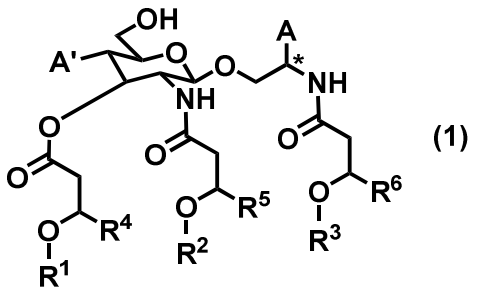
CLAIMS

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.

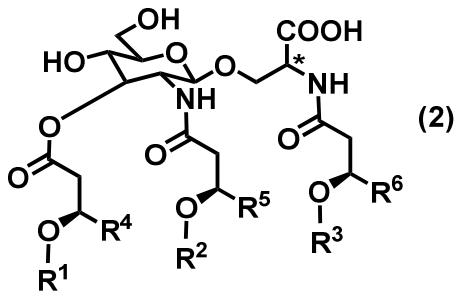
3. The compound of claim 1 or 2, or a pharmaceutically acceptable salt thereof, wherein R^1 is $-C(O)(CH_2)_n-X$, R^2 is $-C(O)(CH_2)_o-Y$, and R^3 is $-C(O)(CH_2)_p-Z$.

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,

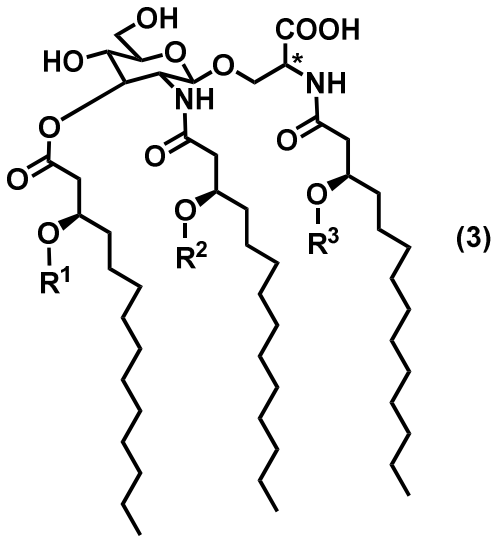
provided that when the stereochemistry of * is S-configuration, Y is methyl,

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 $-C(O)(CH_2)_p-Z$,

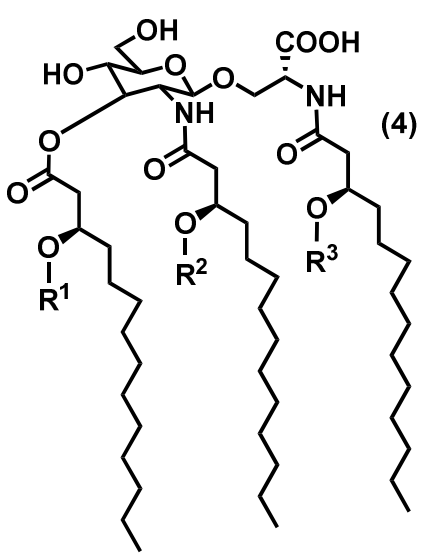
X, Y, and Z are independently methyl, C_{6-10} aryl, or 5- to 10-membered heteroaryl, provided that at least one of X, Y, or Z is C_{6-10} aryl or 5- to 10-membered heteroaryl,

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

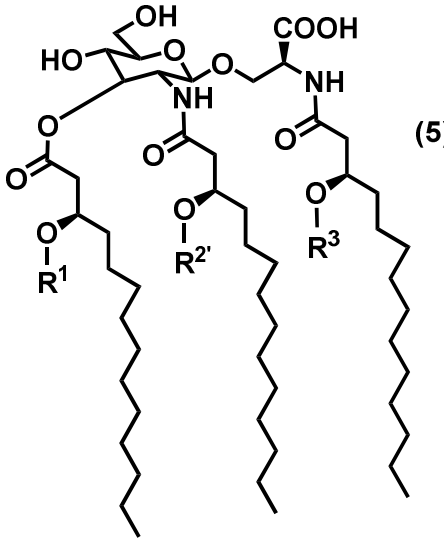
n, o, and p are independently an integer of 6 – 10,

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, or a pharmaceutically acceptable salt thereof.

12. The compound of claim 1 which is (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, or a pharmaceutically acceptable salt thereof.

13. The compound of claim 1 which is (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, or a pharmaceutically acceptable salt thereof.

~~12~~14. A pharmaceutical composition comprising the compound of any one of claims 1 to ~~11~~13, or a pharmaceutically acceptable salt thereof.

~~13~~15. The pharmaceutical composition of claim ~~12~~14, which is a lipid formulation.

~~14~~16. The pharmaceutical composition of claim ~~12 –~~14 or ~~13~~15, wherein the lipid formulation is a liposome formulation including phospholipid.

~~15~~17. The pharmaceutical composition of claim ~~14~~16, wherein the phospholipid is 1,2-dimyristoyl-sn-glycero-3-phosphocholine and egg yolk phosphatidylglycerol.

~~16~~18. The pharmaceutical composition of claim ~~14 –~~16 or ~~15~~17, 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~~19. The pharmaceutical composition of any one of claims ~~12 –~~14 to ~~16~~18, which further comprises an antigen.

~~18~~20. The pharmaceutical composition of claim ~~17~~19, wherein the antigen is a pathogen-derived antigen.

~~19~~21. A vaccine adjuvant comprising the compound of any

one of claims 1 to ~~11~~13, or a pharmaceutically acceptable salt thereof.

~~20~~22. The vaccine adjuvant of claim ~~19~~21, which is an adjuvant for infection vaccine.

~~21~~23. 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~~24. The kit of claim ~~21~~23, wherein the antigen is a pathogen-derived antigen.

~~23~~25. A medicament for use in treating or preventing infection, comprising the compound of any one of claims 1 to ~~11~~13, or a pharmaceutically acceptable salt thereof, which is used in combination with a pathogen-derived antigen.

~~24~~26. Use of the compound of any one of claims 1 to ~~11~~ 13 or a pharmaceutically acceptable salt thereof in the preparation of a vaccine adjuvant.