COMPUTATIONAL MEDICINE

https://icm.jhu.edu/

Computational Medicine (CM) is an emerging discipline devoted to the development of quantitative approaches for understanding the mechanisms, diagnosis and treatment of human disease through applications of mathematics, engineering and computational science. The core approach of CM is to develop computational models of the molecular biology, physiology, and anatomy of disease, and apply these models to improve patient care. CM approaches can provide insight into and across many areas of biology, including genetics, genomics, molecular networks, cellular and tissue physiology, organ systems, and whole body pharmacology.

CM research at ICM is sub-divided into four key areas: Computational Molecular Medicine (http://icm.jhu.edu/research-areas-2/computational-molecular-medicine/); Computational Physiological Medicine (http://icm.jhu.edu/research-areas-2/computational-physiological-medicine/); Computational Anatomy (http://icm.jhu.edu/research-areas-2/computational-anatomy/); Computational Healthcare (http://icm.jhu.edu/research-areas-2/computational-healthcare/). Techniques for and applications in each of these four key subareas are introduced during the required core courses, exposing students to the breadth of Computational Medicine, and enabling each student to identify a preferred area of interest:

- **Computational Physiological Medicine** develops mechanistic models of biological systems in disease, and applies the insights gained from these models to develop improved diagnostics and therapies. Therapies could be diverse drugs, electrical stimulation, mechanical support devices and more.
- **Computational Molecular Medicine** harnesses the enormous amount of disease-relevant data produced by next-generation sequencing, microarray and proteomic experiments of large patient cohorts, using statistical models to identify the drivers of disease and the susceptible links in disease networks.
- **Computational Anatomy** uses medical imaging to analyze the variation in structure of human organs in health and disease. Such image analysis has been integrated into clinical workflows to assist in the diagnosis and prognosis of complex diseases.
- **Computational Healthcare** is an emerging field devoted to understanding populations of patients and their interaction with all aspects of the healthcare process.

CM is distinct from Computational Biology in its focus on human health, disease, and treatment; translation to and application in the clinic is a near-term goal of all CM research. Applications of CM are as broad as medicine itself, and include: identification of optimal drugs using associated genomic and proteomic biomarkers; discovery of image-based biomarkers for diagnosis and prognosis; design and dynamic adjustment of individualized non-drug therapies such as deep brain stimulation, cardiac stimulation, and cochlear implants; modeling and learning from patient EHR data to improve patient outcomes and efficiency of care; optimization of healthcare policy decisions by quantitative analysis; and more. CM is one of the pillars of the University's Strategic Initiative in Individualized Health.

Programs

- Computational Medicine, Minor (https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/degree-programs/computational-medicine/computational-medicine-minor/)
- Computational Medicine, Pre-Doctoral Training Program (https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/degree-programs/computational-medicine/computational-medicine-pre-doctoral-training-program/)