Claims

1. A hydrophobic peptide and/or peptidomimetic capable of forming a hydrogel, the hydrophobic peptide and/or peptidomimetic having the general formula:

$$Z\text{-}(X)_a\text{-}Z'_b$$

wherein

Z is an N-terminal protecting group;

X is, at each occurrence, independently selected from the group consisting of hydrophobic aliphatic amino acids and hydrophobic aliphatic amino acid derivatives, and wherein the overall hydrophobicity decreases from N- to C-terminus;

a is an integer selected from 3 to 7, preferably 5 to 6;

Z' is a C-terminal group selected from the group of small molecules, functional groups and linkers; and

b is 0 or 1.

2. The hydrophobic peptide and/or peptidomimetic according to claim 1, wherein said hydrophobic aliphatic amino acids and hydrophobic aliphatic amino acid derivatives are either D-amino acids or L-amino acids, wherein preferably, said hydrophobic aliphatic amino acids are selected from the group consisting of alanine (Ala, A), homoallylglycine, homopropargylglycine, isoleucine (Ile, I), norleucine, leucine (Leu, L), valine (Val, V) and glycine (Gly, G), preferably from the group consisting of alanine (Ala, A), isoleucine (Ile, I), leucine (Leu, L), valine (Val, V) and glycine (Gly, G), wherein preferably all or a portion of said hydrophobic aliphatic amino acids are arranged in an order of decreasing amino acid size in the direction from N- to C-terminus, wherein the size of the hydrophobic aliphatic amino acids is defined as I = L > V > A > G, wherein preferably, said hydrophobic aliphatic amino acids arranged in an order of decreasing amino acid size have a sequence which is a repetitive or non-repetitive sequence.

3. The hydrophobic peptide and/or peptidomimetic according to any to claim 1 or 2, wherein said hydrophobic aliphatic amino acids have a sequence selected from

ILVAG (SEQ ID NO: 1),
LIVAG (SEQ ID NO: 2),
IVAG (SEQ ID NO: 3),
LVAG (SEQ ID NO: 4),
ILVA (SEQ ID NO: 5),
LIVA (SEQ ID NO: 6),
IVG (SEQ ID NO: 13), and
IVA (SEQ ID NO: 15).

4. The hydrophobic peptide and/or peptidomimetic according to any of the foregoing claims, wherein $(X)_a$ has a sequence selected from the group consisting of SEQ ID NO. 1 and SEQ ID NO. 2.

5. The hydrophobic peptide and/or peptidomimetic according to any of the foregoing claims, wherein said N-terminal protecting group ***Z*** 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,
wherein R is preferably selected from the group consisting of methyl, ethyl, propyl, isopropyl, butyl and isobutyl, wherein preferably, said N-terminal protecting group ***Z*** is an acetyl group, wherein preferably, said N-terminal protecting group ***Z*** 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, phosphate, carbonate, sulfate, nitrate, maleimide, vinyl sulfone, azide, alkyne, alkene, carbohydrate, imide, peroxide, ester, aryl, ketone, sulphite, nitrite, phosphonate, and silane.

6. The hydrophobic peptide and/or peptidomimetic according to any one of the preceding claims, wherein said C-terminal group ***Z'*** is selected from
- functional groups, such as polar or non-polar functional groups,
such as (but not limited to)
-COOH, -COOR, -COR, -CONHR or -CONRR' with R and R' being selected from the group consisting of H, unsubstituted or substituted alkyls, and unsubstituted or substituted aryls,

$-NH_2$, -OH, -SH, -CHO, maleimide, imidoester, carbodiimide ester, isocyanate;

- small molecules,

  such as (but not limited to) sugars, alcohols, hydroxy acids, amino acids, vitamins, biotin;

- linkers terminating in a polar functional group,

  such as (but not limited to) ethylenediamine, PEG, carbodiimide ester, imidoester;

- linkers coupled to small molecules or vitamins,

  such as biotin, sugars, hydroxy acids.

7. The hydrophobic peptide and/or peptidomimetic according to any one of the preceding claims, wherein said C-terminal group ***Z'*** can be used for chemical conjugation or coupling of at least one compound selected from

bioactive molecules or moieties,

such as growth factors, cytokines, lipids, cell receptor ligands, hormones, prodrugs, drugs, vitamins, antigens, antibodies, antibody fragments, oligonucleotides (including but not limited to DNA, messenger RNA, short hairpin RNA, small interfering RNA, microRNA, peptide nucleic acids, aptamers), saccharides;

label(s), dye(s),

such as fluorescent or radioactive label(s), imaging contrast agents;

pathogens,

such as viruses, bacteria and parasites;

micro- and nanoparticles

or combinations thereof

wherein said chemical conjugation can be carried out before or after self-assembly of the peptide and/or peptidomimetic.

8. The hydrophobic peptide and/or peptidomimetic according to any of the foregoing claims, wherein the C-terminus of the peptide and/or peptidomimetic is functionalized, such as by chemical conjugation or coupling of at least one compound selected from

bioactive molecules or moieties,

such as growth factors, cytokines, lipids, cell receptor ligands, hormones, prodrugs, drugs, vitamins, antigens, antibodies, antibody fragments, oligonucleotides (including but not limited to DNA, messenger RNA, short hairpin RNA, small interfering RNA, microRNA, peptide nucleic acids, aptamers), saccharides;

label(s), dye(s),

such as fluorescent or radioactive label(s), imaging contrast agents;

pathogens,

such as viruses, bacteria and parasites;

micro- and nanoparticles

or combinations thereof

wherein said chemical conjugation can be carried out before or after self-assembly of the peptide and/or peptidomimetic.

9. The hydrophobic peptide and/or peptidomimetic according to any of the foregoing claims, wherein the hydrophobic peptide and/or peptidomimetic is 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, and preferably the hydrophobic peptide and/or peptidomimetic is stable in aqueous solution at physiological conditions, at a temperature up to 90 °C, for at least 1 hour.

10. A hydrogel comprising the hydrophobic peptide and/or peptidomimetic of any one of claims 1 to 9.

11. The hydrogel according to claim 10, 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, wherein preferably, the hydrogel is characterized by a storage modulus G' to loss modulus G'' ratio that is greater than 2, wherein preferably, 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 and wherein preferably, the hydrogel has a higher mechanical strength than collagen or its hydrolyzed form (gelatin).

12. The hydrogel according to any one of claims 10 to 11, comprising fibers of the hydrophobic peptide and/or peptidomimetic of any one of claims 1 to 9, said fibers defining a

network that is capable of entrapping at least one of a microorganism, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a synthetic polymer, a micro-or nanoparticle, a small organic molecule or a pharmaceutically active compound, wherein preferably, the hydrogel comprises at least one of a microorganism, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a synthetic polymer, a small organic molecule, a micro-or nanoparticle, or a pharmaceutically active compound entrapped by the network of fibers of the hydrophobic peptide and/or peptidomimetic, and wherein preferably, the fibers of the hydrophobic polymer are coupled to the at least one of a microorganism, a virus particle, a peptide, a peptoid, a protein, a nucleic acid, an oligosaccharide, a polysaccharide, a vitamin, an inorganic molecule, a synthetic polymer, a small organic molecule, a micro-or nanoparticle, or a pharmaceutically active compound entrapped by the network of fibers of the hydrophobic peptide and/or peptidomimetic.

13. The hydrogel according to any one of claims 10 to 12, 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 pharmaceutical composition and a cosmetic composition, wherein preferably, the hydrogel is injectable.

14. Use of the hydrogel according to any one of claims 10 to 13 in at least one of the following:

medical tool kit,
a fuel cell,
a solar cell,
an electronic cell,
in vitro regenerative medicine and *in vitro* tissue regeneration,
implantable scaffold
in vitro disease model
2D and 3D synthetic cell culture substrate,
biosensor development,
high-throughput screening,
biofunctionalized surfaces, and
biofabrication, such as bio-printing.

15. A method of preparing a hydrogel, the method comprising dissolving a hydrophobic peptide and/or peptidomimetic according to any one of claims 1 to 9 in an aqueous solution, wherein preferably, the dissolved hydrophobic peptide and/or peptidomimetic 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 and wherein preferably, the hydrophobic peptide and/or peptidomimetic is dissolved at a concentration from 0.01 μg/ml to 100 mg/ml, preferably at a concentration from 1 mg/ml to 50 mg/ml, more preferably at a concentration from about 1 mg/ml to about 20 mg/ml.

16. A wound dressing or wound healing agent comprising a hydrogel of any one of claims 10 to 13.

17. A surgical implant, or stent, the surgical implant or stent comprising a peptide and/or peptidomimetic scaffold, wherein the peptide and/or peptidomimetic scaffold is formed by a hydrogel according to any one of claims 10 to 13.

18. A pharmaceutical and/or cosmetic composition and/or a biomedical device and/or electronic device comprising the hydrophobic peptide and/or peptidomimetic of any one of claims 1 to 9, preferably further comprising a pharmaceutically active compound.

19. The pharmaceutical or cosmetic composition of claim 18, wherein the pharmaceutical and/or cosmetic composition is provided in the form of a topical gel or cream, a spray, a powder, or a sheet, patch or membrane,
or wherein the pharmaceutical and/or cosmetic composition is provided in the form of an injectable solution, and wherein preferably further comprising a pharmaceutically acceptable carrier.

20. A kit of parts, the kit comprising a first container with a hydrophobic peptide and/or peptidomimetic according to any one of claims 1 to 9 and a second container with an aqueous solution, wherein preferably, the aqueous solution of the second container further comprises a pharmaceutically active compound.
and/or wherein the first and/or third container with a hydrophobic peptide and/or peptidomimetic further comprises a pharmaceutically active compound.

21. An *in vitro* method of tissue regeneration comprising the steps:

(a) providing a hydrogel as defined in any of claims 10 to 13,

(b) exposing said hydrogel to cells which are to form regenerated tissue,

(c) allowing said cells to grow on said hydrogel.

22. Use of a hydrogel according to any one of claims 10 to 13, in the manufacture of a medicament for tissue regeneration in a body, wherein said hydrogel is provided at a place in a body where tissue regeneration is intended,
wherein said hydrogel is preferably injectable at a place in the body where tissue regeneration is intended.

23. Use of a pharmaceutical composition according to claim 18, in the manufacture of a medicament for the treatment of a wound and for wound healing, wherein an effective amount of the pharmaceutical composition is adapted to be applied to the wound.

24. A bioimaging device comprising a hydrogel of any one of claims 10 to 13 for *in vitro* and/or *in vivo* use,
preferably for oral application, for injection and/or for topical application.

25. A 2D or 3D cell culture substrate comprising a hydrogel of any one of claims 10 to 13.