scope of the invention may be embodied in many other forms.

**Summary ~~of the Invention~~**

In the present ~~invention~~disclosure, ~~A~~applicant has optimised its proprietary smart polymer, PNPHO, to bond with Thymosin beta-4 to form a cell-friendly medical filler material.

According to ~~a first~~one aspect of the present ~~invention~~ disclosure, there ~~if~~ is provided a composition comprising a polymer and a natural or synthetic peptide or protein (NSPP), wherein the polymer comprises:

a first monomer for binding water;

a second monomer for imparting mechanical properties to said hydrogel;

a third monomer for binding to a natural or synthetic peptide or protein (NSPP); and

a fourth monomer for imparting phase-transition behaviour;

and wherein the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4 or a functional homolog thereof.

In an ~~embodiment~~example, the first monomer is selected from: polyethers, polyvinyl alcohol (PVA); poly(vinyl pyrrolidone) (PVP); poly(amino acids) and dextran.

In an ~~embodiment~~example, the polyethers are selected from: polyethylene glycol (PEG), oligo(ethylene glycol) (OEG) or macromonomers thereof, polyethylene oxide (PEO), polyethylene oxide-co-propylene oxide (PPO), co-polyethylene oxide block or random copolymers thereof.

In an ~~embodiment~~example, the first monomer is oligo (ethylene) glycol monomethyl ether methacrylate (OEGMA).

In an ~~embodiment~~example, the second monomer is a methacrylate, or a random co-polymer comprising a methacrylate.

In an ~~embodiment~~example, the second monomer is selected from: hydroxyethyl methacrylate (HEMA), a hydroxyethyl methacrylate poly(lactic acid) copolymer (HEMA-PLA), poly(lactic acid), poly(caprolactone), poly(glycolide), poly(glycolide-co-lactide) or poly(glycolide-co-caprolactone).

In an ~~embodiment~~example, the second monomer is hydroxyethyl methacrylate poly(lactic acid) (HEMA-PLA).

In an ~~embodiment~~example, the third monomer has electrophilic functional groups for

binding to said NSPP.

In an ~~embodiment~~example, the third monomer is selected from: N-hydroxysulfosuccinimide (SNHS), N-hydroxyethoxylated succinimide (ENHS), and N-acryloxysuccinimide (NAS).

In an ~~embodiment~~example, the third monomer is N-acryloxysuccinimide (NAS). In an ~~embodiment~~example, the fourth monomer is selected from: poly(ethylene oxide)/poly(propylene oxide) and poly(N-isopropylacrylamide) (PNIPAAm) homopolymers and copolymers.

In an ~~embodiment~~example, the fourth monomer is (N-isopropylacrylamide). In an ~~embodiment~~example, the polymer comprises the first monomer in an amount of from about 3 to about 8 mol%.

In an ~~embodiment~~example, **t**he polymer comprises the second monomer in an amount of from about 5 to about 9 mol%.

In an ~~embodiment~~example, the polymer comprises the third monomer in an amount of at least about 7 mol%, such as 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 or 19 mol%.

In an ~~embodiment~~example, the polymer comprises: the first monomer in an amount of from about 3 to about 8 mol%, the second monomer in an amount of from about 5 to about 9 mol%, the third monomer in an amount of at least about 7 mol%, and the fourth monomer in an amount which makes up the remainder to 100% of the polymer composition.

In an ~~embodiment~~example, the polymer comprises the fourth monomer in an amount from about 60 to about 85 mol%, preferably, about 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84 or 85 mol%.

In an ~~embodiment~~example, the first monomer is OEGMA, the second monomer is HEMA-PLA, the third monomer is NAS, and the fourth monomer is NIPAAm, and wherein the polymer comprises: OEGMA in an amount of from about 3 to about 8 mol%, HEMA-PLA in an amount of from about 5 to about 9 mol%, NAS in an amount of greater than about 7 mol% and NIPAAm in an amount of up to about 85 mol%.

In an ~~embodiment~~example, the polymer comprises: OEGMA in an amount of about 5 mol%, HEMA-PLA in an amount of about 7 mol%, NAS in an amount of greater than about 7 mol% and NIPAAm in an amount about 81 mol%.

In an ~~embodiment~~example, the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4.

In an ~~embodiment~~example, the composition comprises essentially equimolar amounts of the polymer and Thymosin beta-4.

In an ~~embodiment~~ example to partially or completely fill a cavity, the concentration of the

polymer is from about 100 mg/mL to about 300 mg/mL of the composition.

According to another ~~a second~~ aspect of the present ~~invention~~ disclosure there is provided a hydrogel comprising the composition ~~according to the first aspect of the present invention~~ as disclosed herein and water, wherein the binding of the NSPP to the third monomer crosslinks the polymer, thereby forming a hydrogel, with the water contained therein.

According to ~~a third~~another aspect of the present ~~invention~~ disclosure there is provided a method of making a hydrogel, the method comprising adding water to the composition ~~of the first aspect of the invention~~as disclosed herein.

According to ~~a fourth~~another aspect of the present ~~invention~~ disclosure there is provided a method of making a hydrogel, the method comprising mixing an aqueous solution of the composition ~~of the first aspect of the present invention~~ as disclosed herein with an aqueous solution of the natural or synthetic peptide or protein (NSPP).

In an ~~embodiment~~example, the hydrogel is formed at body temperature. In an ~~embodiment~~example, the hydrogel is formed following administration of the composition and the NSPP to a mammal by injection or by administering an aerosol.

According to ~~a fifth aspect~~another example of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for repair and/or restoration of both hard and soft tissue. Hard tissue (also termed calcified tissue) is tissue which is mineralised and has a firm intercellular matrix; the hard tissues of humans are bone, tooth enamel, dentin, and cementum. Soft tissue includes the tissues that connect, support, or surround other structures and organs of the body, not being hard tissue such as bone. Soft tissue includes tendons, ligaments, fascia, skin, fibrous tissues, fat, and synovial membranes (which are connective tissue), and muscles, nerves and blood vessels (which are not connective tissue).

According to another aspect of the present disclosure there is provided use of a composition as disclosed herein in the manufacture of a hydrogel for: repair and/or restoration of hard or soft body tissue; wound healing; temporary wrinkle reduction; temporarily lifting the base of a scar and promoting healing; supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing; supporting dermal connective tissue formation in scar management of post burn injuries; supporting vascular ingrowth in an acute dermal defect with bleeding and promoting

healing; filling a surgically generated dermal cavity; supporting a skin grafting operation; physically delivering bone graft substitutes; filling a prosthetic; use as a filler with no tissue-inductive properties; supporting and repairing periodontal tissue after tooth extraction; or temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting.

According to ~~a sixth aspect~~another example of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present~~as disclosed herein ~~invention~~ in the manufacture of a hydrogel for wound healing.

According to another example ~~a seventh aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for temporary wrinkle reduction.

According to another example ~~an eighth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for temporarily lifting the base of a scar and promoting healing.

According to another example ~~a ninth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing.

According to another example ~~a tenth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for supporting dermal connective tissue formation in scar management of post burn injuries.

According to another example ~~an eleventh aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for supporting vascular ingrowth in an acute dermal defect with bleeding and promoting healing.

According to another example ~~a twelfth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for filling a surgically generated dermal cavity.

According to another example ~~a thirteenth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for supporting a skin grafting operation.

According to another example ~~a fourteenth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for physically delivering bone graft substitutes.

According to another example ~~a fifteenth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for filling a prosthetic.

According to another example ~~a sixteenth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for use as a filler with no tissue-inductive properties.

According to another example~~a seventeenth aspect~~ of the present ~~invention~~

disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for supporting and repairing periodontal tissue after tooth extraction.

According to another example ~~an eighteenth aspect~~ of the present ~~invention~~ disclosure there is provided use of a composition ~~according to the first aspect of the present invention~~ as disclosed herein in the manufacture of a hydrogel for temporarily lifting a periodontal ligament tissue and/or supporting periodontal

ligament tissue grafting.

According to another ~~a nineteenth~~ aspect of the present ~~invention~~ disclosure there is provided use of a hydrogel ~~according to the second aspect of the present invention~~ as disclosed herein in the manufacture of a medicament for repair and/or restoration of tissue.

According to another example ~~a twentieth aspect~~ of the present ~~invention~~ disclosure there is provided a method of repair and/or restoration of tissue, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example~~a twenty-first aspect~~ of the present ~~invention~~ disclosure there is provided a method of wound healing, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a twenty-second aspect~~ of the present ~~invention~~ disclosure there is provided a method of temporary wrinkle reduction, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a twenty-third aspect~~ of the present ~~invention~~ disclosure there is provided a method of temporarily lifting the base of a scar and promoting healing, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a twenty-fourth aspect~~ of the present ~~invention~~ disclosure there is provided a method of supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made

by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to ~~a twenty-fifth aspect~~ another example of the present ~~invention~~ disclosure there is provided a method of supporting dermal connective tissue formation in scar management of post burn

injuries, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a twenty-sixth aspect~~ of the present ~~invention~~ disclosure there is provided a method of supporting vascular ingrowth in an acute dermal defect with bleeding and promoting healing, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a twenty-seventh aspect~~ of the present ~~invention~~ disclosure there is provided a method of filling a surgically generated dermal cavity, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a twenty-eighth aspect~~ of the present ~~invention~~ disclosure there is provided a method of supporting a skin grafting operation, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a twenty-ninth aspect~~ of the present ~~invention~~ disclosure there is provided a method of physically delivering bone graft substitutes, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a thirtieth aspect~~ of the present ~~invention~~ disclosure there is provided a method of filling a prosthetic, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the filler has no tissue-inductive properties. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a thirty-first aspect~~ of the present ~~invention~~ disclosure there is provided a method of supporting and repairing periodontal tissue after tooth extraction, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a thirty-second aspect~~ of the present ~~invention~~ disclosure there is provided a method of temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting, the method comprising administering to a mammal a composition ~~according to the first aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of the mammal.

According to another example ~~a thirty-third aspect~~ of the present ~~invention~~ disclosure there is provided a method of repair and/or restoration of tissue, the method comprising administering to a mammal a hydrogel ~~according to the second aspect of the present invention~~as disclosed herein. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a thirty-fourth aspect~~ of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in the repair and/or restoration of tissue. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another aspect of the present disclosure there is provided a composition as disclosed herein for use in: the repair and/or restoration of tissue; wound healing; temporary wrinkle reduction; temporarily lifting the base of a scar and promoting healing; supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing; supporting dermal connective tissue formation in scar management of post burn injuries; supporting vascular ingrowth in an acute dermal defect with bleeding and promoting healing; filling a surgically generated dermal cavity; supporting a skin grafting operation; physically delivering bone graft substitutes; filling a prosthetic; use as a

filler with no tissue-inductive properties; supporting and repairing periodontal tissue after tooth extraction; or temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting.

According to ~~a thirty-fifth aspect~~ another example of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in wound healing. In an ~~embodiment~~ example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to ~~a thirty-sixth aspect~~ another example of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in temporary wrinkle reduction. In an ~~embodiment~~ example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to ~~a thirty-seventh aspect~~ another example of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~as disclosed herein for use in temporarily lifting the base of a scar and promoting healing. In an ~~embodiment~~example, the administration step

is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a thirty-eighth aspect~~ of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a thirty-ninth aspect~~ of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in supporting dermal connective tissue formation in scar management of post burn injuries. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a fortieth aspect~~ of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in supporting vascular ingrowth in an acute dermal defect with bleeding and promoting healing. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a forty-first aspect~~ of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in filling a surgically generated dermal cavity. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a forty-second aspect~~ of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in supporting a skin grafting operation. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a forty-third aspect~~ of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed

herein for use in physically delivering bone graft substitutes. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another example ~~a forty-fourth aspect~~ of the present ~~invention~~ disclosure there is provided a

composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in filling a prosthetic. In an ~~embodiment~~example, the filler has no tissue-inductive properties. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another ~~a forty-fifth~~ aspect of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in supporting and repairing periodontal tissue after tooth extraction. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to another ~~a forty-sixth~~ aspect of the present ~~invention~~ disclosure there is provided a composition ~~according to the first aspect of the present invention~~ as disclosed herein for use in temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting. In an ~~embodiment~~example, the administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

According to ~~a forty-seventh~~another aspect of the present ~~invention~~ disclosure there is provided a hydrogel ~~according to the second aspect of the present invention~~ as disclosed herein for use in repair and/or restoration of tissue. In an ~~embodiment~~example, an administration step is made by injection or by administering an aerosol, thereby to form a hydrogel at the body temperature of a mammal.

In all aspects and ~~embodiments~~ examples wherein the administration step is made by administering an aerosol, the aerosol may be applied to any opening of the body, such as but not limited to the nasal cavity, the mouth or an open wound.

According to ~~a forty-eighth~~another aspect of the present ~~invention~~ disclosure there is provided a kit for forming a hydrogel, the kit comprising: a polymer and a natural or synthetic peptide or protein (NSPP), wherein the polymer comprises: a first monomer for binding water; a second monomer for imparting mechanical properties to said hydrogel; a third monomer for binding to a natural or synthetic peptide or protein (NSPP); and a fourth monomer for imparting phase-transition behaviour; and wherein the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4 or a functional homolog thereof. In an ~~embodiment~~example, the kit further comprises water in a separate container.

According to ~~a forty-ninth~~another aspect of the present ~~invention~~ disclosure there is provided a kit for forming a hydrogel, comprising in separate containers: a natural or

synthetic peptide or protein (NSPP); and a composition, wherein the composition comprises: a first monomer for binding water; a second monomer for imparting mechanical properties to said hydrogel;

a third monomer for binding to a natural or synthetic peptide or protein (NSPP); and a fourth monomer for imparting phase-transition behaviour; wherein the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4 or a functional homolog thereof; and wherein the NSPP and the second monomer are crosslinked, thereby enabling formation of the hydrogel when the composition is contacted with water.

In an ~~embodiment~~example, one or both of the NSPP and the composition are in solid form. In an ~~embodiment~~example, the kit further comprises water in a separate container. In an ~~embodiment~~example, the kit further comprises instructions for the sequential or simultaneous administration of the components of the kit. In an ~~embodiment~~example, the kit is configured such that the composition, the NSPP and water are mixed together when dispensed.

In an ~~embodiment~~example, the NSPP and the composition are used as a filler to deliver bone graft substitutes *in situ* in a patient in need of treatment with such. The filler keeps BGS in place (adhesive) for at least 6 weeks (degradation) and provides scaffolds for cell ingrowth (bone osteoblasts).

In another ~~embodiment~~example, to form an aerosol for topical administration, the concentration of the polymer in the composition is from about 5 mg/mL to about 70 mg/mL. For instance, the concentration of the polymer in the composition is from about 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69 or 70 mg/mL. The polymer can therefore be delivered via aerosol in very low concentrations, can be adhered to the surgical site and used accordingly.

**Definitions and nomenclature**

In describing and claiming the present invention, the following terminology will be used in accordance with the definitions set out below. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments of the invention only and is not intended to be limiting. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one having ordinary skill in the art to which the invention pertains.

Unless the context clearly requires otherwise, throughout the description and the claims, the words “comprise”, “comprising”, and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense

**THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-**

1. A composition comprising a polymer and a natural or synthetic peptide or protein (NSPP), wherein the polymer comprises:

a first monomer for binding water;

a second monomer for imparting mechanical properties to said hydrogel;

a third monomer for binding to a natural or synthetic peptide or protein (NSPP); and

a fourth monomer for imparting phase-transition behaviour;

and wherein the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4 or a functional homolog thereof.

2. The composition according to claim 1, wherein the first monomer is selected from: polyethers, polyvinyl alcohol (PVA); poly(vinyl pyrrolidone) (PVP); poly(amino acids) and dextran.

3. The composition according to claim 2, wherein the polyethers are selected from: polyethylene glycol (PEG), oligo(ethylene glycol) (OEG), polyethylene oxide (PEO), polyethylene oxide-co-propylene oxide (PPO), co-polyethylene oxide block or random copolymers thereof.

4. The composition according to claim 2, wherein the first monomer is oligo (ethylene) glycol monomethyl ether methacrylate (OEGMA).

5. The composition according to any one of the preceding claims, wherein the second monomer is a methacrylate, or a random co-polymer comprising a methacrylate.

6. The composition according to any one of the preceding claims, wherein the second monomer is selected from: hydroxyethyl methacrylate (HEMA), a hydroxyethyl methacrylate poly(lactic acid) copolymer (HEMA-PLA), poly(lactic acid), poly(caprolactone), poly(glycolide), poly(glycolide-co-lactide) or poly(glycolide-co-caprolactone).

7. The composition according any one of the preceding claims, wherein the second monomer is hydroxyethyl methacrylate poly(lactic acid) (HEMA-PLA).

8. The composition according to any one of the preceding claims, wherein the third monomer has electrophilic functional groups for binding to said NSPP.

9. The composition according to any one of the preceding claims, wherein the third monomer is selected from: N-hydroxysulfosuccinimide (SNHS), N-hydroxyethoxylated succinimide (ENHS), and N-acryloxysuccinimide (NAS).

10. The composition according to any one of the preceding claims, wherein the third monomer is N-acryloxysuccinimide (NAS).

11. The composition according to any one of the preceding claims, wherein the fourth monomer is selected from: poly(ethylene oxide)/poly(propylene oxide) and poly(N-isopropylacrylamide) (PNIPAAm) homopolymers and copolymers.

12. The composition according to any one of the preceding claims, wherein the fourth monomer is (N-isopropylacrylamide).

13. The composition according to any one of the preceding claims wherein the polymer comprises the first monomer in an amount of from about 3 to about 8 mol%, preferably about 5 mol%.

14. The composition according to any one of the preceding claims, wherein the polymer comprises the second monomer in an amount of from about 5 to about 9 mol%, preferably about 7 mol%.

15. The composition according to any one of the preceding claims, wherein the polymer comprises the third monomer in an amount of at least about 7 mol%.

16. The composition according to any one of the preceding claims, wherein the polymer comprises:

the first monomer in an amount of from about 3 to about 8 mol%,

the second monomer in an amount of from about 5 to about 9 mol%,

the third monomer in an amount of at least about 7 mol%, and

the fourth monomer in an amount which makes up the remainder to 100% of the polymer composition.

17. The composition according to any one of the preceding claims, wherein the polymer comprises the fourth monomer in an amount from about 60 to about 85 mol%.

18. The composition according to claim 1, wherein:

the first monomer is OEGMA,

the second monomer is HEMA-PLA,

the third monomer is NAS, and

the fourth monomer is NIPAAm,

and wherein the polymer comprises:

OEGMA in an amount of from about 3 to about 8 mol%,

HEMA-PLA in an amount of from about 5 to about 9 mol%,

NAS in an amount of greater than about 7 mol% and

NIPAAm in an amount of up to about 85 mol%.

19. The composition according to claim 18, wherein the polymer comprises:

OEGMA in an amount of about 5 mol%,

HEMA-PLA in an amount of from about 7 mol%,

NAS in an amount of greater than about 7 mol% and

NIPAAm in an amount of up to about 81 mol%.

20. The composition according to any one of the preceding claims, wherein the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4.

21. The composition according to any one of the preceding claims, comprising

equimolar amounts of the polymer and Thymosin beta-4.

22. The composition according to any one of the preceding claims, wherein the concentration of the polymer is from about 100 mg/mL to about 300 mg/mL of the composition.

23. A hydrogel comprising the composition according to any one of claims 1 to 22 and water, wherein the binding of the NSPP to the third monomer crosslinks the polymer, thereby forming a hydrogel, with the water contained therein.

24. A method of making a hydrogel, the method comprising adding water to the composition of any one of claims 1 to 22.

25. A method of making a hydrogel, the method comprising mixing an aqueous solution of the composition of any one of claims 1 to 22 with an aqueous solution of the natural or synthetic peptide or protein (NSPP).

26. A method according to claim 25, wherein the hydrogel is formed at body temperature.

27. A method according to claim 25 or claim 26, wherein the hydrogel is formed following administration of the composition and the NSPP to a mammal by injection.

28. Use of a composition according to any one of claims 1 to 22 in the manufacture of a hydrogel for: repair and/or restoration of hard or soft body tissue; wound healing; temporary wrinkle reduction; temporarily lifting the base of a scar and promoting healing; supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing; supporting dermal connective tissue formation in scar management of post burn injuries; supporting vascular ingrowth in an acute dermal defect with bleeding and promoting healing; filling a surgically generated dermal cavity; supporting a skin grafting operation; physically delivering bone graft

substitutes; filling a prosthetic; use as a filler with no tissue-inductive properties; supporting and repairing periodontal tissue after tooth extraction; or temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting.

29. Use of a hydrogel according to claim 23 in the manufacture of a medicament for repair and/or restoration of tissue.

~~30. A method for: repair and/or restoration of hard or soft body tissue; wound healing; temporary wrinkle reduction; temporarily lifting the base of a scar and promoting healing; supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing; supporting dermal connective tissue formation in scar management of post burn injuries; supporting vascular ingrowth in an acute dermal defect with bleeding and promoting healing; filling a surgically generated dermal cavity; supporting a skin grafting operation; physically delivering bone graft substitutes; filling a prosthetic; use as a filler with no tissue-inductive properties; supporting and repairing periodontal tissue after tooth extraction; or temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting, the method comprising administering to a mammal a composition according to any one of claims 1 to 22.~~

~~31. A method of repair and/or restoration of tissue, the method comprising administering to a mammal a hydrogel according to claim 23.~~

~~32.~~30. ~~A method~~The use according to claim 28 or 29~~ 30 or claim 31~~, wherein:

- the ~~administration step is made by~~ composition as defined in claim 28 is to be injected to a mammal to form a hydrogel at the body temperature of the mammal;
- the hydrogel as defined in claim 29 is to be injected to the mammal; ~~injection~~ or ~~by administering~~
- an aerosol is to be administered to the mammal~~, thereby~~ to form a hydrogel at the body temperature of the mammal.

~~33.~~31. A composition according to any one of claims 1 to 22 for use in: the repair

and/or restoration of tissue; wound healing; temporary wrinkle reduction; temporarily lifting the base of a scar and promoting healing; supporting dermal connective tissue formation in scar tissue after a surgical intervention and promoting healing; supporting dermal connective tissue formation in scar management of post burn injuries; supporting vascular ingrowth in an acute dermal defect with bleeding and promoting healing; filling a surgically generated dermal cavity; supporting a skin grafting operation; physically delivering bone graft substitutes; filling a prosthetic; use as a filler with no tissue-inductive properties; supporting and repairing periodontal tissue after tooth extraction; or temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting.

~~34.~~32. A composition for use according to claim ~~33~~31, wherein the filler has no tissue-inductive properties.

~~35.~~33. A composition according to any one of claims 1 to 22 for use in supporting and repairing periodontal tissue after tooth extraction.

~~36.~~34. A composition according to any one of claims 1 to 22 for use in temporarily lifting a periodontal ligament tissue and/or supporting periodontal ligament tissue grafting.

~~37.~~35. A hydrogel according to claim 23 for use in repair and/or restoration of tissue.

~~38.~~36. A composition for use according to any one of claims ~~33~~ 31 to ~~37~~35~~,~~ wherein:

- the composition as defined in any one of claims 31 to 34 is to be injected to a mammal to form a hydrogel at the body temperature of the mammal;

- ~~administration step is made by injection or by administering~~ the hydrogel as defined in claim 35 is to be injected to the mammal; or

- an aerosol is to be administered to the mammal~~, thereby~~ to form a hydrogel at the body temperature of the mammal.

~~39.~~37. A hydrogel for use according to claim ~~37~~35, wherein:

- the hydrogel as defined in claim 35 is to be injected to the mammal; ~~administration step is made by injection~~ or ~~by administering~~
- an aerosol is to be administered to the mammal ~~, thereby~~ to form a hydrogel at the body temperature of the mammal.

~~40.~~38. A kit for forming a hydrogel, the kit comprising:

a polymer and a natural or synthetic peptide or protein (NSPP), wherein the polymer comprises:

a first monomer for binding water;

a second monomer for imparting mechanical properties to said hydrogel;

a third monomer for binding to a natural or synthetic peptide or protein (NSPP); and

a fourth monomer for imparting phase-transition behaviour;

and wherein the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4 or a functional homolog thereof.

~~41.~~39. The kit according to claim ~~40~~38, further comprising water in a separate container.

~~42.~~40. A kit for forming a hydrogel, comprising in separate containers:

a natural or synthetic peptide or protein (NSPP); and

a composition,

wherein the composition comprises:

a first monomer for binding water;

a second monomer for imparting mechanical properties to said hydrogel;

a third monomer for binding to a natural or synthetic peptide or protein (NSPP); and

a fourth monomer for imparting phase-transition behaviour;

wherein the natural or synthetic peptide or protein (NSPP) is Thymosin beta-4 or a functional homolog thereof;

and wherein the NSPP and the second monomer are crosslinked,

thereby enabling formation of the hydrogel when the composition is contacted with water.

~~43.~~41. The kit according to claim ~~42~~ 40 wherein one or both of the NSPP and the composition are in solid form.

~~44.~~42. The kit according to claim ~~42~~ 40 or claim ~~43~~ 41 further comprising water in a separate container.

~~45.~~43. The kit according to any one of claims ~~42~~ 40 to ~~44~~ 42 further comprising instructions for the sequential or simultaneous administration of the components of the kit.

~~46.~~44. The kit according to any one of claims ~~42~~ 40 to ~~45~~43, configured such that the composition, the NSPP and water are mixed together when dispensed.