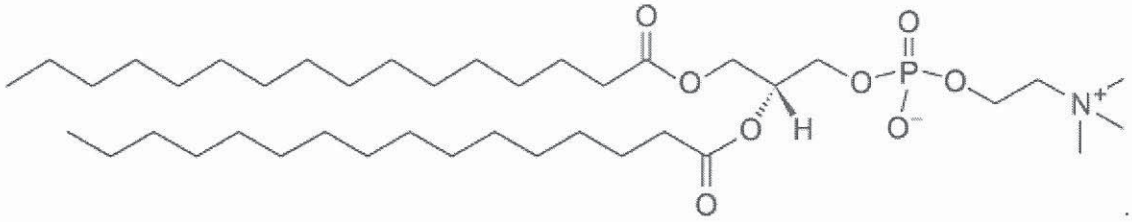
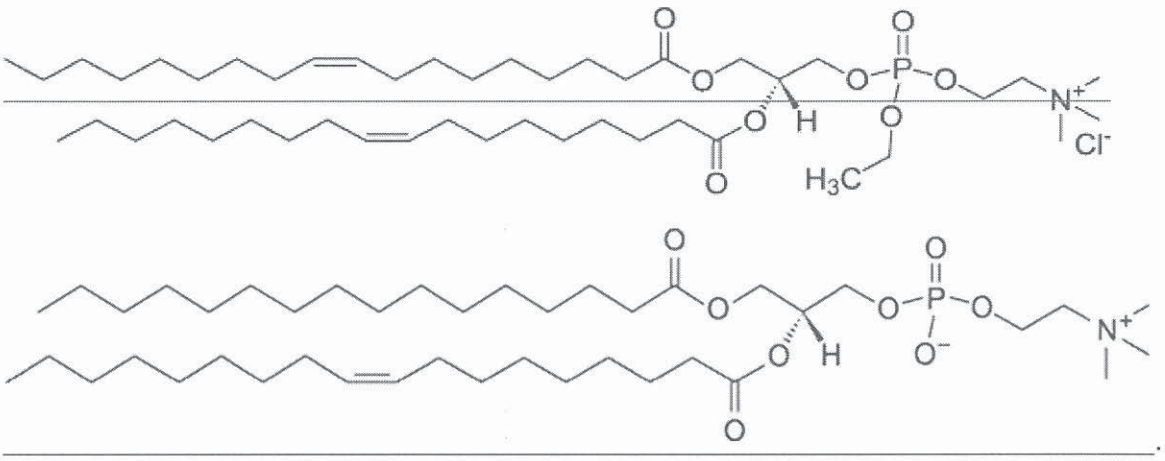
[0046] The structure of DPPC is



[0047] In various embodiments, the phosphatidylcholines may each comprise at least one unsaturated fatty acid moiety. For example, the phosphatidylcholines may each comprise L-α-phosphatidylcholine or 95% Egg phosphatidylcholines (EPC).

[0048] The structure of EPC is



[0049] In various embodiments, the sphingolipids may each comprise at least one unsaturated fatty acid moiety. For example, the sphingolipids may each comprise hexadecanoylsphingomyelin or Egg Sphingomyelin.

[0050] In various embodiments, the prostaglandin drug and/or the prostaglandin derivative is encapsulated in the liposomes.

[0051] In the context of various embodiments, the term "prostaglandin drug" may generally refer to a drug that contains any member of a group of lipid compounds that are derived enzymatically from fatty acids and have important functions in the animal body. Every prostaglandin contains 20 carbon atoms, including a 5-carbon ring. A prostaglandin derivative forms the prostanoid class of fatty acid derivatives, for example, a subclass of eicosanoids.

[0052] The prostaglandin drug and/or the prostaglandin derivative used in ocular drug delievery may include a drug that is effective in preventing or treating a disease in the eye. The prostaglandin drug and/or the prostaglandin derivative may be for delivery to the eye. In various embodiments, the prostaglandin drug or the prostaglandin derivative may be selected from the group consisting of latanoprost, bimatoprost, travoprost, carboprosttrometamol, gemeprost, sulprostone, dinoprostone (PGE2), alprostadil (PGE1),

CLAIMS

1. A liposomal formulation for ocular drug delivery comprising:

(i) liposomes comprising at least one lipid bilayer; and

(ii) a prostaglandin drug and/or a prostaglandin derivative encapsulated in the liposomes,

wherein the liposomes have a mean diameter of less than 2 μm; and

wherein the liposomes comprise phosphatidylcholines,

wherein the liposomal formulation has a drug to lipid mole ratio of about 0.01 to about 0.50.

2. The liposomal formulation as claimed in claim 1, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.01 to about 0.37.

3. The liposomal formulation as claimed in claim 2, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.015 to about 0.37.

4. The liposomal formulation as claimed in claim 3, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.04 to about 0.37.

~~2~~5. The liposomal formulation as claimed in any one of claims 1 to 4~~claim 1~~, wherein the liposomes comprise mixtures of phosphatidylcholines and at least one of sphingolipids, sterol lipids, saccharolipids, or polyketide lipids.

~~3~~6. The liposomal formulation as claimed in any one of claims 1 to 5~~claim 1 or 2~~, wherein the phosphatidylcholines are selected from the group consisting of 1,2-dioleoyl-sn-glycero-3-phosphocholines (DOPC), 1,2-dioleoyl-sn-glycero-O-ethyl-3-phosphocholines, 1,2-Dilauroyl-sn-glycero-3-phosphocholines (DLPC), 1,2-Dimyristoyl-sn-glycero-3-phosphocholines (DMPC), 1,2-Dipalmitoyl-sn-glycero-3-phosphocholines(DPPC),1,2-Distearoyl-sn-glycero-3-phosphocholines (DSPC) and

mixtures thereof.

47. The liposomal formulation as claimed in ~~any one of claims 1 to 3~~claim 6, wherein the phosphatidylcholines are 1,2-Dipalmitoyl-sn-glycero-3-phosphocholines (DPPC).

58. The liposomal formulation as claimed in any one of claims 1 to 47, wherein the phosphatidylcholines each comprises at least one unsaturated fatty acid moiety.

69. The liposomal formulation as claimed in claim 58, wherein the phosphatidylcholines each comprises L-α-phosphatidylcholine or 95% Egg phosphatidylcholines (eggPC 95%)~~(EPC)~~.

710. The liposomal formulation as claimed in any one of claims 25 to 69, wherein the sphingolipids each comprises at least one unsaturated fatty acid moiety.

811. The liposomal formulation as claimed in claim 710, wherein the sphingolipids each comprises hexadecanoylsphingomyelin or Egg Sphingomyelin.

912. The liposomal formulation as claimed in any one of the preceding claims, wherein the prostaglandin drug or the prostaglandin derivative is selected from the group consisting of latanoprost, bimatoprost, travoprost, carboprosttrometamol, gemeprost, sulprostone, dinoprostone (PGE2), alprostadil (PGE1), beroprost, iloprost, epoprostenol, treprostinil, misoprostol, enoprostil, omoprostil, limaprost. unoprostone isopropyl, arthrotec, and mixtures thereof.

1013. The liposomal formulation as claimed in any one of claims 1 to 912, wherein the prostaglandin drug comprises latanoprost.

1114. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposomes have a mean diameter of less than 1 μm.

~~12~~15. The liposomal formulation as claimed in claim ~~11~~14, wherein the liposomes have a mean diameter of about 100 nm to about 300 nm.

~~13~~16. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposomes are small unilamellar vesicles (SUV) or a large unilamellar vesicles (LUV) or multilamellar vesicles.

~~14. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.01 to about 0.50.~~

~~15~~17. The liposomal formulation as claimed in claim ~~14~~1, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.50.

~~16~~18. The liposomal formulation as claimed in any one of claims 1 to 16~~claim 14~~, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.18.

~~17~~19. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposomal formulation has a polydisperisty index of less than or equal to 0.25.

~~18~~20. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposome further comprises cholesterol.

~~19~~21. The liposomal formulation as claimed in claim ~~18~~20, wherein the cholesterol is of an amount of about 10 % to about 40 % by weight of the liposome.

~~20~~22. The liposomal formulation as claimed in any one of any one the preceding claims, wherein the liposome further comprises a linear C_8-C_{20} alkyl or alkenyl amine.

~~21~~23. The liposomal formulation as claimed in claim ~~20~~22, wherein the linear C_8-C_{20} alkyl or alkenyl amine is stearyl amine.

~~22~~24. The liposomal formulation as claimed in claim ~~21~~23, wherein the stearyl amine is of an amount of about 5 % to about 25 % by weight of the liposome.

~~23~~25. The liposomal formulation as claimed in claim ~~22~~24, wherein the stearyl amine is of an amount of about 10 % to about 20 % by weight of the liposome.

~~24~~26. A pharmaceutical composition comprising the liposomal formulation as claimed in any one of claims 1-~~23~~25.

~~25~~27. The pharmaceutical composition as claimed in claim ~~24~~26, wherein the pharmaceutical composition is in a form of an ophthalmic solution.

~~26~~28. The pharmaceutical composition as claimed in claim ~~25~~27, wherein the pharmaceutical composition is for use in ocular drug delivery in ~~a form of eye drops,~~ an injection solution~~,~~ or a viscous aqueous vehicle.

~~27~~29. The pharmaceutical composition as claimed in claim ~~26~~28, wherein the viscous aqueous vehicle comprises an aqueous solution of polysaccharides.

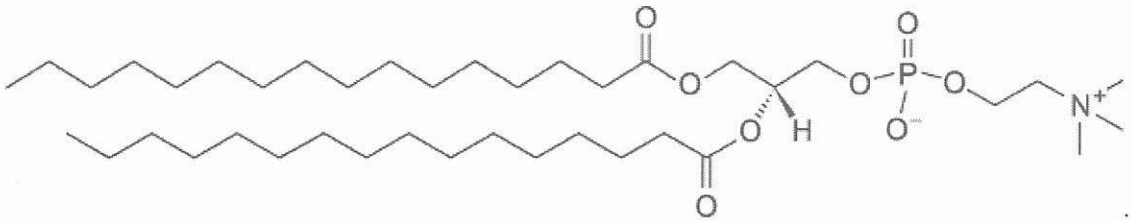
~~28~~30. The pharmaceutical composition as claimed in claim ~~27~~29, wherein the polysaccharide is hyaluronic acid.

~~29~~31. Use of a~~Method for treating or preventing an ocular disease, comprising administering the~~ liposomal formulation as claimed in any one of claims 1-~~23~~25 or the pharmaceutical composition as claimed in any one of claims 26-30~~24-28~~ in the treatment or prevention of an ocular disease, comprising administering the liposomal formulation or the pharmaceutical composition to a subject in need thereof.

~~30~~32. The use~~method~~ as claimed in claim ~~29~~31, wherein the ocular disease is glaucoma.

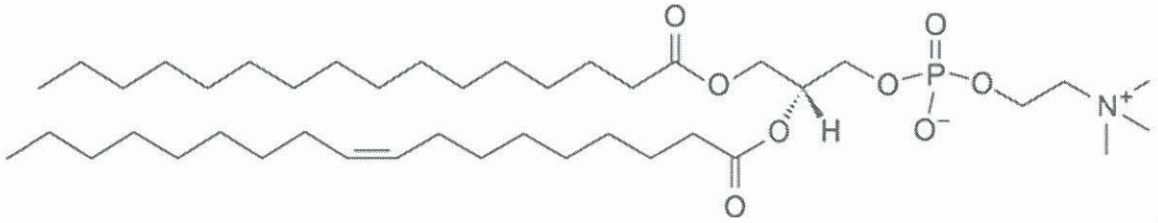
~~31~~33. The use~~method~~ as claimed in claim ~~29~~31 or ~~30~~32 wherein the use~~method~~ comprises administering the liposomal formulation or pharmaceutical composition by subconjunctival injection to provide sustained release of the ocular drug.

[0046] The structure of DPPC is



[0047] In various embodiments, the phosphatidylcholines may each comprise at least one unsaturated fatty acid moiety. For example, the phosphatidylcholines may each comprise L-α-phosphatidylcholine or 95% Egg phosphatidylcholines (EPC).

[0048] The structure of EPC is



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[0050] In various embodiments, the prostaglandin drug and/or the prostaglandin derivative is encapsulated in the liposomes.

[0051] In the context of various embodiments, the term "prostaglandin drug" may generally refer to a drug that contains any member of a group of lipid compounds that are derived enzymatically from fatty acids and have important functions in the animal body. Every prostaglandin contains 20 carbon atoms, including a 5-carbon ring. A prostaglandin derivative forms the prostanoid class of fatty acid derivatives, for example, a subclass of eicosanoids.

[0052] The prostaglandin drug and/or the prostaglandin derivative used in ocular drug delievery may include a drug that is effective in preventing or treating a disease in the eye. The prostaglandin drug and/or the prostaglandin derivative may be for delivery to the eye. In various embodiments, the prostaglandin drug or the prostaglandin derivative may be selected from the group consisting of latanoprost, bimatoprost, travoprost, carboprosttrometamol, gemeprost, sulprostone, dinoprostone (PGE2), alprostadil (PGE1),

CLAIMS

1. A liposomal formulation for ocular drug delivery comprising:

(i) liposomes comprising at least one lipid bilayer; and

(ii) a prostaglandin drug and/or a prostaglandin derivative encapsulated in the liposomes,

wherein the liposomes have a mean diameter of less than 2 μm; and

wherein the liposomes comprise phosphatidylcholines,

wherein the liposomal formulation has a drug to lipid mole ratio of about 0.01 to about 0.50.

2. The liposomal formulation as claimed in claim 1, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.01 to about 0.37.

3. The liposomal formulation as claimed in claim 2, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.015 to about 0.37.

4. The liposomal formulation as claimed in claim 3, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.04 to about 0.37.

5. The liposomal formulation as claimed in any one of claims 1 to 4, wherein the liposomes comprise mixtures of phosphatidylcholines and at least one of sphingolipids, sterol lipids, saccharolipids, or polyketide lipids.

6. The liposomal formulation as claimed in any one of claims 1 to 5, wherein the phosphatidylcholines are selected from the group consisting of 1,2-dioleoyl-sn-glycero-3-phosphocholines (DOPC), 1,2-dioleoyl-sn-glycero-O-ethyl-3-phosphocholines, 1,2-Dilauroyl-sn-glycero-3-phosphocholines (DLPC), 1,2-Dimyristoyl-sn-glycero-3-phosphocholines (DMPC), 1,2-Dipalmitoyl-sn-glycero-3-phosphocholines(DPPC),1,2-Distearoyl-sn-glycero-3-phosphocholines (DSPC) and mixtures thereof.

7. The liposomal formulation as claimed in claim 6, wherein the phosphatidylcholines are 1,2-Dipalmitoyl-sn-glycero-3-phosphocholines (DPPC).

8. The liposomal formulation as claimed in any one of claims 1 to 7, wherein the phosphatidylcholines each comprises at least one unsaturated fatty acid moiety.

9. The liposomal formulation as claimed in claim 8, wherein the phosphatidylcholines each comprises L-α-phosphatidylcholine or 95% Egg phosphatidylcholines (eggPC 95%).

10. The liposomal formulation as claimed in any one of claims 5 to 9, wherein the sphingolipids each comprises at least one unsaturated fatty acid moiety.

11. The liposomal formulation as claimed in claim 10, wherein the sphingolipids each comprises hexadecanoylsphingomyelin or Egg Sphingomyelin.

12. The liposomal formulation as claimed in any one of the preceding claims, wherein the prostaglandin drug or the prostaglandin derivative is selected from the group consisting of latanoprost, bimatoprost, travoprost, carboprosttrometamol, gemeprost, sulprostone, dinoprostone (PGE2), alprostadil (PGE1), beroprost, iloprost, epoprostenol, treprostinil, misoprostol, enoprostil, omoprostil, limaprost. unoprostone isopropyl, arthrotec, and mixtures thereof.

13. The liposomal formulation as claimed in any one of claims 1 to 12, wherein the prostaglandin drug comprises latanoprost.

14. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposomes have a mean diameter of less than 1 μm.

15. The liposomal formulation as claimed in claim 14, wherein the liposomes

have a mean diameter of about 100 nm to about 300 nm.

16. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposomes are small unilamellar vesicles (SUV) or a large unilamellar vesicles (LUV) or multilamellar vesicles.

17. The liposomal formulation as claimed in claim 1, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.50.

18. The liposomal formulation as claimed in any one of claims 1 to 16, wherein the liposomal formulation has a drug to lipid mole ratio of about 0.18.

19. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposomal formulation has a polydisperisty index of less than or equal to 0.25.

20. The liposomal formulation as claimed in any one of the preceding claims, wherein the liposome further comprises cholesterol.

21. The liposomal formulation as claimed in claim 20, wherein the cholesterol is of an amount of about 10 % to about 40 % by weight of the liposome.

22. The liposomal formulation as claimed in any one of any one the preceding claims, wherein the liposome further comprises a linear C_8-C_{20} alkyl or alkenyl amine.

23. The liposomal formulation as claimed in claim 22, wherein the linear C_8-C_{20} alkyl or alkenyl amine is stearyl amine.

24. The liposomal formulation as claimed in claim 23, wherein the stearyl amine is of an amount of about 5 % to about 25 % by weight of the liposome.

25. The liposomal formulation as claimed in claim 24, wherein the stearyl amine is of an amount of about 10 % to about 20 % by weight of the liposome.

26. A pharmaceutical composition comprising the liposomal formulation as claimed in any one of claims 1-25.

27. The pharmaceutical composition as claimed in claim 26, wherein the pharmaceutical composition is in a form of an ophthalmic solution.

28. The pharmaceutical composition as claimed in claim 27, wherein the pharmaceutical composition is for use in ocular drug delivery in an injection solution or a viscous aqueous vehicle.

29. The pharmaceutical composition as claimed in claim 28, wherein the viscous aqueous vehicle comprises an aqueous solution of polysaccharides.

30. The pharmaceutical composition as claimed in claim 29, wherein the polysaccharide is hyaluronic acid.

31. Use of a liposomal formulation as claimed in any one of claims 1-25 or the pharmaceutical composition as claimed in any one of claims 26-30 in the treatment or prevention of an ocular disease, comprising administering the liposomal formulation or the pharmaceutical composition to a subject in need thereof.

32. The use as claimed in claim 31, wherein the ocular disease is glaucoma.

33. The use as claimed in claim 31 or 32 wherein the use comprises administering the liposomal formulation or pharmaceutical composition by subconjunctival injection to provide sustained release of the ocular drug.