R^1	R^2
α-Rha-	H
α–Glc(1-2)-α-Rha-	H
H	α-Rha-
H	β–QuiNAc(1-3)-α-Rha-
H	β–FucNAc(1-3)-α-Rha-
H	α-Rha[2,3,4-OAc]-
H	β-QuiNAc(1-3)-α-Rha[2,4-OAc]-
H	β-FucNAc(1-3)-α-Rha[2,4,-OAc]-

[0004] The present disclosure also includes compositions comprising an antigen **1a** and/or **1b** and a pharmaceutically acceptable vehicle. In another aspect, the present disclosure provides a composition comprising a synthetic oligosaccharide as disclosed herein and a pharmaceutically acceptable vehicle. Preferably the composition contains a single antigen or a known, defined mixture of antigens.

[0005] The present disclosure further provides vaccine compositions, including immunogenic and immunoprotective compositions, comprising antigen **1a** and/or **1b** and a pharmaceutically acceptable vehicle. In an aspect, the present disclosure provides a composition comprising an oligosaccharide as disclosed herein as a vaccine. These vaccine compositions can optionally include a pharmaceutically acceptable adjuvant. Preferably, the vaccine compositions are endotoxin-free. The vaccine compositions can be mono-, di-, tri- or tetravalent. In an aspect, the present disclosure provides

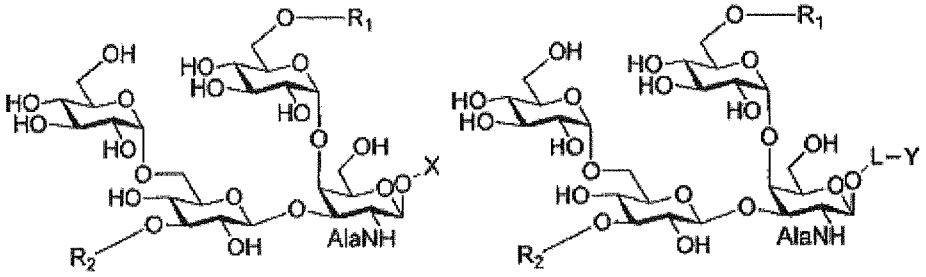
an oligosaccharide of the present invention for use in the production of an antibody against *Pseudomonas aeruginosa*. In an aspect, the present disclosure provides an antibody producing cell comprising an antibody against an oligosaccharide as disclosed herein. In another aspect, the present disclosure provides an antibody produced by the antibody producing cell as disclosed herein. In another aspect, the present disclosure provides a method of detecting the presence of *Pseudomonas aeruginosa* in a sample, comprising contacting the sample with an antibody against an oligosaccharide as disclosed herein. In another aspect, the present disclosure provides a kit comprising an antibody against an oligosaccharide as disclosed herein.

[0006] The present disclosure further provides a method for synthetically forming oligosaccharides **1a** and antigens **1b**.

[0007] The present disclosure further provides methods for diagnosing, treating, and preventing infections caused by *P. aeruginosa*. In an aspect, the present disclosure provides a pharmaceutical composition comprising an oligosaccharide as disclosed herein for use in inducing an immune response against *Pseudomonas aeruginosa* in a subject. In another aspect, the present disclosure provides use of an oligosaccharide as disclosed herein in the manufacture of a medicament for inducing an immune response against *Pseudomonas aeruginosa* in a subject. In another aspect, the present disclosure provides an antibody preparation against an oligosaccharide as disclosed herein. In another aspect, the present disclosure provides a pharmaceutical composition comprising an antibody preparation as disclosed herein for use in providing passive immunity against *Pseudomonas aeruginosa* in a subject. In another aspect, the present disclosure provides use of an antibody preparation as disclosed herein in the manufacture of a medicament for providing passive immunity against *Pseudomonas aeruginosa* in a subject. In another aspect, the present disclosure provides a pharmaceutical composition comprising an oligosaccharide as disclosed herein or an antibody thereto for treating or preventing a disease associated with *P. aeruginosa* infection in a subject. In another aspect, the present disclosure provides use of an oligosaccharide as disclosed herein or an antibody thereto in the manufacture of a medicament for treating or preventing a disease associated with *P. aeruginosa* infection in a subject.

Claims

1. A synthetic oligosaccharide **1a** or **1b**



1a **1b**

where each of R^1 and R^2 is independently H, a monosaccharide or an oligosaccharide, X is H, a linker group, or a protecting group; L is a linker and Y is a carrier.

2. The oligosaccharide of claim 1, which is oligosaccharide 1a.

3. The oligosaccharide of claim 1, which is oligosaccharide 1b.

4. The oligosaccharide of any of claims 1-3, wherein each of R^1 and R^2 is independently chosen from H, α-Rha-, α-Glc(1-2)-α-Rha-, β-QuiNAc(1-3)-α-Rha-, β-FucNAc(1-3)-α-Rha-, α-Rha[2,3,4- OAc]-, β-OuiNAc(1-3)-α-Rha[2,4-OAc]-, or β-FucNAc(1-3)-α-Rha[2,4,-OAc]-.

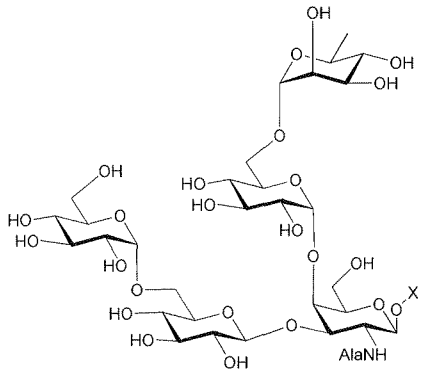
5. The oligosaccharide of any of claims 1-4, wherein R^1 and R^2 are selected from one of the combinations listed in the following table:

R^1	**R^2**
α-Rha-	H
α-Glc(1-2)-α-Rha-	H

H	α-Rha-
H	β-QuiNAc(1-3)- α-Rha-
H	β-FucNAc(1-3)- α-Rha-
H	α-Rha[2,3,4-OAc]-
H	β-QuiNAc(1-3)- α-Rha[2,4-OAc]-
H	β-FucNAc(1-3)- α-Rha[2,4,-OAc]-

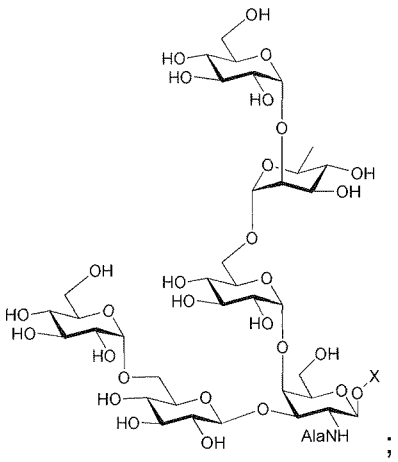
6. The oligosaccharide of any of claims 1-2 or 4-5, wherein oligosaccharide 1a has

formula (2a):



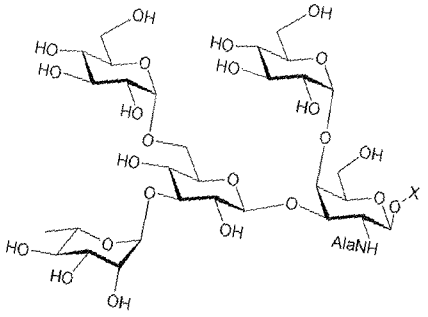
;

Formula (3a):



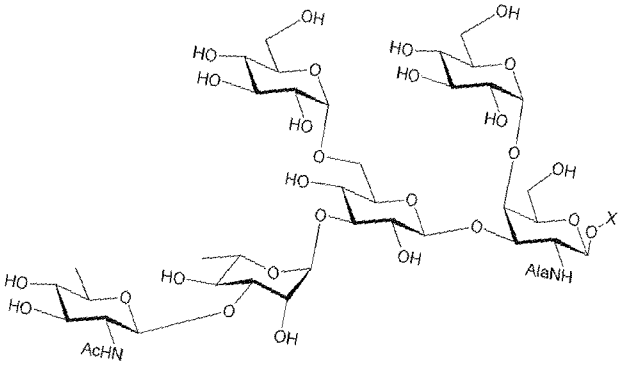
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Formula (4a):



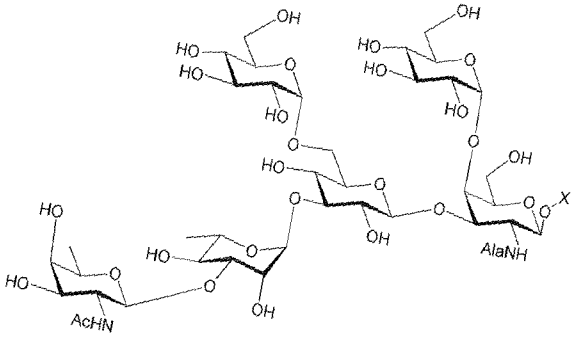
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Formula (5a):



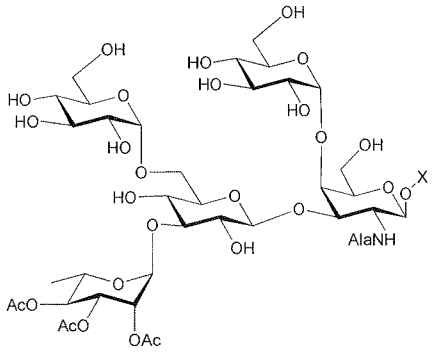
Formula (6a):

;



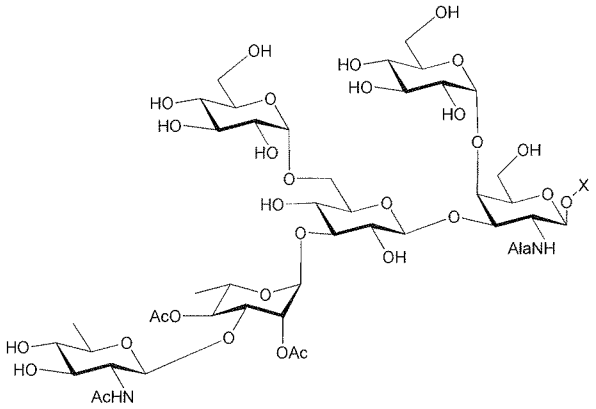
Formula (7a):

;



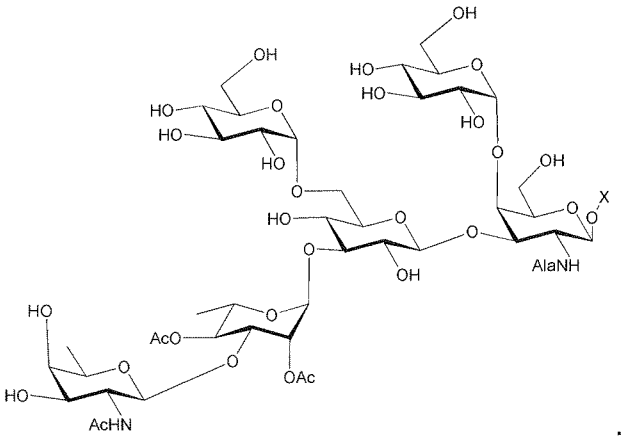
;

Formula (8a):



; or

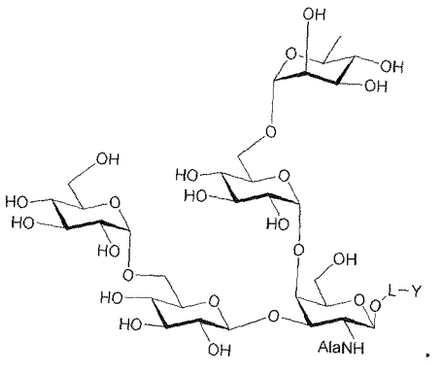
Formula (9a):



.

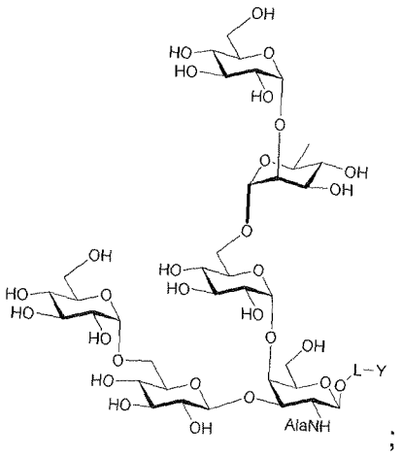
7. The oligosaccharide of any of claims 1 or 3-5, wherein oligosaccharide 1b has

formula (2b):



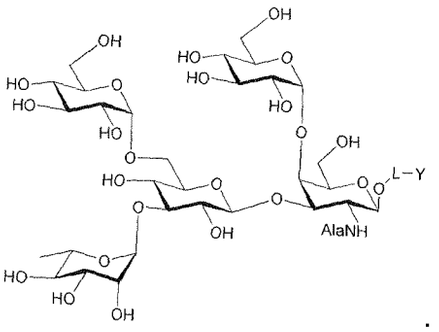
;

Formula (3b):



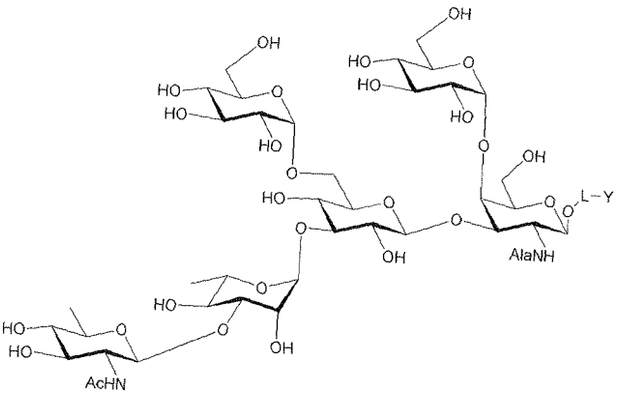
;

Formula (4b):



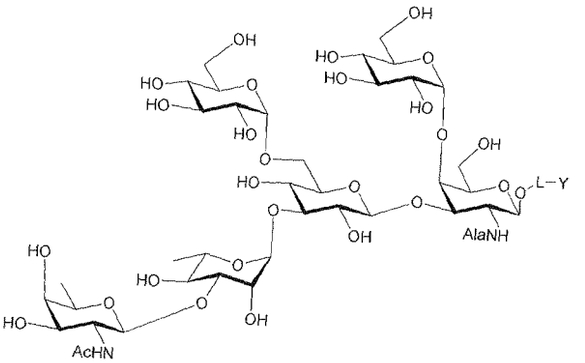
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Formula (5b):



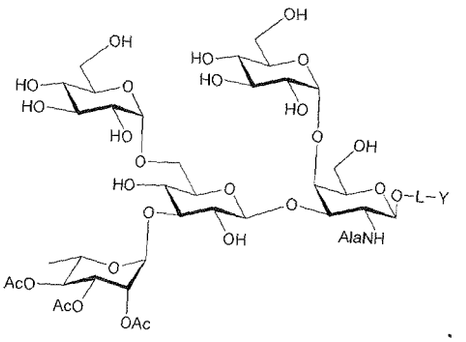
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Formula (6b):



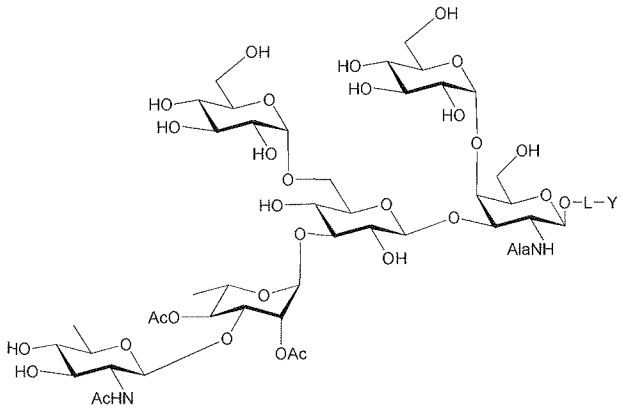
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Formula (7b):



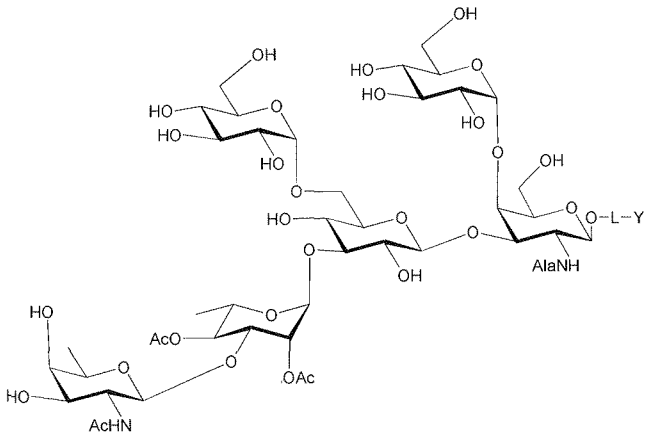
;

Formula (8b):



; or

Formula (9b):



.

8. The oligosaccharide of any one of claims 1, 3-5, or 7, where L is an alkylenethiol linker.

9. The oligosaccharide of any one of claims 1, 3-5, or 7-8, where Y is a carrier chosen from a protein, a peptide, a lipid, a polymer, a dendrimer, a virosome, a virus-like particle, or a combination thereof.

10. The oligosaccharide of claim 9, where the carrier is a carrier protein.

11. The oligosaccharide of claim 10, where the carrier protein is chosen from a bacterial toxoid, a toxin, an exotoxin, and a nontoxic derivative thereof.

12. The oligosaccharide of claim 11, wherein the carrier protein is chosen from tetanus toxoid, tetanus toxin Fragment C, diphtheria toxoid, CRM, cholera toxoid, a *Staphylococcus aureus* exotoxins or toxoids, *Escherichia coli* heat labile enterotoxin, *Pseudomonas aeruginosa* exotoxin A, a genetically detoxified variants thereof, a bacterial outer membrane proteins, serotype B outer membrane protein complex (OMPC), outer membrane class 3 porin (rPorB), a porin, keyhole limpet hemocyanine (KLH), hepatitis B virus core protein, thyroglobulin, an albumins, ovalbumin, pneumococcal surface protein A (PspA), pneumococcal adhesin protein (PsaA), a purified protein derivative of tuberculin (PPD), a transferrin binding proteins, a peptidyl agonists of TLR-5, or a derivatives and/or a combinations of the above carriers.

13. The oligosaccharide of claim 12, wherein the carrier protein is chosen from CRM 197, Neisseria meningitidis, bovine serum albumin (BSA), human serum albumin (HSA), poly(lysine:glutamic acid), flagellin of motile bacteria, or a derivatives and/or a combinations thereof.

14. The oligosaccharide of claim 12, wherein the carrier protein is chosen from tetanus toxoid, CRM 197, or OMPC.

15. A composition comprising a synthetic oligosaccharide of any one of claims 1-14 and a pharmaceutically acceptable vehicle.

16. The composition of claim 15, comprising a plurality of different oligosaccharides, where each oligosaccharide is an oligosaccharide of formula **1a** or **1b**.

17. The composition of claim 15 or 16, further comprising an adjuvant.

18. The composition of claim 17, where the adjuvant is chosen from an aluminum salts, RIBI, a toll-like receptor agonists, AS01, AS02, AS03, AS04, AS05,

CpG-oligodeoxynucleotide, MF-59, Montanide ISA-51 VG, Montanide ISA-720, Quil A, QS21, synthetic saponins, an immunostimulating complexes, stearyi tyrosine, a virus-like particle, a reconstituted influenza virosomes, a cytokine, mast cell activator compound 48/80, a liposome, a muramyl dipeptides, SAF-1, or a combinations thereof.

19. The composition of any of claims 15-18, comprising an amount of at least one oligosaccharide sufficient to confer immunity against *Pseudomonas aeruginosa*.

20. A composition comprising an oligosaccharide of any one of claims 1-14 as a vaccine.

21. A pharmaceutical composition comprising an oligosaccharide of any of claims 1-14 for use in inducing an immune response against *Pseudomonas aeruginosa* in a subject.

22. The pharmaceutical composition of claim 21, further comprising an adjuvant.

23. The pharmaceutical composition of claim 21 or 22, wherein the immune response is an antigen-specific immune response.

24. Use of an oligosaccharide of any of claims 1-14 in the manufacture of a medicament for inducing an immune response against *Pseudomonas aeruginosa* in a subject.

25. An antibody preparation against an oligosaccharide according to any one of claims 1-14.

26. The antibody preparation of claim 25, where the antibody preparation comprises at least one member chosen from a polyclonal antibody, a monoclonal

antibody, a mouse monoclonal IgG antibody, a humanized antibody, a chimeric antibody, a single chain antibodies, a fragment thereof, or a combination thereof.

27. A pharmaceutical composition comprising an antibody preparation of claim 25 or 26 for use in providing passive immunity against *Pseudomonas aeruginosa* in a subject.

28. Use of an antibody preparation of claim 25 or 26 in the manufacture of a medicament for providing passive immunity against *Pseudomonas aeruginosa* in a subject.

29. A pharmaceutical composition comprising an oligosaccharide of any of claims 1-14 or an antibody thereto for treating or preventing a disease associated with *P. aeruginosa* infection in a subject.

30. Use of an oligosaccharide of any of claims 1-14 or an antibody thereto in the manufacture of a medicament for treating or preventing a disease associated with *P. aeruginosa* infection in a subject.

31. The use of claim 28 or 30, wherein the subject is human.

32. An oligosaccharide of any one of claims 1-14 for use in the production of an antibody against *Pseudomonas aeruginosa*.

33. The oligosaccharide for use of claim 32, wherein the antibody is a monoclonal antibody.

34. The oligosaccharide for use of claim 32 or 33, wherein the antibody is produced in a subject.

35. The oligosaccharide for use of any of claims 32-34, wherein the oligosaccharide is used in combination with an adjuvant.

36. An antibody producing cell comprising an antibody against an oligosaccharide of any one of claims 1-14.

37. An antibody produced by the antibody producing cell of claim 36.

38. A method of detecting the presence of *Pseudomonas aeruginosa* in a sample, comprising contacting the sample with an antibody against an oligosaccharide of any of claims 1-14.

39. A kit comprising an antibody against an oligosaccharide of any of claims 1-14.