SYSTEMS BIOLOGY AND BIOINFORMATICS (SYBB)

SYBB 311. Technologies in Bioinformatics. 3 Units.
This course introduces students to the high-throughput technologies used to collect data for bioinformatics research in various fields including genomics, proteomics, clinical informatics, imaging, and metagenomics. This class surveys the conceptual models and tools used to analyze and interpret data collected by high-throughput technologies, and the latest applications of bioinformatics in the current state of science. This course will focus on genotyping, DNA/RNA sequencing, mass spectrometry-based proteomics, phosphoproteomics, electronic health records, metagenomics and immunology. The knowledge structures that we will cover include biomedical ontologies and databases, bioinformatics tools, essential algorithms in bioinformatics and networks. There will be in class exercises and assignments covering tools for genome/proteome exploration and analysis. This is an active learning course that will provide a hands-on learning experience for the students. Offered as SYBB 311 and SYBB 411. Prereq: BIOL 214 and BIOL 215 or Graduate standing.

SYBB 312R. Basic Statistics for Engineering and Science Using R Programming. 3 Units.
For advanced undergraduate students in engineering, physical sciences, life sciences. Comprehensive introduction to probability models and statistical methods of analyzing data with the object of formulating statistical models and choosing appropriate methods for inference from experimental and observational data and for testing the model's validity. Balanced approach with equal emphasis on probability, fundamental concepts of statistics, point and interval estimation, hypothesis testing, analysis of variance, design of experiments, and regression modeling. Note: Credit given for only one (1) of STAT 312, STAT 312R, STAT 313 or SYBB 312R. Offered as STAT 312R and SYBB 312R. Prereq: MATH 122 or equivalent.

SYBB 319. Applied Probability and Stochastic Processes for Biology. 3 Units.
Applications of probability and stochastic processes to biological systems. Mathematical topics will include: introduction to discrete and continuous probability spaces (including numerical generation of pseudo random samples from specified probability distributions), Markov processes in discrete and continuous time with discrete and continuous sample spaces, point processes including homogeneous and inhomogeneous Poisson processes and Markov chains on graphs, and diffusion processes including Brownian motion and the Ornstein-Uhlenbeck process. Biological topics will be determined by the interests of the students and the instructor. Likely topics include: stochastic ion channels, molecular motors and stochastic ratchets, actin and tubulin polymerization, random walk models for neural spike trains, bacterial chemotaxis, signaling and genetic regulatory networks, and stochastic predator-prey dynamics. The emphasis will be on practical simulation and analysis of stochastic phenomena in biological systems. Numerical methods will be developed using a combination of MATLAB, the R statistical package, MCell, and/or URDME, at the discretion of the instructor. Student projects will comprise a major part of the course. Offered as BIOL 319, ECSE 319, MATH 319, SYBB 319, BIOL 419, EBME 419, MATH 419, PHOL 419, and SYBB 419. Prereq: MATH 224 or MATH 223 and BIOL 300 or BIOL 306 and MATH 201 or MATH 307 or consent of instructor.

SYBB 387. Undergraduate Research in Systems Biology. 1 - 3 Units.
This course provides students research experience in data science, proteomics, bioinformatics, and clinical informatics under the guidance of faculty affiliated with the Systems Biology and Bioinformatics program. Areas of research include production of big data at bench (cellular proteomics, structural proteomics, genomics, and interaction proteomics) and analysis of big data such as computational/statistical biology, bioinformatics tool development and clinical research informatics. A written report must be approved by the sponsor and submitted to the director of the Center for Proteomics and Bioinformatics before credit is granted.

SYBB 402. Introduction to Scientific Computing. 1 Unit.
This course will introduce students to basic data analysis, scripting and computational skills. SYBB 402 is designed for those with little or no prior programming experience. However, advanced programmers can still learn the tools and resources available to conduct scientific research. Students will gain hands-on experience working with data science software, Linux operating system, R/python packages, and functions designed for bioinformatics applications. At the end of the class, the students will complete a small-scale project/final, where they analyze a publicly available dataset and produce a short report. This course will prepare students for the SYBB Survey Series, which is composed of the following course sequence: (A) Technologies in Bioinformatics, (B) Data Integration in Bioinformatics, (C) Translational Bioinformatics, and (D) Programming for Bioinformatics. Each standalone section of this course series introduces students to an aspect of a bioinformatics project - from data collection (SYBB 311/411A) to data integration (SYBB 311/411B), to research applications (SYBB 311/411C), with a fourth module (SYBB 412) introducing basic bioinformatics programming skills.

SYBB 411. Technologies in Bioinformatics. 3 Units.
This course introduces students to the high-throughput technologies used to collect data for bioinformatics research in various fields including genomics, proteomics, clinical informatics, imaging, and metagenomics. This class surveys the conceptual models and tools used to analyze and interpret data collected by high-throughput technologies, and the latest applications of bioinformatics in the current state of science. This course will focus on genotyping, DNA/RNA sequencing, mass spectrometry-based proteomics, phosphoproteomics, electronic health records, metagenomics and immunology. The knowledge structures that we will cover include biomedical ontologies and databases, bioinformatics tools, essential algorithms in bioinformatics and networks. There will be in class exercises and assignments covering tools for genome/proteome exploration and analysis. This is an active learning course that will provide a hands-on learning experience for the students. Offered as SYBB 311 and SYBB 411. Prereq: Graduate Standing or BIOL 214 and BIOL 215.

SYBB 412. Survey of Bioinformatics: Programming for Bioinformatics. 3 Units.
SYBB 412 is a 3 credit-course that will introduce students to bioinformatics analysis and basic programming. This course is designed for those with little or no prior programming experience. However, advanced programmers can still learn bioinformatics pipelines and software packages to conduct research. Students will gain hands-on experience working with bioinformatics software, R packages and functions designed for bioinformatics applications. Programming for Bioinformatics course mainly focuses on R (rproject.org), and introduces students to basic programming in R, what packages are available, and teaches an introductory hands-on experience working with R by walking through the students in analyzing large -omics datasets. At the end of the class, the students are assessed with a small-scale project, where they analyze a publicly available dataset and produce a short report. This is an active learning class where adaptive learning and active learning teaching practices are used. Adaptive learning provide personalized learning, where efficient, effective, and customized learning paths to engage each student is offered. Recommended Preparation: BIOL 326 (Genetics) or equivalent Prereq: (SYBB 411 and SYBB 402 and Graduate Standing) or Requisites Not Met Permission.

SYBB 419. Applied Probability and Stochastic Processes for Biology. 3 Units.
Applications of probability and stochastic processes to biological systems. Mathematical topics will include: introduction to discrete and continuous probability spaces (including numerical generation of pseudo random samples from specified probability distributions), Markov processes in discrete and continuous time with discrete and continuous sample spaces, point processes including homogeneous and inhomogeneous Poisson processes and Markov chains on graphs, and diffusion processes including Brownian motion and the Ornstein-Uhlenbeck process. Biological topics will be determined by the interests of the students and the instructor. Likely topics include: stochastic ion channels, molecular motors and stochastic ratchets, actin and tubulin polymerization, random walk models for neural spike trains, bacterial chemotaxis, signaling and genetic regulatory networks, and stochastic predator-prey dynamics. The emphasis will be on practical simulation and analysis of stochastic phenomena in biological systems. Numerical methods will be developed using a combination of MATLAB, the R statistical package, MCell, and/or URDME, at the discretion of the instructor. Student projects will comprise a major part of the course. Offered as BIOL 319, ECSE 319, MATH 319, SYBB 319, BIOL 419, EBME 419, MATH 419, PHOL 419, and SYBB 419.

SYBB 421. Fundamentals of Clinical Information Systems. 3 Units.
Technology has played a significant role in the evolution of medical science and treatment. While we often think about progress in terms of the practical application of, say, imaging to the diagnosis and monitoring of disease, technology is increasingly expected to improve the organization and delivery of healthcare services, too. Information technology plays a key role in the transformation of administrative support systems (finance and administration), clinical information systems (information to support patient care), and decision support systems (managerial decision-making). This introductory graduate course provides the student with the opportunity to gain insight and situational experience with clinical information systems (CIS). Often considered synonymous with electronic medical records, the "art" of CIS more fundamentally examines the effective use of data and information technology to assist in the migration away from paper-based systems and improve organizational performance. In this course we examine clinical information systems in the context of (A) operational and strategic information needs, (B) information technology and analytic tools for workflow design, and (C) subsequent implementation of clinical information systems in patient care. Legal and ethical issues are explored. The student learns the process of "plan, design, implement" through hands-on applications to select CIS problems, while at the same time gaining insights and understanding of the impacts placed on patients and health care providers. Offered as EBME 473, MGTE 473, and SYBB 421.

SYBB 459. Bioinformatics for Systems Biology. 3 Units.
Description of omic data (biological sequences, gene expression, protein-protein interactions, protein-DNA interactions, protein expression, metabolomics, biological ontologies), regulatory network inference, topology of regulatory networks, computational inference of protein-protein interactions, protein interaction databases, topology of protein interaction networks, module and protein complex discovery, network alignment and mining, computational models for network evolution, network-based functional inference, metabolic pathway databases, topology of metabolic pathways, flux models for analysis of metabolic networks, network integration, inference of domain-domain interactions, signaling pathway inference from protein interaction networks, network models and algorithms for disease gene identification, identification of dysregulated subnetworks network-based disease classification. Offered as CSDS 459 and SYBB 459.

SYBB 461. Cancer Systems Biology. 3 Units.
Cancer systems biology (CSB) addresses the complexity associated with cancer through the integration of experimental biology and computational and mathematical analysis. In- stead of focusing on a single mutation or alteration, cancer systems biology looks at the changing cancer ecosystem, thus allowing cancer biologists and oncologists to understand and predict genomic events that affect the tumor system. In this class survey on CSB topics will be covered. The students will be exposed to expert knowledge on various topics on CSB. Problem-based learning and active learning approaches will be used to help cover these topics. Students will be evaluated with a term project that includes a presentation and a written report on the analysis and execution of systems approaches to cancer research. Prereq: SYBB 402 and SYBB 411 and SYBB 412.

SYBB 472. BioDesign. 3 Units.
Medical device innovations that would have been considered science fiction a decade ago are already producing new standards of patient care. Innovation leading to lower cost of care, minimally invasive procedures and shorter recovery times is equally important to healthcare business leaders, educators, clinicians, and policy-makers. Innovation is a driver of regional economic development and wealth creation in organizational units ranging in size from the start-up to the Fortune 500 companies. In a broader context, the pace of translational research leading to product and service innovation is highly interdisciplinary, thus, new products and services result from team efforts, marked by a systematic, structured approach to bringing new medical technologies to market and impacting patient care. In this course we examine medical technology innovations in the context of (A) addressing unmet clinical needs, (B) the process of inventing new medical devices and instruments, and (C) subsequent implementation of these advances in patient care. In short, the student learns the process of "identify, invent, implement" in the field of BioDesign. Offered as EBME 472, MGTE 472, and SYBB 472.

SYBB 501. Biomedical Informatics and Systems Biology Journal Club. 0 Unit.
The purpose of this journal club is to provide an opportunity for students to critically discuss a wide variety of informatics and systems biology topics and to present their works in progress. A wide range of informatics and systems theory approaches to conducting biomedical research will be accomplished through the guided selection of articles to be discussed during the club. Potential articles will be chosen from scientific journals including: Nature, Science, BMC Bioinformatics, BMC Systems Biology, the Journal of Bioinformatics and Computational Biology, and the Journal for Biomedical Informatics. During journal presentations, trainees will be expected to lead a discussion of the article that leads to the critical evaluation of the merit of the article and its implication for biomedical informatics and systems biology. The Journal Club will also provide a forum for trainees to present proposed, on-going, and completed research. Trainees will attend and participate in the Journal Club throughout their tenure in the program. The Journal Club will meet twice a month and each trainee will be required to present one journal article and one research in progress presentation yearly. The Journal Club will also include sessions where issues related to the responsible conduct of research are reviewed and extended.

SYBB 528. Contemporary Approaches to Drug Discovery. 3 Units.
This course is designed to teach the students how lead compounds are discovered, optimized, and processed through clinical trials for FDA approval. Topics will include: medicinal chemistry, parallel synthesis, drug delivery and devices, drug administration and pharmacokinetics, and clinical trials. A special emphasis will be placed on describing how structural biology is used for in silico screening and lead optimization. This component will include hands-on experience in using sophisticated drug discovery software to conduct in silico screening and the development of drug libraries. Each student will conduct a course project involving in silico screening and lead optimization against known drug targets, followed by the drafting of an inventory disclosure. Another important aspect of this course will be inclusion of guest lectures by industrial leaders who describe examples of success stories of drug development. Offered as BIOC 528, PHOL 528, PHRM 528, and SYBB 528.

SYBB 535. Independent Study in Biomedical Informatics. 1 - 3 Units.
For students pursuing MS or PhD degrees in SYBB, this course provides the opportunity for in-depth exposure to a subfield of systems biology and/or biomedical informatics. Degree-seeking students can enroll in this course prior to beginning 601 or 701 research. In conjunction with their proposed research advisor, enrolled students will undertake a self-directed study of a subfield of systems biology and/or biomedical informatics pertinent to their research area. The selected readings may also represent topics not covered by the student's coursework. The student's performance will be evaluated in an end-of-semester presentation or report at their advisor's discretion.

SYBB 555. Current Proteomics and Bioinformatics. 3 Units.
This course is designed for graduate students across the university who wish to acquire a better understanding of fundamental concepts of proteomics and related bioinformatics as well as hands-on experience with techniques used in current proteomics. Lectures will cover protein/peptide separation techniques, protein mass spectrometry, and biological applications which include quantitative proteomics, protein modification proteomics, interaction proteomics, structural genomics and structural proteomics. Also, it will cover experimental design, basic statistical concept and issues related to high-dimensional data from high-throughput technologies. Laboratory portion will involve practice on the separation of proteins by two-dimensional gel electrophoresis, molecular weight measurement of proteins by mass spectrometry, peptide structural characterization by tandem mass spectrometry. It will also include bioinformatics tools for protein identification and protein-protein interaction networks. The instructors' research topics will also be discussed. Recommended preparation: CBIO 453, CBIO 455, and PQHS 431.

SYBB 601. Systems Biology and Bioinformatics Research. 1 - 18 Units.
(Credit as arranged.)

SYBB 651. Thesis M.S.. 1 - 18 Units.
(Credit as arranged.)

SYBB 701. Dissertation Ph.D.. 1 - 9 Units.
(Credit as arranged.) Prereq: Predoctoral research consent or advanced to Ph.D. candidacy milestone.