Micro- and NanoBiotechnology

Faculty in the department of biomedical engineering are using micro- and nano-technology to develop new approaches for the manipulation and study of individual biomolecules and cells, and to recreate the complex environment of biological tissues. Cornell is home to the world-class Cornell NanoScale Science and Technology Facility (CNF), a national user facility in its 4th decade of operation, and the NSF-funded Nanobiotechnology Center. Both are just a five minute walk from BME’s home in Weill Hall, leading to easy access to these sophisticated technologies and the large university and user communities.

Some specific faculty projects

By integrating biomaterials, tissue engineering, and microfabrication techniques the Fischbach-Teschl lab develops culture models to study the role of microenvironmental aberrations in cancer. Specific areas of interest include the application of micropatterning and microfluidic strategies to evaluate tumor vascularization from a physical sciences perspective and to assess the contribution of nanomaterial properties in the development and progression of breast cancer bone metastasis.

A necessary step in metastasis is the dissemination of malignant cells into the bloodstream, where cancer cells travel throughout the body as circulating tumor cells (CTC) in search of an opportunity to seed a secondary tumor. Prof. Michael King’s lab is using selectin-based adhesion, in combination with nanoscale liposomes and naturally occurring halloysite nanotubes, to achieve (1) detection and isolation of intact, viable CTC; and (2) targeted drug and gene delivery to circulating tumor cells of epithelial origin.

Prof. Jan Lammerding’s lab is developing microfluidic devices to measure (sub-)cellular biomechanics to investigate how changes in cellular and nuclear stiffness can contribute to the pathology of muscular dystrophies, premature aging, and cancer. In addition, the lab is applying micropatterning and microfluidics approaches to study the migration of cancer cells in 3-D and to develop in vitro models for muscle differentiation.

Prof. William Olbricht’s lab uses microfabrication techniques to build implantable devices that enhance drug delivery to the brain and other neural tissues. The devices are used in therapies for disorders such as glioma, stroke, and tissue ischemia.

Prof. David Putnam’s group, in collaboration with Matt DeLisa in Chemical and Biomolecular Engineering, has engineered bacteria to create and stabilize new vaccines. The stabilizing technology is based on bacterial outer membrane vesicles, or OMVs, and a protein called ClyA. Using this technology the investigators have created new vaccine candidates using proteins that are normally poorly antigenic.
Cynthia Reinhart-King’s Lab develops and utilizes microfabricated devices to recreate the physical and chemical microenvironment within tissues to understand disease progression. In recent work, they have used novel devices to investigate the mechanisms driving metastatic cell invasion and endothelial cell chemotaxis.

One goal of Prof. Michael Shuler’s lab is to couple micro- and nanofabrication techniques with cell cultures to predict toxicology and efficacy of pharmaceuticals. Their cell culture analog or “body-on-a-chip” systems are microfluidic devices with interconnected cell-containing compartmentsto mimic pharmacokinetic response of humans to drugs or environmental chemicals. These systematic CCA can be coupled with modules representing barrier tissues such as the gastrointestinal (GI) tract to predict human response to oral ingestion or chemical toxicants or drugs.

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Representative publications


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