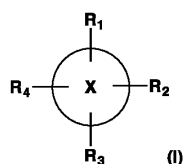


CLAIMS

What Is Claimed Is:

1. A compound of formula (I):



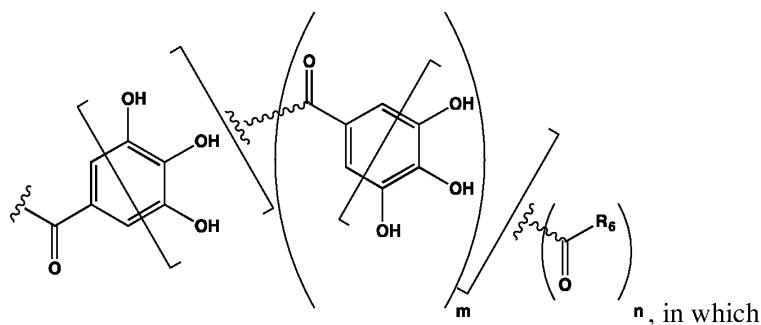
or a pharmaceutically acceptable salt thereof,

wherein:

Ring X is a 3 to 7 membered monocyclic ring, which is selected from the group consisting of aryl, heteroaryl, cycloalkyl, and cycloheteroalkyl;

at least one of R₁, R₂, R₃, and R₄ is OR₅ or CH₂OR₅ and the other R₁, R₂, R₃, and R₄ each independently are halogen, OH, OR₅, CH₂OR₅, CO₂H, OC=OR₆, (C=O)R₆, R₆, C1-10 alkyl, C2-10 alkenyl, C2-10 alkynyl, H, or absent

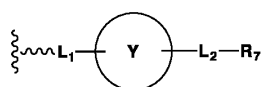
R₅ is of the formula



m independently is 1, 2, 3, 4, 5, 6, or 7;

n independently is 0, 1, 2, or 3; and

R₆ is of the formula:



, in which Ring Y is a 3 to 7 membered monocyclic ring,

which is selected from the group consisting of aryl, heteroaryl, cycloalkyl, and

cycloheteroalkyl;

each of L₁ and L₂, independently, is a moiety selected from the group consisting of N, O, S, CH₂, C=O, C₂₋₁₀ alkyl, C₂₋₁₀ alkenyl, C₂₋₁₀ alkynyl, -(W-(CH₂)_s)-, and absent, wherein s is 0, 1, 2, 3, 4, or 5, and W is O, S, or N; and

R₇ is selected from the group consisting of aryl, heteroaryl, aralkyl, C₂₋₁₀ alkyl, C₂₋₁₀ alkenyl, C₂₋₁₀ alkynyl, and H.

2. The compound of claim 1, wherein the X ring is , wherein R₁, R₂, R₃, and R₄ are each OR₅, wherein each of m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0.

3. The compound of claim 1, wherein the X ring is , wherein R₁, R₂, R₃, and R₄ are each OR₅ or CH₂OR₅, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0.

4. The compound of claim 1, wherein the X ring is , wherein R₁, R₂, and R₃ are each OR₅ or OC=OR₆, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0 or 1.

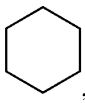
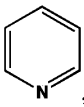
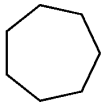
5. The compound of claim 4, wherein at least one of R₁, R₂, or R₃ is OC=OR₆.

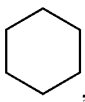
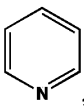
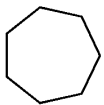
6. The compound of claim 1, wherein the X ring is an aryl, heteroaryl or cycloalkyl ring; wherein R₁, R₂, R₃, and R₄ are each OH, CO₂H, OR₅ or (C=O)R₆, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and n is 0 or 1.

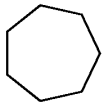
7. The compound of claim 6, wherein the X ring is , wherein R₁, R₂, R₃, and R₄, are each OH, CO₂H, OR₅ or (C=O)R₆, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0 or 1.

8. The compound of claim 6, wherein the X ring is , wherein R₁, R₂, R₃, and R₄ are each OH, CO₂H, or OR₅, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 1.

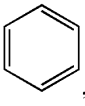
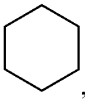
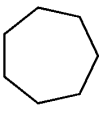
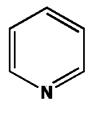
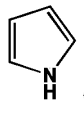
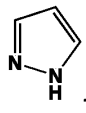
9. The compound of claim 6, wherein the X ring is , wherein R₁, R₂, R₃, and R₄ are each OH, OR₅, or (C=O)R₆, at least one of R₁, R₂, or R₃ and R₄ being (C=O)R₆, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0.

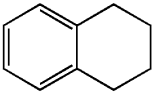
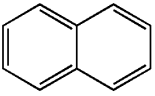
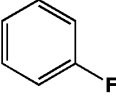
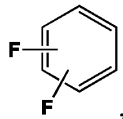
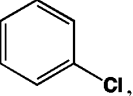
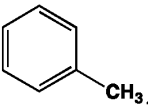
10. The compound of claim 6, wherein the X ring is , , , ,
or , wherein R₁ is OR₅, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0 or 1.

5 11. The compound of claim 6, wherein the X ring is , , , ,
or , wherein R₁ is OR₅, wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0.

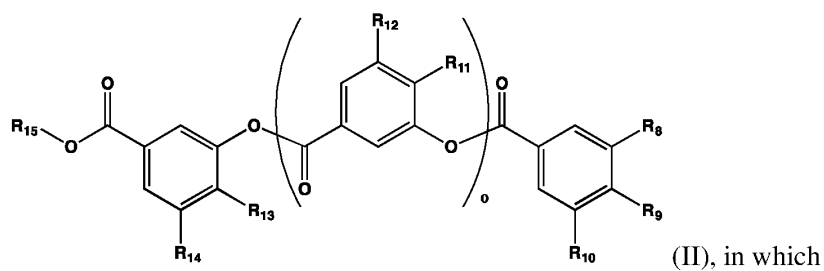
12. The compound of claim 6, wherein the X ring is , or , R₁ is OR₅,
wherein m is 0, 1, 2, 3, 4, 5, 6, or 7, and wherein n is 0.

10

13. The compound of any one of claims 1, 4, 6, 7, 8, and 10, wherein the ring Y is
, , , , , ,  or .

14. The compound of any one of claims 1, 4, 6, 7, 8, and 10, wherein the R₇ is
15 , , , , , , ,
, or absent.

15. The compound of claim 1, wherein the compound is of the Formula (II):



R₉-R₁₄ are each independently H, OH, NH₂, halogen, C₁₋₃ alkyl, or C₁₋₃ alkoxy;

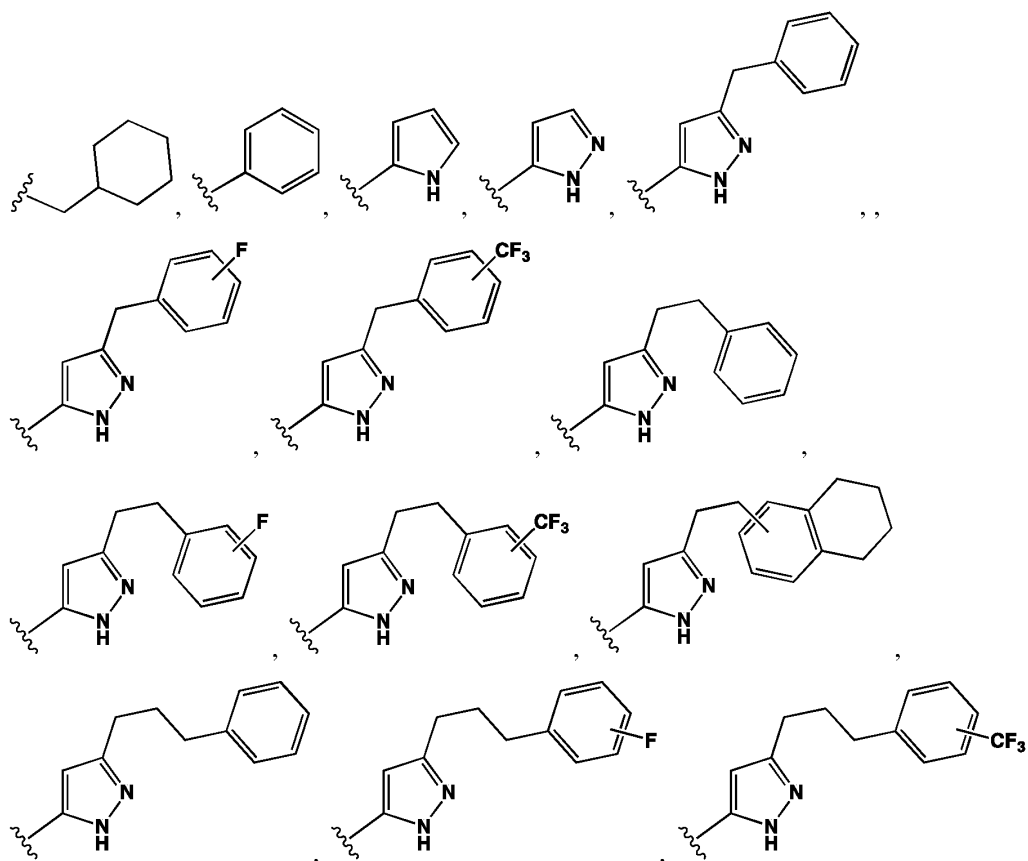
R₈ is H, OH, NH₂, halogen, C₁₋₃ alkyl, C₁₋₃ alkoxy, aryl, heteroaryl, or

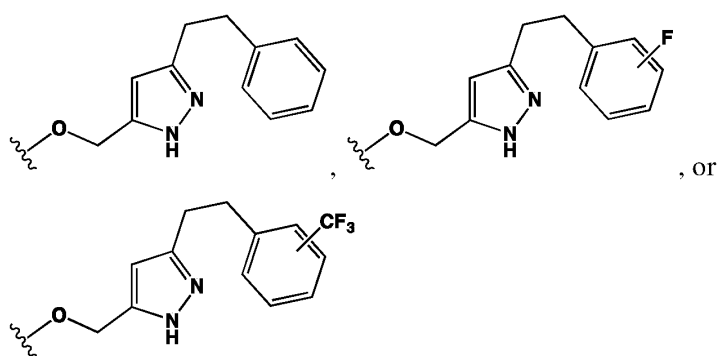
O(CO)R₆; and

5 R₁₅ is H, alkyl, cycloalkyl, aryl, alkylaryl, heteroaryl, or alkylheteroaryl; o is 1, 2, 3, 4, or 5.

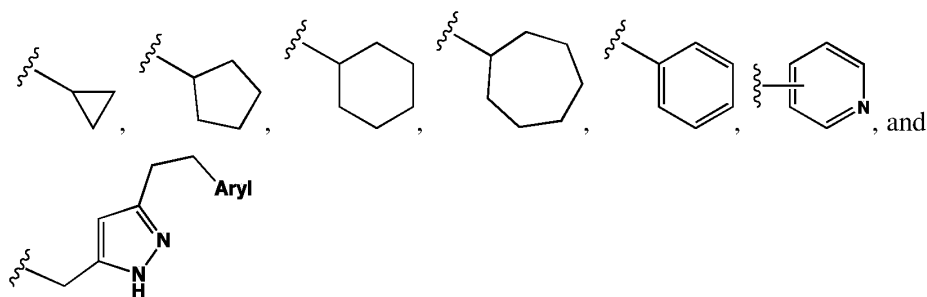
16. The compound of claim 15, wherein each of R₉-R₁₄ is OH.

10 17. The compound of any one of claims 1, 4, 6, 7, 8, 10, 15 and 16, wherein R₆ is





18. The compound of any one of claims 15-17, wherein R_{15} is selected from the group consisting of:



19. The compound of claim 1, which is selected from the compounds listed in Table 1.

20. A composition, comprising the compound of any one of claims 1-19 and a carrier.

21. The composition of claim 20, wherein the composition is a pharmaceutical composition, a nutraceutical composition, a health food, or a medical food.

22. A method of treating coronavirus infection, comprising administering to a subject in need thereof an effective amount of the compound of any one of claims 1-19 or the composition of claim 20 or claim 21.

23. The method of claim 22, wherein the coronavirus virus is selected from the group consisting of SARS-CoV-2, severe acute respiratory syndrome coronavirus (SARS-

CoV), middle east respiratory syndrome coronavirus (MERS-CoV), 229E alpha coronavirus, NL63 alpha coronavirus, OC43 beta coronavirus, and HKU1 beta coronavirus.

24. The method of claim 23, wherein the compound or composition is
5 administered by oral, by injection, by external use, or by inhalation.

25. The method of claim 23, wherein the composition is placed in a medical
device selected from the group consisting of an inhaler, a nebulizer, a nasal spray, and a
vaporization aerosol device for administration to the subject.

10

26. The method of claim 23, wherein the subject is a human subject.

27. The method of claim 23, wherein the subject is administered the composition
continuously or at a frequency of every five minutes to one time every three months.

15

28. The method of claim 23, wherein the human subject is further treated by one
or more additional anti-viral agents.

29. The method of claim 28, wherein the one or more additional anti-viral agents
20 comprise a viral entry inhibitor, a viral uncoating inhibitor, a viral reverse transcriptase
inhibitor, a viral protein synthesis inhibitor, a viral protease inhibitor, a viral polymerase
inhibitor, a viral integrase inhibitor, an interferon, or the combination thereof.

30. The method of claim 28, wherein the viral entry inhibitor is selected from the
25 group consisting of maraviroc, enfuvirtide, ibalizumab, fostemsavir, plerixafor,
epigallocatechin gallate, vicriviroc, aplaviroc, maraviroc, tromantadine, nitazoxanide,
umifenovir, and podofilox.

31. The method of claim 28, wherein the viral uncoating inhibitor is selected from
30 the group consisting of amantadine, rimantadine, and pleconaril.

32. The method of claim 28, wherein the viral reverse transcriptase inhibitor is
selected from the group consisting of zidovudine, didanosine, zalcitabine, stavudine,

lamivudine, abacavir, emtricitabine, entecavir, truvada, nevirapine, raltegravir, and tenofovir disoproxil.

33. The method of claim 28, wherein the viral protease inhibitor is selected from
5 the group consisting of fosamprenavir, ritonavir, atazanavir, nelfinavir, indinavir, saquinavir, saquinavir, famciclovir, fomivirsen, lopinavir, ribavirin, darunavir, oseltamivir, and tipranavir.

34. The method of claim 28, wherein the viral polymerase inhibitor is selected
10 from the group consisting of amatoxins, rifamycin, cytarabine, fidaxomicin, tagetitoxin, foscarnet sodium, idoxuridine, penciclovir, sofosbuvir, trifluridine, valacyclovir, valganciclovir, vidarabine, and remdesivir.

35. The method of claim 28, wherein the viral integrase inhibitor is selected from
15 the group consisting of raltegravir, elvitegravir, dolutegravir, bictegravir, and cabotegravir.

36. The method of claim 28, wherein the interferon is selected from the group
consisting of type I interferon, type II interferon, type III interferon, and peginterferon alfa-
2a.
20

37. A method of inhibiting D-amino acid oxidase (DAAO) in a subject,
comprising administering to a subject in need thereof an effective amount of the compound of
any one of claims 1-19 or the composition of claim 20 or claim 21.

25 38. The method of claim 37, wherein the subject is a human having, suspected of having, or at risk for a central nervous system (CNS) disorder, a metabolic disorder, or pain.

39. The method of claim 38, wherein the CNS disorder is selected from the group
consisting of schizophrenia, psychotic disorders, Alzheimer's disease, frontotemporal
30 dementia, vascular dementia, dementia with Lewy bodies, senile dementia, mild cognitive impairment, benign forgetfulness, closed head injury, autistic spectrum disorder, Asperger's disorder, fragile X syndrome, attention deficit hyperactivity disorders, attention deficit disorder, obsessive compulsive disorder, tic disorders, childhood learning disorders, premenstrual syndrome, depression, major depressive disorder, anhedonia, suicidal ideation

and/or behaviors, bipolar disorder, anxiety disorders, panic disorder, post-traumatic stress disorder, chronic mild and unpredictable stress, eating disorders, addiction disorders, personality disorders, Parkinson's disorder, Huntington's disorder, multiple sclerosis, amyotrophic lateral sclerosis, ataxia, Friedreich's ataxia, Tourette's syndrome, nocturnal
5 enuresis, non-epileptic seizures, blepharospasm, Duchenne muscular dystrophy, and stroke.

40. The method of claim 38, wherein the metabolic disorder is selected from the group consisting of obesity, hyperlipidemia, hypercholesterolemia, hyperglycemia, hyperinsulinemia, insulin resistance, and diabetes.

10

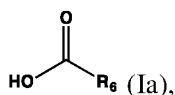
41. The method of claim 38, wherein the pain is selected from the group consisting of psychogenic pain, acute pain, chronic pain, chronic pain syndromes, neuropathic pain, nociceptive pain, and hyperalgesia.

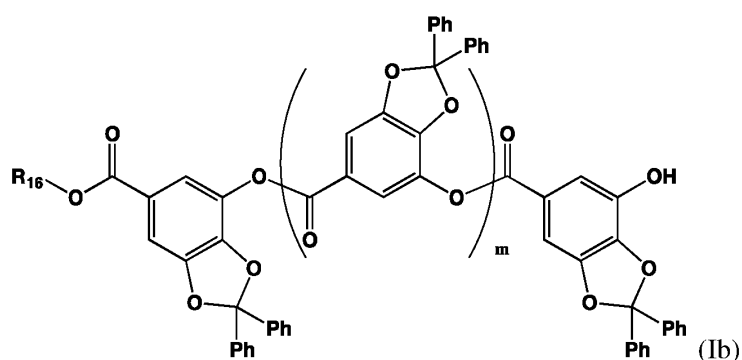
42. The method of claim 41, wherein the psychogenic pain is selected from the group consisting of headache, muscle pain, back pain and stomach pain, the neuropathic pain is selected from the group consisting of sciatica, carpal tunnel syndrome, diabetic neuropathy, postherpetic neuralgia, and central pain syndrome, and the nociceptive pain is selected from the group consisting of radicular pain, somatic pain, and visceral pain.

20

43. The method of any one of claims 38-42, wherein the human subject is further treated by one or more additional pharmaceutical agents for treating and/or reducing the risk for a CNS disorder.

25 44. A method of preparing the compound of claim 1, comprising:
(a) providing compounds of formula (Ia) and (Ib)





wherein R_{16} is the group selected from alkyl group, alkylsilyl group, or arylsilyl group;

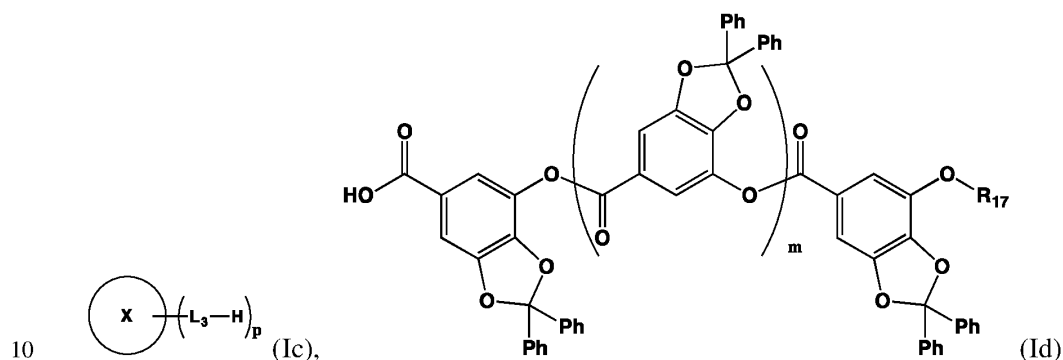
(b) reacting the compound of formula (Ia) with formula (Ib) to produce intermediate I;

(c) de-protecting the R_{16} group to produce intermediate II; and

5 (d) de-protecting the cyclic acetal groups and purifying the reaction mixture to obtain the compound of claim 1.

45. A method of preparing the compound of claim 1, comprising:

(a) providing compounds of formula (Ic) and (Id)



wherein $p = 1, 2, 3,$ or 4 ; each of L_3 , independently, is a moiety selected from the group consisting of NH, O, S, $-((CH_2)_5-W)-$, or absent; R_{17} is the group selected from benzyl group, allyl group, ethoxymethyl group, methoxymethyl group, ethoxyethyl group, alkyl silyl group, or aryl silyl group;

15 (b) reacting the compound of formula (Ic) with formula (Id), to allow conjugation of formula (Id) to one or more of L_3 of the formula (Ic), thereby producing intermediate III;

(c) de-protecting the R_{17} group to produce intermediate IV;

(d) de-protecting the cyclic acetal groups and purifying the reaction mixture to obtain the compound of claim 1.

20

46. The method of claim 44, further comprising, after step (c),
(e) reacting the intermediate II with formula (Ic) and allowing conjugation of the intermediate II to one or more L₃ of the formula (Ic) to produce intermediate V.

5 47. The method in claim 45, further comprising after step (c),
(e) reacting the intermediate IV with formula (Ia) to produce intermediate VI.

48. A method of preparing the compound (Ia), comprising:

(a) providing compound of formula (Ie);



(b) reacting the compound of formula (Ie) with strong organic base under -78°C to 0°C to produce intermediate VII;

(c) reacting the intermediate VII with alkyl group protected oxalic acid to produce intermediate VIII;

15 (d) reacting the intermediate VIII with a cyclizing reagent to produce intermediate IX; and,

(e) de-protecting the alkyl group of the protected oxalic acid to obtain the formula (Ia).

20 49. The method of claim 48, wherein the strong organic base in step (b) is alkali alkoxide, alkyl lithium, lithium alkylamide, lithium alkylsilylamide.

50. The method of claim 48, wherein the cyclizing reagent in step (d) is hydrazine, hydrazine hydrate, hydroxyl amine, or any acceptable salts of which thereof.