

# Biology

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## Majors

### The Major in Biology

Total units required: 58 to 67

#### Required courses:

Code	Title	Units
Biol 2960	Principles of Biology I	4
Biol 2970	Principles of Biology II	4
Chem 111A or Chem 105	General Chemistry I Introductory General Chemistry I	3
Chem 112A or Chem 106	General Chemistry II Introductory General Chemistry II	3
Chem 151	General Chemistry Laboratory I	2
Chem 152	General Chemistry Laboratory II	2
Chem 261	Organic Chemistry I with Lab	4
Chem 262	Organic Chemistry II with Lab	4
Math 132	Calculus II	3
Math 2200 or Math 233 or Math 3200	Elementary Probability and Statistics Calculus III Elementary to Intermediate Statistics and Data Analysis	3
Physics 191	Physics I	3
Physics 191L	Physics I Laboratory	1
Physics 192	Physics II	3
Physics 192L	Physics II Laboratory	1
<b>Total Units</b>		<b>40</b>

Students may substitute Chem 401 Physical Chemistry I for Chem 262 Organic Chemistry II with Lab. Students who plan to take physical chemistry must take Math 233 Calculus III. Math 2200 Elementary Probability and Statistics (required for the tracks in ecology and evolution and in genomics and computational biology) and Math 322 Biostatistics are valuable, particularly for students interested in research. Students who have taken Math 233 may take Math 3200 Elementary to Intermediate Statistics and Data Analysis rather than Math 2200 Elementary Probability and Statistics for a more advanced treatment of statistics.

At least 18 units in advanced biology courses (numbered 300 or above) are required. These 18 units may not include Biol 303A, Biol 307A, Biol 3160, Biol 363, Biol 374, Biol 387, Biol 388, Biol 3900, Biol 4106, Biol 4202, Biol 429, Biol 4582, Biol 487 or

Biol 488; cross-listed courses originating in other departments (except Biol 360, Biol 4580, Biol 4810, Biol 4820 and Biol 4833, which count as biology major credit despite external origins); courses in University College; or more than 3 units of history-of-science courses.

**Majors are required to take at least one course from each of the following three areas:**

#### Area A: Cellular and Molecular Biology

Code	Title	Units
Biol 3041	Plant Biology and Genetic Engineering	4
Biol 324	Human Genetics	3
Biol 334	Cell Biology	3
Biol 349	Microbiology	4
Biol 424	Immunology	4
Biol 4492	Infectious Diseases: History, Pathology, and Prevention	3
Biol 451	General Biochemistry	4
Biol 4810	General Biochemistry I	3
Biol 4820	General Biochemistry II	3

#### Area B: Organismal Biology

Code	Title	Units
Biol 3151	Endocrinology	3
Biol 328	Principles in Human Physiology	4
Biol 3411	Principles of the Nervous System	3
Biol 3421	Introduction to Neuroethology	3
Biol 3422	Genes, Brains and Behavior	3
Biol 4023	How Plants Work: Physiology, Growth and Metabolism	3
Biol 4030	Biological Clocks	3
Biol 4071	Developmental Biology	3
Biol 4381	Cell-Based Tissue Engineering and Regenerative Medicine	3
Biol 4580	Principles of Human Anatomy and Development	3

#### Area C: Evolution, Ecology and Population Biology

Code	Title	Units
Biol 3220	Woody Plants of Missouri	3
Biol 347	Darwin and Evolutionary Controversies	3
Biol 3501	Evolution	4
Biol 370	Animal Behavior	3
Biol 381	Introduction to Ecology	3
Biol 4181	Population Genetics (and Microevolution)	3
Biol 4182	Macroevolution	3

Biol 4183	Molecular Evolution	3
Biol 419	Community Ecology	3
Biol 4195	Disease Ecology	4
Biol 472	Behavioral Ecology	4

Majors also must take an advanced laboratory course from the following list:

Code	Title	Units
Biol 3110	Vertebrate Structure Laboratory	4
Biol 3423	Behavioral Genetics Laboratory	3
Biol 3491	Microbiology Laboratory	3
Biol 3492	Laboratory Experiments with Eukaryotic Microbes	3
Biol 3493	Bacterial Bioprospecting and Biotechnology	3
Biol 360	Biophysics Laboratory	3
Biol 373W	Laboratory on the Evolution of Animal Behavior (Writing Intensive)	3
Biol 404	Laboratory of Neurophysiology	4
Biol 4193	Experimental Ecology Laboratory	4
Biol 4220	Practical Bioinformatics	4
Biol 4342	Research Explorations in Genomics	4
Biol 434W	Research Explorations in Genomics (Writing Intensive)	4
Biol 437	Laboratory on DNA Manipulation	4
Biol 4522	Laboratory in Protein Analysis, Proteomics and Protein Structure	3
Biol 4523	Molecular Methods in Enzyme Analysis	4
Biol 4525	Structural Bioinformatics of Proteins (Writing Intensive)	4

All courses to be counted toward a major in biology must be taken for a letter grade if a letter grade is offered. A grade of C- or better must be earned in all of these courses.

In special cases, students may earn credit for graduate courses offered by the Division of Biology and Biomedical Sciences.

### Optional Biology Major Tracks

A student majoring in biology may choose one of five optional tracks within the major if the student's interests lie primarily within one of these subfields of biology. A track provides strong training for graduate study in its subfield. *All tracks require completion of the biology major requirements as stated above but provide concentrated study in one of the five subfields.*

### The Major in Biology: *Ecology and Evolution Track*

Additional requirements include Math 2200 or Math 3200. Students whose main interest is ecology must take at least two ecology electives and one evolution elective; students whose main interest is evolution must take at least two evolution electives and one ecology elective (evolution electives: Biol 3501, Biol 4181, Biol 4182 and Biol 4183; ecology electives: Biol 370, Biol 381, Biol 419, Biol 4195 and Biol 472). Also required are one elective in analytical methodology (CSE 131 or Math 322) and one elective in earth and planetary sciences (EPSc 201 or EPSc 323). The course used to fulfill the advanced laboratory requirement for the major must be Biol 373W, Biol 4193, Biol 437, Biol 4342 or Biol 434W.

### The Major in Biology: *Genomics and Computational Biology Track*

Additional requirements include an advanced genomics/computational biology elective (Biol 324, Biol 4183, Biol 548 or Biol 5488); statistics (Math 2200 or Math 3200); and two outside electives (CSE 131 and CSE 247). CSE 240 is strongly recommended. The course used to fulfill the advanced laboratory requirement for the major must be Biol 3492, Biol 4220, Biol 4342, Biol 434W, Biol 437 or Biol 4525. Biology courses recommended for students in this track include Biol 334, Biol 3422, Biol 349, Biol 3491, Biol 4030, Biol 4181, Biol 4183 and Biol 4810. Recommended mathematics electives include Math 217 and Math 309.

### The Major in Biology: *Microbiology Track*

Additional requirements include Biol 349, which should be taken during the spring of the sophomore year, and either Biol 451 or the pair of courses Biol 4810 and Biol 4820. The advanced laboratory course used to fulfill major requirements must be one of the following: Biol 3491, Biol 3492, Biol 3493 or Biol 437. At least one of the following must be taken as an advanced microbiology elective: Biol 4492 or Biol 5426. At least one of the following must be taken as an allied elective: the pair of courses Biol 191 and Biol 192, Biol 424, Chem 453 or EPSc 323. Students should select one course each from biology major areas B and C. Biol 3501 is highly recommended as the course used to fulfill biology major area C. The total number of upper-level credits earned in major-track biology courses and allied electives must be at least 24.

### The Major in Biology: *Molecular Biology and Biochemistry Track*

Additional requirements include both Biol 4810 and Biol 4820 as well as either Biol 334 or Biol 349. The advanced laboratory course used to fulfill major requirements must be one of the following: Biol 3423, Biol 3491, Biol 3492, Biol 3493,

Biol 4342/Biol 434W, Biol 437, Biol 4522, Biol 4523 or Biol 4525. Additional biology courses recommended for students in this track include Biol 3041, Biol 4023, Biol 4071, Biol 4183, Biol 4833 and Biol 5312.

### The Major in Biology: Neuroscience Track

Biology major requirements must be met with the following courses: Biol 3058, area A (Biol 334, Biol 451, Biol 4810 or Biol 4820), area B (Biol 3411), and any course in area C. Students must then choose one of the following laboratory pathways: (1) Laboratory Pathway 1: one of the following courses: Biol 3423, Biol 360, Biol 373W or Biol 404; or (2) Laboratory Pathway 2: any other upper-level biology laboratory course on the list of approved laboratory courses for the biology major plus 6 credits of Biol 500N and/or Biol 500U (Independent Research in Neuroscience). Students must select at least one biology elective (Biol 3110, Biol 3151, Biol 328, Biol 3421, Biol 3422, Biol 4030, Biol 437 or Biol 4580) and one outside elective either in physics (Physics 350, Physics 355 or Physics 360) or psychology (Psych 330, Psych 360 or Psych 3604). Math 2200 or Math 3200 is recommended. Optional seminar courses in neuroscience include Biol 171 and Biol 4934. Physics 360 may count either as the advanced laboratory requirement or the outside elective course but not for both requirements.

Related majors can be found in the biomedical engineering (<http://bulletin.wustl.edu/undergrad/engineering/biomedical/#majors>), philosophy-neuroscience-psychology (PNP) (<http://bulletin.wustl.edu/undergrad/artsci/philosophyneurosciencepsychology/#majors>) and philosophy of science (<http://bulletin.wustl.edu/undergrad/artsci/philosophy/#majors>) pages of this *Bulletin*.

### The Major in Environmental Biology

Students interested in environmental biology typically take Biol 2950 Introduction to Environmental Biology during fall of the first year of study, although it may be taken later.

#### Required courses:

Code	Title	Units
Biol 2950	Introduction to Environmental Biology	3
Biol 2960	Principles of Biology I (lecture and lab)	4
Biol 2970	Principles of Biology II (lecture and lab)	4
Biol 381	Introduction to Ecology	3
Chem 111A or Chem 105	General Chemistry I (lecture and lab) Introductory General Chemistry I	3
Chem 112A or Chem 106	General Chemistry II Introductory General Chemistry II	3
Chem 151	General Chemistry Laboratory I	2

Chem 152	General Chemistry Laboratory II	2
EPSc 201	Earth and the Environment (lecture and lab)	4
or EPSc 202	Introduction to Earth, Environmental, and Planetary Science	
or EPSc 219	Energy and the Environment	
Math 131	Calculus I	3
Math 132	Calculus II	3
Physics 191	Physics I	3
Physics 191L	Physics I Laboratory	1
<b>Total Units</b>		<b>38</b>

#### One of the following chemistry courses:

Code	Title	Units
Chem 261	Organic Chemistry I with Lab	4
EPSc 323	Biogeochemistry	3
EECE 210	Introduction to Environmental Engineering	3
EECE 505	Aquatic Chemistry	3
EECE 531	Environmental Organic Chemistry	3

#### One of the following courses in statistics or GIS:

Code	Title	Units
Math 2200	Elementary Probability and Statistics	3
Math 3200	Elementary to Intermediate Statistics and Data Analysis	3
EnSt 380	Applications in GIS	3

#### One upper-level biology lab course:

Any course that fulfills the advanced laboratory requirement of the biology major is acceptable; we recommend Biol 4193 Experimental Ecology Laboratory (4 credits, writing intensive).

#### One of the following Biol 300+ courses (Areas A and B in Biology):

Code	Title	Units
Biol 3041	Plant Biology and Genetic Engineering	4
Biol 3151	Endocrinology	3
Biol 328	Principles in Human Physiology	4
Biol 334	Cell Biology	3
Biol 3411	Principles of the Nervous System	3
Biol 3421	Introduction to Neuroethology	3
Biol 3422	Genes, Brains and Behavior	3
Biol 349	Microbiology	4
Biol 4023	How Plants Work: Physiology, Growth and Metabolism	3
Biol 4030	Biological Clocks	3

Biol 451	General Biochemistry	4
Biol 4580	Principles of Human Anatomy and Development	3
Biol 4810	General Biochemistry I	3

**One of the following Biol 300+ courses (Area C in Biology):**

Code	Title	Units
Biol 3220	Woody Plants of Missouri	3
Biol 3501	Evolution	4
Biol 370	Animal Behavior	3
Biol 4181	Population Genetics	3
Biol 4182	Macroevolution	3
Biol 419	Community Ecology	3
Biol 4195	Disease Ecology	4
Biol 472	Behavioral Ecology	4

**One additional Biol 300+ major-track course (may include Biol 500):**

Please refer to the Biology Course Listings (p. ) in this *Bulletin*.

**One of the following EnSt or EPSC 300+ courses:**

Code	Title	Units
EnSt 364	Field Methods for Environmental Science	3
EnSt 365	Applied Conservation Biology	3
EPSc 323	Biogeochemistry (only if not already taken for chemistry requirement)	3
EPSc 352	Earth Materials	5
EPSc 353	Earth Forces	4
EPSc 385	Earth History	3
EPSc 409	Surface Processes	3
EPSc 413	Introduction to Soil Science	3
EPSc 428	Hydrology	3
EPSc 429	Environmental Hydrogeology	3
EPSc 443	Methods in Biogeochemistry	3
EPSc 444	Environmental Geochemistry	3
EPSc 486	Paleoclimatology	3

## Additional Information

**Research:** Research opportunities are available during the student's first and second years through Biol 200; such opportunities are available during the third and fourth years through Biol 500. A research emphasis in the major requires at least 6 credits (two semesters) of Biol 500 research and an approved senior thesis on this research, which is presented at the undergraduate symposium. The research emphasis is acknowledged on the degree as a research milestone.

**Senior Honors:** Biology majors are encouraged to work for senior honors, which require a 3.30 grade-point average in biology, a 3.30 GPA in nonbiological sciences (mathematics, chemistry and physics courses), and a 3.65 overall GPA at the time of graduation. Also required are 6 units of Biol 500 research and an approved thesis from this work, equivalent to the research emphasis described in the preceding paragraph. Students interested in senior honors should begin Biol 500 no later than the spring of the junior year.

The Department of Biology awards the Marian Smith Spector Prize to an undergraduate who has an excellent academic record and who submits an outstanding honors thesis; it also awards the Ralph S. Quatrano Prize to the student whose thesis shows the greatest evidence of creativity in design, research methodology and/or broader scientific implications. The Harrison D. Stalker Prize is awarded to a graduating senior whose college career is distinguished by scholarship, service and breadth of interest.