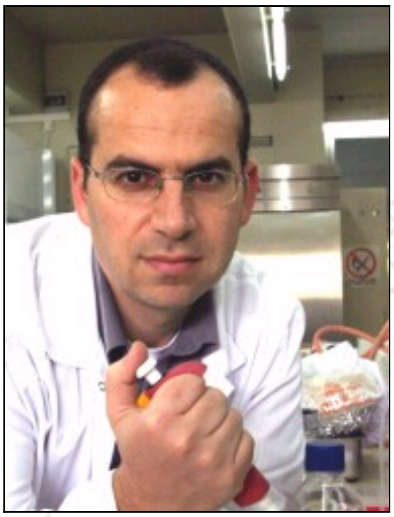

Dror Seliktar, Ph.D.
Associate Professor

E-mail: dror@bm.technion.ac.il
Homepage: www.bm.technion.ac.il/~dror
Office phone: 04-829-4805
Office Room: 168

B.Sc. 1994 Mechanical Engineering, Drexel University, Philadelphia, PA, USA

M.Sc. 1998 Mechanical Engineering, Georgia Institute of Technology, Atlanta, GA, USA

Ph.D. 2000 Biomedical Engineering, Georgia Institute of Technology, Atlanta, GA, USA

Field of research:

Tissue engineering, Biomaterials, Mechanical Stimulation

About:

Dr. Dror Seliktar is an associate professor in the Technion Faculty of Biomedical Engineering. A recent addition to the faculty, Dr. Seliktar, who was born in Glasgow, Scotland in 1972, received his B.Sc. in mechanical engineering from Drexel University in 1994, and an M.Sc. and Ph.D. in mechanical engineering and biomedical engineering respectively, from the Georgia Institute of Technology in 2000.

After earning his Ph.D., Dr. Seliktar was awarded a two-year post-doctoral appointment at the Swiss Federal Institute of Technology in Zurich and received the competitive International Postdoctoral Research Award from the United States' National Science Foundation. Before his appointment at the Technion, Dr. Seliktar was a visiting scholar at the University of Toronto and the Samuel Lunenfeld Research Institute of Mount Sinai Hospital in that city.

For his research and teaching accomplishments, Dr. Seliktar was awarded with the Dudi Ben-Aharon Award for Excellence in Research (2007), the Salomon and Simon Mani Award for Excellence in Teaching (2005), the Hershel Rich - Technion Innovation Award (2005), and the International Society for Applied Cardiovascular Biology (ISACB) Young Investigator Award (2000). He currently serves as a member of the editorial board of Acta Biomaterialia, the scientific advisory board of Calisra Ventures, LLC., and the innovations and patents evaluation committee of the Rambam Health Care Campus.

Research interests:

Research Vision

The development of therapeutic strategies for treating tissue damage and disease is the primary motivation in our laboratory. Our research vision is to implement novel approaches that advance the development of biological substitutes and/or tissue restoration therapies, through a better understating of mechanobiology and biomaterials design. In this context, we hope to use a methodology that systematically controls the cellular events associated with tissue physiology in order to guide regeneration, in vitro or in vivo. Our current activities can be classified into three research areas as detailed below. The central and underlying theme of these three research areas is the basic understanding of how cells interact with biomaterials and how this interaction may be exploited for enhancing tissue reconstruction and repair.

1. Development of novel bio-synthetic hydrogels

Proteins such as bovine collagen and human fibrinogen are attractive building blocks in bioactive materials, yet they possess limitations in stability and mechanics; for example, a fibrinogen-based scaffold would rapidly dissolve after in vivo placement. Our laboratory has developed a

technology to chemically derivatize proteins such as fibrinogen or collagen and then to polymerize them in situ to form hydrogels that can be degraded by proteolysis, and thus infiltrated by cells after implantation. This technology, which is based on the grafting of synthetic polymers such as polyethylene glycol (PEG) to naturally occurring, reconstituted proteins, yields a polymerizable PEG-protein adduct that can be crosslinked in situ by light-induced photocrosslinking to create a stable, elastic hydrogel. Cells can infiltrate this provisional matrix by proteolysis of the protein component of the gels using plasmin or matrix metalloproteinases (MMPs), allowing remodeling and morphogenesis. This PEG-protein injectable matrix can be further developed by tailoring elastic properties and/or susceptibility to remodeling as well as incorporating bound bioactive factors. We have published on the use of this unique class of bio-synthetic hybrid hydrogels for in vivo tissue regeneration of osseous defects and in vitro tissue engineering, including with embryonic stem cells, cardiac myocytes, smooth muscle cells, neural cells, and chondrocytes.

2. Regulation of cell differentiation and morphogenesis via matrix physical properties

The regulation of cellular morphogenesis and differentiation via the physical properties of the provisional extracellular matrix (ECM) is poorly understood and our group has been working towards elucidating the dominant physical factors of the ECM that influence cell spreading, migration and differentiation in 3-D culture. We apply our biosynthetic PEG-protein hydrogel as an ECM-analog for cell culture, with highly defined and precisely controllable density, microarchitecture, proteolytic susceptibility, compliance and biofunctionality. The matrix is used to encapsulate mesenchymal cells while pseudo-independently altering biochemical and physical properties of the environment using simple compositional modifications to the bio-synthetic constituents. We have shown that the proteolytic resistance and compliance of the matrix have a profound influence on the regulation of cell morphogenesis and phenotype determination. Beyond the control over the intrinsic physical attributes of the hydrogel, our laboratory has recently developed an optical 3-D micro-patterning approach to non-invasively create any prescribed geometrical feature having submicron spatial resolution in situ, anywhere within the PEG-protein hydrogel biomaterial. The micropatterns are made using a simple but highly effective application of computer-guided laser micro-ablation that creates localized imperfections in the hydrogel architecture. These imperfections are used to guide anisotropic cellular development within the amorphous material, including preferentially guiding neural cellular development in the hydrogels based on contact guidance and differential mechanical resistance of the scaffolding. Precisely controlled bulk material properties and custom 3-D landscaping with micropatterning are collectively used to elucidate the dominant and influential physical factors affecting morphogenesis patterns, phenotypic states, and differentiation of various cell types.

3. Mechanical stimulation for tissue engineering

In cardiovascular and orthopedic tissues, the question of how cells experience stresses or strains in their mechanical environment is particularly important because of the complicated nature of the mechanical forces experienced by these cells. Appreciating the mechanisms of cellular response to externally applied physical perturbations is also important for determining which mechanical forces to apply to developing tissue-engineered constructs, as well as for predicting long-term adaptation of tissue-engineered constructs after implantation. Our research in this area has focused on developing new strategies to investigate cellular response to a variety of stress and strain environments. Using hydrogels as a scaffolding material, cellularized constructs are mechanically stimulated for several weeks in culture using custom designed bioreactors that permit precise control of the mechanical forces and loading conditions. The biological and physicochemical response of the cellualrized constructs to the application of externally applied forces is extensively analyzed and correlated to cell phenotype and hallmarks of construct development using smooth muscle cells, cardiac myocytes, chondrocytes, and stem cells.

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