BIOMATHEMATICS

Mission Statement

An increasing number of problems in the biological sciences are being solved using sophisticated mathematical and computational tools. The biomathematics degree blends mathematics, biology, and computer science in preparation for continued graduate studies and for careers in the quantitative life sciences. The degree's mission is to provide a world class undergraduate education in applied mathematics used in support of the life sciences.

The degree's mission is supported and motivated by these facts:

- Biological data is being generated with unprecedented precision and in unfathomable volumes.
- Quantifying biological observations requires mathematical and statistical analysis.
- The basic principles of complex biological systems support mathematical and computational modeling, which can lead to testable hypotheses and new discoveries.

Requirements

Requirements: 3 Free Electives 12 hours, 3 MA Electives 12 hours, 5 Tech Electives 20 hours, 1 Domain Elective 4 hours

Summary of Graduation Requirements

Code	Title	Hours
HSSA		**36 hours**
Standard requirement, one course must be:		
ENGL H290	Technical & Professional Communication	
RHIT		
RHIT 100	Foundations for Rose-Hulman Success	1
Math Core		**40 hours**
MA 111	Calculus I	5
MA 112	Calculus II	5
MA 113	Calculus III	5
MA 200	Career Preparation	1
MA 221	Matrix Algebra & Differential Equations I	4
MA 222	Matrix Algebra & Differential Equations II	4
MA 332	Introduction to Computational Science	4
MA 371	Linear Algebra I	4
or MA 373	Applied Linear Algebra for Engineers	
MA 381	Introduction to Probability with Applications to Statistics	4
MA 223	Engineering Statistics	4
or MA 382	Introduction to Statistics with Probability	
Biomath Core		**16 hours**
BMTH 311	Systems Biology	4
BMTH 312	Bioinformatics	4
BMTH 413	Computational Biology	4
BMTH 301	Introduction to Biomathematics: Continuous Models	4
or BMTH 302	Introduction to Biomathematics: Discrete Models	
Basic Science		**40 hours**
BIO 110	Cell Structure and Function	4
BIO 130	Evolution & Diversity	4
BIO 120	Comparative Anatomy & Physiology	4
or BIO 210	Mendelian & Molecular Genetics	
BIO 220	Microbiology	4
BIO 230	Cell Biology	4
CHEM 111	General Chemistry I	3
CHEM 111L	General Chemistry I Lab	1
CHEM 113	General Chemistry II	3
CHEM 113L	General Chemistry II Laboratory	1
PH 111	Physics I	4
PH 112	Physics II	4
CHEM 251	Organic Chemistry I	3
or PH 113	Physics III	
CHEM 251L	Organic Chemistry I Laboratory	1
Computer Science		**4 hours**
CSSE 120	Introduction to Software Development	4
Capstone Experience		**8 hours**
BMTH 496	Capstone Experience I	2
BMTH 497	Capstone Experience II	4
BMTH 498	Capstone Experience III	2
Domain Elective		**4 hours**
Select any of the following, with no course substitutions permitted:		4
BIO 330	Evolutionary Biology (4R-0L-4C W (alternate years)) [1]	
CHEM 330	Biochemistry I (4R-0L-4C F,S) [2]	
CSSE 304	Programming Language Concepts (4R-0L-4C W) [3]	
MA 366	Introduction to Real Analysis (4R-0L-4C W) [4]	
Math Electives		**8 hours**
Select any mathematics course numbered 300 or above or		8
MA 276	Introduction to Proofs	
Biomathematics Electives		**4 hours**
Select any BMTH course numbered 300 or above, or		4
MA 482	Biostatistics	
Technical Electives		**20 hours**
Courses numbered 200 or above in the physical sciences, life sciences, computer science, or engineering. Coursework in mathematics and biomathematics is not allowed.		
Free Electives		**12 hours**
Select 12 hours of Free Electives		
Total		**193 hours**

1 Prereq. BIO 130 Evolution & Diversity
2 Prereq. CHEM 251 Organic Chemistry I

[3] Prereq. CSSE 230 Data Structures and Algorithm Analysis and CSSE 280 Introduction to Web Programming
[4] Prereq. MA 371 Linear Algebra I and MA 276 Introduction to Proofs

Focus Areas

Students earning a major in Biomathematics are encouraged to gain depth in a particular mathematical or scientific area. By pursuing focused coursework in the following suggested areas, students will advance their preparation for graduate studies or careers in mathematical life sciences. Gaining depth through advanced electives also provides biomathematics students with an opportunity to apply knowledge gained through BMTH coursework. The following focus areas are illustrative examples to consider.

Applied Mathematics

Code	Title	Hours
BE 350	Biocontrol Systems	4
MA 332	Introduction to Computational Science (rrequired for majo)	4
MA 330	Vector Calculus	4
MA 342	Computational Modeling	4
MA 366	Introduction to Real Analysis	4
MA 367	Functions of a Complex Variable	4
MA 436	Introduction to Partial Differential Equations	4
MA 477	Graph Theory	4
MA 491	Introduction to Mathematical Modeling	2

Biochemistry

Code	Title	Hours
BMTH 301	Introduction to Biomathematics: Continuous Models	4
BMTH 312	Bioinformatics	4
CHEM 251 & CHEM 252 & CHEM 253	Organic Chemistry I and Organic Chemistry II and Organic Chemistry III	9
CHEM 326	Bioanalytical Chemistry	4
CHEM 330 & CHEM 331	Biochemistry I and Biochemistry II	8
CHEM 430	Advanced Biochemistry	4

Bioinformatics & Biostatistics

Code	Title	Hours
BMTH 312	Bioinformatics	4
MA 381	Introduction to Probability with Applications to Statistics (required for major)	4
MA 382	Introduction to Statistics with Probability	4
MA 386	Statistical Programming	4
MA 482	Biostatistics	4

Biomechanics

Code	Title	Hours
BE 233	Biomaterials	3
BE 545	Orthopaedic Biomechanics	4

Biophysics

Code	Title	Hours
PH 302	Biophysics	4

Cellular and Molecular Biology

Code	Title	Hours
BIO 220 & BIO 230	Microbiology and Cell Biology	8
BIO 411	Genetic Engineering	4
BIO 421	Applied Microbiology	4
BIO 431	Genomics & Proteomics	4
BMTH 301	Introduction to Biomathematics: Continuous Models	4

Computational Biology

Code	Title	Hours
BMTH 301	Introduction to Biomathematics: Continuous Models	4
BMTH 413	Computational Biology	4
CSSE 220	Object-Oriented Software Development	4
CSSE 333	Intro to Database Systems	4
CSSE 403	Programming Language Paradigms	4
CSSE 313	Artificial Intelligence	4
MA/CSSE 335	Introduction to Parallel Computing	4
MA 342	Computational Modeling	4
MA 433	Numerical Analysis	4
MA 435	Finite Difference Methods	4
MA/CSSE 473	Design & Analysis of Algorithms	4

Ecology

Code	Title	Hours
BIO 130	Evolution & Diversity	4
BIO 107	Introduction to Environmental Science	4
BIO 320	Ecology	4
BMTH 301	Introduction to Biomathematics: Continuous Models	4

Epidemiology & Pathology

Code	Title	Hours
BIO 410	Infection & Immunity	4
BIO 441	Virology	4
BIO 451	Cancer Biology	4
BIO 461	Evolutionary Medicine	4
BIO 471	Genetic & Molecular Analysis of Inherited Human Disease	4
BMTH 301	Introduction to Biomathematics: Continuous Models	4

Evolution

Code	Title	Hours
BIO 130	Evolution & Diversity	4
BIO 330	Evolutionary Biology	4
BIO 461	Evolutionary Medicine	4

Imaging and Optics

Code	Title	Hours
BE 435	Biomedical Optics	4
ECE 480	Introduction to Image Processing	4
BE 541	Medical Imaging Systems	4

MA 439	Mathematical Methods of Image Processing	4
PH 302	Biophysics	4

Medicine

Code	Title	Hours
BIO 120	Comparative Anatomy & Physiology	4
BIO 410	Infection & Immunity	4
BIO 441	Virology	4
BIO 451	Cancer Biology	4
BIO 461	Evolutionary Medicine	4
BIO 471	Genetic & Molecular Analysis of Inherited Human Disease	4
BE 541	Medical Imaging Systems	4
CHEM 251 & CHEM 252 & CHEM 253	Organic Chemistry I and Organic Chemistry II and Organic Chemistry III	9
CHEM 330 & CHEM 331	Biochemistry I and Biochemistry II	8
CHEM 430	Advanced Biochemistry	4

Physiology

Code	Title	Hours
BIO 120	Comparative Anatomy & Physiology	4
BE 520	Introduction to Brain Machine Interfaces	4

The second major in biomathematics is open to all majors with the following requirements and restrictions. Eligibility and limitations:

- The MA/BMTH double major must be separated by at least 24 hours.

Plan of Study

Below is a sample plan of study that illustrates one way to achieve the program requirements. Any given student's plan of study may differ based on a variety of factors (e.g., advanced credit, placement exams, adding a minor). Enrolled students will work with their academic advisor; utilize the degree audit/planner to create a specific plan of study.

Course	Title	Hours
Freshman		
Fall		
BIO 130	Evolution & Diversity	4
MA 111	Calculus I	5
CHEM 111	General Chemistry I	3
CHEM 111L	General Chemistry I Lab	1
HUM H190	First-Year Writing Seminar	4
RHIT 100	Foundations for Rose-Hulman Success	1
	Hours	**18**
Winter		
PH 111	Physics I	4
PH 111L	Physics I Lab	0
MA 112	Calculus II	5
CHEM 113	General Chemistry II	3
CHEM 113L	General Chemistry II Laboratory	1
BIO 110	Cell Structure and Function	4
	Hours	**17**
Spring		
CSSE 120	Introduction to Software Development	4
PH 112	Physics II	4
PH 112L	Physics II Lab	0
MA 113	Calculus III	5
HSSA Elective		4
	Hours	**17**
Sophomore		
Fall		
BIO 210	Mendelian & Molecular Genetics	4
MA 221	Matrix Algebra & Differential Equations I	4
HSSA Elective		4
PH 113 or CHEM 251	Physics III (PH113 requires lab) or Organic Chemistry I	4
	Hours	**16**
Winter		
BIO 220	Microbiology	4
MA 222	Matrix Algebra & Differential Equations II	4
MA 381	Introduction to Probability with Applications to Statistics	4
HSSA Elective		4
MA 200	Career Preparation	1
	Hours	**17**
Spring		
BIO 230	Cell Biology	4
MA 371	Linear Algebra I	4
HSSA Elective		4
BMTH 301	Introduction to Biomathematics: Continuous Models	4
	Hours	**16**
Junior		
Fall		
BMTH 311	Systems Biology	4
MA 382	Introduction to Statistics with Probability	4
HSSA Elective		4
Elective [1]		4
	Hours	**16**
Winter		
BMTH 312	Bioinformatics	4
MA 332	Introduction to Computational Science	4
ENGL H290	Technical & Professional Communication	4
Elective [1]		4
	Hours	**16**
Spring		
BMTH Elective		4
HSSA Elective		4
Elective [1]		4
Elective [1]		4
	Hours	**16**
Senior		
Fall		
BMTH 496	Capstone Experience I	2
HSSA Elective		4
Elective [1]		4
Elective [1]		4
	Hours	**14**
Winter		
BMTH 497	Capstone Experience II	4
BMTH 413	Computational Biology	4
Elective [1]		4
Elective [1]		4
	Hours	**16**
Spring		
BMTH 498	Capstone Experience III	2
Elective [1]		4
Elective [1]		4

Elective [1]	4
Hours	**14**
Total Hours	**193**

[1] **Requirements:**
3 Free Electives 12 hours
2 MA Electives 8 hours
5 Tech Electives 20 hours
1 Domain Elective 4 hours

Program Objectives
Program Goals and Objectives

The biomathematics degree will provide a broad based undergraduate experience that

1. prepares students with a rigorous education in applied mathematics,
2. educates students in the fundamental principles of biology,
3. trains students to work in a computational arena,
4. introduces students to several of the sister disciplines of computational biology, mathematical biology, bioinformatics, systems biology, and biostatistics, and
5. guides students through an advanced undergraduate research project.

The degree will also liberally educate students through the study of the humanities and social sciences. Students of the program will be encouraged to participate in external and internal research programs and industrial internships and/or co-ops.

Graduates of the biomathematics program will have an ability to:

1. Mathematically model, solve, and analyze problems in biomathematics.
2. Implement computational approaches to solve and analyze problems in biomathematics.
3. Write lucidly about biomathematics.
4. Speak fluently and coherently about biomathematics.
5. Synthesize new and previous knowledge through a capstone experience.

Learning Outcomes
Program Outcomes

Graduates will be prepared for graduate study in any of the sister fields as well as for careers in the quantitative life sciences. Each graduate will complete a capstone research experience that will culminate in a written report and a public presentation.