Biotechnology Basics

Total: 30 hours

Title: **Microarrays and Biostatistics** (Prof. Phillip Stafford)
Duration: 3 hours including lab
Description: Microarrays have provided an extremely high-throughput technology for measuring tens of thousands of individual experiments. From RNA to antibodies, proteins to sugar molecules, peptides to polymers, there have been dozens of new microarray platforms introduced in the last 5 years. Analysis of microarray data requires particular emphasis on multiple testing corrections, feature selection, and classification methods. Some methods work well with high density data, some do not. In this class we will examine the basics of microarray biostatistics using expression, SNP and peptide microarray data. We will create R code for testing sample data, then we will download data from published papers and do the analysis in lab.

Title: **Peptide Microarrays as Tools for Ligand Discovery and Diagnostic Development** (Prof. Chris Diehnelt 3 hours)
An introduction to the use of peptide microarrays as a source of new ligands for affinity agents, therapeutics and diagnostics. Peptide-protein interactions, fluorescence detection, peptide-antibody interactions, cell screening, surface plasmon resonance (SPR), peptide immobilization chemistry, microarray data analysis.

Title: **Renewable Energy Using Microorganisms**.
(Prof. Bruce E. Rittmann, 3 hours)
An introduction to ways in which microorganisms can produce useful forms of renewable energy from sunlight and carbon dioxide or from streams of waste organics. Basics of microbial metabolism, methanogenesis, microbial electrochemical cells, photosynthesis to make biofuels, and the global energy context.

Title: **Fluorescence spectroscopy at the single-molecule level**
(Prof. Marcia Levitus, 6 hours):
Fundamentals of fluorescence spectroscopy, energy transfer, instrumentation for single molecule spectroscopy, applications of single molecule fluorescence in biochemistry, molecular motors, superresolution imaging, fluorescence correlation spectroscopy

Title: **Artificial ribosome as instrument for translation of protein having unnatural amino acids**
(Prof. Larisa Dedkova, 1.5 hours).
Design an artificial ribosome; preparation of library of cells having modified ribosome genes; selection of ribosome variants with improved ability to use unnatural amino acids (for example D- or β- amino acids) for *in vitro* translation of peptide and protein.
Ribosome synthesis of antibacterial peptide having unnatural amino acids in predetermined position.

Title: **Multifunctional Radical Quenchers as Mitochondrial Therapeutic Agents**
(Prof. Omar M. Khdour, 1.5 hours)
While oxidative stress is not the cause of many of mitochondrial diseases as in Friedreich's ataxia, it is likely to contribute importantly to the progression of the disease. A number of coenzyme Q_{10} analogues were evaluated for their ability to blunt the effects of oxidative stress, and the progression of mitochondrial diseases.

Title: **Ultrafast Biology**
(Prof. Neal Woodbury, 3 hours)
Ultrafast laser primer, Ultrafast absorbance methods, Ultrafast fluorescence methods, protein dynamics on fast timescales, energy transfer in biology, electron transfer in biology, biological solar energy conversion, Fluorescence resonant energy transfer as a tool for biological measurements, Fluorescence anisotropy as a tool in biological measurements

Title: **New Molecular Technologies to Outpace Infectious Disease**
(Prof. Kathryn Sykes, 3 hours)
A brief overview of vaccine history, description of current approaches to vaccine development, and analysis of their pros and cons will be presented. A "portrait" of an ideal vaccine will be drawn. New molecular technologies currently being developed to build better vaccines will be described, and their contribution to outpacing disease will be discussed.

Title: **Progress Toward a Universal Prophylactic Cancer Vaccine**
(Prof. Stephen Albert Johnston, 3 hours)
The idea of a creating a cancer vaccine that everyone could safely be administered to very effectively prevent the occurrence of cancer is very attractive. Advances in our understanding of the immune response to cancer and large sequencing efforts have now make this ideal solution to this formidable chronic disease feasible. Yet, to achieve such a goal a number of fundamental issues must be addressed. These will be enumerated and the approaches being taken to overcome them will be discussed.

Title: **Our war against viruses**
(Prof. Bertram Jacobs, 3 hours)
Re-newing strategies for vaccine and anti-viral drug development. We will discuss new strategies for HIV vaccine development and use of botanical extracts as potential anti-virals.

Title: **Functional Proteomics and its Applications in Biomedical Research**
(Profs. Mith Magee and Ji Qiu, 3 hours)
This course will be an introduction to the strategies and processes for creating Nucleic Acid Programmable Protein Arrays. This will include bioinformatics and processes for high-throughput cloning. We will also review using the NAPPA platform for screening autoantibody biomarkers in various diseases, cancer and autoimmune diseases (type 1 diabetes, rheumatoid arthritis) and infectious diseases. We will also include discussion of improvement strategies for future applications, post-translational modification, high-throughput protein-protein interaction and kinetic studies.

Topic: **Biological applications of piezoelectric liquid dispensing**
(Profs. Peter Wiktor and Nagaraj Vinay J, 3 hours)

Topic: **Chemical and Bio Sensors**

(Profs. Nongjian Tao and Shaopeng Wang, 3 hours)
Microfabricated tuning fork sensor arrays,nanosensors, hybrid electrochemical and conductimetric sensors, wireless sensors, micro- and nano-fluidic devices with integrated protein detection and separation,new label-free biomolecular detection and imaging techniques, coded particles

Topic: **Chemically Programmed Design and Assembly of Biologically Inspired Nanomaterials**
(Prof. Hao Yan, 3 hours)
Macromolecular interactions and biosensing, design of novel DNA nanostructures, implementation of the designed structure in the construction of patterned DNA arrays and nanomechanical devices, DNA based functional nanodevices, self-assembly of 2D and 3D protein arrays, biomolecular imaging by Atomic Force Microscopy and Electron Microscopy, DNA/RNA/Protein manipulation, gel electrophoresis, labeling, hybridization, PCR and footprinting, cloning.

Topic: **Single Molecule Biophysics**
(Prof. Stuart Lindsay, 6 hours)
DNA sequencing, genes and protein functionality, chemistry and physics of the liquid-solid interface, electrochemical and charge transfer processes at the single-molecule level. Instrumentation for biomolecular research. Molecular visualization

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