Systems Biology Courses of Interest 2014-2015

Below is a list of courses that our students and faculty have suggested.

Course Catalog	http://www.registrar.fas.harvard.edu/fasro/courses/
Course Evaluations (Q Scores)	http://q.fas.harvard.edu/harvardQ/index.jsp
Nanocourses	https://nanosandothercourses.hms.harvard.edu/node/8

Fall Semester

Applied Computation 209. Data Science
Catalog Number: 46831
Rafael A. Irizarry (Public Health) and Verena S. Kaynig-Fittkau
Half course (fall term). Tu., Th., 2:30–4, and a weekly section. EXAM GROUP: 14
Learning from data in order to gain useful predictions and insights. This course introduces methods for five key facets of an investigation: data wrangling, cleaning, and sampling to get a suitable data set; data management to be able to access big data quickly and reliably; exploratory data analysis to generate hypotheses and intuition; prediction based on statistical methods such as regression and classification; and communication of results through visualization, stories, and interpretable summaries. Built around three modules: prediction and elections, recommendation and business analytics, and sampling and social network analysis.
Note: Only one of CS 109, AC 209, or Stat 121 can be taken for credit. Only admitted graduate students can take AC 209, in which case we expect significant differences in readings, assignments, and projects.
Prerequisite: Programming knowledge at the level of CS 50 or above, and statistics knowledge at the level of Stat 100 or above (Stat 110 recommended).

Applied Mathematics 115. Mathematical Modeling
Catalog Number: 1768
Zhiming Kuang (fall term) and Ariel Amir (spring term)
Half course (fall term; repeated spring term). Fall: M., W., 11–12:30; Spring: M., W., 1–2:30. EXAM GROUP: Fall: 18; Spring: 8
Abstracting the essential components and mechanisms from a natural system to produce a mathematical model, which can be analyzed with a variety of formal mathematical methods, is perhaps the most important, but least understood, task in applied mathematics. This course approaches a number of problems without the prejudice of trying to apply a particular method of solution. Topics drawn from biology, economics, engineering, physical and social sciences.
Note: Applied Mathematics 115 is also offered as Engineering Sciences 115. Students may not take both for credit. Undergraduate Engineering Students should enroll in Engineering Sciences 115.
Prerequisite: Mathematics at least at the level of Applied Mathematics 21a, b but preferably at the level of Applied Mathematics 105 (formerly Applied Mathematics 105b). Additional skills in analysis, algebra, probability, statistics and computer programming will increase the value of the course to students.

BCMP 200. Molecular Biology
Catalog Number: 5591
Joseph John Loparo (Medical School), Paul J. Anderson (Medical School), Lee Stirling Churchman (Medical School), Shobha Vasudevan (Medical School), Johannes Walter (Medical School), Timur Yusufzai (Medical School), and other members of the Departments.
Half course (fall term). M., W., F., 10:45-12:15. EXAM GROUP: 5
An advanced treatment of molecular biology's Central Dogma. Considers the molecular basis of information transfer from DNA to RNA to protein, using examples from eukaryotic and prokaryotic systems. Lectures, discussion groups, and research seminars.
Note: Offered jointly with the Medical School as BP 723.0.
Prerequisite: Intended primarily for graduate students familiar with basic molecular biology or with strong biology/chemistry background.

***BCMP 218. Molecular Medicine**
Catalog Number: 2049 Enrollment: Limited to 35.
George Q. Daley (Medical School), David E. Cohen (Medical School), and Irving M. London (Medical School)
Half course (fall term). Tu., 1–3. EXAM GROUP: 8
A seminar on various human diseases and their underlying genetic or biochemical bases. Primary scientific papers discussed. Lectures by faculty and seminars conducted by students, faculty supervision.
Note: Faculty mentors will guide student-led discussions of the papers. Jointly offered with the Medical School as HT 140.
Prerequisite: Molecular Biology and Biochemistry.

Chemistry 163. Frontiers in Biophysics
Catalog Number: 3635
Xiaoliang Sunney Xie
Half course (fall term). M., F., 1–2:30. EXAM GROUP: 1
This course introduces the physical chemistry underpinnings of life processes, including thermodynamics, equilibrium and nonequilibrium statistical mechanics and chemical kinetics. These principles will be illustrated in the context of recent experimental advances, in particular single-molecule enzymology, molecular motors, live cell imaging, and stochastic gene expression. Statistical analyses and numerical simulations of important biological processes will be covered throughout the course.
Note: Primarily for advanced undergraduate students and graduate students with either biological or physical backgrounds.
Prerequisite: Chemistry 160, Chemistry 161, or permission of the instructor.

Computer Science 50 (Letter Grade). Introduction to Computer Science I
Catalog Number: 4949
David J. Malan
Half course (fall term). M., W., 1-2:30, and a weekly section. EXAM GROUP: 1
Introduction to the intellectual enterprises of computer science and the art of programming. This course teaches students how to think

algorithmically and solve problems efficiently. Topics include abstraction, algorithms, data structures, encapsulation, resource management, security, software engineering, and web development. Languages include C, PHP, and JavaScript plus SQL, CSS, and HTML. Problem sets inspired by real-world domains of biology, cryptography, finance, forensics, and gaming. Designed for concentrators and non-concentrators alike, with or without prior programming experience.
Note: To take CS50 for a letter grade, register for catalog number 4949. This course will also meet on Fri 9/5 and Fri 10/17. Students with conflicts may watch those lectures online.

Genetics 201. Principles of Genetics
Catalog Number: 4225
Fred Winston (Medical School), Thomas G. Bernhardt (Medical School), Maxwell G. Heiman (Medical School), Mitzi I. Kuroda (Medical School), and Steven A. McCarroll (Medical School)
Half course (fall term). M., W., F., 9–10:20. EXAM GROUP: 10
An in-depth survey of genetics, beginning with basic principles and extending to modern approaches and special topics. We will draw on examples from various systems, including yeast, *Drosophila*, *C. elegans*, mouse, human and bacteria.
Note: Intended for first-year graduate students. Offered jointly with the Medical School as GN 701.0.

***MCB 52. Molecular Biology**
Catalog Number: 1938 Enrollment: Limited to 40.
A. Thomas Torello
Half course (fall term). T., Th., from 1:00 - 2:30 and a 90 minute discussion session weekly. EXAM GROUP: 8
An integrated and quantitative introduction to the principles of molecular biology with an emphasis on the experimental underpinning of key concepts. This course covers the biochemistry and structure of DNA; the Central Dogma of molecular biology (DNA replication and repair, transcription and RNA processing, and translation); and an overview of gene regulation and systems biology. The weekly section emphasizes problem solving and the scientific method. The investigative, discovery-based laboratory research project is optional.

MCB 291. Genetics, Genomics and Evolutionary Biology
Catalog Number: 2833
Elena M. Kramer, James Mallet, and John L. Rinn
Half course (fall term). M., W., 10–11:30, F., 10–12. EXAM GROUP: 5
This course covers the fundamentals of classical genetics, molecular genetics, macro- and microevolution, phylogenetics, and developmental evolution. The emphasis is on major concepts and terminology, reading landmark primary literature, and acquainting students with research techniques.
Note: Required for first year graduate students in the Molecules, Cells and Organisms (MCO) Training Program.

MCB 292. Cellular Biology, Neurobiology and Developmental Biology
Catalog Number: 4288 Enrollment: Limited to 30.

Ethan Garner, Venkatesh N. Murthy, and Alexander F. Schier
Half course (fall term). Tu., Th., 10–11:30. EXAM GROUP: 12
The biology of the individual cell lies at the heart of multi-cellular phenomena such as development and neural function. This course will emphasize critical evaluation of the primary literature, experimental design and scientific writing.
Note: Required for first year graduate students in the Molecules, Cells and Organisms (MCO) Training Program.

MCB 293. Biochemistry, Chemical and Structural Biology
Catalog Number: 2706
Andres Leschziner and Rachelle Gaudet
Half course (fall term). F., at 2, M., W., 2–4. EXAM GROUP: 1
This course will introduce basic principles in general, organic and physical chemistry, including kinetics and thermodynamics, as well as macromolecular structure. Concepts will be illustrated with examples taken from the visual system.
Note: Required for first year graduate students in the Molecules, Cells and Organisms (MCO) Training Program.

Statistics 110. Introduction to Probability
Catalog Number: 0147
Kevin Andrew Rader
Half course (fall term). Tu., Th., 1–2:30, and weekly sections to be arranged. EXAM GROUP: 8
A comprehensive introduction to probability. Basics: sample spaces and events, conditional probability, and Bayes' Theorem. Univariate distributions: density functions, expectation and variance, Normal, t, Binomial, Negative Binomial, Poisson, Beta, and Gamma distributions. Multivariate distributions: joint and conditional distributions, independence, transformations, and Multivariate Normal. Limit laws: law of large numbers, central limit theorem. Markov chains: transition probabilities, stationary distributions, convergence.
Prerequisite: Mathematics 18 or above (may be taken concurrently).

Statistics 220. Bayesian Data Analysis
Catalog Number: 6270
Jun S. Liu
Half course (fall term). Tu., Th., 11:30–1. EXAM GROUP: 15
Basic Bayesian models, followed by more complicated hierarchical and mixture models with nonstandard solutions. Includes methods for monitoring adequacy of models and examining sensitivity of models.
Note: Emphasis throughout term on drawing inferences via computer simulation rather than mathematical analysis.
Prerequisite: Statistics 110 and 111.

Systems Biology 200. Dynamic & Stochastic Processes in Cells
Catalog Number: 8701
Johan M. Paulsson (Medical School) and Jeremy M. Gunawardena (Medical School)

Half course (fall term). Tu., Th., 10-11:30, and a weekly section to be arranged. EXAM GROUP: 12
Rigorous introduction to (i) dynamical systems theory as a tool to understand molecular and cellular biology (ii) stochastic processes in single cells, using tools from statistical physics and information theory.
Note: Students planning to take both quarter courses (SB303 and 304) must enroll in this as a half course on their study card as SysBio200 for now and in the future. Students who take one half of this quarter can NOT ever take the other half for credit.
Prerequisite: College-level calculus.

Systems Biology 204. Biomolecular Engineering and Synthetic Biology
Catalog Number: 71179
Peng Yin (Medical School), George M. Church (Medical School), William Shih (Medical School), and Pamela A. Silver (Medical School)
Half course (fall term). M., W., 2–3:30. EXAM GROUP: 7
A course focusing on the rational design, construction, and applications of nucleic acid- and protein-based synthetic molecular and cellular machinery and systems. Students are mentored to produce substantial term projects.
Note: See http://sb204.net for details

BCMP 308qc. Cell Fate Decisions in Development and Disease
Catalog Number: 21552 Enrollment: Limited to 12.
Alan B. Cantor (Medical School) 5150
Quarter course (fall term). W., 1:30 - 3:30.
This quarter course will offer students an in-depth examination of current knowledge regarding mechanisms of cell fate decisions. In addition, it will examine these processes in the context of developmental cell plasticity, cellular reprogramming, and cancer. This will primarily be a literature-based course, with examination and discussion of key studies in the field. Concepts involving epigenetics, chromatin remodeling, the instructive roles of transcription factors, transcription factor networks, transcription factor cross-antagonism, feedback loops, multilineage priming, non-coding RNAs, lineage identity maintenance, mitotic bookmarking, lateral inhibition, and cell signaling will be explored. These ideas will be examined in the context of blood, breast, lung, and gastrointestinal tract development.

Neurobiology 306qc. Quantitative Methods for Biologists
Catalog Number: 85319 Enrollment: Limited to 80.
Michael Springer and Richard T. Born (Medical School)
Quarter course (fall term; repeated spring term). Fall: M., W., 9–5, Tu., Th., F., 1–5.
The goals of this course are to introduce students to programming in the MATLAB environment and to begin using this tool for analyzing data and for gaining intuition about the behavior of complex systems through the use of numerical simulations.
Note: This bootcamp course will meet in August from 8/11 - 8/22.

MIT 20.420 Biomolecular Kinetics and Cellular Dynamics *Prof. Bruce Tidor, Prof. Karl Wittrup, A. Jassanoff* *TR9.30-11* Fundamental analysis of biological rate processes using approaches from biomolecular reaction kinetics and dynamical systems engineering. Topics include binding and hybridization interactions, enzyme reactions, metabolic cycles, gene regulation, receptor/ligand trafficking systems, intra- and intercellular signaling, and cell population dynamics.
MIT7.81 Systems Biology *J. Gore* *TR1-2.30* Introduction to cellular and population-level systems biology with an emphasis on synthetic biology, modeling of genetic networks, cell-cell interactions, and evolutionary dynamics. Cellular systems include genetic switches and oscillators, network motifs, genetic network evolution, and cellular decision-making. Population-level systems include models of pattern formation, cell-cell communication, and evolutionary systems biology. Students taking graduate version explore the subject in more depth.
MIT 6.047 / 6.878 / HST.507 Computational Biology: Genomes, Networks, Evolution *Manolis Kellis* http://compbio.mit.edu/6.047 Covers the algorithmic and machine learning foundations of computational biology, combining theory with practice. Principles of algorithm design, influential problems and techniques, and analysis of large-scale biological datasets. Topics include (a) genomes: sequence analysis, gene finding, RNA folding, genome alignment and assembly, database search; (b) networks: gene expression analysis, regulatory motifs, biological network analysis; (c) evolution: comparative genomics, phylogenetics, genome duplication, genome rearrangements, evolutionary theory. These are coupled with fundamental algorithmic techniques including: dynamic programming, hashing, Gibbs sampling, expectation maximization, hidden Markov models, stochastic context-free grammars, graph clustering, dimensionality reduction, Bayesian networks.

J-Term

Systems Biology 301qc. Studying Evolution through Models and Experiments Catalog Number: 31854

Roy Kishony (Medical School) 5501 *Quarter course (spring term). M. through F., 10–12.* Intensive January course covering theoretical foundations in population genetics, genetic drift versus selection, identifying selection in genomes, advances in laboratory evolution experiments, with applications to key questions in systems biology and evolution. *Note:* January 13, 2014 - January 24, 2014. Class will be held in Warren Alpert RM 563, HMS. To register for this course, please contact the Systems Biology Department. Course website: http://isites.harvard.edu/k100765.	
Microbiology 302qc. Introduction to Infectious Disease Research: Infectious Diseases Consortium Boot Camp Catalog Number: 96439 *Eric J. Rubin (Public Health) 4084* *Quarter course (spring term). M. through F., 9-5.* This intensive January course provides an introduction to the breadth of infectious disease research carried out at Harvard. Students will learn techniques for studying infectious diseases, more about different types of infectious diseases, and meet faculty, students, and postdocs in infectious diseases labs at Harvard.	
***Systems Biology 305qc. Practical Synthetic Biology** Catalog Number: 22318 *Jeff Way and Pamela A. Silver (Medical School) 1595* *Quarter course (spring term). M. through F., 4–6.* Synthetic biology is a new discipline that seeks to enable the predictable engineering of biological systems. According to one conception of synthetic biology, proteins and genetic regulatory elements are modular and can be combined in a predictable manner. In practice however, assembled genetic devices do not function as expected. The purpose of the course is to go beyond the textbook, first-pass description of molecular mechanisms and focus on details that are specifically relevant to engineering biological systems. *Note:* January 13, 2014 - January 24, 2014. Class will be held in Warren Alpert RM 563, HMS. To register for this course, please contact the Systems Biology Department. Course website: http://isites.harvard.edu/k100763.	

Applied Mathematics 105. Ordinary and Partial Differential Equations
Catalog Number: 6316
Margo S. Levine
Half course (spring term). M., W., F., at 11. EXAM GROUP: 14
Ordinary differential equations: power series solutions; special functions; eigenfunction expansions. Review of vector calculus. Elementary partial differential equations: separation of variables and series solutions; diffusion, wave and Laplace equations. Brief introduction to nonlinear dynamical systems and to numerical methods.
Prerequisite: Applied Mathematics 21a and 21b, or Mathematics 21a and 21b.

Applied Mathematics 115. Mathematical Modeling
Catalog Number: 1768
Zhiming Kuang (fall term) and Ariel Amir (spring term)
Half course (fall term; repeated spring term). Fall: M., W., 11–12:30; Spring: M., W., 1–2:30. EXAM GROUP: Fall: 18; Spring: 8
Abstracting the essential components and mechanisms from a natural system to produce a mathematical model, which can be analyzed with a variety of formal mathematical methods, is perhaps the most important, but least understood, task in applied mathematics. This course approaches a number of problems without the prejudice of trying to apply a particular method of solution. Topics drawn from biology, economics, engineering, physical and social sciences.
Note: Applied Mathematics 115 is also offered as Engineering Sciences 115. Students may not take both for credit. Undergraduate Engineering Students should enroll in Engineering Sciences 115.
Prerequisite: Mathematics at least at the level of Applied Mathematics 21a, b but preferably at the level of Applied Mathematics 105 (formerly Applied Mathematics 105b). Additional skills in analysis, algebra, probability, statistics and computer programming will increase the value of the course to students.

Applied Mathematics 126. Statistics and Inference in Biology
Catalog Number: 89788
Michael Manish Desai
Half course (spring term). M., W., 10–11:30. EXAM GROUP: 5
We often deal with incomplete information when going about our lives: recognizing a friend's face covered by a shadow, having a phone conversation where the reception is poor, reading a document with lots of spelling and grammatical errors. In such circumstances, we make good guesses to process and understand the data. How do we do this? What kind of mathematical framework do we need to interpret noisy and incomplete data? This course will develop a set of statistical tools that will help us solve such poorly posed problems. We will draw on examples from primary literature in biology to study optical illusions, text recognition, sequence alignment, decoding cryptographs, processing of chemo-attractive signals to find food, and survival strategies of bacteria in unpredictable environments to motivate the underlying mathematical framework.

Prerequisite: Mathematics 19a/b or Mathematics 21a/b.

BCMP 201. Biological Macromolecules: Structure, Function and Pathways
Catalog Number: 5068
Stephen C. Harrison (Medical School), Stephen C. Blacklow (Medical School), and Peter K. Sorger (Medical School)
Half course (spring term). Tu., Th., 9:30–11, W., 4–5:30. EXAM GROUP: 2
Macromolecular structure with emphasis on biochemistry, interactions and catalysis in cellular processes and pathways. Links between theory and observation will emerge from discussion of fundamental principles, computational approaches and experimental methods.
Note: The course is intended for all Division of Medical Sciences (DMS) graduate students and is open to advanced undergraduates. Offered jointly with the Medical School as BP 714.0.

Biophysics 205. Computational and Functional Genomics
Catalog Number: 6777 Enrollment: Limited to 20.
Martha L. Bulyk (Medical School), Suzanne Gaudet (Medical School), and Shamil R. Sunyaev (Medical School)
Half course (spring term). M., W., 2:30–4. EXAM GROUP: 18
Experimental functional genomics, computational prediction of gene function, and properties and models of complex biological systems. The course will primarily involve critical reading and discussion rather than lectures.
Prerequisite: Molecular Biology (MCB 52 or equivalent), solid understanding of basic probability and statistics.

Biophysics 242r. Special Topics in Biophysics
Catalog Number: 6011
James M. Hogle (Medical School) and Stephen C. Harrison (Medical School)
Half course (spring term). Hours to be arranged.
Biophysical topics emerging from special interest research not normally available in established curriculum. This year’s focus to be on Structural Biology from Molecules to Cells.
Note: Weekly lectures with discussion sections.
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Biostatistics 297. Genomic Data Manipulation
Catalog Number: 67195 Enrollment: This course is targeted at students in experimental biology programs with an interest in understanding how available genomic techniques and resources can be applied in their research.
Curtis Huttenhower (Public Health)
Half course (spring term). M., W., 3:30–5:20, and a weekly 90-minute lab. EXAM GROUP: 17
Introduction to genomic data, computational methods for interpreting these data, and survey of current functional genomics research. Covers biological data processing, programming for large datasets, high-throughput data (sequencing, proteomics, expression, etc.), and related publications.

Note: Offered jointly with the School of Public Health as BIO508.

Cell Biology 201. Molecular Biology of the Cell
Catalog Number: 1044
Marcia C. Haigis (Medical School)
Half course (spring term). M., W., 10:30-12, and sections F., at 10:30-12. EXAM GROUP: 5
Molecular basis of cellular compartmentalization, protein trafficking, cytoskeleton dynamics, mitosis, cell locomotion, cell cycle regulation, signal transduction, cell-cell interaction, cell death, and cellular/biochemical basis of diseases.
Note: Methodological focus on current approaches in cell biology including quantitative tools. Emphasis on experimental design. Offered jointly with the Medical School as CB 713.0.
Prerequisite: Basic knowledge in biochemistry, genetics and cell biology.

Cell Biology 207. Developmental Biology: Molecular Mechanisms of Vertebrate Development
Catalog Number: 2044 Enrollment: Limited to 25.
Andrew B. Lassar (Medical School), John G. Flanagan (Medical School), Wolfram Goessling (Medical School), Jordan A. Kreidberg (Medical School), Sean Megason (Medical School), Trista Elizabeth North (Medical School), Ramesh Shivdasani (Medical School), Jessica Whited (Medical School), and Malcolm Whitman (Dental School)
Half course (spring term). M., Th., 2–4. EXAM GROUP: 18
Analyzes the developmental programs of frog, chick, zebrafish, and mouse embryos, emphasizing experimental strategies for understanding the responsible molecular mechanisms that pattern the vertebrate embryo. Morphogenesis, organogenesis, stem cells and regeneration will also be discussed.
Note: Offered jointly with the Medical School as CB 710.0. Includes lectures and conference sessions in which original literature is discussed in depth. Short research proposals are required in lieu of exams.

Computer Science 1. Great Ideas in Computer Science
Catalog Number: 6903
Henry H. Leitner
Half course (spring term). Tu., Th., 10–11:30. EXAM GROUP: 12
An introduction to the most important discoveries and intellectual paradigms in computer science, designed for students with little or no previous background. Explores problem-solving using high and low-level programming languages; presents an integrated view of computer systems, from switching circuits up through compilers and GUI design. Examines theoretical and practical limitations related to unsolvable and intractable computational problems, and the social and ethical dilemmas presented by such issues as software unreliability and invasions of privacy.
Note: May not be taken for credit after completing Computer Science 50. This course, when taken for a letter grade, meets the General Education requirement for Empirical and Mathematical Reasoning.

Computer Science 181. Machine Learning

Catalog Number: 6454
Ryan Prescott Adams
Half course (spring term). M., W., 1–2:30. EXAM GROUP: 8
Introduction to machine learning, providing a probabilistic view on artificial intelligence and reasoning under uncertainty. Topics include: supervised learning, ensemble methods and boosting, neural networks, support vector machines, kernel methods, clustering and unsupervised learning, maximum likelihood, graphical models, hidden Markov models, inference methods, and computational learning theory. Students should feel comfortable with multivariate calculus, linear algebra, probability theory, and complexity theory. Students will be required to produce non-trivial programs in Python.
Prerequisite: Computer Science 51, Computer Science 121, Statistics 110, Math 21a and 21b (or equivalent).

Engineering Sciences 222. Advanced Cellular Engineering
Catalog Number: 0696
Neel S. Joshi
Half course (fall term). M., W., F., at 9. EXAM GROUP: 10
This is a combined introductory graduate/upper-level undergraduate course that focuses on examining modern techniques for manipulating cellular behavior and the application of these techniques to problems in the biomedical and biotechnological arenas. Topics will include expanding the genetic code, genetic circuits, rewiring signaling pathways, controlling behavior through cell-matrix interactions, and directed differentiation of stem cells. Lectures will review fundamental concepts in cell biology before delving into topical examples from current literature. Students will work individually and in teams to determine the boundaries of existing cellular engineering techniques using scientific literature and propose original research to address unmet technological needs.
Note: This course does not have a laboratory section, but it is taught concurrently with Biomedical Engineering 121. Students interested in gaining hands-on experience with cell culture experiments should enroll in Biomedical Engineering 121.
Prerequisite: At least one semester of college-level organic chemistry and molecular/cellular biology. Physics at the level of Physics AP50 or Physics 12.

Genetics 228. Genetics in Medicine - From Bench to Bedside
Catalog Number: 9840
Susan A. Slaugenhaupt (Medical School) and Christopher Holmes Newton-Cheh (Medical School)
Half course (spring term). F., 2–5. EXAM GROUP: 18
Focus on translational medicine: the application of basic genetic discoveries to human disease. Will discuss specific genetic disorders and the approaches currently used to speed the transfer of knowledge from the laboratory to the clinic.
Note: Course will include patient presentations and lectures by investigators known for their work in a specific disease area. Course will be held at MGH (transportation provided to MGH). Offered jointly with the Medical School as GN 711.0. For more information visit Massachusetts General Hospital and select GEN 228.
Prerequisite: Genetics 201 or equivalent.

Mathematics 243. Evolutionary Dynamics
Catalog Number: 8136
Martin A. Nowak
Half course (spring term). Tu., Th., 2:30–4. EXAM GROUP: 11
Advanced topics of evolutionary dynamics. Seminars and research projects.
Prerequisite: Experience with mathematical biology at the level of Mathematics 153.

MCB 111. Mathematics in Biology
Catalog Number: 6444
Michael Manish Desai
Half course (spring term). M., W., 9–10:30. EXAM GROUP: 10
Develops the mathematics needed for quantitative understanding of biological phenomena including data analysis, simple models, and framing quantitative questions. Topics include probability, transforms and linear algebra, and dynamical systems, each motivated by current biological research.
Prerequisite: Mathematics 19 or higher.

Microbiology 201. Molecular Biology of the Bacterial Cell
Catalog Number: 38739
David Z. Rudner (Medical School), Thomas G. Bernhardt (Medical School), Simon L. Dove (Medical School), and Ann Hochschild (Medical School)
Half course (spring term). Tu., Th., 10–12. EXAM GROUP: 12
This course is devoted to bacterial structure, physiology, genetics, and regulatory mechanisms. The class consists of lectures and group discussions emphasizing methods, results, and interpretations of classic and contemporary literature.

OEB 242. Population Genetics
Catalog Number: 0903
Daniel L. Hartl and Michael Manish Desai
Half course (spring term). W., 2–5. EXAM GROUP: 18
Mathematical theory, experimental data, and history of ideas in the field, including analytical methods to study genetic variation with applications to evolution, demographic history, agriculture, health and disease. Includes lectures, problem sets, and student presentations.
Prerequisite: LS1b or permission of the instructor.

OEB 290. Microbial Sciences: Chemistry, Ecology and Evolution
Catalog Number: 7185 Enrollment: Limited to 30.
Michael S. Gilmore (Medical School)
Half course (spring term). F., at 8:30, F., 9:45–11:45. EXAM GROUP: 10
This is an interdisciplinary graduate-level and advanced undergraduate-level course in which students explore topics in molecular microbiology,

microbial diversity, and microbially-mediated geochemistry in depth. This course will be taught by faculty from the Microbial Sciences Initiative. Topics include the origins of life, biogeochemical cycles, microbial diversity, and ecology.
Note: Also offered as Microbiology 210.
Prerequisite: For advanced undergraduates, Life Sciences 1a and 1b are required, or permission of instructor. MCB 52 is recommended.

Statistics 111. Introduction to Theoretical Statistics
Catalog Number: 1836
Kevin Andrew Rader
Half course (spring term). Tu., Th., 1–2:30, and weekly sections to be arranged. EXAM GROUP: 1
Basic concepts of statistical inference from frequentist and Bayesian perspectives. Topics include maximum likelihood methods, confidence and Bayesian interval estimation, hypothesis testing, least squares methods and categorical data analysis.
Prerequisite: Mathematics 19a and 19b or equivalent and Statistics 110.

XMIT 7.05 General Biochemistry
Instructors: Gene M Brown, Matthew G. Vander Heiden, Michael B Yaffe
Lecture: MWF9.30-11 (10-250
Contributions of biochemistry toward an understanding of the structure and functioning of organisms, tissues, and cells. Chemistry and functions of constituents of cells and tissues and the chemical and physical-chemical basis for the structures of nucleic acids, proteins, and carbohydrates. General metabolism of carbohydrates, fats, and nitrogen-containing materials such as amino acids, proteins, and related compounds.

XMIT 8.592J: **Statistical Physics in Biology**

Mehran Kardar and Leonid Mirny
TR 9.30-11
A survey of problems at the interface of statistical physics and modern biology: Bioinformatic methods for extracting information content of DNA; gene finding, sequence comparison, phylogenetic trees. Physical interactions responsible for structure of biopolymers; DNA double helix, secondary structure of RNA, elements of protein folding. Considerations of force, motion, and packaging; protein motors, membranes. Collective behavior of biological elements; cellular networks, neural networks, evolution.

XMIT 20.490 Computational & Systems Biology
C. Burge, A. Keating, E. Fraenkel
http://web.mit.edu/7.91/
Provides an introduction to computational and systems biology. Includes units on the analysis of protein and nucleic acid sequences, protein structures, and biological networks. Presents principles and methods used for sequence alignment, motif finding, expression array analysis, structural modeling, structure design and prediction, and network analysis and modeling. Techniques include dynamic programming, Markov and hidden Markov models, Bayesian networks, clustering methods, and energy minimization approaches. Exposes students to emerging research areas. Designed for students with strong backgrounds in either molecular biology or computer science. Some foundational material covering basic programming skills, probability and statistics is provided for students with less quantitative backgrounds. Students taking graduate version complete additional assignments.