Biological Sciences

Christopher Osgood, Chair

The Department of Biological Sciences offers a broad selection of course offerings. The undergraduate curriculum is based on a two-semester foundations course and core courses that provide a well-rounded introduction to the major subdisciplines of biology. The elective courses allow students to explore multiple facets of the biological sciences or to deepen their understanding of a single subdiscipline.

Many of our students tailor their undergraduate degrees for entry into professional and graduate schools. The department has an excellent program in secondary science education for those desiring to teach, an outstanding pre-health track for students interested in the medical professions, and the combination of academic and research opportunities necessary to best prepare students for research-based graduate studies. Students seeking careers in medicine, dentistry, osteopathy, optometry or podiatry should check the College of Sciences section of the catalog for additional information. Students should confer with their advisors to select the most appropriate math courses and science courses. The most frequently recommended biology courses are in the areas of human or vertebrate anatomy and physiology and those stressing the molecular and cellular levels of organization. However, students also are encouraged to explore other disciplines while they have the opportunity to develop a broader view of life processes and the human condition.

**Bachelor of Science—Biology Major**

**Lower-Division General Education**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 110C</td>
<td>English Composition (required)</td>
<td>6</td>
</tr>
<tr>
<td>ENGL 231C</td>
<td>Introduction to Technical Writing (required)</td>
<td></td>
</tr>
<tr>
<td>COMM 101R</td>
<td>Public Speaking</td>
<td>3</td>
</tr>
<tr>
<td>or COMM 103R Voice and Diction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or COMM 112R Introduction to Interpersonal Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or DANC/ THEA 152R</td>
<td>Acting One</td>
<td></td>
</tr>
<tr>
<td>MATH 162M</td>
<td>Precalculus I (required)</td>
<td>3</td>
</tr>
<tr>
<td>Language and Culture</td>
<td>0-6</td>
<td></td>
</tr>
<tr>
<td>CS 121G</td>
<td>Introduction to Information Literacy and Research</td>
<td>3</td>
</tr>
<tr>
<td>or STEM 251G</td>
<td>Computer Literacy: Communication and Information</td>
<td></td>
</tr>
<tr>
<td>Human Creativity</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Interpreting the Past</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Philosophy and Ethics</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>The Nature of Science (select one of the following)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>PHYS 111N &amp; PHYS 112N</td>
<td>Introductory General Physics and Introductory General Physics</td>
<td></td>
</tr>
<tr>
<td>OEAS 110N &amp; OEAS 112N</td>
<td>Earth Science and Historical Geology</td>
<td></td>
</tr>
<tr>
<td>OEAS 111N &amp; OEAS 112N</td>
<td>Physical Geology and Historical Geology</td>
<td></td>
</tr>
<tr>
<td>Impact of Technology</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Human Behavior</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

| Departmental Requirements ** | |
| BIOL 121N & BIOL 122N | General Biology I and General Biology I Lab | 4 |

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 123N &amp; BIOL 124N</td>
<td>General Biology II and General Biology II Lab</td>
<td>49-55</td>
</tr>
</tbody>
</table>

* Grade of C or better required in both courses
** Must be passed with a C (2.0) or better to continue in the program.

Upon completion of BIOL 121N / BIOL 122N and BIOL 123N / BIOL 124N students must complete the following core courses, some of which are prerequisites** or corequisites*** for upper-level biology courses (see course descriptions for prerequisites to individual courses). Core courses [BIOL 291, BIOL 292, BIOL 293, BIOL 303] must be passed with a C (2.0 or better).

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 291</td>
<td>Ecology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 292</td>
<td>Evolution</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 293</td>
<td>Cell Biology +</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 303</td>
<td>Genetics +</td>
<td>3</td>
</tr>
</tbody>
</table>

*** Prerequisite – designated course must be completed before enrolling in the course requiring the prerequisite.

** Corequisite – designated course may have been completed or taken during the same semester the student is enrolling in the course requiring the corequisite.

+ Have (Precalculus) and (Organic Chemistry) as pre- or corequisites.

In addition to the core courses, all majors must complete at least one writing intensive (W) course and earn a grade of C or better: BIOL 401W, BIOL 405W, BIOL 415W, BIOL 423W, BIOL 430W, BIOL 436W, BIOL 471W, BIOL 481W, or BIOL 488W.

**Biology Electives.** Students must choose at least 16 elective hours at the 300-level or above from the courses offered by the Department of Biological Sciences. Some non-laboratory course options include BIOL 302, BIOL 311, BIOL 331, BIOL 346, BIOL 355, BIOL 403, BIOL 416, BIOL 445, BIOL 446, and BIOL 494.

A minimum of three of the courses must have a structured laboratory/field component. Some examples of these courses include BIOL 401W, BIOL 404, BIOL 415W, BIOL 420, BIOL 422, BIOL 424, BIOL 426, BIOL 441, BIOL 461, and BIOL 481W.

To be clear, BIOL 368 (Internship) and BIOL 369 (Practicum) courses cannot be used to satisfy this requirement. Additionally, transfer courses will not meet the laboratory/field component unless approved by the Biology curriculum committee. Transfer courses should be submitted to the College of Sciences Advising Office for consideration.

Students may use the four credits of BIOL 241 or BIOL 251 taken at Old Dominion University towards the upper-division elective requirements. However, no 200-level transfer credits can be used towards the elective courses.

Students may use no more than six credits of unstructured courses to satisfy the requirement (see below). Elective courses must be passed with a grade of C (2.0) or better unless they are specified as Pass/Fail courses, in which case they must be passed (P).

A Biology writing intensive course is required and must be completed with a grade of C or better. All writing intensive courses are marked with a ‘W’ at the end of the course number. This course should be taken during the junior or senior year after completion of the required prerequisites.

**Unstructured Courses.** Students may take advantage of several non-classroom experiences (“Unstructured Courses”) offered by the Department of Biological Sciences and may receive elective credit for these experiences. These include BIOL 367 (Cooperative Education), BIOL 368 (Internship), BIOL 369 (Practicum), BIOL 497 (Undergraduate Research) and BIOL 498 (Independent Study). BIOL 367, BIOL 368, BIOL 369 and BIOL 498 cannot be used to satisfy the laboratory requirement but can be used to satisfy one of the required 16 elective hours. See
individual course descriptions and the chief departmental advisor for more information about these opportunities.

Non-biology degree requirements:

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 121N</td>
<td>4</td>
</tr>
<tr>
<td>&amp; CHEM 122N</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 123N</td>
<td>4</td>
</tr>
<tr>
<td>&amp; CHEM 124N</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 211</td>
<td>3</td>
</tr>
<tr>
<td>CHEM elective-5 credits of CHEM elective at the 200-level or higher (excluding CHEM 343T)</td>
<td>5</td>
</tr>
<tr>
<td>MATH 205</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 200</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 211</td>
<td>3</td>
</tr>
<tr>
<td>STAT 130M</td>
<td>3</td>
</tr>
<tr>
<td>Total Hours</td>
<td>22</td>
</tr>
</tbody>
</table>

Elective Credit

Elective credit will be needed to meet the minimum requirement of 120 credit hours for the degree.

Upper-Division General Education Requirements

The Professional Education core satisfies this requirement for the secondary education concentration.

- Option A. Approved Disciplinary Minor (a minimum of 12 hours determined by the department) or second degree or second major.
- Option B. Interdisciplinary Minor (specifically 12 hours, 3 of which may be in the major)
- Option C. International Business and Regional Courses or an approved Certification Program such as teaching license
- Option D. Two Upper-Division (300-level or above) courses from outside the College of Sciences and not required by the major (6 hours)

Requirements for Graduation

Requirements for graduation (non-teacher education tracks) include a minimum cumulative grade point average of 2.00 overall and in the major. 120 credit hours, which must include both a minimum of 30 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University, completion of ENGL 110C, ENGL 211C or ENGL 221C or ENGL 231C, and a writing intensive (W) course in the major with a grade of C or better, completion of the Senior Assessment, and completion of the Biology Department Senior Assessment when offered.


This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Marine Biology Concentration

The marine biology concentration provides students with coursework, specialized advising, and practical experience in marine biology while ensuring a strong, balanced education in one of the traditional natural sciences in which students major. The concentration requires completion of the general biology foundation courses (BIOL 121N, BIOL 122N and BIOL 123N, BIOL 124N), or equivalent, with a grade of C (2.0) or better. In addition, at least 15 semester credit hours in approved marine biology related courses (See Marine Biology Concentration Curriculum sheet) at the 300 or 400 level are necessary, with Marine Biology (BIOL 331) and Oceanography (OEAS 306) being required courses. BIOL 331 will satisfy 3 credits toward the required 16 credits of the biology electives; the remaining 13 credit hours needed to satisfy the biology elective requirements should be taken from approved marine biology elective courses. All required and elective courses used for the concentration must be passed with a C (2.0) or better. The mathematics requirement for the concentration is MATH 211 Calculus I or MATH 205 Calculus for Life Sciences, and the non-biology physical science requirements are OEAS 111N (Physical Geology) and PHYS 111N (Introductory General Physics). Students in the program are expected to participate in non-credit, monthly meetings of the ODU Marine Biology Student Association. One course completed at an off-campus marine biology laboratory or study abroad program is strongly recommended, as is a research, practicum, or internship experience in marine biology. Other requirements are listed under the Bachelor of Science—Biology Major. Marine biology students may also select a minor in ocean and earth science.

A variety of facilities are available to students interested in the marine biology concentration. On-campus facilities include a modern marine wet laboratory along with biology faculty research laboratories specializing in marine: benthic ecology, animal biomechanics and physiology, marine fish biology and systematics, conservation biology, phytoplankton biology, coastal wetland plants, disease ecology, microbiology, and tropical ecology. Field studies and course-related trips to nearby marine habitats in the Chesapeake Bay and Atlantic Ocean are supported by departmental field vehicles and small vessels, as well as by the Ocean, Earth and Atmospheric Sciences Department's 55-foot research vessel, the R/V Fay Slover. Research requiring SCUBA is supported by the ODU Academic Diving Program, a local chapter of the American Academy of Underwater Scientists. Off-campus access to marine laboratories on Virginia's Eastern Shore and the Florida Keys are available through collaborative agreements with other colleges and universities.


This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Bachelor of Science—Biology Major Secondary Education Concentration

This program leads to eligibility for teacher licensure in Virginia and is available only to individuals holding a baccalaureate degree or completing requirements for a Bachelor of Science degree in biology.

Biology Major with Teaching Licensure in Biology

Students pursuing a biology major with teaching licensure complete the following biology core sequence and 16 credit hours of electives at the 300-level or above, to include three lab or field courses. Students may use four credits at the 200-level to meet their upper-division requirement.

<table>
<thead>
<tr>
<th>Course</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 121N &amp; BIOL 122N</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 123N &amp; BIOL 124N</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 291</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 292</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 293</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 303</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 405W</td>
<td>3</td>
</tr>
<tr>
<td>Total Hours</td>
<td>23</td>
</tr>
</tbody>
</table>
Electives must include one approved course each in botany, zoology, microbiology, and human anatomy and physiology (see chief departmental advisor for details).

Non-biology requirements are:

- **CHEM 121N** Foundations of Chemistry I Lecture 4
- & **CHEM 122N** Foundations of Chemistry I Laboratory 2
- **CHEM 123N** Foundations of Chemistry II Lecture 4
- & **CHEM 124N** Foundations of Chemistry II Laboratory 2
- **CHEM 211** Organic Chemistry I Lecture 3
- **CHEM 212** Organic Chemistry I Laboratory 2
- **OEAS 110N** Earth Science 4
- or **OEAS 111N** Physical Geology 4
- **PHYS 111N** Introductory General Physics 4
- or **MATH 200** Calculus for Life Sciences 3
- or **MATH 211** Calculus I 3
- **STAT 130M** Elementary Statistics 3

**Total Hours** 27

### Admission

Students must first declare the biology teacher preparation track as their major with the appropriate advisor. All students must apply for and be admitted into the approved biology teacher preparation program. Students must meet the required criteria for admission by passing the Virginia Board of Education prescribed assessments and earn the minimum required grade point averages (GPA).

### Virginia Board of Education Prescribed Assessments for Admission to an Approved Teacher Education Program

Old Dominion University students seeking admission to an approved teacher education program must have submitted Praxis Core or approved alternative test of mathematics, reading, and writing (SAT or ACT).

For the most current information on the prescribed Virginia Board of Education admission assessment, visit the Office of Clinical Experiences website, http://www.odu.edu/occe and review the Professional Education Handbook.

### Required grade point averages (GPA)

- A cumulative GPA of 2.75 is required.
- A major/content GPA of 2.75 is required - all biology courses must be passed with a grade of C (2.0) or above and all other science content courses must be passed with a grade of C- or higher.
- A professional education GPA of 2.75 is required – all professional education courses must be passed with a grade of C- or higher.

Although students may enroll in a limited number of education courses, students must be admitted into the approved biology teacher preparation program prior to enrolling in any instructional strategies practicum education course. Students must also meet with an education advisor in the Office of Clinical Experiences.

### Continuance

Students must maintain a cumulative GPA of 2.75, a major/content GPA of 2.75 and a professional education GPA of 2.75. Biology courses must be passed with a grade of C (2.0) or higher. The remaining courses required for the major and in the professional education core must be completed with a grade of C- or higher for continuance. A professional education GPA of 2.75 is required for continuance. Students must take and pass the Virginia Communication and Literacy Assessment (VCLA) and the Praxis Subject Assessment, Biology content knowledge (formerly Praxis II) prior to or while enrolled in the instructional strategies course. All assessments must be passed prior to the start of the Teacher Candidate Internship Orientation session.

### Background Clearance Requirement

Old Dominion University requires a background clearance check of candidates interested in many of the professional education programs. Professional education programs have several field experiences that are required for continuance and graduation from the program. The background clearance must be successfully completed prior to a field experience placement. Candidates will be provided a field experience placement when the background check process is completed with resolution of any issues. The process to complete the ODU clearance background check is located at: http://www.odu.edu/success/academic/teacher-education/placement/background-checks. The ODU clearance process includes: an FBI fingerprint, a child protective service/social service review, and a Virginia State Police sex offender registry review. Candidates interested in the professional education programs are advised to complete this clearance process immediately upon entry into the program since the clearance process takes a minimum of eight weeks to complete.

### Virginia Board of Education Prescribed Assessments for Licensure

Virginia Communication and Literacy Assessment (VCLA) – a passing score of 155 is required on this reading and writing assessment.

Praxis Subject Assessment, Biology content knowledge: (test code: 5235) – passing score of 155 is required.

To review more information on the Virginia Board of Education prescribed assessments visit the Office of Clinical Experiences website, www.odu.edu/occe.

### Graduation

Requirements for graduation include completion of ENGL 211C, ENGL 221C or ENGL 221C, and the writing intensive (W) course in the major with a grade of C or better, completion of the Biology and Senior Assessments, a minimum cumulative 2.75 GPA, in the major area, and in the professional education core, with no grade less than a C in the major and C- in the professional education core; successful completion of the Teacher Candidate Internship and a minimum of 125 credit hours, which must include both a minimum of 32 credit hours overall and 12 credit hours in upper-level courses in the major program from Old Dominion University. Note that a grade of C (2.0) or better must be earned in all biology courses used to satisfy departmental requirements.

### The Professional Education core courses and requirements are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM 101</td>
<td>Step 1 – Inquiry Approaches to Teaching</td>
<td>1</td>
</tr>
<tr>
<td>STEM 102</td>
<td>Step 2 – Inquiry Based STEM Lesson Design</td>
<td></td>
</tr>
<tr>
<td>STEM 201</td>
<td>Knowing and Learning in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 202</td>
<td>Classroom Interactions in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 401</td>
<td>Project Based Instruction in STEM Education</td>
<td>3</td>
</tr>
<tr>
<td>STEM 402</td>
<td>Perspectives on STEM</td>
<td>3</td>
</tr>
<tr>
<td>STEM 485</td>
<td>Apprentice Teaching</td>
<td>9</td>
</tr>
<tr>
<td>BIOL 468W</td>
<td>Research Methods in Mathematics and Science</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Hours** 26

Due to changing University requirements, national accreditation standards, and the Virginia Board of Education licensure regulations, the teacher preparation programs in the College of Sciences are under constant revision. Any changes resulting from these factors supersede the program requirements described in this Catalog. Students are encouraged to obtain current program information from their advisors and from the Office of Clinical Experiences website at: www.odu.edu/occe.
Four-Year Plan - Biology Major
Secondary Education Concentration - BS (http://catalog.odu.edu/undergraduate/collegeofsciences/biologicalsciences/biology-secondaryed-bs-fouryearplan)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Minor in Biology
The minor in biology offers students additional support to their chosen majors, prepares students for post-baccalaureate professional or graduate programs, offers greater job opportunities to graduates, and/or provides recognition of study in this academic area. The minor requires the successful completion of a minimum of 12 credit hours of coursework (a maximum of three credits at the 200-level, selected from the Biology 200-level core courses, and a minimum of nine credits at the 300-400 level). Courses selected at the 300-400 level may not include BIOL 303 or unstructured coursework and may include only one course from the Biology core.

For completion of the minor, a student must have a C (2.0) or better in BIOL 121N & BIOL 122N, BIOL 123N & BIOL 124N, and the 200-level course, if any, used to fulfill the requirements of the minor. The student must also have a minimum overall cumulative grade point average of 2.0 in all courses designated for the minor and taken by the student exclusive of 100-level and prerequisite courses and complete a minimum of six hours of upper-level work through courses offered at Old Dominion University.

Conservation Leadership Interdisciplinary Minor
Tatyana Lobova, Department of Biological Sciences, Coordinator (tlobova@odu.edu)

The interdisciplinary minor in Conservation Leadership is offered by Old Dominion University in collaboration with the U.S. Fish and Wildlife Service (USFWS) as part of a long-term, sustainable program of conservation-related service-learning, internships and leadership programs. The minor will facilitate the development of the next generation of professionals who can address conservation issues and challenges posed by a changing climate and sea level rise. A unique aspect of this interdisciplinary minor is the requirement to take one course that is designated as a service-learning (SL) course in which the student will work at a USFWS (or related) facility.

The interdisciplinary minor in Conservation Leadership requires 15 credit hours of 300/400-level courses selected from at least two different disciplines with a maximum of six credits from any one discipline. There are two required, core courses and a required internship; a service-learning component is also required and is satisfied by IDS 467/BIOL 467/OEAS 467. The remaining six elective credits must be chosen from different disciplines. Three credit hours in the interdisciplinary minor may be in the major if a major course is listed as an option for the interdisciplinary minor. As such, it will be credited toward both the major and the interdisciplinary minor. Course substitutions may be approved by the interdisciplinary minor coordinator.

Course requirements and options are as follows.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDS/BIOL/OEAS 466W</td>
<td>Introduction to Mitigation and Adaptation Studies</td>
<td>3</td>
</tr>
<tr>
<td>IDS/BIOL/OEAS 467</td>
<td>Sustainability Leadership</td>
<td>3</td>
</tr>
<tr>
<td>IDS 368</td>
<td>Internship in Interdisciplinary Studies</td>
<td>3</td>
</tr>
<tr>
<td>Select two (6 credits of which 3 credits must be a Service-Learning (SL) course)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOL 311</td>
<td>Global Change Biology</td>
<td></td>
</tr>
<tr>
<td>BIOL 334</td>
<td>Field Ethnobotany</td>
<td></td>
</tr>
</tbody>
</table>

Honors Program in Biology
A. Honors Research

Undergraduates with junior or senior standing and a GPA of 3.00 or better are eligible to participate in Honors Research. After consultation with the program director (Dr. Deborah A. Waller), students select a professor who agrees to oversee the research project. Students then enroll in two 4-credit courses, BIOL 487 and BIOL 488W. The courses may be taken in any sequence: fall-spring, spring-summer, summer-summer, summer-fall. Normally both semesters are required but a student may receive credit for only one semester. The research project, time commitment by the student and the basis for the grade are mutually determined by the student and professor. Because first-semester research results are often preliminary, the second semester is graded on the final research paper and/or seminar presented to the honors committee and interested faculty. Professors should encourage students to publish results and present papers at scientific meetings when appropriate. Students should also be urged to apply for funds from agencies that provide seed money to undergraduates. The program director can provide information on scientific societies that sponsor meetings and/or offer small grants. Successful completion of both courses with a C (2.0) or better will allow the student to use BIOL 488W as a lab course in meeting his/her requirements.
B. Bachelor's Degree with Honors in Biological Sciences and Honors Designation for Biology courses

Students maintaining an overall GPA of at least 3.25 and of 3.50 in biology can receive a "Bachelor's Degree with Honors in Biological Sciences" subject to satisfaction of the minimum University standards for the Honors degree and completion of one of the following two options:

Option 1: Successful completion of two semesters of biological research taken as BIOL 487 / BIOL 488W (Honors Research).

Option 2: Successful completion of three upper-division courses in Biological Sciences and achievement of the "Honors" designation in each.

Students petitioning for designation of an upper-division biology course as "Honors" must have a minimum overall GPA of 3.25 and a GPA of at least 3.50 in biology.

To receive the "Honors" designation for a course, students must achieve a final course score of at least 95% or the equivalent of an "A" on the University grade scale.

Faculty are encouraged to assign and work with students on other activities deemed appropriate for an "Honors" course designation and utilize the results of these activities in the assignment of a course grade.

Advanced Placement

Students may receive advanced placement (AP) credit for BIOL 121N & BIOL 122N or BIOL 123N & BIOL 124N (4 credits) by a score of 3 on the advanced placement examination. Students receiving a score of 4 or 5 will receive credit for both BIOL 121N & BIOL 122N and BIOL 123N & BIOL 124N (8 credits). Official score reports should be sent to the Office of Admissions prior to registration for evaluation.

BIOLOGICAL SCIENCES Courses

BIOL 103. Basic Bacteriology. 4 Credits.
A course designed to acquaint the student with the elementary principles of bacteriology and other disease causing microorganisms. Emphasis is placed on microorganisms as etiological agents in disease, on practical methods of disinfection, and on the factors of infection and immunity.

BIOL 105N. Biology for Nonscience Majors I. 4 Credits.
An introductory biology course for nonbiology majors. This course concentrates on major biological concepts concerning molecular biology, cellular biology, cellular reproduction, classical and molecular genetics, energetics, and ecology. This course would be beneficial to students pursuing elementary education degrees due to the discussion of biological topics included in the Virginia Standards of Learning. Cannot be substituted for BIOL 121N and BIOL 122N or BIOL 123N and BIOL 124N.

BIOL 106N. Biology for Nonscience Majors II. 4 Credits.
An introductory biology course for nonbiology majors. This course concentrates on plants and animals at the organismal level by examining major biological concepts involving diversity, ecology, behavior, and evolution. This course would be beneficial to those students who are pursuing elementary education degrees because it teaches biological topics included in the Virginia Standards of Learning. Cannot be substituted for BIOL 121N and BIOL 122N or for BIOL 123N and BIOL 124N.

BIOL 110N. Environmental Sciences. 3 Credits.
An introductory, non-sequential course for nonbiology majors focusing on scientific inquiry and the structure and function of the human body with units on diet, nutrition, exercise, infectious disease, and cancer. Cannot be substituted for BIOL 121N or BIOL 123N. Prerequisites: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, or completion of MATH 102M or higher. Pre- or corequisite: BIOL 113N.

 BIOL 111N. Environmental Sciences Lab. 1 Credit.
A lab course emphasizing the process of science, evolutionary biology, ecology, and the basic biology of viruses, prokaryotes, and eukaryotes. Students required to take BIOL 123N cannot earn credit for BIOL 105N, BIOL 106N, BIOL 110N, BIOL 112N, or BIOL 117N. Prerequisites: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, or completion of MATH 102M or higher, and BIOL 121N passed with a grade of C (2.0) or higher. Pre- or corequisite: BIOL 124N.

BIOL 112N. General Biology I. 3 Credits.
A course designed to acquaint the student with the elementary principles of bacteriology and other disease causing microorganisms. Emphasis is placed on microorganisms as etiological agents in disease, on practical methods of disinfection, and on the factors of infection and immunity.

BIOL 113N. General Biology II. 3 Credits.
An introductory, non-sequential course for nonbiology majors focusing on scientific inquiry and the structure and function of the human body with units on diet, nutrition, exercise, infectious disease, and cancer. Cannot be substituted for BIOL 121N or BIOL 124N. Pre- or corequisite: BIOL 110N.

BIOL 117N. Introduction to Human Biology. 3 Credits.
An introductory lecture course for non-majors focusing on scientific inquiry and the structure and function of the human body with units on diet, nutrition, exercise, infectious disease, and cancer. Cannot be substituted for BIOL 121N or BIOL 123N. Pre- or corequisite: BIOL 113N.

BIOL 121N. General Biology I Lab. 1 Credit.
A lab course emphasizing the process of science, biological molecules, cell biology, metabolism, molecular biology, and Mendelian genetics. Students required to take BIOL 121N cannot earn credit for BIOL 105N, BIOL 106N, BIOL 110N, BIOL 112N, or BIOL 117N. Prerequisites: Placement into ENGL 110C. Pre- or corequisite: BIOL 122N and MATH 102M or higher.

BIOL 122N. General Biology I Lab. 1 Credit.
A lab course emphasizing the process of science, biological molecules, cell biology, metabolism, molecular biology, and Mendelian genetics. Students required to take BIOL 122N cannot earn credit for BIOL 111N, BIOL 113N, or BIOL 118N. Prerequisites: Placement into ENGL 110C. Pre- or corequisite: BIOL 121N and MATH 102M or higher.

BIOL 123N. General Biology II. 3 Credits.
An introduction to the process of science, evolutionary biology, ecology, and the basic biology of viruses, prokaryotes, and eukaryotes. Students required to take BIOL 123N cannot earn credit for BIOL 105N, BIOL 106N, BIOL 110N, BIOL 112N, or BIOL 117N. Prerequisites: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, or completion of MATH 102M or higher, and BIOL 121N passed with a grade of C (2.0) or higher. Pre- or corequisite: BIOL 124N.

BIOL 124N. General Biology II Lab. 1 Credit.
A lab course emphasizing the process of science, evolutionary biology, ecology, and the basic biology of viruses, prokaryotes, and eukaryotes. Students required to take BIOL 124N cannot earn credit for BIOL 111N, BIOL 113N, or BIOL 118N. Prerequisite: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, or completion of MATH 102M or higher, and BIOL 121N. Pre- or corequisite: BIOL 123N.
BIOL 136N. Honors General Biology I. 3 Credits.
This course is available only to students in the Honors College. An introduction to the process of science, biological molecules, cell biology, metabolism, molecular biology, and Mendelian genetics. Students required to take BIOL 136N cannot earn credit for BIOL 105N, BIOL 106N, BIOL 110N, BIOL 112N, or BIOL 117N. Prerequisites: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, and enrollment in the Honors College. Pre- or corequisite: BIOL 137N and MATH 102M or higher.

BIOL 137N. Honors General Biology I Lab. 1 Credit.
This lab course is available only to students in the Honors College. This lab course emphasizes the process of science, biological molecules, cell biology, metabolism, molecular biology, and Mendelian genetics. Students required to take BIOL 137N cannot earn credit for BIOL 111N, BIOL 113N, or BIOL 118N. Prerequisites: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, and enrollment in the Honors College. Pre- or corequisite: BIOL 136N and MATH 102M or higher.

BIOL 138N. Honors General Biology II. 3 Credits.
This course is available only to students in the Honors College. An introduction to the process of science, evolutionary biology, ecology, and the basic biology of viruses, prokaryotes, and eukaryotes. Students required to take BIOL 138N cannot earn credit for BIOL 105N, BIOL 106N, BIOL 110N, BIOL 112N, or BIOL 117N. Prerequisite: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, or completion of MATH 102M or higher, enrollment in the Honors College, and BIOL 136N. Pre- or corequisite: BIOL 139N.

BIOL 139N. Honors General Biology II Lab. 1 Credit.
This lab course is available only to students in the Honors College. This lab course emphasizes the process of science, evolutionary biology, ecology, and the basic biology of viruses, prokaryotes, and eukaryotes. Students required to take BIOL 139N cannot earn credit for BIOL 111N, BIOL 113N, or BIOL 118N. Prerequisite: Placement into ENGL 110C and qualifying Math SAT/ACT score, or qualifying score on the Math placement test, or completion of MATH 102M or higher, enrollment in the Honors College, and BIOL 136N. Pre- or corequisite: BIOL 138N.

BIOL 195. Biology Lab Topics. 1-3 Credits.
Laboratory topics.

BIOL 196. Topics. 1-3 Credits.
Topics in Biology.

BIOL 240. Fundamentals of Anatomy and Physiology I. 4 Credits.
This is the first of a two-part course that investigates the structure and function of the human body. Emphasis is on the basic organization of the body, biochemical composition, cellular structure, function, tissues and organs of the following systems: integumentary, skeletal, muscular, nervous, sensory and endocrine. In lab, students will study the interrelationship between structure and function of the human body using models, histological preparations, and human and feline anatomical specimens. Students with credit for BIOL 240 cannot receive credit for BIOL 250.

BIOL 241. Fundamentals of Anatomy and Physiology II. 4 Credits.
The second of a two-part course that investigates the structure and function of the human body. Emphasis is on the basic organization of the body, biochemical composition, cellular structure, function, tissues and organs of the following systems: cardiovascular, lymphatic, immune, respiratory, urinary, digestive, reproductive and human development. In lab, students will study the interrelationship between structure and function of the human body using models, histological preparations, and human and feline anatomical specimens. Students with credit for BIOL 241 cannot receive credit for BIOL 251. Prerequisites: BIOL 240 or permission of the instructor.

BIOL 250. Human Anatomy and Physiology I. 4 Credits.
This course emphasizes the gross anatomical relationships and the molecular, cellular, physiological, and metabolic process of the integument, muscular/skeletal, neural, and immune systems. Students with credit for BIOL 250 cannot receive credit for BIOL 240.

BIOL 251. Human Anatomy and Physiology II. 4 Credits.
This course emphasizes the physiology and pathophysiology of the cardiac, pulmonary, renal, endocrine, and reproductive systems. Only BIOL 251 (4 credits) may count toward upper-division elective requirements for the Biology major. Students with credit for BIOL 251 cannot receive credit for BIOL 241. Prerequisites: BIOL 250 or permission of the instructor.

BIOL 291. Ecology. 3 Credits.
An introduction to the basic concepts of ecology for both biology majors and nonmajors. The concepts are introduced with respect to terrestrial and aquatic environments. Prerequisites: BIOL 123N and BIOL 124N or BIOL 138N and BIOL 139N must be passed with a grade of C or higher.

BIOL 292. Evolution. 3 Credits.
An introduction to the basic concepts of evolution for both biology majors and nonmajors. The concepts are introduced with respect to terrestrial and aquatic environments. Prerequisites: BIOL 123N and BIOL 124N or BIOL 138N and BIOL 139N must be passed with a grade of C or higher.

BIOL 293. Cell Biology. 3 Credits.
A comprehensive course in the structural and functional features of cells, including prokaryotic and eukaryotic cells. The course will also examine biomacromolecules, techniques in cell and molecular biology, and current frontiers in cell biology research. Prerequisites: BIOL 123N and BIOL 124N or BIOL 138N and BIOL 139N must be passed with a grade of C or higher.

BIOL 300. Fundamental Biomolecules. 3 Credits.
This course provides a detailed understanding of the four major classes of organic biological molecules as well as inorganic biological molecules (vitamins and trace minerals). The course focuses on how these biomolecules relate to everyday life for a diversity of organisms. This course will additionally emphasize current research and topics in the media as they pertain to biomolecules. This course counts as an elective for BIOL majors; students with premedical, dental or veterinary emphasis should consider if this course will satisfy requirements for medical, dental, or veterinary schools. Prerequisites: BIOL 123N or BIOL 138N or BIOL 251 with a C or better and CHEM 107N or CHEM 123N or CHEM 137N or CHEM 173T with a C or better.

BIOL 302. Introduction to Immunology. 3 Credits.
A review of the phenomena of immune resistance, the cells and tissues involved in immune responses and the consequences of immunization. Prerequisite: BIOL 293.

BIOL 303. Genetics. 3 Credits.
An introduction to the principles of biological inheritance and variation and the molecular basis of gene structure and function. Prerequisites: BIOL 123N and BIOL 124N or BIOL 138N and BIOL 139N must be passed with a grade of C or higher.

BIOL 304. Animal Nutrition. 3 Credits.
The course incorporates the fields of animal physiology, biochemistry, ecology and behavior to provide a comprehensive framework for energy acquisition, processing, and use in animals. The course content integrates cellular and molecular mechanisms of digestion and absorption, with tissue-specific and whole-animal metabolism, to the environmental influences on food resource availability and the diverse adaptations of animals to specific dietary and energetic constraints. The course primarily focuses on vertebrate animals. Prerequisites: BIOL 123N and BIOL 124N. Pre- or corequisite: BIOL 305.

BIOL 305. Animal Nutrition Laboratory. 2 Credits.
This course in comparative animal nutrition and metabolism explores how diverse animals accomplish the universal task of acquiring food energy from their environments, processing and assimilating these resources, and use food energy in metabolism to support vital functions (e.g., growth, repair, reproduction). Prerequisites: BIOL 123N and BIOL 124N. Pre- or corequisite: BIOL 304.
BIOL 306. Human Genetics. 3 Credits.
Human genetics applies the principles of genetics to understanding human disease and evolution. It covers classical genetics, molecular genetics and population genetics, meeting the undergraduate genetics requirement for biology and biochemistry majors. Prerequisites: BIOL 121N, BIOL 122N, BIOL 123N, and BIOL 124N or the equivalent with a grade of C (2.0) or better. Pre- or corequisite: CHEM 441.

BIOL 307. Invertebrate Zoology. 4 Credits.
An examination of the invertebrate phyla with emphasis on classification, morphology, phylogeny, and general biology. Prerequisites: BIOL 292 must be passed with a grade of C or higher.

BIOL 308. Botany. 4 Credits.
A general introduction to the structure, function, ecology, and diversity of plants. Prerequisites: BIOL 291 and BIOL 292 must be passed with a grade of C or higher.

BIOL 309. Foundations of Pathophysiology. 4 Credits.
This course is designed to teach the fundamentals of abnormal functions essential to understanding diseases, disease processes, and production of signs and symptoms. Chemical, biological, and biochemical alterations in physiology of all major organ systems will be considered. Prerequisites: BIOL 240/BIOL 241 OR BIOL 250/BIOL 251.

BIOL 310. Field Invertebrate Zoology. 5 Credits.
An examination of the invertebrate phyla with emphasis on classification, morphology, phylogeny, and general biology. This course will be taught as a full, immersive, field course in the Florida Keys. Prerequisite: BIOL 292 must be passed with a grade of C or higher.

BIOL 311. Global Change Biology. 3 Credits.
This course will emphasize the application of evolutionary and ecological principles such as species geographic range shifts, changes in phenology, acclimation, adaptation, and extinction in response to global environmental changes. Prerequisites: BIOL 291 and BIOL 292 must be passed with a grade of "C" or higher.

BIOL 313. Introduction to Neuroanatomy. 4 Credits.
This course is designed to give students a comprehensive understanding of the structure and function of the human nervous system, with a major focus on neuroanatomy. The basic principles of cellular neuroscience, neurophysiology, as well as, the sensory and motor pathways will be discussed in detail. Clinically relevant applications will be discussed when relevant. The laboratory component of this course will use cadavers and human tissue to study head and neck structures. Prerequisites: BIOL 241 or BIOL 251 and BIOL 293 must be passed with a C (2.0) or better.

BIOL 314. Developmental Biology. 5 Credits.
An analysis of development in animals. Lectures will explore experimental approaches to the study of gametogenesis, fertilization, cleavage and morphogenesis. Laboratories will emphasize the morphological features of the developing vertebrate embryo. Prerequisites: BIOL 240 or BIOL 250 and BIOL 241 or BIOL 251 must be passed with a grade of C or higher. Pre- or corequisite: CHEM 211.

BIOL 316. General Microbiology. 3 Credits.
This lecture course is a general survey of the nature and diversity of microorganisms, especially bacteria but including viruses and fungi, the roles and functions of microorganisms and basic microbiological research. Prerequisites: BIOL 293 and BIOL 303 must be passed with a grade of C or higher. Pre- or corequisite: BIOL 317.

BIOL 317. General Microbiology Laboratory. 2 Credits.
Laboratory course emphasizing basic techniques in microbiology. Prerequisites: BIOL 293 and BIOL 303 must be passed with a grade of C or higher. Pre- or corequisite: BIOL 316.

BIOL 322. Ethnobotany. 3 Credits.
A survey of plants used for food, fiber, medicine, dyes, perfumes, oils, and waxes. The role of plants in folklore and religion is included. A student research project with a written paper and presentation is required. Prerequisites: BIOL 292 AND BIOL 308 must be passed with a grade of C or higher.

BIOL 331. Marine Biology. 3 Credits.
A survey of the variety, ecology and adaptations of marine organisms. The course is designed to broadly introduce students to life in the oceans and the many special features of marine species that have evolved in the earth's oldest and most extensive ecosystem. Prerequisites: BIOL 291 must be passed with a grade of C (2.0) or higher.

BIOL 334. Field Ethnobotany. 4 Credits.
Identification, ecology, and uses of plants and mushrooms for food, oils, dyes, and cordage, based on collection and preparation of local materials. A field-intensive course with hands-on experience. A class project and presentation are required. Prerequisites: BIOL 123N and BIOL 124N must be passed with a grade of C or higher.

BIOL 336. Vertebrate Zoology. 4 Credits.
This course will emphasize the organisms classified as vertebrates - fish, amphibians, reptiles, birds, and mammals - in addition to their evolutionary relatives. Detailed discussions of the changes that accompany this diversification of life will include topics in evolution, comparative anatomy, geology, and taxonomy. The lab will be a survey of specimens representing the major groups discussed in lecture. Prerequisites: BIOL 291 and BIOL 292 must be passed with a grade of "C" or higher.

BIOL 340. Field Botany. 4 Credits.
A survey of plants and plant communities of the Mid-Atlantic Coastal Plain. Skills in plant and mushroom identification, specimen preparation, and research databases are emphasized. Most classes are field trips. Prerequisites: BIOL 291 must be passed with a grade of C (2.0) or higher.

BIOL 346. Plant Geography. 3 Credits.
The distribution and characteristics of major plant community types in North America are discussed. Abundant pictures are used to illustrate the flora and plant communities. Prerequisites: BIOL 123N and BIOL 124N must be passed with a grade of C (2.0) or higher.

BIOL 350. Phage Discovery and Genomics I. 4 Credits.
This course is the first semester of a two-semester laboratory and scientific writing course designed to provide a unique undergraduate research experience. It focuses on the discovery of viruses (also known as bacteriophage or phage) that infect bacteria with an emphasis on laboratory techniques. Students will collect phage from environmental samples and learn the laboratory techniques required for the isolation, purification and propagation of viruses. Students will further characterize phage based on microscopy, molecular microbiology techniques, and nucleic acid sequencing. This course emphasizes independent research and additional time outside of the laboratory will be required for sample collection and analysis. This course also is designed to complement the MonarchTeach curriculum. Prerequisite: BIOL 303.

BIOL 351. Phage Discovery and Genomics II. 3 Credits.
This is the second course of a two-semester laboratory and scientific writing sequence that is designed to provide a unique research experience for undergraduate students. The second semester course is a continuation of the research on the phage project that was started in Phage Discovery and Genomics I (BIOL 350). The students will analyze the newly sequenced bacteriophage genome using bioinformatics tools with an emphasis on Genomics. The bioinformatics will be completed using computer software, mathematical modeling and presented in formal scientific laboratory reports and formal presentations. Upon successful completion of the year-long course, some students will be invited to participate in the SEA-PHAGE program coordinated by the Howard Hughes Medical Institute. The course is designed with an emphasis on independent research that could lead to a scientific publication. Prerequisites: BIOL 350 and BIOL 303 must be passed with a grade of "C" or higher.

BIOL 355. Stem Cell Biology. 3 Credits.
Tissue homeostasis requires the birth of new cells, typically derived from stem cells, as well as the removal of cells that are not needed or have become damaged. This course will focus on understanding the mechanisms by which new cells are generated and old or diseased cells are removed. The pathological consequences of failures in one or both of these key processes will be explored as well. Applications of stem cells to regenerative medicine will be considered in detail. Prerequisites: A grade of "C" or higher in BIOL 293.
BIOL 367. Cooperative Education. 1-3 Credits.
Student participation for credit in a paid work environment based on the academic relevance of the work experience as determined by the department and the Cooperative Education program, prior to the semester in which the work experience is to take place. Unstructured course. Students must identify a full-time biology faculty member with the expertise to determine if the cooperative education experience is appropriate for a biology curriculum, approve the learning contract, review the submitted assignments (student report and supervisor’s evaluation) and assign a P/F grade. Prerequisites: approval by the department chair and Cooperative Education/Career Development Services.

BIOL 368. Internship. 1-3 Credits.
Supervised participation in non-research professional setting. Requires a minimum of 3 hours per week or equivalent for 1 credit, completion of work report and other documents relevant to the work experience, and supervisor evaluation. Unstructured course. Students must identify a full-time biology faculty member with the expertise to determine if the internship is appropriate for a biology curriculum, approve the learning contract, review the submitted assignments (student report and supervisor’s evaluation) and assign a P/F grade. Prerequisites: BIOL 123N and BIOL 124N must be passed with a grade of C (2.0) or higher, junior standing, and approval of a full-time biology faculty member.

BIOL 369. Practicum. 1-3 Credits.
A supervised experience in a research, teaching, or a work/field setting and culminating in the preparation of a written document relevant to the practicum experience. Unstructured course. Students must identify a full-time biology faculty member with the expertise to determine if the practicum is appropriate for a biology curriculum, approve the learning contract, review the submitted assignments (student report and supervisor’s evaluation) and assign a P/F grade. Prerequisites: BIOL 123N and BIOL 124N must be passed with a grade of C (2.0) or higher, junior standing, and approval of a full-time biology faculty member and the practicum coordinator.

BIOL 380. Research in Pathogen Biology I: Laboratory Investigation. 4 Credits.
This is the first course of a two-semester laboratory and analysis sequence that is designed to provide a genuine research experience for undergraduate students. Students will design a novel research question in pathogen biology, then use modern laboratory techniques such as polymerase chain reaction and next-generation DNA sequencing to examine this question and test hypotheses. Data generated in this course will be analyzed in the second course in the series, BIOL 381. Data and analyses generated during these courses may be used for publication in scientific journals. Prerequisites: BIOL 303.

BIOL 381. Research in Pathogen Biology II: Analysis. 4 Credits.
This is the second course of a two-semester laboratory and analysis sequence that is designed to provide a genuine research experience for undergraduate students. In this semester, students will analyze data generated during the previous semester in BIOL 380. Modern methods of data analysis will be used, including statistical and bioinformatics techniques. Data and analyses generated during these courses may be used for publication in scientific journals. Prerequisite: BIOL 303; BIOL 380 preferred.

BIOL 395. Topics. 1-3 Credits.
A structured specialty course designed to meet the needs of students in biology. Students are expected to perform at the level of other junior level classes. Prerequisites: BIOL 123N and BIOL 124N must be passed with a grade of C or higher.

BIOL 396. Topics in Biological Sciences. 4-5 Credits.
A structured specialty course for students at the junior level. Courses may include lecture and laboratory components. Prerequisites: BIOL 123N and BIOL 124N with grades of C or better.

BIOL 400/500. Vascular Plant Families. 5 Credits.
An evolutionary survey of vascular plant families and the principles and methodologies that define them; emphasis is placed on recognition and skills of identification. A field intensive hands-on course. A research project including a written paper and presentation is required. Prerequisites: BIOL 292 and BIOL 308 with a C or better.

BIOL 401W/501. Entomology. 4 Credits.
A comprehensive survey of the insects, including taxonomy, morphology, physiology, reproductive and developmental biology, and ecology. Research techniques in entomology will be learned through both field and laboratory work. Writing skills will be learned through written summaries, essay exams, laboratory reports and research proposals. This is a writing intensive course. Prerequisites: BIOL 291 and BIOL 292 must be passed with a grade of C (2.0) or higher.

BIOL 402/502. Scientific Diving Methods for Marine Research. 4 Credits.
This lecture/field experience course will train students in the common techniques used by marine scientists who employ scuba for their research. It satisfies the requirements for an American Academy of Underwater Scientist certification and covers other topics such as: use of underwater research equipment and marine resource surveys. A multi-day scuba trip is required. Prerequisites: junior standing and scuba diving certification.

BIOL 403/503. Medical Microbiology. 3 Credits.
This course integrates the disciplines of microbiology, immunology, and biochemistry with the pathophysiology of infections and the appropriate pharmacology in a problem-based learning setting. Students will learn the fundamental concepts and terminologies of infectious diseases. The material will be case studies in small group tutorials and emphasize independent learning. Prerequisites: BIOL 240 or BIOL 250, BIOL 316 and BIOL 317, and CHEM 441 must be passed with a grade of C or higher or instructor approval.

BIOL 404/504. Conservation Biology. 5 Credits.
The application of fundamental biological principles to the preservation of biodiversity, including the role of ecological and evolutionary theory to the preservation of biotas on a regional and global basis. Lectures will cover modern approaches to conservation biology, including conservation ethics and management issues. Laboratories will include discussion of case studies, introduction to software applicable to conservation biology, presentations by regional conservation practitioners, and visits to relevant field sites. Prerequisites: BIOL 291 must be passed with a grade of C or higher and junior standing or permission of instructor.

BIOL 405W. Biology Seminar. 3 Credits.
This course offers a capstone experience in scientific writing, faculty-mentored library research, the review and synthesis of material from the primary technical literature, and oral presentation. Students will develop a deeper understanding of the purposes and types of scientific writing, the structure and interpretation of technical papers, and the oral and written communication skills appropriate to the discipline. This is a writing intensive course. Prerequisites: BIOL 291, BIOL 292, BIOL 293, and BIOL 303 and two 300- or 400-level elective courses, a grade of C or better in ENGL 211C or ENGL 221C or ENGL 231C, and CS 120G or CS 121G or CS 126G or HLTH 120G or IT 150G or STEM 251G.

BIOL 407/507. The Pharmacology and Neurobiology of How Recreational Drugs Work. 3 Credits.
This course in drug use and abuse is designed to distinguish between drug use and drug abuse as well as provide pharmacological knowledge of how recreational drugs work. Students will acquire knowledge regarding the abuse of prescription drugs, depressants, stimulants, hallucinogens, marijuana and inhalants. This information will be used to analyze pathophysiologial conditions that can occur as a result of drug use and abuse. Prerequisite: BIOL 293 or equivalent. Pre- or corequisite: BIOL 408 recommended.

BIOL 408/508. Introduction to Pharmacology. 4 Credits.
This is a general introductory course in pharmacology dealing with chemistry, general properties and pharmacological effects on various physiological systems, therapeutic usefulness and toxicities of drugs. The course is designed to prepare upper-level undergraduate and graduate students for more advanced courses in pharmacology. Prerequisite: course background in cell biology and/or human physiology.
Biol 411/511. Zymology: Fermentation Science. 4 Credits.
This is an introductory course in the theory and practice of zymology (fermentation). Edible and potable products of fermentation (beer, wine, mead, yogurt, cheese) have been known since antiquity and play an important role in today’s society. The science of fermentation touches on many biological disciplines, such as microbiology and biochemistry, and the study of yeasts has provided considerable foundation to the fields of cell biology and molecular biology. In this course, we will cover fundamentals of fermentation and its practical application to production of beer, one of the oldest beverages produced by humans. Prerequisite: Biol 293.

Biol 412/512. Plant Physiology. 4 Credits.
A study of the physiological processes occurring in plants. A laboratory and greenhouse oriented course stressing plant nutrients, cell metabolism—respiration, photosynthesis, nitrogen metabolism, and plant hormones. Prerequisites: Biol 292 must be passed with a grade of C or higher. Pre- or corequisite: Biol 293 and Chem 211.

Biol 415W/515. Marine Ecology. 5 Credits.
A lecture and laboratory course designed to introduce students to important ecological processes operating in coastal marine environments; this is a writing-intensive course. The course covers synthetic topics as well as the ecology of specific marine habitats. The laboratory is designed to provide students with experience in marine research and the organisms and ecological conditions common in various marine habitats visited by the class. A field trip of several days over fall break is required. Prerequisites: Biol 291 and Biol 292 must be passed with a grade of C or higher. Pre- or corequisite: Biol 293 and Chem 211.

Biol 416/516. Clinical Immunology. 3 Credits.
A description of common immunological problems seen in the clinic. Prerequisites: Biol 302.

Biol 419/519. Wetland Plants. 5 Credits.
A field-oriented course on the identification and ecology of aquatic and wetland plants with emphasis on plants used to delineate wetlands following federal guidelines. Activities include the use of identification databases, apps, and traditional florals, and monographs to develop identification skills using plants from the diversity of habitats in the region. A research project including a written paper and presentation is required. Prerequisites: Biol 291 and Biol 331 and Engl 211C or Engl 221C or Engl 231C must be passed with a grade of “C” or higher; instructor approval required.

Biol 420/520. Ichthyology. 5 Credits.
The biology of marine and freshwater fishes including morphology, physiology, evolution, distribution, ecology, and reproduction. Prerequisites: Biol 292 must be passed with a grade of C or higher and junior standing.

Biol 422/522. Field Studies in Ornithology. 4 Credits.
A combined lecture and field study of birds with emphasis on identification, behavior, and field methods. Extensive field trips, including at least one weekend, are taken. Prerequisites: Biol 291 and Biol 292 must be passed with a grade of C or higher or permission of the instructor.

Biol 423W/523. Cellular and Molecular Biology. 3 Credits.
The molecular organization of eukaryotic cells is presented along with cell evolution, molecular genetics, the internal organization of the cell and the behavior of cells in multicellular organisms. This is a writing intensive course. Prerequisites: Biol 293, Biol 303, and a grade of C or better in Engl 211C or Engl 221C or Engl 231C.

Biol 424/524. Comparative Animal Physiology. 5 Credits.
An introduction to the basic mechanisms by which different animals function. How organisms acquire and use energy, regulate their internal environment, circulate and exchange gases and wastes, receive and conduct information about their environment, and move and use muscles will be some of the topics covered. Emphasis will be on how organisms make changes in these basic mechanisms to deal with different environmental conditions. Prerequisites: Biol 292 must be passed with a grade of C or higher.

Biol 425/525. Cancer Biology. 3 Credits.
This course will examine how mutation leads to altered gene products and expression, subverted cell activity, cell immortalization, and tumor formation. Students will explore the differences between benign tumors and malignant tumors as well as the factors involved in malignancy. The course will conclude with the exploration of current cancer therapy. Prerequisites: Biol 293 and Biol 303 must be passed with a grade of C or higher.

Biol 426/526. Histology. 5 Credits.
The structure and function of cells, tissues and organs at both the light microscopic and ultrastructural levels. Prerequisites: Biol 240 or Biol 250 and Biol 293 must be passed with a grade of C or higher.

Biol 430W/530. Microbial Pathogenesis. 3 Credits.
Examination of bacterium-host interactions with an emphasis on how bacteria cause disease, particularly the means by which the bacterium is able to circumvent host defense mechanisms. This is a writing intensive course. Prerequisites: Biol 316 and Biol 317 and a grade of C or better in Engl 211C or Engl 221C or Engl 231C.

Biol 435/535. Marine Conservation Biology. 3 Credits.
This highly interdisciplinary science of conserving marine biodiversity will be taught through a review of old and new literature. This will include its history, marine ecology related to conservation biology, threats to marine biodiversity, assessment of extinction risk, conservation challenges of marine habitats and regions, and methods for conserving marine biodiversity. Prerequisites: Biol 331 must be passed with a grade of C or higher.

Biol 436W/536. Infectious Disease Epidemiology. 3 Credits.
This lecture course will focus on concepts related to the spread and control of infectious diseases. This course is a writing-intensive course. Prerequisites: Biol 291, and Biol 292, and Biol 293, and Biol 303, and Math 200 or Math 163 or Math 211 or Math 205, and Stat 130M or Stat 310, and Engl 231C or Engl 221C or Engl 211C; all must be passed with a grade of “C” or higher.

Biol 437W/537. One Health: People, Animals and the Environment. 3 Credits.
A course that examines the interdependence between human health, animal health and environmental health. The One Health approach to the threat of emerging infectious diseases includes understanding the interconnectedness of human and animal pathogens, epidemic zoonoses and corresponding environmental factors, insights into mechanisms of microbial evolution towards pathogenicity, new technologies and approaches towards disease surveillance, and political and bureaucratic strategies. This is a writing intensive course. Prerequisites: Biol 291 and Biol 293. Pre- or corequisite: Biol 292 and Biol 303; a Microbiology course is recommended.

Biol 438/538. The Biology of Woody Plants. 4 Credits.
The study of trees and shrubs (dendrology), their identification, ecology, structure and anatomy, lore, and uses are emphasized in this field-oriented course. A research project including a written paper and presentation is required. Prerequisites: Biol 308 or its equivalent must be passed with a grade of “C” or higher.

Biol 440/540. Methods in Immunological Research. 4 Credits.
The major objective of this hands-on course is to use basic laboratory techniques to prepare monoclonal antibodies to use for identification and characterization of mouse immune cells. Students will learn basic training in molecular and cellular biology techniques aiming at building basic knowledge in flow cytometry, from the experimental designs to data acquisition and analysis. The course will cover: instrumentation, sample preparation; data analysis; and applications in immunology. Prerequisites: Biol 123N and Biol 124N.

Biol 441/541. Animal Behavior. 5 Credits.
Animal behavior with special attention to its evolution and ecological significance. Field and laboratory activities will emphasize the observational and experimental techniques used to study behavior. Prerequisites: Biol 291 and Biol 292 must be passed with a grade of C or higher and junior standing or permission of the instructor.
BIOL 444/544. Field Studies in Marine Biology. 5 Credits.
An intensive study abroad field course offered during the summer at a foreign marine laboratory where students will be engaged in lectures and field studies of coastal marine environments. Check with the Director of the Marine Biology Concentration Program for details. Prerequisite: BIOL 331 must be passed with a grade of C or higher.

BIOL 445/545. Community Ecology. 3 Credits.
The goal of this course is to introduce and evaluate both classical and emerging paradigms in community ecology. This will be achieved by examining those processes (biotic and abiotic) that structure ecological communities and by exposing students to quantitative and theoretical aspects of these paradigms. Prerequisites: BIOL 291 must be passed with a grade of C or higher.

BIOL 446/546. Comparative Biomechanics. 3 Credits.
The principles of fluid and solid mechanics will be applied to a variety of plant and animal systems to understand how organisms deal with the immediate physical world and its accompanying constraints. A diverse range of topics will be covered, including aerial flight in insects, wind resistance in trees, jet propulsion in squid, flow within blood vessels, forces on intertidal organisms, viscoelasticity in biological materials, and energy storage during terrestrial movement. Prerequisites: BIOL 293 must be passed with a grade of C or higher; PHYS 111N and PHYS 112N are recommended.

BIOL 450/550. Principles of Plant Ecology. 4 Credits.
This course emphasizes the general theoretical concepts in plant ecology with statistical methods. The structure, development, processes, and history of plant communities are studied. Laboratories involve extensive fieldwork. A weekend field trip is required. Prerequisites: BIOL 291 must be passed with a grade of C or higher and senior standing.

BIOL 451/551. Bioinformatics and Genomics I. 4 Credits.
The application of computer science to biology has led to major breakthroughs in the ability to read and understand the code written in genomes. This course will give students the skills to participate in the computational revolution in biology. The course will give students hands-on experience in writing simple yet powerful computer programs in the Python programming language and making beautiful data visualizations in the R programming language. Students will also learn how to combine existing pieces of bioinformatics software for their own workflows. Prerequisites: BIOL 123N and BIOL 124N must be passed with a grade of C (2.0) or higher, junior standing, and permission of the instructor.

BIOL 452/552. Bioinformatics and Genomics II. 4 Credits.
The application of computer science to biology has led to major breakthroughs in the ability to read and understand the code written in genomes. This course will give students the skills to participate in the computational revolution in biology. The course will build on the knowledge of writing programs. Students will learn about some key techniques “under the hood” of software that have been critical to the genomics revolution. Topics will include: graph algorithms, evolutionary trees, probability models for DNA and protein sequences, and an introduction to deep learning in biology. Prerequisites: Knowledge of Python programming and permission of instructor, or BIOL 451 must be passed with a grade of C (2.0) or higher.

BIOL 453/553. Molecular Ecology. 4 Credits.
This course will explore the biology of organisms by using molecular (nucleic acid and/or protein) techniques and data. It covers a wide variety of subdisciplines within Biology, including genetics, physiology, ecology, and evolution. This course will explore basic theory in population genetics, ecology, and evolution and cover DNA, RNA, and Protein techniques and their application to biological research. Prerequisites: BIOL 291, BIOL 292, BIOL 293, AND BIOL 303 all must be passed with a grade of C or higher.

BIOL 457/557. General Virology. 3 Credits.
A basic course covering the history of virology, viral taxonomy, genetics, and the molecular biology and host responses to the major mammalian virus groups. Examples of recent impacts of viruses on human health such as influenza pandemics will also be covered. Prerequisites: BIOL 293 and BIOL 303 must be passed with a grade of C or higher.

BIOL 460/560. Frontiers in Nanoscience and Nanotechnology. 1 Credit.
Review of the structure, synthesis and properties of key nano-materials and their impact on living systems. Prerequisites: BIOL 293 must be passed with a grade of C or higher.

BIOL 461/561. Human Cadaver Dissection. 5 Credits.
Students will dissect a human cadaver fully and learn all of the major structures. The course will be divided into three sections: back and limbs, TAP (thorax, abdomen and pelvis), and head and neck. Instructor demonstrations include brain removal and dissection. Prerequisites: BIOL 241 or BIOL 251, or its equivalent, must be passed with a grade of C (2.0) or higher.

BIOL 462/562. Microbial Genetics. 3 Credits.
This course will emphasize the fundamental concepts of microbial genetics including the study of gene structure, gene regulation, operons, DNA replication, RNA biology, protein synthesis, plasmid biology, mobile genetic elements, and recombinant DNA technology. Prerequisites: BIOL 316 and BIOL 317 must be passed with a grade of C (2.0) or higher.

BIOL 463/563. Cell Signaling in Host Pathogen Interactions. 3 Credits.
This course will emphasize cell dynamics including host and pathogen induced cellular signaling, the regulation of actin cytoskeleton rearrangement, and the modulation of host transcription and translation by different pathogens. Prerequisite: BIOL 293.

BIOL 464/564. Biomedical Applications of Low Temperature Plasmas. 3 Credits.
This course is cross listed between ECE and Biology. It is intended for senior undergraduate students and first year graduate students. The course contents are multidisciplinary, combining materials from engineering and the biological sciences. The course covers an introduction to the fundamentals of non-equilibrium plasmas, low temperature plasma sources, and cell biology. This is followed by a detailed discussion of the interaction of low temperature plasma with biological cells, both prokaryotes and eukaryotes. Potential applications in medicine such as wound healing, blood coagulation, sterilization, and the killing of various types of cancer cells will be covered. Prerequisites: Senior standing.

BIOL 465/565. Biotechnology. 3 Credits.
This course provides an overview of how microbes are manipulated to solve practical problems through biotechnology. Topics include basic concepts in microbial technology, industrial microbiology, microbes in drug development, food microbiology, microbial interactions, gut microbiota, and metagenomics. Prerequisites: BIOL 316 and BIOL 317 must be passed with a grade of C or higher or permission of instructor.

BIOL 466W/566. Introduction to Mitigation and Adaptation Studies. 3 Credits.
Students will be introduced to the science underpinning mitigation of human-induced changes in the Earth system, including but not limited to climate change and sea level rise, and adaptation to the impacts of these changes. The course will cover the environmental hazards and the opportunities and limitations for conservation, mitigation and adaptation. This is a writing intensive course. Cross listed with IDS 466W and OEAS 466W. Prerequisites: BIOL 291 or permission of instructor.

BIOL 467/567. Sustainability Leadership. 3 Credits.
In this class, students will discover what makes a leader for sustainability. They will consider a range of global and local crises from a leadership point of view in the context of sustainability science, which addresses the development of communities in a rapidly changing social, economic, and environmental system-of-systems environment. The course will be based on taking a problem-motivated and solution-focused approach to the challenges considered. The course includes a service learning project focusing on a leadership experience in solving a real-world environmental problem. Prerequisite: BIOL 466W or OEAS 466W or IDS 466W.
BIOL 468W. Research Methods in Mathematics and Science, 3 Credits. Emphasizes the tools and techniques used to solve scientific problems. Topics include use and design of experiments, use of statistics to interpret experimental results, mathematical modeling of scientific phenomena, and oral and written presentation of scientific results. Students will perform four independent inquiries, combining skills from mathematics and science to solve research problems. Required for Biology teaching licensure track; not available as upper-division elective in content area. This is a writing intensive course. Prerequisites: BIOL 307 or BIOL 308 or BIOL 316 and BIOL 317 or MATH 212 and ENGL 211C or ENGL 221C or ENGL 231C and STEM 201 must be passed with a grade of C or higher or permission of instructor, and admission to Monarch Teach.

BIOL 470T/570. Diseases that Changed our World, 3 Credits. Despite advancements in the development of antimicrobials and vaccines and in securing clear water and food supplies, modern civilizations are not immune to epidemic diseases. This course will provide insight into the role of different technologies in the struggle to attain disease control and eradication and explore the challenge of forecasting emerging plagues, describing the nature and evolution of diseases and conveying their significance in shaping Western culture and civilization, their impact, their consequences, their costs, and the lessons learned. Prerequisites: BIOL 291 and BIOL 293 must be passed with a grade of "C" or higher.

BIOL 471W/571. Marine Vertebrate Ecology, Management & Conservation, 3 Credits. Course will explore the biology, diversity and major life history patterns of a suite of marine megafauna, including sea turtles, marine mammals, seabirds and sharks. Students will determine the major drivers behind large-scale declines of many marine megafauna species and be challenged to understand and attempt to solve conservation and management issues. This is a writing intensive course, with a focus on the content and mechanics of scientific writing. Prerequisites: BIOL 291, BIOL 292, and ENGL 211C or ENGL 221C or ENGL 231C must be passed with a C (2.0) or better. Pre- or corequisites: BIOL 331 OR OEAS 306.

BIOL 474/574. Mushrooms, 4 Credits. This field oriented course emphasizes the identification, classification, ecology, culture, and uses of mushrooms and other fleshy fungi. Prerequisites: BIOL 308 must be passed with a grade of C or higher.

BIOL 475/575. Neurobiology, 3 Credits. This course will focus on understanding brain structure as well as the morphology and function of the central nervous system in general. Fundamental processes such as neuron morphogenesis, guidance, polarity, migration, and growth cone motility will be emphasized. The cellular and molecular basis of neurological disorders also will be discussed. Prerequisites: BIOL 240 or BIOL 250 or BIOL 293 must be passed with a grade of "C" or higher or permission of instructor.

BIOL 476/576. Cancer Immunology and Immunotherapy, 3 Credits. Introduction to the immune system, tumor antigens, immunosuppressive cells and molecules, and cancer immunotherapy treatment approaches. Prerequisites: BIOL 123N, BIOL 124N, and BIOL 293 or permission of the instructor.

BIOL 478/578. Microbial Ecology, 3 Credits. Study of the interactions between microorganisms, particularly bacteria, and their environment. Emphasis is placed on nutrient cycling and the influence of microbes on global mineral dynamics. The effects of physical and chemical factors on the distribution and activity of microbes in their environments and the applications (biotechnology) of these interactions are studied. Prerequisites: BIOL 316 and BIOL 317 must be passed with a grade of C or higher.

BIOL 479/579. Microbial Ecology Laboratory, 1 Credit. A laboratory for measurement of microbial numbers and activity in natural environments. Pre- or corequisite: BIOL 478.

BIOL 481W/581. Forensic and Medical Entomology, 5 Credits. This is a writing intensive course that provides a comprehensive survey of the insects used in legal investigations and medically important insects. Topics covered include the taxonomy, morphology, physiology, reproductive and developmental biology, and ecology of these insects along with the diseases they may vector. Research techniques in forensic and medical entomology will be learned through both field and laboratory activities. Prerequisites: BIOL 291 and BIOL 292 must be passed with a grade of C (2.0) or higher.

BIOL 482/582. Human and Veterinary Parasitology, 3 Credits. The course will emphasize the principles of parasitism, including biology, physiology, genetics, morphology, and phylogeny of the major parasitic groups with a specific focus on the significant parasites of humans and animals of veterinary importance. The general biology of parasites including their life cycles, diagnosis, and treatment will be included as well. Prerequisites: BIOL 293 and BIOL 303 must be passed with a grade of C or higher or permission of instructor.

BIOL 487. Honors Research in Biology, 2 Credits. Student performs mentored research in biological science. Student and faculty mentor must meet on a regular basis. The course is intended to be taken as a series with BIOL 488W. Available for pass/fail grading only. Prerequisites: admission to the Honors Program and senior standing.

BIOL 488W. Honors Research in Biology, 4 Credits. Independent study and scheduled meetings with faculty advisor. Supervised independent study in an area of individual interest in biology. The work in this course results in the production of a thesis. This is a writing intensive course. Prerequisites: BIOL 487, admission to the Honors Program, senior standing, and a grade of C or better in ENGL 211C or ENGL 221C or ENGL 231C.

BIOL 490/590. Advanced Human Physiology, 4 Credits. All major physiological systems will be examined with an emphasis on normal physiology. Some clinical applications will be discussed. Prerequisites: BIOL 241 or BIOL 251 must be passed with a grade of C (2.0) or higher.

BIOL 494. Entrepreneurship in Biology, 3 Credits. Ecological entrepreneurs consider the impact of products on the environment and are mindful of natural resources, sustainability, and social equity. In this novel class students will test their skill at biologically-inspired entrepreneurship after learning about biomimicry, sustainability, and other relevant concepts. Prerequisites: BIOL 291 and BIOL 292.

BIOL 496/596. Topics in Biological Sciences, 1-4 Credits. A structured specialty course for students at the senior level. Courses may include lecture and laboratory components. Prerequisites: BIOL 123N and BIOL 124N must be passed with a grade of C (2.0) or higher, junior standing, and permission of instructor.

BIOL 497. Undergraduate Research, 1-3 Credits. The student performs laboratory and/or field research under the supervision of a Department of Biological Sciences faculty member. The student must devote a minimum of 3 hours per week for the equivalent of 1 credit. The student must maintain lab/field notes, must submit a written report, may be required to give an oral presentation, and must be evaluated by the faculty supervisor. If 3 credits are taken, then BIOL 497 counts as an upper-level biology elective course with a laboratory or field component. Prerequisites: BIOL 123N and BIOL 124N or BIOL 138N and BIOL 139N must be passed with a grade of C or higher, junior standing, permission of the supervising faculty member, and permission of the Chief Departmental Advisor and Chair of the Department of Biological Sciences.
BIOL 498/598. Independent Study. 1-3 Credits.
This unstructured course is based on a supervised project, without a laboratory or field component, that is selected to suit the needs of the individual student. The completion of a formal scientific paper documented with the appropriate primary technical literature is required. An oral presentation also may be required. Contact the Chief Departmental Advisor for details. Prerequisites: BIOL 123N and BIOL 124N or BIOL 138N and BIOL 139N must be passed with a grade of C or higher; junior standing, permission of the supervising faculty member, permission of the Chief Departmental Advisor, and permission of the Chair of the Department of Biological Sciences also are required.