

Rose-Hulman Institute of Technology Course Catalog

Biology

The twenty-first century will see unparalleled advances in the biological sciences. Disciplines such as biology and biomedical engineering are burgeoning and will greatly impact the way we live in the future. The areas of functional genomics and proteomics will drive discoveries in molecular medicine, gene therapy and tissue engineering. Drug discovery will be facilitated by the elucidation of new target molecules and many pharmaceutical compounds will be produced using biological processes. Environmental management, remediation and restoration will also benefit from advances in biology. Biologists will be at the forefront of these advances and will drive the medical, agricultural, environmental and industrial applications of biological sciences.

The biology program will produce biologists with the chemistry, mathematics, and physics background needed to solve biotechnological problems in the coming decades. Those students wishing to strengthen their engineering skills can earn the area minor in biomedical engineering. Other students may choose to pursue a second major in Biochemistry and Molecular Biology. The program will prepare graduates for professional careers in government and industrial research laboratories, and in the biotechnology and health-related industries.

Those wishing to continue their studies in graduate or health professions programs will be exceptionally well qualified to do so.

A BIO science/technical elective is any Rose-Hulman course that has a prefix of BE, BIO, BMTH, CE, CHE, CHEM, CSSE, ECE, GEOL, MA, ME, PH, OE, EP, ES, EM or any EMGT course that is not cross-listed with an RH, GS, IA or SV course. Courses that do not count as science or technical electives are those courses with AS, MS, RH, GS, IA, SV, GE, JP, SP, FL, GRAD and CLSK prefixes.

SUMMARY

Required BIO courses	52 credits
BIO electives	12 credits
Free electives	8 credits
HSS electives	24 credits
Required HSS	12 credits
Required MA, CHEM, PH	63 credits
Required CLSK	1 credit
Sci/Tech electives	12 credits
Required BE course	4 credits
Total	188 credits

Biochemistry & Molecular Biology (Second Major Only)

The biochemistry & molecular biology program exists to give students an opportunity to augment their education in this technologically-important field. To support this effort, Rose-Hulman provides students with access to a modern and well-equipped biochemistry lab, along with an excellent biological sciences facility.

Biochemistry & molecular biology is available to Rose-Hulman students as a second major. This means that the student will receive a first degree in some other discipline and then can augment their education with this program. Students whose first degree programs are in chemistry or chemical engineering will find the program easiest since there is considerable overlap between those programs and the biochemistry & molecular biology requirements. Students from other disciplines are also encouraged to participate, but will have to take more courses. All students are encouraged to take individual courses in the program, regardless of whether or not they wish to fulfill the second major requirements, or to participate in related research projects under faculty supervision.

Two degree or double major programs in Biochemistry & Molecular Biology and Biochemistry are not allowed.

Required Courses

Course	Description	Hours
CHEM 111, 113, 115	General Chemistry	12
CHEM 251, 252, 253	Organic Chemistry	9
CHEM 251L, 252L, 253L	Organic Chemistry Lab	3
CHEM 330, 430, 433	Biochemistry	9
CHEM 361, 362 or CHEM 360 and		
CHE 303, 304	Physical Chemistry	8
BIO 110, 120, 130	Biology	12
BIO 210	Genetics	4
BIO 220, 230	Molecular Biology	8
BIO 411	Genetic Engineering	4
Total		69

Elective Courses

Choose 12 credits* from the following courses:

Course	Description
BIO 330	Evolutionary Biology
BIO 421	Microbiology
BIO 431	Genomics and Proteomics
BIO 441	Virology
BIO 451	Cancer Biology
BIO 492	Directed Study in Biology
CHEM 225	Analytical Chemistry
CHEM 291	Introduction to Research
CHEM 331	Biochemistry II
CHEM 431	Biochemical Instrumentation

CHEM 451	Organic Structure Determination
CHEM 290 or	
CHEM 490	Chemical Research
PH 302	Biophysics

Total Credits for Second Major 81

**Students with a major in chemistry need to take 8 credits of electives, with 4 credits from the BIO electives listed, and 4 credits chosen from any BIO or BE course.*

STUDENTS WITH A MAJOR IN BIOLOGY must take 12 credits of electives, with 8 credits from the elective courses listed above with a CHEM prefix, and 4 credits from any 300 level or above BIO course (total: 29 hours required beyond Biology major).

Biology Minor

Biology is an exciting subject that has applications relevant to all other fields of study at the Institute. Students who are interested in enriching their major area of study with a knowledge of life sciences can do so with the Biology Minor. With proper course selection, the Minor will provide another marketable dimension to any Bachelor of Science degree granted by the Institute.

The Minor in Biology has the following requirements.

1. All students must complete BIO110 (Cell Structure and Function) or BIO130 (Evolution and Diversity) and four more courses in biology (BIO) or allied areas, above those courses already specifically required to fulfill the student's major, subject to the following requirements:
 - a. At least three of the four electives must be BIO courses.
 - b. At least three of the electives must be 200-level or above.
2. Students electing to pursue the minor in Biology must follow a plan of study that is approved by the Minor Advisor. Current advisor information and a form for the planning and approval of a minor can be obtained from the BBE Department Secretary.
3. Allied area courses could include:

BE310	Analysis of Physiological Systems I	IA236	Communicating STEM to a Public Audience
BE320	Analysis of Physiological Systems II	IA239	Rhetoric of Science
BE570	Intro to Tissue Engineering	IA401	Philosophy of Science
BMTH310	Mathematical Biology	IA471	Computational Psychology
BMTH311	Systems Biology	MA482/BE482	Bioengineering Statistics
BMTH312	Bioinformatics	ME447	Visualizing Data

BMTH413	Computational Biology	PH302	Biophysics
CE460	Intro to Environmental Engineering	SV304	Bioethics
CHE545	Intro to Biochemical Engineering	SV371	Social Psychology
CHEM264	Intro to Environmental Science	SV373	Abnormal Psychology
CHEM330	Biochemistry	SV472	Studying Human Behavior
CHEM430	Advanced Biochemistry	SV386	Human Evolution

Additional courses not listed here can be considered on a case-by-case basis.

Biochemistry & Molecular Biology Minor

Completion of BIO110, CHEM111, CHEM113 and CHEM115. In addition, the student must complete five courses from the following list that are not already named required courses by the student's major or minor programs:

Course	Description
BIO 210	Mendelian and Molecular Genetics
BIO 220 or BIO 230	Prokaryotic Cell and Molecular Biology Eukaryotic Cell and Molecular Biology
BIO 411 or BIO 431	Genetic Engineering Genomics and Proteomics
CHEM 230 or CHEM 251 and CHEM 252	Introduction to Organic Chemistry and Biochemistry Organic Chemistry I Organic Chemistry II
CHEM 330	Biochemistry
CHEM 430 with CHEM 433	Advanced Biochemistry Biochemistry Laboratory

Biology is an exciting subject that has applications relevant to all other fields of study at the Institute. Students who are interested in enriching their major area of study with a knowledge of life sciences can do so with the Biology Minor. With proper course selection, the Minor will provide another marketable dimension to any Bachelor of Science degree granted by the Institute.

Plan of Study

Freshman

Fall

Course	Credit
BIO 110 Cell Structure & Function	4
CHEM 111 General Chemistry	4
MA 111 Calculus I	5
CLSK College & Life Skills	1
Total Credits: 14	

Winter

Course	Credit
BIO 120 Comparative Anatomy & Physiology	4
CHEM 113 General Chemistry II	4
MA 112 Calculus II	5
RH 131 Rhetoric & Composition	4
Total Credits: 17	

Spring

Course	Credit
BIO 130 Evolution and Diversity	4
CHEM 115 General Chemistry III	4
MA 113 Calculus III	5
BE 100 Problem Solving in the Biological Sciences and Engineering	4
Total Credits: 17	

Sophomore

Fall

Course	Credit
BIO 210 Mendelian & Molecular Genetics	4
CHEM 251 Organic Chemistry I	3

CHEM 251L Organic Chemistry I Laboratory	1
PH 111 Physics I	4
MA 212 Matrix Algebra and Systems of Differential Equations	4
Total Credits: 16	

Winter

Course	Credit
BIO 220 Prokaryotic Cell & Molecular Biology	4
CHEM 252 Organic Chemistry II	3
CHEM 252L Organic Chemistry II Lab	1
PH 112 Physics II	4
RH 330 Technical and Professional Communication	4
Total Credits: 16	

Spring

Course	Credit
BIO 230 Eukaryotic Cell & Molecular Biology	4
CHEM 253 Organic Chemistry III	3
CHEM 253L Organic Chemistry III Lab	1
PH 113 Physics III	4
MA 223 Engineering Statistics	4
Total Credits: 16	

Junior

Fall

Course	Credit
BIO 320 Ecology	4
CHEM 330 Biochemistry	4
HSS Elective	4
BIO 399 Practice of Science	4
Total Credits: 16	

Winter

Course	Credit
BIO 330 Evolutionary Biology	4
BIO 496 Senior Thesis Research I	2

BIO Elective	4
HSS Elective	4
Total Credits: 14	

Spring

Course	Credit
BIO 310 Plant Structure & Function	4
BIO 497 Senior Thesis Research II	4
SV 304 Bioethics	4
HSS Elective	4
Total Credits: 16	

Senior

Fall

Course	Credit
BIO 498 Senior Thesis Research III	4
Science/Technical Elective	4
HSS Elective	4
Free Elective	4
Total Credits: 16	

Winter

Course	Credit
BIO 499 Senior Thesis Research IV	2
Science/Technical Elective	4
BIO Elective	4
HSS Elective	4
Total Credits: 14	

Spring

Course	Credit
BIO Elective	4
Science/Technical Elective	4
HSS Elective	4
Free Elective	4
Total Credits: 16	

NOTES

A BIO science/technical elective is any Rose-Hulman course that has a prefix of BE, BIO, BMTH, CE, CHE, CHEM, CSSE, ECE, GEOL, MA, ME, PH, OE, EP, ES, EM or any EMGT course that is not cross-listed with an RH, GS, IA or SV course. Courses that

do not count as science or technical electives are those courses with AS, MS, RH, GS, IA, SV, GE, JP, SP, FL, GRAD and CLSK prefixes.

Biology - Course Descriptions

[BIO 101 Essential Biology 4R-OL-4C F,W,S](#)

Prerequisites: There are no prerequisites for this course.

Corequisites: There are no corequisites for this course.

Surveys basic concepts in the biological sciences and describes how new advances related to these concepts affect contemporary society. Students who have completed BIO110, BIO120 or BIO130 cannot receive credit for taking BIO101.

[BIO 102 Nutrition 4R-OL-4C W](#)

Prerequisites: There are no prerequisites for this course.

Corequisites: There are no corequisites for this course.

This course surveys essential concepts in the nutritional sciences, including food composition, diet construction and analysis, physiological processes, and special nutritional needs for certain groups. This course counts as a free elective for BIO or BE majors and not as an BIO elective.

[BIO 110 Cell Structure and Function 3R-3L-4C F,S](#)

Prerequisites: There are no prerequisites for this course.

Corequisites: There are no corequisites for this course.

Introduces structures, mechanisms, and laboratory techniques in cellular and molecular biology. Discusses biomolecules, bioenergetics, biosynthesis, enzymatic function, genetics, and cellular regulatory systems.

[BIO 120 Comparative Anatomy & Physiology 3R-3L-4C W](#)

Prerequisites: There are no prerequisites for this course.

Corequisites: There are no corequisites for this course.

The structural and functional relationships between tissues and organ systems are discussed using a comparative approach. The lecture is combined with laboratory exercises and observations, which may require dissection of biological specimens.

[BIO 130 Evolution and Diversity 3R-3L-4C S](#)

Prerequisites: There are no prerequisites for this course.

Corequisites: There are no corequisites for this course.

Introduces fundamental principles, important applications, and field and laboratory techniques in organismal biology. Discusses mechanisms of evolution, the history of life on earth, biological diversity, and ecology.

[BIO 191 Special Topics in Biology XR-OL-XC](#)

Prerequisites: Arranged prerequisite by consent of instructor

Corequisites: There are no corequisites for this course.

Introduces structures, mechanisms, and laboratory techniques in cellular and molecular biology. Discusses biomolecules, bioenergetics, biosynthesis, enzymatic function, genetics, and cellular regulatory systems.

[BIO 205 Cellular Physiology 4R-OL-4C F](#)

Prerequisites: BIO 110 F,S

Corequisites: There are no corequisites for this course.

The flow of information in biological systems provides a framework for detailed discussion of cell structure and function, with particular attention paid to the physiology of excitable cells. Cellular communication and the interactions of cells in tissues and the immune system are also examined. Reproduction and organismal development will also be addressed at the cellular level. A student who earns credit for BIO205 cannot earn credit for BIO210 or BIO230 without departmental consent.

BIO 210 Mendelian & Molecular Genetics 3R-3L-4C F

Prerequisites: BIO 110 F,S or instructor consent

Corequisites: There are no corequisites for this course.

A discussion of Mendelian genetics including the molecular mechanisms of nuclear and cytoplasmic inheritance. Information flow and control of gene expression are addressed at the molecular level. Basic genetic techniques are covered in both lecture and laboratory.

BIO 220 Microbiology 3R-3L-4C W

Prerequisites: BIO 110 F,S or instructor consent.

Corequisites: There are no corequisites for this course.

Discusses the essential properties of eubacteria and archaea. Bacterial nutrition, growth, genetics and structural and metabolic diversity are discussed in detail. The basics of virology are also addressed. Fundamental laboratory methodologies are also covered.

BIO 230 Cell Biology 3R-3L-4C S

Prerequisites: BIO 110 F,S or instructor consent

Corequisites: There are no corequisites for this course.

Examines the structure and function of various eukaryotic cells. Biomembranes, organelles, the cytoskeleton, energetics, protein sorting, signal transduction and cell interactions are discussed in detail. Essential methods in cell biology are addressed in both lectures and laboratories.

BIO 310 Plant Structure & Function 3R-3L-4C S

Prerequisites: BIO 130 S or instructor consent.

Corequisites: There are no corequisites for this course.

Surveys the structure, physiology, diversity, evolution, and ecological importance of plants and related groups of organisms.

BIO 320 Ecology 3R-3L-4C F

Prerequisites: BIO 130 S or instructor consent

Corequisites: There are no corequisites for this course.

Surveys adaptations of organisms, population dynamics, species interactions, and the structure and function of natural communities and ecosystems.

BIO 330 Evolutionary Biology 4R-0L-4C W

Prerequisites: BIO 130 S or instructor consent

Corequisites: There are no corequisites for this course.

Surveys three major themes of evolutionary biology: adaptation, diversity of life, and the shared characteristics of life. Mechanisms of evolution, speciation, phylogeny, and macroevolutionary processes are discussed.

BIO 340 Introduction to Biomedical Research: Clinical Methodology 1R-1L-1C

Prerequisites: BIO 120 W and Jr/Sr standing or consent of instructor.

Corequisites: There are no corequisites for this course.

Designed to introduce biology/bioengineering students to the basics of biomedical research using the clinical methodology typical of patient sample analysis. Students will learn to relate testing procedures with specific diseases and to use data obtained from laboratory testing to understand more about specific patient health problems.

BIO 350 Principles of Synthetic Biology 2R-0L-2C W

Prerequisites: There are no prerequisites for this course.

Corequisites: There are no corequisites for this course.

Open to all majors. This course covers the biological foundations of synthetic biology. It is directed at understanding how biological information is stored and processed, and how it is expressed as biological function. Particular attention will be paid to how the expression of this information is regulated and how cells can be engineered to solve contemporary problems in health, energy, manufacturing and sustainability.

BIO 351 Synthetic Biology Design 2R-0L-2C S

Prerequisites: BIO 350 W

Corequisites: There are no corequisites for this course.

Open to all majors. This course focuses on the design of novel biological parts, devices and systems, and their use in engineering cell function. Bioengineering principles and the design of genetic logic circuits, memory modules, biosensors and other cellular devices will be addressed. For the final project, students will design a novel biological system that meets the standards and goals of the International Genetically Engineered Machine Competition.

BIO 352 Synthetic Biology Laboratory 4C (studio format, 4 days x 3 hrs) Su1

Prerequisites: Instructor Consent

Corequisites: There are no corequisites for this course.

Open to all majors. This project-based studio laboratory course focuses on the fundamental laboratory techniques employed in the synthetic biology laboratory. Relevant background and theory will be discussed and applied in the hands-on learning of core laboratory techniques. In practice, students will build and test novel genetic devices designed to advance the current International Genetically Engineered Machine Competition (iGEM) Team project. Significant contribution to the project will earn students membership on the Rose-Hulman iGEM team and attribution in iGEM competition materials.

BIO 399 Practice of Science 4R-0L-4C

Prerequisites: BIO 330 W, and MA 223 F,W,S or consent of instructor

Corequisites: There are no corequisites for this course.

This course focuses on skills required for implementing scientific research, including reading the primary literature, experimental design, scientific writing, oral presentations, research proposal writing, poster presentations, and investigation of research programs (through seminars or individual meetings). Each student chooses a project and research mentor by the end of the course.

BIO 410 Infection and Immunity 4R-0L-4C Arranged

Prerequisites: BIO 110 F,S or instructor consent

Corequisites: There are no corequisites for this course.

Discussion of various pathogens, how they cause disease, and how they elicit the innate and adaptive immune responses employed to combat them. Cellular and

molecular mechanisms of immunity are addressed, as is the epidemiology of various human diseases.

BIO 411 Genetic Engineering 4R-0L-4C Assigned

Prerequisites: BIO 205 F or BIO 210 F or consent of instructor

Corequisites: There are no corequisites for this course.

Discusses the basics of molecular biology and the genetic and molecular techniques used to engineer prokaryotic and eukaryotic cells, plants, and animals for the production of useful traits or compounds. The application of DNA technology to the diagnosis and treatment of disease is also addressed.

BIO 421 Applied Microbiology 4R-0L-4C Assigned

Prerequisites: BIO 110 F,S *Arranged prerequisite or instructor consent

Corequisites: There are no corequisites for this course.

Discusses the fundamental biology of microprobes and the processes underlying their use in the production of chemicals, therapeutics and foods. The basics of microbial ecology and the environmental applications of microbial biotechnology are also discussed.

BIO 431 Genomics and Proteomics 4R-0L-4C S

Prerequisites: BIO 205 F or BIO 210 F or consent of instructor

Corequisites: There are no corequisites for this course.

Exploration of the methodologies used to generate systems-level sets of genetic and protein data, and the tools used to access and analyze the prodigious amounts of data emerging from such projects. The application of these technologies to investigate biological questions and model complex biological systems is also discussed.

BIO 441 Virology 3R-3L-4C

Prerequisites: BIO 110 F,S or instructor consent

Corequisites: There are no corequisites for this course.

Virology focuses on the study of viruses as well as non-viral entities such as prions and viroids. In this course, students will learn about the structures, genomes, replication strategies, and pathogenic mechanisms of various viruses. Viruses causing diseases of medical and economic importance will be emphasized. In addition, the techniques used to study viruses and the uses of viruses in the treatment of disease will be addressed.

BIO 451 Cancer Biology 4R-0L-4C

Prerequisites: BIO 205 F or BIO 210 F or consent of instructor

Corequisites: There are no corequisites for this course.

This course focuses on cancer at the molecular and cellular level. Specific cellular molecules and the changes to these cellular molecules that contribute to transformational and immortalization of cells and tumor progression will be studied. The mechanisms behind these molecular changes, cancer promotion and initiation events, and cancer molecule-specific treatment options will be addressed. In addition, students will study a variety of specific cancer types.

BIO 461 Evolutionary Medicine 4R-0L-4C Arranged

Prerequisites: BIO 130 S*, and BIO 205 F* or BIO 210 F* *Arranged prerequisite or instructor consent.

Corequisites: There are no corequisites for this course.

This course examines medicine and medical practice from the perspective of evolutionary constraints, challenges, and diversity. Topics include theoretical

foundations of the field, cancer patterns, mental health, genetic disease, evolutionary health promotion, and others.

BIO 471 Genetic & Molecular Analysis of Inherited Human Disease 4R-0L-4C S

Prerequisites: BIO 205 F* or BIO 210 F* *Arranged prerequisite or consent of instructor

Corequisites: There are no corequisites for this course.

Strategies and methods used to identify and understand the genetic and molecular bases of inherited human disease are addressed. Topics include, human population genetics, pedigrees, genetic and physical mapping of human genes, linkage analysis, and diagnostic testing. Primary literature is routinely utilized.

BIO 491 Special Topics in Biology XR-0L-XC

Prerequisites: Arranged prerequisite or instructor consent

Corequisites: There are no corequisites for this course.

Covers upper level material of mutual interest to student and instructor which cannot be acquired in any other listed BIO course.

BIO 492 Directed Study in Biology XR-XL-XC

Prerequisites: Arranged prerequisite or instructor consent

Corequisites: There are no corequisites for this course.

Covers biology material of mutual interest to the student and instructor which cannot be experienced in any other listed BIO course. A student may take between 1-4 credits in any given term, and a maximum of 8 credits of this course are permitted. Prior approval of the BBE department is required to use this course to fulfill BIO elective credit requirements.

BIO 496 Senior Thesis Research I 0R-6L-2C F,W,S

Prerequisites: BIO 399 F and consent of instructor

Corequisites: There are no corequisites for this course.

Initiation of senior thesis under the direction of an BBE faculty mentor. Major tasks include creation and submission of a research proposal and piloting procedures. Additional requirements for adequate progress determined by each faculty mentor.

BIO 497 Senior Thesis Research II 0R-12L-4C F,W,S

Prerequisites: BIO 399 F and consent of instructor

Corequisites: There are no corequisites for this course.

Continuation of research under the direction of an BBE faculty mentor. Major tasks include data acquisition and methodological refinement. Additional requirements for adequate progress determined by each faculty mentor.

BIO 498 Senior Thesis Research III 0R-12L-4C F,W,S

Prerequisites: BIO 399 F and consent of instructor

Corequisites: There are no corequisites for this course.

Continuation of research under the direction of an BBE faculty mentor. Major tasks include data acquisition and preliminary analysis. Additional requirements for adequate progress determined by each faculty mentor.

BIO 499 Senior Thesis Research IV 0R-6L-2C W

Prerequisites: BIO 399 F and consent of instructor

Corequisites: There are no corequisites for this course.

Completion of senior thesis under the direction of an BBE faculty mentor. Major tasks include final analysis, public presentation of results, and submission of the written thesis. Additional requirements for adequate progress determined by each faculty mentor.

BIO CPT Curricular Practical Training 1R-0L-1C

Prerequisites: Consent of department head

Corequisites: There are no corequisites for this course.

Any international student with an F-1 Visa employed by any company in the form of an internship, co-op, or practicum must enroll in a CPT course. The CPT experience is to be complimentary training to the student's curriculum and should contribute substantially to his/her learning experience. Students must have an offer of employment from a company prior to registering for this course. The CPT must be approved by the Department Head, Director of International Student Services, and the student's advisor. Students are required to submit a report at the conclusion of the employment to his/her instructor to receive a grade for the CPT experience.

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