CLAIMS

1. A biocompatible support structure for spine disc replacement comprising:

one or more of an annular ring, a first plate, or a second plate of a biocompatible material, in which:

the annular ring comprises an inner surface wall, an outer surface wall, a first planar surface, and a second planar surface; and

the biocompatible material is present in an amount of about 1% to about 100% by weight of the biocompatible support structure.

2. A support structure according to Claim 1, in which the annular ring has a medial thickness of about 100 μm to about 6000 μm and a lateral thickness of about 100 μm to about 2000 μm.

3. A support structure according to Claim 1, in which the first plate and the second plate have a thickness from about 100 μm to about 1200 μm.

4. A support structure according to Claim 1, in which the support structure has one or more of: a flexural modulus of about 0.2 GPa to about 100 GPa; a modulus of elasticity of about 0.02 GPa to about 100 GPa; and/or a tensile strength of about 1 MPa to about 1000 MPa.

5. A support structure according to Claim 1, in which the biocompatible material is selected from the group consisting of polysaccharides, biocompatible polymers, rubber, silicon, biocompatible metals, biocompatible ceramics, polyethylene glycol, polypropylene glycol, polyamino acids, natural and biopolymers, or combinations of two or more thereof.

6. A support structure according to Claim 5, in which:

the biocompatible material is selected from the group consisting of PLA, PGA, PLGA, PDO, polycaprolactones, bioresorbable metal alloys, and combinations thereof; and

the biocompatible material degrades, absorbs, or resorbs at a rate of about 1 month to about 7 years.

7. A support structure according to Claim 1, in which the annular ring is configured to have the shape of an intervertebral disc of a subject.

8. A support structure according to Claim 1, in which the annular ring has one or more apertures having an average size of about10 μm to about 10,000 μm.

9. A support structure according to Claim 1, in which the support structure further comprises one or more appendage elements connected to and extending distally from the first planar surface or the second planar surface of the annular ring or a planar surface of the first plate or the second plate; and/or one or more linking elements connecting a cross-section of the annular ring from one area of the inner surface wall to another area of the inner surface wall, or connecting a planar surface of the first plate to a planar surface of the second plate.

10. A method for fabricating a biocompatible support structure for spine disc replacement according to Claim 1, the method of fabricating comprising:

depositing one or more layers of a biocompatible material to a substrate;

crosslinking the biocompatible material; and

optionally repeating the depositing and crosslinking steps to obtain the biocompatible support structure.

11. A method according to Claim 10, in which the method of fabricating comprises one or more of injection molding, rotational molding, molding using positive molds, molding using negative molds, subtractive manufacturing, milling and machining, and three-dimensional (3D) printing.

12. A method according to Claim 11, in which:

the depositing comprises 3D printing the one or more layers of biocompatible material; and

the 3D printing is selected from the group consisting of ink-jet printing, layer-by-layer printing, extrusion printing, and bioprinting.

13. A method according to Claim 11, in which the method of fabricating comprises injection molding, in which the injection molding comprises:

depositing one or more layers of the biocompatible material to a substrate, in which the substrate is a mold of the biocompatible support structure;

crosslinking the biocompatible material in the mold, and optionally repeating the depositing and crosslinking steps; and

removing the biocompatible support structure from the mold.

14. A spine disc replacement composition comprising:

a biocompatible support structure for spine disc replacement according to Claim 1; and

a tissue-engineered construct comprising a bio ink.

15. A spine disc replacement composition according to Claim 14, in which the bio ink comprises one or more of a hydrogel, agarose, collagen, chitosan, fibrin, hyaluronic acid, carrageenan, polyethylene oxide, polypropylene oxide, polyethylene oxide-co-polypropylene oxide, hydroxypropyl methyl cellulose, poly(propylene fumarate-co-ethylene glycol), poly(ethylene glycol)-co-poly(lactic acid), poly(vinyl alcohol), KDLl 2 oligopeptides, poly(n-isopropyl acrylamide), or combinations of two or more thereof.

16. A spine disc replacement composition according to Claim 15, in which the bio ink comprises an alginate hydrogel present in an amount of about 0.5% (w/v) to about 10% (w/v); and/or about 5 mg/ml to about 200 mg/ml of collagen.

17. A spine disc replacement composition according to Claim 14, in which the tissue-engineered construct comprises a nucleus pulposus structure comprising type II collagen, and an annulus fibrosus structure comprising type I collagen.

18. A spine disc replacement composition according to Claim 14, in which the tissue-engineered construct further comprises a population of cells present in a concentration of about $1.0x10^5$ cells/ml to about $5.0x10^7$ cells/ml.

19. A spine disc replacement composition according to Claim 14, in which:

the annular ring of the biocompatible support structure increases the axial stiffness of the tissue-engineered construct by about 5 times to about 10,000 times stiffness; and/or

the first plate or second plate of the biocompatible support structure increases the axial load capacity of the tissue-engineered construct by about 1% to about 10,000%; and or

the composition withstands an axial compression of about 1 kN to about 10,000 kN, a shear force of about 0.2 kN to about 1,000 kN, or a combination thereof.

20. A method of fabricating a spine disc replacement composition according to Claim 14 comprising:

fabricating the biocompatible support structure, comprising:

depositing the biocompatible material to a substrate;

optionally crosslinking the biocompatible material; and

optionally repeating the depositing and optional crosslinking steps to obtain the biocompatible support structure;

fabricating the tissue-engineered construct comprising:

depositing a bio ink in or around the biocompatible support structure;

crosslinking the bio ink, and optionally repeating the depositing and crosslinking steps, to form the tissue-engineered construct; and

curing the spine disc replacement composition.

CLAIMS

1. A biocompatible support structure for spine disc replacement comprising:

an annular ring, optionally a first plate, and optionally a second plate of a biocompatible material, in which:

the annular ring comprises an inner surface wall, an outer surface wall, a first planar surface, and a second planar surface;

the biocompatible material is present in an amount of 1% to 100% by weight of the biocompatible support structure; and

the annular ring has at least one aperture extending therethrough from the outer surface wall to the inner surface wall and having an average size of 10 μm to 10,000 μm.

2. A support structure according to Claim 1, in which the annular ring has a medial thickness of 100 μm to 6000 μm and a lateral thickness of 100 μm to 2000 μm.

3. A support structure according to Claim 1, in which the first plate and the second plate are present and have a thickness from 100 μm to 1200 μm.

4. A support structure according to Claim 1, in which the support structure has one or more of: a flexural modulus of 0.2 GPa to 100 GPa; a modulus of elasticity of 0.02 GPa to 100 GPa; and/or a tensile strength of 1 MPa to 1000 MPa.

5. A support structure according to Claim 1, in which the biocompatible material is selected from the group consisting of polysaccharides, biocompatible polymers, rubber, silicon, biocompatible metals, biocompatible ceramics, polyethylene glycol, polypropylene glycol, polyamino acids, natural and biopolymers, or combinations of two or more thereof.

6. A support structure according to Claim 5, in which:

the biocompatible material is selected from the group consisting of PLA, PGA, PLGA, PDO, polycaprolactones, bioresorbable metal alloys, and combinations thereof; and

the biocompatible material degrades, absorbs, or resorbs at a rate of 1 month to 7 years.

7. A support structure according to Claim 1, in which the annular ring is configured to have the shape of an intervertebral disc of a subject.

8. A support structure according to Claim 1, in which the annular ring has one or more apertures having an average size of 2,000 μm to 5,000 μm.

9. A support structure according to Claim 1, in which the support structure further comprises one or more appendage elements connected to and extending distally from the first planar surface or the second planar surface of the annular ring or a planar surface of the first plate or the second plate; and/or one or more linking elements connecting a cross-section of the annular ring from one area of the inner surface wall to another area of the inner surface wall, or connecting a planar surface of the first plate to a planar surface of the second plate.

10. A method suitable for fabricating a biocompatible support structure for spine disc replacement according to Claim 1, the method of fabricating comprising:

depositing one or more layers of a biocompatible material to a substrate;

crosslinking the biocompatible material; and

optionally repeating the depositing and crosslinking steps to obtain the biocompatible support structure.

11. A method according to Claim 10, in which the method of fabricating comprises one or more of injection moulding, rotational moulding, moulding using positive moulds, moulding using negative moulds, subtractive manufacturing, milling and machining, and three-dimensional (3D) printing.

12. A method according to Claim 11, in which:

the depositing comprises 3D printing the one or more layers of biocompatible material; and

the 3D printing is selected from the group consisting of ink-jet printing, layer-by-layer printing, extrusion printing, and bioprinting.

13. A method according to Claim 11, in which the method of fabricating comprises injection moulding, in which the injection moulding comprises:

depositing one or more layers of the biocompatible material to a substrate, in which the substrate is a mould of the biocompatible support structure;

crosslinking the biocompatible material in the mould, and optionally repeating the depositing and crosslinking steps; and

removing the biocompatible support structure from the mould.

14. A spine disc replacement composition comprising:

a biocompatible support structure for spine disc replacement according to Claim 1; and

a tissue-engineered construct comprising a bio ink, the bio ink comprising at least one of a hydrogel, agarose, collagen, chitosan, fibrin, hyaluronic acid, carrageenan, polyethylene oxide, polypropylene oxide, polyethylene oxide-co-polypropylene oxide, hydroxypropyl methyl cellulose, poly(propylene fumarate-co-ethylene glycol), poly(ethylene glycol)-co-poly(lactic acid), poly(vinyl alcohol), KDLl 2 oligopeptides, poly(n-isopropyl acrylamide), or combinations of two or more thereof, and

in which the tissue-engineered construct is formed by depositing and crosslinking the bio ink in or around the biocompatible support structure.

15. A spine disc replacement composition according to Claim 14, in which the bio ink comprises an alginate hydrogel present in an amount of 0.5% (w/v) to 10% (w/v); and/or 5 mg/ml to 200 mg/ml of collagen.

16. A spine disc replacement composition according to Claim 15, in which the tissue-engineered construct comprises a nucleus pulposus structure comprising type II collagen, and an annulus fibrosus structure comprising type I collagen.

17. A spine disc replacement composition according to Claim 14, in which the tissue-engineered construct further comprises a population of cells present in a concentration of $1.0x10^5$ cells/ml to $5.0x10^7$ cells/ml.

18. A spine disc replacement composition according to Claim 14, in which:

the annular ring of the biocompatible support structure increases the axial stiffness of the tissue-engineered construct by 5 times to 10,000 times stiffness; and/or

the first plate or second plate of the biocompatible support structure increases the axial load capacity of the tissue-engineered construct by 1% to 10,000%; and or

the composition withstands an axial compression of 1 kN to 10,000 kN, a shear force of 0.2 kN to 1,000 kN, or a combination thereof.

19. A method of fabricating a spine disc replacement composition according to Claim 14 comprising:

fabricating the biocompatible support structure, comprising:

depositing the biocompatible material to a substrate;

optionally crosslinking the biocompatible material; and

optionally repeating the depositing and optional crosslinking steps to obtain the biocompatible support structure;

fabricating the tissue-engineered construct comprising:

depositing a bio ink in or around the biocompatible support structure;

crosslinking the bio ink, and optionally repeating the depositing and crosslinking steps, to form the tissue-engineered construct; and

curing the spine disc replacement composition.