

Lisa E. Freed, MD PhD

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Education

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|-----------------|---|
| 1/1986 – 9/1988 | Ph.D. Applied Biological Sciences, Massachusetts Institute of Technology |
| 9/1982 – 6/1988 | M.D. Harvard-MIT Division of Health Sciences & Technology; Harvard Medical School |
| 9/1981 – 6/1982 | S.M. Nutrition & Food Science, Massachusetts Institute of Technology |
| 9/1978 – 6/1982 | S.B. Life Sciences, Massachusetts Institute of Technology |

Postdoctoral Fellowships

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| 1/1991 – 1/1992 | NIH National Research Service Award
Massachusetts Institute of Technology |
| 9/1988 – 12/1989 | Fulbright Fellowship
Institute for International Education |

Professional Appointments

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|------------------|---|
| 7/2016 - Present | Research Scientist
Koch Institute for Integrative Cancer Research
Massachusetts Institute of Technology |
| 1/2009 - 7/2016 | MIT-Affiliated Research Scientist and Principal Investigator
Harvard-MIT Division of Health Sciences & Technology (HST);
Institute for Medical Engineering & Sciences (IMES)
Massachusetts Institute of Technology |
| 1/2009 - 7/2016 | Senior Technical Member of the Staff
Draper, Cambridge, Massachusetts |
| 8/1998 – 12/2008 | Principal Research Scientist
Harvard-MIT Division of Health Sciences & Technology
Massachusetts Institute of Technology |
| 1/1993 - 7/1998 | Research Scientist and Principal Investigator
Harvard-MIT Division of Health Sciences & Technology
Massachusetts Institute of Technology |
| 1/1991 - 12/1992 | Instructor
Department of Anatomy & Cellular Biology
Harvard Medical School |
| 3/1990 - 8/1990 | Lecturer
Harvard-MIT Division of Health Sciences & Technology |
| 3/1990 - 8/1990 | Postdoctoral Associate
Harvard-MIT Division of Health Sciences & Technology |

Honors & Awards (selected)

2012	Mass High Tech Women to Watch
2012	MIT Koch Image Award
2006	MIT Leader to Leader Fellow
2005	Center for Integration of Medicine and Innovative Technologies Award
2004, 2006	NASA Space Act Awards for Inventions, Scientific & Technical Contributions
2001	German Society of Orthopedics Wilhelm-Roux Prize for Basic Research
2000	American Institute for Medical and Biological Engineering Fellow
1988 - 1989	Harvard University Frederick Sheldon Traveling Fellowship
1987	MIT Chapter of Sigma Xi
1986 - 1988	Whitaker Health Sciences and Technology MD-PhD Fellowship
1985 - 1986	American Heart Association Pre-doctoral Fellowship
1982 - 1983	M.A. Cartland-Shackford Medical Fellowship

Professional Services (selected)

2009 - 2010	FIRST LEGO League, Challenge Advisor to "Body Forward" Team
2008 - 2014	MIT Institutional Animal Care and Use Committee (IACUC)
2007 - 2011	NIH Study Section ad hoc Reviewer
2006 - 2008	Alumni Planning Board, Leader to Leader (L2L) Program
2006 - 2007	HST and Harvard Medical School Admissions Committee
2006 - 2007	MIT Environmental Health & Safety (EHS) Working Group
2005 - 2008	HST Newsletter Editorial Board
1999 - 2006	MIT Pre-Health Advisory Board
1996 - 2004	NASA Scientific Oversight of the Design and Testing of a Cell Culture Unit for the International Space Station
1995 - 1997	NASA-NIH Advisory Committee on Biomedical and Behavioral Research

Publications

* Many of the papers are publically available through PubMed Central:
www.ncbi.nlm.nih.gov/sites/myncbi/lisa.freed.1/bibliography/40371011/public/?sort=date&direction=descending

Journal Articles (90):

- Xu, X., Anselmo, A.C., Buerkli, S., Zeng, Y., Tang, W., McHugh, K.J., Rosenberg, E., Zhuang, J., Sugarman, J.L., Behrens, A.M., Nguyen, T., Le, X., Guerra, A.S., Freed, L.E., Weinstock, S.B., Sears, C.B., Nikolic, B., Wood, L., Eckhoff, P.A., Oxley, J.D., Moretti, D., Zimmermann, M.B., Langer, R., Jaklenec. Development of a Heat-Stable Microparticle Platform for Oral Micronutrient Delivery: from Conception to Human Trials. *Science Translational Medicine* (under review).
- Morgan, K.Y., Sklaviadis, D., Tochka, Z.L., Fischer, K.M., Morgan, T.D., Hearon, K., Langer, R., Freed, L.E. Multi-Material Tissue Engineering Scaffolds with Hierarchical Pore Architectures. *Advanced Functional Materials*, 26(32): 5873-5883, 2016.
- Fischer, K.M., Morgan, K.Y., Hearon, K., Sklaviadis, D., Tochka, Z.L., Fenton, O.S., Anderson, D.G., Langer, R., Freed, L.E. Poly(limonene thioether) Scaffold for Tissue Engineering. *Advanced Healthcare Materials*, 5(7): 813-821, 2016.

4. Ye, X., Lu, L., Kolewe, M.E., Hearon, K., Fisher, K.M., Coppeta, J., Freed, L.E. Scalable Unit for Building Cardiac Tissue, *Advanced Materials*, 26(42): 7202-7208, 2014.
5. Park, H., Larson, B.L., Kolewe, M.E., Vunjak-Novakovic, G., Freed, L.E. Biomimetic Scaffold Combined with Electrical Stimulation and Growth Factor Promotes Tissue Engineered Cardiac Development, *Experimental Cell Research*, 321(2) 297-306, 2014.
6. Ye, X., Lu, L., Kolewe, M.E., Park, H., Larson, B.L., Kim, E., Freed, L.E. A Biodegradable Microvessel Scaffold as a Framework to Enable Vascular Support of Engineered Tissues, *Biomaterials*, 34(38): 10007-10015, 2013.
7. Kolewe, M.E., Park, H., Gray, C., Ye, X., Langer, R., Freed, L.E. 3D Structural Patterns in Scalable Elastomeric Polymer Scaffolds Guide Engineered Tissue Architecture. *Advanced Materials*, 25(32): 4459-4465, 2013.
8. Neal, R.A., Jean, A., Park, H., Wu, P.B., Hsiao, J., Engelmayr, G.C. Jr, Langer, R., Freed, L.E. Three-Dimensional Elastomeric Scaffolds Designed with Cardiac-Mimetic Structural and Mechanical Features, *Tissue Engineering-Part A*, 19(5-6):793-807, 2013.
9. Park, H., Larson, B.L., Guillemette, M.D., Jain, S.R., Hua, C., Engelmayr, G.C., Freed, L.E. The Significance of Pore Microarchitecture in a Multi-Layered Elastomeric Scaffold for Contractile Cardiac Muscle Constructs, *Biomaterials*, 32: 1856-1864, 2011.
10. Abrahamsson, C.K., Yang, F., Park, H., Brunger, J.M., Valonen, P.K., Langer, R., Welter, J.F., Caplan, A.I., Guilak, F., Freed, L.E., Chondrogenesis and Mineralization during *in vitro* Culture of Human Mesenchymal Stem Cells on 3D-Woven Scaffolds, *Tissue Engineering – Part A*, 16(12) 3709-3918, 2010.
11. Valonen, P.K., Moutos, F.T., Kusanagi, A., Moretti, M., Diekman, B., Welter, J., Caplan, A., Guilak, F., Freed, L.E. *In Vitro* Generation of Mechanically Functional Cartilage Grafts based on Adult Human Stem Cells and 3D-Woven poly(ϵ -caprolactone) Scaffolds, *Biomaterials* 31: 2193-2200, 2010.
12. Guillemette, M.D., Park, H., Hsiao, J.C., Jain, S.R., Larson, B.L., Langer, R., Freed, L.E., Combined Technologies for Microfabricating Elastomeric Cardiac Tissue Engineering Scaffolds, *Macromolecular Bioscience* 10(11) 1330-1337, 2010.
13. Mobine HR, Engelmayr G.C., Moussazadeh N., Anwar T.R., Freed L.E., Edelman E.R. Encapsulated Pheochromocytoma Cells Secrete Potent Non-Catecholamine Factors, *Tissue Engineering-Part A*, 15(7):1719-28, 2009.
14. Freed, L.E., Engelmayr, G.C., Borenstein, J.T., Moutos, F.T., Guilak, F. Advanced Material Strategies for Tissue Engineering Scaffolds. *Advanced Materials*, 21 (32-33): 3410-3418, 2009.
15. Cheng, M., Moretti, M., Engelmayr, G.C., Freed, L.E. Insulin-like Growth Factor-I and Slow, Bi-Directional Perfusion Enhance the Formation of Tissue Engineered Cardiac Grafts, *Tissue Engineering*, 15(3): 645-653, 2009.
16. Moretti, M., Freed, L.E., Padera, R.F., Lagana, K., Boschetti, F., Raimondi, M. An Integrated Experimental-Computational Approach for the Study of Engineered Cartilage Constructs Subjected to Combined Regimens of Hydrostatic Pressure and Interstitial Perfusion, *Biomedical Materials and Engineering* 18:273-278, 2008.
17. Engelmayr, G.C., Cheng, M., Bettinger, C.J., Borenstein, J.T., Langer, R., Freed, L.E. Accordion-Like Honeycombs for Tissue Engineering of Cardiac Anisotropy. *Nature Materials*, 7: 1003-1010, 2008
Commentary in same issue, p. 932-933.
18. Nichol, J.W., Engelmayr, G.C., Cheng, M., Freed, L.E. Co-culture Induces Alignment in Engineered Cardiac Constructs via MMP-2 Expression, *Biochemical and Biophysical Research Communications* 373: 360-365, 2008.
19. Radisic M., Park, H., Martens, T.P., Salazar-Lazaro, J.E., Geng, W., Wang, Y., Langer, R., Freed, L.E., Vunjak-Novakovic, G. Pre-treatment of Synthetic Elastomeric Scaffolds by Cardiac Fibroblasts Improves Engineered Heart Tissue, *Journal of Biomedical Materials Research-A* 86: 713-724, 2008.
20. Augst, A., Marolt, D., Freed, L.E., Vepari, C., Meinel, L., Farley, M., Fajardo, R., Patel, N., Gray, M.L., Kaplan, D.L., Vunjak-Novakovic, G. Effects of chondrogenic and osteogenic regulatory factors on composite constructs grown using human bone marrow stem cells, silk scaffolds and bioreactors, *Journal of the Royal Society Interface* 5: 929-939, 2008.
21. Moutos, F.T., Freed, L.E., Guilak, F. A Biomimetic Three-Dimensional Woven Composite Scaffold for Functional Tissue Engineering of Cartilage. *Nature Materials* 6:162-167, 2007; Commentary in same issue, p. 89-90.
22. Cheng, M., Park, H., Engelmayr, G.C., Moretti, M., Freed, L.E. Effects of Regulatory Factors on Engineered Cardiac Tissue In Vitro. *Tissue Engineering* 13(11): 2709-2719, 2007.
23. Freed, L.E., Guilak, F., Guo, X.E., Gray, M.L., Tranquillo, R., Holmes, J., Radisic, M., Sefton, M., Kaplan, D., Vunjak-Novakovic, G. Advanced Tools: Scaffolds, Bioreactors, and Signaling, *Tissue Engineering* 12: 3285- 3305, 2006.

24. Radisic M., Park, H., Chen, F., Salazar-Lazzaro, J.E., Wang, Y., Dennis, R. Langer, R., Freed L.E., Vunjak-Novakovic, G. Biomimetic Approach to Cardiac Tissue Engineering: Oxygen Carriers and Channeled Scaffolds, *Tissue Engineering*, 12(8) 1-15, 2006.
25. Marolt, D., Augst, A., Freed, L.E., Vepari, C., Fajardo, R., Patel, N., Gray, M., Farley, M., Kaplan, D., Vunjak-Novakovic, G. Bone and Cartilage Tissue Constructs Grown Using Human Bone Marrow Stromal Cells, Silk Scaffolds, and Rotating Bioreactors, *Biomaterials* 27(36):6138-6149, 2006.
26. Boublik J., Park, H., Radisic, M., Tognana, E., Chen, F., Pei, M., Vunjak-Novakovic, G., Freed, L.E. Mechanical Properties and Remodeling of Hybrid Cardiac Constructs made from Heart Cells, Fibrin, and a Biodegradable Elastomeric Knitted Fabric, *Tissue Engineering* 11 (7/8): 1122-1132, 2005.
27. Tognana, E., Chen, F., Padera, R.F., Leddy, H.A., Christensen, S.E., Guilak, F., Vunjak-Novakovic, G., Freed, L.E. Adjacent Tissue (Cartilage, Bone) Affect the Functional Integration of Engineered Calf Cartilage In Vitro, *Osteoarthritis and Cartilage* 13(2): 129-138, 2005.
28. Tognana, E., Chen, F., Padera, R.F., Vunjak-Novakovic, G., Freed, L.E. Development and Remodeling of Engineered Cartilage-Explant Composites In Vitro and In Vivo, *Osteoarthritis and Cartilage* 13 (10): 896-905, 2005.
29. Seidel, J.O., Pei, M., Gray, M.L., Langer, R., Freed, L.E., Vunjak-Novakovic, G. Long Term Culture of Tissue Engineered Cartilage in a Perfused Chamber with Mechanical Stimulation, *Biorheology* 41: 445-458, 2004.
30. Schäfer, D., Seidel, J.O, Martin, I., Jundt, G., Heberer, M., Grodzinsky, A.L., Vunjak-Novakovic, G., Freed, L.E. Engineering and Characterization of Functional Osteochondral Repair Tissue, *Orthopäde* 33: 721-726, 2004.
31. Radisic, M., Park, H. Shin, H., Consi, T., Schoen, F.J., Freed, L.E., Vunjak-Novakovic, G. Novakovic G. Functional Assembly of Engineered Myocardium by Electrical Stimulation of Cardiac Myocytes cultured on Scaffolds, *Proceedings of the National Academy of Sciences USA* 101: 18129-18134, 2004.
32. Radisic, M., Yang, L, Boublik, J, Cohen, R.J., Langer, R., Freed, L.E., Vunjak-Novakovic, G. Medium Perfusion Enables Engineering of Compact and Contractile Cardiac Tissue. *American Journal of Physiology (Heart Circ. Physiol.)* 286: H507-516, 2004.
33. Radisic, M., Euloth, M., Langer, R., Freed, L.E., Vunjak-Novakovic, G. High Density Seeding of Myocyte Cells for Cardiac Tissue Engineering, *Biotechnology and Bioengineering* 82: 403-414, 2003.
34. Bursac, N., Papadaki, M., White, J.A., Eisenberg S.R., Vunjak-Novakovic, G., Freed, L.E. Cultivation in Rotating Bioreactors Promotes Maintenance of Cardiac Myocyte Electrophysiology and Molecular Properties, *Tissue Engineering*, 9(6): 1243-1253, 2003.
35. Madry, H., Padera, R., Seidel, J., Langer, R., Freed, L.E., Trippel, S.B., Vunjak-Novakovic, G. Gene Transfer of a Human Insulin-Like Growth Factor I cDNA Enhances Tissue Engineering of Cartilage, *Human Gene Therapy*, 13: 1621-1630, 2002.
36. Vunjak-Novakovic, G., de Luis J., Searby, N., Freed L.E. Microgravity Studies of Cells and Tissues, *Annals of the New York Academy of Sciences*, 974: 504-517, 2002.
37. Pei, M., Solchaga, L.A., Seidel, J., Zeng, L, Vunjak-Novakovic, G., Caplan, A.I., Freed, L.E. Bioreactors Mediate the Effectiveness of Tissue Engineering Scaffolds. *FASEB Journal on-line doi: 10.1096/fj.02-0083fje* and *FASEB Journal*, 16: 1691-1694, 2002.
38. Pei, M., Seidel, J., Vunjak-Novakovic, G., Freed, L.E. Growth Factors for Sequential Cellular De- and Redifferentiation in Tissue Engineering. *Biochemical and Biophysical Research Communications*, 294: 149-154, 2002.
39. Schaefer, D., Martin, I., Jundt, G., Seidel, J., Heberer, M., Grodzinsky, A.J, Bergin, I., Vunjak-Novakovic, G., Freed, L.E. Tissue Engineered Composites for the Repair of Large Osteochondral Defects, *Arthritis and Rheumatism*, 46: 2524-2534, 2002.
40. Vunjak-Novakovic, G., Obradovic, B., Martin, I., Freed, L.E. Bioreactor Studies of Native and Tissue Engineered Cartilage, *Biorheology*, 39:259-268, 2002.
41. Carrier, R.L., Rupnick, M.A., Langer, R., Schoen, F.J., Freed, L.E., Vunjak-Novakovic, G. Effects of Oxygen on Engineered Cardiac Muscle, *Biotechnology and Bioengineering*, 78: 617-625, 2002.
42. Carrier, R.L., Rupnick, M.A., Langer, R., Schoen, F.J., Freed, L.E., Vunjak-Novakovic, G. Perfusion Improves Tissue Architecture of Engineered Cardiac Muscle, *Tissue Engineering* 8: 175-187, 2002.
43. Gooch, K.J., Blunk, T., Courter, D.L., Sieminski, A.L., Vunjak-Novakovic, G, Freed, L.E. Bone Morphogenetic Proteins-2, -12, and -13 Modulate In Vitro Development of Engineered Cartilage, *Tissue Engineering* 8: 591-601, 2002.
44. Blunk, T., Sieminski, A.L., Gooch, K.J., Courter, D.L., Hollander, A.P., Nahir, A.M., Langer, R., Vunjak-Novakovic, G., Freed, L.E. Differential Effects of Growth Factors on Tissue Engineered Cartilage, *Tissue Engineering*, 8: 73-84, 2002.
45. Papadaki, M., Bursac, N., Langer, R., Merok, J., Vunjak-Novakovic, G., Freed, L.E. Tissue Engineering of Functional Cardiac Muscle: Molecular, Structural and Electrophysiological Studies, *American Journal of Physiology*. 280 (Heart Circ. Physiol.) H168-H178, 2001.

46. Obradovic, B., Martin, I., Padera, R.F., Treppo, S., Freed, L.E., Vunjak-Novakovic G. Integration of Engineered Cartilage, *Journal of Orthopaedic Research* 19, 1089-1097, 2001.
47. Obradovic, B., Martin, I., Freed, L.E., Vunjak-Novakovic, G. Bioreactor Studies of Natural and Tissue Engineered Cartilage, *Orthopedia Traumatologia Rehabilitacija*, 3: 181-189, 2001.
48. Martin, I., Shastri, V.P., Padera, R.F., Yang, J., McKay, A.J., Langer, R., Vunjak Novakovic, G., Freed, L.E. Selective Differentiation of Bone Marrow Stromal Cells Cultured on Three Dimensional Polymer Foams, *Journal of Biomedical Materials Research*, 55: 229-235, 2001.
49. Martin, I., Suetterlin, R., Baschong, W., Heberer, M., Vunjak-Novakovic, G., Freed, L.E. Enhanced Cartilage Tissue Engineering by Sequential Exposure of Chondrocytes to FGF-2 During 2D Expansion and BMP-2 During 3D Cultivation, *Journal of Cellular Biochemistry* 83: 121-128, 2001.
50. Gooch, K.J., Blunk, T., Courter, D.L., Sieminski, A.L., Bursac, P.M., Vunjak-Novakovic, G, Freed, L.E. IGF-I and Mechanical Environment Interact to Modulate Engineered Cartilage Development, *Biochemical and Biophysical Research Communications*, 286: 909-915, 2001.
51. Gooch, K.J., Kwon, J.H., Blunk, T., Langer, R., Freed, L.E., Vunjak-Novakovic, G. Effects of Mixing Intensity on Tissue Engineered Cartilage. *Biotechnology and Bioengineering*, 72: 402-407, 2001.
52. Obradovic, B., Meldon J., Freed, L.E., Vunjak-Novakovic, G. Mathematical Model of Glycosaminoglycan Deposition in Tissue Engineered Cartilage, *Journal of the American Institute of Chemical Engineers*, 46: 1860-1871, 2000.
53. Schaefer, D., Martin, I., Shastri, P., Padera, R.F., Langer, R., Freed, L.E., Vunjak-Novakovic, G. In Vitro Generation of Osteochondral Composites, *Biomaterials*, 21: 2599-2606, 2000.
54. Martin, I., Obradovic, B., Treppo, S., Grodzinsky, A.J., Langer, R., Freed, L.E., Vunjak-Novakovic, G. Modulation of the Mechanical Properties of Tissue Engineered Cartilage, *Biorheology*, 37: 141 – 147, 2000.
55. Vunjak-Novakovic, G., Preda, C., Bordonaro, J., Pellis, N., de Luis, J., Freed, L.E. Microgravity Studies of Cells and Tissues: from Mir to ISS, *American Institute of Physics (AIP) Conference Proceedings*, 458, 442, 1999. doi: 10.1063/1.57609.
56. Martin I., Obradovic B., Freed L.E., Vunjak-Novakovic G. A Method for Quantitative Analysis of Glycosaminoglycan Distribution in Cultured Natural and Engineered Cartilage, *Annals of Biomedical Engineering*, 27: 656-662, 1999.
57. Martin, I., Vunjak-Novakovic, G., Yang, J., Langer, R., Freed, L.E. Mammalian Chondrocytes Expanded in the Presence of Fibroblast Growth Factor-2 Maintain the Ability to Differentiate and Regenerate Three-dimensional Cartilaginous Tissue, *Experimental Cell Research*, 253: 681 - 688, 1999.
58. Freed L.E., Martin I., Vunjak-Novakovic G. Frontiers in Tissue Engineering: In Vitro Modulation of Chondrogenesis, *Clinical Orthopedics and Related Research*, 367S: S46-S58, 1999.
59. Carrier R., Papadaki M., Rupnick, M., Schoen F.J., Bursac N., Langer R., Freed L.E, Vunjak-Novakovic G. Cardiac Tissue Engineering: Cell Seeding, Cultivation Parameters and Tissue Construct Characterization, *Biotechnology and Bioengineering*, 64: 580-589, 1999.
60. Bursac N., Papadaki M., Cohen R.J., Schoen F.J., Eisenberg S.R., Carrier R., Vunjak-Novakovic G., Freed, L.E. Cardiac Muscle Tissue Engineering: Toward an In Vitro Model for Electrophysiological Studies, *American Journal of Physiology*, 277 (Heart Circ. Physiol. 46): H433-H444, 1999.
61. Obradovic B, Carrier R.L., Vunjak-Novakovic G.V., Freed L.E. Gas Exchange is essential for Bioreactor Cultivation of Tissue Engineered Cartilage, *Biotechnology and Bioengineering*, 63: 197-205, 1999.
62. Freed L.E., Pellis N., Searby N., de Luis J., Preda C., Bordonaro J., Vunjak-Novakovic G. Microgravity Cultivation of Cells and Tissues, *Gravitational and Space Biology Bulletin*, 12 (2): 57-66, 1999.
63. Vunjak-Novakovic, G., Martin, I., Obradovic, B., Treppo S., Grodzinsky, A.J., Langer R., Freed, L.E. Bioreactor Cultivation Conditions Modulate the Composition and Mechanical Properties of Tissue Engineered Cartilage, *Journal of Orthopedic Research*, 17, 130-138, 1999.
64. Riesle J., Hollander A.P., Langer R., Freed L.E., Vunjak-Novakovic G. Collagen in Tissue Engineered Cartilage: Types, Structure and Crosslinks. *Journal of Cellular Biochemistry*, 71: 313-327 1998.
65. Freed, L.E., Vunjak-Novakovic, G. Culture of Organized Cell Communities, *Advanced Drug Delivery Reviews*, 33 (1,2) 15-30 1998.
66. Martin, I, Padera, R.F., Vunjak-Novakovic, G., Freed, L.E. In Vitro Differentiation of Chick Embryo Bone Marrow Stromal Cells into Cartilaginous and Bone-like Tissues, *Journal of Orthopedic Research* 16: 181-189, 1998.
67. Freed, L.E., Hollander, A.P., Martin, I., Barry, J.R., Martin, I., Vunjak-Novakovic, G. Chondrogenesis in a Cell-Polymer-Bioreactor System, *Experimental Cell Research*, 240: 58-65, 1998.
68. Freed, L.E., Langer, R., Martin, I., Pellis, N., Vunjak-Novakovic, G. Tissue Engineering of Cartilage in Space, *Proceedings of the National Academy of Sciences USA*, 94: 13885-13890, 1997; Commentary in same issue on p. 13380-13382.
69. Vunjak-Novakovic G., Obradovic B., Bursac P., Martin, I., Langer R., Freed L.E. Dynamic Seeding of Polymer

- Scaffolds for Cartilage Tissue Engineering, *Biotechnology Progress*, 14: 193-202, 1998.
70. Freed, L.E. and Vunjak-Novakovic, G. Microgravity Tissue Engineering, *In Vitro Cellular and Developmental Biology* 33: 381-385, 1997.
 71. Vunjak-Novakovic and G., Freed, L.E. Cell Polymer Bioreactor System for Tissue Engineering, *Journal of the Serbian Chemical Society* 62: 787-799, 1997.
 72. Bursac P.M., Freed, L.E., Biron R., Vunjak-Novakovic, G. Mass Transfer Studies of Tissue Engineered Cartilage, *Tissue Engineering*, 2 (2) 141-150, 1996.
 73. Vunjak-Novakovic G., Freed, L.E. Cell-Polymer System for Tissue Engineering, *Chemical Industry* 49 (12) 511-519, 1996.
 74. Freed L.E., Vunjak-Novakovic, G. Biomedical Reactors: Mixing Patterns in Oscillating and Rotating Vessels, *Journal of the Serbian Chemical Society*, 61 (4-5) 283-295, 1996.
 75. Vunjak-Novakovic G., Freed, L.E., Langer, R. Chondrocytes Cultured on Biodegradable Polymers, *Synovial Journal de Rhumatologie*, 4, 4-5, 1996.
 76. Vunjak-Novakovic, G., Freed, L.E., Biron R., Langer, R. Effects of Mixing on Tissue Engineered Cartilage, *Journal of the American Institute of Chemical Engineers*, 42 (3) 850-860, 1996.
 77. Freed L.E., Vunjak-Novakovic, G. Cultivation of Cell-Polymer Constructs in Simulated Microgravity, *Biotechnology and Bioengineering*, 46, 306-313, 1995.
 78. Langer, R., Vacanti, J.P., Vacanti, C., Atala, A., Freed, L.E., Vunjak-Novakovic, G. Tissue Engineering: Biomedical Applications, *Tissue Engineering*, 1(2): 151-161, 1995.
 79. Mikos, A.G., Lyman, M.D., Freed, L.E., Langer, R., Wetting of Poly(L-lactic acid) and Poly (DL-lactic-co-glycolic acid) Foams for Tissue Culture, *Biomaterials*, 15: 55-58, 1994.
 80. Freed, L.E., Grande, D.A., Emmanuel, J., Marquis, J.C., Lingbin, Z., Langer, R., Joint Resurfacing using Allograft Chondrocytes and Synthetic Biodegradable Polymer Scaffolds, *Journal of Biomedical Materials Research*, 28: 891-899, 1994.
 81. Freed, L.E., Vunjak-Novakovic, G., Biron, R., Eagles, D. Lesnoy, D., Barlow S., Langer, R. Biodegradable Polymer Scaffolds for Tissue Engineering, *Bio/Technology*, 12, 689-693, 1994.
 82. Freed, L.E., Marquis, J.C., Vunjak-Novakovic, G., Emmanuel, J., Langer, R. Composition of Cell-Polymer Cartilage Implants, *Biotechnology and Bioengineering*, 43, 605-614, 1994.
 83. Freed, L.E., Vunjak-Novakovic, G., Marquis, J.C., Langer, R. Kinetics of Chondrocyte Growth in Cell - Polymer Implants, *Biotechnology and Bioengineering*, 43, 597-604, 1994.
 84. Freed, L.E., Vunjak-Novakovic G., Langer, R. Cultivation of Cell-Polymer Cartilage Implants in Bioreactors, *Journal of Cell Biochemistry*, 51, 257-264, 1993.
 85. Freed, L.E., Marquis, J.C., Nohria, A., Mikos, A.G., Emmanuel, J., Langer, R., Neocartilage Formation In Vitro and In Vivo using Cells Cultured on Synthetic Biodegradable Polymers, *Journal of Biomedical Materials Research*, 27: 11-23, 1993.
 86. Freed, L.E., G. Vunjak-Novakovic, P.A. Drinker and R. Langer, Bioreactor Based on Suspended Particles of Immobilized Enzyme, *Annals of Biomedical Engineering*, 21, 57-65, 1993.
 87. Freed, L.E., Vunjak-Novakovic, G., Bernstein, H., Cooney C.L., Langer, R. The Kinetics of Immobilized Heparinase in Human Blood, *Annals of Biomedical Engineering*, 21, 67-76, 1993.
 88. Freed, L.E., Endemann, G., Tomera, J.F., Gavino, V.C., Brunengraber, H. Lipogenesis from Ketone Bodies in Perfused Livers of Streptozotocin Diabetic Rats, *Diabetes*, 37: 50-55, 1988.
 89. Kopito, R., Weinstock, S., Freed, L.E., Murray, D., Brunengraber, H., Metabolism of Plasma Mevalonate in Rats and Humans, *Journal of Lipid Research*, 23: 577-583, 1982.
 90. Freed, L.E., Freed, C., O'Donnell, R., Small Signal Gain Saturation Intensity of I & II Vibrational Band Transitions in Sealed-off CO₂ Lasers, *Journal of Quantum Electronics*, 18: 1229-1236, 1982.

Book Chapters (12):

1. Moffat, K.L., Neal, R.A., Freed, L.E., Guilak, F. 2014. Engineering Functional Tissues: In Vitro Culture Parameters, in: *Principles of Tissue Engineering*, 4th Edition (R. Lanza, R. Langer and J. Vacanti, eds., Elsevier/Academic Press) Ch. 13, pp. 237-260, ISBN: 978-0-12-398358-9.
2. Freed, L.E. and Guilak, F. 2007. Engineering Functional Tissues, in: *Principles of Tissue Engineering* 3rd Edition, (R. Lanza, R. Langer and J. Vacanti, eds., Elsevier/Academic Press) Ch. 11, pp. 137-153.
3. Freed, L.E., Rupnick, M.A., Schaefer, D., Vunjak-Novakovic, G. 2003. Engineering Functional Cartilage and Cardiac Tissue: In Vitro Culture Parameters, in: *Functional Tissue Engineering: the Role of Biomechanics* (F. Guilak, D. Butler, D. Mooney, S. Goldstein, eds, Springer Verlag) Ch. 27, pp. 360-376.
4. Freed L.E., Vunjak-Novakovic, G. 2003. Tissue Engineering of Cartilage, In: *Principles and Applications in Engineering Series: Tissue Engineering* (B. Palsson, J.A. Hubbell, R. Plonsey, J.D. Bronzino, eds., CRC Press). Ch. 23, pp.23-1 – 23-26.

5. Freed, L.E. and G. Vunjak-Novakovic, 2002. Spaceflight Bioreactor Studies of Cells and Tissues, in: *Cell Biology and Biotechnology in Space* (A. Cogoli, ed., Elsevier Science) *Advances in Space Biology and Medicine* Ch. 8, pp. 177-195.
6. Freed, L.E. and G. Vunjak-Novakovic, 2002. Cell-Polymer-Bioreactor Systems, in: *Methods of Tissue Engineering* (A. Atala and R.P. Lanza, eds. Academic Press) Ch. 6, pp. 99-114.
7. Freed, L.E. and Vunjak-Novakovic, G. 2000. Tissue Engineering Bioreactors, in: *Principles of Tissue Engineering*, 2nd edition (R.P. Lanza, R. Langer and J. Vacanti, eds., Academic Press) Ch. 13, pp. 143-156.
8. Freed, L.E. and Vunjak-Novakovic, G. 2000. Tissue Engineering of Cartilage, in: *The Biomedical Engineering Handbook*, 2nd edition, (J.D. Bronzino, ed., CRC Press) Vol. II, pp. 124-1 – 124-26.
9. Gooch, K.J, Blunk, T, Tennant, C.J, Vunjak-Novakovic, G, Langer R, Freed L.E., 1998. Mechanical Forces and Growth Factors utilized for Tissue Engineering. in: *Frontiers in Tissue Engineering*, C.W. Patrick, A.G. Mikos, L.V. McIntyre, eds, Elsevier press, Oxford, pp. 61-82.
10. Freed, L.E. and Vunjak-Novakovic, G. 1997. Tissue Culture Bioreactors: Chondrogenesis as a Model System, in: *Principles of Tissue Engineering*, 1st edition (R.P. Lanza, R. Langer and W.L. Chick, eds., Landes and Springer Verlag, Ch. 11, pp. 151-165).
11. Freed L.E. and Vunjak-Novakovic, G. 1996. Cultivation of Cell-Polymer Cartilage Implants in Bioreactors, in: *Cell and Tissue Culture Laboratory Procedures*, J.B. Griffiths, A. Doyle, D.G. Newell (eds), Wiley & Sons 2E: 6.1 - 6.11.
12. Freed, L.E. and Vunjak-Novakovic, G. 1995. Tissue Engineering of Cartilage, in: *The Biomedical Engineering Handbook*, J.D. Bronzino, ed., CRC Press. Ch. 120, pp. 1778-1796.

Patents and Patent Applications (7):

1. US 20140243995A1, Publication Date: August 28, 2014
“Stacked Planar Sheet Tissue Engineering Scaffolds with 3-D Structural Order”
Inventors: M.E. Kolewe, L.E. Freed, C. Gray, R. Langer
2. US8367410B2, Publication Date: February 5, 2013
“Application of Electrical Stimulation for Functional Tissue Engineering *In Vitro* and *In Vivo*”
Inventors: M. Radisic, H. Park, R. Langer, L.E. Freed, G. Vunjak-Novakovic
3. US20100297233A1, Publication Date: November 25, 2010
“Oscillating Cell Culture Bioreactor”
Inventors: M.G. Moretti, L.E. Freed, R. Langer
4. US20050037952A1, Publication Date: February 17, 2005
“Effect of Bone Morphogenetic Proteins on Engineered Cartilage”
Inventors: L.E. Freed, K. Gooch, D.Courter, T. Blunk, A. Sieminski, G. Vunjak-Novakovic
5. US6582960B1, Publication Date: June 24, 2003
“Fibroblast Growth Factor-2 for Expansion of Chondrocytes and Tissue Engineering”
Inventors: I. Martin, L.E. Freed, R. Langer, G. Vunjak-Novakovic
6. US7252982A1, Publication Date: November 28, 2002
“Tissue Engineering Enhanced by the Transfer of a Growth Factor Gene”
Inventors: H. Madry, G. Vunjak-Novakovic, S. Trippel, L.E. Freed, R. Langer
7. US4846786A, Publication Date: July 11, 1989
“Bioreactor Containing Suspended, Immobilized Species”
Inventors: L.E. Freed, J. Kadam, P.A. Drinker, R. Thebeau, R. Langer

Teaching

2001- 2009	HST-521: “Biomaterials & Tissue Engineering in Medical Devices & Artificial Organs” Role: Guest Lecturer (HST medical & dental students / MEMP PhD students)
2003-2005	HST-535: “Principles & Practice of Tissue Engineering” Role: Guest Lecturer (MIT undergraduate/graduate students)
1990-1992	HST-010: “Human Functional Anatomy” Role: Core Instructor (HST medical students / MEMP PhD students)
1991-1993	10.02J: “Biotechnology & Engineering” Role: Guest Lecturer (MIT undergraduates)

1986	7.54J: "Human Physiology" Role: Teaching Assistant (MIT undergraduates)
1982	20.211J: "Metabolic Biochemistry" Role: Teaching Assistant (MIT undergraduates)

Mentoring

Pre-professional student advisees (recent):

Demetra Sklaviadis, (pre-graduate student / technical assistant) 2014 – 2016
 Zachary Tochka, 2014-15 (pre-medical student / technical assistant) 2014 – 2015
 Amanda Pinheiro, (MIT Summer Research Program, MSRP) summer, 2015
 Jennifer Yu (UROP) 2012 -2013
 Patrick Wu, (pre-medical student / technical assistant) 2011 - 2012
 Elizabeth Walker, (UROP) 2011 – 2012
 Saloni Jain, (UROP) 2009 - 2011

Graduate students:

Eric Schmitt, S.M. Thesis, "Design and development of a stamping press capable of punching microscale holes in polymer membranes", Tufts University Dept. of Mechanical Engineering (co-supervised by Profs. Thomas James and Robert White), August, 2013.

Christoffer Abrahamsson, S.M. Thesis, "Cartilage formation and mineralization by human mesenchymal stem cells in 3D woven poly(ϵ -caprolactone) scaffolds", Chalmers University of Technology, Goteborg, Sweden (primary research supervisor), August, 2010.

Jan Boublik, M.D.Thesis, "Generation of a three-dimensional cardiac tissue graft", Medizinische Hochschule Hanover, Germany (primary research supervisor), October, 2004.

Milica Radisic, Ph.D. Thesis, "Biomimetic approach to cardiac tissue engineering", MIT Dept. of Chemical Engineering (co-supervised with Prof. Robert Langer and Dr. Gordana Vunjak-Novakovic), July, 2004.

Joachim Seidel, Ph.D. Thesis, "Long term culture of tissue engineered cartilage and effects of mechanical stimulation", Swiss Federal Institute of Technology (ETH), Zurich, Switzerland (co-supervised with Profs. Stusse and Robert Langer), October, 2003.

Gregory Altman, Ph.D. Thesis, "Tissue engineered cruciate ligament", Tufts University Dept. of Chemical Engineering (co-supervised with Prof. David Kaplan), April, 2002.

Predrag Bursac. Ph.D. Thesis, "Structure function Relationships in cartilaginous tissues", Boston University Dept. of Biomedical Engineering (co-supervised with Prof. Dimitrije Stamenovic), September, 2000.

Nenad Bursac, Ph.D. Thesis, "Engineered cardiac tissue: A novel in vitro model for electrophysiological studies of cardiac muscle", Boston University Dept. of Biomedical Engineering (co-supervised with Profs. Solomon Eisenberg and Richard J. Cohen), June, 2000.

Rebecca Carrier, Ph.D. Thesis, "Cardiac tissue engineering: bioreactor cultivation parameters", MIT Dept. of Chemical Engineering (co-supervised with Prof. Robert Langer & Dr. Gordana Vunjak-Novakovic), June, 2000

Bojana Obradovic, Ph.D. Thesis, "Bioreactor studies of tissue engineered cartilage: Experiments and modeling", Tufts University Dept. of Chemical Engineering (co-supervised with Prof. Jerry Meldon & Dr. Gordana Vunjak-Novakovic), November, 1999.

Anju Nohria, M.D. HST Thesis, "Expression and controlled release of interleukin-1 receptor antagonist", Harvard-MIT Division of Health Sciences and Technology (co-supervised with Profs. Robert Langer and Lee Gehrke), June, 1994.

Post-doctoral trainees:

Dr. Kathy Ye Morgan, PhD, 2014 - 2016
 Dr. M. Keith Hearon, PhD, 2014 - 2016
 Dr. Kristin Fischer, PhD, 2013 – 2015
 Dr. Liang Lu, PhD, 2013 - 2014
 Dr. Xiaofeng Ye, MD, 2012 - 2014
 Dr. Marty Kolewe, PhD, 2011 - 2014
 Dr. Bijoy Karikkineth, PhD, 2011 - 2012

Dr. Rebekah Neal-Hensley, PhD, 2011 - 2012
 Dr. Benjamin Larson, PhD, 2009 - 2012
 Dr. Maxime Guillemette, PhD, 2009 - 2011
 Dr. Piia Valonen, PhD, 2007 - 2008
 Dr. George Engelmayr, PhD, 2005 – 2009
 Dr. Jason Nichol, PhD, 2005 - 2008
 Dr. Mingyu Cheng, MD-PhD, 2005 – 2007
 Dr. Matteo Moretti, PhD, 2005 – 2006
 Dr. Alexander Augst, PhD, 2004 - 2005
 Dr. Hyounghshin Park, PhD, 2004 - 2007
 Dr. Enrico Tognana, PhD, 2002 - 2004
 Dr. Fen Chen, MD, 2000 - 2003
 Dr. Ming Pei, MD-PhD, 2000 - 2002
 Dr. Dirk Schaefer, MD, 1998 - 2000
 Dr. Shane Williams, PhD, 1997 – 1999
 Dr. Maria Papadaki, PhD, 1997 - 1999
 Dr. Ivan Martin, PhD, 1996 - 1999
 Dr. Jens Riesle, PhD, 1996 - 1998
 Dr. Torsten Blunk, PhD, 1996 - 1997
 Dr. Keith Gooch, PhD, 1995 – 1997

Research Support

Active:

NIH (NHLBI) 1-R01 HL107503 06/15/11 – 10/31/17
 Title: “Scalable Units for Building Vascularized Cardiac Grafts”
 PI: L.E. Freed
 Goal is to design, fabricate, and demonstrate in vitro and in vivo scalable units for building vascularized myocardial grafts. The grafts will be comprised of heart cells, endothelial cells, and slowly degradable elastomeric scaffolds.

Completed:

NIH (NIBIB-ISS Biomed) 1-UH3-AR059655 09/14/12 – 02/01/15
 Title: “Osteocytes and Mechanotransduction”
 Subaward PI: L.E. Freed (Prime Contract: Massachusetts General Hospital)
 Goal was to use an osteocytic cell line to study mechanotransduction and hormones in a spaceflight experiment aboard the ISS.

NIH (NIAMS) 1-R42-AR055414 07/01/10 - 06/30/13
 Title: Hip Joint Resurfacing with Human Cartilage
 PI: L.E. Freed (Applicant Organization: Cytex Therapeutics, Inc.)
 Goal was to combine adult human stem cell, 3D-weaving, and bioreactor technologies to engineer functional cartilage for complete resurfacing of a human hip joint.

Draper Internal Research and Development award 07/01/11 – 06/30/13
 Title: Muscle Tissue Engineering
 PI: L.E. Freed
 Goal was to develop tissue engineering capability at Draper including scaffolds and bioreactors.

NIH (NHLBI) 1-R01-HL092836 05/01/08 – 03/31/13
 Title: “Microfabricated Vascularized 3D Tissue Engineered Constructs”
 Subaward PI: L.E. Freed (Prime Contract: Brigham & Women’s Hospital)
 Goal was to engineer hydrogels with controlled mechanical, chemical, biological properties.

NIH (NIBIB-ISS Biomed) 1-UH2 AR059655 09/01/10 – 08/31/12
 Title: Osteocytes and Mechanotransduction

- Subaward PI: L.E. Freed (Prime Contract: Massachusetts General Hospital)
Goal was to establish and use an osteocytic cell line to study mechanotransduction and hormones at 1g toward a possible spaceflight experiment
- NIH (NHLBI) 1-R01-HL086521-01 (ARRA award) 07/01/09 – 12/30/11
Title: Rational Design of a Cardiac Tissue Engineering Scaffold”
PI: L.E. Freed
Goal was to rationally design scaffolds that when combined with cells can enhance regeneration of heart tissue, and novel culture devices that can enhance cell viability and differentiation in engineered cardiac grafts.
- NASA NNJ04HC72G 12/01/03-11/30/10
Title: Microgravity Tissue Engineering
PI: L.E.Freed
Goal was to investigate how biophysical stimuli that are physiologic in nature, magnitude, and regime of application can direct dissociated cells to regenerate functional skeletal and cardiac tissues.
- Draper Internal Research & Development Award 07/01/09 – 06/30/10
Title: Multi-Tissue Construct Engineering
PI: L.E. Freed
Goal was to develop platform technologies for in vitro generation of multiphasic tissues.
- NIH (NIAMS) 1-R41-AR055414-01 09/01/07-08/31/08
Title: Hip Joint Resurfacing with Human Cartilage
PI: L.E. Freed (Applicant Organization: Cytex Therapeutics, Inc.)
Goal was to develop an implant suitable for complete resurfacing of the femoral head of the human hip joint and proven ability to integrate with bone.
- NIH-NRSA 1-F32-HL084968-01 05/01/06 – 04/30/09
Title: “Cell Adhesion and Guidance Motifs for Cardiac Grafts”
Co-sponsors: L.E. Freed and R. Langer; PI: G.C. Engelmayr, Postdoctoral Fellow,
Goal was to design, microfabricate and test novel elastomeric scaffolds for cardiac tissue engineering
- American Heart Association award # 0625886-T 07/01/06 – 06/30/08
Title: Enhancement of 3D Cardiac Grafts by Endothelial Cell Signaling and Cyclic Stretch
Sponsor: L.E. Freed; PI: J. Nichol, Postdoctoral Fellow
Goal was to study heart cell interactions and mechanical conditioning in 3D cardiac grafts
- NIH 1-P41-EB002520-01A1 08/15/04 –07/31/07
Title: Tissue Engineering Resource Center
Key Personnel: L.E. Freed (Prime Award to Tufts University)
Goal was to provide training and resources for skeletal and cardiac tissue engineering.
- Project Roberto Rocca (MIT-Milano Politecnico) 10/18/05 – 10/17/06
Title: Tissue Engineering of Human Cartilage in Bioreactors
PI: L.E. Freed
Goal was to develop new bioreactors to engineer cartilage and other tissues
- NASA (subcontract of # NAS 9-02078) 06/01/05-09/30/05
Title: Pharmacological Studies of Cardiac Tissue Constructs
PI: L.E.Freed
Goal was to study cell and tissue level responses of cardiac constructs to pharmaceutical agents
- Fidia Advanced Biomaterials (Abano Terme, IT) (grant# 009337) 05/06/02-01/01/05
Title: “Tailored Biomaterials for Tissue Engineering”
PI: L.E. Freed
Goal was to custom-design new tailored materials for skeletal and cardiac tissue engineering
- NASA (grant #NCC8-174) 03/01/99-12/30/04
Title: “Microgravity Tissue Engineering”
PI: L.E.Freed
Goal was to investigate how biophysical stimuli can direct dissociated cells to regenerate functional skeletal and cardiac tissues.

- NASA (grant # NAG9-836) 09/01/95-08/31/99
Title: "Microgravity Tissue Engineering"
PI: L.E.Freed
Goal was to investigate how biophysical stimuli that are physiologic in nature, magnitude, and regime of application can direct dissociated cells to regenerate functional skeletal and cardiac tissues.
- NASA (grant# 970001) 1996-2004
Title: "Design & Development of the Cell Culture Unit for the International Space Station",
Key Personnel: L.E. Freed (Subcontract of Payload Systems Inc, PI J. de Luis)
Goal was to design demonstrate a cell culture unit for the International Space Station",
- NASA (grant# NAG9-655) 12/01/92 – 11/30/96
Title: "Microgravity Studies of Cell-Polymer Cartilage Implants"
PI: L.E.Freed
Goal was to investigate how biophysical stimuli that are physiologic in nature, magnitude, and regime of application can direct dissociated cells to regenerate functional cartilage
- NIH (grant # 1F32 GM14191-01) 01/15/91 – 01/14/93
Title: "Creating Cartilaginous Autografts for Plastic Surgery"
PI: L.E.Freed
Goal was to design biocompatible, biodegradable polymers to use as scaffolds to support cell growth for the purpose of creating autologous cartilage implants for clinical use.

Extracurricular Activities (selected)

MIT Alumni Groups

- Ashdown House (formerly graduate student house)
- Women's Independent Living Group (WILG)
- Master's Swim Club
- Women's Intramural Waterpolo
- Varsity Women's Swimming & Diving

Personal Interests

- Outdoor Swimming; Snorkeling; Hiking; Nature; Music