The Major in Biology

Total units required: 58

Required courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biol 2960</td>
<td>Principles of Biology I</td>
<td>4</td>
</tr>
<tr>
<td>Biol 2970</td>
<td>Principles of Biology II</td>
<td>4</td>
</tr>
<tr>
<td>Chem 111A</td>
<td>General Chemistry I</td>
<td>3</td>
</tr>
<tr>
<td>or Chem 105</td>
<td>Introductory General Chemistry I</td>
<td></td>
</tr>
<tr>
<td>Chem 112A</td>
<td>General Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>or Chem 106</td>
<td>Introductory General Chemistry II</td>
<td></td>
</tr>
<tr>
<td>Chem 151</td>
<td>General Chemistry Laboratory I</td>
<td>2</td>
</tr>
<tr>
<td>Chem 152</td>
<td>General Chemistry Laboratory II</td>
<td>2</td>
</tr>
<tr>
<td>Chem 261</td>
<td>Organic Chemistry I with Lab</td>
<td>4</td>
</tr>
<tr>
<td>Chem 262</td>
<td>Organic Chemistry II with Lab</td>
<td>4</td>
</tr>
<tr>
<td>Math 132</td>
<td>Calculus II</td>
<td>3</td>
</tr>
<tr>
<td>Math 2200</td>
<td>Elementary Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>or Math 233</td>
<td>Calculus III</td>
<td></td>
</tr>
<tr>
<td>or Math 3200</td>
<td>Elementary to Intermediate Statistics and Data Analysis</td>
<td></td>
</tr>
<tr>
<td>Physics 191</td>
<td>Physics I</td>
<td>3</td>
</tr>
<tr>
<td>or Physics 193</td>
<td>Focused Physics I</td>
<td></td>
</tr>
<tr>
<td>Physics 191L</td>
<td>Physics I Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>or Physics 193L</td>
<td>Focused Physics I Laboratory</td>
<td></td>
</tr>
<tr>
<td>Physics 192</td>
<td>Physics II</td>
<td>3</td>
</tr>
<tr>
<td>or Physics 194</td>
<td>Focused Physics II</td>
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<tr>
<td>Physics 192L</td>
<td>Physics II Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>or Physics 194L</td>
<td>Focused Physics II Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

Total Units: 40

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 3180, Biol 343, Biol 363, Biol 387, Biol 388, Biol 3900, Biol 4202, Biol 429, Biol 4582, Biol 487 or Biol 488; cross-listed courses originating in other departments (except Biol 354, Biol 360, Biol 4540, Biol 4580, Biol 4810, Biol 4820 and Biol 4833, which count as biology major credit despite external origins); courses in the School of Continuing & Professional Studies; 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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biol 324</td>
<td>Human Genetics</td>
<td>3</td>
</tr>
<tr>
<td>Biol 334</td>
<td>Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3481</td>
<td>Parasitology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 349</td>
<td>Microbiology</td>
<td>4</td>
</tr>
<tr>
<td>Biol 424</td>
<td>Immunology</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4344</td>
<td>Epigenetics</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4492</td>
<td>Infectious Diseases: History, Pathology, and Prevention</td>
<td></td>
</tr>
<tr>
<td>Biol 451</td>
<td>General Biochemistry</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4810</td>
<td>General Biochemistry I</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4820</td>
<td>General Biochemistry II</td>
<td>3</td>
</tr>
</tbody>
</table>

Area B: Organismal Biology

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biol 3151</td>
<td>Endocrinology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 328</td>
<td>Principles in Human Physiology</td>
<td>4</td>
</tr>
<tr>
<td>Biol 3411</td>
<td>Principles of the Nervous System</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3421</td>
<td>Introduction to Neuroethology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3422</td>
<td>Genes, Brains and Behavior</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4023</td>
<td>How Plants Work: Physiology, Growth and Metabolism</td>
<td></td>
</tr>
<tr>
<td>Biol 4030</td>
<td>Biological Clocks</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4071</td>
<td>Developmental Biology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4072</td>
<td>Regenerative and Stem Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4381</td>
<td>Cell-Based Tissue Engineering and Regenerative Medicine</td>
<td></td>
</tr>
<tr>
<td>Biol 4580</td>
<td>Principles of Human Anatomy and Development</td>
<td>3</td>
</tr>
</tbody>
</table>

Area C: Evolution, Ecology and Population Biology

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biol 3220</td>
<td>Woody Plants of Missouri</td>
<td>3</td>
</tr>
<tr>
<td>Biol 347</td>
<td>Darwin and Evolutionary Controversies</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3501</td>
<td>Evolution</td>
<td>4</td>
</tr>
<tr>
<td>Biol 370</td>
<td>Animal Behavior</td>
<td>3</td>
</tr>
<tr>
<td>Biol 381</td>
<td>Introduction to Ecology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4181</td>
<td>Population Genetics (and Microevolution)</td>
<td>3</td>
</tr>
</tbody>
</table>
evolution must take at least two evolution electives and one ecology elective; students whose main interest is ecology must take at least two ecology electives. Additional requirements include one elective in analytical methodology (CSE 131 or Math 322) and one elective in Earth, environmental, and planetary sciences (EEPS 201 or EEPS 323). The course used to fulfill the advanced laboratory requirement for the major must be Biol 4193, Biol 4342 or Biol 434W.

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

**Total units required (including the biology major requirements):** 64

Additional requirements include an advanced genomics/computational biology elective (Biol 324, Biol 4183, Biol 4344, 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 as well. The course used to fulfill the advanced laboratory requirement for the major must be Biol 3492, Biol 4220, Biol 4342, Biol 434W 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

**Total units required (including the biology major requirements):** 68

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 or Biol 3493. At least one of the following must be taken as an advanced microbiology elective: Biol 3481, Biol 4242, 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 24, Chem 453 or EEPS 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 (6 additional units to the 18 units required for the biology major).

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

**Total units required (including the biology major requirements):** 58

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 4522, Biol 4523 or Biol 4525. Additional biology courses recommended for students in this track include Biol 4023, Biol 4071, Biol 4183, Biol 4344, Biol 4833 and Biol 5312.

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**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**

**Total units required (including the biology major requirements):** 65

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, environmental, and planetary sciences (EEPS 201 or EEPS 323). The course used to fulfill the advanced laboratory requirement for the major must be Biol 4193, Biol 4342 or Biol 434W.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biol 3110</td>
<td>Vertebrate Structure Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>Biol 3423</td>
<td>Behavioral Genetics Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3491</td>
<td>Microbiology Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3492</td>
<td>Laboratory Experiments with Eukaryotic Microbes</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3493</td>
<td>Bacterial Bioprospecting and Biotechnology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 360</td>
<td>Biophysics Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>Biol 404</td>
<td>Laboratory of Neurophysiology</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4193</td>
<td>Experimental Ecology Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4220</td>
<td>Practical Bioinformatics</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4342</td>
<td>Research Explorations in Genomics</td>
<td>4</td>
</tr>
<tr>
<td>Biol 434W</td>
<td>Research Explorations in Genomics (Writing Intensive)</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4522</td>
<td>Laboratory in Protein Analysis, Proteomics and Protein Structure</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4523</td>
<td>Molecular Methods in Enzyme Analysis</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4525</td>
<td>Structural Bioinformatics of Proteins (Writing Intensive)</td>
<td>4</td>
</tr>
</tbody>
</table>

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.
The Major in Biology: Neuroscience Track

Total units required (including the biology major requirements): 60

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 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 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 493. 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.

Total units required: 58-65

Required courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biol 2950</td>
<td>Introduction to Environmental Biology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 2960</td>
<td>Principles of Biology I (lecture and lab)</td>
<td>4</td>
</tr>
<tr>
<td>Biol 2970</td>
<td>Principles of Biology II (lecture and lab)</td>
<td>4</td>
</tr>
<tr>
<td>Biol 381</td>
<td>Introduction to Ecology</td>
<td>3</td>
</tr>
<tr>
<td>Chem 111A or Chem 105</td>
<td>General Chemistry I (lecture and lab)</td>
<td>3</td>
</tr>
<tr>
<td>Chem 112A or Chem 106</td>
<td>General Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>Chem 151</td>
<td>General Chemistry Laboratory I</td>
<td>2</td>
</tr>
<tr>
<td>Chem 152</td>
<td>General Chemistry Laboratory II</td>
<td>2</td>
</tr>
<tr>
<td>EEPS 201</td>
<td>Earth and the Environment (lecture and lab)</td>
<td>3-4</td>
</tr>
<tr>
<td>or EEPS 202</td>
<td>Introduction to Earth, Environmental, and Planetary Science</td>
<td></td>
</tr>
<tr>
<td>or EEPS 219</td>
<td>Energy and the Environment</td>
<td></td>
</tr>
<tr>
<td>Math 131</td>
<td>Calculus I</td>
<td>3</td>
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</table>

Math 132 Calculus II 3
Physics 191 Physics I 3
or Physics 193 Focused Physics I
Physics 191L Physics I Laboratory 1
or Physics 193L Focused Physics I Laboratory

One of the following chemistry courses:

<table>
<thead>
<tr>
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<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Chem 261</td>
<td>Organic Chemistry I with Lab</td>
<td>4</td>
</tr>
<tr>
<td>EECE 210</td>
<td>Introduction to Environmental Engineering</td>
<td>3</td>
</tr>
<tr>
<td>EECE 505</td>
<td>Aquatic Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>EECE 531</td>
<td>Environmental Organic Chemistry</td>
<td>3</td>
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</table>

One of the following courses in statistics or GIS:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Math 2200</td>
<td>Elementary Probability and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>Math 3200</td>
<td>Elementary to Intermediate Statistics and Data Analysis</td>
<td>3</td>
</tr>
<tr>
<td>EnSt 380</td>
<td>Applications in GIS</td>
<td>3</td>
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</tbody>
</table>

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):

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>Biol 3151</td>
<td>Endocrinology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 328</td>
<td>Principles in Human Physiology</td>
<td>4</td>
</tr>
<tr>
<td>Biol 334</td>
<td>Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3411</td>
<td>Principles of the Nervous System</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3421</td>
<td>Introduction to Neuroethology</td>
<td>3</td>
</tr>
<tr>
<td>Biol 3422</td>
<td>Genes, Brains and Behavior</td>
<td>3</td>
</tr>
<tr>
<td>Biol 349</td>
<td>Microbiology</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4023</td>
<td>How Plants Work: Physiology, Growth and Metabolism</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4030</td>
<td>Biological Clocks</td>
<td>3</td>
</tr>
<tr>
<td>Biol 451</td>
<td>General Biochemistry</td>
<td>4</td>
</tr>
<tr>
<td>Biol 4580</td>
<td>Principles of Human Anatomy and Development</td>
<td>3</td>
</tr>
<tr>
<td>Biol 4810</td>
<td>General Biochemistry I</td>
<td>3</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
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</tr>
</thead>
<tbody>
<tr>
<td>EEPS 317</td>
<td>Soil Science</td>
<td>3</td>
</tr>
<tr>
<td>EEPS 323</td>
<td>Biogeochemistry (only if not already taken for chemistry requirement)</td>
<td>3</td>
</tr>
<tr>
<td>EEPS 340</td>
<td>Minerals, Rocks, Resources and the Environment</td>
<td>4</td>
</tr>
<tr>
<td>EEPS 353</td>
<td>Earth Forces</td>
<td>4</td>
</tr>
<tr>
<td>EEPS 385</td>
<td>Earth History</td>
<td>3</td>
</tr>
<tr>
<td>EEPS 409</td>
<td>Surface Processes</td>
<td>3</td>
</tr>
<tr>
<td>EEPS 428</td>
<td>Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>EEPS 442</td>
<td>Aqueous Geochemistry</td>
<td>3</td>
</tr>
<tr>
<td>EEPS 486</td>
<td>Paleoecology</td>
<td>3</td>
</tr>
<tr>
<td>EnSt.364</td>
<td>Field Methods for Environmental Science</td>
<td>3</td>
</tr>
<tr>
<td>EnSt.365</td>
<td>Applied Conservation Biology</td>
<td>3</td>
</tr>
</tbody>
</table>

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 their 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.