**BIOGRAPHICAL SKETCH**

NAME: **Danial Barati**

POSITION TITLE: **Postdoctoral Fellow**

EDUCATION/TRAINING:

| INSTITUTION AND LOCATION | DEGREE | Start Date MM/YYYY | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|---|
| University of Tehran, Tehran, Iran | B.S. | 09/2005 | 09/2009 | Chemical Engineering |
| University of South Carolina, Columbia, SC, US | M.Sc | 08/2010 | 08/2013 | Chemical Engineering |
| University of South Carolina, Columbia, SC, US | Ph. D. | 08/2013 | 08/2016 | Chemical Engineering |

**A. Personal Statement**

My career goal is to obtain an independent PI position at a top research institution to lead an interdisciplinary research group aiming to develop novel therapies for tissue regeneration by working at the interface of stem cells, biomaterials, and medicine. I am particularly interested in translating my research from bench to bedside via collaborating with industry partners or starting up my own company. During my Ph.D. and postdoctoral training, I have over 7 years of experience in polymers synthesis, biomaterials fabrication, drug delivery and tissue regeneration. My Ph.D. research has resulted in 11 journal articles (4 first-author) in leading journals in the field of drug delivery and tissue engineering, which have been cited for over 130 times. My Ph.D research focused on developing novel biodegradable biomaterials and nano-drug delivery systems for bone and cartilage tissue engineering applications. I have reported several strategies to fabricate biodegradable scaffolds with tunable mechanical properties and degradation rates as well as nanoparticulate systems for sequential delivery of various types of growth factors. During my current postdoctoral research in Dr. Fan Yang's lab at Stanford, I extend my expertise into novel scaffold design and validating biological therapies using relevant animal models. **My faculty sponsor, Prof. Fan Yang, Ph.D.,** is an Associate Professor in Orthopedic Surgery and Bioengineering, and she is an internationally recognized leader in the field of biomaterials research. My proposal leverages upon a recent invention of macroporous microribbon-based scaffold reported in Prof. Fan Yang's lab. This biomaterials platform is fundamentally different from conventional hydrogels in that it combines both injectability and macroporosity to best support stem cell survival, nutrient diffusion and new tissue deposition. The potential of integrating drug delivery with the advantages of microribbon-based hydrogels for accelerating the repair of craniofacial defects treatment have never been investigated before, yielding a unique opportunity for innovation and impacts. **My co-mentor, Prof. Stuart Goodman, M.D., Ph.D.,** is a clinician scientist with over 30 years of research experience in the field of orthopaedic surgery and bioengineering. Yang lab and Goodman lab already enjoys an established collaboration with demonstrated track record of joint grants and publications, which will greatly help me to receive mentoring from both basic science and clinical perspectives. **My co-investigator, Dr. Xinming Tong**, is an Instructor in Orthopaedic Surgery. Dr. Tong is a polymer scientist by training and is the co-inventor of microribbon platform in Fan Yang lab. Dr. Tong will be responsible for synthesizing and characterizing microribbons in this proposal. In summary, **my solid interdisciplinary training background and the complimentary expertise from my mentor, co-mentor and co-investigator makes me the ideal candidate to carry out the proposed work**.

While the proposal is highly innovative, the feasibility of my proposed strategy is high as it leverages upon my extensive experience in developing drug delivery platforms as well as recent publications from my faculty mentor (Fan Yang)'s lab on the microribbon-based scaffold platform as listed below:


1. **Danial Barati**, Seyed Ramin Pajoum Shariati, Seyedsina Moeinzadeh, Juan M. Melero-Martin, Ali Khademhosseinic, Esmaiel Jabbari. Spatiotemporal release of BMP-2 and VEGF enhances osteogenic and vasculogenic differentiation of human mesenchymal stem cells and endothelial colony-forming cells co-encapsulated in a patterned hydrogel. 2016. Journal of Controlled Release. 10 February 2016, Pages 126–136.
2. **Danial Barati**, Joshua D. Walters, Seyed Ramin Pajoum Shariati, Seyedsina Moeinzadeh, and Esmaiel Jabbari. Effect of Organic Acids on Calcium Phosphate Nucleation and Osteogenic Differentiation of Human Mesenchymal Stem Cells on Peptide Functionalized Nanofibers. 2015. Langmuir, 31 (18), pp 5130–5140.
3. Li-Hsin Han, Stephanie Yu, Tianyi Wang, Anthony W. Behn, **Fan Yang**. Microribbon-Like Elastomers for Fabricating Macroporous and Highly Flexible Scaffolds that Support Cell Proliferation in 3D. Advanced Functional Materials. 2013 Jan; 23:346–58.
4. Li-Hsin Han, Bogdan Conrad, Michael T. Chung, Lorenzo Deveza, Xinyi Jiang, Andrew Wang, Manish J. Butte, Michael T. Longaker, Derric Wan, **Fan Yang**. Microribbon-based hydrogels accelerate stem cell-based bone regeneration in a mouse critical-size cranial defect model. *J Biomed Mater Res A.* 2016. Jun; 104(6):1321-31.


## B. Positions and Honors

### Positions

08/2016-07/2017 Postdoctoral research of tissue engineering at University of South Carolina
07/2017-present Postdoctoral research of Stem Cell Therapy Biomaterial at Stanford University

### Other Experiences and Professional Memberships

2012-2013 Biomedical Engineering Society (BMES), Member
2013-2015 American Institute of Chemical Engineers (AIChE), Member
2013-2016 Tissue Engineering and Regenerative Medicine International Society, Member
2015-2016 Orthopedic Research Society (ORS), Member
2015-present Review editor in Material Letters Journal
2015-present Review editor in Journal of Bioactive and Compatible Polymers
2015-present Review editor in Journal of Biomaterial Applications
2015-present Review editor in Journal of Artificial Organs
2015-present Review editor in Journal of Neuroscience and Biomedical Engineering
2015-present Review editor in Journal of Dove Medical Press

### Academic and Professional Honors

JUN 2007 Merit Student of University of Tehran, Iran.
NOV 2012 2012 Young Investigator Travel Grant, Biomedical Engineering Society International Conference. Atlanta, GA, US.
NOV 2014 2014 Young Investigator Travel Grant, American Institute of Chemical Engineers International Conference. Atlanta, GA, US.
MAR 2015 2015 Young Investigator Travel Grant, Orthopedic Research Society International Conference. Las Vegas, NV, US.
SEP 2015 2015 Young Investigator Travel Grant, Tissue Engineering and Regenerative Medicine International Society International Conference. Boston, MA, US.

## C. Contributions to Science

### 3.1. Engineering Biodegradable and Inert Hydrogels for Bone and Cartilage Tissue Engineering Applications.

It is well-established that the fate of encapsulated cells is determined by the physical and mechanical properties of their microenvironment including degradation rate and stiffness. The overall goal of this study was to engineer inert biodegradable hydrogels with tunable physical properties capable of 3D encapsulation of cells for tissue

engineering applications. Specifically, we fabricated inert biodegradable hydrogels polyethylene glycol (PEG) extended with short segments of different types of hydroxyl acids including glycolide (G), L-lactide (L), pdioxanone (D), and Ɛ-caprolactone (C) following by investigating the effect of these different chemical compositions on hydrogels properties. This novel polymeric design combines the most positive features of the PEG hydrogel with the ability to biodegradation. We demonstrated that chain-extension of PEG generated water soluble macromers with faster gelation rates, lower sol fractions, higher compressive moduli, and a wide-ranging degradation rate when crosslinked into a hydrogel. These gels exhibited a wide range of degradation times from a few days for G-based to a few weeks for L-based, a few months for D-based, and many months for C-based. Marrow stromal cells and endothelial progenitor cells had the highest expression of vasculogenic markers when co-encapsulated in the faster degrading L-based gel. The findings of my work in this project demonstrate that chain extension of star PEG macromers with the above hydroxy acids produces hydrogels with a wide range of physical and mechanical properties to serve as cell carriers in regenerative medicine from the compliant vascular tissue to the stiff bone tissue.

a) **Danial Barati**, S Moeinzadeh, O Karaman, E Jabbari, “Time dependence of material properties of polyethylene glycol hydrogels chain extended with short hydroxy acid segments”, Polymer, 2014.
b) S Moeinzadeh, **Danial Barati**, SK Sarvestani, O Karaman, E Jabbari, “Nanostructure formation and transition from surface to bulk degradation in polyethylene glycol gels chain-extended with short hydroxy acid segments”, Biomacromolecules, 2013
c) S Moeinzadeh, **Danial Barati**, X He, E Jabbari, “Gelation characteristics and osteogenic differentiation of stromal cells in inert hydrolytically degradable micellar polyethylene glycol hydrogels”, Biomacromolecules, 2012.

### 3.2. Designing Load Bearing Scaffolds for Bone Tissue Engineering Applications.

Natural bone contains a nanocomposite structure made of approximately 30% organic matter and approximately 70% mineral phase. The **hydroxylapatite (HA)** nanocrystals (mineral phase) on the surface of collagen nanofibers (organic phase) provides the bone with superior mechanical stability. The overall aim of this study was designing a nanocomposite structure comprised of degradable aligned **electrospun nanofibers** (NF) and HA nanocrystals to resemble natural structure of bone tissue. We also noted that natural bone tissue contains ~5.5% organic acids and mostly **citric acid (CA)** that play a considerable role in controlling the extent of HA nucleation. We proved that nucleated NFs in the presence of CA revealed HA content of as high as 240 wt%. We clarified that mechanical stiffness and degradation of the HA nucleated NFs were directly related to percent crystallinity and HA content. Moreover, we evaluated the effect of the HA nucleated NFs on osteogenic differentiation of human Mesenchymal Stem Cells seeded on the microsheets and cultured in osteogenic medium. It was observed that the extent of osteogenic differentiation of cells on HA nucleated NFs with CA was significantly higher than that of NFs nucleated without CA. Surprisingly, only nucleated NFs with CA stimulated bone nodule formation by the seeded stem cells.

a) **Danial Barati**, JD Walters, SR Pajoum Shariati, S Moeinzadeh, E Jabbari, “Effect of Organic Acids on Calcium Phosphate Nucleation and Osteogenic Differentiation of Human Mesenchymal Stem Cells on Peptide Functionalized Nanofibers”, Langmuir, 2015.

### 3.3. Designing and Optimizing of Nanoscale Drug Delivery Systems for Bone and Cartilage Tissue Engineering Applications

It has been reported that there is a close correlation between vascularization and bone formation in endochondral ossification as the maximum extent of bone formation follows maximum level of vascular factors expression. In bone marrow, endothelial progenitor cells (EPCs) form an osteoblast-vascular niche by proximity to osteoprogenitor cells in the endosteum. Hence, several studies have investigated the combined effect of **bone morphogenetic protein 2 (BMP2)** and **vascular endothelial growth factor (VEGF)** on differentiation of MSCs and EPCs. The main objective of this work was to investigate the effect of spatial and temporal release of BMP2 and VEGF on the extent of osteogenic and vasculogenic differentiation of hMSCs and EPCs encapsulated in a patterned hydrogel. Therefore, I designed a **nanogel (NG)** system based on polyethylene glycol (PEG) macromers chain- extended with short lactide (L) and glycolide (G) segments to facilitate timed- release of BMP2 and VEGF. We demonstrated that timed-release of VEGF in a time period of 10 days and BMP2 in 21 days from NGs can result in the highest extent of osteogenic and vasculogenic differentiation of the encapsulated hMSCs

and EPCs compared to bolus addition of growth factors. Further, timed-release of VEGF and BMP2 from NGs increased bFGF expression of stem cells encapsulated in the hydrogels. Our results suggest that mineralization and vascularization are coupled by localized secretion of paracrine signaling factors by the differentiating hMSCs and EPCs.

a) **Danial Barati**, SR Pajoum Shariati, S Moeinzadeh, JM Melero-Martin, A Khademhosseini, E Jabbari, "Spatiotemporal release of BMP-2 and VEGF enhances osteogenic and vasculogenic differentiation of human mesenchymal stem cells and endothelial colony-forming cells co-encapsulated in a patterned hydrogel", Journal of Controlled Release 2016.

b) S Moeinzadeh, **Danial Barati**, SK Sarvestani, T Karimi, E Jabbari, " Experimental and Computational Investigation of the Effect of Hydrophobicity on Aggregation and Osteoinductive Potential of BMP-2-Derived Peptide in a Hydrogel Matrix", Tissue Engineering Part A, 2014.

c) T Karimi, **Danial Barati**, O Karaman, S Moeinzadeh, E Jabbari, " A developmentally inspired combined mechanical and biochemical signaling approach on zonal lineage commitment of mesenchymal stem cells in articular cartilage regeneration", Integrative Biology, 2015.

**Complete List of Published Work in my Google Scholar profile:**
**https://scholar.google.com/citations?user=6L2ml8MAAAAJ&hl=en**

**D. Additional Information: Research Support and/or Scholastic Performance**

**UNIVERSITY OF TEHRAN**

| YEAR | COURSE TITLE | GRADE |
|---|---|---|
| 2005 | CALCULUS I | 94 |
| 2005 | PHYSICS I | 92 |
| 2005 | CHEMICAL ENG. THERMODYNAMICS I | 90 |
| 2006 | STATICS AND STRENGTH OF MATERIALS | 82 |
| 2006 | ENGINEERING MATHEMATIC | 100 |
| 2006 | BIOCHEMICAL ENGINEERING | 83 |
| 2007 | FLUID MECHANICS I | 86 |
| 2007 | PHYSICS II | 93 |
| 2008 | HEAT TRANSFER I | 91 |
| 2008 | GENERAL CHEMISTRY II | 85 |
| 2008 | MASS TRANSFER | 83 |
| 2009 | MATERIAL AND ENERGY BALANCE | 96 |
| 2009 | GENERAL MICROBIOLOGY | 86 |
| 2009 | HEAT TRANSFER II | 90 |

**UNIVERSITY OF SOUTH CAROLINA**

| YEAR | COURSE TITLE | GRADE |
|---|---|---|
| 2010 | ADV CHEM ENGR THERMODYNM | 2010 |
| 2010 | ADV FLUID FLOW ANALYSIS | A |
| 2010 | CHEMICAL REACTOR DESIGN | A |
| 2011 | TOPIC/MATERIALS CHARACTR | A |
| 2012 | INTRO POLYMER SYNTHESIS | B+ |
| 2012 | BIOLOGCL MICROSCPC IMAG | A |
| 2013 | CHEMICAL PROCESS ANALYS | A |
| 2013 | ADV MASS TRANSFER | A |