UCI Samueli School of Engineering
Department of Chemical and Biomolecular Engineering

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Cellular materials: engineering complexity through biomaterial design

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Abstract: Advances in the fields of tissue engineering and regenerative medicine require biomaterials that instruct, rather than simply permit, a desired cellular response. A major challenge to progress in our field is the complex organization of the tissues in our bodies, which are hierarchical, vary in space and time, and can differ person-to person. Prof. Harley's research program is developing biomaterials that replicate the complex cellular and extracellular microenvironment found in the tissues and organs of our body. These include porous, hydrogel/granular, and composite biomaterials for musculoskeletal tissue regeneration, hematopoietic stem cell biomanufacturing, and as model systems to investigate endometrial pathologies and invasive brain cancer. I will describe efforts using bioinspired design motifs to create composite biomaterials to regenerate craniomaxillofacial bones and musculoskeletal insertions. I will also describe (granular) hydrogel models to study niche regulation of hematopoietic stem cells and patient-derived glioblastoma specimens. These tools enable study of dynamic processes such as remodeling and multicellular signaling that inform stem cell quiescence as well as brain cancer invasion and drug resistance. However, contemporary tissue engineering efforts must also consider patient heterogeneity, gender/sex, and social factors. Hence, I will also describe efforts to account for sex differences in tissue engineering models as well as to create hierarchical models of the endometrial tissue microenvironment to investigate endometriosis. These new paradigms are essential for accelerating translation of scientific discoveries into innovations that improve our collective quality of life.

Bio: Brendan Harley is the Robert W. Schaefer Professor in the Dept. of Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign. He received a B.S. in Engineering Sciences from Harvard University (2000), a Sc.D. in Mechanical Engineering from MIT (2006), and performed postdoctoral studies at the Joint Program for Transfusion Medicine at Children's Hospital Boston (2006 – 2008). His research group develops biomaterial platforms to dynamically regulate cell behavior for applications in musculoskeletal regeneration, hematopoietic stem cell biomanufacturing, as well as to investigate endometrial pathologies and invasive brain cancer. He has received funding from the NSF, NIH, American Cancer Society, the U.S. Army, and the AO Foundation. Prof. Harley co-founded a regenerative medicine company, Orthomimetics Ltd., to commercialize a biomaterial for osteochondral regeneration.

Dr. Harley has received a number of awards and honors including an NSF CAREER award (2013), the Young Investigator Award (2014) and the Clemson Award for Basic Research (2021) from the Society for Biomaterials, as well as university research, teaching, and promotion awards (U. Illinois). He is an elected Fellow of the American Association for the Advancement of Science (2014), the American Institute for Medical and Biological Engineering (2018), and the Biomedical Engineering Society (2021).

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