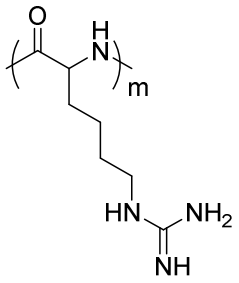
Claims

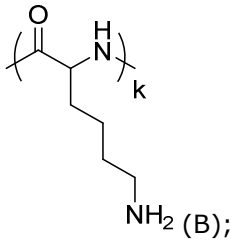
1. A functionalised polypeptide of Formula (I) or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, comprising:

a) monomeric units of Formula (A)



(A); and

b) at least one monomeric unit of Formula (B)



(B);

wherein

m is an integer from 5 to 100; and

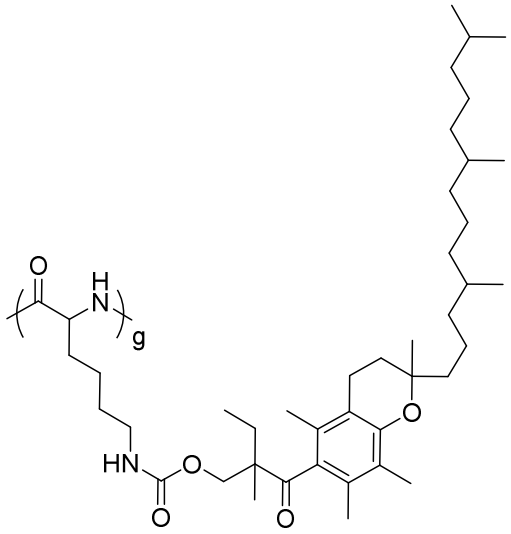
k is an integer from 1 to 20;

wherein a percentage of monomeric units of Formula (A) relative to the functionalised polypeptide of Formula (I) is 50% to 98%.

2. The functionalised polypeptide according to claim 1, wherein the monomeric units of Formula (A) and at least one monomeric unit of Formula (B) form a random co-polypeptide; and

wherein the functionalised polypeptide of Formula (I) is characterised by percentage of monomeric units of Formula (A) relative to the functionalised polypeptide of Formula (I) of 95%.

3. The functionalised polypeptide according to claim 1 or 2, wherein the functionalised polypeptide of Formula (I) further comprises at least one monomeric unit of Formula (C):



(C)

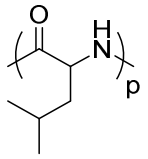
wherein g is an integer from 1 to 10.

4. The functionalised polypeptide according to claim 3, wherein the functionalised polypeptide of Formula (I) is characterised by a percentage of monomeric units of Formula (C) relative to the functionalised polypeptide of Formula (I) of 5% to 20%; and
wherein the monomeric units of Formula (C), monomeric units of Formula (A) and at least one monomeric unit of Formula (B) form a random co-polypeptide.

5. The functionalised polypeptide according to claim 3 or 4, wherein m is 18, k is 2, and g is 2, or m is 30, k is 3, and g is 2.

6. The functionalised polypeptide according to any one of claims 3 to 5, wherein when monomeric units of Formula (C) are present, the functionalised polypeptide of Formula (I) is characterised by a micelle diameter of 10 nm to 200 nm, and/or a critical micelle concentration (CMC) value of 1 µg/mL to 100 µg/mL, and/or by a zeta potential (ζ) of +1 mV to +30 mV.

7. The functionalised polypeptide according to any one of claims 1 to 6, wherein the functionalised polypeptide of Formula (I) further comprises monomeric units of Formula (D):



(D)

wherein p is an integer from 5 to 100.

8. The functionalised polypeptide according to claim 7, wherein m is 27, k is 2, and p is 12.

9. The functionalised polypeptide according to claim 7 or 8, wherein the functionalised polypeptide of Formula (I) is characterised by at least one of the following:

a) a degree of polymerisation of 5 to 100; and

b) a polydispersity index (PDI) of 1.1 to 1.7;

10. The functionalised polypeptide according to any one of claims 1 to 9, wherein the functionalised polypeptide of Formula (I) is characterised by an antimicrobial activity against Gram-positive bacteria, Gram-negative bacteria and fungi.

11. The functionalised polypeptide according to claim 10, wherein the Gram-positive bacteria is selected from S. aureus and MRSA, the Gram-negative bacteria is selected from E. coli, A. baumannii, P. aeruginosa and K. pneumonia, and the fungi is C. albican.

12. The functionalised polypeptide according to any one of claims 1 to 11, wherein the functionalised polypeptide of Formula (I) is characterised by at least one of the following:

a) an antimicrobial activity with a minimum inhibition concentration (MIC) of 1 μg/mL to 200 μg/mL;

b) a minimum bactericidal concentration or minimum fungicidal concentration (MBC or MFC)/MIC ratio (R) of 1 to 500;

c) a minimum haemolytic concentration at 50% lysis (HC_{50}) of 100 μg/mL to 8000 μg/mL, and/or by a haemolytic concentration (HC_{50}) of 4000 μg/mL to 8000 μg/mL;

d) an IC_{50} value of 1 μg/mL to 200 μg/mL against cancer cells; and

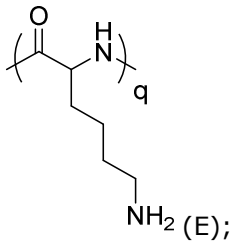
e) an IC_{50} ratio of human breast cancer cell line (MCF-7) relative to drug-resistant human breast cancer cell line (MCF-7/ADR) of 1.

13. A functionalised polypeptide nanoparticle, comprising:

a) functionalised polypeptides of Formula (I) or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof according to any one of claims 1 to 11; and

b) functionalised polypeptides of Formula (II) or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, comprising

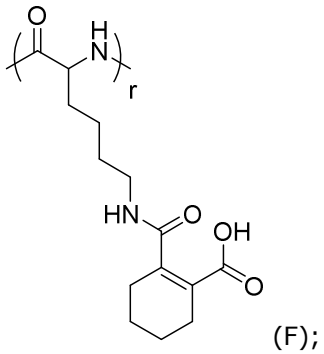
i) monomeric units of Formula (E):



(E);

wherein q is an integer from 0 to 10;

ii) monomeric units of Formula (F):



(F);

wherein r is an integer from 10 to 100; and

iii) a methoxy poly(ethylene glycol) (mPEG) terminal end;

wherein a percentage of monomeric units of Formula (F) relative to the functionalised polypeptide of Formula (II) is 50% to 98%;

wherein a mole ratio of functionalised polypeptides of Formula (I) to functionalised polypeptides of Formula (II) is 1:1 to 1:10.

14. The functionalised polypeptide nanoparticle according to claim 13, wherein q is an integer from 1 to 8, r is an integer from 15 to 50.

15. The functionalised polypeptide nanoparticle according to claim 13 or 14, wherein the monomeric units of Formula (E) and monomeric units of Formula (F) form a random co-polypeptide; and/or

wherein the functionalised polypeptide nanoparticle is dissociable at a pH of 1 to less than 7.

16. The functionalised polypeptide nanoparticle according to any one of claims 13 to 15, wherein the mPEG terminal end has a molecular weight of 2000 g/mol to 10,000 g/mol; and/or is characterised by percentage of monomeric units of Formula (F) relative to the functionalised polypeptide of Formula (II) of 80 to 90%.

17. The functionalised polypeptide nanoparticle according to any one of claims 13 to 16, wherein the functionalised polypeptide nanoparticle is characterised by at least one of the following:

a) an IC_{50} value of 1 µg/mL to 200 µg/mL against cancer cell;

b) an IC_{50} value at a pH of 6.5 of 10 µg/mL to 50 µg/mL against cancer cells;

c) an IC_{50} value at a pH of 7.4 of 25 µg/mL to 150 µg/mL against cancer cells; and

d) an IC_{50} ratio of human breast cancer cell line (MCF-7) relative to drug-resistant human breast cancer cell line (MCF-7/ADR) of 1.

18. A pharmaceutical composition comprising an effective amount of a functionalised polypeptide of formula (I) according to any one of claims 1 to 12 or a functionalised polypeptide nanoparticle according to any one of claims 13 to 17 or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein the pharmaceutical composition optionally further comprises a pharmaceutically acceptable carrier, excipient or diluent.

19. A method for treating a microbial infection and/or cancer, the method comprising administering to a subject in need thereof a therapeutically effective amount of a functionalised polypeptide of formula (I) according to any one of claims 1 to 12 or a functionalised polypeptide nanoparticle according to any one of claims 13 to 17 or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof.

20. The method according to claim 19, wherein the microbial infection is a bacterial infection or a fungal infection, and wherein the cancer is a drug resistant cancer, breast cancer or a tumorous cancer.