Applied Mathematics-Biology

The Applied Math - Biology concentration recognizes that mathematics is essential to address many modern biological problems in the post genomic era. Specifically, high throughput technologies have rendered vast new biological data sets that require novel analytical skills for the most basic analyses. These technologies are spawning a new "data-driven" paradigm in the biological sciences and the fields of bioinformatics and systems biology. The foundations of these new fields are inherently mathematical, with a focus on probability, statistical inference, and systems dynamics. These mathematical methods apply very broadly in many biological fields including some like population growth, spread of disease, that predate the genomics revolution. Nevertheless, the application of these methods in areas of biology from molecular genetics to evolutionary biology has grown very rapidly in with the availability of vast amounts of genomic sequence data. Required coursework in this program aims at ensuring expertise in mathematical and statistical sciences, and their application in biology. The students will focus in particular areas of biology. The program culminates in a senior capstone experience that pairs student and faculty in creative research collaborations.

Standard program for the Sc.B. degree

Required coursework in this program aims at ensuring expertise in mathematical and statistical sciences, and their application in biology. The students will focus in particular areas of biology. The program culminates in a senior capstone experience that pairs student and faculty in creative research collaborations. Applied Math - Biology concentrators are prepared for careers in medicine, public health, industry and academic research.

Required Courses:

- **Students are required to take all of the following courses.**

  - MATH 0090 Introductory Calculus, Part I 1 credit
  - MATH 0100 Introductory Calculus, Part II 1 credit
  - or MATH 0170 Advanced Placement Calculus 1 credit
  - MATH 0180 Intermediate Calculus (or equivalent placement) 1 credit
  - MATH 0520 Linear Algebra 1 credit
  - or MATH 0540 Honors Linear Algebra 1 credit
  - CHEM 0330 Equilibrium, Rate, and Structure 1 credit
  - PHYS 0030 Basic Physics A 1 credit
  - or PHYS 0050 Foundations of Mechanics 1 credit

  Select one of the following sequences: 2 credits

  - APMA 0330 & APMA 0340 Methods of Applied Mathematics I, II and Methods of Applied Mathematics I, II
  - APMA 1650 Statistical Inference I 1 credit
  - or APMA 1655 Statistical Inference I 1 credit
  - APMA 1070 Quantitative Models of Biological Systems 1 credit
  - APMA 1080 Inference in Genomics and Molecular Biology 1 credit
  - BIOL 0200 The Foundation of Living Systems (or equivalent) 1 credit

Additional Courses

In addition to required courses listed above, students must take the following:

- Two additional courses in Applied Math or Biology. At least one of these must be a directed research course, e.g. a senior seminar or independent study in Applied Math or a directed research/independent study in Biology. For example: 2 credits

Total Credits: 18

Students whose independent study is expected to be in an experimental field are strongly encouraged to take APMA 1660, which covers experimental design and the analysis of variance (ANOVA), a method commonly used in the analysis of experimental data.

A course from the APMA 1930 series
- APMA 1970 Independent Study
- BIOL 1950 Directed Research/Independent Study
- BIOL 1960 Directed Research/Independent Study

We strongly recommend that Applied Mathematics-Biology concentrators take one of the following programming courses on or before their first semester as a concentrator: APMA 0160, CSCI 0040, CSCI 0190, CSCI 0170, CSCI 0190, CLPS 0950. Those who do can use it as their second Applied Math or Biology course.

Four classes in the biological sciences agreed upon by the student and advisor. These four courses should form a cohesive grouping in a specific area of emphasis, at least two of which should be at the 1000-level. Some example groupings are below:

**Areas of Emphasis and Suggested Courses:**

Some areas of possible emphasis for focusing of elective courses are listed below. Given the large number of course offerings in the biosciences and neuroscience, students are free to explore classes in these areas that are not listed below. However, all classes must be approved by the concentration advisor. APMA 1910 cannot be used as an elective.

**Biochemistry**
- BIOL 0280 Biochemistry
- BIOL 1270 Advanced Biochemistry
- CHEM 0350/0360 Organic Chemistry
- CHEM 1230 Chemical Biology

**Biotechnology and Physiology**
- BIOL 0800 Principles of Physiology
- BIOL 1100 Cell Physiology and Biophysics
- and/or appropriate bioengineering courses, such as:
  - BIOL 1090 Polymer Science for Biomaterials
  - BIOL 1120 Biomaterials
  - BIOL 1140 Tissue Engineering
  - BIOL 1150 Stem Cell Engineering
  - BIOL 1210 Synthetic Biological Systems

**Ecology, Evolution, and Genetics**
- BIOL 0410 Invertebrate Zoology
- & BIOL 0480 and Evolutionary Biology
- BIOL 0420 Principles of Ecology
- & BIOL 0430 and The Evolution of Plant Diversity
- BIOL 0470 Genetics
- BIOL 1420 Experimental Design in Ecology
- BIOL 1430 Population Genetics
- BIOL 1465 Human Population Genomics
- BIOL 1540 Molecular Genetics

**Neuroscience**
- APMA 0410 Mathematical Methods in the Brain Sciences
- Neurosciences courses: See https://www.brown.edu/academics/neuroscience/undergraduate/neuroscience-concentration-requirements
- BIOL 1100 Cell Physiology and Biophysics
- BIOL 1110 Topics in Signal Transduction
- BIOL 1190 Synaptic Transmission and Plasticity
Honors
Requirements and Process: Honors in the Applied Math-Biology concentration is based primarily upon an in-depth, original research project carried out under the guidance of a Brown (and usually Applied Math or BioMed) affiliated faculty advisor. Projects must be conducted for no less than two full semesters, and student must register for credit for the project via APMA 1970 or BIOL 1950/BIOL 1960 or similar independent study courses. The project culminates in the writing of a thesis which is reviewed by the thesis advisor and a second reader. It is essential that the student have one advisor from the biological sciences and one in Applied Mathematics. The thesis work must be presented in the form of an oral presentation (arranged with the primary thesis advisor) or posted at the annual Undergraduate Research Day in either Applied Mathematics or Biology. For information on registering for BIOL 1950/BIOL 1960, please see https://www.brown.edu/academics/biology/undergraduate-education/undergraduate-research

Excellence in grades within the concentration as well as a satisfactory evaluation by the advisors are also required for Honors. The student's grades must place them within the upper 20% of their cohort, in accordance with the university policy on honors. Honors recipients typically maintain a Grade Point Average of 3.4 or higher in the concentration. However, in the case of outstanding independent research as demonstrated in the thesis and supported by the Thesis Committee, candidates with a GPA between 3.0 and 3.4 will be considered and are encouraged to apply.

The deadline for applying to graduate with honors in the concentration are the same as those of the biology concentrations. However, students in the joint concentration must inform the undergraduate chair in Applied Mathematics of their intention to apply for honors by these dates.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

- Helvetica was used instead of Arial.

The editor may contact Leepfrog for a draft with the correct fonts in place.