

## Systems Biology

Systems biology is a rapidly emerging area of research activity at the interface of mathematics, engineering, and the biological sciences. It is becoming increasingly clear that research and teaching in biology requires the mastery of advanced quantitative skills. Rapid advances in our understanding of biological phenomena at the molecular level have clarified how much more we need to understand about complex networks of interconnected, nonlinear elements that characterize biological systems at multiple levels. The biochemical networks that control cell metabolism, the neural networks that control behavior, the hierarchical network of multiple levels of cells, tissues, and organs of an organism, and the networks of interactions between species in an ecosystem all share this general character. New quantitative methods are needed to find statistically significant patterns in biological data, to search larger databases of molecules for homology, to create and simulate complex models of biological systems, and to analyze and understand the dynamics of biological patterns that extend over space and time. The systems biology degree program is intended to provide the quantitative skills and multidisciplinary understanding necessary for work in this area.

For more information, see <http://www.case.edu/artsci/sysbio/sysbio.html>

### Required Courses

#### Biology

BIOL 250: Intro. to Cell and Molecular Sys.  
 BIOL 251: Intro. to Org. and Pop. Sys.  
 BIOL 300: Dynamics of Biol. Sys. I  
 BIOL 306: Dynamics of Biol. Sys. II

#### Mathematics

MATH 121: Calculus I  
 MATH 122: Calculus II  
 MATH 223: Calculus III  
 MATH 224: Differential Eqs.

#### Chemistry

CHEM 105: Principles of Chem. I  
 CHEM 113: Principles of Chem. Lab  
 CHEM 106: Principles of Chem. II

#### Computer Science

EECS 132: Elem. Computer Programming  
 EECS 233: Intro. to Data Structures<sup>a</sup>  
 EECS 302/MATH 304: Discrete Mathematics

#### Physics

PHYS 121: General Physics I  
 PHYS 122: General Physics II

#### Statistics

STAT 312: Stats for Eng. & Science

---

<sup>a</sup>Should be taken after EECS 302, even though EECS 302 is not a formal prerequisite.

### Biology Electives (12 cr.)

Any upper-level BIOL course can count as a biology elective (e.g. not 214/215/216 or any of the 100-level courses). This includes BIOL 388, 388S, 389, 390. We recommend that systems biology students take BIOL 388S and 390.

## Subspecialty Electives (6 cr.)

Students will choose one of the approved subspecialization tracks. Approved tracks currently include

- **Neuroscience Track:** Introduction to Neurobiology (BIOL 373), plus one other neurobiology elective (currently includes BIOL 374, BIOL 376, BIOL/MATH 378, BIOL 382).
- **Genetics Track:** two of Biotechnology Lab: Genes and Genetic Engineering (BIOL 301), Genetics (BIOL 326), Plant Genomics and Proteomics (BIOL 328), Bioinformatics in Practice (EECS 359), Genetic Basis of Behavior (BIOL 359).
- **Evolutionary Biology Track:** Advanced Evolutionary Biology (BIOL 364), plus one other evolution or ecology course (currently includes BIOL 225, 307, 336, 345, 351, 358, 365, 366, 368).
- **Cellular and Molecular Biology Track:** Cell Biology (BIOL 325), Drugs, Brain, and Behavior (BIOL 382), Principles of Developmental Biology (BIOL 362), and Microbiology (BIOL 343).

## Systems electives (6 cr.)

Students will take two of the following courses:

### Largely computer science

EECS 313: Signal Processing  
EECS 324: Simulation Techniques in Engineering  
EECS 340: Algorithms and Data Structures  
EECS 341: Introduction to Database Systems  
EECS 365: Complex Systems Biology

### Largely mathematical

EECS 246: Signals and Systems  
BIOL 304: Fitting models to data: maximum likelihood methods and model selection  
MATH 201: Introduction to Linear Algebra  
MATH 234: Differential Equations and Dynamic Systems  
MATH 319: Biological Stochastic Processes  
MATH/BIOL 378: Computational Neuroscience  
OPRE 411A: Linear Programming plus OPRE 411B: Deterministic Models with Applications STAT

## Sample Schedule for Non-premedical Students

### Year 1

#### Fall

Open Elective (3)  
 MATH 121: Calculus I (4)  
 CHEM 105: Principles of Chem. I (3)  
 CHEM 113: Principles of Chem. Lab. (2)  
 SAGES: First Year Seminar (4)  
 PHED 101: Physical Education (0)

#### Spring

BIOL 250: Intro. to Cell. and Molec. Sys. (3)  
 MATH 122: Calculus II (4)  
 CHEM 106: Principles of Chem. II (3)  
 EECS 132: Elem. Computer Programming (3)  
 SAGES: University Seminar (3)  
 PHED 102: Physical Education (0)

### Year 2

#### Fall

BIOL 251: Intro. to Org. & Pop. Sys. (3)  
 PHYS 121: General Physics I (4)  
 MATH 223: Calculus III (3)  
 SAGES: University Seminar (3)  
 GER Course (3)

#### Spring

BIOL 300: Dyn. of Biol. Sys. I (3)  
 PHYS 122: General Physics II (4)  
 MATH 224: Calculus IV (3)  
 GER Course (3)  
 Open Elective (3)

### Year 3

#### Fall

BIOL 306: Dyn. of Biol. Sys. II (3)  
 Open Elective (3)  
 GER Course (3)  
 EECS 302/MATH 304: Discrete Math (3)  
 BIOL Elective

#### Spring

STAT 312: Basic Stats for Eng. & Science (3) (3)  
 BIOL Elective (3)  
 GER Course (3)  
 EECS 233: Intro. Data Structures (3)  
 SAGES: Dept. Sem. (3)

### Year 4

#### Fall

Senior Capstone (3) (BIOL 388S rec.)  
 Systems Elective (3)  
 BIOL Subspecialty Elective (3)  
 BIOL Elective (3)  
 Open Elective (3)

#### Spring

Open Elective (3)  
 Systems Elective (3)  
 BIOL Subspecialty Elective (3)  
 Open Elective (3)  
 Open Elective (3)

## Sample Schedule for Premedical Students

### Year 1

#### Fall

Open Elective (3)  
MATH 121: Calculus I (4)  
CHEM 105: Principles of Chem. I (3)  
CHEM 113: Principles of Chem. Lab. (2)  
SAGES: First Year Seminar (4)  
PHED 101: Physical Education (0)

#### Spring

BIOL 250: Intro to Cell. and Molec. Sys. (3)  
MATH 122: Calculus II (4)  
CHEM 106: Principles of Chem. II (3)  
EECS 132: Elem. Computer Programming (3)  
SAGES: University Seminar (3)  
PHED 102: Physical Education (0)

### Year 2

#### Fall

BIOL 216L: Organisms and Ecosystems Lab (1)  
CHEM 223: Intro. Org. Chem. I (3)  
CHEM 233: Intro. Org. Chem. Lab I (2)  
MATH 223: Calculus III (3)  
SAGES: University Seminar (3)  
BIOL 251: Intro to Org. & Pop. Sys. (3)

#### Spring

BIOL 300: Dyn. of Biol. Sys. I (3)  
CHEM 224: Intro. Org. Chem. II (3)  
GER Course (3)  
MATH 224: Calculus IV (3)  
GER Course (3)  
BIOL 215L: Cells and Proteins Lab (1)

### Year 3

#### Fall

BIOL 306: Dyn. of Biol. Sys. II (3)  
PHYS 121: General Physics I (4)  
BIOC 307: Gen. Biochem. (4)  
EECS 302/MATH 304: Discrete Math (3)  
Open Elective (3)

#### Spring

STAT 312: Basic Stats for Eng. & Science (3)  
PHYS 122: General Physics II (4)  
GER Course (3)  
EECS 233: Intro. Data Structures (3)  
SAGES: Dept. Sem. (3)

### Year 4

#### Fall

Senior Capstone (3) (BIOL 388S rec.)  
Systems Elective (3)  
BIOL Subspecialty Elective (3)  
BIOL Elective (3)  
GER Course (3)

#### Spring

Open Elective (3)  
Systems Elective (3)  
BIOL Subspecialty Elective (3)  
BIOL Elective (3)  
BIOL Elective (3)