CLAIMS

1. A hydrogel precursor composition for bioink comprising:

   i. a first component comprising a hyaluronic acid (HA) component conjugated to

      a. at least one first reactive functional group, and

      b. at least one catechol and/or phenol group;

   ii. a second component comprising a hyaluronic acid (HA) component conjugated to at least one second reactive functional group; and

   iii. at least one rheological modifier component;

   wherein the at least one second reactive functional group is configured to form a crosslink with the at least one first reactive functional group **characterized** in that the at least one rheological modifier component comprises hyaluronic acid with a molecular weight of 1200 kDa - 1900 kDa, and the at least one rheological component comprises 2 - 50 wt-% from the total weight of the hydrogel precursor composition.

2. The hydrogel precursor composition of claim 1, wherein

   i. the at least one first reactive functional group is selected from a hydrazide, a hydrazine, a carbohydrazide, an aminooxy, an amine, a semicarbazide, a thiosemicarbazide and/or a carbazate group, preferably the at least one first reactive functional group is carbohydrazide group (-$CONHNH_2$), and the at least one second reactive functional group is an aldehyde group (-CHO), and/or

   ii. the at least one first reactive functional group is semicarbazide or aminooxy, and the at least one second reactive functional group is ketone.

3. The hydrogel precursor composition of claim 1 or 2, comprising:

   i. a first component comprising the HA component conjugated to the at least one first reactive functional group and to the at least one catechol group, wherein the at least one first reactive group is a carbohydrazide group (-$CONHNH_2$);

ii. a second component comprising the HA component conjugated to the at least one second reactive functional group, wherein the at least one second reactive functional group is an aldehyde group (-CHO); and

iii. at least one rheological modifier component.

4. The hydrogel precursor composition of any preceding claim, wherein, the rheological modifier component of the hydrogel precursor composition further comprises alginate, chitosan, nanocellulose, polyethylene glycol, poloxamer, polyvinyl alcohol, an extracellular matrix protein, albumin, or mixtures thereof.

5. The hydrogel precursor composition of any preceding claim wherein the rheological modifier component of the hydrogel precursor composition further comprises collagen, preferably type I, with a molecular weight of 250-300 kDa.

6. The hydrogel precursor composition of any preceding claim wherein the rheological modifier component of the hydrogel precursor composition further comprises human fibronectin with a molecular weight of 440 - 530 kDa.

7. The hydrogel precursor composition of any preceding claim wherein the rheological modifier component of the hydrogel precursor composition further comprises laminin, preferably human or mouse recombinant laminin, with a molecular weight of 400 - 900 kDa.

8. The hydrogel precursor composition of any preceding claim, wherein the at least one first reactive functional group is conjugated to the HA component of the first component via a linker L_1, wherein said linker L_1 is conjugated to a carboxyl group of the HA component, preferably through a substitution of a carboxylate hydroxy group of a glucuronic acid residue of the HA component, and wherein the linker L_1 is formed of 1-10 moieties, each moiety being independently selected from a group consisting of phenylene ($-C_6H_4-$), oxime (-C=N-O-), imine (-C=N-C-), alkylene ($-CH_2-$), containing 1-12 carbon atoms, ethynydiyl (-C≡C-), ethylenediyl (-C=C-), ether (-O-), thioether (-S-), amide (-CO-NH-, -CO-NR´-, -NH-CO- and -NR´-CO-) wherein R´ represents an alkyl group containing less than 5 carbon atoms, carbonyl (-CO-), ester (-COO- and –OOC-), disulfide (-SS-), sulfonamide ($-SO_2$-NH-, $-SO_2$-NR´-), sulfone (-

SO_2-), phosphate (-O-PO_2-O-), diaza (-N=N-), diimine (-NHNH-), secondary amine (-NH-) and tertiary amine.

9. The hydrogel precursor composition of claim 8, wherein the first component comprises plurality of first reactive functional groups and wherein the first reactive functional groups, or the linkers L_1 conjugated to the first reactive functional groups, are conjugated to 5 - 20 %, preferably 9 - 15 %, more preferably 12 - 13 % of disaccharide repeat units of the HA component of the first component.

10. The hydrogel precursor composition according to claim 8 or 9 wherein the at least one first reactive functional group is a carbohydrazide group and the linker L_1 is -NHNH-.

11. The hydrogel precursor composition of any preceding claim, wherein the at least one phenol and/or catechol group is conjugated to the HA component of the first component via a linker L_2, wherein said linker L_2 is conjugated to a carboxyl group of the HA component, preferably through a substitution of a carboxylate hydroxy group of a glucuronic acid residue of the HA component, and wherein the linker L_2 is formed of 1-10 moieties, each moiety being independently selected from a group consisting of phenylene (-C_6H_4-), oxime (-C=N-O-), imine (-C=N-C-), alkylene (-CH_2-) containing 1-12 carbon atoms, ethynydiyl (-C≡C-), ethylenediyl (-C=C-), ether (-O-), thioether (-S-), amide (-CO-NH-, -CO-NR´-, -NH-CO- and -NR´-CO-) wherein R´ represents an alkyl group containing less than 5 carbon atoms, carbonyl (-CO-), ester (-COO- and –OOC-), disulfide (-SS-), sulfonamide (-SO_2-NH-, -SO_2-NR´-), sulfone (-SO_2-), phosphate (-O-PO_2-O-), diaza (-N=N-), diimine (-NHNH-), secondary amine (-NH-), and tertiary amine, preferably the linker L_2 is -NH$(CH_2)_2$-.

12. The hydrogel precursor composition of claim 11, wherein the first component comprises plurality of catechol groups and/or phenol groups and wherein the catechol and/or phenol groups, or the linkers L_2 conjugated to the catechol and/or phenol groups, are conjugated to 1 - 20 %, preferably 2 - 10 %, more preferably 3 - 6 %, even more preferably 3,0 - 3,6 % of disaccharide repeat units of the HA component of the first component.

13. The hydrogel precursor composition of any preceding claim, wherein the at least one second reactive functional group is conjugated to the HA component of the second component via a linker L_3, wherein said linker L_3 is conjugated to a carboxyl group of the HA component, preferably through a substitution of carboxylate hydroxy group of a glucuronic acid residue of the HA component, and wherein the linker L_3 is formed of 1-10 moieties, each moiety being independently selected from the group consisting of phenylene ($-C_6H_4-$), oxime (-C=N-O-), imine (-C=N-C-), alkylene ($-CH_2-$) containing 1-12 carbon atoms, ethynydiyl (-C≡C-), ethylenediyl (-C=C-), ether (-O-), thioether (-S-), amide (-CO-NH-, -CO-NR´-, -NH-CO- and -NR´-CO-) wherein R´ represents an alkyl group containing less than 5 carbon atoms, carbonyl (-CO-), ester (-COO- and -OOC-), disulfide (-SS-), sulfonamide ($-SO_2$-NH-, $-SO_2$-NR´-), sulfone ($-SO_2-$), phosphate ($-O-PO_2-O-$), diaza (-N=N-), diimine (-NHNH-), and tertiary amine.

14. The hydrogel precursor composition of claim 13, wherein the second component comprises plurality of second reactive functional groups, preferably aldehyde groups, wherein the second reactive functional groups or the linkers L_3 conjugated to the second reactive functional groups, are conjugated to 5 - 50 %, preferably 9 - 15 %, more preferably 11 - 13 % of the disaccharide repeat units of the HA component of the second component.

15. The hydrogel precursor composition according to claim 13 or 14 wherein the at least one second reactive functional group is an aldehyde group (-CHO) and the linker L_3 is $-NHCH_2-$.

16. The hydrogel precursor composition according any of the preceding claims wherein molecular weight of the first and the second component is 100 -1000 kDa.

17. The hydrogel precursor composition according any of the preceding claims wherein molecular weight of the first and the second component is 100 -300 kDa.

18. The hydrogel precursor component according to claim 1 wherein the at least one rheological modifier component comprises

    - hyaluronic acid with a molecular weight of 1200 kDa - 1900 kDa, and

- collagen, preferably type I with molecular weight of 250-300,

wherein the at least one rheological component comprises 2 - 50 wt-%, preferably 9 - 40 wt-%, more preferably 11 - 23 wt-% from the total weight of the hydrogel precursor composition.

19. The hydrogel precursor component according to claim 18 wherein the at least one rheological modifier component comprises one or more extracellular matrix proteins preferably selected from gelatin, laminin, fibronectin, vitronectin, and fragments and/or mixtures thereof.
20. The hydrogel precursor component of claim 18 or 19 wherein the at least one first reactive group is carbohydrazide and the at least one second reactive group is aldehyde.
21. The hydrogel precursor component of claim 18 or 19 wherein the at least one first reactive group is aldehyde and the at least one second reactive group is carbohydrazide.
22. The hydrogel precursor composition of any one of claims 18-21 wherein molecular weight of the first and the second component is 100 -1000 kDa.
23. The hydrogel precursor composition according any of claims 18- 21 wherein molecular weight of the first and the second component is 100 -300 kDa.
24. A bioink obtainable by mixing the hydrogel precursor composition according to any one of claims 1-23 with a fluid comprising cells.
25. Use of the hydrogel precursor composition of any one of claims 1-23, or the bioink of claim 24, for additive manufacturing, such as 3D printing.
26. A method for 3D printing the bioink of claim 24, the method comprising:

a) mixing the hydrogel precursor composition according to any one of claims 1-23 with a fluid comprising cells;

b) allowing the first component of the hydrogel precursor composition to crosslink with the second component of the hydrogel precursor composition in said fluid, and

c) 3D printing the bioink when the viscosity of the bioink is 200- 2000 Pa·s.