

# Biomedical Informatics

The mission of the Institute for Informatics (I<sup>2</sup>) focuses on the informatics landscape at Washington University School of Medicine in order to transform research, education and patient care by emphasizing precision medicine and efforts to improve the quality of health care and public health initiatives locally, nationally and worldwide.

Our vision at I<sup>2</sup> is to serve as the academic and professional home for a preeminent interdisciplinary program of research, education and service in informatics at Washington University by enabling advances in biomedical research and improvements in the quality of health care.

The institute coordinates informatics efforts across the Medical Campus and the Danforth Campus while also developing partnerships with the Health Systems Innovation Laboratory at BJC HealthCare, the Cortex Innovation Community and other regional partners.

I<sup>2</sup> offers a Master of Science (MS) and a certificate program in biomedical informatics. The purpose of the MS and certificate courses is to provide comprehensive and competency-based training in core biomedical informatics theories and methods for the following individuals:

- Recent college graduates with backgrounds in the biological and/or computational sciences
- In-career learners with a broad range of experiences in biomedicine/biosciences, mathematics, physical or computer information sciences or engineering, and cognitive and/or social sciences

Website: <https://informatics.wustl.edu/>

## Degrees & Offerings

- PhD in Biomedical Informatics (<http://dbbs.wustl.edu/divprograms/BIDS/Pages/default.aspx>)
- Master of Science in Biomedical Informatics (<http://bulletin.wustl.edu/medicine/degrees-offerings/biomedical-informatics-ms/>)
- Certificate Program in Biomedical Informatics (<http://bulletin.wustl.edu/medicine/degrees-offerings/biomedical-informatics-cert/>)

## Research

**Joanna Abraham, PhD** (<https://i2db.wustl.edu/people/joanna-abraham-phd-fcmi-famia/>), is focused on improving collaborative practices in health care using principles and techniques from informatics to promote patient safety, quality and care continuity.

**Research interests:** handoffs, care transitions, care coordination, decision making, health IT, medical errors, mixed methods, systematic reviews, evidence synthesis

**Chih-Hung Chang, PhD** (<https://i2db.wustl.edu/people/chih-hung-chang-phd/>), is focused on the integration of methodology and technology to advance clinical care, research and education.

**Research interests:** item response theory, Rasch measurement, computerized adaptive testing, psychometrics, informatics, smart testing and smart learning, health-related quality of life, patient-reported outcomes, clinical outcomes, shared decision making, quality improvement

**Randi Foraker, PhD** (<https://i2db.wustl.edu/people/randi-foraker-phd-ma-faha-famia-facmi/>), is focused on applying epidemiology and informatics techniques to solve problems in the population health domain.

**Research interests:** approaches for the integration of socioeconomic and patient-reported outcome data with electronic health record data; interventional approaches to the use of electronic health records in order to address modifiable risk factors for disease and enable patient-centered decision making; study design methodology and data analysis

**Thomas Kannampallil, PhD** (<https://i2db.wustl.edu/people/thomas-kannampallil-phd-famia/>), is focused on integrating cognitive, behavioral and computational informatics techniques to develop health information technology solutions in the areas of clinical decision support, clinical reasoning and clinical workflow.

**Research interests:** clinical decision support applications for tracking, monitoring and evaluating electronic health record-based activities such as medication/lab orders, decision-making for chronic care, and opioid management; tracking and analysis of medical errors in a variety of situations (e.g., medication orders, transitions of care, clinical decision-making) and evaluating their impact on clinical outcomes and patient safety; use of cognitive and human factors approaches for identifying behavioral, collaborative and workflow challenges in the design and use of health information technology

**Albert M. Lai, PhD** (<https://i2db.wustl.edu/people/albert-lai/>), is focused on applying computer science and informatics techniques to solve problems in the clinical domain.

**Research interests:** clinical research informatics, clinical informatics, consumer health informatics, telemedicine, usability, natural language processing, mobile health

**Fuhai Li, PhD** (<https://i2db.wustl.edu/people/fuhai-li-phd/>), is focused on applying statistical, machine learning, deep learning and data mining approaches to diverse biomedical dataset integration and interpretation to solve the challenges of bioinformatics, systems biology and image informatics.

**Research interests:** integrative large-scale pharmacogenomics analysis for target, signaling network, drug and drug combination discovery; genomics data driven tumor-stromal communication discovery and modeling

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**Philip R.O. Payne, PhD, FACMI (<https://i2db.wustl.edu/people/philip-r-o-payne-phd-facmi-famia-faimbe-fiahsi/>)**, is the founding director of I<sup>2</sup> at Washington University in St. Louis, where he also serves as the Robert J. Terry Professor and Professor of Computer Science and Engineering. Previously, Dr. Payne was Professor and Chair of the Department of Biomedical Informatics at The Ohio State University.

**Research interests:** knowledge-based approaches to the discovery and analysis of biomolecular and clinical phenotypes and the ensuing identification of precision diagnostic and therapeutic strategies in cancer; interventional approaches to the use of electronic health records in order to address modifiable risk factors for disease and enable patient-centered decision making; the study of human factors and workflow issues surrounding the optimal use of health care information technology

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**Po-Yin Yen, PhD, RN (<https://i2db.wustl.edu/people/po-yin-yen-phd-rn-facmi-famia-faan/>)**, is focused on applied clinical informatics research to support clinicians adapting to health information technology.

**Research interests:** clinical informatics, usability, technology acceptance, human-computer interaction, literature mining, data visualization, workflow analysis, time motion study

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## Faculty

**Philip R.O. Payne, PhD, FACMI (<https://i2db.wustl.edu/people/philip-r-o-payne-phd-facmi-famia-faimbe-fiahsi/>)**  
Director, Institute for Informatics  
Robert J. Terry Professor  
Professor of Medicine, Division of General Medical Sciences, School of Medicine  
Professor of Computer Science and Engineering, School of Engineering and Applied Science

**Joanna Abraham, PhD (<https://i2db.wustl.edu/people/joanna-abraham-phd-fcmi-famia/>)**  
Assistant Professor of Anesthesiology, School of Medicine

**Chih-Hung Chang, PhD (<https://i2db.wustl.edu/people/chi-hung-chang-phd/>)**  
Professor of Occupational Therapy and of Medicine, Division of General Medical Sciences, School of Medicine

**Randi Foraker, PhD, MA, FAHA (<https://i2db.wustl.edu/people/randi-foraker-phd-ma-faha-famia-facmi/>)**  
Associate Professor of Medicine, Division of General Medical Sciences, School of Medicine  
Director, Center for Population Health Informatics

**Thomas Kannampallil, PhD (<https://i2db.wustl.edu/people/thomas-kannampallil-phd-famia/>)**

Assistant Professor of Anesthesiology, School of Medicine  
Associate Chief Research Information Officer, School of Medicine

**Albert M. Lai, PhD (<https://i2db.wustl.edu/people/albert-lai/>)**

Deputy Director, Institute for Informatics  
Chief Research Information Officer, School of Medicine  
Associate Professor of Medicine, Division of General Medical Sciences, School of Medicine

**Fuhai Li, PhD (<https://i2db.wustl.edu/people/fuhai-li-phd/>)**

Assistant Professor of Pediatrics, School of Medicine

**Aristeidis Sotiras, PhD (<https://i2db.wustl.edu/people/aristeidis-sotiras-phd/>)**

Assistant Professor of Medicine, School of Medicine

**Po-Yin Yen, PhD, RN (<https://i2db.wustl.edu/people/po-yin-yen-phd-rn-facmi-famia-faan/>)**

Assistant Professor of Medicine, Division of General Medical Sciences, School of Medicine  
Assistant Professor, Goldfarb School of Nursing, Barnes-Jewish College

## Courses

Visit online course listings to view offerings for M18 BMI (<https://courses.wustl.edu/CourseInfo.aspx?sch=M&dept=M18>).

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### M18 BMI 5000 Independent Study in Biomedical Informatics

Investigation of a topic in biomedical informatics of mutual interest to the student and mentor. Students and mentor must fill out an agreement and return to the I2 education office to gain MS credit approval.

Credit variable, maximum 3 units.

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### M18 BMI 5200 Biomedical Informatics Journal Club

Trainees will attend weekly one-hour seminars and student-led journal club discussions in which current peer-reviewed publications relevant to biomedical informatics will be reviewed and discussed.

Credit 1 unit.

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### M18 BMI 5201 Biomedical Informatics Rotation

Students will be responsible for arranging two rotations to identify a thesis lab or capstone project site. Each rotation will last approximately one month, with the goal being to expose students to research and practical biomedical informatics opportunities in both academic and industry settings.

Credit 1 unit.

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### M18 BMI 5204 Mixed Methods in Biomedical Informatics

Building on the fundamentals of biomedical informatics in BMI I & II, this course will introduce students to the various research methods and underlying theories used to conduct biomedical informatics research studies. This course will cover research methods, including the systematic review of published research as well as qualitative, quantitative, and mixed methods. Under each topic, we will focus on the formulation of research questions/hypotheses, the selection of appropriate study design, data collection and analysis methods, and methods to ensure rigor and reproducibility of research. The course will encompass several hands-on components for students to practice and apply their learned skills.

Credit 3 units.

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**M18 BMI 5205 The Electronic Health Record**

The electronic health record (EHC) has become a central technology for the provision of clinical care. This course will use the EHR as a reference point to explore key areas in clinical informatics, including history, applications and policy.

Credit 3 units.

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**M18 BMI 5302 Introduction to Biomedical Informatics I**

This survey and methods course provides an overview of the theories and methods that comprise the field of biomedical informatics. Topics to be covered include the following: (1) information architecture as applied to the biomedical computing domain; (2) data and interoperability standards; (3) biological, clinical, and population health relevant data analytics; (4) health care information systems; (5) human factors and cognitive science; (6) the evaluation of biomedical computing applications; and (7) ethical, legal, and social implications of technology solutions as applied to the field of biomedicine.

The course will consist of both didactic lectures and experiential learning opportunities, including hands-on laboratory sessions and journal-club-style discussions. The course will culminate with a capstone project requiring the in-depth examination, critique, and presentation of a student-selected topic related to the broad field of biomedical informatics. Biomedical Informatics I is designed primarily for individuals with a background in the health and/or life sciences who have completed a course in introductory statistics (e.g., Math 1011). No assumptions are made about computer science or clinical background; however, some experience with computers and a high-level familiarity with health care will be useful. This course does not require any programming knowledge, and it will not teach students how to program.

Credit 3 units.

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**M18 BMI 5303 Introduction to Biomedical Informatics II**

This course builds upon the principles taught in Biomedical Informatics I by focusing on theories and informatics methods used in the study of populations. Topics include study design, statistical inference, bias, confounding factors, causality, and multi-level populations scale data. This course is intended to enable individuals to critically select relevant methods and evaluate their results as part of both the design of new projects as well as the review of results available in the public domain (e.g., literature, public data sets). Core concepts to be reviewed during this course include computational skills, data modeling and integration, formal knowledge representation, in silico hypothesis generation, quantitative data analysis principles, and critical thinking skills surrounding the ability to ask and answer questions about complex and heterogeneous biomedical data. Prerequisite: M18 5302 or instructor permission.

Credit 3 units.

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**M18 BMI 5304 Introduction to Biomedical Data Science I**

This course (formerly Biomedical Computing I) provides an introduction to fundamental principles of informatics tools and data analysis, and it is expected to fulfill the requirements of computer science prerequisites for suggested biomedical informatics electives. Competencies and concepts covered will include the following:

(1) an overview of the Linux/Unix command line interface; (2) an introduction to programming using Python and R; (3) database models, management, and querying using MySQL; (4) basic data manipulation, analysis, and visualization using Excel, Python, and R; and (5) an introduction to the development of web applications. This course is designed primarily for individuals who wish to learn the basic skills required for biomedical informatics-based research and who have little or no computational experience using command line shells, programming, and databases. No assumptions are made about

computer science or clinical background; however, some experience with computers and a high-level familiarity with the health and life sciences will be useful. The course will consist of both didactic lectures as well as experiential learning opportunities including hands-on laboratory sessions and a culminating project.

Credit 3 units.

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**M18 BMI 5305 Introduction to Biomedical Data Science II**

Building upon the fundamental principles of informatics tools and data analysis taught in Biomedical Data Science I (M18-5304), this course provides students with more advanced methods in the areas of biomedical computing, including data analysis, machine learning, deep learning models, natural language processing, deployment of data analysis models on supercomputers, and development of web apps. Both theory and coding applications and practices will be introduced for usage in the space of genomics, imaging, and medical records data analysis to help students apply learned computational tools and models. Prerequisite: M18-5304 or instructor permission.

Credit 3 units.

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**M18 BMI 5401 Biomedical Informatics Capstone**

Students will demonstrate how to synthesize and apply the full spectrum of biomedical informatics theories and methods used in the program curriculum. The capstone project focuses on an applied informatics problem with relevance to health care research or delivery at the individual or population level, resulting in a report that outlines the student's problem selection and the design, conduct, and results of the student's research. Each trainee will also be expected to present their project and its outcomes or findings in a public seminar, where questions will be posed by both the audience and a committee of faculty members. The specific selection of the capstone or thesis project track as part of a trainee's degree program is to be discussed with and approved by the individual's faculty and academic adviser. Students who do not enroll in the capstone course will enroll in the thesis course. Prerequisites: Introduction to Biomedical Informatics I and II (M18 5302 and M18 5303), Introduction to Biomedical Data Science I and II (M18 5304 and M18 5305), and a minimum of one Advanced Topics course. Permission of the faculty and adviser is also required.

Credit variable, maximum 3 units.

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**M18 BMI 5402 Biomedical Informatics Thesis**

Students will demonstrate how to synthesize and apply the full spectrum of biomedical informatics theories and methods included in the program curriculum. The thesis project requires students to formulate research questions that focus on the development or extension of a theoretical framework or a novel method with relevance to the field of informatics, resulting in a report that outlines the student's topic selection and the design, conduct, and results of the student's research. Each trainee will also be expected to present their project and its outcomes or findings in a public seminar, where questions will be posed by both the audience and a committee of faculty members. The specific selection of the capstone or thesis project track as part of a trainee's degree program is to be discussed with and approved by the individual's faculty and academic adviser. Students who do not enroll in the thesis course will enroll in the capstone course. Prerequisites: Introduction to Biomedical Informatics I and II (M18 5302 and M18 5303), Introduction to Biomedical Data Science I and II (M18 5304 and M18 5305), and a minimum of one Advanced Topics course. Permission of the faculty and academic adviser is also required.

Credit variable, maximum 3 units.