Claims

1. An amphiphilic peptide and/or peptoid capable of self-assembling into three-dimensional macromolecular nanofibrous networks, which entrap water and form a hydrogel, the amphiphilic peptide and/or peptoid comprising an amphiphilic sequence consisting of:

a hydrophobic non-repetitive sequence stretch of n aliphatic amino acids, wherein *n* is an integer from 2 to 15,

a hydrophilic sequence stretch linked to said hydrophobic sequence stretch and having a polar moiety containing lysine, lysine analogues, derivative of lysine or lysine substitute, said polar moiety comprising *m* adjacent hydrophilic amino acids, wherein *m* is an integer from 1 to 5, wherein an N-terminal amino acid of the amphiphilic peptide and/or peptoid is an isoleucine (I), and wherein the N-terminus is modified with a functional group selected from the group consisting of vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, thioester, aryl, ketone, sulphite, nitrite, phosphonate and silane.

2. A hydrogel comprising a concentration of an amphiphilic peptides and/or peptoids above 1 mg/ml aligned to form fibrous structures by self-assembling into three-dimensional macromolecular nanofibrous networks, which entrap water and form a hydrogel, each amphiphilic peptide and/or peptoid monomer comprising an amphiphilic sequence consisting of:

a hydrophobic non-repetitive sequence stretch of n aliphatic amino acids, wherein *n* is an integer from 2 to 15,

a hydrophilic sequence stretch linked to said hydrophobic sequence stretch and having a polar moiety containing lysine, lysine analogues, derivative of lysine or lysine substitute, said polar moiety comprising *m* adjacent hydrophilic amino acids, wherein *m* is an integer from 1 to 5, wherein an N-terminal amino acid of the amphiphilic peptide and/or peptoid is an isoleucine (I).

3. The hydrogel of claim 2, wherein the amphiphilic peptide and/or peptoid has a C-terminus and an N-terminus, wherein the N-terminus is protected by an N-terminal protecting group.

4. The amphiphilic peptide and/or peptoid or hydrogel of claim 1 or 2, wherein the amphiphilic peptide and/or peptoid has a C-terminus and an N-terminus, wherein the C-terminus is protected by a C-terminal protecting group.

5. The hydrogel of claim 3, wherein said N-terminal protecting group has the general formula –C(O)–R, wherein R is selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls.

6. The hydrogel of claim 5, wherein said N-terminal protecting group is an acetyl group.

7. The hydrogel of claim 3, wherein said N-terminal protecting group is a peptidomimetic molecule, including natural and synthetic amino acid derivatives, wherein the N-terminus of said peptidomimetic molecule may be modified with a functional group selected from the group consisting of carboxylic acid, amide, alcohol, aldehyde, amine, imine, nitrile, an urea analog, thiol, phosphate, carbonate, sulfate, nitrate, maleimide, vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, thioester, aryl, ketone, sulphite, nitrite, phosphonate and silane.

8. The amphiphilic peptide and/or peptoid or hydrogel of claim 4, wherein said C-terminal protecting group is an amide group.

9. The amphiphilic peptide and/or peptoid or hydrogel of claim 8, wherein the C-terminus of said amphiphilic peptide and/or peptoid has the formula -CONHR or -CONRR', with R and R' being selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls.

10. The amphiphilic peptide and/or peptoid or hydrogel of claim 4, wherein said C-terminal protecting group is an ester group.

11. The amphiphilic peptide and/or peptoid or hydrogel of claim 10, wherein the C-terminus of said amphiphilic peptide and/or peptoid has the formula $-CO_2R$, with R being selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls.

12. The amphiphilic peptide and/or peptoid or hydrogel of claim 4, wherein said C-terminal protecting group is a peptidomimetic molecule, including natural and synthetic amino acid derivatives, wherein the C-terminus of said peptidomimetic molecule may be modified with a functional group selected from the group consisting of carboxylic acid, amide, alcohol, aldehyde, amine, imine, nitrile, an urea analog, thiol, phosphate, carbonate, sulfate, nitrate, maleimide, vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, thioester, aryl, ketone, sulphite, nitrite, phosphonate and silane.

13. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein n is an integer from 2 to 6, preferably 2 to 5.

14. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein m is an integer from 1 to 2.

15. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein the amphiphilic peptide and/or peptoid consists of o amphiphilic sequences, as defined in any one of the foregoing claims, which amphiphilic sequences are linked to each other, o being an integer from 1 to 3.

16. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein, for a given amphiphilic peptide and/or peptoid, said aliphatic amino acids and said hydrophilic amino acids are either D-amino acids or L-amino acids.

17. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein each of the hydrophilic amino acids has a polar group which is independently selected from a hydroxyl, an ether, a carboxyl, an imido, an amido, an ester, an amino, a guanidino, a thio, a thioether, a seleno, and a telluro group.

18. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein said polar moiety of said hydrophilic sequence stretch comprises m adjacent hydrophilic amino acids, m being defined as in any one of claims 1 to 13, said hydrophilic amino acids being selected from the group comprising aspartic acid, asparagine, glutamic acid, glutamine, 5-N-ethyl-glutamine (theanine), citrulline, thio-citrulline, cysteine, homocysteine, ethionine, seleno-methionine, telluromethionine, threonine, allo-threonine, serine, homoserine, arginine, homoarginine, ornithine (Orn), 2,4-diaminobutyric acid (Dab), 2,3-diaminopropionic acid (Dap), lysine and N(6)-carboxy-methyllysine, histidine, and wherein said hydrophobic sequence stretch comprises n aliphatic amino acids, n being as defined in any one of claims 1 to 12, said aliphatic amino acids being selected from the group comprising isoleucine, norleucine, leucine, valine, alanine, glycine, homoallylglycine and homopropargylglycine.

19. The amphiphilic peptide and/or peptoid or hydrogel of claim 18, wherein m is 1 or 2.

20. The amphiphilic peptide and/or peptoid or hydrogel of claim 19, wherein m is 2 and wherein said polar moiety comprises two identical amino acids, or wherein m is 1 and wherein said polar moiety comprises any one of lysine, ornithine (Orn), 2,4-diaminobutyric acid (Dab), and 2,3-diaminopropionic acid (Dap).

21. The amphiphilic peptide and/or peptoid or hydrogel of claim 20, wherein said polar moiety is adjacent to the hydrophobic sequence stretch of n aliphatic amino acids.

22. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 19 to 21, wherein said polar moiety has a sequence selected from Lys, Orn, Dab, Dap, Cys-Lys, Cys-Orn, Cys-Dab, Cys-Dap, Lys-Lys, Lys-Ser, Lys-Thr, Lys-Orn, Lys-Dab, Lys-Dap, Ser-Lys, Ser-Orn, Ser-Dab, Ser-Dap, Orn-Lys, Orn-Orn, Orn-Ser, Orn-Thr, Orn-Dab, Orn-Dap, Dab-Lys, Dab-Ser, Dab-Thr, Dab-Orn, Dab-Dab, Dab-Dap, Dap-Lys, Dap-Ser, Dap-Thr, Dap-Orn, Dap-Dab, Dap-Dap.

23. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 22, wherein said polar moiety consists of at least one amino acid positioned at the C-terminus of the amphiphilic peptide and/or peptoid.

24. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 23, wherein said hydrophobic sequence stretch comprises and/or forms the N-terminus of the amphiphilic peptide and/or peptoid.

25. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 24, wherein all or a portion of the aliphatic amino acids of the hydrophobic sequence stretch are arranged in an order of decreasing amino acid size in the direction from N- to C-terminus of the amphiphilic peptide and/or peptoid, wherein the size of the aliphatic amino acids is defined as I = L > V > A > G.

26. The amphiphilic peptide and/or peptoid or hydrogel of claim 25, wherein said aliphatic amino acids arranged in order of decreasing amino acid size have a sequence with a length of 2 to 7, preferably 2 to 6, more preferably 2 to 5 amino acids.

27. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 25 or 26, wherein said aliphatic amino acids arranged in an order of decreasing amino acid size have a sequence selected from ILVAG, IVAG, IVA and IV.

28. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 27, wherein the amphiphilic sequence undergoes a conformational change during self-assembly, preferably a conformational change from a random coil conformation to a helical intermediate structure to a final beta conformation.

29. The amphiphilic peptide and/or peptoid or hydrogel of claim 28, wherein the conformational change is dependent on the concentration of the amphiphilic peptide and/or peptoid, dependent on the ionic environment, pH dependent and/or temperature dependent.

30. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 30, wherein the amphiphilic linear sequence comprises a single hydrophilic and at least two aliphatic amino acids.

31. The hydrogel of any one of claims 2-30, wherein the amphiphilic sequence is one of SEQ ID NO: 49 to 56 and SEQ ID NO: 71-78.

32. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 31, being stable in aqueous solution at physiological conditions at ambient temperature for a period of time in the range from 1 day to at least 6 months, preferably to at least 8 months more preferably to at least 12 months.

33. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 32, being stable in aqueous solution at physiological conditions, at a temperature up to 90 °C, for at least 1 hour.

34. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims having the general formula:

$$Z_p\text{-}(X)_n\text{-}(Y)_m\text{-}Z'_q,$$

wherein

Z is an N-terminal protecting group,

X is, at each occurrence, independently selected from an aliphatic amino acid,

Y is, at each occurrence, independently selected from a hydrophilic amino acid,

Z' is a C-terminal protecting group,

n is an integer selected from 2 to 6, preferably 2 to 5 wherein each aliphatic amino acid is not repeated,

m is selected from 1 and 2, wherein, preferably, m is 1,

and p and q are independently selected from 0 and 1, wherein, preferably, p is 1, wherein an N-terminal amino acid of the amphiphilic peptide and/or peptoid is an isoleucine (I) and wherein at least one hydrophilic amino acid contains lysine, lysine analogues, derivative of lysine or lysine substitute.

35. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein the C-terminal amino acid of the amphiphilic peptide and/or peptoid is selected from the group consisting of a lysine (K), an ornithine (Orn), a 2,4-diaminobutyric acid (Dab) and a 2,4-diaminopropionic acid (Dap).

36. The hydrogel of claim 35, wherein the amphiphilic peptide and/or peptoid has a sequence selected from the group comprising ILVAGK (SEQ ID NO: 49 or 50), ILVAG(Orn) (SEQ ID NO: 51 or 52), ILVAG(Dab) (SEQ ID NO: 53 or 54), ILVAG(Dap) (SEQ ID NO: 55 or 56), IVK (SEQ ID NO: 71 or 72), IV(Orn) (SEQ ID NO: 73 or 74), IV(Dab) (SEQ ID NO: 75 or 76), IV(Dap) (SEQ ID NO: 77 or 78),.

37. The amphiphilic peptide and/or peptoid or hydrogel of claims 35 or the hydrogel of claim 37, wherein the amphiphilic peptide and/or peptoid has an amidated C-terminus.

38. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 35 to 37, wherein the amphiphilic peptide and/or peptoid has an acetylated N-terminus.

39. The hydrogel of any one of claims 2 to 38, wherein the hydrogel is characterized by a storage modulus G' to loss modulus G'' ratio that is greater than 2.

40. The hydrogel of any one of claims 2 to 39, wherein the hydrogel is characterized by a storage modulus G' from 100 Pa to 80,000 Pa at a frequency in the range of from 0.02 Hz to 16 Hz.

41. The hydrogel of any one of claims 2 to 40, wherein the hydrogel has a higher mechanical strength than collagen or its hydrolyzed form (gelatine).

42. The hydrogel of any one of claims 2 to 41, comprising fibers of the at least one amphiphilic peptide and/or peptoid, said fibers defining a network that is capable of entrapping at

least one of a microorganism, a cell, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a nano- or microparticle, a synthetic polymer, a small organic molecule, a cosmetic agent or a pharmaceutically active compound.

43. The hydrogel of claim 42, wherein the hydrogel comprises at least one of a microorganism, a cell, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a nano- or microparticle, a synthetic polymer, a small organic molecule, a cosmetic agent or a pharmaceutically active compound entrapped by the network of fibers of the amphiphilic peptide and/or peptoid.

44. The hydrogel of claim 43, wherein the fibers of the amphiphilic peptide and/or peptoid are coupled to the at least one of a microorganism, a cell, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a nano- or microparticle, a synthetic polymer, a small organic molecule, a cosmetic agent or a pharmaceutically active compound.

45. The hydrogel of any one of claims 42 to 44, wherein said pharmaceutically active compound is selected from the group comprising haemostatic agents, antibiotics, anti-microbial agents, anti-fungal agents, anti-inflammatory agents, analgesics, anti-coagulants, antibodies, antigens, growth factors and cytokines.

46. The hydrogel of any one of claims 2 to 45, wherein said hydrogel is provided in an injectable form and gels.

47. The hydrogel of any one of claims 2 to 46, wherein the hydrogel is comprised in at least one of a fuel cell, a solar cell, an electronic cell, a biosensing device, a medical device, an implant, a wound dressing, a pharmaceutical composition and a cosmetic composition.

48. The hydrogel of claim 47, wherein the pharmaceutical composition or the cosmetic composition are provided in the form of a topical gel or cream, a spray, a powder, or a sheet, patch or membrane.

49. The hydrogel of claim 47, wherein the pharmaceutical composition or the cosmetic composition is provided in the form of an injectable solution.

50. The hydrogel of any one of claims 2 to 46 for use in at least one of the following: release of a pharmaceutically active compound, medical tool kit, a fuel cell, a solar cell, an electronic cell, tissue regeneration, tissue replacement, wound healing, skin care, stem cell therapy and gene therapy.

51. A method of preparing a hydrogel, the method comprising dissolving a concentration of an amphiphilic peptide and/or peptoid monomers above 1 mg/ml wherein the amphiphilic peptide and/or peptoid of any one of claims 1 to 39 is dissolved in an aqueous solution.

52. The method of claim 51, wherein the dissolved concentration of amphiphilic peptide and/or peptoid in aqueous solution is further exposed to temperature, wherein the temperature is in the range from 20 °C to 90 °C, preferably from 20 °C to 70 °C.

53. The method of claim 52, wherein the dissolved concentration of amphiphilic peptide and/or peptoid in aqueous solution is exposed to a temperature in the range from 35 °C to 40 °C.

54. The method of any one of claims 51 to 53, wherein the at least one amphiphilic peptide and/or peptoid is dissolved at a concentration from 1 mg/ml to 50 mg/ml, preferably at a concentration from about 1 mg/ml to about 20 mg/ml.

55. The method of any one of claims 51 to 54, further comprising at least one of the steps of:
- adding at least one bioactive agent;
- adding at least one gelation enhancer;
- adding at least one buffer, preferably at least one physiologically acceptable buffer.

56. The method of claim 55, wherein said gelation enhancer is a salt or a solution of a salt.

57. The method of claim 55, wherein said gelation enhancer is a cross-linking agent.

58. A surgical implant or stent, comprising a peptide and/or peptoid scaffold, wherein the peptide and/or peptoid scaffold is formed by a hydrogel of any one of claims 2 to 45.

59. A pharmaceutical and/or cosmetic composition and/or a biomedical device and/or electronic device comprising at least one amphiphilic peptide and/or peptoid of claim 1 , or a hydrogel of any one of claims 2 to 45.

60. The pharmaceutical and/or cosmetic composition and/or the biomedical device, and/or the electronic devices of claim 59, further comprising a pharmaceutically active compound.

61. The pharmaceutical and/or cosmetic composition of claims 59 or 60, further comprising a pharmaceutically acceptable carrier.

62. The pharmaceutical and/or cosmetic composition of any one of claims 59 to 61, which is injectable.

63. A kit of parts, the kit comprising a first container with at least one amphiphilic peptide and/or peptoid of any one of claims 1, 8-35 or 38 and a second container with an aqueous solution.

64. The kit of parts of claim 63, wherein the aqueous solution of the second container further comprises a pharmaceutically active compound.

65. The kit of parts of claims 63 or 64, wherein the first container with at least one amphiphilic peptide and/or peptoid further comprises a pharmaceutically active compound.

66. The kit of parts of any one of claims 63 to 65, further comprising a third container with a gelation enhancer.

67. The kit of parts of claim 66, wherein said gelation enhancer is a salt or a solution of a salt.

68. The kit of parts of any one of claims 63 to 67, wherein at least one of said first, second or third container is provided as a spray bottle or a syringe.

69. A kit of parts, the kit comprising a first container with an aqueous solution of at least one amphiphilic peptide and/or peptoid of any one of claims 1, 8-35 or 38 , and a second container with a gelation enhancer.

70. The kit of parts of claim 69, wherein the first container further comprises a pharmaceutically active compound.

71. The kit of parts of claim 69 or 70, wherein said gelation enhancer is a salt or a solution of a salt.

72. The kit of parts of any one of claims 69 to 71, wherein at least one of said first and said second container is provided as a spray bottle or a syringe.

73. A method of tissue regeneration which is performed *in vitro* or *ex vivo* comprising the steps:

a) providing a hydrogel as defined in any one of claims 2 to 45;
b) exposing said hydrogel to cells which are to form regenerated tissue;
c) allowing said cells to grow on or in said hydrogel.

74. The method of claim 73, wherein said tissue is selected from the group comprising skin tissue, nucleus pulposus in the intervertebral disc, cartilage tissue, synovial fluid and submucosal connective tissue in the bladder neck.

75. The method of claim 73, which is performed *ex vivo*, wherein, in step a) or b), cells from a patient or from a donor are mixed with said hydrogel.

76. The method of any one of claims 73 to 75, wherein said hydrogel comprises one or more bioactive therapeutics that stimulate regenerative processes and/or modulate the immune response.

77. Use of a a hydrogel of any one of claims 2 to 45in the manufacture of a hydrogel for the treatment of wounds.

78. The use of claim 77, wherein said wound is a burn wound.

79. The use of claim 77 or 78, wherein said hydrogel induces autolytic debridement.

80. The use of claim 77, wherein said hydrogel functions as a haemostatic agent.

81. The use of any one of claims 77 to 80, wherein said hydrogel functions as an anti-inflammatory agent, which acts by scavenging extracellular nucleic acids that stimulate the innate immune system.

82. The use of any one of claims 77 to 81, wherein, said hydrogel is mixed with cells.

83. The use of any one of claims 77 to 82, wherein said hydrogel comprises one or more bioactive therapeutics that diffuse into the wound and facilitate the healing response by modulating the inflammatory response and/or stimulating regenerative processes.

Claims

1. An amphiphilic peptide and/or peptoid capable of self-assembling into three-dimensional macromolecular nanofibrous networks, which entrap water and form a hydrogel, the amphiphilic peptide and/or peptoid comprising an amphiphilic sequence consisting of:

a hydrophobic non-repetitive sequence stretch of n aliphatic amino acids, wherein *n* is an integer from 2 to 15,

a hydrophilic sequence stretch linked to said hydrophobic sequence stretch and having a polar moiety containing lysine, lysine analogues, derivative of lysine or lysine substitute, said polar moiety comprising *m* adjacent hydrophilic amino acids, wherein *m* is an integer from 1 to 5, ~~and~~ wherein an N-terminal amino acid of the amphiphilic peptide and/or peptoid is an isoleucine (I), and wherein the N-terminus is modified with a functional group selected from the group consisting of vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, thioester, aryl, ketone, sulphite, nitrite, phosphonate and silane.

2. A hydrogel comprising a concentration of an amphiphilic peptides and/or peptoids above 1 mg/ml aligned to form fibrous structures by self-assembling into three-dimensional macromolecular nanofibrous networks, which entrap water and form a hydrogel, each amphiphilic peptide and/or peptoid monomer comprising an amphiphilic sequence consisting of:

a hydrophobic non-repetitive sequence stretch of n aliphatic amino acids, wherein *n* is an integer from 2 to 15,

a hydrophilic sequence stretch linked to said hydrophobic sequence stretch and having a polar moiety containing lysine, lysine analogues, derivative of lysine or lysine substitute, said polar moiety comprising *m* adjacent hydrophilic amino acids, wherein *m* is an integer from 1 to 5, wherein an N-terminal amino acid of the amphiphilic peptide and/or peptoid is an isoleucine (I).

3. The hydrogel ~~amphiphilic peptide and/or peptoid~~ of claim ~~1~~2, wherein the amphiphilic peptide and/or peptoid has a C-terminus and an N-terminus, wherein the N-terminus is protected by an N-terminal protecting group.

~~3~~4. The amphiphilic peptide and/or peptoid or hydrogel of claim 1 or 2, wherein the amphiphilic peptide and/or peptoid has a C-terminus and an N-terminus, wherein the C-terminus is protected by a C-terminal protecting group.

~~4~~5. The hydrogel ~~amphiphilic peptide and/or peptoid~~ of claim ~~2~~3, wherein said N-terminal protecting group has the general formula –C(O)–R, wherein R is selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls.

~~5~~6. The hydrogel ~~amphiphilic peptide and/or peptoid~~ of claim ~~4~~5, wherein said N-terminal protecting group is an acetyl group.

~~6~~7. The hydrogel ~~amphiphilic peptide and/or peptoid~~ of claim ~~2~~3, wherein said N-terminal protecting group is a peptidomimetic molecule, including natural and synthetic amino acid derivatives, wherein the N-terminus of said peptidomimetic molecule may be modified with a functional group selected from the group consisting of carboxylic acid, amide, alcohol, aldehyde, amine, imine, nitrile, an urea analog, thiol, phosphate, carbonate, sulfate, nitrate, maleimide, vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, thioester, aryl, ketone, sulphite, nitrite, phosphonate and silane.

~~7~~8. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~3~~4, wherein said C-terminal protecting group is an amide group.

~~8~~9. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~7~~8, wherein the C-terminus of said amphiphilic peptide and/or peptoid has the formula -CONIIR or -CONRR', with R and R' being selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls.

~~9~~10. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~3~~4, wherein said C-terminal protecting group is an ester group.

~~10~~11. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~9~~10, wherein the C-terminus of said amphiphilic peptide and/or peptoid has the formula $-CO_2R$, with R being selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls.

~~11~~12. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~3~~4, wherein said C-terminal protecting group is a peptidomimetic molecule, including natural and synthetic amino acid derivatives, wherein the C-terminus of said peptidomimetic molecule may be modified with a functional group selected from the group consisting of carboxylic acid, amide, alcohol, aldehyde, amine, imine, nitrile, an urea analog, thiol, phosphate, carbonate, sulfate, nitrate, maleimide, vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, thioester, aryl, ketone, sulphite, nitrite, phosphonate and silane.

~~12~~13. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein n is an integer from 2 to 6, preferably 2 to 5.

~~13~~14. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein m is an integer from 1 to 2.

~~14~~15. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein the amphiphilic peptide and/or peptoid consists of o amphiphilic sequences, as defined in any one of the foregoing claims, which amphiphilic sequences are linked to each other, o being an integer from 1 to ~~about~~ 3.

~~15~~16. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein, for a given amphiphilic peptide and/or peptoid, said aliphatic amino acids and said hydrophilic amino acids are either D-amino acids or L-amino acids.

~~16~~17. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein each of the hydrophilic amino acids has a polar group which is independently selected

from a hydroxyl, an ether, a carboxyl, an imido, an amido, an ester, an amino, a guanidino, a thio, a thioether, a seleno, and a telluro group.

~~17~~18. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein said polar moiety of said hydrophilic sequence stretch comprises m adjacent hydrophilic amino acids, m being defined as in any one of claims 1 to 13, said hydrophilic amino acids being selected from the group comprising aspartic acid, asparagine, glutamic acid, glutamine, 5-N-ethyl-glutamine (theanine), citrulline, thio-citrulline, cysteine, homocysteine, ~~methionine,~~ ethionine, selenomethionine, telluromethionine, threonine, allo-threonine, serine, homoserine, arginine, homoarginine, ornithine (Orn), 2,4-diaminobutyric acid (Dab), 2,3-diaminopropionic acid (Dap), lysine and N(6)-carboxy-methyllysine, histidine, and wherein said hydrophobic sequence stretch comprises n aliphatic amino acids, n being as defined in any one of claims 1 to 12, said aliphatic amino acids being selected from the group comprising isoleucine, norleucine, leucine, valine, alanine, glycine, homoallylglycine and homopropargylglycine.

~~18~~19. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~17~~18, wherein m is 1 or 2.

~~19~~20. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~18~~19, wherein m is 2 and wherein said polar moiety comprises two identical amino acids, or wherein m is 1 and wherein said polar moiety comprises any one of lysine, ornithine (Orn), 2,4-diaminobutyric acid (Dab), and 2,3-diaminopropionic acid (Dap).

~~20~~21. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~19~~20, wherein said polar moiety is adjacent to the hydrophobic sequence stretch of n aliphatic amino acids.

~~21~~22. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims ~~18~~19 to ~~20~~21, wherein said polar moiety has a sequence selected from Lys, Orn, Dab, Dap, Cys-Lys, Cys-Orn, Cys-Dab, Cys-Dap, Lys-Lys, Lys-Ser, Lys-Thr, Lys-Orn, Lys-Dab, Lys-Dap, Ser-Lys, Ser-Orn, Ser-Dab, Ser-Dap, Orn-Lys, Orn-Orn, Orn-Ser, Orn-Thr, Orn-Dab, Orn-Dap, Dab-Lys, Dab-Ser, Dab-Thr, Dab-Orn, Dab-Dab, Dab-Dap, Dap-Lys, Dap-Ser, Dap-Thr, Dap-Orn, Dap-Dab, Dap-Dap.

~~22. The amphiphilic peptide and/or peptoid of any one of the foregoing claims, wherein said polar moiety comprises the C-terminus of the amphiphilic peptide and/or peptoid, or wherein said polar moiety comprises the N-terminus of the amphiphilic peptide and/or peptoid.~~

~~23. The amphiphilic peptide and/or peptoid of claim 22, wherein said polar moiety comprises the C-terminus of the amphiphilic peptide and/or peptoid.~~

~~24~~23. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to ~~23~~22, wherein said polar moiety consists of at least one amino acid positioned at the C-terminus of the amphiphilic peptide and/or peptoid.

~~25~~24. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to ~~24~~23, wherein said hydrophobic sequence stretch comprises and/or forms the N-terminus of the amphiphilic peptide and/or peptoid.

~~26~~25. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to ~~25~~24, wherein all or a portion of the aliphatic amino acids of the hydrophobic sequence stretch are arranged in an order of decreasing amino acid size in the direction from N- to C-terminus of the amphiphilic peptide and/or peptoid, wherein the size of the aliphatic amino acids is defined as I = L > V > A > G.

~~27~~26. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~26~~25, wherein said aliphatic amino acids arranged in order of decreasing amino acid size have a sequence with a length of 2 to 7, preferably 2 to 6, more preferably 2 to 5 amino acids.

~~28~~27. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims ~~26~~25 or ~~27~~26, wherein said aliphatic amino acids arranged in an order of decreasing amino acid size have a sequence selected from ILVAG, IVAG, IVA and IV.

~~29~~28. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to ~~28~~27, wherein the amphiphilic sequence undergoes a conformational change during self-assembly, preferably a conformational change from a random coil conformation to a helical intermediate structure to a final beta conformation.

~~30~~29. The amphiphilic peptide and/or peptoid or hydrogel of claim ~~29~~28, wherein the conformational change is dependent on the concentration of the amphiphilic peptide and/or peptoid, dependent on the ionic environment, pH dependent and/or temperature dependent.

~~31~~30. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to 30, wherein the amphiphilic linear sequence comprises a single hydrophilic and at least two aliphatic amino acids.

~~32~~31. The ~~amphiphilic peptide and/or peptoid~~ hydrogel of any one of ~~the foregoing~~ claims 2-30, wherein the amphiphilic sequence is one of SEQ ID NO: 49 to 56 and SEQ ID NO: 71-78.

~~33~~2. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to ~~32~~31, being stable in aqueous solution at physiological conditions at ambient temperature for a period of time in the range from 1 day to at least 6 months, preferably to at least 8 months more preferably to at least 12 months.

~~34~~33. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims 1 to ~~33~~32, being stable in aqueous solution at physiological conditions, at a temperature up to 90 °C, for at least 1 hour.

~~35~~34. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims having the general formula:

$$Z_p\text{-}(X)_n\text{-}(Y)_m\text{-}Z'_q,$$

wherein

Z is an N-terminal protecting group,

X is, at each occurrence, independently selected from an aliphatic amino acid,

Y is, at each occurrence, independently selected from a hydrophilic amino acid,

Z' is a C-terminal protecting group,

n is an integer selected from 2 to 6, preferably 2 to 5 wherein each aliphatic amino acid is not repeated,

m is selected from 1 and 2, wherein, preferably, m is 1,

and p and q are independently selected from 0 and 1, wherein, preferably, p is 1, wherein an N-terminal amino acid of the amphiphilic peptide and/or peptoid is an isoleucine (I) and wherein at least one hydrophilic amino acid contains lysine, lysine analogues, derivative of lysine or lysine substitute.

~~36~~35. The amphiphilic peptide and/or peptoid or hydrogel of any one of the foregoing claims, wherein the C-terminal amino acid of the amphiphilic peptide and/or peptoid is selected from the group consisting of a lysine (K), an ornithine (Orn), a 2,4-diaminobutyric acid (Dab) and a 2,4-diaminopropionic acid (Dap).

~~37~~36. The hydrogel ~~amphiphilic peptide and/or peptoid~~ of claim 3~~6~~5, wherein the amphiphilic peptide and/or peptoid has a sequence selected from the group comprising ILVAGK (SEQ ID NO: 49 or 50), ILVAG(Orn) (SEQ ID NO: 51 or 52), ILVAG(Dab) (SEQ ID NO: 53 or 54), ILVAG(Dap) (SEQ ID NO: 55 or 56), IVK (SEQ ID NO: 71 or 72), IV(Orn) (SEQ ID NO: 73 or 74), IV(Dab) (SEQ ID NO: 75 or 76), IV(Dap) (SEQ ID NO: 77 or 78),.

~~38~~37. The amphiphilic peptide and/or peptoid or hydrogel of ~~any one of~~ claims ~~36~~35 or the hydrogel of claim~~and~~ 37, wherein the amphiphilic peptide and/or peptoid has an amidated C-terminus.

~~39~~38. The amphiphilic peptide and/or peptoid or hydrogel of any one of claims ~~36~~35 to ~~38~~37, wherein the amphiphilic peptide and/or peptoid has an acetylated N-terminus.

~~40. A hydrogel comprising a concentration of amphiphilic peptide and/or peptoid of any one of claims 1 to 39 above 1 mg/ml, preferably a concentration of amphiphilic peptide and/or peptoid of any one of claims 35 to 39 above 1 mg/ml.~~

~~41. The hydrogel of claim 40, wherein the hydrogel is stable in aqueous solution at ambient temperature for a period of at least 7 days, preferably at least 2 to 4 weeks, more preferably at least 1 to 6 months.~~

42~~39~~. The hydrogel of any one of claims ~~40 or 41~~2 to 38, wherein the hydrogel is characterized by a storage modulus G' to loss modulus G'' ratio that is greater than 2.

43~~40~~. The hydrogel of any one of claims ~~40 to 42~~2 to 39, wherein the hydrogel is characterized by a storage modulus G' from 100 Pa to 80,000 Pa at a frequency in the range of from 0.02 Hz to 16 Hz.

44~~41~~. The hydrogel of any one of claims ~~40 to 43~~2 to 40, wherein the hydrogel has a higher mechanical strength than collagen or its hydrolyzed form (gelatine).

~~45. The hydrogel of any one of claims 40 to 44, further comprising a non-peptidic polymer.~~

46~~42~~. The hydrogel of any one of claims ~~40~~ 2 to 45~~41~~, comprising fibers of the at least one amphiphilic peptide and/or peptoid ~~of any one of claims 1 to 39~~, said fibers defining a network that is capable of entrapping at least one of a microorganism, a cell, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a nano- or microparticle, a synthetic polymer, a small organic molecule, a cosmetic agent or a pharmaceutically active compound.

47~~43~~. The hydrogel of claim 46~~42~~, wherein the hydrogel comprises at least one of a microorganism, a cell, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a nano- or microparticle, a synthetic polymer, a small organic molecule, a cosmetic agent or a pharmaceutically active compound entrapped by the network of fibers of the amphiphilic peptide and/or peptoid.

48~~44~~. The hydrogel of claim 47~~43~~, wherein the fibers of the amphiphilic peptide and/or peptoid are coupled to the at least one of a microorganism, a cell, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a

nano- or microparticle, a synthetic polymer, a small organic molecule, a cosmetic agent or a pharmaceutically active compound.

~~49. The hydrogel of claim47, wherein the at least one of a microorganism, a cell, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a nano- or microparticle, a synthetic polymer, a small organic molecule, a cosmetic agent or a pharmaceutically active compound is coupled to said non-peptidic polymer.~~

~~50~~45. The hydrogel of any one of claims ~~46~~ 42 to ~~49~~44, wherein said pharmaceutically active compound is selected from the group comprising haemostatic agents, antibiotics, anti-microbial agents, anti-fungal agents, anti-inflammatory agents, analgesics, anti-coagulants, antibodies, antigens, growth factors and cytokines.

~~51~~46. The hydrogel of any one of claims ~~40~~ 2 to ~~50~~45, wherein said hydrogel is provided in an injectable form and gels.

~~52~~47. The hydrogel of any one of claims ~~40~~ 2 to ~~51~~46, wherein the hydrogel is comprised in at least one of a fuel cell, a solar cell, an electronic cell, a biosensing device, a medical device, an implant, a wound dressing, a pharmaceutical composition and a cosmetic composition.

~~53~~48. The hydrogel of claim ~~52~~47, wherein the pharmaceutical composition or the cosmetic composition are provided in the form of a topical gel or cream, a spray, a powder, or a sheet, patch or membrane.

~~54~~49. The hydrogel of claim ~~52~~47, wherein the pharmaceutical composition or the cosmetic composition is provided in the form of an injectable solution.

~~55~~50. The hydrogel of any one of claims ~~40~~ 2 to ~~51~~ 46 for use in at least one of the following: release of a pharmaceutically active compound, medical tool kit, a fuel cell, a solar cell, an electronic cell, tissue regeneration, tissue replacement, wound healing, skin care, stem cell therapy and gene therapy.

~~56~~51. A method of preparing a hydrogel, the method comprising dissolving a concentration of an amphiphilic peptide and/or peptoid monomers above 1 mg/ml~~at least one amphiphilic peptide and/or peptoid~~ wherein the amphiphilic peptide and/or peptoid of any one of claims 1 to 39 is dissolved in an aqueous solution.

~~57~~52. The method of claim ~~56~~51, wherein the dissolved concentration of ~~at least one~~ amphiphilic peptide and/or peptoid in aqueous solution is further exposed to temperature, wherein the temperature is in the range from 20 °C to 90 °C, preferably from 20 °C to 70 °C.

~~58~~53. The method of claim ~~57~~2, wherein the dissolved concentration of ~~at least one~~ amphiphilic peptide and/or peptoid in aqueous solution is exposed to a temperature in the range from 35 °C to 40 °C.

~~59~~54. The method of any one of claims ~~56~~-51 to ~~58~~53, wherein the at least one amphiphilic peptide and/or peptoid is dissolved at a concentration from 1 mg/ml to 50 mg/ml, preferably at a concentration from about 1 mg/ml to about 20 mg/ml.

~~60~~55. The method of any one of claims ~~56~~-51 to ~~59~~54, further comprising at least one of the steps of:

- adding at least one bioactive agent;
- ~~adding at least one non-peptidic polymer;~~
- adding at least one gelation enhancer;
- adding at least one buffer, preferably at least one physiologically acceptable buffer.

~~61~~56. The method of claim ~~60~~55, wherein said gelation enhancer is a salt or a solution of a salt.

~~62~~57. The method of claim ~~60~~55, wherein said gelation enhancer is a cross-linking agent.

~~63. The method of claim 60, wherein said adding at least one non-peptidic polymer further comprises mixing or cross-linking the at least one non-peptidic polymer with the at least one amphiphilic peptide and/or peptoid.~~

~~64~~58. A surgical implant or stent, comprising a peptide and/or peptoid scaffold, wherein the peptide and/or peptoid scaffold is formed by a hydrogel of any one of claims ~~40~~ 2 to ~~51~~45.

~~65~~59. A pharmaceutical and/or cosmetic composition and/or a biomedical device and/or electronic device comprising at least one amphiphilic peptide and/or peptoid of ~~any one of~~ claims 1 ~~to 39, preferably at least one amphiphilic peptide and/or peptoid of any one of claims 34 to 39~~, or a hydrogel of any one of claims ~~40~~ 2 to ~~51~~45.

~~66~~60. The pharmaceutical and/or cosmetic composition and/or the biomedical device, and/or the electronic devices of claim ~~65~~59, further comprising a pharmaceutically active compound.

~~67~~61. The pharmaceutical and/or cosmetic composition of claims ~~65~~ 59 or ~~66~~60, further comprising a pharmaceutically acceptable carrier.

~~68~~62. The pharmaceutical and/or cosmetic composition of any one of claims ~~65~~ 59 to ~~67~~61, which is injectable.

~~69~~63. A kit of parts, the kit comprising a first container with at least one amphiphilic peptide and/or peptoid of any one of claims 1, 8-35 or 38 ~~to 39, preferably of at least one amphiphilic peptide and/or peptoid of any one of claims 35 to 39,~~ and a second container with an aqueous solution.

~~70~~64. The kit of parts of claim ~~69~~63, wherein the aqueous solution of the second container further comprises a pharmaceutically active compound.

~~71~~65. The kit of parts of claims ~~69~~ 63 or ~~70~~64, wherein the first container with at least one amphiphilic peptide and/or peptoid further comprises a pharmaceutically active compound.

~~72~~66. The kit of parts of any one of claims ~~69~~ 63 to ~~71~~65, further comprising a third container with a gelation enhancer.

~~73~~67. The kit of parts of claim ~~72~~66, wherein said gelation enhancer is a salt or a solution of a salt.

~~74~~68. The kit of parts of any one of claims ~~69~~-63 to ~~73~~67, wherein at least one of said first, second or third container is provided as a spray bottle or a syringe.

~~75~~69. A kit of parts, the kit comprising a first container with an aqueous solution of at least one amphiphilic peptide and/or peptoid of any one of claims 1, 8-35 or 38 ~~to 39, preferably of at least one amphiphilic peptide and/or peptoid of any one of claims 35 to 39~~, and a second container with a gelation enhancer.

~~76~~70. The kit of parts of claim ~~75~~69, wherein the first container further comprises a pharmaceutically active compound.

~~77~~71. The kit of parts of claim ~~75~~-69 or ~~76~~70, wherein said gelation enhancer is a salt or a solution of a salt.

~~78~~72. The kit of parts of any one of claims ~~75~~-69 to ~~77~~71, wherein at least one of said first and said second container is provided as a spray bottle or a syringe.

~~79~~73. A method of tissue regeneration which is performed *in vitro* or *ex vivo* comprising the steps:

a) providing a hydrogel as defined in any one of claims ~~40~~-2 to ~~51~~45;
b) exposing said hydrogel to cells which are to form regenerated tissue;
c) allowing said cells to grow on or in said hydrogel.

~~80~~74. The method of claim ~~79~~73, wherein said tissue is selected from the group comprising skin tissue, nucleus pulposus in the intervertebral disc, cartilage tissue, synovial fluid and submucosal connective tissue in the bladder neck.

~~81~~75. The method of claim ~~79~~73, which is performed *ex vivo*, wherein, in step a) or b), cells from a patient or from a donor are mixed with said hydrogel.

~~82~~76. The method of any one of claims ~~79~~ 73 to ~~81~~75, wherein said hydrogel comprises one or more bioactive therapeutics that stimulate regenerative processes and/or modulate the immune response.

~~83~~77. Use of a ~~concentration above 1 mg/ml of amphiphilic peptide and/or peptoid capable of self-assembling into three-dimensional macromolecular nanofibrous networks, which entrap water and form~~ a hydrogel of any one of claims 2 to 45~~, the amphiphilic peptide and/or peptoid comprising an amphiphilic sequence consisting of:~~

~~a hydrophobic sequence stretch of n aliphatic amino acids, wherein *n* is an integer from 2 to 15,~~

~~a hydrophilic sequence stretch linked to said hydrophobic sequence stretch and having a polar moiety containing lysine, lysine analogues, derivative of lysine or lysine substitute, said polar moiety comprising *m* adjacent hydrophilic amino acids, wherein *m* is an integer from 1 to 5~~ in the manufacture of a hydrogel for the treatment of wounds.

784. The use of claim ~~83~~77, wherein said wound is a burn wound.

~~85~~79. The use of claim ~~83~~ 77 or 784, wherein said hydrogel induces autolytic debridement.

~~86. The use of any one of claims 83 to 85, wherein said hydrogel comprises at least one amphiphilic peptide and/or peptoid of any one of claims 34 to 39.~~

~~87~~80. The use of claim ~~86~~77, wherein said hydrogel functions as a haemostatic agent.

~~88~~81. The use of any one of claims ~~86 or 87~~77 to 80, wherein said hydrogel functions as an anti-inflammatory agent, which acts by scavenging extracellular nucleic acids that stimulate the innate immune system.

~~89~~82. The use of any one of claims ~~83~~ 77 to ~~88~~81, wherein, said hydrogel is mixed with cells.

~~90~~83. The use of any one of claims ~~83~~ 77 to ~~89~~82, wherein said hydrogel comprises one or more bioactive therapeutics that diffuse into the wound and facilitate the healing response by modulating the inflammatory response and/or stimulating regenerative processes.