CLAIMS

We claim:

1. An engineered vertebral disc implant comprising:

   an engineered vertebral disc, wherein the engineered vertebral disc comprises a nucleus pulposus region and an annulus fibrosus region; and

   two endplates, wherein the endplates comprise a porous polymer foam, and wherein the endplates comprise channels.

2. The engineered vertebral disc implant of claim 1 wherein the endplates further comprise hydroxyapatite.

~~3. The engineered vertebral disc implant of claim 2, wherein the hydroxyapatite is coated on a surface of the endplates.~~

~~4. The engineered vertebral disc implant of any one of claims 2-3, wherein the hydroxyapatite is present throughout the endplates~~

~~5~~3. The engineered vertebral disc implant of ~~any one of~~ claim~~s~~ 1~~-4~~, wherein the endplates have a bone interface side and a vertebral disc interface side, wherein at least one of the two endplates comprises:~~.~~

   a body; and

   a projection on the bone interface side that extends outwardly from the body.

~~6. The engineered vertebral disc implant of claim 5, wherein at least one of the two endplates comprises:~~

~~a body; and~~

~~a projection on the bone interface side that extends outwardly from the body.~~

~~7~~4. The engineered vertebral disc implant of ~~any one of claims 1-6~~claim 1, wherein at least one of the two endplates further comprises one or more vascular-promoting agents.

~~8~~5. The engineered vertebral disc implant of claim ~~7~~4, wherein the one or more vascular-promoting agents are vascular endothelial growth factor, deferoxamine, nimodipine, or phthalimide neovascularization factor (PNF-1).

~~9~~6. The engineered vertebral disc implant of ~~any one of claims 1-8~~claim 1, wherein the nucleus pulposus region comprises a top surface, bottom surface, and a side edge extending between the top and bottom surfaces and defining a perimeter of the nucleus pulposus region~~.~~, wherein the perimeter of the nucleus pulposus is circumferentially surrounded by the annulus fibrosus region.

~~10. The engineered vertebral disc implant of claim 9, wherein the perimeter of the nucleus pulposus is circumferentially surrounded by the annulus fibrosus region.~~

~~11~~7. The engineered vertebral disc implant of ~~any one of claims 1-10~~ claim 3, wherein the annulus fibrosus region comprises a top surface, a bottom surface, an inner side edge, and an outer side edge that defines a perimeter of the annulus fibrosus region, wherein the inner side edge and the outer side edge extend between the top surface and the bottom surface~~.~~, wherein the vertebral disc interface side of a first endplate is attached to the top surfaces of the nucleus pulposus and annulus fibrosus regions, and wherein the vertebral disc interface side of a second endplate is attached to the bottom surfaces of the nucleus pulposus and annulus fibrosus regions.

~~12. The engineered vertebral disc implant of claim 11, wherein the vertebral disc interface side of a first endplate is attached to the top surfaces of the nucleus pulposus and annulus fibrosus regions, and wherein the vertebral disc interface side of a second endplate is attached to the bottom surfaces of the nucleus pulposus and annulus fibrosus regions.~~

~~13~~8. The engineered vertebral disc implant of ~~any one of claims 1-12~~claim 1, wherein the nucleus pulposus region comprises a hydrogel.

~~14~~9. The engineered vertebral disc implant of claim ~~13~~8, wherein the hydrogel comprises viable cells.

~~15. The engineered vertebral disc implant of claim 14, wherein the viable cells are mesenchymal stem cells or native disc cells, or a combination thereof.~~

~~16~~10. The engineered vertebral disc implant of ~~any one of claims 13-15~~ claim 8, wherein the hydrogel is a hyaluronic acid or agarose hydrogel.

~~17~~11. The engineered vertebral disc implant of ~~any one of claims 1-16~~ claim 1, wherein the annulus fibrosus region comprises one or more sheets of nano-fibrous PCL.

~~18. The engineered vertebral disc implant of claim 17, wherein the sheets of nano-fibrous PCL are aligned to form a lamellar structure.~~

~~19~~12. The engineered vertebral disc implant of ~~any one of claims 1-18~~ claim 1, wherein the annulus fibrosus region further comprises polyethylene oxide (PEO).

~~20~~13. The engineered vertebral disc implant of ~~any one of claims 1-19~~ claim 1, wherein the annulus fibrosus region comprises viable cells.

~~21. The engineered vertebral disc implant of claim 20, wherein the viable cells are mesenchymal stem cells or native disc cells.~~

~~22. The engineered vertebral disc implant of any one of claims 15-21, wherein the cells in the nucleus pulposus region and cells in the annulus fibrosus region are from the same source.~~

~~23~~14. The engineered vertebral disc implant of ~~any one of claims 15-22~~ claim 9, wherein the cells of the nucleus pulposus region or annulus fibrosus region have been previously cultured.

~~24. The engineered vertebral disc implant of any one of claims 1-23, wherein the engineered vertebral disc implant has been cultured.~~

~~25. The engineered vertebral disc implant of any one of claims 1-24, wherein the engineered vertebral disc implant further comprises proteoglycan and collagen.~~

~~26. The engineered vertebral disc implant of any one of claims 1-25, wherein the channels of each endplate comprise a plurality of channels that are spaced apart relative to a transverse axis.~~

~~27. The engineered vertebral disc implant of claim 26, wherein the plurality of channels of each endplate are parallel or substantially parallel to one another, and wherein the plurality of channels of each endplate are perpendicular or substantially perpendicular to the transverse axis.~~

~~28. The engineered vertebral disc implant of any one of claims 1-27, wherein each endplate has a thickness, and wherein each channel of the endplate has a depth that is less than the thickness of the endplate.~~

~~29. The engineered vertebral disc implant of claim 28, wherein the depth of each channel is measured from the bone interface side of the endplate toward the vertebral disc interface side of the endplate.~~

~~30. The engineered vertebral disc implant of any one of claims 26-29, wherein the channels of each endplate are evenly spaced relative to the transverse axis.~~

~~31. The engineered vertebral disc implant of claim 30, wherein sequential channels of each endplate are spaced apart by a distance ranging from 0.5 to 5 mm.~~

~~32. The engineered vertebral disc implant of any one of claims 5-31, wherein each endplate has a peripheral side edge extending between the bone interface side and the vertebral disc interface side of the endplate, and wherein each channel of the endplate has opposing ends that are spaced from the peripheral side edge of the endplate.~~

~~33. The engineered vertebral disc implant of any one of claims 6-32, wherein the projection cooperates with the body to define at least one channel of the endplate.~~

~~34. The engineered vertebral disc implant of claim 33, wherein the body solely defines a plurality of channels of the endplate.~~

~~35. The engineered vertebral disc implant of any one of claims 33-34, wherein the projection is centrally positioned on the endplate relative to the transverse axis.~~

~~36. The engineered vertebral disc implant of any one of claims 34-35, wherein the at least one channel defined by the projection and the body has a depth greater than the depths of the channels defined solely by the body.~~

~~37. The engineered vertebral disc implant of claim 36, wherein the depth of each channel defined by the projection and the body has a depth ranging from 0.5 to 3.5 mm, and wherein the depth of each channel defined solely by the body has a depth ranging from 0.5 to 1.5 mm.~~

~~38. The engineered vertebral disc implant of any one of claims 36-37, wherein at a maximum depth of each channel of the endplate, each channel is equally or substantially equally spaced from the vertebral disc interface side of the endplate.~~

~~39~~15. The engineered vertebral disc implant of ~~any one of claims 1-38~~ claim 1, wherein the porous polymer foam is poly (ε–caprolactone) (PCL), poly(lactic-co-glycolic acid), polylactic acid, poly-DL-lactide, or polydiaxanone.

~~40~~16. A method of treating disc degeneration comprising implanting one or more of the engineered vertebral disc implants of ~~claims 1-39~~ claim 1 to a subject in need thereof, wherein the endplates of the engineered vertebral disc implant are attached to the vertebra of the subject.

~~41~~17. The method of claim ~~40~~16, wherein the engineered vertebral disc implant is cultured prior to implanting to a patient.

~~42. The method of claim 41, wherein the engineered vertebral disc implant is cultured in the presence of TGF-β3 prior to implanting to a patient.~~

~~43. The method of any one of claims 41-42, wherein the culturing results in differentiation of the cells in the engineered vertebral disc implant.~~

~~44~~18. The method of ~~any one of claims 40-43~~ claim 16, further comprising removing the degenerated disc prior to implanting the engineered vertebral disc implant.

~~45~~19. The method of ~~any one of claims 40-44~~ claim 16, further comprising removing a portion of the vertebra prior to implanting engineered vertebral disc implants.

~~46~~20. The method of claim ~~45~~19, wherein removing a portion of the vertebra comprises scraping or drilling into the vertebra.

~~47~~21. The method of ~~any one of claims 40-46~~ claim 16, wherein the cells in the engineered vertebral disc implant are the cells obtained from the subject.

~~48~~22. The method of ~~any one of claims 40-47~~ claim 16, wherein the endplates are attached to the vertebra via the bone interface side.

~~49. The method of any one of claims 40-48, wherein the endplates integrate with the vertebra.~~

~~50. The method of any one of claims 40-49, wherein the subject's cells infiltrate into the engineered vertebral disc implant.~~

~~51. The method of any one of claims 40-50, wherein the endplates comprise collagen.~~

~~52. The method of any one of claims 40-51, wherein the endplates vascularize.~~

23. The engineered vertebral disc implant of claim 2, wherein at least one of the two endplates further comprises one or more vascular-promoting agents.

24. The method of claim 16, wherein the endplates further comprise hydroxyapatite.

25. The method of claim 24, wherein at least one of the two endplates further comprises one or more vascular-promoting agents.