected. Also, in the description of the synthetic methods described below, it is to be understood that all proposed reaction conditions, including choice of solvent, reaction atmosphere, reaction temperature, duration of the experiment and work up procedures, are chosen to be the conditions standard for that reaction, which should be readily recognized

by one skilled in the art. It is understood by one skilled in the art of organic synthesis that the functionality present on various portions of the molecule must be compatible with the reagents and reactions proposed. Such restrictions to the substituents that are compatible with the reaction conditions will be readily apparent to one skilled in the art and alternate 5 methods must then be used. This will sometimes require a judgment to modify the order of the synthetic steps or to select one particular process scheme over another in order to obtain a desired compound of the invention. It will also be recognized that another major consideration in the planning of any synthetic route in this field is the judicious choice of the protecting group used for protection of the reactive functional groups present in the 10 compounds described in this invention. An authoritative account describing the many alternatives to the trained practitioner is Greene et al. (Protective Groups in Organic Synthesis, Fourth Edition, Wiley and Sons (2006)).

Scheme I

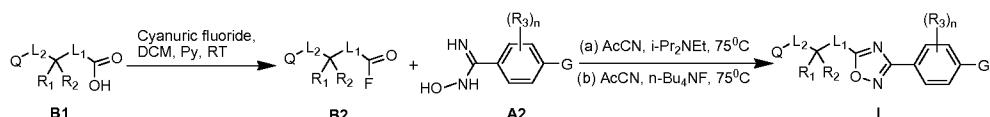


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[0114] Oxadiazoles of formula I can be synthesized using the protocol outlined in Scheme I. Treatment of nitrile A1 with hydroxylamine hydrochloride in the presence of a suitable base like sodium bicarbonate yields the aldoxime intermediate A2. Reaction of intermediate A2 with carboxylic acid intermediate B1 in the presence of HOBT and EDAC in an aprotic solvent such as DMF at room temperature to 125°C forms oxadiazole C1. Alternatively intermediate A2 can be reacted with acid intermediate B1 with DIC, followed by treatment with tetra-n-butylammonium fluoride to form I. The G group on the the oxadiazole of formula I can be prepared prior to or after the coupling of A2 and B1.

25

Scheme II

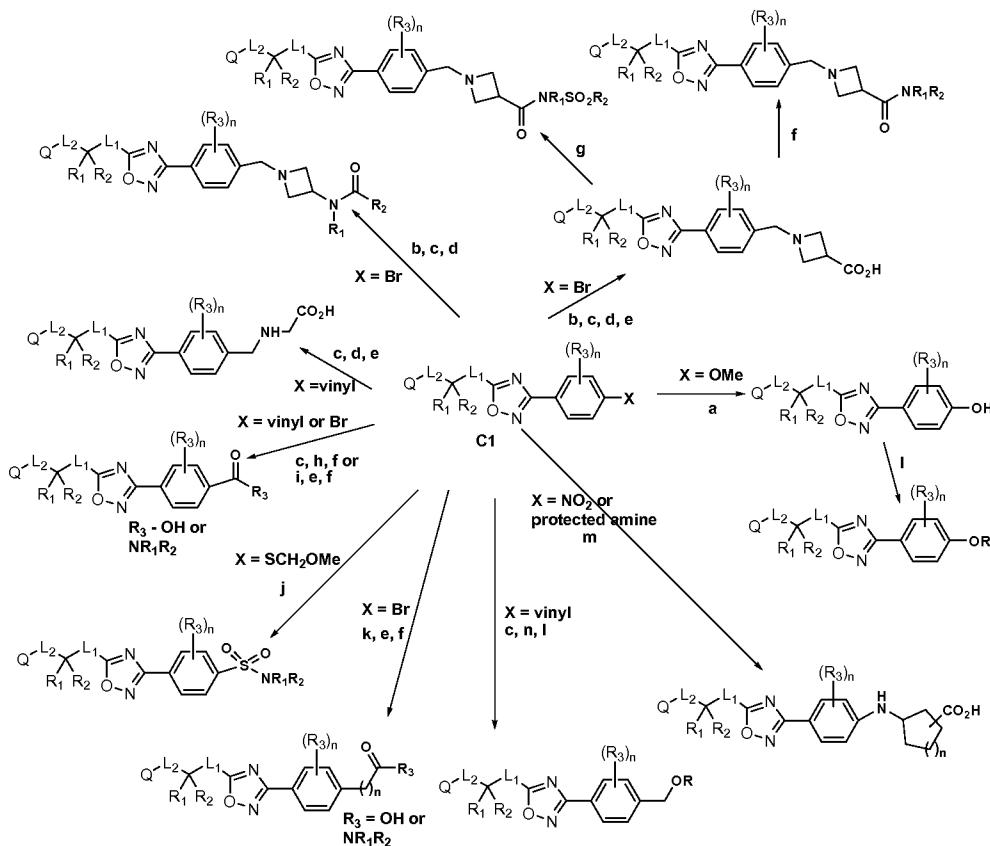


[0115] Oxadiazoles of formula I may also be synthesized using the protocol outlined in Scheme II. Carboxylic acid intermediate B1 can be converted to its acid fluoride B2 by

reaction with cyanuric fluoride in presence of an organic base such as pyridine. Acid fluoride B2 is treated with aldoxime intermediate A2 in acetonitrile in the presence of an organic base such as Hunig's base and subsequently reacted with tetra-n-butylammonium fluoride to form I.

5 [0116] The group X in C1 can be modified to other groups following the transformations as outlined in Schemes III and IV. When X = vinyl, these transformations are not applicable to compounds where L<sub>1</sub> and L<sub>2</sub> are each independently (CH<sub>2</sub>)<sub>0-3</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-3</sub>.

Scheme III



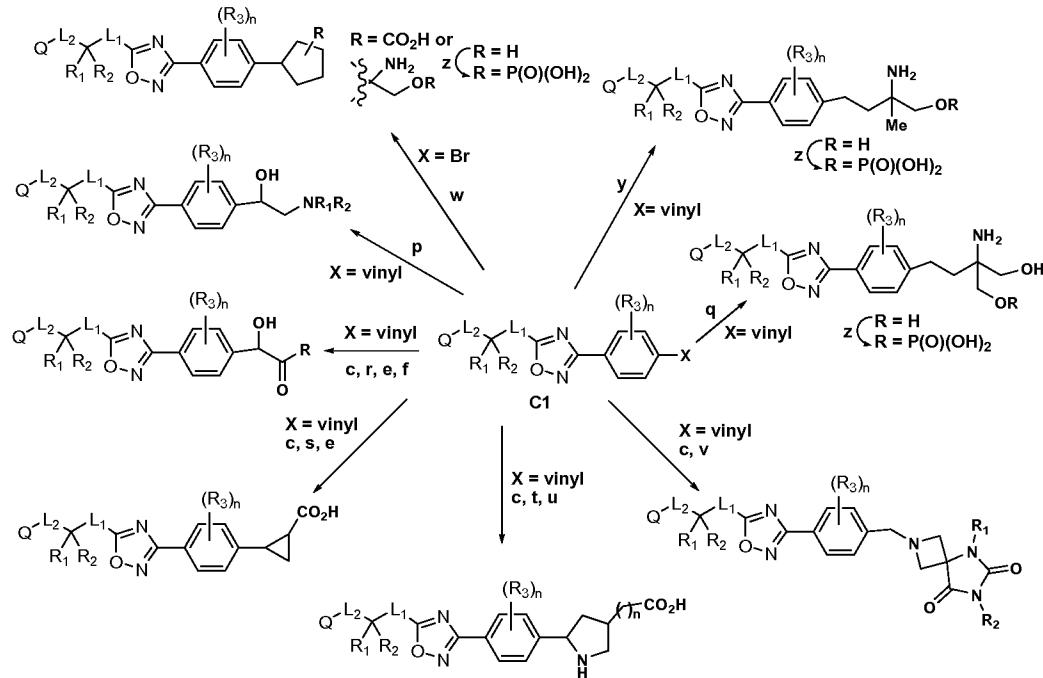
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Reagents: a) BBr<sub>3</sub>, CH<sub>2</sub>Cl<sub>2</sub>; (b) tributylvinyl tin, Pd(PPh<sub>3</sub>)<sub>4</sub>, LiCl; (c) O<sub>3</sub>, CH<sub>2</sub>Cl<sub>2</sub>, or OsO<sub>4</sub>, NaIO<sub>4</sub>; (d) azetidine carboxylic acid or ester, or appropriately substituted amine, MeOH, Cl(CH<sub>2</sub>)<sub>2</sub>Cl, NaCNBH<sub>4</sub>; (e) TFA, CH<sub>2</sub>Cl<sub>2</sub> or NaOH; (f) NHR<sub>1</sub>R<sub>2</sub>, BOP, Et<sub>3</sub>N, THF; (g) (1) NH<sub>2</sub>SO<sub>2</sub>NR<sub>2</sub>, EDAP, DMAP, CH<sub>2</sub>Cl<sub>2</sub>; (2) NaH, DMF, R<sub>1</sub>-Cl or R<sub>1</sub>-Br; (h) NaClO<sub>2</sub>, 2-methyl-2-butene, NaH<sub>2</sub>PO<sub>4</sub>, H<sub>2</sub>O, *tert*-BuOH; (i) CO, MeOH, Pd(OAc)<sub>2</sub>, PPh<sub>3</sub>; (j) (1) Cl<sub>2</sub>, dioxane; (2) R<sub>1</sub>R<sub>2</sub>NH; (k) ZnBr(CH<sub>2</sub>)<sub>n</sub>CO<sub>2</sub>R, dichlorobis(tri-O-tolylphosphine)palladium

(II); (I) NaH, DMF, R-Br; (m) Na(OAc)<sub>3</sub>BH, AcOH, CH<sub>2</sub>Cl<sub>2</sub>, appropriately substituted ketone; (n) NaBH<sub>4</sub>, MeOH.

Scheme IV

5



For reagents a-n, see Scheme III. (o) RB(OH)<sub>2</sub>, Pd(PPh<sub>3</sub>)<sub>4</sub>, K<sub>2</sub>CO<sub>3</sub>, EtOH; (p) (i) m-CPBA, CH<sub>2</sub>Cl<sub>2</sub>; (ii) NR<sub>1</sub>R<sub>2</sub>, EtOH; (q) (i) 9-BBN, NaOH, H<sub>2</sub>O<sub>2</sub>; (ii) CBr<sub>4</sub>, PPh<sub>3</sub>; (iii) dimethylacetamidomalonate, NaOMe, MeOH; (iv) LAH, THF; (r) (i) TMSCN, ZnI<sub>2</sub>, CH<sub>2</sub>Cl<sub>2</sub>; (ii) HCl, H<sub>2</sub>O, AcOH; (s) (i) Ph<sub>3</sub>P=CHCO<sub>2</sub>Et, THF; (ii) CH<sub>2</sub>N<sub>2</sub>, Pd(OAc)<sub>2</sub>, THF; (t) (i) p-toluenesulfonamide, Si(OEt)<sub>4</sub>; (ii) ((trimethylsilyl)methyl)allyl acetate, Pd(OAc)<sub>2</sub>, Pd(PPh<sub>3</sub>)<sub>4</sub>; (u) (i) 9-BBN, NaOH, H<sub>2</sub>O<sub>2</sub>; (ii) Jones reagent; (v) spirocyclic azetidine-hydantoin, NaCNBH<sub>4</sub>, molecular sieves, CH<sub>2</sub>Cl<sub>2</sub>; (w) substituted cyclopentyl BF<sub>3</sub><sup>-</sup>K<sup>+</sup>, K<sub>3</sub>PO<sub>4</sub>, Pd(OAc)<sub>2</sub>, 2-PCy<sub>2</sub>-2'-6'-(O-iPr)<sub>2</sub>-biphenyl, toluene-H<sub>2</sub>O (y) (i) 9-BBN, NaOH, H<sub>2</sub>O<sub>2</sub>; (ii) CBr<sub>4</sub>, Ph<sub>3</sub>P; (iii) alanine, N-(phenylmethylene)-1-methylethyl ester, NaHMDS; (iv) HCl; (v) LAH, THF (z) (i) NaHMDS, tetrabenzylidiphosphate; (ii) H<sub>2</sub>, Pd(OH)<sub>2</sub>, MeOH.

[0117] The sequence of reactions outlined in the Schemes I-IV may be interchanged to synthesize oxadiazoles of formula (I).

## ABBREVIATIONS

AcCN	acetonitrile
ACOH	acetic acid
aq.	aqueous
5 9-BBN	9-borabicyclo[3.3.1]nonane
BF <sub>3</sub> ·OEt <sub>2</sub>	boron trifluoride diethyl etherate
BOC	t-butyl carbamate
BOP	benzotriazol-1-yloxytris(trimethylamino)phosphonium hexafluorophosphate
10 BOP-Cl	bis(2-oxo-3-oxazolidinyl)phosphinic chloride
Cbz	benzyloxycarbonyl
DCM	dichloromethane
DIBAL-H	diisobutylaluminum hydride
DIC	diisopropylcarbodiimide
15 DMAP	N,N-Dimethyl-4-amino-pyridine
DME	dimethyl ether
DMF	dimethylformamide
DMSO	dimethyl sulfoxide
EDAC	1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride
20 EDAP	ethyldiethylaminopropyl carbodiimide
EDCI	1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride
Et <sub>3</sub> N	triethyl amine
EtOAc	ethyl acetate
EtOH	ethyl alcohol
25 h	hour(s)
HOEt	hydroxybenzotriazole
HPLC	high pressure liquid chromatography
hr	hour(s)
i-Pr <sub>2</sub> NEt	diisopropylethyl amine
30 LAH	lithium aluminum hydride
m-CPBA	3-chloroperbenzoic acid
MeCN	acetonitrile

	MeOH	methanol
	min	minute(s)
	NaHMDS	sodium bis(trimethylsilyl) amide
	Na(OAc) <sub>3</sub> BH	sodium triacetoxyborohydride
5	n-Bu <sub>4</sub> NF	tetrabutylammonium fluoride
	2-PCy <sub>2</sub> -2'6'-(O-iPr) <sub>2</sub> -biphenyl	2-(Dicyclohexylphosphino)-2',6'-isopropoxybiphenyl
	Pd(OAc) <sub>2</sub>	palladium acetate
	Pd(OH) <sub>2</sub>	palladium hydroxide
10	Pd(PPh <sub>3</sub> ) <sub>4</sub>	tetrakis(triphenylphosphine)palladium
	PPh <sub>3</sub>	triphenylphosphine
	Py	pyridine
	RT	room temperature
	Si(OEt) <sub>4</sub>	tetraethyl orthosilicate
15	TBAF	tetrabutylammonium fluoride
	t-BuOH	tertiary butanol
	TFA	trifluoroacetic acid
	THF	tetrahydrofuran
	TLC	thin layer chromatography
20	TMSCN	trimethylsilyl cyanide
	Δ	heat

## EXAMPLES

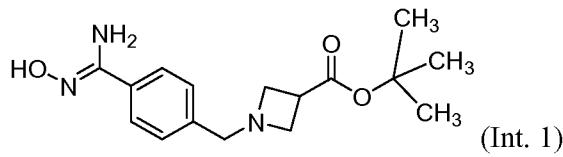
[0118] The following examples illustrate the particular and preferred embodiments of the present invention and do not limit the scope of the present invention. Chemical abbreviations and symbols as well as scientific abbreviations and symbols have their usual and customary meanings unless otherwise specified. Additional abbreviations employed in the Examples and elsewhere in this application are defined above. Common intermediates are generally useful for the preparation of more than one Example and are identified sequentially (e.g., Intermediate 1, Intermediate 2, etc. and are abbreviated as Int. 1, Int. 2, etc. Compounds of the Examples are identified by the example and step in which they were prepared (e.g., "1-A" denotes the Example 1, step A), or by the example only

where the compound is the title compound of the example (for example, "1" denotes the title compound of Example 1). In some instances alternate preparations of intermediates or examples are described. Frequently chemists skilled in the art of synthesis may devise alternative preparations which may be desirable based on one or more considerations such 5 as shorter reaction time, less expensive starting materials, ease of operation, amenable to catalysis, avoidance of toxic reagents, accessibility of specialized instrumentation, and decreased number of linear steps. The intent of describing alternative preparations is to further enable the preparation of the examples of this invention. In some instances some functional groups in the outlined examples and claims may be replaced by well known 10 biosteric replacements known in the art, for example, replacement of a carboxylic acid group with a tetrazole or a phosphate moiety.

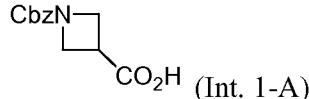
## INTERMEDIATE 1

(Z)-tert-butyl 1-(4-(N'-hydroxycarbamimidoyl)-benzyl)azetidine-3-carboxylate

15



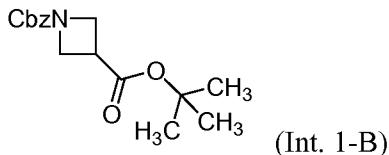
Int. 1-A: 1-(Benzylloxycarbonyl)azetidine-3-carboxylic acid



[0119] To a solution of azetidine-3-carboxylic acid (88 g, 0.871 mol) and sodium 20 bicarbonate (161 g, 1.92 mol) in water (1.75 L) at room temperature was added a solution of benzyl 2,5-dioxopyrrolidin-1-ylcarbonate (239 g, 0.959 mol) in tetrahydrofuran (3.5 L). The reaction mixture was stirred at room temperature overnight. The solvent was removed under reduced pressure, and the aqueous layer was washed with ethyl acetate (2 x 500 mL). The aqueous layer was acidified with a 1.0 N aqueous solution of hydrochloric 25 acid and extracted with ethyl acetate (3 x 750 mL). The organic layer was washed with water, washed with brine, and dried over anhydrous sodium sulfate. Concentration under reduced pressure afforded 1-(benzylloxycarbonyl) azetidine-3-carboxylic acid as colorless oil (202 g, 99% yield). The compound had an HPLC retention time = 2.27 min. – Column: Column: YMC Combiscreen ODS-A 4.6 x 50 mm (4 min.); Solvent A = 10%

MeOH, 90% H<sub>2</sub>O, 0.1% TFA; Solvent B = 90% MeOH, 10% H<sub>2</sub>O, 0.1% TFA. LC/MS M<sup>+1</sup> = 236.15. <sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>) δ ppm 3.39-3.49 (m, 1H), 4.22 (d, *J*=7.28 Hz, 4H), 5.11 (s, 2H), and 7.29-7.39 (m, 5H).

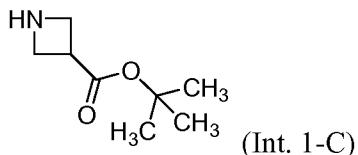
5 Int. 1-B: 1-Benzyl 3-*tert*-butyl azetidine-1,3-dicarboxylate



[0120] To a solution of 1-(benzyloxycarbonyl)azetidine-3-carboxylic acid (200 g, 0.851 mol) in dichloromethane (6.0 L) at 0°C was added *t*-butanol (158 g, 2.13 mol), DMAP (52.0 g, 0.425 mol), and EDCI (163 g, 0.853 mol). The reaction mixture was 10 stirred at room temperature overnight. The reaction mixture was concentrated, and the residue was dissolved in ethyl acetate, washed with a 10% aqueous solution of citric acid, washed with a 10 % aqueous solution of sodium bicarbonate, washed with brine, and dried over anhydrous sodium bicarbonate. Concentration under reduced pressure afforded 1-benzyl-3-*tert* butyl-azetidine-1,3-dicarboxylate (200 g, 81% yield) as a colorless oil. The 15 compound had an HPLC retention time = 3.27 min. – Column: Column: YMC Combiscreen ODS-A 4.6 x 50 mm (4 min.); Solvent A = 10% MeOH, 90% H<sub>2</sub>O, 0.1% TFA; Solvent B = 90% MeOH, 10% H<sub>2</sub>O, 0.1% TFA. LC/MS M<sup>+1</sup> = 292.15. <sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>) δ ppm 1.46 (s, 9H), 3.24-3.33 (m, 1H), 4.14 (d, *J*=7.53 Hz, 4H), 5.10 (s, 2H), and 7.30-7.39 (m, 5H).

20

Int. 1-C: *tert*-Butyl azetidine-3-carboxylate

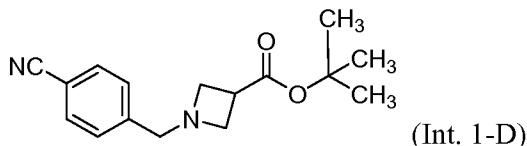


25 [0121] A mixture of 1-benzyl-3-*tert*-butyl-azetidine-1,3-dicarboxylate (140 g, 0.480 mol) and 10 % palladium on carbon (28.0 g) in ethyl acetate (1.40 L) was placed in an autoclave under 3.0kg/cm<sup>2</sup> of hydrogen pressure overnight. The reaction mixture was filtered through Celite, and the Celite bed was washed with ethyl acetate. Acetic acid

(28.9 g, 0.480 mol) was added to the filtrate, and it was concentrated below 50°C to give *tert*-butyl azetidine-3-carboxylate acetic acid salt (96 g, 92% yield) as a colorless oil. <sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>) δ ppm 1.47 (s, 9H), 2.02 (s, 3H), 3.52-3.63 (m, 1H), and 4.00-4.10 (m, 4H).

5

Int. 1-D: *tert*-Butyl 1-(4-cyanobenzyl)azetidine-3-carboxylate



[0122] To a solution of *tert*-butyl azetidine-3-carboxylate acetic acid salt (92.0 g, 0.423 mol) in methanol (1.0 L) at room temperature was added 4-cyanobenzaldehyde (50.8 g, 0.381 mol). The reaction mixture was cooled to 0°C, and sodium cyanoborohydride (28.8 g, 0.458 mol) was added portion-wise. The reaction mixture was allowed to warm to room temperature and was stirred overnight. The reaction mixture was concentrated under reduced pressure, and the residue was diluted with a 10% aqueous solution of sodium bicarbonate, extracted with ethyl acetate, washed with brine, and dried over anhydrous sodium sulfate. Concentration under reduced pressure followed by purification by flash silica gel column chromatography using a 20% mixture of ethyl acetate in petroleum ether afforded *tert*-butyl 1-(4-cyanobenzyl)azetidine-3-carboxylate (89%) (the desired product and alcohol impurity formed were not separated by column completely, and the mixture was taken for next step). LC/MS M<sup>+1</sup> = 273.18. <sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>) δ ppm 1.46 (s, 9H), 3.22-3.31 (m, 3H), 3.48-3.56 (m, 2H), 3.66 (s, 2H), 7.39 (d, J=8.28 Hz, 2H), and 7.60 (d, J=8.28 Hz, 2H).

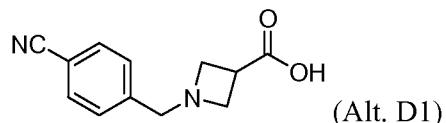
### Intermediate 1

[0123] To *tert*-butyl 1-(4-cyanobenzyl)azetidine-3-carboxylate (89.0 g, 0.326 mol) in *tert*-butanol (1.30 L), was added sodium bicarbonate (109.8 g, 1.31 mol) and hydroxylamine hydrochloride (45.5 g, 0.654 mol). The reaction mixture was heated at reflux for 7 h, and then cooled to room temperature and stirred overnight. The reaction mixture was diluted with water, extracted with ethyl acetate, washed with water, washed with brine, and dried over anhydrous sodium sulfate. Concentration followed by purification by flash silica gel chromatography using 2.5 % methanol in chloroform

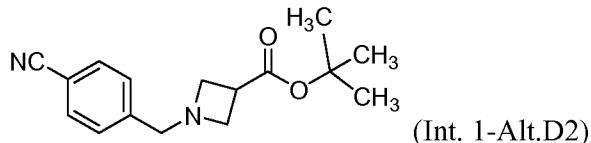
containing 0.2% triethylamine as eluent afforded (*Z*)-*tert*-butyl 1-(4-(N<sup>1</sup>-hydroxycarbamimidoyl)benzyl)azetidine-3-carboxylate (64 g, 0.210 mol, 55% yield over 2 steps). The compound had an HPLC retention time = 7.03 min. – Column: XBridge Phenyl 150x4.6 mm 3.5u, SC/749. 1mL/min. Solvent A = 5% MeCN, 95% H<sub>2</sub>O, 0.05% TFA; Solvent B = 95% MeCN, 5% H<sub>2</sub>O, 0.05% TFA. Time/%B: 0min/0%, 15min/50%, 18min/100%, 20min/100%. LC/MS M<sup>+1</sup> = 306.2. <sup>1</sup>H-NMR (400 MHz, CDCl<sub>3</sub>) δ ppm 1.45 (s, 9H), 3.23-3.30 (m, 3H), 3.49-3.57 (m, 2H), 3.63 (s, 2H), 4.85 (s, 2H), 7.31 (d, J=8.28 Hz, 2H), and 7.57 (d, J=8.28 Hz, 2H).

10 Alternative Preparation of Int.1-D: *tert*-butyl 1-(4-cyanobenzyl)azetidine-3-carboxylate

Alt. D1. 1-(4-Cyanobenzyl)azetidine-3-carboxylic acid



[0124] A mixture of 4-formylbenzonitrile (2.88 g, 22.0 mmol), azetidine-3-carboxylic acid (2.02 g, 20 mmol), and acetic acid (1.15 mL, 20.0 mmol) in dichloromethane (20 mL) and methanol (80 mL) was stirred at room temperature for 1 h. Sodium triacetoxyborohydride (6.78 g, 32.0 mmol) was added and stirring was continued at room temperature for 18 hr. The volatiles were removed under reduced pressure, and the residue was partitioned between water (50 mL) and diethyl ether (50 mL). The aqueous phase was washed with diethyl ether (50 mL) and was then concentrated to dryness. The residue was dissolved in water (20 mL) and loaded onto a 2.5 x 20 cm HP-20 column [Preparation of HP-20 Gel: ~400 ml of dry, unused MCI CHP-20 Gel (75-150 micron) was swelled in methanol for 24 hrs. The gel was filtered and rinsed with 1 liter of methanol. It was then transferred to a bottle for storage under methanol. Immediately before use, the desired amount of gel was rinsed thoroughly with 20 volumes of water]. The column was eluted with 240 mL of water and 400 mL of methanol. The product containing fractions were concentrated and co-evaporated from ethanol and ethyl acetate/heptane to afford 1-(4-cyanobenzyl)azetidine-3-carboxylic acid (3.25 g, 15.0 mmol, 75 % yield) as a white solid. MS:(M+H) = 217.18. <sup>1</sup>H NMR (400 MHz, MeOD) δ ppm 3.39 (m, 1H), 4.08 (m, 4H), 4.32 (s, 2H), 7.63 (d, J= 8.3 Hz, 2H), and 7.82 (d, J= 8.3 Hz, 2H).

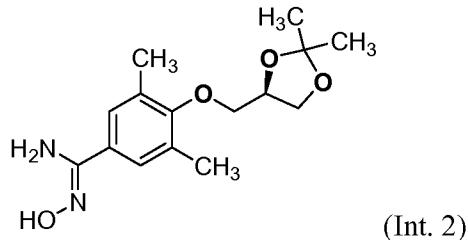
Int. 1-Alt.D2. *tert*-Butyl 1-(4-cyanobenzyl)azetidine-3-carboxylate

[0125] To a mixture of 1-(4-cyanobenzyl)azetidine-3-carboxylic acid (3.25 g, 15.0 mmol), DMAP (1.84 g, 15.0 mmol), and *tert*-butanol (14.1 mL, 150 mmol) in dichloroethane (150 mL) was added EDC (4.32 g, 22.5 mmol), and the reaction mixture was allowed to stir over the weekend. The volatiles were removed under reduced pressure, and the residue was partitioned between ethyl acetate (250 mL) and a saturated aqueous solution of sodium bicarbonate (250 mL). The organic layer was washed with water (250 mL), washed with brine (100 mL), and dried over anhydrous magnesium sulfate. Concentration under reduced pressure afforded a light yellow oil which was chromatographed on a 5 x 15 cm silica gel column, eluting with a 0-40% ethyl acetate/hexane gradient to give *tert*-butyl 1-(4-cyanobenzyl)azetidine-3-carboxylate (3.5 g, 12.9 mmol, 86 % yield) as a colorless liquid. HPLC retention time = 1.38 minutes (YMC-15 Combi 4.6 x 50 mm S-5 ODS column) eluting with 10-90% aqueous methanol + 0.2% phosphoric acid over a 4 minute gradient. MS:(M+H) = 273.18. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ ppm 1.46 (s, 9H), 3.26 (m, 3H), 3.52 (m, 2H), 3.66 (s, 2H), 7.39 (d, *J*= 8.3 Hz, 2H), and 7.60 (d, *J*= 8.3 Hz, 2H).

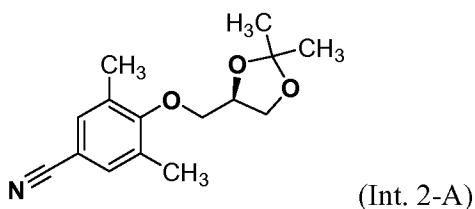
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## INTERMEDIATE 2

## (R)-4-((2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-N-hydroxy-3,5-dimethylbenzimidamide



## Int. 2-A: 1-(4-fluorophenyl)cyclohexanecarbaldehyde



(Int. 2-A)

[0126] Nitrogen was bubbled in a solution of 4-hydroxy-3,5-dimethylbenzonitrile (5.0 g, 34.0 mmol) and (R)-(-)-2,2-dimethyl-1,3-dioxolane-4-methanol (9.53 ml, 76 mmol) in THF (125 ml) at room temperature. The solution was made in a 500 ml flask w/ 3 necks fitted with a reflux condenser for 10 min. To this was added triphenylphosphine (20.05 g, 76 mmol) in one portion. Nitrogen was bubbled for an additional 10 minutes, followed by the dropwise addition of diethyl azodicarboxylate (12.04 ml, 76 mmol). The color of the reaction mixture changed from pale to a dark reddish brown and the reaction was exothermic. The reaction vessel was immersed in a preheated oil bath held at 65°C. The reaction was found to be nearly complete after 3h. The contents of the reactor were cooled and evaporated. The semi solid residue was taken in ether and washed with water. The aqueous layer was extracted with ether (2X). The combined organic layer was then washed with brine. It was then dried over anhydrous MgSO<sub>4</sub>, and then concentrated. Triphenylphosphineoxide was crystallized out and filtered with ether and hexanes. The product was purified on a 330g ISCo cartridge eluted with 0 to 30% EtOAc-hexanes. (R)-4-((2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-3,5-dimethylbenzonitrile (7.49 g, 28.7 mmol, 84 % yield) was obtained as a clear oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.27 (2 H, s), 4.38-4.49 (1 H, m), 4.08-4.19 (1 H, m), 3.88 (1 H, ddd, *J*=8.18, 5.99, 1.87 Hz), 3.73-3.84 (2 H, m), 2.25 (6 H, s), 1.41 (3 H, s), 1.36 (3 H, s).

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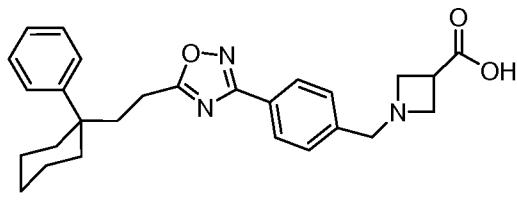
## Intermediate 2

[0127] Nitrogen was bubbled in a solution of (R)-4-((2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-3,5-dimethylbenzonitrile (8.1 g, 31.0 mmol) and hydroxylamine hydrochloride (4.31 g, 62.0 mmol) in MeOH (150 ml) at room temperature (the solution was made in a 500 ml flask w/ 3 necks fitted with a reflux condenser) for 10 min. To this was then added the sodium bicarbonate (10.42 g, 124 mmol) in one portion. Nitrogen was bubbled for an additional 10 minutes. The reaction mixture was set to stir at 60°C. It was heated for a total of 25h. The reaction mixture was cooled, concentrated in vacuo and then chromatographed (330g Redisep cartridge pre-saturated and then eluted with 10% EtOAc-

hexanes). 7.29 g (Yield = 82%) of the (R,Z)-4-((2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-N'-hydroxy-3,5-dimethylbenzimidamide was obtained as a white solid. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.25 (2 H, s), 4.80 (3 H, br. s.), 4.49 (1 H, qd, *J*=5.93, 5.71 Hz), 4.18 (1 H, dd, *J*=8.35, 6.59 Hz), 3.94 (1 H, dd, *J*=8.35, 5.93 Hz), 3.81-3.88 (1 H, m), 3.73-3.80 (1 H, m), 2.29 (6 H, s), 1.46 (3 H, s), 1.40 (3 H, s).

## EXAMPLE 1

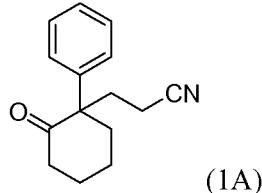
1-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid



10

(1)

Preparation 1A: 3-(2-oxo-1-phenylcyclohexyl)propanenitrile

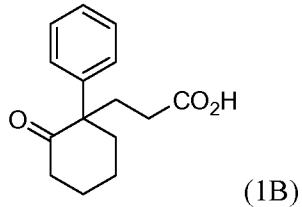


(1A)

Reference: W. E. Bachmann and L. B. Wick JACS 72, 3388, 1950.

15 [0128] Triton B surfactant (500 μL) was added to a stirred solution of 2-phenylcyclohexanone (5 g, 28.7 mmol) in dioxane (40 mL). A solution of acrylonitrile (1.8 g, 33.9 mmol) in dioxane (5 mL) was added dropwise. A slight exotherm was observed. The solution was stirred at room temperature for 3 h and concentrated. The residue was diluted with EtOAc (50 mL) and washed with water (20 mL, 2x). The EtOAc extract was dried (MgSO<sub>4</sub>), filtered, and concentrated. The residual oil was chromatographed on a silica gel column. Elution with 2% EtOAc in heptane, followed by 5% EtOAc in heptane afforded 3-(2-oxo-1-phenylcyclohexyl)propanenitrile (5.05 g, 77% yield) as a colorless oil. HPLC: *t*<sub>R</sub> = 2.73 min, YMC Combi S5 ODS 4.6 x 50 mm, 4 min gradient, Detection Wave length 220 nm, Starting solvent: 10% aq. MeOH- 0.2% H<sub>3</sub>PO<sub>4</sub>; 20 Final solvent: 90% aq. MeOH-0.2% H<sub>3</sub>PO<sub>4</sub>. LC/MS: m/e 228.26 (M+H)<sup>+</sup>, 250.14 (M+Na)<sup>+</sup>.

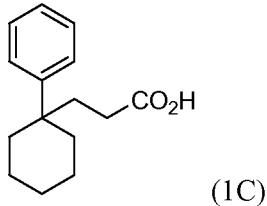
## Preparation 1B: 3-(2-oxo-1-phenylcyclohexyl)propanoic acid



[0129] A mixture of 3-(2-oxo-1-phenylcyclohexyl)propanenitrile (5.05 g, 22.22 mmol) in acetic acid (11.1 mL), conc. HCl (33.2 mL), and water (11.1 mL) was refluxed for 16 h under N<sub>2</sub>, cooled to room temperature, and poured into water (66 mL). The product separated out as an layer of oil. The suspension was cooled to 0°C in an ice bath for 30 min. with occasional swirling and the crystallized product was collected by filtration and rinsed several times with water, and dried *in vacuo* to obtain 3-(2-oxo-1-phenylcyclohexyl)propanoic acid (1B, 4.77 g, 85% yield) as a white crystalline solid.

HPLC:  $t_R$  = 2.47 min, YMC Combiscreen ODS-A 4.6 x 50 mm, 4 min gradient, Detection Wave length 220 nm, Starting solvent: 10% aq. MeOH- 0.1% TFA; Final solvent: 90% aq. MeOH-0.1% TFA. LC/MS: m/e 247.2 (M+H)<sup>+</sup>, 229.2 (M+H-H<sub>2</sub>O)<sup>+</sup>.

## 15 Preparation 1C: 3-(1-phenylcyclohexyl)propanoic acid (1C)



[0130] A mixture of 3-(2-oxo-1-phenylcyclohexyl)propanoic acid (1 g, 4.06 mmol), potassium hydroxide (0.770 g, 13.72 mmol), hydrazine monohydrate (0.348 mL, 6.09 mmol) and ethylene glycol (5 mL) was heated to 130°C for 1.5h. The condenser was removed and the mixture was heated to 200°C for 30min. The reaction mixture was then heated under reflux with a reflux condenser for additional 1.5h. The reaction mixture was cooled to room temperature and diluted with 1N HCl to a total reaction volume of 25 mL. The precipitated product was collected by filtration, washed several times with water, and dried *in vacuo* to obtain 3-(1-phenylcyclohexyl)propanoic acid as a white solid (1C, 923 mg, 93% yield). HPLC:  $t_R$  = 3.7 min, Chromolith SpeedRod 4.6 x 50 mm, 4 min gradient,

Detection Wave length 220 nm, Starting solvent: 10% aq. MeOH- 0.2% H<sub>3</sub>PO<sub>4</sub>; Final solvent: 90% aq. MeOH-0.2% H<sub>3</sub>PO<sub>4</sub>. LC/MS: m/e 215.19 (M+H-H<sub>2</sub>O)<sup>+</sup>.

Example 1:

5 [0131] To a stirred solution of the 3-(1-phenylcyclohexyl)propanoic acid (0.118 g, 0.508 mmol) and the (Z)-tert-butyl 1-(4-(N'-hydroxycarbamimidoyl)benzyl)azetidine-3-carboxylate (Intermediate 1, 0.155 g, 0.508 mmol) in acetonitrile (5.0 mL) at room temperature was added the 1,3-diisopropylcarbodiimide (0.095 mL, 0.609 mmol). The stirring was continued at room temperature and followed by LC/MS. After 90 min.,

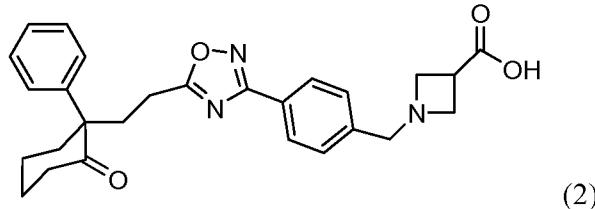
10 TBAF (0.609 mL, 0.609 mmol) was added to the reaction. The reaction was found to be over after 2h. The reaction mixture was diluted with EtOAc and washed with water followed by brine. It was then concentrated and purified by preparative HPLC to give the tert-butyl 1-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate as a glassy solid. LCMS of the tert-butyl 1-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (Conditions: Start % B = 0; Final % B = 100; Gradient Time = 2 min; Flow Rate = 5 ml/min; Wavelength = 220; Solvent A = 10% MeOH - 90% H<sub>2</sub>O - 0.1% TFA; Solvent B = 90% MeOH - 10% H<sub>2</sub>O - 0.1% TFA and Column 4 = Phenomenex Luna 5u C18 4.6 x 30 mm (2 min. grad)) (M+H)<sup>+</sup> = 502.39. Retention time = 1.927.

15 [0132] The glassy solid tert-butyl 1-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate was dissolved in 3mL of 4N HCl in dioxane, and the mixture was stirred for 5h. The reaction was followed by LC/MS and was evaporated and dried in vacuo. The residue was purified by prep. HPLC (Phenomenex S10 30 x 100 mm, 40min gradient time, Detection Wave length 220 nm,

20 Starting solvent: 10% aq. MeOH- 0.1% TFA; Final solvent: 90% aq. MeOH-0.1% TFA) to give the 1-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (47.5 mg, yield = 21%) as a white solid. LC/MS: m/e 446.17 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CD<sub>3</sub>OD): δ ppm 8.1 (d, J = 8.28 Hz, 2H), 7.61 (d, J = 8.28 Hz, 2H), 7.40-7.46 (m, 2H), 7.32-7.39 (m, 2H), 7.14-7.21 (m, 1H), 4.49 (s, 2H), 4.36 (d, J = 7.28 Hz, 4H), 3.66-3.77 (m, 1H), 2.55-2.69 (m, 2H), 2.2-2.33 (m, 2H), 2.04-2.19 (m, 2H), 1.33-1.79 (m, 8H).

## EXAMPLE 2

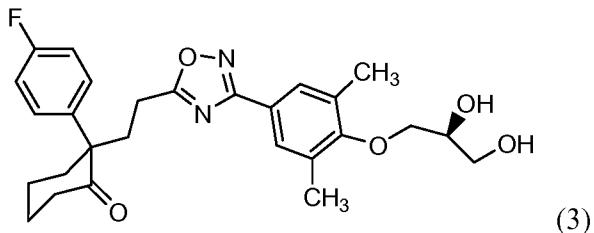
## 1-(4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid



5 [0133] A mixture of 3-(2-oxo-1-phenylcyclohexyl)propanoic acid (24.32 mg, 0.099 mmol, Preparation 1B), (Z)-methyl 1-(4-(N'-hydroxycarbamimidoyl)benzyl) azetidine-3-carboxylate (26 mg, 0.099 mmol), HOBT (15.12 mg, 0.099 mmol) and EDAC (18.93 mg, 0.099 mmol) in DMF (1 mL) was stirred at room temperature for 5 h. The reaction mixture was partitioned between EtOAc (30 mL) and water (30 mL). The organic layer was washed with saturated sodium bicarbonate solution (30 mL), water (30 mL) and brine (20 mL), dried ( $\text{MgSO}_4$ ), filtered, and concentrated to afford crude (Z)-methyl 1-(4-(3-(2-oxo-1-phenylcyclohexyl)propanoyloxy)carbamimidoyl)benzyl)azetidine-3-carboxylate (26 mg, 0.053 mmol, 54% yield) which was dissolved in toluene (2 mL) and heated to 105°C for 8 h. The solution was concentrated and the residue was chromatographed on a 10 gm ISCO silica gel cartridge, eluting with a 0-100% EtOAc/hexanes gradient. The pure fractions were concentrated to afford methyl 1-(4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (18 mg, 0.038 mmol, 75% yield) which was stirred as a solution in MeOH (1 mL) and 1 N aq. NaOH solution (0.19 mL, 0.190 mmol) at room temperature for 1 h. A 1N aq. HCl solution (0.3 mL) was added and the volatiles were removed *in vacuo*. The residue was subjected to preparative HPLC (YMC- 20 x 50 mm S-10 ODS column) eluting with 10-90% aqueous methanol and 0.1% TFA over a 10 minute gradient. The pure fraction was concentrated to afford 1-(4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid, TFA (13 mg, 60% yield) as a colorless oil. LC/MS: m/e 460.21 ( $\text{M}+\text{H}$ )<sup>+</sup>. <sup>1</sup>H NMR (500 MHz,  $\text{CD}_3\text{OD}$ ):  $\delta$  ppm 1.75-1.81 (m, 4H), 1.99 (m, 1H), 2.09 (m, 1H), 2.26 (m, 1H), 2.38 (m, 3H), 2.73 (m, 2H), 2.88 (m, 1H), 3.69 (m, 1H), 4.34 (m, 4H), 4.47 (s, 2H), 7.25 (m, 3H), 7.39 (m, 2H), 7.59 (d, 2H), 8.08 (d, 2H).

## EXAMPLE 3

2-(2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl)cyclohexanone

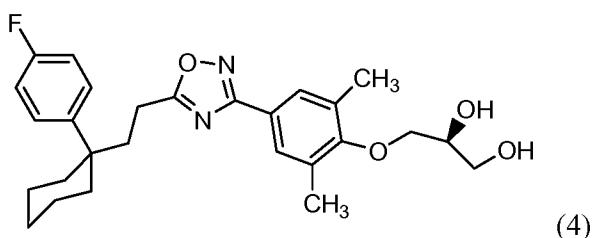


[0134] A solution of 3-(1-(4-fluorophenyl)-2-oxocyclohexyl)propanoic acid (30 mg, 0.114 mmol, Preparation 1B) and (R)-4-((2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-N-hydroxy-3,5-dimethylbenzimidamide (33.4 mg, 0.114 mmol) in dichloromethane (900  $\mu$ L) was treated with N,N'-diisopropylcarbodiimide (19  $\mu$ L, 0.125 mmol). The reaction mixture was stirred at room temperature for 1.5 h and concentrated. The residue was dissolved in acetonitrile (900  $\mu$ L) and treated with a solution of 1N tetra-*n*-butylammonium fluoride in THF (57  $\mu$ L, 0.057 mmol). After 2.5 h, additional 1N tetra-*n*-butylammonium fluoride solution in THF (28  $\mu$ L, 0.028 mmol) was added and stirring was continued for 16 h. The reaction mixture cooled to 0°C and treated with TFA (1.5 mL). After 1 min, the ice bath was removed and stirring was continued for additional 55 min. The reaction mixture was concentrated and the residue was purified by reversed-phase autoprep HPLC ( Phenomenex S10 30 x 100 mm, 40min gradient time, Detection Wave length 220 nm, Starting solvent: 10% aq. MeOH- 0.1% TFA; Final solvent: 90% aq. MeOH-0.1% TFA) to obtain 2-(2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl)cyclohexanone (23.2 mg, 34% yield) as a white solid. LC/MS: m/e 483.16 ( $M+H$ )<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CD<sub>3</sub>OD):  $\delta$  ppm 7.59 (s, 2H), 7.20-7.23 (m, 2H), 7.06-7.10 (m, 2H), 3.91-3.99 (m, 1H), 3.82-3.89 (m, 1H), 3.74-3.81 (m, 1H), 3.59-3.72 (m, 2H), 2.75-2.86 (m, 1H), 2.33-2.2 (m, 2H), 2.56-2.74 (m, 2H), 2.30-2.42 (m, 2H), 2.29 (s, 6H), 2.19-2.26 (m, 1H), 2.00-2.12 (m, 1H), 1.90-2.00 (m, 1H), 1.63-1.85 (m, 4H).

25

#### EXAMPLE 4

2-(2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl)cyclohexanone

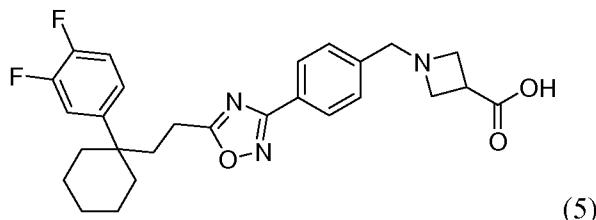


[0135] A solution of 3-(1-(4-fluorophenyl)cyclohexyl)propanoic acid (20 mg, 0.08 mmol, Preparation 1C) and (R)-4-((2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-N-hydroxy-3,5-dimethylbenzimidamide (23.5 mg, 0.08 mmol) in dichloromethane (1.5 mL) was treated with N,N'-diisopropylcarbodiimide (15  $\mu$ L, 0.096 mmol). The reaction mixture was stirred at room temperature for 2 h and then treated with a solution of 1N tetra-*n*-butylammonium fluoride in THF (40  $\mu$ L, 0.04 mmol). After 3.5 h, the reaction mixture was concentrated and the residue was cooled to 0°C and treated with TFA (1 mL). After 1 min, the ice bath was removed and stirring was continued for additional 1 h. The reaction mixture was concentrated and the residue was purified by reversed-phase autoprep HPLC (Phenomenex S10 30 x 100 mm, 40min gradient time, Detection Wave length 220 nm, Starting solvent: 10% aq. MeOH- 0.1% TFA; Final solvent: 90% aq. MeOH-0.1% TFA) to obtain 2-(2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl)cyclohexanone (37.4 mg, 28% yield) as a colorless viscous oil. LC/MS: m/e 469.20 ( $M+H$ )<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CD<sub>3</sub>OD):  $\delta$  ppm 7.64 (s, 2H), 7.33-7.51 (m, 2H), 6.92-7.15 (m, 2H), 3.96-4.04 (m, 1H), 3.87-3.94 (m, 1H), 3.79-3.86 (m, 1H), 3.64-3.77 (m, 2H), 2.47-2.68 (m, 2H), 2.34 (s, 6H), 2.03-2.18 (m, 4H), 1.55-1.81 (m, 4H), 1.31-1.56 (m, 4H).

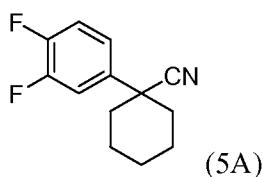
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## EXAMPLE 5

1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid

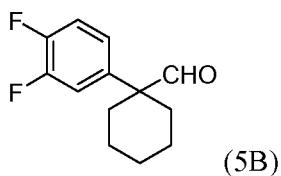


25 Preparation 5A: 1-(3,4-difluorophenyl)cyclohexanecarbonitrile



[0136] To a solution of 2-(3,4-difluorophenyl)acetonitrile (2 g, 13.06 mmol) in 20 mL of DMF at 0°C was added 60% sodium hydride (1.149 g, 28.7 mmol), and the mixture was stirred at the same temperature for 5 mins. Then a solution of 1,5-dibromopentane (1.779 5 mL, 13.06 mmol) in 20 mL of DMF was added dropwise and the mixture was stirred at a temperature in the range 0°C to room temperature for 5 hrs. The reaction was quenched with water, and extracted with EtOAc. The mixture was washed with water and brine. The combined aqueous layers were back extracted with EtOAc once and washed with brine. The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily 10 residue. It was purified by CombiFlash (120g silica gel) eluting with 1:9 EtOAc-hexane to give 1-(3,4-difluorophenyl) cyclohexanecarbonitrile (2.52 g, 11.39 mmol, 87 % yield). <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.12-7.35 (3 H, m), 2.14 (2 H, d, J=11.86 Hz), 1.75-1.95 (6 H, m), 1.64-1.75 (2 H, m).

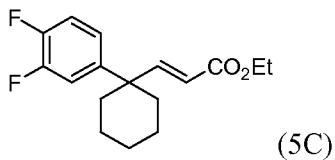
15 Preparation 5B: 1-(3,4-difluorophenyl)cyclohexanecarbaldehyde



[0137] To a solution of 1-(3,4-difluorophenyl)cyclohexanecarbonitrile (1 g, 4.52 mmol) in toluene (10 mL) at 0°C was added 1M DiBAL-H (9.94 mL, 9.94 mmol) in dichloromethane, and the mixture was stirred at a temperature in the range of from 0°C to 20 room temperature for 5 hrs. The reaction was quenched with dropwise addition of 0.8 mL of MeOH and stirred for 5 mins. To the mixture was added 15 mL of 2N HCl slowly with stirring. After stirring for 20 mins, the product was extracted with ethyl acetate, and the extracts were washed with water and brine. It was dried over sodium sulfate and evaporated to give 1-(3,4-difluorophenyl) cyclohexanecarbaldehyde as an oil.

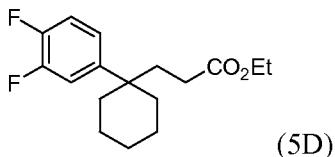
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Preparation 5C: (E)-ethyl 3-(1-(3,4-difluorophenyl)cyclohexyl)acrylate



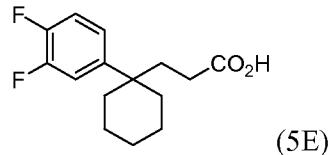
[0138] To a solution of triethyl phosphonoacetate (1.802 mL, 9.00 mmol) in THF (20 mL) at 0°C was added 1M potassium t-butoxide (9.00 mL, 9.00 mmol) dropwise, and the mixture was stirred at the same temperature. After 15 mins, a solution of 1-(3,4-difluorophenyl)cyclohexanecarbaldehyde (1009 mg, 4.5 mmol) in 10 mL of THF was added, and the mixture was stirred at room temperature for 2 hrs. The mixture was diluted with EtOAc, washed with water and brine, dried over Na<sub>2</sub>SO<sub>4</sub>, and evaporated to give an oily residue. The residue was purified by CombiFlash (80 g silica gel) eluting with 5:95 EtOAc - hexane to give (E)-ethyl 3-(1-(3,4-difluorophenyl)cyclohexyl)acrylate (608 mg, 45.9 % yield for 2 steps) as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 6.98-7.16 (3 H, m), 6.91 (1 H, d, J=15.82 Hz), 5.60 (1 H, d, J=16.26 Hz), 4.17 (2 H, q, J=7.18 Hz), 1.83-2.06 (4 H, m), 1.40-1.61 (6 H, m), 1.27 (3 H, t, J=7.03 Hz).

15 Preparation 5D: Ethyl 3-(1-(3,4-difluorophenyl)cyclohexyl)propanoate



[0139] To a solution of (E)-ethyl 3-(1-(3,4-difluorophenyl)cyclohexyl)acrylate (550 mg, 1.869 mmol) in MeOH (20 mL) was added ~150 mg of 10% Pd/C (wet, 50%), and the mixture was stirred under hydrogen (50 psi) for 6 hrs. The catalyst was removed by 20 filtering through Celite and the solvent was evaporated off to give ethyl 3-(1-(3,4-difluorophenyl)cyclohexyl)propanoate as an oil. LC/MS: m/e 297.16 (M+H)<sup>+</sup>.

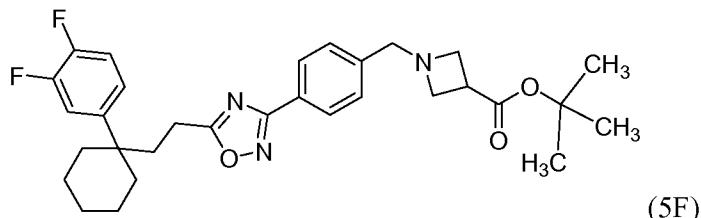
Preparation 5E: 3-(1-(3,4-difluorophenyl)cyclohexyl)propanoic acid



[0140] To a solution of ethyl 3-(1-(3,4-difluorophenyl)cyclohexyl)propanoate (540 mg, 1.822 mmol) in MeOH (15 mL) was added 1N NaOH (3.64 mL, 3.64 mmol), and the mixture was stirred at room temperature for 20 hrs. Since the reaction was not complete on TLC, an additional 1.82 mL of 1N NaOH was added, and it was continued to stir for 3 hrs. TLC showed that the reaction was complete. Next, the reaction mixture was acidified with the addition of 6 mL of 1N HCl, and the product was extracted with EtOAc. The extract was washed with water and brine, dried over Na<sub>2</sub>SO<sub>4</sub>, and evaporated to give 3-(1-(3,4-difluorophenyl)cyclohexyl) propanoic acid (489 mg, 1.822 mmol, 100 % yield) as a white solid.

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Preparation 5F: tert-Butyl 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate



[0141] To a solution of 3-(1-(3,4-difluorophenyl)cyclohexyl)propanoic acid (0.050 g, 0.186 mmol) and (Z)-tert-butyl 1-(4-(N'-hydroxycarbamimidoyl)benzyl)azetidine-3-carboxylate (0.057 g, 0.186 mmol) in acetonitrile (2 mL) was added 1,3-diisopropylcarbodiimide (0.032 mL, 0.205 mmol), and the mixture was stirred at room temperature for 4 hrs. LC/MS indicated completion of the first amide formation. Next, 1M TBAF (0.205 mL, 0.205 mmol) was added, and the mixture was stirred at room temperature overnight.

[0142] The solvent was evaporated off and the residue was purified by CombiFlash (12 g silica gel) eluting with 3:7 EtOAc-hexane to give tert-butyl 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (50.1 mg, 0.093 mmol, 50.0 % yield) as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.96 (2 H, d, J=8.35 Hz), 7.37 (2 H, d, J=8.79 Hz), 7.03-7.21 (3 H, m), 3.48-3.56 (2 H, m), 3.21-3.32 (4 H, m), 2.51-2.61 (2 H, m), 2.03-2.13 (4 H, m), 1.23-1.89 (13 H, m), 1.45 (9 H, s).

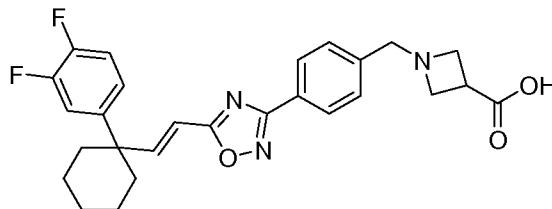
Example 5:

[0143] To tert-butyl 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (50.1 mg, 0.093 mmol) was added trifluoroacetic acid (2 mL, 26.0 mmol), and the mixture was stirred for 30 mins. The acid was evaporated off to give an oily residue. It was purified by preparative HPLC (Column: 5 Phen-Luna 5u C18 21.2 x 100 mm, Sol A: 10% MeOH - 90% H<sub>2</sub>O - 0.1% TFA, Sol B: 90% MeOH - 10% H<sub>2</sub>O - 0.1% TFA, Start %B: 50, Final %B: 100, Gradient Time: 10 mins) to give pure 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid, TFA (40.5 mg, 0.067 mmol, 71.5 % yield) as a foamy solid. LC/MS: m/e 482.14 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 12.51 (1 H, br. s.), 8.02 (2 H, d, J=7.03 Hz), 7.47 (2 H, d, J=7.91 Hz), 6.98-7.21 (3 H, m), 4.28-4.62 (4 H, m), 4.01-4.24 (2 H, m), 3.53-3.83 (1 H, m), 2.49-2.68 (2 H, m), 1.94-2.18 (4 H, m), 1.21-1.72 (8 H, m).

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## EXAMPLE 6

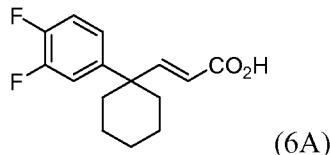
(E)-1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid



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(6)

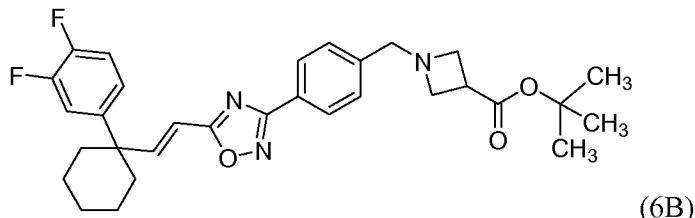
Preparation 6A: (E)-3-(1-(3,4-difluorophenyl)cyclohexyl)acrylic acid



[0144] To a solution of (E)-ethyl 3-(1-(3,4-difluorophenyl)cyclohexyl)acrylate (Preparation 5C, 53 mg, 0.180 mmol) in MeOH (1 mL) was added 1M NaOH (0.216 mL, 0.216 mmol), and the mixture was stirred at room temperature overnight. The mixture

was acidified by the addition of 0.3 mL of 1N HCl, and the product was extracted with EtOAc. The extract was washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give the (E)-3-(1-(3,4-difluorophenyl)cyclohexyl)acrylic acid as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 11.94 (1 H, br. s.), 7.11 (2 H, m), 7.02 (1H, d, J=15.82 Hz), 6.98-7.06 (1H, m), 5.62 (1 H, d, J=15.82 Hz), 1.83-2.06 (4 H, m), 1.37-1.65 (6 H, m).

Preparation 6B: (E)-tert-butyl 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate



10 [0145] To a solution of (E)-3-(1-(3,4-difluorophenyl)cyclohexyl)acrylic acid (47.9 mg, 0.18 mmol) and (Z)-tert-butyl 1-(4-(N'-hydroxycarbamimidoyl)benzyl)azetidine-3-carboxylate (55.0 mg, 0.180 mmol) in acetonitrile (2 mL) was added 1,3-diisopropylcarbodiimide (0.031 mL, 0.198 mmol), and the mixture was stirred at room temperature for 3 hrs. LC/MS after 2.5 hrs indicated completion of the first amide formation reaction. Next, 1M TBAF (0.198 mL, 0.198 mmol) was added, and the mixture was stirred at room temperature for 9 hrs.

15 [0146] The mixture was added to EtOAc and washed with water and brine, dried over Na<sub>2</sub>SO<sub>4</sub>. Evaporation of the solvent gave an oily residue, which was purified by Combiflash (12g silica gel) eluting with 3:7 EtOAc-hexane to give (E)-tert-butyl 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (59 mg, 0.110 mmol, 61.2 % yield) as an oil. LC/MS: m/e 536.20 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 8.00 (2 H, d, J=8.35 Hz), 7.38 (2 H, d, J=7.91 Hz), 7.12 (1 H, d, J=16.26 Hz), 7.07-7.22 (3 H, m), 6.22 (1 H, d, J=16.26 Hz), 3.65 (2 H, s), 3.51-3.56 (2 H, m), 3.22-3.31 (3 H, m), 1.93-2.14 (4 H, m), 1.45 (9 H, s), 1.39-1.66 (7 H, m).

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Example 6:

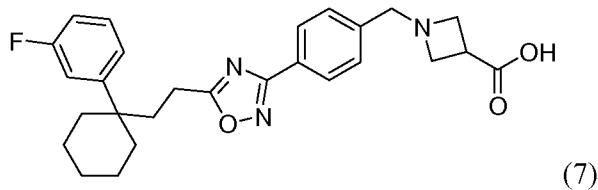
[0147] (E)-tert-butyl 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (59 mg, 0.110 mmol) was dissolved in TFA (2 mL, 26.0 mmol), and the mixture was stirred for 30 mins at room temp. The acid was

evaporated off, and the residue was dissolved in 2 mL of DMF and was purified by preparative LC/MS with the following conditions: Column: Waters SunFire C18, 19 x 250 mm, 5- $\mu$ m particles; Guard Column: Waters XBridge C18, 19 x 10 mm, 5- $\mu$ m particles; Mobile Phase A: 5:95 acetonitrile:water with 10-mM ammonium acetate; Mobile Phase B: 5 95:5 acetonitrile:water with 10-mM ammonium acetate; Gradient: 15-100% B over 25 minutes, then a 5-minute hold at 100% B; Flow: 20 mL/min. Fractions containing product were combined and dried via centrifugal evaporation. (E)-1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylic acid was obtained as a waxy solid (28.7 mg, 54.3% yield). LC/MS: m/e 479.7 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, DMSO-d6)  $\delta$  ppm 7.95 (2 H, d, J=8.28 Hz), 7.55 (1 H, ddd, J=12.99, 7.97, 2.38 Hz), 7.39-7.48 (3 H, m), 7.31 (1 H, ddd, J=6.46, 4.33, 2.01 Hz), 7.15 (1 H, d, J=16.31 Hz), 6.50 (1 H, d, J=16.56 Hz), 3.65 (2 H, s), 3.44 (2 H, br. s.), 3.25 (3 H, m), 2.08 (4 H, m), 1.47 (6 H, m).

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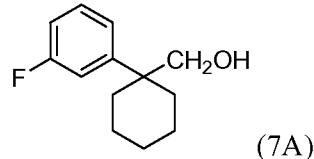
## EXAMPLE 7

1-(4-(5-(2-(1-(3-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid



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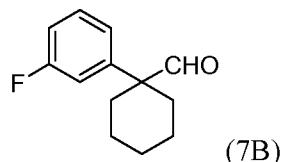
Preparation 7A: (1-(3-fluorophenyl)cyclohexyl)methanol



[0148] To a solution of 1-(3-fluorophenyl)cyclohexanecarboxylic acid (0.8 g, 3.60 mmol) in THF (10 mL) at 0°C was added 2M lithium aluminum hydride (2.500 mL, 5.0 mmol) in THF dropwise and the mixture was stirred at 0°C for 1.5 hrs. The reaction was quenched with Na<sub>2</sub>SO<sub>4</sub>.10H<sub>2</sub>O and stirred for 0.5 hrs. The reaction mixture was filtered through Celite and washed with EtOAc. The filtrate was washed with 1N HCl followed

by 1N NaOH and brine. The EtOAc layer was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give (1-(3-fluorophenyl)cyclohexyl)methanol (675 mg, 3.24 mmol, 90 % yield) as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.33 (1 H, td, J=8.02, 6.37 Hz), 7.16 (1 H, d, J=7.91 Hz), 7.09 (1 H, dt, J=11.26, 2.17 Hz), 6.89-6.96 (1 H, m), 3.50 (2 H, s), 2.10 (2 H, dd, J=12.85, 5 3.84 Hz), 1.30-1.66 (9 H, m).

Preparation 7B: 1-(3-fluorophenyl)cyclohexanecarbaldehyde



[0149] To a solution of oxalyl chloride (0.851 mL, 9.72 mmol) in 15 ml of CH<sub>2</sub>Cl<sub>2</sub> at -10 20°C was added DMSO (0.690 mL, 9.72 mmol) dropwise, and the mixture was stirred for 30 mins. Then a solution of (1-(3-fluorophenyl)cyclohexyl)methanol (675 mg, 3.24 mmol) in 5 mL of CH<sub>2</sub>Cl<sub>2</sub> was added dropwise and the mixture was stirred for 30 mins at -20°C. Next, triethylamine was added (1.807 mL, 12.96 mmol) dropwise, and the resulting suspension was stirred for 1 hr at a temperature in the range of from -20°C to 20°C and 15 then for 1.5 hrs at room temperature. It was diluted with Et<sub>2</sub>O and washed with water and brine. The combined washings were back-extracted with Et<sub>2</sub>O once and washed with brine. The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by CombiFlash (120 g silica gel) eluting with 5:95 followed by 2:8 EtOAc-hexane to give 1-(3-fluorophenyl) cyclohexanecarbaldehyde (470 mg, 70.3% 20 yield) as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 9.37 (1 H, s), 7.33 (1 H, td, J=8.02, 6.15 Hz), 7.07-7.11 (1 H, m), 7.04 (1 H, dt, J=10.77, 2.20 Hz), 6.94-7.00 (1 H, m), 2.28 (2 H, dd, J=13.51, 4.94 Hz), 1.83 (2 H, ddd, J=13.62, 10.55, 3.30 Hz), 1.29-1.72 (6 H, m).

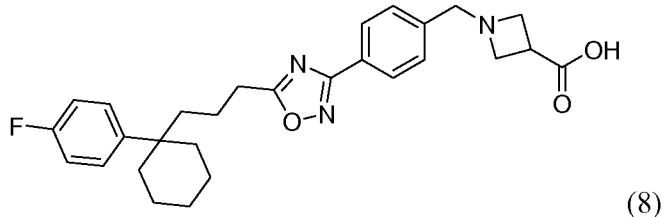
25 Example 7:

[0150] The titled compound was made using the general experimental protocol outlined for the compounds in Example 5 by employing 1-(3-fluorophenyl) cyclohexanecarbaldehyde (Preparation 7B). LC/MS: m/e 464.21 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 10.33 (1 H, br. s.), 8.04 (2 H, d, J=7.03 Hz), 7.48 (2 H, d, J=7.91 Hz), 7.26-7.33 (1 H, m), 7.12 (1 H, d, J=7.91 Hz), 7.05 (1 H, d, J=10.99 Hz), 6.88 (1 H, td, 30

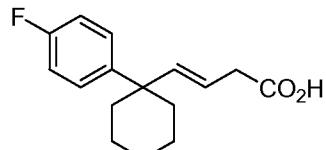
J=8.24, 1.98 Hz), 4.43 (2 H, br. s.), 4.36 (2 H, s), 4.01-4.17 (2 H, m), 3.54-3.82 (1 H, m), 2.52-2.61 (2 H, m), 2.04-2.18 (4 H, m), 1.33-1.70 (8 H, m).

## EXAMPLE 8

5 1-(4-(5-(3-(1-(4-fluorophenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid



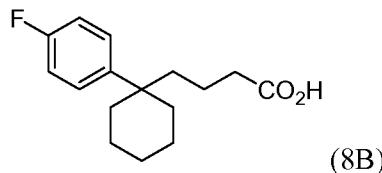
Preparation 8A: (E)-4-(1-(4-fluorophenyl)cyclohexyl)but-3-enoic acid



10 [0151] To a stirred suspension of 1-(4-fluorophenyl)cyclohexanecarbaldehyde (160 mg, 0.776 mmol) and 2-carboxyethyl triphenylphosphonium bromide (483 mg, 1.164 mmol) in THF (7 mL) at -78°C was added 1M lithium bis(trimethylsilyl)amide (2.172 mL, 2.172 mmol) in THF dropwise, and the mixture was stirred for 30 mins at -78°C, and 30 mins at a temperatures in the range of from -78°C to room temperature. Next, the mixture was stirred overnight at room temperature. After addition of 3 mL of 1N HCl, the mixture was extracted with EtOAc (2x), and the combined extracts were washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. The residue was purified by Combiflash (24 g silica gel) eluting with 5:95 followed by 3:7 EtOAc-hexane to give (E)-4-(1-(4-fluorophenyl) cyclohexyl)but-3-enoic acid (37.7 mg, 0.144 mmol, 18.53 % yield) along with the unreacted starting material (41.5 mg). <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.28-7.33 (2 H, m), 6.93-6.99 (2 H, m), 5.97 (1 H, dt, J=11.64, 1.76 Hz), 5.58 (1 H, dt, J=11.64, 7.25 Hz), 2.59 (2 H, dd, J=7.25, 1.76 Hz), 1.86-1.96 (2 H, m), 1.54-1.76 (8 H, m), 1.22-1.33 (2 H, m).

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Preparation 8B: 4-(1-(4-fluorophenyl)cyclohexyl)butanoic acid



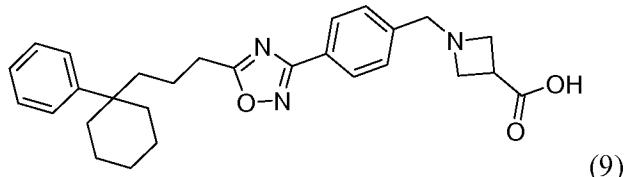
[0152] To a solution of (E)-4-(1-(4-fluorophenyl)cyclohexyl)but-3-enoic acid (37.3 mg, 0.142 mmol) in MeOH (10 mL) was added about 50 mg of 10% Pd/C (50% wet) and the solution was stirred under H<sub>2</sub> (50 psi) for 4 hrs. After removal of the catalyst by 5 filtering thru Celite, the solvent was evaporated off to give 4-(1-(4-fluorophenyl)cyclohexyl) butanoic acid (30 mg, 0.113 mmol, 80 % yield) as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 9.80 (1 H, br. s.), 7.42-7.49 (1 H, m), 7.21-7.27 (2 H, m), 6.98 (2 H, t, J=8.79 Hz), 2.11 (2 H, t, J=7.47 Hz), 1.97-2.07 (2 H, m), 1.17-1.61 (10 H, m).

10 Example 8:

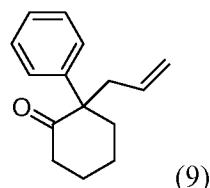
[0153] Example 8 was made using the general experimental protocol outlined for the preparation of compounds in Example 5 by employing 4-(1-(4-fluorophenyl)cyclohexyl) butanoic acid (Preparation 8B). LC/MS: m/e 478.09 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 8.83 (1 H, br. s.), 8.09 (2 H, d, J=7.91 Hz), 7.51 (2 H, d, J=8.35 Hz), 7.19-15 7.30 (2 H, m), 6.98 (2 H, td, J=8.79, 4.39 Hz), 4.54 (2 H, br. s.), 4.38 (2 H, br. s.), 3.77-4.16 (3 H, m), 2.75 (2 H, t, J=7.25 Hz), 2.04 (4 H, t, J=7.47 Hz), 1.18-1.65 (10 H, m).

#### EXAMPLE 9

1-(4-(5-(3-(1-(4-fluorophenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-20 3-carboxylic acid

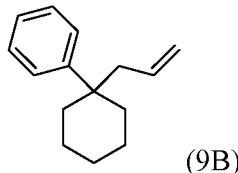


Preparation 9A: 2-allyl-2-phenylcyclohexanone



[0154] To a solution of 2-phenylcyclohexanone (2 g, 11.48 mmol) in 50 ml of anhydrous DME in an ice bath was added 1M sodium bis(trimethylsilyl)amide (12.63 mL, 12.63 mmol) dropwise and the solution was stirred at the same temp for 20 minutes. In a separated flask allylpalladium chloride dimer (0.104 g, 0.287 mmol) was dissolved in 10 ml of anhydrous DME, and was added triphenylphosphine (0.151 g, 0.574 mmol) to the solution. It was stirred for 20 minutes at room temp and then allyl acetate (1.300 mL, 12.05 mmol) was added. This solution was added to the anion solution dropwise and the mixture was stirred at room temp for 2 hrs. The reaction was quenched with saturated NH<sub>4</sub>Cl and extracted with hexane. The organic layer was washed with brine. The 10 combine aqueous layers were back-extracted with hexane once and combined. Dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by CombiFlash (120 g silica gel) eluting with hexane followed by 1:9 EtOAc-hexane to give 2.24 g of 2-allyl-2-phenylcyclohexanone. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.35 (2 H, t, J=7.58 Hz), 7.21-7.27 (1 H, m), 7.12-7.18 (2 H, m), 5.35-5.52 (1 H, m), 4.82-4.97 (2 H, m), 2.61-2.72 (1 H, m), 2.39-2.55 (2 H, m), 2.24-2.38 (2 H, m), 1.89-1.99 (1 H, m, J=9.39, 6.15, 2.88, 2.88 Hz), 1.62-1.81 (4 H, m).

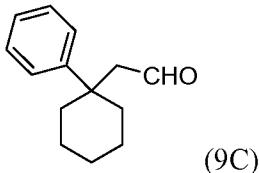
Preparation 9B: (1-allylcyclohexyl)benzene



[0155] To a solution of 2-allyl-2-phenylcyclohexanone (1.97 g, 9.19 mmol) in ethylene glycol (8 mL, 143 mmol) were added hydrazine (0.8 mL, 25.5 mmol) and potassium hydroxide (1.547 g, 27.6 mmol), and the mixture was stirred at 100°C for 1 hr and refluxed in a 180°C oil bath for 2.5 hrs. TLC showed that the hydrazone formation nearly complete. Then the excess hydrazine and water were distilled out in a 200°C oil bath, and it was continued to heat at the same temperature for 4 hrs. After cooling to room temp it was added to ether and washed with water and brine. The combined aqueous layers were back-extracted with ether (2x) and combined. Dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by CombiFlash (80 g silica gel) eluting with hexane followed by 5:95 EtOAc-hexane to give product (825 mg). <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.31 (4 H, d, J=4.39 Hz), 7.17 (1 H, dq, J=4.39, 4.25 Hz), 5.32-5.45

(1 H, m), 4.89 (1 H, s), 4.83-4.87 (1 H, m), 2.26 (2 H, d,  $J=7.47$  Hz), 2.07 (2 H, dd,  $J=13.84, 6.59$  Hz), 1.33-1.63 (8 H, m).

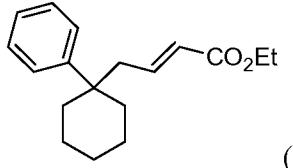
Preparation 9C: 2-(1-phenylcyclohexyl)acetaldehyde



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[0156] To a solution of (1-allylcyclohexyl)benzene (210 mg, 1.048 mmol) in THF (5 mL) was added a solution of sodium periodate (538 mg, 2.52 mmol) in water (5.00 mL), and 0.105 ml of 2.5% OsO<sub>4</sub> in t-BuOH, and the mixture was stirred at room temp for 18 hrs. It was extracted with EtOAc and washed with brine. The combined aqueous layers were back extracted with EtOAc and combined. Dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D)  $\delta$  ppm 9.36 (2 H, t,  $J=3.08$  Hz), 7.18-7.42 (5 H, m), 2.58 (2 H, d,  $J=3.30$  Hz), 1.34-1.81 (10 H, m).

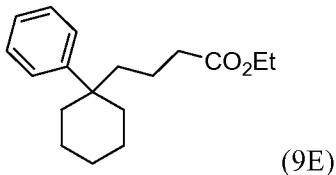
Preparation 9D: (E)-ethyl 4-(1-phenylcyclohexyl)but-2-enoate



15

[0157] To a solution of triethyl phosphonoacetate (0.601 mL, 3.00 mmol) in THF (10 mL) at 0°C was added 1 M potassium tert-butoxide (3.00 mL, 3.00 mmol) in THF dropwise and the mixture was stirred for 30 mins at the same temp. Then a solution of 2-(1-phenylcyclohexyl)acetaldehyde (405 mg, 2.0 mmol) in 4 ml of THF was added dropwise and the mixture was stirred for 0.5 hrs at 0°C and for 1.5 hrs at room temp. It was added to EtOAc and washed with water (2x) and saturated NH<sub>4</sub>Cl. It was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by Combiflash (80 g silica gel) eluting with 5:95 EtOAc-hexane to give (E)-ethyl 4-(1-phenylcyclohexyl)but-2-enoate (213.7 mg). <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D)  $\delta$  ppm 7.27-7.37 (4 H, m), 7.15-7.23 (1 H, m), 6.60 (1 H, ddd,  $J=15.49, 7.91, 7.80$  Hz), 5.66 (1 H, dt,  $J=15.60, 1.32$  Hz), 4.12 (2 H, q,  $J=7.18$  Hz), 2.39 (2 H, dd,  $J=7.80, 1.21$  Hz), 2.11 (2 H, dd,  $J=13.07, 5.60$  Hz), 1.33-1.66 (8 H, m), 1.24 (3 H, t,  $J=7.18$  Hz).

## Preparation 9E: Ethyl 4-(1-phenylcyclohexyl)butanoate

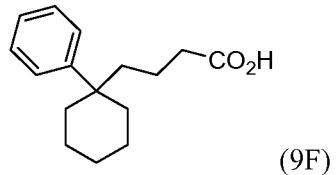


[0158] To a solution of (E)-ethyl 4-(1-phenylcyclohexyl)but-2-enoate (140 mg, 0.514

5 mmol) in MeOH (15mL) was added about 50 mg of 10 % Pd/C and the mixture was stirred under H<sub>2</sub> (30 psi) for 1 hr. The catalyst was filtered off and the filtrate was evaporated to give ethyl 4-(1-phenylcyclohexyl)butanoate as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.31 (2 H, s), 7.30 (2 H, s), 7.13-7.20 (1 H, m), 4.06 (2 H, q, J=7.03 Hz), 2.04-2.13 (4 H, m), 1.33-1.63 (10 H, m), 1.24-1.32 (2 H, m), 1.20 (3 H, t, J=7.14 Hz).

10

## Preparation 9F: 4-(1-phenylcyclohexyl)butanoic acid



[0159] To a solution of ethyl 4-(1-phenylcyclohexyl)butanoate (0.211 g, 0.77 mmol)

in MeOH (5 mL) was added 1M sodium hydroxide (1.155 mL, 1.155 mmol) and the mixture was stirred at room temp for 5 hrs. Then additional 0.39 ml of 1M NaOH was added and stirring was continued for 3 hrs. To the mixture was added 2 ml of 1N HCl and extracted with EtOAc (2x). The combined extracts were washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue, which became white solid upon storing at room temp.

20

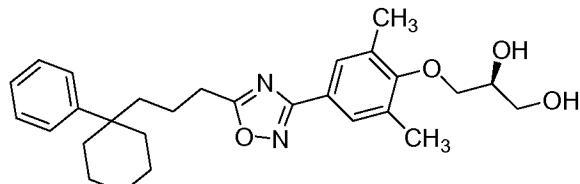
## Example 9

[0160] Example 9 was made using the experimental protocol outlined for the compounds in Example 5 by employing 4-(1-phenylcyclohexyl) butanoic acid

(Preparation 8F). <sup>1</sup>H NMR (400 MHz, METHANOL-d<sub>3</sub>) δ ppm 8.10 (2 H, d, J=7.47 Hz), 7.65 (2 H, d, J=7.47 Hz), 7.22-7.40 (4 H, m), 7.15 (1 H, t, J=6.81 Hz), 4.52 (2 H, d, J=14.06 Hz), 4.21-4.45 (4 H, m), 3.61-3.81 (1 H, m), 2.76 (2 H, t, J=7.25 Hz), 2.13 (2 H, dd, J=12.52, 5.05 Hz), 1.31-1.69 (10 H, m).

## EXAMPLE 10

(S)-3-(2,6-dimethyl-4-(5-(3-(1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol



5

(10)

[0161] The titled compound was made using the experimental protocol outlined for the compound in Example 4 by employing 4-(1-phenylcyclohexyl)butanoic acid (Preparation 9F). LC/MS: m/e 465.16 ( $M+H$ )<sup>+</sup>. <sup>1</sup>H NMR (400 MHz,  $CCl_3D$ )  $\delta$  ppm 7.64 (2 H, s), 7.21-7.33 (4 H, m), 7.04-7.15 (1 H, m), 6.77-6.78 (1 H, m), 3.97-4.13 (1 H, m), 3.68-3.92

10

(4 H, m), 2.66 (2 H, t,  $J=7.25$  Hz), 2.27 (6 H, s), 2.03 (2 H, d,  $J=7.03$  Hz), 1.23-1.65 (12 H, m).

## EXAMPLE 11

1-(4-(5-(3-(2-oxo-1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-

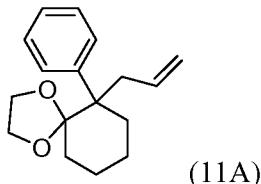
15

carboxylic acid



(11)

Preparation 11A: 6-Allyl-6-phenyl-1,4-dioxaspiro[4.5]decane

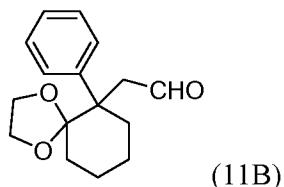


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[0162] A solution of 2-allyl-2-phenylcyclohexanone (370 mg, 1.727 mmol), ethylene glycol (0.481 mL, 8.63 mmol) and tosic acid (32.8 mg, 0.173 mmol) in benzene (10 mL) was refluxed under Dean-Stark trap for 1.5 hrs. Then additional 0.3 ml of ethylene glycol and ~20 mg of tosic acid were added and the mixture was continued to reflux for

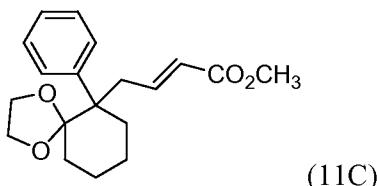
additional 15 hrs. After cooling, 2 ml of saturated NaHCO<sub>3</sub> was added and the product was extracted with EtOAc. The extract was washed with brine, and the combined aqueous layers were back-extracted with EtOAc once and combined. The extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by Combiflash (40 g silica gel) eluting with 1:9 EtOAc-hexane to give 444.5 mg of ketal as an oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.56 (2 H, d, J=7.25 Hz), 7.24-7.31 (2 H, m), 7.15-7.21 (1 H, m), 5.22-5.35 (1 H, m), 4.99 (1 H, d, J=16.70 Hz), 4.86 (1 H, d, J=10.11 Hz), 3.77 (1 H, q, J=7.03 Hz), 3.67 (1 H, td, J=6.87, 4.94 Hz), 3.57 (1 H, td, J=6.76, 4.94 Hz), 2.85-3.04 (2 H, m), 2.67 (1 H, dd, J=14.39, 8.68 Hz), 2.26 (1 H, ddd, J=13.68, 8.84, 5.16 Hz), 1.50-10 1.92 (7 H, m).

Preparation 11B: 2-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)acetaldehyde



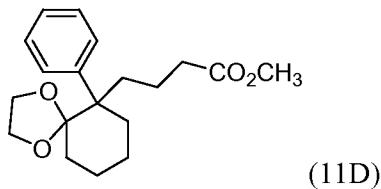
[0163] To a solution of 6-allyl-6-phenyl-1,4-dioxaspiro[4.5]decane (444 mg, 1.719 mmol) in THF (5 mL) was added a solution of sodium periodate (441 mg, 2.062 mmol) in water (5.00 mL), and 0.175 ml of 2.5% OsO<sub>4</sub> in t-BuOH, and the mixture was stirred for 3 hrs. At the end of the stirring it was added to EtOAc and washed with water, aq. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> and brine. It was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue.

20 Preparation 11C: (E)-Methyl 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)but-2-enoate



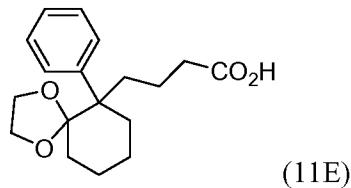
[0164] A solution of 2-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)acetaldehyde (0.448 g, 1.72 mmol) and methyl (triphenylphosphoranylidene)-acetate (1.150 g, 3.44 mmol) in THF (7 mL) was refluxed for 18 hrs. After cooling it was evaporated and the residue was purified by Combiflash (40 g silica gel) eluting with 1:9 EtOAc-hexane to give (E)-methyl 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)but-2-enoate as an oil (136 mg). LC/MS: m/e 317.20 (M+H)<sup>+</sup>.

## Preparation 11D: Methyl 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)butanoate



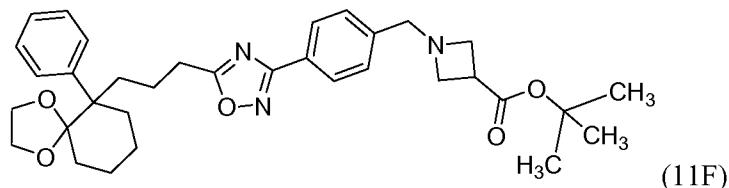
[0165] To a solution of (E)-methyl 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)but-2-enoate (136 mg, 0.430 mmol) in MeOH (15mL) was added about 50 mg of 10 % Pd/C and the mixture was stirred under H<sub>2</sub> (25 psi) for 3.5 hrs. It was filtered through Celite and evaporated to give an oily residue. LC/MS: m/e 319.10 (M+H)<sup>+</sup>.

## Preparation 11E: 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)butanoic acid



[0166] To a solution of methyl 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)butanoate (0.137 g, 0.43 mmol) in MeOH (3 mL) was added 1N sodium hydroxide (1.290 mL, 1.290 mmol), and the mixture was stirred at room temp for 4 hrs. It was made acidic with 1.4 mL of 1N HCl and the product was extracted with EtOAc (2x). The combined extracts were washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give a solid residue (128 mg).

## Preparation 11F: tert-butyl 1-(4-(5-(3-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate



[0167] To a solution of (Z)-tert-butyl 1-(4-(N'-hydroxycarbamimidoyl)benzyl)azetidine-3-carboxylate (50 mg, 0.164 mmol) and 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)butanoic acid (59.8 mg, 0.196 mmol) in acetonitrile (2 mL) was added N,N'-diisopropylcarbodiimide (0.031 mL, 0.196 mmol), and the mixture was stirred for 1 hr at

room temp. LC/MS after 1 hr (78045-023-01) showed that the first reaction was complete. Then 1M TBAF (0.213 mL, 0.213 mmol) was added, and the mixture was stirred at room temp for 18 hrs. It was partitioned between EtOAc and water, and the aqueous layer was extracted with EtOAc once more. Combined extracts were washed 5 with Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by CombiFlash (24 g silica gel) eluting with 1:1 EtOAc-hexane to give tert-butyl 1-(4-(5-(3-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (45.3 mg). LC/MS: m/e 574.20 (M+H)<sup>+</sup>.

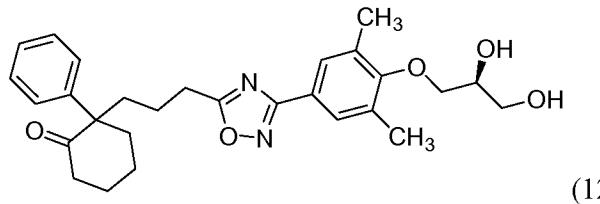
## 10 Example 11:

[0168] 10 tert-butyl 1-(4-(5-(3-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (45 mg, 0.078 mmol) was dissolved in 1 ml of 4N HCl in dioxane, and the solution was stirred for 7 hrs at room temperature. Then 15 the acid and solvent were evaporated off and the residue was azeotroped with acetonitrile 5 times. The final residue was dissolved in CH<sub>2</sub>Cl<sub>2</sub> and evaporated to give an oily residue, which was dried in vacuo to give a white foamy solid residue. The resulting material was purified by prep HPLC (Waters Sunflower C-18 19x100 mm w/guard, Solvent A: 95% H<sub>2</sub>O, 5% CH<sub>3</sub>CN, 0.05% TFA, Solvent B: 95% CH<sub>3</sub>CN, 5% H<sub>2</sub>O, 0.05% TFA; start %B = 20, final %B = 100) to afford a TFA salt of the titled compound as a waxy solid (32 mg). 20 LC/MS: m/e 474.09 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.98 (2 H, d, J=7.91 Hz), 7.42 (2 H, d, J=7.91 Hz), 7.28 (2 H, t, J=7.47 Hz), 7.14-7.22 (1 H, m), 7.07 (2 H, d, J=7.47 Hz), 4.19-4.58 (4 H, m), 4.01 (2 H, br. s.), 3.45-3.79 (1 H, m), 2.62-2.76 (3 H, m), 2.10-2.36 (2 H, m), 1.77-1.95 (2 H, m), 1.50-1.74 (6 H, m), 1.29-1.47 (1 H, m).

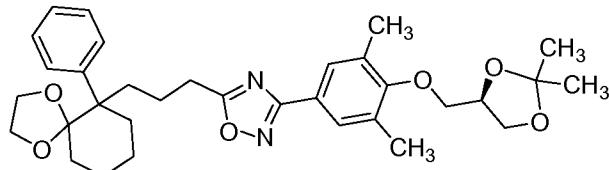
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## EXAMPLE 12

2-(3-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)propyl)-2-phenylcyclohexanone



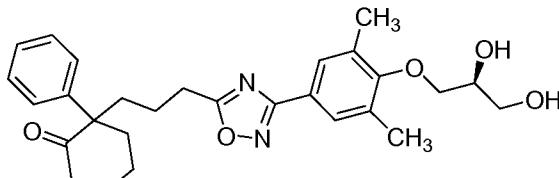
Preparation 12A: 3-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-3,5-dimethylphenyl)-5-(3-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)propyl)-1,2,4-oxadiazole



(12A)

[0169] To a solution of 4-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)butanoic acid (62.0 mg, 0.204 mmol) and (R,Z)-4-((2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-N'-hydroxy-3,5-dimethylbenzimidamide (50 mg, 0.17 mmol) in acetonitrile (2 mL) was added N,N'-diisopropylcarbodiimide (0.032 mL, 0.204 mmol), and the mixture was stirred for 1 hr at room temp. Then 1M TBAF (0.221 mL, 0.221 mmol) was added, and the mixture was stirred at room temp for 18 hrs. It was partitioned between EtOAc and water, and the aqueous layer was extracted with EtOAc once more. Combined extracts were washed with Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by CombiFlash (24 g silica gel) eluting with 3:7 followed by 1:1 EtOAc-hexane to give 3-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-3,5-dimethylphenyl)-5-(3-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)propyl)-1,2,4-oxadiazole as an oil (57 mg). LC/MS: m/e 563.21 (M+H)<sup>+</sup>.

Preparation 12B: 2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)propyl)-2-phenylcyclohexanone



(12B)

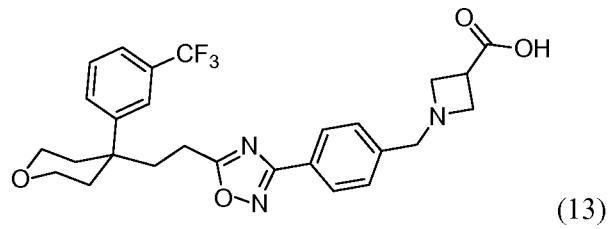
[0170] To a solution of 3-((R)-2,2-dimethyl-1,3-dioxolan-4-yl)methoxy)-3,5-dimethylphenyl)-5-(3-(6-phenyl-1,4-dioxaspiro[4.5]decan-6-yl)propyl)-1,2,4-oxadiazole (57 mg, 0.101 mmol) in acetic acid (1 mL) was added 1N HCl (0.2 mL, 0.200 mmol), and the mixture was stirred at 0°C for 1.5 hrs. The mixture was poured into saturated Na<sub>2</sub>CO<sub>3</sub> and the product was extracted with EtOAc (2X). The combined extracts were washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. The residue was purified by CombiFlash (24 g silica gel) eluting with 1:1 followed by 7:3 EtOAc-hexane,

to afford 2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)propyl)-2-phenylcyclohexanone as a solid (34.4 mg). LC/MS: m/e 479.1 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.67 (2 H, s), 7.31-7.38 (2 H, m), 7.24 (1 H, t, J=7.25 Hz), 7.14 (2 H, d, J=7.47 Hz), 4.06-4.15 (2 H, m), 3.75-3.90 (5 H, m), 2.70-2.81 (3 H, m), 5 2.26-2.38 (8 H, m), 1.84-1.97 (2 H, m), 1.59-1.78 (6 H, m), 1.37-1.52 (1 H, m).

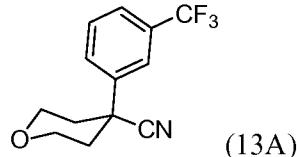
## EXAMPLE 13

1-(4-(5-(2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid

10



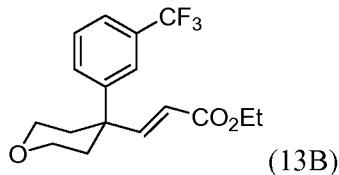
Preparation 13A: 4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-carbonitrile



[0171] A solution of 2-(3-(trifluoromethyl)phenyl)acetonitrile (2 g, 10.8 mmol) in 15 DMF (10 mL) was added dropwise to a suspension of sodium hydride (1.05 g, 26.3 mmol, 60% in oil dispersion) in DMF (10 mL), cooled to 0°C in an ice water bath. After addition, the mixture was warmed to room temperature and stirred for 30 min. The suspension was cooled to 0°C and a solution of 1-chloro-2-(2-chloroethoxy)ethane (2 g, 13.98 mmol) in DMF (20 mL) was added dropwise over a period of 30 min. The dark 20 suspension was warmed to room temperature and stirred for additional 1.5 h. The mixture was quenched by addition of aq. 10% LiCl solution (50 mL) and diluted with EtOAc (100 mL). The organic extract was separated and the aqueous layer was extracted with EtOAc (30 mL, 2x). EtOAc extracts were combined, washed with 10% aq. LiCl solution (30 mL, 3x), and brine (25 mL, 2x), dried (MgSO<sub>4</sub>), filtered, and concentrated to obtain a dark 25 brown oil (HPLC and LC/MS). The crude oil was chromatographed on a silica gel column. Elution with 10% EtOAc in heptane, followed by 20% EtOAc in heptane

afforded 4-(3-(trifluoromethyl)phenyl) tetrahydro-2H-pyran-4-carbonitrile as a light yellow solid (2.31g, 84% yield). HPLC:  $t_R$  = 2.75 min, YMC Combi S5 ODS 4.6 x 50 mm, 4 min gradient, Detection Wave length 220 nm, Starting solvent: 10% aq. MeOH-0.2%  $H_3PO_4$ ; Final solvent: 90% aq. MeOH-0.2%  $H_3PO_4$ . LC/MS: m/e 256.06 ( $M+H$ )<sup>+</sup>, 5 229.02 ( $M+H-HCN$ )<sup>+</sup>.

Preparation 13B: Ethyl 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)acrylate



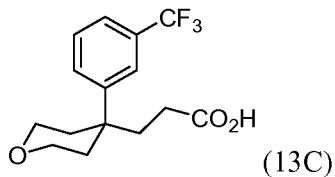
10 [0172] A 1M solution of diisobutylaluminumhydride (18.34 mL, 18.34 mmol) in toluene was added dropwise to a solution of 4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-carbonitrile (2.31 g, 9.17 mmol) in toluene (25 mL). The reaction mixture was stirred at room temperature for 4 h and diluted with EtOAc and 2 N aq. HCl solution. The organic layer was separated and the aqueous layer was extracted with EtOAc. The EtOAc extracts were combined, washed with 2N aq. HCl solution, brine, dried ( $Na_2SO_4$ ), and evaporated under vacuum to yield 0.83 g of an orange oil which was chromatographed on silica gel (Teledyne-Isco RediSep 40 g column). Elution with 20% EtOAc in hexanes, followed by 30% EtOAc in hexanes afforded 4-(3-(trifluoromethyl)phenyl)- tetrahydro-2H-pyran-4-carbaldehyde (970 mg, 41% yield) as a yellow viscous oil. <sup>1</sup>H NMR (400 MHz,  $CDCl_3$ ):  $\delta$  ppm 9.44 (s, 1H), 7.37-7.72 (m, 4H), 3.93 (ddd, 2 H), 3.60 (dt, 2H), 2.45 (d, 2H), 1.97-2.24 (m, 2H).

15 [0173] N,N-diisopropylethylamine (2.95 mL, 16.9 mmol) and anhydrous lithium bromide (489 mg, 5.63 mmol) were added to a stirred solution of 4-(3-(trifluoromethyl)phenyl)-tetrahydro-2H-pyran-4-carbaldehyde (485 mg, 1.88 mmol) in

20 THF (15 mL). After 20 min., triethyl phosphonoacetate (1.12 mL, 5.63 mmol) was added and the mixture was stirred at room temperature for 16 h. Additional N,N-diisopropylethylamine (980  $\mu$ L, 5.64 mmol) was added and stirring was continued for additional 160 min. The reaction mixture was diluted with EtOAc and 1N aq. HCl solution. The organic layer was separated, washed with 1N aq. HCl solution, brine, dried ( $Na_2SO_4$ ), filtered, and concentrated under vacuum to obtain a thin yellow oil which was

chromatographed on silica gel (Teledyne-Isco RediSep 12 g column). Elution with 5%, 10%, and 20% EtOAc in hexanes afforded ethyl 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl) acrylate (569 mg, 92% yield) as a viscous yellow oil. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ ppm 7.38-7.68 (m, 4H), 6.98 (d, 1H), 5.71 (d, 1H), 4.19 (q, 2H), 3.76 (dd, 4H), 2.06-2.34 (m, 4H), 1.29 (t, 3H).

Preparation 13C: 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)propanoic acid



10 [0174] A solution of ethyl 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)acrylate (101 mg, 308 μmol) and platinum(IV) oxide (10.3 mg, 46 μmol) in ethanol (2 mL) was hydrogenated at 1 atmosphere for 4.25 h. The catalyst was removed by filtration through a Whatman Autovial filter and the filtrate was concentrated under vacuum to afford ethyl 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)propanoate (99 mg, 15 97% yield) as a viscous colorless oil. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ ppm 7.34-7.60 (m, 4H), 4.02 (q, 2H), 3.81 (ddd, 2H), 3.43-3.63 (m, 2H), 2.07-2.23 (m, 2H), 1.97-2.04 (m, 2H), 1.84-1.96 (m, 4H), 1.19 (t, 3H).

10 [0175] A solution of ethyl 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)propanoate (99 mg, 302 μmol) in a 1:1 mixture of THF and MeOH (1.088 mL) was treated 20 with a 2.78 M aq NaOH solution (544 μL, 1.512 mmol) and the mixture was stirred at room temperature for 80 min. The reaction mixture was concentrated and the residue was diluted with aq. 1N HCl solution (8 mL). After a brief sonication (< 1 min) a precipitation was observed. The precipitated solid was collected by filtration, washed several times with water, and dried under vacuum to obtain 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-25 2H-pyran-4-yl)propanoic acid (77 mg, 84% yield) as a white solid. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ ppm 7.38-7.62 (m, 4H), 3.81 (ddd, 2H), 3.54 (ddd, 2H), 2.08-2.29 (m, 2H, m), 1.93-2.04 (m, 4H), 1.84-1.93 (m, 2H).

## Example 13:

[0176] N,N'-Diisopropylcarbodiimide (15 mg, 119  $\mu$ mol) was added to a stirred solution of 3-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)propanoic acid (30

5 mg, 99  $\mu$ mol) and tert-butyl-1-(4-(N'-hydroxycarbamimidoyl)benzyl)azetidine-3-carboxylate (30 mg, 99  $\mu$ mol) in dichloromethane (1.5 mL). The reaction mixture was stirred at room temperature for 1 h and concentrated. The residue was diluted with acetonitrile (1.5 mL) and treated with a 1 M solution of tetra-*n*-butylammonium fluoride (99  $\mu$ L, 99  $\mu$ mol). The mixture was stirred at room temperature for 16 h and concentrated.

10 The crude residue was chromatographed on silica gel (Teledyne-Isco RediSep 12g column), and eluted with 50% and 70% EtOAc in hexanes to obtain tert-butyl 1-(4-(5-(2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylate (46.5 mg, 82% yield) as a white solid.

[0177] A solution of tert-butyl 1-(4-(5-(2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-

15 2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (46 mg, 80  $\mu$ mol) in trifluoroacetic acid (1.5 mL) was stirred at room temperature for 75 min.

Trifluoroacetic acid was removed under reduced pressure, followed by co-evaporation with ether. The crude product was purified by reversed-phase autoprep HPLC (

Phenomenex S10 30 x 100 mm, 40min gradient time, Detection Wave length 220 nm,

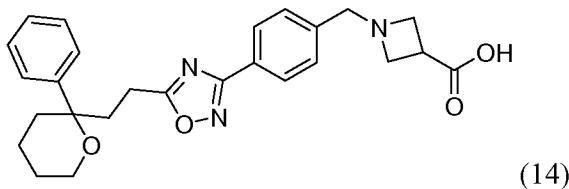
20 Starting solvent: 10% aq. MeOH- 0.1% TFA; Final solvent: 90% aq. MeOH-0.1% TFA) to obtain 1-(4-(5-(2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylic acid (25 mg, 47% yield) as a white solid.

LC/MS: m/e 516.19 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CD<sub>3</sub>OD):  $\delta$  ppm 8.09 (d, *J*=8.28 Hz, 2H), 7.66-7.75 (m, 2H), 7.62 (d, *J*=8.28 Hz, 2H), 7.49-7.59 (m, 2 H), 4.50 (s, 2 H), 4.29-

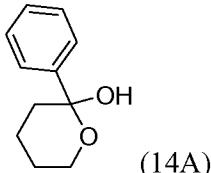
25 4.42 (m, 4 H), 3.87 (ddd, *J*=11.73, 5.46, 3.64 Hz, 2H), 3.72 (dt, *J*=16.75, 8.31 Hz, 1H), 3.45-3.63 (m, 2H), 2.60-2.79 (m, 2H), 2.32-2.36 (m, 2H), 2.27-2.32 (m, 2H), 1.90-2.08 (m, 2H).

## EXAMPLE 14

30 1-(4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid



## Preparation 14A: 2-phenyltetrahydro-2H-pyran-2-ol

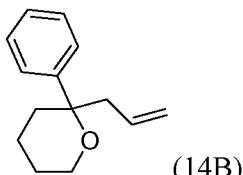


5 [0178] To a solution of delta-valerolactone (1.854 mL, 19.98 mmol) in THF (20 mL) was added 1M phenylmagnesium bromide (19.98 mL, 19.98 mmol) dropwise at room temperature (exothermic), and the mixture was stirred at room temperature for 5 hrs. Then the reaction was quenched with saturated NH<sub>4</sub>Cl and extracted with EtOAc. The extract was washed with brine, and the combined aqueous layers were back extracted with EtOAc once and combined. The extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. It was purified by CombiFlash (120 g silica gel) eluting with 4:6 followed by 1:1 EtOAc-hexane to give 1.97 g of 2-phenyltetrahydro-2H-pyran-2-ol as oil. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.92-8.00 (1 H, m), 7.17-7.60 (5 H, m), 3.67 (1 H, t, J=6.15 Hz), 3.03 (1 H, t, J=7.14 Hz), 2.25-2.37 (1 H, m), 1.75-1.92 (2 H, m), 1.54-1.71 (2 H, m), 1.30-1.43 (1 H, m).

10

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## Preparation 14B: 2-allyl-2-phenyltetrahydro-2H-pyran

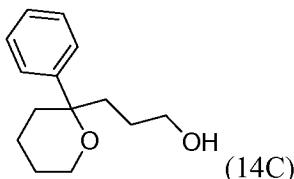


[0179] To a solution of 2-phenyltetrahydro-2H-pyran-2-ol (1.066 g, 5.98 mmol) and allyltrimethylsilane (1.901 mL, 11.96 mmol) in CH<sub>2</sub>Cl<sub>2</sub> (25 mL) at 0°C was added BF<sub>3</sub>·OEt<sub>2</sub> (0.758 mL, 5.98 mmol) dropwise, and the mixture was stirred at the same temperature for 1 hr. Then the reaction was quenched with saturated NaHCO<sub>3</sub> and the product was extracted with EtOAc. The extract was washed with brine, and the combined aqueous layers were back extracted with EtOAc once and combined. The extracts were

20

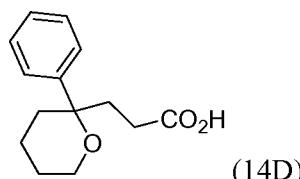
dried over  $\text{Na}_2\text{SO}_4$  and evaporated to give an oily residue. It was purified by CombiFlash (80 g silica gel) eluting with 1:9 followed by 4:6 EtOAc-hexane to give 2-allyl-2-phenyltetrahydro-2H-pyran as oil (0.954 g).  $^1\text{H}$  NMR (400 MHz,  $\text{CCl}_3\text{D}$ )  $\delta$  ppm 7.10-7.45 (5 H, m), 5.47-5.65 (1 H, m,  $J$ =17.19, 10.11, 7.33, 7.33 Hz), 4.84-5.00 (2 H, m), 3.64-3.78 (1 H, m), 3.41-3.57 (1 H, m), 2.35-2.48 (1 H, m), 2.20-2.35 (1 H, m), 1.55-1.81 (4 H, m), 1.35-1.54 (2 H, m).

Preparation 14C: 3-(2-phenyltetrahydro-2H-pyran-2-yl)propan-1-ol



10 [0180] To a solution of 2-allyl-2-phenyltetrahydro-2H-pyran (700 mg, 3.46 mmol) in THF (7 mL) at 0°C was added 1M borane tetrahydrofuran complex (1.730 mL, 1.730 mmol) dropwise, and the mixture was stirred overnight at room temperature. After cooling to 0°C, water (0.07 ml) was added to destroy the excess borane. After stirring for 10 mins, 3M NaOH (0.42 mL, 1.260 mmol) was added and stirred for 10 mins. Then 30%  $\text{H}_2\text{O}_2$  (0.42 mL, 4.11 mmol) was added and the cooling bath was removed. It was refluxed for 1.5 hrs and cooled to room temperature. It was extracted with EtOAc (2x), and the combined extracts were washed with brine, dried over  $\text{Na}_2\text{SO}_4$  and evaporated to give 3-(2-phenyltetrahydro-2H-pyran-2-yl)propan-1-ol as oil.  $^1\text{H}$  NMR (400 MHz,  $\text{CCl}_3\text{D}$ )  $\delta$  ppm 7.11-7.44 (5 H, m), 3.66-3.81 (2 H, m), 3.48-3.59 (2 H, m), 2.22-2.37 (2 H, m), 1.35-1.89 (8 H, m).

Preparation 14D: 3-(2-phenyltetrahydro-2H-pyran-2-yl)propanoic acid



25 [0181] To a solution of 3-(2-phenyltetrahydro-2H-pyran-2-yl)propan-1-ol (640 mg, 2.91 mmol) in acetone (10 mL) at 0°C was added 4.15 mL of 0.7 M Jone's reagent, and the mixture was stirred for 30 mins at 0°C and for 1 hr at room temperature. It was added to  $\text{CH}_2\text{Cl}_2$  and washed with water twice. The extract was dried over  $\text{Na}_2\text{SO}_4$  and evaporated

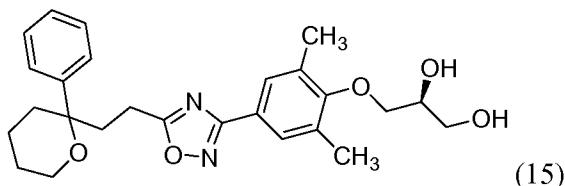
to give an oily residue. The residue was purified by CombiFlash (40 g silica gel) eluting with 4:6 EtOAc-hexane to 3-(2-phenyltetrahydro-2H-pyran-2-yl)propanoic acid (346 mg). LC/MS: m/e 235.21 (M+H)<sup>+</sup>.

5 Example 14:

[0182] The titled compound was made using the experimental protocol outlined in Example 5 by employing 3-(2-phenyltetrahydro-2H-pyran-2-yl)propanoic acid. LC/MS: m/e 448.09 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, METHANOL-d<sub>3</sub>) δ ppm 8.08 (2 H, d, J=8.35 Hz), 7.62 (2 H, d, J=8.35 Hz), 7.33-7.46 (4 H, m), 7.19-7.28 (1 H, m), 4.50 (2 H, s), 4.30-10 4.43 (4 H, m), 3.68-3.78 (2 H, m), 3.54-3.62 (1 H, m), 2.81-2.96 (1 H, m), 2.67-2.80 (1 H, m), 2.29-2.44 (2 H, m), 2.14 (1 H, ddd, J=13.84, 10.33, 6.15 Hz), 1.78-1.88 (1 H, m), 1.57-1.78 (2 H, m), 1.38-1.54 (2 H, m).

EXAMPLE 15

15 (2S)-3-(2,6-dimethyl-4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol

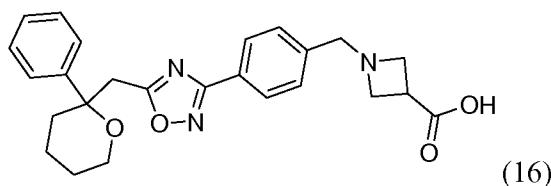


[0183] The titled compound was made using the experimental protocol outlined in Example 4 by employing 3-(2-phenyltetrahydro-2H-pyran-2-yl)propanoic acid (Preparation 14D). LC/MS: m/e 453.13 (M+H)<sup>+</sup>. <sup>1</sup>H NMR (400 MHz, CCl<sub>3</sub>D) δ ppm 7.68 (2 H, s), 7.32-7.43 (3 H, m), 7.22-7.29 (2 H, m), 4.04-4.18 (2 H, m), 3.70-3.92 (6 H, m), 3.56-3.65 (1 H, m), 2.90 (1 H, ddd, J=15.93, 11.32, 4.83 Hz), 2.66 (1 H, ddd, J=16.04, 11.21, 5.27 Hz), 2.31 (6 H, s), 2.22-2.43 (2 H, m), 2.12 (1 H, ddd, J=13.62, 11.42, 5.27 Hz), 1.76-1.88 (1 H, m), 1.56-1.76 (2 H, m), 1.40-1.54 (2 H, m).

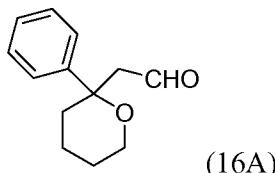
25

EXAMPLE 16

1-(4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid

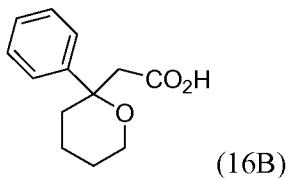


Preparation 16A: 2-(2-phenyltetrahydro-2H-pyran-2-yl)acetaldehyde



5 [0184] To a solution of 2-allyl-2-phenyltetrahydro-2H-pyran (370 mg, 1.829 mmol, Preparation 14B) in THF (2.5 mL) was added a solution of N-methylmorpholine-N-oxide (321 mg, 2.74 mmol) in water (2.5 mL), and then 0.37 mL of 2.5% OsO<sub>4</sub> in water was also added. The mixture was stirred at room temperature for 1 day. The reaction was quenched with aq Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> and the product was extracted with EtOAc. The extract was 10 washed with brine, and the combined aqueous layers were back extracted with EtOAc once and combined. The extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. The residue was dissolved in MeOH (5 mL). A solution of sodium periodate (469 mg, 2.195 mmol) in water (5 mL) was added dropwise at 0°C. As soon as the addition started, white precipitate formed. The mixture was stirred for 30 mins at the same 15 temperature and poured into EtOAc. The extract was washed with brine, and the combined aqueous layers were back extracted with EtOAc and combined. The extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to give an oily residue. The residue was purified by Combiflash (40 g silica gel) eluting with 1:9 EtOAc-hexane to give 2-(2-phenyltetrahydro-2H-pyran-2-yl) acetaldehyde as an oil (239 mg). <sup>1</sup>H NMR (400 MHz, 20 CCl<sub>3</sub>D) δ ppm 9.64-9.68 (1 H, m), 7.36-7.46 (4 H, m), 7.25-7.31 (1 H, m), 3.74-3.81 (1 H, m), 3.55-3.64 (1 H, m), 2.58-2.75 (2 H, m), 2.29-2.39 (1 H, m), 1.80-1.92 (1 H, m), 1.59-1.75 (2 H, m), 1.40-1.58 (2 H, m).

25 Preparation 16B: 2-(2-phenyltetrahydro-2H-pyran-2-yl)acetic acid



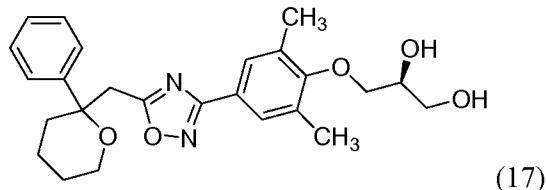
[0185] To a solution of 2-(2-phenyltetrahydro-2H-pyran-2-yl)acetaldehyde (100 mg, 0.490 mmol) and sulfamic acid (57.0 mg, 0.587 mmol) in THF (1.5 mL) was added a solution of sodium chlorite (53.1 mg, 0.587 mmol) in water (1.5 mL) dropwise, and the mixture was stirred at room temperature for 3 hrs. Then the product was extracted with EtOAc (3x) and the combined extracts were washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , and evaporated to give 2-(2-phenyltetrahydro-2H-pyran-2-yl)acetic acid as oil. LC/MS: m/e 221.14 ( $\text{M}+\text{H}$ )<sup>+</sup>.

10 Example 16:

[0186] The titled compound was made according to the general procedure outlined in Example 5 by employing 2-(2-phenyltetrahydro-2H-pyran-2-yl)acetic acid (Preparation 16B). LC/MS: m/e 434.12 ( $\text{M}+\text{H}$ )<sup>+</sup>.  $^1\text{H}$  NMR (400 MHz,  $\text{CCl}_3\text{D}$ )  $\delta$  ppm 8.04 (2 H, d,  $J=7.03$  Hz), 7.48 (2 H, d,  $J=7.91$  Hz), 7.29-7.39 (4 H, m), 7.21-7.30 (1 H, m), 4.29-4.59 (4 H, m), 4.09 (2 H, d,  $J=1.76$  Hz), 3.77 (2 H, d,  $J=11.42$  Hz), 3.44-3.57 (1 H, m), 3.28 (2 H, s), 2.52 (1 H, d,  $J=13.62$  Hz), 1.85-2.04 (1 H, m), 1.28-1.77 (4 H, m).

EXAMPLE 17

(2S)-3-(2,6-dimethyl-4-((2-phenyltetrahydro-2H-pyran-2-yl)methyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol

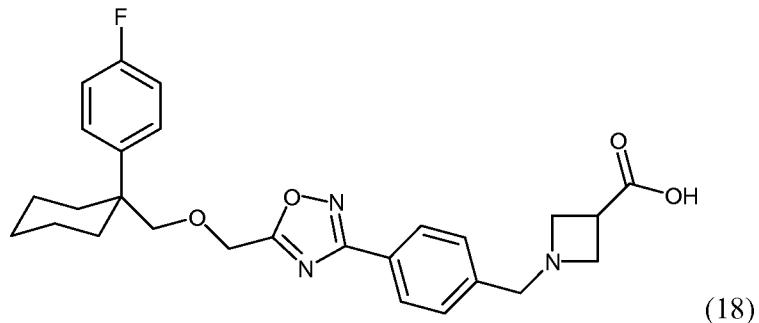


[0187] The titled compound was made according to the general procedure outlined in Example 4 by employing 2-(2-phenyltetrahydro-2H-pyran-2-yl)acetic acid (Preparation 16B). LC/MS: m/e 439.16 ( $\text{M}+\text{H}$ )<sup>+</sup>.  $^1\text{H}$  NMR (400 MHz,  $\text{METHANOL-d}_3$ )  $\delta$  ppm 7.61 (2 H, s), 7.29-7.41 (4 H, m), 7.21-7.28 (1 H, m), 3.96-4.04 (1 H, m), 3.86-3.93 (1 H, m), 3.65-3.85 (4 H, m), 3.53 (1 H, td,  $J=11.21, 2.64$  Hz), 3.22-3.36 (2 H, m), 2.50-2.62 (1 H, m), 2.35 (6 H, s), 1.95-2.08 (1 H, m), 1.37-1.82 (4 H, m).

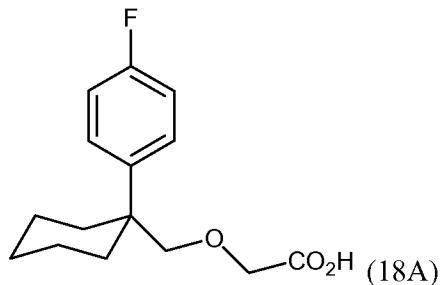
## EXAMPLE 18

1-(4-((5-(((1-(4-fluorophenyl)cyclohexyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid

5



Preparation 18A: 2-((1-(4-fluorophenyl)cyclohexyl)methoxy)acetic acid



10 [0188] A solution of (1-(4-fluorophenyl)cyclohexyl)methanol (108 mg, 521  $\mu$ mol) in toluene was cooled to 0°C and treated with a 50% aq. NaOH solution (500  $\mu$ L) followed by tetrabutylammonium hydrogen sulfate (44 mg, 130  $\mu$ mol). The mixture was stirred at 0°C for 30 min and *tert*-butyl bromoacetate (152 mg, 781  $\mu$ mol) was added. The ice bath was removed, and stirring was continued at room temperature for 2 h. The reaction

15 mixture was diluted with EtOAc and water. The organic layer was separated, washed with water, brine, dried ( $\text{Na}_2\text{SO}_4$ ), and concentrated. The crude oil was chromatographed on silica gel (Teledyne-Isco RediSep 12g silica gel column) and eluted with hexanes, followed by 1% and 3% EtOAc in hexanes to obtain *tert*-butyl 2-((1-(4-fluorophenyl)cyclohexyl)methoxy)acetate (100 mg, 60% yield) as a colorless viscous oil.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  ppm 7.28-7.46 (m, 2H), 6.92-7.09 (m, 2H), 3.78 (s, 2H), 3.39 (s, 2H), 2.09 (d, 2H), 1.67-1.86 (m, 2H), 1.47-1.59 (m, 4H), 1.44 (s, 9H), 1.31-1.38 (m, 2H).

[0189] A solution of tert-butyl 2-((1-(4-fluorophenyl)cyclohexyl)methoxy)acetate (100 mg, 310  $\mu$ mol) in trifluoroacetic acid (1 mL) was stirred at room temperature for 85 min. TFA was removed under reduced pressure, followed by co-evaporation with ether to obtain the crude 2-((1-(4-fluorophenyl)cyclohexyl)methoxy)acetic acid (79 mg, 96% yield) as a white solid.  $^1$ H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  ppm 7.30-7.43 (m, 2H), 6.93-7.17 (m, 2H), 3.91 (s, 2H), 3.46 (s, 2H), 2.13 (d, 2H), 1.60-1.76 (m, 2H), 1.55 (dd, 3H), 1.26-1.44 (m, 3H).

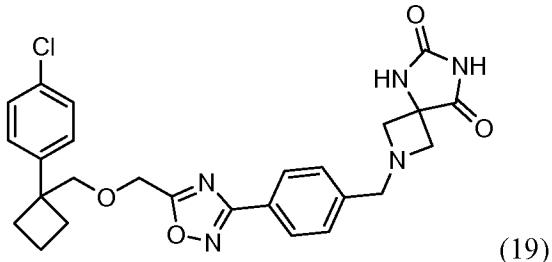
Example 18:

[0190] N,N'-Diisopropylcarbodiimide (17 mg, 135  $\mu$ mol) was added to a stirred solution of crude 2-((1-(4-fluorophenyl)cyclohexyl)methoxy)acetic acid (30 mg, 113  $\mu$ mol) and tert-butyl-1-(4-(N'-hydroxycarbamimidoyl)benzyl)azetidine-3-carboxylate (34 mg, 113  $\mu$ mol) in dichloromethane (1.5 mL). The reaction mixture was stirred at room temperature for 40 min and concentrated. The residue was diluted with acetonitrile (1.5 mL) and treated with a 1 M solution of tetra-*n*-butylammonium fluoride (113  $\mu$ L, 113  $\mu$ mol). The mixture was stirred at room temperature for 16 h and concentrated. The crude residue was chromatographed on silica gel (Teledyne-Isco RediSep 12g column), and eluted with 10%, 20% and 30% EtOAc in hexanes to obtain tert-butyl 1-(4-(5-(((1-(4-fluorophenyl)cyclohexyl)methoxy) methyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (38.5 mg, 64% yield) as a viscous colorless oil.

[0191] A solution of tert-butyl 1-(4-(5-(((1-(4-fluorophenyl)cyclohexyl)methoxy) methyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylate (37 mg, 69  $\mu$ mol) in trifluoroacetic acid (1.5 mL) was stirred at room temperature for 2 h. Trifluoroacetic acid was removed under reduced pressure, followed by co-evaporation with ether to obtain a solid which was stirred with ether (7 mL) for 3.5 h, filtered and dried to obtain 1-(4-(5-(((1-(4-fluorophenyl)cyclohexyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylic acid (26 mg, 63% yield) as a white solid. LC/MS: m/e 480.21 (M+H)<sup>+</sup>.  $^1$ H NMR (400 MHz, CD<sub>3</sub>OD):  $\delta$  ppm 8.17 (d, *J*=8.03 Hz, 2H), 7.65 (d, *J*=7.78 Hz, 2H), 7.43 (dd, *J*=8.28, 5.52 Hz, 2H), 7.02 (t, *J*=8.53 Hz, 2H), 4.68 (s, 2H), 4.52 (s, 2H), 4.38 (d, *J*=7.53 Hz, 4H), 3.72 (ddd, *J*=16.63, 8.78, 8.47 Hz, 1H), 3.59 (s, 2H), 2.05-2.30 (m, 2H), 1.68-1.88 (m, 2H), 1.48-1.69 (m, 3H), 1.27-1.47 (m, 3H).

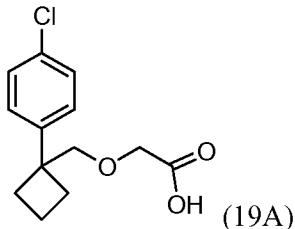
## EXAMPLE 19

2-(4-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-2,5,7-triazaspiro[3.4]octane-6,8-dione



5

Preparation 19A: 2-((1-(4-chlorophenyl)cyclobutyl)methoxy)acetic acid

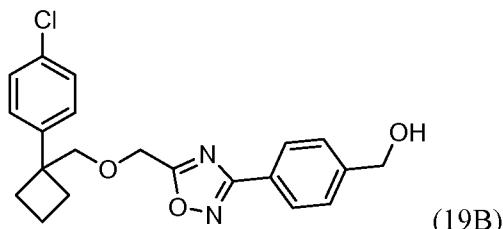


[0192] A solution of (1-(4-chlorophenyl)cyclobutyl)methanol (1.5 g, 7.63 mmol) in toluene (21 mL) was cooled to 0°C and treated with a 33% aq. NaOH solution (7.43 mL) followed by tetrabutylammonium hydrogen sulfate (647 mg, 1.91 mmol). The mixture was stirred at 0°C for 10 min and *tert*-butyl bromoacetate (1.11 mL, 7.63 mmol) was added. The ice bath was removed, and stirring was continued at room temperature for 50 min. Additional *tert*-butyl bromoacetate (1.11 mL, 7.63 mmol) was added and the mixture was stirred at room temperature for 16 h. Additional *tert*-butyl bromoacetate (1.11 mL, 7.63 mmol) was added and the mixture was stirred at room temperature for additional 24 h. The reaction mixture was diluted with EtOAc and water. The organic layer was separated, washed with water, brine, dried (Na<sub>2</sub>SO<sub>4</sub>), and concentrated. The crude oil was chromatographed on silica gel (Teledyne-Isco RediSep 80 g silica gel column) and eluted with hexanes, followed by 1% and 2% EtOAc in hexanes to obtain *tert*-butyl 2-((1-(4-chlorophenyl)cyclobutyl)methoxy)acetate (1.77 g, 75% yield) as a white solid. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ ppm 7.25-7.28 (2 H, m), 7.06-7.19 (2 H, m), 3.85 (2 H, s), 3.64 (2 H, s), 2.22-2.49 (4 H, m), 1.98-2.18 (1 H, m), 1.73-1.93 (1 H, m), 1.45 (9 H, s).

[0193] A solution of *tert*-butyl 2-((1-(4-fluorophenyl)cyclohexyl)methoxy)acetate (1.77 g, 5.69 mmol) in trifluoroacetic acid (40 mL) was stirred at room temperature for 37

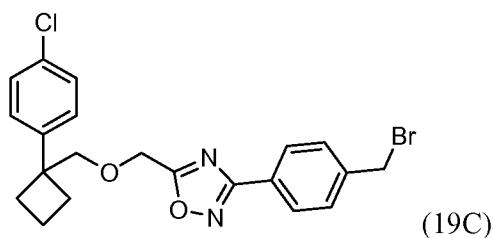
min. TFA was removed under reduced pressure, followed by co-evaporation with ether to obtain the crude 2-((1-2-((1-(4-chlorophenyl)cyclobutyl)methoxy)acetic acid (1.36 g, 94% yield) as a white solid. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ ppm 7.27-7.33 (2 H, m), 6.97-7.19 (2 H, m), 3.99 (2 H, s), 3.71 (2 H, s), 2.21-2.45 (4 H, m), 1.99-2.20 (1 H, m), 1.78-1.98 (1 H, m).

Preparation 19B: (4-((5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol



10 [0194] N,N'-Diisopropylcarbodiimide (38 mg, 302 μmol) was added to a stirred solution of crude 2-((1-2-((1-(4-chlorophenyl)cyclobutyl)methoxy)acetic acid (70 mg, 275 μmol) and N'-hydroxy-4-(hydroxymethyl)benzimidamide (46 mg, 275 μmol) in dichloromethane (2.5 mL). The reaction mixture was stirred at room temperature for 2.25 h and concentrated. The residue was diluted with acetonitrile and treated with a 1 M solution of tetra-*n*-butylammonium fluoride (275 μL, 275 μmol). The mixture was stirred at room temperature for 110 min and concentrated. The crude residue was chromatographed on silica gel (Teledyne-Isco RediSep 12g column), and eluted with 5%, 20% and 30% EtOAc in hexanes to obtain (4-((5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (92mg, 87% yield) as a viscous oil. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ ppm 8.06 (2 H, d, *J*=8.36 Hz), 7.50 (2 H, d, *J*=8.36 Hz), 7.22-7.37 (2 H, m), 6.93-7.20 (2 H, m), 4.79 (2 H, d, *J*=5.94 Hz), 4.68 (2 H, s), 3.77 (1 H, s), 2.25-2.50 (4 H, m), 1.96-2.18 (1 H, m), 1.81-1.97 (1 H, m), 1.77 (1 H, t, *J*=5.94 Hz).

15 25 Preparation 19C: 3-(4-(bromomethyl)phenyl)-5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazole



[0195] Phosphorous tribromide (30  $\mu$ L, 323  $\mu$ mol) was added to a stirred solution of crude (4-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (83 mg, 215  $\mu$ mol) at 0°C. The ice bath was removed and stirring was continued for 16 h. The reaction mixture was diluted with dichloromethane and water. The dichloromethane extract was washed with satd. Aqueous NaHCO<sub>3</sub> solution, brine, dried (Na<sub>2</sub>SO<sub>4</sub>), filtered, and evaporated under reduced pressure to obtain crude 3-(4-(bromomethyl)phenyl)-5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazole (91 mg, 95% crude yield). LC/MS: m/e 448.92 (M+H)<sup>+</sup>.

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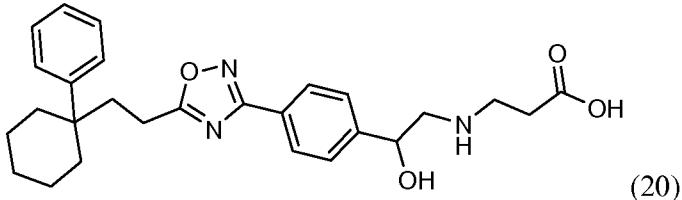
#### Example 19

[0196] A solution of crude 3-(4-(bromomethyl)phenyl)-5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazole (47 mg, 105  $\mu$ mol) and 2,5,7-triazaspiro[3.4]octane-6,8-dione, trifluoroacetic acid salt (80 mg, 314  $\mu$ mol) and Cs<sub>2</sub>CO<sub>3</sub> (102 mg, 314  $\mu$ mol) in dry DMSO (3.6 mL) was stirred at room temperature for 16 h. The crude reaction mixture was purified by reversed-phase autoprep HPLC (YMC S5 20 x 100 mm, 10min gradient time, Detection Wave length 220 nm, Starting solvent: 10% aq. MeOH- 0.1% TFA; Final solvent: 90% aq. MeOH-0.1% TFA) to obtain 2-(4-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-2,5,7-triazaspiro[3.4]octane-6,8-dione, TFA as a white solid (38.5 mg, 58% yield). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  ppm 8.17 (2 H, d, *J*=8.36 Hz), 7.67 (2 H, d, *J*=8.36 Hz), 7.22-7.31 (2 H, m), 7.06-7.22 (2 H, m), 4.77 (2 H, s), 4.62 (2 H, br. s.), 4.54 (2 H, d, *J*=12.10 Hz), 4.37 (2 H, d, *J*=12.32 Hz), 3.84 (2 H, s), 2.27-2.49 (4 H, m), 2.04-2.25 (1 H, m), 1.77-2.02 (1 H, m). LC/MS: m/e 508.11, 509.96 (M+H)<sup>+</sup>.

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#### EXAMPLE 20

N-(2-hydroxy-2-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)ethyl)-  
β-alanine



(20)

[0197] Cyanuric fluoride (0.018 mL, 0.215 mmol) was added to a mixture of 3-(1-phenylcyclohexyl)propanoic acid (50 mg, 0.215 mmol) and pyridine (0.017 mL, 0.215 mmol) in dichloromethane (5 mL). After 1 h, the reaction mixture was diluted with dichloromethane and washed with 1M aq. HCl solution. The organic layer was dried ( $\text{MgSO}_4$ ), filtered and concentrated. The residue was diluted with ethyl acetate and washed with saturated aqueous NaCl solution. The organic layer was dried ( $\text{MgSO}_4$ ), filtered and concentrated. This crude residue was dissolved in acetonitrile (5 mL). (Z)-tert-butyl 3-(2-hydroxy-2-(4-(N'-hydroxycarbamimidoyl)phenyl)ethylamino)propanoate (69.6 mg, 0.215 mmol) and diisopropylethyl amine (0.038 mL, 0.215 mmol) were added and the mixture was heated to 75°C. After 2 h, a 1M solution of tetra-*n*-butylammonium fluoride in THF (0.215 mL, 0.215 mmol) was added and the mixture was heated at 75°C overnight. The reaction mixture was diluted with ethyl acetate and washed with saturated aqueous NaCl solution. The organic layer was dried ( $\text{MgSO}_4$ ), filtered and concentrated. The crude residue was treated with 1:1 mixture of dichloromethane and trifluoroacetic acid for 1 h. The mixture was concentrated, diluted with AcCN, filtered, and purified by HPLC (HPLC conditions: Phenomenex Luna C18 5 micron column (250 x 30mm); 25-200% AcCN/water (0.1% TFA); 25 minute gradient; 20 mL/min) to obtain N-(2-hydroxy-2-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)ethyl)-beta-alanine (35 mg, 24% yield) as a colorless oil.  $^1\text{H}$  NMR (400 MHz,  $\text{DMSO}-d_6$ ):  $\delta$  ppm 8.63 (1 H, d), 7.95 (2 H, d,  $J=8.57$  Hz), 7.56 (2 H, d,  $J=8.35$  Hz), 7.30-7.45 (4 H, m), 6.33 (1 H, br, s), 4.95 (1 H, dd,  $J=10.11, 2.2$  Hz), 3.13-3.32 (3 H, m), 2.99-3.09 (1 H, m), 2.69 (2 H, td,  $J=7.25, 2.64$  Hz), 2.52-2.59 (2 H, m), 2.15 (2 H, d,  $J=14.5$  Hz), 1.16-1.72 (11 H, m).

EXAMPLE 21

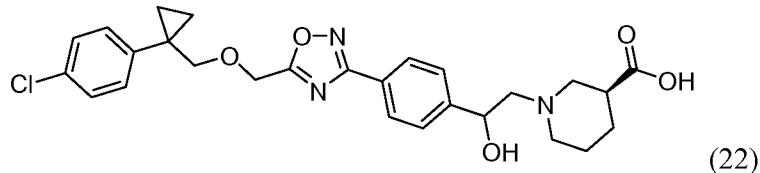
## N-(2-(5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-beta-alanine



[0198] Cyanuric fluoride (0.035 mL, 0.415 mmol) was added to a mixture of 2-((1-(4-chlorophenyl)cyclopropyl)methoxy)acetic acid (100 mg, 0.415 mmol) and pyridine (0.034 mL, 0.415 mmol) in dichloromethane (20 mL). After 2 h, the reaction mixture was diluted with dichloromethane and washed with 1M aq. HCl solution. The organic layer was dried ( $\text{MgSO}_4$ ), filtered and concentrated to obtain 2-((1-(4-chlorophenyl)cyclopropyl)methoxy)acetic acid fluoride (49.7 mg, 0.205 mmol) was added to a mixture of *tert*-butyl 3-(2-hydroxy-2-(4-(N'-hydroxycarbamimidoyl)phenyl)ethylamino)propanoate (66.3 mg, 0.205 mmol) and diisopropylethyl amine (0.054 mL, 0.308 mmol) in acetonitrile (5 mL) and the mixture was stirred at room temperature. After 1 h, a 1M solution of tetra-*n*-butylammonium fluoride in THF (0.215 mL, 0.215 mmol) was added and the mixture was stirred at room temperature overnight. The reaction mixture was diluted with ethyl acetate and washed with saturated aqueous NaCl solution. The organic layer was dried ( $\text{MgSO}_4$ ), filtered, and concentrated. The crude residue was treated with 1:1 mixture of dichloromethane and trifluoroacetic acid for 2 h. The mixture was concentrated, diluted with AcCN, filtered, and purified by HPLC (HPLC conditions: Phenomenex Luna C18 5 micron column (250 x 30mm); 25-100% AcCN/water (0.1% TFA); 25 minute gradient; 20 mL/min). Isolated fractions with the correct mass were collected and freeze-dried overnight to obtain N-(2-(4-((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-beta-alanine (45 mg, 34% yield) as an orange oil. HPLC retention time = 3.09 minutes (Waters Sunfire C18 4.6x 50 mm) eluting with 10-90% aqueous methanol with 0.1% TFA over a 4 minute gradient. LC/MS: m/e 472.13, 474.06 ( $\text{M}+\text{H}^+$ ).

## EXAMPLE 22

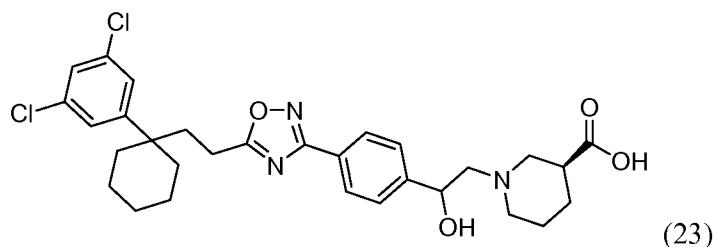
(3S)-1-(2-(4-((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid



[0199] 2-((1-(4-chlorophenyl)cyclopropyl)methoxy)acetic acetyl fluoride (49.7 mg, 5 mmol) was added to a mixture of (3S)-ethyl 1-(2-hydroxy-2-(4-(N'-hydroxycarbamimidoyl)phenyl)ethyl)piperidine-3-carboxylate (Intermediate 3, 68.8 mg, 0.205 mmol) and diisopropylethyl amine (0.054 mL, 0.308 mmol) in acetonitrile (5 mL). The mixture was stirred at room temperature for 1 h, and a 1M solution of tetra-*n*-butylammonium fluoride in THF (0.205 mL, 0.205 mmol) was added. The mixture was stirred at room temperature overnight, diluted with ethyl acetate, and washed with saturated aqueous NaCl solution. The organic layer was dried (MgSO<sub>4</sub>), filtered, and concentrated. The crude residue was treated with a 1:3 mixture of 1 N aq. NaOH solution and methanol for 2 h. The mixture was acidified with TFA, filtered, and purified by HPLC (HPLC conditions: Phenomenex Luna C18 5 micron column (250 x 30mm); 25-100% AcCN/water (0.1% TFA); 25 minute gradient; 20 mL/min). Isolated fractions with the correct mass were collected and freeze-dried overnight to obtain (3S)-1-(2-(4-((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (70 mg, 50% yield) as a clear glassy solid. HPLC retention time = 3.09 minutes (Waters Sunfire C18 4.6x 50 mm) eluting with 10-90% aqueous methanol with 0.1% TFA over a 4 minute gradient. LC/MS: m/e 512.14, 514.12 (M+H)<sup>+</sup>.

EXAMPLE 23

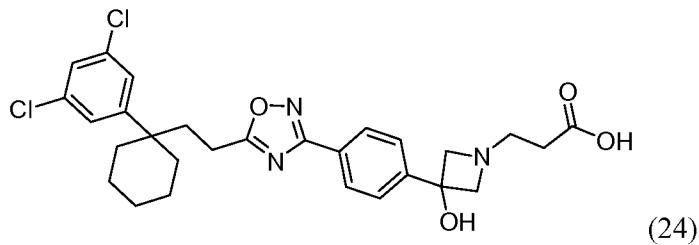
(3S)-1-(2-(4-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid



[0200] BOP-Cl (33.4 mg, 0.131 mmol) was added to a mixture of (3S)-ethyl 1-(2-hydroxy-2-(4-(N'-hydroxycarbamimidoyl)phenyl)ethyl)piperidine-3-carboxylate (Intermediate 3, 40 mg, 0.119 mmol), 3-(1-(3,5-dichlorophenyl)cyclohexyl)propanoic acid (35.9 mg, 0.119 mmol), and diisopropylethyl amine (0.042 mL, 0.239 mmol) in DMF (3 mL). The mixture was stirred at room temperature for 2 h, and a 1M solution of tetra-*n*-butylammonium fluoride in THF (0.119 mL, 0.119 mmol) was added. The mixture was heated to 80°C overnight, diluted with ethyl acetate, and washed with saturated aqueous NaCl solution. The organic layer was dried (MgSO<sub>4</sub>), filtered and concentrated. The crude product was dissolved in acetonitrile (3 mL), treated with 6 N aq. HCl solution and heated to 50°C overnight. The mixture was filtered, and purified by HPLC (HPLC conditions: Phenomenex Luna C18 5 micron column (250 x 30mm); 25-100% AcCN/water (0.1% TFA); 25 minute gradient; 30 mL/min). Isolated fractions with the correct mass were collected and freeze-dried overnight to obtain (3S)-1-(2-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (52 mg, 63% yield) as a white solid. HPLC retention time = 3.75 minutes (Waters Sunfire C18 4.6x 50 mm) eluting with 10-90% aqueous methanol with 0.1% TFA over a 4 minute gradient. LC/MS: m/e 572.16, 574.10 (M+H)<sup>+</sup>.

## EXAMPLE 24

20 3-(3-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-3-hydroxy-1-azetidinyl)propanoic acid



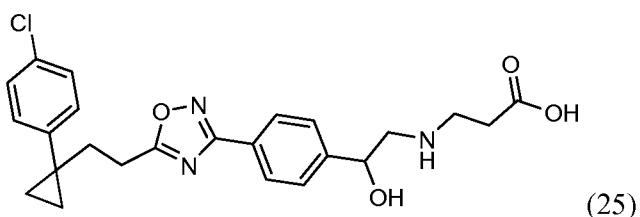
[0201] BOP-Cl (36.4 mg, 0.143 mmol) was added to a mixture of crude tert-butyl 3-hydroxy-3-(4-(N'-hydroxycarbamimidoyl)phenyl)azetidine-1-carboxylate (Intermediate 4, 40 mg, 0.13 mmol), 3-(1-(3,5-dichlorophenyl)cyclohexyl)propanoic acid (39.2 mg, 0.13 mmol) and diisopropylethyl amine (0.045 mL, 0.26 mmol) in DMF (3 mL). The mixture was stirred at room temperature for 2 h, and a 1M solution of tetra-*n*-butylammonium fluoride in THF (0.13 mL, 0.13 mmol) was added. The mixture was heated to 80°C

overnight, diluted with ethyl acetate, and washed with saturated aqueous NaCl solution. The organic layer was dried (MgSO<sub>4</sub>), filtered, and concentrated. The crude product was purified on a 24 g ISCO cartridge and eluted with EtOAc-hexanes gradient to obtain tert-butyl 3-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-3-hydroxyazetidine-1-carboxylate (56 mg, 50% yield, HPLC purity: 80%). HPLC retention time = 4.71 minutes (Waters Sunfire C18 4.6x 50 mm) eluting with 10-90% aqueous methanol with 0.1% TFA over a 4 minute gradient. LC/MS: m/e 572.25 (M+H)<sup>+</sup>.

[0202] *tert*-Butyl 3-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-3-hydroxyazetidine-1-carboxylate (56 mg, 0.098 mmol, HPLC purity: 80%) was treated with TFA in dichloromethane for 1 h and concentrated. The residue was dissolved in 2-propanol (3 mL). *tert*-Butyl acrylate (0.143 mL, 0.978 mmol) and diisopropylethyl amine (0.034 mL, 0.196 mmol) were added and the mixture was heated to 80°C overnight. The reaction mixture was concentrated and then treated with TFA in dichloromethane for 3 h. The mixture was concentrated and a DMF solution of the crude material was purified via preparative LC/MS with the following conditions: Column: Waters XBridge C18, 19 x 250 mm, 5-μm particles; Guard Column: Waters XBridge C18, 19 x 10 mm, 5-μm particles; Mobile Phase A: 5:95 methanol:water with 10-mM ammonium acetate; Mobile Phase B: 95:5 methanol:water with 10-mM ammonium acetate; Gradient: 45-100% B over 25 minutes, then a 5-minute hold at 100% B; Flow: 20 mL/min. Fractions containing the desired product were combined and dried via centrifugal evaporation to obtain 3-(3-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-3-hydroxy-1-azetidinyl)propanoic acid (30 mg, 56% yield). HPLC retention time = 3.75 minutes (Waters XBridge C18 4.6x 50 mm) eluting with 5-95% aqueous AcCN with 0.05% TFA over a 5.3 minute gradient. LC/MS: m/e 544.07, 545.97 (M+H)<sup>+</sup>.

#### EXAMPLE 25

N-(2-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-β-alanine



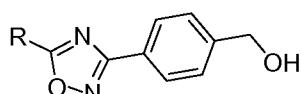
[0203] Cyanuric fluoride (0.018 mL, 0.215 mmol) was added to a mixture of 3-(1-(4-chlorophenyl)cyclopropyl)propanoic acid (47mg, 0.209 mmol) and pyridine (0.017 mL, 0.215 mmol) in dichloromethane(5 mL). After 1 h, the reaction mixture was diluted with 5 dichloromethane and washed with 1M aq. HCl solution. The organic layer was dried ( $\text{MgSO}_4$ ), filtered and concentrated. The crude residue was dissolved in acetonitrile (5 mL). (Z)-tert-butyl 3-(2-hydroxy-2-(4-(N'-hydroxycarbamimidoyl)phenyl)ethylamino) propanoate (67.6 mg, 0.209 mmol) and diisopropylethyl amine (0.037 mL, 0.209 mmol) were added and the mixture was stirred at room temperature for 1 h. A 1M solution of 10 tetra-*n*-butylammonium fluoride in THF (0.314 mL, 0.314 mmol) was added and the mixture was heated to 75 °C overnight. The reaction mixture was diluted with ethyl acetate and washed with saturated aqueous NaCl solution. The organic layer was dried ( $\text{MgSO}_4$ ), filtered and concentrated. The crude residue was treated with 1:1 mixture of dichloromethane and trifluoroacetic acid for 1 h. The mixture was concentrated, diluted 15 with AcCN, filtered, and purified by HPLC (HPLC conditions: Phenomenex Luna C18 5 micron column (250 x 30mm); 25-100% AcCN/water (0.1% TFA); 25 minute gradient; 20 mL/min) to obtain N-(2-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-beta-alanine (38 mg, 25% yield) as a colorless oil.  $^1\text{H}$  NMR (400 MHz,  $\text{MeOH-}d_3$ ):  $\delta$  ppm 8.02 (2 H, m), 7.59 (2 H, m,  $J=8.35$  Hz), 7.30-7.36 (2 H, m), 7.22-7.28 (2 H, m), 5.06 (1 H, m), 3.32-3.41 (1 H, m), 3.13-3.26 (1 H, m), 2.92 (1 H, t,  $J=7.58$  Hz), 2.80 (2 H, t,  $J=6.81$  Hz), 2.15 (1 H, t,  $J=7.58$  Hz), 1.58-1.7 (1 H, m), 1.35-20 1.46 (2 H, m), 1.02 (2 H, t,  $J=7.25$  Hz), 0.72-0.84 (3 H, m).

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#### EXAMPLES 26-31

[0204] Examples 26-31 were synthesized a general procedure outlined below. A solution of the appropriate carboxylic acid (50  $\mu\text{mol}$ ), EDAC (9.59 mg, 50  $\mu\text{mol}$ ), HOBT (6.76 mg, 50  $\mu\text{mol}$ ) in DMF (250  $\mu\text{L}$ ) was stirred at room temperature for 30 min. A

solution of amidoxime (8.31 mg, 50  $\mu$ mol) in DMF (250  $\mu$ L) was added and the mixture was agitated at room temperature for 1 h and then heated to 125°C overnight. The crude reaction mixture was then purified by automated preparative HPLC (Waters Sunfire 19x100 mm 5 $\mu$ m C18, Flow rate 20 mL/min, Gradient time 15 min, Mobile Phase: solvent 5 A: 5% aq. AcCN with 10 mM NH<sub>4</sub>OAC; solvent B: 95% aq. AcCN with 10 mM NH<sub>4</sub>OAC).



Ex.	R	IUPAC Name	HPLC retention time (min)	Observed Mass (M+H) <sup>+</sup>
26		2-(2-(3-(4-(hydroxymethyl)phenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-phenylcyclohexanone	2.74 <sup>a</sup>	377.06
27		(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol	3.24 <sup>a</sup>	362.95
28		(2S)-2-(2-(3-(4-(hydroxymethyl)phenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-methylcyclohexanone	2.14 <sup>a</sup>	315.03
29		(4-(5-(((1-phenylcyclohexyl)oxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol	3.99 <sup>b</sup>	365.1
30		2-((3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)methyl)-2-phenylcyclohexanone	3.58 <sup>c</sup>	363.1

31		(4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol	3.72 <sup>d</sup>	381.19
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HPLC Conditions: <sup>a</sup>Waters XBridge 4.6x50 mm %μm C18, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 5% aq. AcCN with 10 mM NH<sub>4</sub>OAc; solvent B: 95% aq. AcCN with 10 mM NH<sub>4</sub>OAc. <sup>b</sup>YMC

ProC 18 S5 ODS 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min,

5 Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>; solvent B: 90% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>. <sup>c</sup>Chromolith SpeedROD 4.6x50 mm, Start % B = 0, Final %

B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>; solvent B: 90% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>. <sup>d</sup>YMC Combiscreen

ODS-A 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.1% TFA; solvent B: 90% aq.

10 MeOH, 0.1% TFA.

10 MeOH, 0.1% TFA.

### EXAMPLES 32-57

**[0205]** Compounds in Examples 32-57 were synthesized a general protocol as outlined

15 below. Carboxylic acid (63 μmol) was added to a solution of EDAC (9.59 mg, 50 μmol),

HOBT (6.76 mg, 50 μmol) in DMF (200 μL) and the solution was agitated at room

temperature for 30 min. A solution of amidoxime (50 μmol) in DMF (500 μL) and the

reaction mixture was heated to 125°C overnight, cooled to room temperature and a 2M

HCl solution in ethanol (200 μL) was added. The mixture was agitated at room

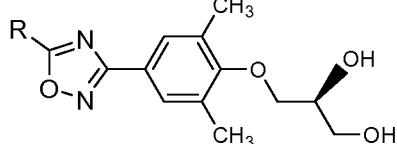
20 temperature for 1.5 h. The crude reaction mixture was then purified by automated

preparative HPLC (Waters Sunfire 19x100 mm 10 μm C18, Flow rate 20 mL/min,

Gradient time 15 min, Mobile Phase: solvent A: 5% aq. MeOH, 0.05% TFA; solvent B:

95% aq. MeOH, 0.05% TFA or solvent A: 5% aq. AcCN, 0.05% TFA; solvent B: 95% aq.

AcCN, 0.05% TFA).



25

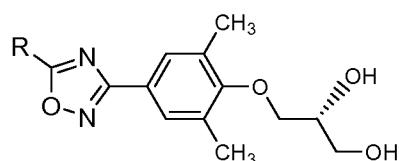
Example	R	IUPAC Name	HPLC retention time (min)	Observed Mass (M+H) <sup>+</sup>
32		2-(2-(3-(4-((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-phenylcyclohexanone	2.92 <sup>a</sup>	464.99
33		(2S)-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanediol	3.22 <sup>a</sup>	450.9
34		(2S)-3-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	2.23 <sup>f</sup>	471.2
35		(2S)-3-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.625 <sup>d</sup>	443.15
36		(2S)-3-(4-(5-(2-(4-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.131 <sup>d</sup>	471.23

37		(2S)-3-(4-(5-(2-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.648 <sup>d</sup>	455.17
38		(2S)-3-(4-(5-(2-(3-(4-fluorophenyl)tetrahydro-3-furanyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.151 <sup>d</sup>	457.25
39		(2S)-3-(4-(5-(2-(3-(4-chlorophenyl)-1-((4-methylphenyl)sulfonyl)-3-pyrrolidinyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.618 <sup>d</sup>	626.28
40		(2S)-3-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-fluoroethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.751 <sup>d</sup>	461.09
41		2-(2-(3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(2-pyridinyl)cyclohexanone	3.433 <sup>d</sup>	466.32

42		2-(2-(3-((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)cyclohexanone	2.55 <sup>a</sup>	388.99
43		(2S)-2-(2-(3-((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-methylcyclohexanone	3.34 <sup>b</sup>	403.2
44		(2S)-3-(4-(5-((E)-2-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)vinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.335 <sup>d</sup>	469.16
45		(2S)-3-(4-(5-(1-(4-chlorophenyl)cyclopropyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.443 <sup>d</sup>	415.1
46		(2S)-3-(4-(5-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.546 <sup>d</sup>	427.2
47		(2S)-3-(4-(5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.616 <sup>d</sup>	459.00

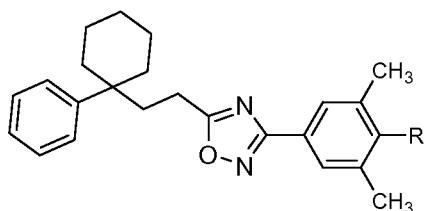
		propanediol		
48		(2S)-3-(4-((Z)-2-(1-(4-chlorophenyl)cyclopropyl)-1-fluorovinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.975 <sup>d</sup>	458.99
49		2-((3-((4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)methyl)-2-phenylcyclohexanone	3.58 <sup>b</sup>	451.2
50		(2S)-3-(4-((2-benzyladamantan-2-yl)methyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	3.89 <sup>a</sup>	503.01
51		(2S)-3-(4-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	2.22i	467.17
52		(2S)-3-(4-((E)-2-(1-(4-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol	2.06i	483.16

53		(2S)-3-(2,6-dimethyl-4-(5-(3-methyl-3-phenylhexyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanediol	2.98 <sup>f</sup>	439.17
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Example	R	IUPAC Name	HPLC retention time (min)	Observed Mass (M+H) <sup>+</sup>
54		(2R)-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanediol	3.20 <sup>f</sup>	451.00
55		2-(2-(3-(4-(((2R)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl) cyclohexanone	2.16 <sup>f</sup>	389.00

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Ex.	R	IUPAC Name	HPLC retention time (min)	Observed Mass (M+H) <sup>+</sup>
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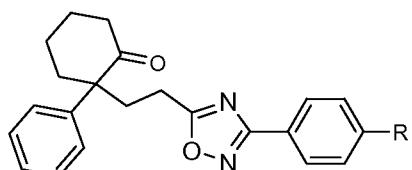
56		(2S)-2-amino-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1-propanol	3.75 <sup>d</sup>	450.3
57		(2S)-1-amino-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-2-propanol	3.14 <sup>d</sup>	495.1 (M+2Na) <sup>+</sup>

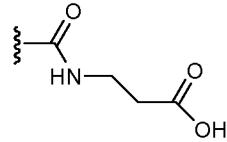
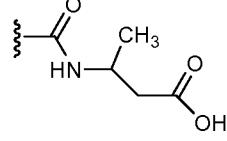
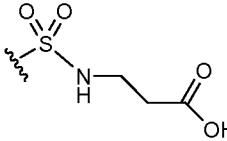
HPLC conditions: <sup>a</sup>Waters XBridge 4.6x50 mm 5  $\mu$ m C18, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 5% aq. AcCN with 10 mM NH<sub>4</sub>OAc; solvent B: 95% aq. AcCN with 10 mM NH<sub>4</sub>OAc. <sup>b</sup>YMC ProC 18 S5 ODS 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>; solvent B: 90% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>. <sup>c</sup>YMC CombiScreen ODS-A 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.1% TFA; solvent B: 90% aq. MeOH, 0.1% TFA. <sup>d</sup>Supelco Ascentis Express C18 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 5% aq. AcCN with 10 mM NH<sub>4</sub>OAc; solvent B: 95% aq. AcCN with 10 mM NH<sub>4</sub>OAc. <sup>e</sup>Waters Sunfire 4.6x 30mm, 5  $\mu$ m C18, Start % B = 40; Final % B = 100; Gradient Time = 2 min; Flow Rate = 5 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in MeOH:Water (10:90).

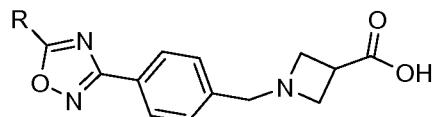
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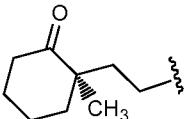
## EXAMPLES 58-143

**[0206]** Examples 58-143 were synthesized following the procedure outlined in the preparation of compound 1, 2, 13, and 18.



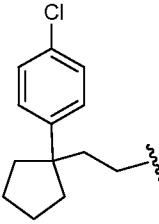
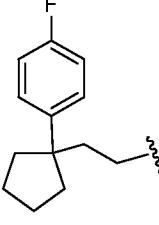
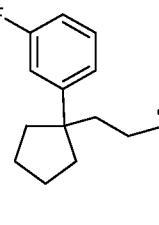
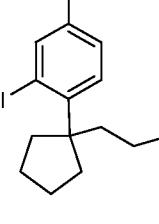
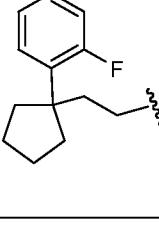
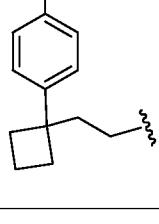
Ex.	R	IUPAC Name	HPLC retention time (min)	Observed Mass (M+H) <sup>+</sup>
58		N-(4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzoyl)-beta-alanine	2.35 <sup>g</sup>	462.2
59		3-((4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzoyl)amino)butanoic acid	2.13 <sup>g</sup>	476.2
60		N-((4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)sulfonyl)-beta-alanine	2.81 <sup>h</sup>	498.1



Ex.	R	IUPAC Name	HPLC retention time (min)	Observed Mass (M+H) <sup>+</sup>
61		1-(4-(5-(2-((1R)-1-methyl-2-oxocyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.12 <sup>d</sup>	398.15
62		1-(4-(5-(2-(1-methyl-2-oxo-3-phenyl-3-piperidinyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.34 <sup>d</sup>	475.18

63		1-(4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.26 <sup>d</sup>	464.21
64		1-(4-(5-(2-(1-(4-methoxyphenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.45 <sup>j</sup>	476.09
65		1-(4-(5-(2-(1-(2-chloro-4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.62 <sup>j</sup>	498.12
66		1-(4-(5-(2-(1-(4-methylphenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.66 <sup>j</sup>	460.22
67		1-(4-(5-(2-(1-(4-(trifluoromethyl)phenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.67 <sup>j</sup>	514.16
68		1-(4-(5-(2-(1-(3,5-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.58 <sup>j</sup>	482.15

69		1-(4-(5-(2-(1-(3,4-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.58 <sup>a</sup>	513.98
70		1-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.64 <sup>a</sup>	513.91
71		1-(4-(5-(2-(1-(3-chlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.64 <sup>j</sup>	480.13
72		1-(4-(5-(2-(1-(2-chloro-6-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.55 <sup>a</sup>	498.2
73		1-(4-(5-(2-(1-(2-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.43 <sup>a</sup>	464.3
74		1-(4-(5-(2-(1-(4-chlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	1.38 <sup>k</sup>	480.27

75		1-(4-(5-(2-(1-(4-chlorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.46 <sup>j</sup>	466.12
76		1-(4-(5-(2-(1-(4-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.19 <sup>a</sup>	450.03
77		1-(4-(5-(2-(1-(3-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.19 <sup>a</sup>	450.05
78		1-(4-(5-(2-(1-(2-chloro-4-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.29 <sup>a</sup>	484.00
79		1-(4-(5-(2-(1-(2-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.28 <sup>a</sup>	450.3
80		1-(4-(5-(2-(1-(4-chlorophenyl)cyclobutyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.36 <sup>j</sup>	452.09

81		1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.93 <sup>d</sup>	438.16
82		1-(4-(5-(2-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.05 <sup>d</sup>	450.22
83		1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1,1-dimethylethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.07 <sup>d</sup>	466.07
84		1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-methylethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.14 <sup>d</sup>	452.03
85		1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1,1-difluoro-2-hydroxyethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.98 <sup>d</sup>	489.92
86		1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-ethoxyethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.24 <sup>d</sup>	482.22

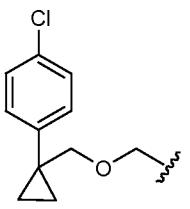
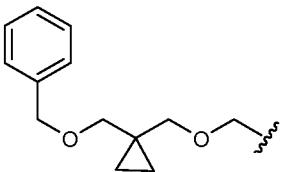
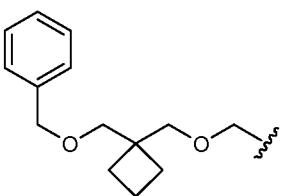
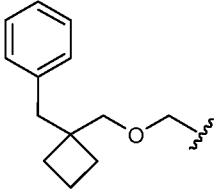
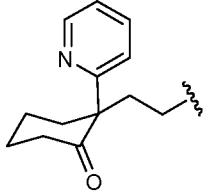
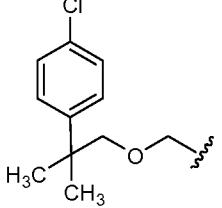
87		1-(4-((E)-2-(1-(3,5-difluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.35 <sup>a</sup>	479.99
88		1-(4-((E)-2-(1-(4-(trifluoromethyl)phenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.50 <sup>a</sup>	511.98
89		1-(4-((E)-2-(1-(3,4-dichlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.58 <sup>a</sup>	511.91
90		1-(4-((E)-2-(1-(3-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.45 <sup>a</sup>	478.00
91		1-(4-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.44 <sup>a</sup>	462.3
92		1-(4-((E)-2-(1-(4-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.59 <sup>a</sup>	478.3

93		1-(4-((E)-2-(1-(4-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.22 <sup>a</sup>	448.03
94		1-(4-((E)-2-(1-(3-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.23 <sup>a</sup>	448.03
95		1-(4-((E)-2-(1-(2-chloro-4-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.32 <sup>a</sup>	481.97
96		1-(4-((E)-2-(1-(2-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.32 <sup>a</sup>	448.3
97		1-(4-((E)-2-(1-(4-chlorophenyl)cyclopropyl)-1-fluorovinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.16, 3.34 <sup>d</sup>	453.97
98		1-(4-((3-(1-(4-chlorophenyl)cyclohexyl)propyl)benzyl)-3-azetidinecarboxylic acid	3.71 <sup>j</sup>	494.14

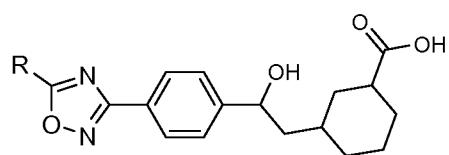
99		1-(4-(5-((1E)-3-(1-(4-fluorophenyl)cyclohexyl)-1-propen-1-yl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.48 <sup>a</sup>	476.09
100		1-(4-(5-((2E)-3-(1-(4-fluorophenyl)cyclohexyl)-2-propen-1-yl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.48 <sup>a</sup>	476.09
101		1-(4-(5-(3-(1-(4-fluorophenyl)cyclopropyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.27 <sup>l</sup>	436.17
102		1-(4-(5-(2-(1-benzylcyclobutyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.11 <sup>d</sup>	432.28
103		1-(4-(5-((E)-2-(1-benzylcyclobutyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.13 <sup>f</sup>	430.10
104		1-(4-(5-(1-(4-chlorophenyl)cyclopropyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.76 <sup>d</sup>	410.11
105		1-(4-(5-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.82 <sup>d</sup>	422.16

106		1-(4-(5-(2-(2-oxo-1-phenylcyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.68 <sup>b</sup>	446.1
107		1-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.45 <sup>d</sup>	466.3
108		1-(4-(5-(2-(4-(3-pyridinyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	1.20 <sup>d</sup>	449.14
109		1-(4-(5-((E)-2-(4-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.82 <sup>f</sup>	514.02
110		1-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.38 <sup>d</sup>	466.24
111		1-(4-(5-(2-(3-(4-fluorophenyl)tetrahydro-3-furanyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.5 <sup>d</sup>	452.2

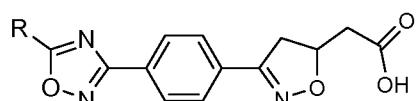
112		1-(4-(5-(2-(3-(4-chlorophenyl)sulfonyl)-3-pyrrolidinyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.08 <sup>d</sup>	621.28
113		1-(4-(5-(((4-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.58 <sup>d</sup>	482.16
114		1-(4-(5-(((4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.83 <sup>d</sup>	532.16
115		1-(4-(5-(((4-(2,4-difluorophenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.57 <sup>d</sup>	500.13
116		1-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.70 <sup>f</sup>	467.92

117		1-(4-((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.88 <sup>d</sup>	454.00
118		1-(4-((1-((benzyloxy)methyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.44 <sup>d</sup>	464.31
119		1-(4-((1-((benzyloxy)methyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.22 <sup>f</sup>	478.3
120		1-(4-((1-benzylcyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.00 <sup>d</sup>	448.30
121		1-(4-((2-(2-oxo-1-(2-pyridinyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.70 <sup>d</sup>	461.18
122		1-(4-((2-(4-chlorophenyl)-2-methylpropoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.04 <sup>d</sup>	456.06

123		1-(4-(5-((3-(benzyloxy)-2,2-dimethylpropoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.20 <sup>f</sup>	466.3
124		1-(4-(5-(3-methyl-3-(4-methylphenyl)butyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.88 <sup>m</sup>	420.14
125		1-(4-(5-(3-(4-chlorophenyl)-3-methylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.67 <sup>n</sup>	440.08
126		1-(4-(5-(3-methyl-3-phenylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	1.17 <sup>o</sup>	406.13
127		1-(4-(5-(3-(4-chloro-3-fluorophenyl)-3-methylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.72 <sup>n</sup>	458.04
128		1-(4-(5-(4-(4-fluorophenyl)-4-methylpentyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	2.42 <sup>l</sup>	438.19
129		1-(4-(5-(4-(4-chlorophenyl)-4-methylpentyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	1.61 <sup>p</sup>	454.10

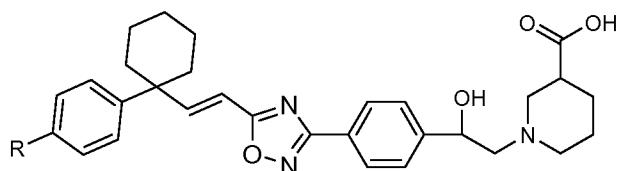


130		(3S)-1-(2-(4-((5-((1-4-nitrophenyl)cyclobutyl)methoxy)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid	3.21 <sup>d</sup>	526.16
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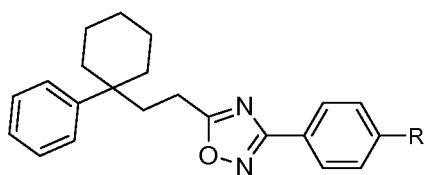


131		(R/S)-3-(4-((5-((2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid	2.20 <sup>p</sup>	460.21
132		(R)-3-(4-((5-((2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid	4.13 <sup>m</sup>	460.1
133		(S)-3-(4-((5-((2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid	4.14 <sup>m</sup>	460.10

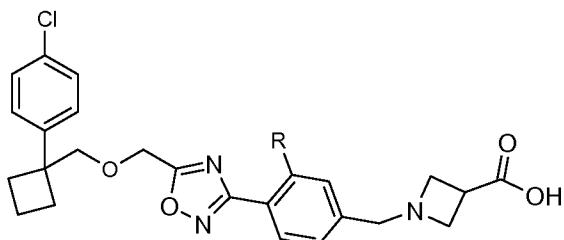
134		(3-(4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid	3.91 <sup>l</sup>	478.08
135		(3-(4-(5-(2-(1-(4-chlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid	1.93 <sup>i</sup>	494.24
136		(3-(4-(5-(3-(1-phenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid	1.85 <sup>q</sup>	474.36



Ex.	R	IUPAC Name	HPLC retention time (min)	Observed Mass (M+H) <sup>+</sup>
137	F	(3S)-1-(2-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid	3.43 <sup>r</sup>	520.07
138	Cl	(3S)-1-(2-(4-(5-((E)-2-(1-(4-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid	3.57 <sup>r</sup>	536.06



Ex.	R	IUPAC Name	HPLC retention time (min)	Observed Mass $(M+H)^+$
139		(3-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-5-isoxazolyl)acetic acid	4.22 <sup>m</sup>	458.08
140		hydroxy(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)acetic acid	2.05 <sup>p</sup>	407.24



Ex.	R	IUPAC Name	HPLC retention time (min)	Observed Mass $(M+H)^+$
141	Cl	1-(3-chloro-4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid	3.23 <sup>d</sup>	502.08
142	CF <sub>3</sub>	1-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-3-(trifluoromethyl)benzyl)-3-azetidinecarboxylic acid	3.33 <sup>d</sup>	536.11

143	F	1-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-3-fluorobenzyl)-3-azetidinecarboxylic acid	2.97 <sup>d</sup>	486.23
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HPLC Conditions: <sup>a</sup>Waters XBridge 4.6x50 mm 5  $\mu$ m C18, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 5% aq. AcCN with 10 mM NH<sub>4</sub>OAc; solvent B: 95% aq. AcCN with 10 mM NH<sub>4</sub>OAc. <sup>b</sup>YMC ProC 18 S5 ODS 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>; solvent B: 90% aq. MeOH, 0.2% H<sub>3</sub>PO<sub>4</sub>. <sup>d</sup>YMC CombiScreen ODS-A 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.1% TFA; solvent B: 90% aq. MeOH, 0.1% TFA. <sup>f</sup>Ascentis C18 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 5% aq. AcCN with 10 mM NH<sub>4</sub>OAc; solvent B: 90% aq. AcCN with 10 mM NH<sub>4</sub>OAc. <sup>g</sup>Luna C18 4.6x30 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.1% TFA; solvent B: 90% aq. MeOH, 0.1% TFA. <sup>h</sup>Chromolith SpeedROD 4.6x50 mm, Start % B = 0, Final % B = 100, Gradient Time = 4 min, Flow Rate = 4 ml/min, Mobile Phase: solvent A: 10% aq. MeOH, 0.1% TFA; solvent B: 90% aq. MeOH, 0.1% TFA. <sup>i</sup>Waters Sunfire 4.6x 30mm, 5 $\mu$ m C18, Start % B = 40; Final % B = 100; Gradient Time = 2 min; Flow Rate = 5 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in MeOH:Water (10:90). <sup>j</sup>Waters Sunfire 4.6x 30mm, 5 $\mu$ m C18, Start % B = 0; Final % B = 100; Gradient Time = 4 min; Flow Rate = 4 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in MeOH:Water (10:90). <sup>k</sup>Phenomenex Luna 5 $\mu$  C18 4.6 x 30 mm, Start % B = 40; Final % B = 100; Gradient Time = 2 min; Flow Rate = 5 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in MeOH:Water (10:90). <sup>l</sup>Waters Sunfire 4.6x 30mm, 5 $\mu$  C18, Start % B = 40; Final % B = 100; Gradient Time = 4 min; Flow Rate = 4 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in MeOH:Water (10:90). <sup>m</sup>Waters Sunfire 4.6x 30mm, 5 $\mu$ m C18, Start % B = 25; Final % B = 100; Gradient Time = 4 min; Flow Rate = 4 ml/min; Mobile

Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in; MeOH:Water (10:90). <sup>n</sup> Waters Sunfire 4.6x 30mm, 5µm C18, Start % B = 30; Final % B = 100; Gradient Time = 4 min; Flow Rate = 4 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in; MeOH:Water (10:90). <sup>o</sup> Waters 5 Sunfire 4.6x 30mm, 5µm C18, Start % B = 30; Final % B = 100; Gradient Time = 2 min; Flow Rate = 5 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in; MeOH:Water (10:90). <sup>p</sup> Waters Sunfire 4.6x 30mm, 5µm C18, Start % B = 0; Final % B = 100; Gradient Time = 2 min; Flow Rate = 5 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in; 10 MeOH:Water (10:90). <sup>q</sup> Waters Sunfire 4.6x 30mm, 5µm C18, Start % B = 50; Final % B = 100; Gradient Time = 2 min; Flow Rate = 5 ml/min; Mobile Phase: Solvent A = 0.1% TFA in MeOH:Water (10:90); Solvent B = 0.1% TFA in; MeOH:Water (10:90). <sup>r</sup> FA\_ASCENTIS 4.6 x 50mm, 2.7µm C18, Start % B = 0; Final % B = 100; Gradient Time = 5.3 min; Flow Rate = 3 ml/min; Mobile Phase: Solvent A = 5% ACN - 95% H<sub>2</sub>O - 10 15 mM NH<sub>4</sub>OAc; Solvent B = 95% ACN - 5% H<sub>2</sub>O - 10 mM NH<sub>4</sub>OAc.

## BIOLOGICAL ASSAYS

### S1P<sub>1</sub> Binding Assay

[0207] Membranes were prepared from CHO cells expressing human S1P1. Cells 20 pellets (1x10<sup>8</sup>cells/pellet) were suspended in buffer containing 20 mM HEPES, pH 7.5, 50 mM NaCl, 2 mM EDTA and Protease Inhibitor cocktail (Roche), and disrupted on ice using the Polytron homogenizer. The homogenate was centrifuged at 20,000 rpm (48,000g) and the supernatant was discarded. The membrane pellets were resuspended in buffer containing 50 mM HEPES, pH 7.5, 100 mM NaCl, 1 mM MgCl<sub>2</sub>, 2 mM EDTA and 25 stored in aliquots at -80 °C after protein concentration determination.

[0208] Membranes (2 µg/well) and 0.03 nM final concentration of 33P-S1P ligand (1 mCi/ml, American Radiolabeled Chemicals) diluted in assay buffer (50 mM HEPES, pH7.4, 5 mM MgCl<sub>2</sub>, 1 mM CaCl<sub>2</sub>, 0.5% fatty acid free BSA, 1 mM NaF) were added to the compound plates (384 Falcon v-bottom plate (0.5 µl/well in a 11 point, 3-fold 30 dilution). Binding was performed for 45 minutes at room temperature, terminated by collecting the membranes onto 384-well Millipore FB filter plates, and radioactivity was measured by TOPCOUNT®. The competition data of the test compounds over a range of

concentrations was plotted as percentage inhibition of radioligand specific binding. The IC<sub>50</sub> is defined as the concentration of competing ligand needed to reduce specific binding by 50%.

[0209] Table A below lists S1P<sub>1</sub> Binding IC<sub>50</sub> values from the following examples of this invention measured in the S1P<sub>1</sub> binding assay described hereinabove. The results in Table A were rounded to two digits.

TABLE A

Example No.	S1P <sub>1</sub> Binding IC <sub>50</sub> (nM)
4	0.12
9	0.47
11	1.68
18	0.31
19	477.1
52	5.75
63	0.21
85	135.3
88	26.71
92	45.65
98	0.54
100	3.40
108	861.3
141	12.04
143	9.72

10 Receptor [35S] GTP $\gamma$ S Binding Assays

[0210] Compounds were loaded in a 384 Falcon v-bottom plate (0.5  $\mu$ l/well in a 11 point, 3-fold dilution). Membranes prepared from S1P<sub>1</sub>/CHO cells or EDG3-Ga15-bla HEK293T cells were added to the compound plate (40  $\mu$ l/well, final protein 3  $\mu$ g/well) with MULTIDROP®. [<sup>35</sup>S]GTP (1250 Ci/mmol, Perkin Elmer) was diluted in assay

15 buffer: 20 mM HEPES, pH7.5, 10 mM MgCl<sub>2</sub>, 150 mM NaCl, 1 mM EGTA, 1 mM DTT,

10  $\mu$ M GDP, 0.1% fatty acid free BSA, and 10  $\mu$ g/ml Saponin to 0.4 nM. 40  $\mu$ l of the [ $^{35}$ S] GTP solution was added to the compound plate with a final concentration of 0.2 nM. The reaction was kept at room temperature for 45 min. At the end of incubation, all the mixtures in the compound plate were transferred to Millipore 384-well FB filter plates via 5 the VELOCITY11® Vprep liquid handler. The filter plate was washed with water 4 times by using the manifold Embla plate washer and dried at 60°C for 45 min. MicroScint 20 scintillation fluid (30  $\mu$ l) was added to each well for counting on the Packard TOPCOUNT®. EC<sub>50</sub> is defined as the agonist concentration that corresponds to 50% of the Ymax (maximal response) obtained for each individual compound tested. The results 10 in Table B were rounded to two digits.

TABLE B

Example No.	GTP $\gamma$ S S1P <sub>1</sub> EC <sub>50</sub> (nM)	GTP $\gamma$ S S1P <sub>3</sub> EC <sub>50</sub> (nM)
4	0.51	10.18
9	0.23	16.4
11	2.17	58.59
18	0.78	9.23
19	1272.0	5385.0
52	8.1	139.3
63	2.74	4.94
85	699.9	>62,500
92	36.85	421.1
98	0.7	27.39
100	0.41	11.75
103	17.05	1489.0
108	7364.0	>62,500
141	50.72	5239.0
143	17.47	3732.0

[0211] A smaller value for GTP $\gamma$ S S1P<sub>1</sub> EC<sub>50</sub> value indicated greater activity for the 15 compound in the GTP $\gamma$ S S1P<sub>1</sub> binding assay. A larger value for the GTP $\gamma$ S S1P<sub>3</sub> EC<sub>50</sub>

value indicated less activity in the GTP $\gamma$ S S1P3 binding assay. The compounds of the present invention, as exemplified by examples in Table B showed GTP $\gamma$ S S1P1 EC50 values of 15  $\mu$ M or lower.

[0212] The compounds of the present invention possess activity as agonists of S1P1 and are selective over S1P<sub>3</sub>, and thus may be used in treating, preventing, or curing various S1P<sub>1</sub> receptor-related conditions while reducing or minimizing the side effects due to S1P<sub>3</sub> activity. The surprising selectivity of the compounds of the present invention indicate their potential use in treating, preventing, or curing autoimmune and inflammatory diseases such as multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease, or psoriasis, while reducing or minimizing possible cardiovascular side effects such as bradycardia and hypertension. Other potential uses of the compounds of the present invention include minimizing or reducing rejection of transplanted organs, while reducing or minimizing side effects due to S1P<sub>3</sub> activity.

15 Blood Lymphocyte Reduction Assay (BLR) in Rodents

[0213] Lewis rats were dosed orally with test article (as a solution or suspension in the vehicle) or vehicle alone (polyethylene glycol 300, "PEG300"). Blood was drawn at 4 hr and 24 h by retro-orbital bleeding. Blood lymphocyte counts were determined on an ADVIA 120 Hematology Analyzer (Siemens Healthcare Diagnostics). The results were measured as a reduction in the percentage of circulating lymphocytes as compared to the vehicle treated group at the 4 hr and 24 hr measurement. The results represent the average results of all animals within each treatment group (n = 3-4).

[0214] The following examples were tested in the Blood Lymphocyte Reduction assay (BLR) described hereinabove and the results are shown in Table C for rats.

25

TABLE C

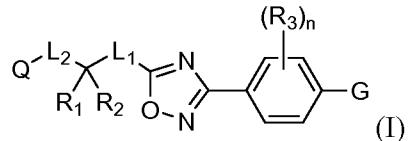
EXAMPLE NO.	DOSE (MG/KG)	% REDUCTION IN LYMPHOCYTES AT 4 HR.
1	1.0	75
48	10.0	83
90	5.0	85

128	10.0	80
133	20.0	84

## CLAIMS

## WHAT IS CLAIMED IS:

5 1. A compound of Formula (I):



or a stereoisomer or a salt thereof, wherein:

(i) R<sub>1</sub> and R<sub>2</sub> are independently C<sub>1</sub>-C<sub>4</sub> alkyl; or(ii) R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic10 group selected from adamantanyl, bicyclo[2.2.1]heptanyl, bicyclo[2.2.2]octanyl, C<sub>3</sub>-<sub>7</sub>cycloalkyl, and a 4- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>;L<sub>1</sub> and L<sub>2</sub> are each independently:

(a) a bond,

15 (b) -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-,(c) -(CH<sub>2</sub>)<sub>0-3</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-3</sub>, and/or(d) -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>- or -(CH<sub>2</sub>)<sub>0-3</sub>S(CH<sub>2</sub>)<sub>1-3</sub>-;

Q is:

(a) H or C<sub>1-6</sub>alkyl; or20 (b) phenyl or 5- to 6-membered heteroaryl substituted with zero to 3 substituents independently selected from F, Cl, C<sub>1-3</sub>alkyl, -CN, -NO<sub>2</sub>, -NH<sub>2</sub>, C<sub>1-2</sub>fluoroalkyl, C<sub>1-3</sub>alkoxy, C<sub>1-2</sub>fluoroalkoxy, -NHC(O)(C<sub>1-3</sub>alkyl), -NHC(O)O(C<sub>1-3</sub>alkyl), -NHS(O)<sub>2</sub>(C<sub>1-3</sub>alkyl), and/or -S(C<sub>1-3</sub>alkyl);provided that if Q is H or C<sub>1-6</sub>alkyl, then L<sub>1</sub> is -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, L<sub>2</sub> is a bond, and R<sub>1</sub>25 and R<sub>2</sub> together with the carbon atom to which they are attached form cyclohexanone; each R<sub>3</sub> is independently F, Cl, C<sub>1-3</sub>alkyl, C<sub>1-3</sub>alkoxy, -CF<sub>3</sub>, -OCF<sub>3</sub>, -NHC(O)(C<sub>1-3</sub>alkyl), and/or -S(C<sub>1-3</sub>alkyl);

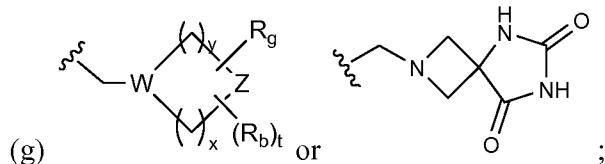
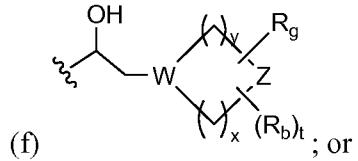
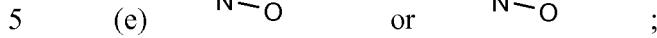
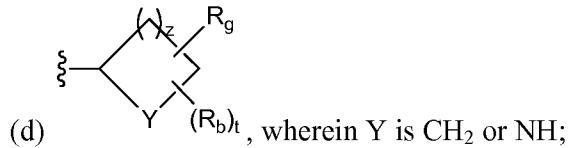
G is:

(a) -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH, -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH, -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>CN, -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>NH<sub>2</sub>, -30 -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>CR<sub>e</sub>(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH, or -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>CR<sub>e</sub>(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OP(O)(OH)<sub>2</sub>;

(b)  $-(CR_eR_e)_bNR_f(CR_eR_e)_bC(O)OH$ ,  $-(CR_eR_e)_bC(O)NR_f(CR_eR_e)_aC(O)OH$ , or -

$(CR_eR_e)_bS(O)_2NR_f(CR_eR_e)_aC(O)OH$ ;

(c)  $-O(CR_eR_e)_aOH$ ,  $-O(CR_eR_e)_aNH_2$ , or  $-O(CR_eR_e)_aCH(NH_2)(CR_eR_e)_bC(O)OH$ ;



wherein one of W and Z is CH or N, and the other of W and Z is CH or C(OH), x is 1 or 2; and y is 1 or 2;

10 each  $R_a$  is independently F, Cl,  $C_{1-3}$ alkyl, and/or  $-S(O)_2R_d$ ; and/or two  $R_a$  attached to the same carbon atom form  $=O$ ;  
 each  $R_b$  is independently H,  $-CH_3$ , F, Cl,  $-OH$ , and/or  $C_{1-3}$ alkoxy, provided that if one  $R_b$  is  $-OH$ , then the second  $R_b$  attached to the same carbon is not  $-OH$ , F, or Cl;  
 each  $R_c$  is independently H, F, and/or  $C_{1-2}$ alkyl;

15  $R_d$  is phenyl substituted with zero to 2 substituents independently selected from F, Cl,  $-CH_3$ ,  $-CF_3$ ,  $-OCH_3$ , and/or  $-OCF_3$ ;  
 each  $R_e$  is independently H,  $-OH$ ,  $-CH_3$ , and/or  $-CH_2OH$ , provided that if one  $R_e$  is  $-OH$ , then the second  $R_e$  attached to the same carbon is not  $-OH$ ;

$R_f$  is H or  $-CH_3$ ;

20  $R_g$  is  $-(CR_eR_e)_bOH$ ,  $-(CR_eR_e)_bC(O)OH$ ,  $-(CR_eR_e)_bCR_e(NH_2)(CR_eR_e)_bOH$ , or - $(CR_eR_e)_bCR_e(NH_2)(CR_eR_e)_bOP(O)(OH)_2$ ;  
 each a is independently 1, 2, 3, and/or 4;  
 each b is independently zero, 1, 2, 3, and/or 4;

n is zero, 1, 2, or 3;

t is zero, 1, or 2; and

z is 1, 2, or 3.

5 2. The compound according to claim 1, or a stereoisomer or a salt thereof, wherein:

(i) R<sub>1</sub> is -CH<sub>3</sub> and R<sub>2</sub> is C<sub>1</sub>-C<sub>4</sub> alkyl; or

(ii) R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl, bicyclo[2.2.1]heptanyl, bicyclo[2.2.2]octanyl, C<sub>3</sub>-<sub>6</sub>cycloalkyl, and a 4- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>;

10 L<sub>1</sub> and L<sub>2</sub> are each independently:

(a) a bond,

(b) -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-,

(c) -(CH<sub>2</sub>)<sub>0-3</sub>-CR<sub>c</sub>=CR<sub>c</sub>-(CH<sub>2</sub>)<sub>0-3</sub>, and/or

15 (d) -(CH<sub>2</sub>)<sub>0-3</sub>O(CH<sub>2</sub>)<sub>1-3</sub>-;

Q is:

(a) H or C<sub>1-4</sub>alkyl; or

(b) phenyl or 5- to 6-membered heteroaryl, each substituted with zero to 3 substituents independently selected from F, Cl, C<sub>1-3</sub>alkyl, C<sub>1-2</sub>fluoroalkyl, C<sub>1-3</sub>alkoxy, and/or C<sub>1-2</sub>fluoroalkoxy;

20 provided that if Q is H or C<sub>1-4</sub>alkyl, then L<sub>1</sub> is -(CR<sub>b</sub>R<sub>b</sub>)<sub>1-4</sub>-, L<sub>2</sub> is a bond, and R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached form cyclohexanone;

each R<sub>3</sub> is independently F, Cl, -CH<sub>3</sub>, -OCH<sub>3</sub>, -CF<sub>3</sub>, and/or -OCF<sub>3</sub>;

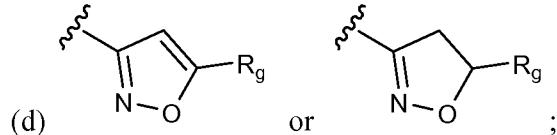
G is:

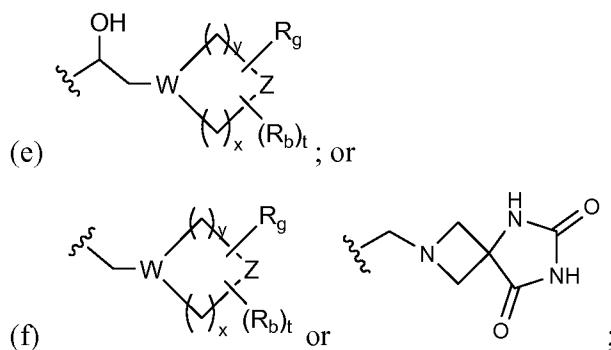
25 (a) -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH or -(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH;

(b) -(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH, -C(O)NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH, or -

S(O)<sub>2</sub>NR<sub>f</sub>(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>C(O)OH;

(c) -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>OH, -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>NH<sub>2</sub>, or -O(CR<sub>e</sub>R<sub>e</sub>)<sub>a</sub>CH(NH<sub>2</sub>)(CR<sub>e</sub>R<sub>e</sub>)<sub>b</sub>C(O)OH;





wherein one of W and Z is CH or N, and the other of W and Z is CH or C(OH), x is 1 or 2; and y is 1 or 2;

5 each  $R_a$  is independently F, Cl,  $C_{1-3}$ alkyl, and/or  $-S(O)_2R_d$ ; and/or two  $R_a$  attached to the same carbon atom form =O;

each  $R_b$  is independently H,  $-CH_3$ , F, Cl,  $-OH$ , and/or  $C_{1-3}$ alkoxy, with the proviso that if one  $R_b$  is  $-OH$ , then the second  $R_b$  attached to the same carbon is not  $-OH$ , F, or Cl; each  $R_c$  is independently H and/or F;

10  $R_d$  is phenyl substituted with zero to 2 substituents independently selected from F, Cl,  $-CH_3$ ,  $-CF_3$ ,  $-OCH_3$ , and/or  $-OCF_3$ ;

each  $R_e$  is independently H,  $-OH$ , and/or  $-CH_3$ , provided that if one  $R_e$  is  $-OH$ , then the second  $R_e$  attached to the same carbon is not  $-OH$ ;

$R_f$  is H or  $-CH_3$ ;

15  $R_g$  is  $-(CR_eR_e)_bOH$  or  $-(CR_eR_e)_bC(O)OH$ ;

each a is independently 1, 2, 3, and/or 4;

each b is independently zero, 1, 2, 3, and/or 4;

n is zero, 1, 2, or 3; and

t is zero, 1, or 2.

20

3. The compound according to claim 2 or a stereoisomer or a salt thereof, wherein:

(i)  $R_1$  is  $-CH_3$  and  $R_2$  is  $C_{1-3}$  alkyl; or

(ii)  $R_1$  and  $R_2$  together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl,  $C_{3-6}$ cycloalkyl, and a 5- to 6-membered

25 heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4  $R_a$ ;

$L_1$  and  $L_2$  are each independently:

(a) a bond,

- (b)  $-(CR_bR_b)_{1-3-}$ ,
- (c)  $-(CH_2)_{0-2-}CR_c=CR_c-(CH_2)_{0-2-}$ , and/or
- (d)  $-(CH_2)_{0-3-}O(CH_2)_{1-3-}$ ;

Q is:

5 (a) H or  $-CH_3$ ;

(b) phenyl substituted with zero to 2 substituents independently selected from F, Cl,  $-CH_3$ ,  $-CF_3$ , and/or  $-OCH_3$ ; or

(c) pyridinyl;

provided that if Q is H or  $-CH_3$ , then  $L_1$  is  $-(CR_bR_b)_{1-3-}$ ,  $L_2$  is a bond, and  $R_1$  and  $R_2$  together with the carbon atom to which they are attached form cyclohexanone;

10 each  $R_3$  is independently F, Cl,  $-CH_3$ , and/or  $-CF_3$ ;

$n$  is zero, 1, or 2;

each  $R_a$  is independently  $-CH_3$  and/or  $-S(O)_2$ (methylphenyl); and/or two  $R_a$  attached to the same carbon atom form  $=O$ ;

15 each  $R_b$  is independently H,  $-CH_3$ , F,  $-OH$ , and/or  $-OCH_2CH_3$ , with the proviso that if one  $R_b$  is  $-OH$ , then the second  $R_b$  attached to the same carbon is not  $-OH$ ;

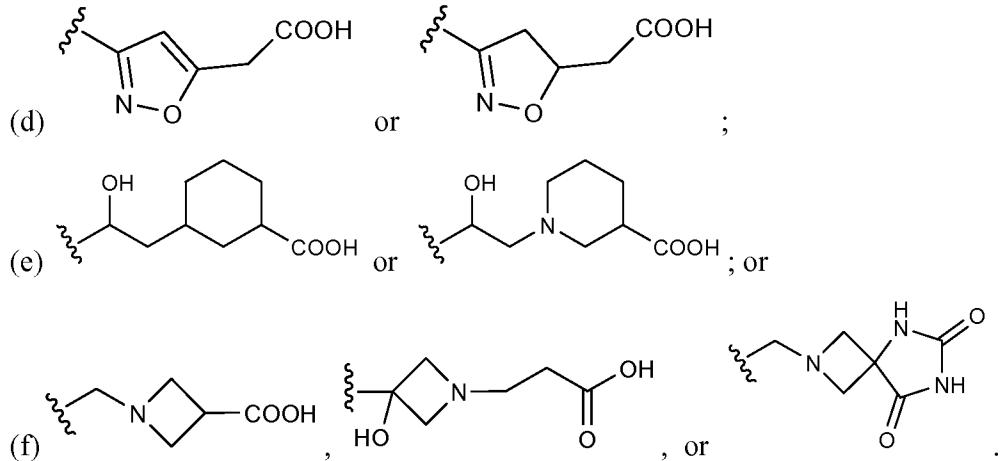
each  $R_c$  is independently H and/or F; and

G is:

(a)  $-CH_2OH$  or  $-CH(OH)C(O)OH$ ;

20 (b)  $-CH(OH)CH_2NHCH_2CH_2C(O)OH$ ,  $-C(O)NHCH_2CH_2C(O)OH$ ,  $-C(O)NHCH(CH_3)CH_2C(O)OH$ , or  $-S(O)_2NHCH_2CH_2C(O)OH$ ;

(c)  $-OCH_2CH(OH)CH_2OH$ ,  $-OCH_2CH(NH_2)CH_2OH$ , or  $-OCH_2CH(OH)CH_2NH_2$ ;



4. The compound according to claim 3 or a stereoisomer or a salt thereof, wherein R<sub>1</sub> is -CH<sub>3</sub> and R<sub>2</sub> is C<sub>1</sub>-C<sub>3</sub> alkyl.

5. The compound according to claim 3 or a stereoisomer or a salt thereof, wherein R<sub>1</sub> and R<sub>2</sub> together with the carbon atom to which they are attached, form a cyclic group selected from adamantanyl, C<sub>3</sub>-<sub>6</sub>cycloalkyl, and a 5- to 6-membered heterocycloalkyl, wherein each of said cycloalkyl and heterocycloalkyl rings is substituted with zero to 4 R<sub>a</sub>.

6. The compound according to claim 1 or a salt thereof, wherein said compound is selected from 1-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (1); 1-(4-(5-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (2); 2-(2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl)cyclohexanone (3); 2-(2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(4-fluorophenyl) cyclohexanone (4); 1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylic acid (5); (E)-1-(4-(5-(2-(1-(3,4-difluorophenyl)cyclohexyl) vinyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (6); 1-(4-(5-(2-(1-(3-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (7); 1-(4-(5-(3-(1-(4-fluorophenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (8); 1-(4-(5-(3-(1-(4-fluorophenyl)cyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (9); (S)-3-(2,6-dimethyl-4-(5-(3-(1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol (10); 1-(4-(5-(3-(2-oxo-1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylic acid (11); 2-(3-(4-((S)-2,3-dihydroxypropoxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)propyl)-2-phenylcyclohexanone (12); 1-(4-(5-(((1-(4-fluorophenyl)cyclohexyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl) azetidine-3-carboxylic acid (18); 2-(4-((5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-2,5,7-triazaspiro[3.4]octane-6,8-dione (19); N-(2-hydroxy-2-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)ethyl)-β-alanine (20); N-(2-(4-((5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl) phenyl)-2-hydroxyethyl)-beta-alanine (21); (3S)-1-(2-(4-(5-(((1-(4-chlorophenyl)cyclopropyl)

methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (22); (3S)-1-(2-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (23); 3-(3-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-3-hydroxy-1-azetidinyl)propanoic acid (24); N-(2-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)- $\beta$ -alanine (25); 2-(2-(3-(4-(hydroxymethyl)phenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-phenylcyclohexanone (26); (4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (27); (2S)-2-(2-(3-(4-(hydroxymethyl)phenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-methylcyclohexanone (28); (4-(5-(((1-phenylcyclohexyl)oxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (29); 2-((3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)methyl)-2-phenylcyclohexanone (30); (4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)methanol (31); 2-(2-(3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-phenylcyclohexanone (32); (2S)-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanediol (33); (2S)-3-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (35); (2S)-3-(4-(5-(2-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (37); (2S)-3-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-fluoroethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (40); 2-(2-(3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-(2-pyridinyl)cyclohexanone (41); 2-(2-(3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)cyclohexanone (42); (2S)-2-(2-(3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)-2-methylcyclohexanone (43); (2S)-3-(4-(5-(1-(4-chlorophenyl)cyclopropyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (45); (2S)-3-(4-(5-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (46); (2S)-3-(4-(5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (47); (2S)-3-(4-(5-((Z)-2-(1-(4-chlorophenyl)cyclopropyl)-1-fluorovinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (48); 2-((3-(4-(((2S)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)methyl)-2-phenylcyclohexanone (49); (2S)-3-(4-(5-((2-

benzyladamantan-2-yl)methyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (50); (2S)-3-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (51); (2S)-3-(4-(5-((E)-2-(1-(4-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (52); (2R)-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanediol (54); 2-(2-(3-(4-(((2R)-2,3-dihydroxypropyl)oxy)-3,5-dimethylphenyl)-1,2,4-oxadiazol-5-yl)ethyl)cyclohexanone (55); (2S)-2-amino-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1-propanol (56); (2S)-1-amino-3-(2,6-dimethyl-4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)-2-propanol (57); N-(4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzoyl)-beta-alanine (58); 3-((4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzoyl)amino)butanoic acid (59); N-((4-(5-(2-(2-oxo-1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)sulfonyl)-beta-alanine (60); 1-(4-(5-(2-((1R)-1-methyl-2-oxocyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (61); 1-(4-(5-(2-(1-methyl-2-oxo-3-phenyl-3-piperidinyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (62); 1-(4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (63); 1-(4-(5-(2-(1-(4-methoxyphenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (64); 1-(4-(5-(2-(1-(2-chloro-4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (65); 1-(4-(5-(2-(1-(4-methylphenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (66); 1-(4-(5-(2-(1-(4-(trifluoromethyl)phenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (67); 1-(4-(5-(2-(1-(3,5-difluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (68); 1-(4-(5-(2-(1-(3,4-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (69); 1-(4-(5-(2-(1-(3,5-dichlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (70); 1-(4-(5-(2-(1-(3-chlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (71); 1-(4-(5-(2-(1-(2-chloro-6-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (72); 1-(4-(5-(2-(1-(2-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (73); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (74); 1-(4-(5-(2-(1-(4-chlorophenyl)

cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (75); 1-(4-(5-(2-(1-(4-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (76); 1-(4-(5-(2-(1-(3-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (77); 1-(4-(5-(2-(1-(2-chloro-4-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (78); 1-(4-(5-(2-(1-(2-fluorophenyl)cyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (79); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclobutyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (80); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (81); 1-(4-(5-(2-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (82); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1,1-dimethylethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (83); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-methylethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (84); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-difluoro-2-hydroxyethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (85); 1-(4-(5-(2-(1-(4-chlorophenyl)cyclopropyl)-1-ethoxyethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (86); 1-(4-(5-((E)-2-(1-(3,5-difluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (87); 1-(4-(5-((E)-2-(1-(4-(trifluoromethyl)phenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (88); 1-(4-(5-((E)-2-(1-(3,4-dichlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (89); 1-(4-(5-((E)-2-(1-(3-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (90); 1-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (91); 1-(4-(5-((E)-2-(1-(4-chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (92); 1-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (93); 1-(4-(5-((E)-2-(1-(3-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (94); 1-(4-(5-((E)-2-(1-(2-chloro-4-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (95); 1-(4-(5-((E)-2-(1-(2-fluorophenyl)cyclopentyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (96); 1-(4-(5-((E)-2-(1-(4-chlorophenyl)cyclopropyl)-1-fluorovinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (97); 1-(4-(5-(3-(1-(4-chlorophenyl)cyclohexyl)

propyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (99); 1-(4-(5-((1E)-3-(1-(4-fluorophenyl)cyclohexyl)-1-propen-1-yl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (99); 1-(4-(5-((2E)-3-(1-(4-fluorophenyl)cyclohexyl)-2-propen-1-yl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (100); 1-(4-(5-(3-(1-(4-fluorophenyl)cyclopropyl)propyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (101); 1-(4-(5-(2-(1-benzylcyclobutyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (102); 1-(4-(5-((E)-2-(1-benzylcyclobutyl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (103); 1-(4-(5-(1-(4-chlorophenyl) cyclopropyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (104); 1-(4-(5-(1-(4-fluorophenyl)-2,2-dimethylcyclopropyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (105); 1-(4-(5-(2-(2-oxo-1-phenylcyclopentyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (106); 1-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy) methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (116); 1-(4-(5-(((1-(4-chlorophenyl)cyclopropyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (117); 1-(4-(5-(((1-((benzyloxy)methyl)cyclopropyl)methoxy) methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (118); 1-(4-(5-(((1-((benzyloxy)methyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (119); 1-(4-(5-(((1-benzylcyclobutyl)methoxy) methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (120); 1-(4-(5-(2-(2-oxo-1-(2-pyridinyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (121); (3S)-1-(2-(4-(5-(((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (130); (R/S)-(3-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl) acetic acid (131); (R)-(3-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl) phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (132); (S)-(3-(4-(5-(2-(1-phenylcyclohexyl) ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (133); (3-(4-(5-(2-(1-(4-fluorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl) acetic acid (134); (3-(4-(5-(2-(1-(4-chlorophenyl)cyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (135); (3-(4-(5-(3-(1-phenylcyclohexyl)propyl)-1,2,4-oxadiazol-3-yl)phenyl)-4,5-dihydro-5-isoxazolyl)acetic acid (136); (3S)-1-(2-(4-(5-((E)-2-(1-(4-fluorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (137); (3S)-1-(2-(4-(5-((E)-2-(1-(4-

chlorophenyl)cyclohexyl)vinyl)-1,2,4-oxadiazol-3-yl)phenyl)-2-hydroxyethyl)-3-piperidinecarboxylic acid (138); (3-(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)-5-isoxazolyl)acetic acid (139); hydroxy(4-(5-(2-(1-phenylcyclohexyl)ethyl)-1,2,4-oxadiazol-3-yl)phenyl)acetic acid (140); 1-(3-chloro-4-(5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (141); 1-(4-(5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-3-(trifluoromethyl)benzyl)-3-azetidinecarboxylic acid (142); 1-(4-(5-((1-(4-chlorophenyl)cyclobutyl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)-3-fluorobenzyl)-3-azetidinecarboxylic acid (143); 1-(4-(5-(2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (13); 1-(4-(5-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (14); (2S)-3-(2,6-dimethyl-4-(5-(2-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol (15); 1-(4-(5-(2-phenyltetrahydro-2H-pyran-2-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)azetidine-3-carboxylic acid (16); (2S)-3-(2,6-dimethyl-4-(5-((2-phenyltetrahydro-2H-pyran-2-yl)methyl)-1,2,4-oxadiazol-3-yl)phenoxy)propane-1,2-diol (17); (2S)-3-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (34); (2S)-3-(4-(5-(2-(4-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (36); (2S)-3-(4-(5-(2-(3-(4-fluorophenyl)tetrahydro-3-furanyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-ropanediol (38); (2S)-3-(4-(5-(2-(3-(4-chlorophenyl)-1-((4-methylphenyl)sulfonyl)-3-pyrrolidinyl)ethyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (39); (2S)-3-(4-(5-((E)-2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)vinyl)-1,2,4-oxadiazol-3-yl)-2,6-dimethylphenoxy)-1,2-propanediol (44); 1-(4-(5-(2-(4-(2-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (107); 1-(4-(5-(2-(4-(3-pyridinyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (108); 1-(4-(5-((E)-2-(4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)vinyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (109); 1-(4-(5-(2-(4-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (110); 1-(4-(5-(2-(3-(4-fluorophenyl)tetrahydro-3-furanyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (111); 1-(4-(5-(2-(3-(4-chlorophenyl)-1-((4-

methylphenyl)sulfonyl)-3-pyrrolidinyl)ethyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (112); 1-(4-(5-(((4-(4-fluorophenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (113); 1-(4-(5-(((4-(3-(trifluoromethyl)phenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (114); 1-(4-(5-(((4-(2,4-difluorophenyl)tetrahydro-2H-pyran-4-yl)methoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (115); (2S)-3-(2,6-dimethyl-4-(5-(3-methyl-3-phenylhexyl)-1,2,4-oxadiazol-3-yl)phenoxy)-1,2-propanediol (53); 1-(4-(5-((2-(4-chlorophenyl)-2-methylpropoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (122); 1-(4-(5-((3-(benzyloxy)-2,2-dimethylpropoxy)methyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (123); 1-(4-(5-(3-methyl-3-(4-methylphenyl)butyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (124); 1-(4-(5-(3-(4-chlorophenyl)-3-methylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (125); 1-(4-(5-(3-methyl-3-phenylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (126); 1-(4-(5-(3-(4-chloro-3-fluorophenyl)-3-methylbutyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (127); 1-(4-(5-(4-(4-fluorophenyl)-4-methylpentyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (128); and 1-(4-(5-(4-(4-chlorophenyl)-4-methylpentyl)-1,2,4-oxadiazol-3-yl)benzyl)-3-azetidinecarboxylic acid (129).

20 7. A pharmaceutical composition comprising a compound according to any one of claims 1-6 or stereoisomers or pharmaceutically acceptable salts thereof, and a pharmaceutically acceptable carrier.

25 8. A method of treating a disease or disorder associated with the activity of G protein-coupled receptor S1P<sub>1</sub>, the method comprising administering to a mammalian patient a compound according to any one of claims 1-6 or stereoisomers or pharmaceutically acceptable salts thereof.

30 9. Use of a compound according to any one of claims 1-6 or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment of autoimmune disease or chronic inflammatory disease.

10. A compound according to any one of claims 1-6 or a pharmaceutically acceptable salt thereof, for use in therapy in treating autoimmune disease or chronic inflammatory disease.

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2011/044597

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>			
INV. C07D271/06	C07D413/10	C07D413/14	A61K31/4245
ADD. A61P37/00	A61P9/00		

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 A61K

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

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

EPO-Internal, CHEM ABS Data, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2010/033701 A2 (GENZYME CORP; XIANG YIBIN [US]; HIRTH BRADFORD [US]; KANE JOHN L [US];) 25 March 2010 (2010-03-25) pages 135 to 146 and 193 to 196; claims ----- A XIANG Y ET AL: "Discovery of novel sphingosine kinase-1 inhibitors. Part 2", BIOORGANIC & MEDICINAL CHEMISTRY LETTERS, PERGAMON, ELSEVIER SCIENCE, GB, vol. 20, no. 15, 17 June 2010 (2010-06-17) , pages 4550-4554, XP027137538, ISSN: 0960-894X [retrieved on 2010-06-17] abstract; table 3 ----- -/-	1,7-10
		1,7-10

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
- "E" earlier document but published on or after the international filing date
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- "P" document published prior to the international filing date but later than the priority date claimed

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"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	Date of mailing of the international search report
27 October 2011	07/11/2011

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## INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/044597

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/058848 A1 (MERCK & CO INC [US]; COLANDREA VINCENT J [US]; DOHERTY GEORGE A [US];) 30 June 2005 (2005-06-30) cited in the application claims 1-23 -----	1,7-10
A	WO 03/105771 A2 (MERCK & CO INC [US]; CHEN WEIRONG [US]; HALE JEFFREY J [US]; LI ZHEN [) 24 December 2003 (2003-12-24) Similar sphingosine kinase 1 inhibitors. Distinguishing feature L1-CR1R2-L2-Qclaims 1-36 -----	1,7-10
A	EP 1 873 153 A1 (DAIICHI SANKYO CO LTD [JP]) 2 January 2008 (2008-01-02) cited in the application claims 1-40 -----	1,7-10

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2011/044597
---

Patent document cited in search report	Publication date	Patent family member(s)			Publication date
WO 2010033701	A2	25-03-2010	NONE		
WO 2005058848	A1	30-06-2005	AU 2004299456 A1	30-06-2005	
			CA 2547198 A1	30-06-2005	
			CN 1894225 A	10-01-2007	
			EP 1697333 A1	06-09-2006	
			JP 4773972 B2	14-09-2011	
			JP 2007515432 A	14-06-2007	
			US 2008249093 A1	09-10-2008	
WO 03105771	A2	24-12-2003	AU 2003276043 A1	31-12-2003	
			CA 2488117 A1	24-12-2003	
			EP 1549640 A2	06-07-2005	
			JP 2005533058 A	04-11-2005	
			US 2005245575 A1	03-11-2005	
EP 1873153	A1	02-01-2008	AU 2006240789 A1	02-11-2006	
			BR PI0609994 A2	18-10-2011	
			CA 2605594 A1	02-11-2006	
			CN 101203512 A	18-06-2008	
			HK 1108686 A1	22-10-2010	
			WO 2006115188 A1	02-11-2006	
			KR 20070121013 A	26-12-2007	
			NZ 563522 A	29-01-2010	
			RU 2382781 C2	27-02-2010	
			US 2008113961 A1	15-05-2008	
			ZA 200709051 A	29-10-2008	