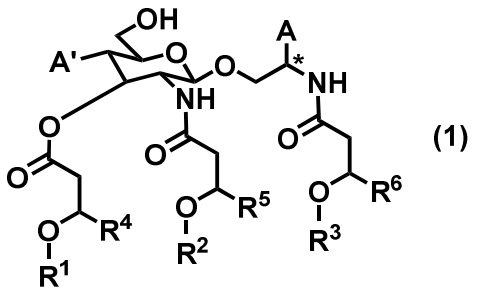
CLAIMS

1. A compound of formula (1):



(1)

or a pharmaceutically acceptable salt thereof, wherein

A and A' are independently hydrogen, hydroxy, or $-(CH_2)_m-COOH$, provided that at least one of A or A' is $-(CH_2)_m-COOH$,

R^1 is $-C(O)(CH_2)_n-X$ or $-CH_2-(CH_2)_n-X$,

R^2 is $-C(O)(CH_2)_o-Y$ or $-CH_2-(CH_2)_o-Y$,

R^3 is $-C(O)(CH_2)_p-Z$ or $-CH_2-(CH_2)_p-Z$,

X, Y, and Z are independently methyl, C_{6-10} aryl (said C_{6-10} aryl may be substituted with 1 – 5 substituents selected independently from hydroxy, C_{1-6} alkyl, halogen, cyano, and C_{1-6} alkoxy), or 5- to 10-membered heteroaryl (said 5- to 10-membered heteroaryl may be substituted with 1 – 4 substituents selected independently from hydroxy, C_{1-6} alkyl, halogen, cyano, and C_{1-6} alkoxy), provided that at least one of X, Y, or Z is C_{6-10} aryl (said C_{6-10} aryl may be substituted with 1 – 5 substituents selected independently from hydroxy, C_{1-6} alkyl, halogen, cyano, and C_{1-6} alkoxy) or 5- to 10-membered heteroaryl (said 5- to 10-membered

heteroaryl may be substituted with 1 – 4 substituents selected independently from hydroxy, C_{1-6} alkyl, halogen, cyano, and C_{1-6} alkoxy),

provided that when A is –COOH and the stereochemistry of * is S-configuration, Y is methyl,

R^4, R^5, and R^6 are independently C_{10-20} alkyl,

m is independently an integer of 0 – 6, and

n, o, and p are independently an integer of 5 – 20.

2. The compound of claim 1, or a pharmaceutically acceptable salt thereof, wherein m is 0.

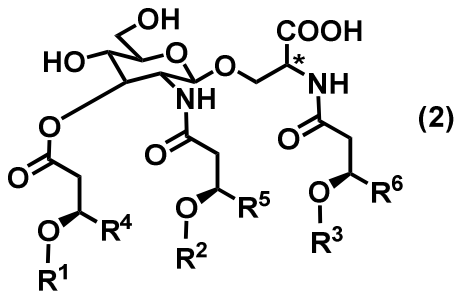
3. The compound of claim 1 or 2, or a pharmaceutically acceptable salt thereof, wherein R^1 is $-C(O)(CH_2)_n-X$, R^2 is $-C(O)(CH_2)_o-Y$, and R^3 is $-C(O)(CH_2)_p-Z$.

4. The compound of any one of claims 1 to 3, or a pharmaceutically acceptable salt thereof, wherein A is COOH.

5. The compound of any one of claims 1 to 4, or a pharmaceutically acceptable salt thereof, wherein A is COOH, and A' is hydroxy.

6. The compound of any one of claims 1 to 5, or a pharmaceutically acceptable salt thereof, wherein R^4, R^5, and R^6 are independently C_{10-12} alkyl.

7. The compound of claim 1 which is represented by formula (2):



(2)

wherein

R^1 is $-C(O)(CH_2)_n-X$,

R^2 is $-C(O)(CH_2)_o-Y$,

R^3 is $-C(O)(CH_2)_p-Z$,

X, Y, and Z are independently methyl, C_{6-10} aryl, or 5- to 10-membered heteroaryl, provided that at least one of X, Y, or Z is C_{6-10} aryl or 5- to 10-membered heteroaryl,

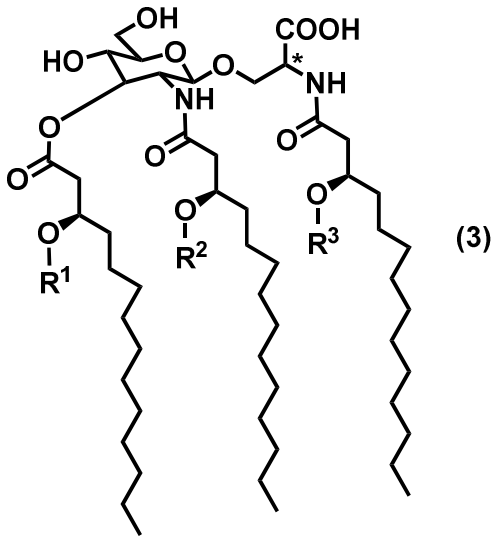
provided that when the stereochemistry of * is S-configuration, Y is methyl,

R^4, R^5, and R^6 are independently C_{10-12} alkyl, and

n, o, and p are independently an integer of 6 – 10,

or a pharmaceutically acceptable salt thereof.

8. The compound of claim 1 which is represented by formula (3):



(3)

wherein

R^1 is $-C(O)(CH_2)_n-X$,

R^2 is $-C(O)(CH_2)_o-Y$,

R^3 is $-C(O)(CH_2)_p-Z$,

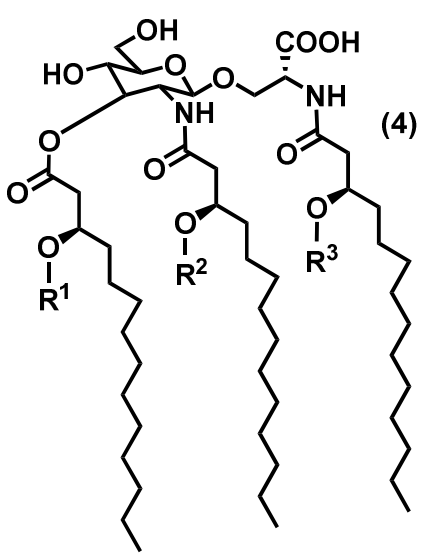
X, Y, and Z are independently methyl, C_{6-10} aryl, or 5- to 10-membered heteroaryl, provided that at least one of X, Y, or Z is C_{6-10} aryl or 5- to 10-membered heteroaryl,

provided that when the stereochemistry of * is S-configuration, Y is methyl, and

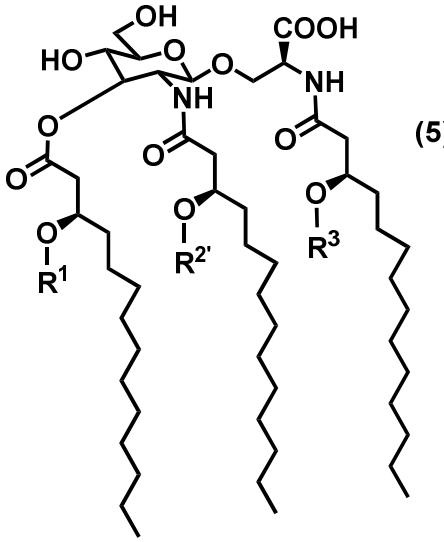
n, o, and p are independently an integer of 6 – 10,

or a pharmaceutically acceptable salt thereof.

9. The compound of claim 1 which is represented by formula (4) or formula (5):



(4)



(5)

wherein

R^1 is $-C(O)(CH_2)_n-X$,

R^2 is $-C(O)(CH_2)_o-Y$,

R^3 is $-C(O)(CH_2)_p-Z$,

$R^{2'}$ is $-C(O)(CH_2)_o-CH_3$,

X, Y, and Z are independently methyl, C_{6-10} aryl, or 5- to 10-membered heteroaryl, provided that at least one of X, Y, or Z in formula (4) is C_{6-10} aryl or 5- to 10-membered heteroaryl, and at least one of X or Z in formula (5) is C_{6-10} aryl or 5- to 10-membered heteroaryl, and

n, o, and p are independently an integer of 7 - 9,

or a pharmaceutically acceptable salt thereof.

10. The compound of any one of claims 1 to 9, or a pharmaceutically acceptable salt thereof, wherein

X, Y, and Z are independently methyl or phenyl, provided that at least one of X, Y, or Z is phenyl,

provided that when A is -COOH and the stereochemistry of * is S-configuration, Y is methyl.

11. The compound of claim 1 which is selected from the following compound group:

(2*R*)-2-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]amino}-3-{[3-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]amino}-5-hydroxy-6-(hydroxymethyl)-4-({(3*R*)-3-[(9-phenylnonanoyl)oxy]tetradecanoyl}oxy)oxan-2-yl]oxy}propanoic acid,

(2*S*)-2-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]amino}-3-{[3-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]amino}-5-hydroxy-6-(hydroxymethyl)-4-({(3*R*)-3-[(9-phenylnonanoyl)oxy]tetradecanoyl}oxy)oxan-2-yl]oxy}propanoic acid,

(2*R*)-2-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]amino}-3-{[4-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]oxy}-5-hydroxy-6-(hydroxymethyl)-3-({(3*R*)-3-[(9-phenylnonanoyl)oxy]tetradecanoyl}amino)oxan-2-yl]oxy}propanoic acid,

(2*R*)-2-({[(3*R*)-3-(9-phenylnonanoyl)oxy]tetradecanoyl}amino)-3-{[3-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]amino}-5-hydroxy-6-(hydroxymethyl)-4-({(3*R*)-3-(decanoyloxy)tetradecanoyl}oxy)oxan-2-yl]oxy}propanoic acid, and

(2*S*)-2-({[(3*R*)-3-(9-phenylnonanoyl)oxy]tetradecanoyl}amino)-3-{[3-{[(3*R*)-3-(decanoyloxy)tetradecanoyl]amino}-5-hydroxy-6-(hydroxymethyl)-4-({(3*R*)-3-(decanoyloxy)tetradecanoyl}oxy)oxan-2-yl]oxy}propanoic acid.

12. A pharmaceutical composition comprising the compound of any one of claims 1 to 11, or a pharmaceutically acceptable salt thereof.

13. The pharmaceutical composition of claim 12, which is a lipid formulation.

14. The pharmaceutical composition of claim 12 or 13, wherein the lipid formulation is a liposome formulation including phospholipid.

15. The pharmaceutical composition of claim 14, wherein the phospholipid is 1,2-dimyristoyl-sn-glycero-3-phosphocholine and egg yolk phosphatidylglycerol.

16. The pharmaceutical composition of claim 14 or 15, wherein the lipid formulation comprises at least one additive selected form the group consisting of an inorganic acid, an inorganic acid salt, an organic acid, an organic acid salt, sugars, a buffering agent, an antioxidant, and

polymers.

17. The pharmaceutical composition of any one of claims 12 to 16, which further comprises an antigen.

18. The pharmaceutical composition of claim 17, wherein the antigen is a pathogen-derived antigen.

19. A vaccine adjuvant comprising the compound of any one of claims 1 to 11, or a pharmaceutically acceptable salt thereof.

20. The vaccine adjuvant of claim 19, which is an adjuvant for infection vaccine.

21. A kit comprising

a) the compound of claim 1 or a pharmaceutically acceptable salt thereof, or a pharmaceutical composition comprising the compound of claim 1 or a pharmaceutically acceptable salt thereof; and

b) a pharmaceutical composition comprising an antigen.

22. The kit of claim 21, wherein the antigen is a pathogen-derived antigen.

23. A medicament for use in treating or preventing

infection, comprising the compound of any one of claims 1 to 11, or a pharmaceutically acceptable salt thereof, which is used in combination with a pathogen-derived antigen.

24. Use of the compound of any one of claims 1 to 11 or a pharmaceutically acceptable salt thereof in the preparation of a vaccine adjuvant.