Biological Sciences

Chair and Professor: Thomas

Professors: Anderson, Austin, Baxter, Bearden, Delehanty, Groome, Finney, Keeley, Magnuson, Meldrum, Peterson, Rose, Sheridan, Winston

Associate Professors: Aho, Evilia, Hill, Lohse, Loxterman, Pilarski, Reinhardt

Assistant Professors: Hale, Ledbetter, Pradhan, Serve, You

Lecturers: Abbruzzese, Black, Curran, Frank, Fultz, Rhett, Shurley, Stewart

Department Mission

We are a community that advances understanding of the biological sciences through active discovery, learning, and engagement with society.

Goals of Biology Graduate Programs

Students successfully completing graduate programs in Biology will:

1. Be able to think critically and comprehend written and verbal communications regarding topics in the life sciences;
2. Attain specific skills appropriate for careers in the biological sciences and related industries; and
3. Attain employment in the biological sciences or related fields.

Degree Programs

Degree programs offered by the Department of Biological Sciences include:

- Doctor of Philosophy (Ph.D.) in Biology
- Doctor of Philosophy (Ph.D.) in Microbiology
- Doctor of Arts (D.A.) in Biology
- Master of Science (M.S.) in Biology
- Master of Science (M.S.) in Microbiology
- Bachelor of Science/Master of Science

Admission Requirements for Biology Graduate Programs

In addition to ISU Graduate School admission requirements, general admission requirements for Biology graduate programs are:

- Availability of a suitable faculty advisor
- Competitive scores on the GRE General Test (verbal and quantitative scores above the 50th percentile and analytical writing score of at least 3.5) and on the GRE Subject Test for Biology or Biochemistry, Cell and Molecular Biology (for doctoral program applicants)
- GPA above 3.0 in science and mathematics courses during the last degree-earning program
- Letters of recommendation from three individuals who can comment on the applicant’s ability to succeed in a biology graduate program
- Prior training commensurate with completion of a B.S. degree in Biology or a related field
- TOEFL score above 577 (paper-based), 233 (computer-based), or 90 (internet-based), if the applicant’s English is a second language
- Availability of financial assistance (see below)

Program-specific additions and modifications of these requirements are described below.

Core Courses for Biology Graduate Programs

All students in the graduate programs in Biology and Microbiology will take the following courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL 6690</td>
<td>Careers in Life Sciences (fall semester of first year)</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 6691</td>
<td>Seminar (second semester for M.S. students; third semester for doctoral students)</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 6605</td>
<td>Biometry (spring semester)</td>
<td>4</td>
</tr>
</tbody>
</table>

Program-specific additions and modifications of these core course requirements are described below.

Financial Assistance

The Department of Biological Sciences provides support for graduate students through Fellowships, Research Assistantships, and Teaching Assistantships. All forms of support include a stipend, full tuition, and other benefits. To be fully considered for the next fall semester GTA appointment, an application should be received by the end of December. Visit the department website or contact the biology graduate programs director for details about financial assistance options.

Doctor of Philosophy (Ph.D.) in Biology

Goals and Program Description

The Ph.D. program in Biology is designed to prepare graduates for careers in the biological sciences, working in academia, industry, and government research labs.

Admission Requirements

In addition to the departmental graduate program admission requirements, students applying to the Ph.D. program in Biology must submit scores for the GRE subject test in Biology or Biochemistry/Cell/Molecular Biology. For applicants who hold only a bachelor’s degree in biology or a related discipline, entrance requirements will be closely followed. Students will normally be required to satisfy deficiencies of any courses typically required for the bachelor’s degree in biology or a related field. For applicants who hold a M.S. degree in Biology or a related discipline, entrance requirements may be more flexible (contact program director for details).

General and Course Requirements

The Doctor of Philosophy is a research degree granted for proven ability, independent investigation, and scholarly contribution in a specialized field. It is not granted solely on the completion of a certain number of credits. Dissertation research must involve original and creative work. Credits for the dissertation and research on which it is based should comprise a substantial portion of the program of study. In addition to the departmental graduate program core course requirements, students in the Ph.D. program in Biology are expected to have knowledge of cell & molecular biology, organismal biology, and ecology & evolution, through coursework or directed readings.

Incoming Ph.D. students are required to take a diagnostic examination to assess the breadth of his or her background in biological science, and to help plan the
Program of Study. The diagnostic exam must be completed in the student’s first semester (as part of BIOL 6690), is conducted by an exam committee appointed by the Chair of the Graduate Committee, and results in a diagnostic exam report. See the Biology Graduate Program website for guidelines and other information.

An advisory committee will guide each student in establishing his or her program of study based upon the student’s diagnostic exam report, background, and research interests. Formation of the advisory committee will occur in the student’s first semester. Typically, a full-time Ph.D. student on a departmental assistantship or fellowship will take 9 credit hours in fall and spring semesters and 1 credit hour in summer semesters, for a total of 75 credit hours for 4 years of study, including:

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</tr>
<tr>
<td>BIOL 6691</td>
<td>Seminar</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 6605</td>
<td>Biometry</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 6648</td>
<td>Graduate Problems</td>
<td>4 or more</td>
</tr>
<tr>
<td>BIOL 6692</td>
<td>Seminar</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 8850</td>
<td>Doctors Dissertation</td>
<td>1-12</td>
</tr>
</tbody>
</table>

Remaining credit hours will come from coursework at the graduate level (55xx or 66xx), the majority of which must be earned from the ISU Department of Biological Sciences. Courses, seminars, special projects, or readings assigned by the student’s advisory committee will provide mastery in appropriate core conceptual areas in the biological sciences (including genetics and evolution; anatomy and physiology of animals or plants; cell biology, biochemistry, & molecular biology; and ecology).

A Ph.D. student is encouraged to develop a minor that complements the student’s area of research. Minors must include 9 credits of coursework reflecting a common theme (e.g., biometry, microscopy, or a related field outside the biological sciences, such as geology, engineering, economics, or computer science). Ph.D. students who develop a minor in Biological Education will leverage the Doctor of Arts in Biology curriculum: The Biological Education minor consists of 4 credits of seminars (BIOL 6693 and/or BIOL 6694) and 5 credits of Supervised Teaching Internships (BIOL 7700). Students who pursue the minor in Biological Education are eligible for D.A. Fellowship support.

Research Requirements

A dissertation proposal defense must be completed no later than the student’s third semester (typically fall); a written proposal will be given to the advisory committee 1 week prior to a proposal seminar (presented to the department as part of BIOL 6691), to be followed by an oral proposal defense. The successful proposal defense will result in the development and submission of the final program of study to the graduate program director. Once the student has successfully defended the research proposal and completed a program of study, the student is advanced to candidacy and may sign up for BIOL 8850 (Doctor’s Dissertation).

By the end of the sixth semester (or whenever coursework described in the program of study is complete), a Ph.D. candidate must sit for a Comprehensive Exam, consisting of a written and an oral portion. The exam will reflect the student’s areas of research and other specific knowledge the student’s advisory committee determines is necessary to successfully address the student’s dissertation research.

A substantial, original research project is required, culminating in a written dissertation describing the research. The dissertation must demonstrate the student’s ability in independent investigation and must be a contribution to scientific knowledge. It must display mastery of the literature of the subject field and must demonstrate an organized, coherent development of ideas, with a clear exposition of results and a creative discussion of the conclusions. The dissertation examination requires a public presentation at a Biological Sciences department seminar, followed by a satisfactory oral defense to the advisory committee.

Additional details regarding the graduate timeline are available on the ISU Department of Biological Sciences website (https://www.isu.edu/bios).

Doctor of Arts (D.A.) in Biology

Goals and Program Description

The Doctor of Arts degree in Biological Sciences is granted for proven ability and scholarly attainment in biological science instruction. The program stresses preparation for undergraduate teaching at colleges and universities and the development of research abilities that complement instruction at the college level. The program is concerned with the development of the candidate as a biologist, a scholar, and a professional educator. The program is designed to provide the student with a broad background in the biological sciences, the ability to conduct and interpret research, and excellent pedagogical skills. All D.A. students are eligible for D.A. Fellowship support, which includes full tuition, benefits, and a stipend (contact the biology graduate programs director for details). All D.A. students must demonstrate:

1. A broad background in the biological sciences and an understanding of scientific inquiry;
2. The ability to synthesize concepts of biology and to effectively communicate these concepts;
3. The ability to conduct, analyze, and critique research in biological sciences and biological sciences instruction;
4. The ability to integrate current biological and educational research into their teaching;
5. Expertise with teaching strategies appropriate for a variety of teaching and learning environments, including undergraduate research;
6. A well-developed philosophy of education.

Admission Requirements

In addition to the departmental graduate program admission requirements, students applying to the D.A. in Biology program will normally have completed a master’s degree in biology or a related discipline prior to entrance into the program, and must submit scores for the GRE subject test in Biology or Biochemistry/Cell/Molecular Biology. If a student enters the program without having completed a master’s degree, he or she must complete this requirement in addition to the degree requirements or design and incorporate a biological research project as a major component of the dissertation project.

General and Course Requirements

Incoming D.A. students are required to take a diagnostic examination to assess the student’s potential to become an effective instructor by examining the depth of his or her background in biological science and communication skills, and to help plan the Program of Study. The diagnostic exam must be completed in the student’s first semester (as part of BIOL 6690), is conducted by an exam committee appointed by the Chair of the Graduate Committee, and results in a diagnostic exam report and a preliminary program of study. See the Biology Graduate Program website for guidelines and other information.

An advisory committee will guide each student in establishing his or her program of study based upon the student’s diagnostic exam report, background and research & teaching interests. Formation of the advisory committee will occur in the student’s first semester. Typically, a full-time D.A. student on a departmental assistantship or fellowship will take 9 credit hours in fall and spring semesters
and 1 credit hour in summer semesters, for a minimum of 48 credit hours beyond the master’s degree, including:

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<tr>
<th>Code</th>
<th>Title</th>
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<tr>
<td>BIOL 6691</td>
<td>Seminar</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 6690</td>
<td>Careers in Life Sciences</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 6605</td>
<td>Biometry</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 6648</td>
<td>Graduate Problems</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 6693</td>
<td>Seminar in College Teaching</td>
<td>2</td>
</tr>
<tr>
<td>BIOL 6694</td>
<td>Advanced Study in College Teaching</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 7700</td>
<td>Supervised Teaching Internship</td>
<td>1-9</td>
</tr>
<tr>
<td>BIOL 8850</td>
<td>Doctors Dissertation</td>
<td>1-12</td>
</tr>
</tbody>
</table>

Remaining credit hours will come from coursework at the graduate level (55xx or 66xx), the majority of which must be earned from the ISU Department of Biological Sciences. Courses, seminars, special projects, or readings assigned by the student’s advisory committee will provide mastery in core conceptual areas in the biological sciences, including genetics and evolution; anatomy and physiology of animals or plants; cell biology, biochemistry, or molecular biology; and ecology. All D.A. students are required to conduct supervised teaching internships (BIOL 7700), composed of rigorous, thoroughly planned pedagogical activities that provide an opportunity for development of skills in traditional and innovative teaching methods and for utilizing techniques, developed during the program (see Guidelines for Supervised Teaching Internships on the Biology Graduate Programs website).

**Research Requirements**

A dissertation proposal must be completed in the student’s third semester (typically fall); a written proposal will be given to the advisory committee 1 week prior to a proposal seminar (presented to the department as part of BIOL 6691), to be followed by an oral proposal defense (see the Biology Graduate Program website for guidelines and other information). Once the student has successfully defended the research proposal, the student is advanced to candidacy and may sign up for BIOL 8850 (Doctor’s Dissertation).

By the end of the sixth semester (or whenever coursework described in the program of study is complete), a D.A. candidate must sit for a Comprehensive Exam administered by the student’s advisory committee, and consist of a written and an oral portion. The exam will reflect core areas of biology, the topics covered in the education seminars, and other specific knowledge the committee determines is necessary to successfully address the student’s dissertation research.

A substantial, original research project is required, culminating in a written dissertation describing the research. The dissertation must demonstrate the student’s ability in independent investigation and must be a contribution to scientific knowledge. It must display mastery of the literature of the subject field and must demonstrate an organized, coherent development of ideas, with a clear exposition of results and a creative discussion of the conclusions. The dissertation examination requires and a public presentation at a Biological Sciences department seminar, followed by a satisfactory oral defense to the advisory committee.

Additional details regarding the graduate timeline are available on the ISU Department of Biological Sciences website (https://www.isu.edu/bios).

**Doctor of Philosophy (Ph.D.) in Microbiology**

**Goals and Program Description**

The Ph.D. in Microbiology is granted for proven ability, independent investigation, and scholarly attainment in a special field. The Ph.D. degree is a research-based academic degree that enhances transferable skills, such as critical reasoning, problem-solving, and in-depth analysis. Recipients may become professors in academia or gain positions in public health agencies and private industry (medical, food and beverage processing, biopharmaceutical, etc.). Other employment areas include biotechnology, patent law, or scientific publishing.

**Admission Requirements**

In addition to the Graduate School Admission requirements, acceptance into the Microbiology Ph.D. program requires:

- A suitable faculty advisor
- GPA of 3.0 or above for all upper division course credits taken in the last degree-earning program
- Competitive GRE General Test scores (verbal and quantitative sections in the 40th percentile or higher and analytical writing score of at least 3.5)
- Applicants who hold only a B.S. degree require a GPA of 3.0 or above in all undergraduate coursework and GRE General Test scores in the 50th percentile or higher for verbal and quantitative sections

The following course work is also recommended for applicants applying to the Microbiology Ph.D. program:

- 1 year of General Biology (+lab)
- 1 year of General Chemistry (+lab)
- 1 year of Organic Chemistry (+lab)
- 1 year of Physics (+lab)
- 1 semester of Calculus (Calculus through Multivariable Calculus recommended)
- 1 semester of Quantitative Analysis, Analytical Chemistry, or Inorganic Chemistry (+lab)
- 1 semester of Statistics
- General Microbiology (+lab)
- Genetics (lab recommended)

If either the GPA or GRE requirement is not met, the Biological Sciences Graduate Programs Committee may choose to admit the candidate to "Classified (with performance requirements)” status. Applicants admitted as "Classified (with performance requirements)” status will be required to rectify any deficiencies as determined by the student’s Advisory Committee.

Students in the Microbiology or Biology M.S. program may be permitted to change to the Microbiology Ph.D. program with approval of the Biological Sciences Graduate Program Committee and ISU Graduate School. Application for change must include: a letter from the student that provides a rationale for the status change and a letter of support from the research advisor.

**General and Course Requirements**

The intent of the Microbiology Ph.D. program is to produce scientists with a broad background in the major sub-disciplines of Microbiology, while ensuring focused study in their major field of interest. The student's Graduate Advisory Committee will direct the student to specific course offerings within the Department and University to satisfy graduate-level coursework guidelines. Training in our Microbiology Ph.D. program is based on a strong foundation
in Mathematics, Chemistry, Genetics, Molecular Biology, and Biochemistry in
addition to extensive coursework offered in three core areas of Microbiology:

- Biochemistry, Genetics, Molecular Biology, and Physiology of
  Microorganisms
- Immunology, Virology, and Medical Microbiology
- Microbial Ecology and Applied, Industrial, and Environmental Microbiology

A minimum of 42 credits in graduate-level coursework, including at least 15
credits earned at the 6600 level, are required for graduation.

### Biology Core Course Requirements

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<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>BIOL 6690</td>
<td>Careers in Life Sciences (fall semester of first year)</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 6605</td>
<td>Biometry (spring semester)</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 6691</td>
<td>Seminar (third semester)</td>
<td>1</td>
</tr>
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### Microbiology Course Requirement

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 6648</td>
<td>Graduate Problems</td>
<td>9</td>
</tr>
<tr>
<td>BIOL 6695</td>
<td>Seminar in Microbiology</td>
<td>6</td>
</tr>
<tr>
<td>BIOL 8850</td>
<td>Doctors Dissertation</td>
<td>6</td>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Advisory Committee recommended courses</td>
<td>15</td>
</tr>
</tbody>
</table>

* Candidates who have already received an M.S. degree may transfer 9 credits of
graduate-level work, providing a grade of “B” or higher was earned. Transfer of
credit is subject to approval by the Graduate Programs Committee.

* Incoming Ph.D. students are required to take a diagnostic assessment to
evaluate the breadth of their knowledge within multiple biological science
disciplines, and to help plan their Program of Study. The diagnostic assessment
must be completed in the student’s first semester as part of BIOL 6690.

### Research Requirements

During the third semester, the student will submit and present a research proposal
in a public forum as part of BIOL 6691. Immediately following the proposal
seminar, the student will defend the research proposal in closed session with her/
his Advisory Committee.

A Comprehensive Examination will be administered, with the student’s Advisory
Committee’s approval, following successful defense of the research proposal
(no later than the fifth semester or equivalent). This examination is intended
to test the student’s breadth of knowledge in relevant sub-disciplines within
the field of Microbiology that pertain to the proposed research project and is
designed to determine if the student is qualified for advancement to candidacy
for the Ph.D. degree. It will be administered during a closed session and it will
consist of a written and an oral portion. There are four potential outcomes of the
Comprehensive Examination:

1. Pass: Student is advanced to candidacy for the Ph.D. degree.
2. Conditional pass: Student is advanced to candidacy for the Ph.D. degree
   contingent on recommendations put forth by the Advisory Committee.
   Failure to successfully complete the requirements set forth by the committee
   by the stated deadline will result in Deferral.
3. Defer program: Student will transfer from the Microbiology Ph.D. program
to the Microbiology M.S. program.
4. Fail: Student will be dismissed from the program completely.

The Ph.D. in Microbiology degree will culminate when the candidate submits a
written dissertation embodying the results of original and creative research. The
dissertation must demonstrate the student’s ability to understand and evaluate
current literature, to design and independently investigate, and to articulate
science in a coherent manner to others. The dissertation requires the candidate to
defend her/his research findings in a public forum, followed by a satisfactory oral
exam conducted by her/his Advisory Committee. A meeting with the candidate’s
Advisory Committee should take place approximately 6 months before the
anticipated public defense date to ensure approval and completion of the Final
Program of Study.

### Master of Science (M.S.) in Biology

#### Goals and Program Description

The Master of Science (M.S.) in Biology degree is designed to enable students to
develop an advanced understanding of the biological sciences and the capability
to teach or conduct biological research. Programs are flexible and can be tailored
to satisfy the professional and goals of each student, preparing students for
careers in industry or for advanced study in the life and health sciences.

#### Admission Requirements

Students must meet departmental graduate program admission requirements.
Students will normally be required to satisfy deficiencies of any courses typically
required for a bachelor’s degree in biology or a related field.

#### General and Course Requirements

Incoming M.S. students are required to take a diagnostic examination to assess
the depth of their background in biological science, and to help plan the Program
of Study. The diagnostic exam must be completed in the student’s first semester
(as part of BIOL 6690), is conducted by an exam committee appointed by the
Chair of the Graduate Committee, and results in a diagnostic exam report. See the
Biology Graduate Program website for guidelines and other information.

An advisory committee will guide each student in establishing his or her program
of study based upon the student’s diagnostic exam report, background, and
research interests. Formation of the advisory committee will occur in the
student’s first semester. A minimum of 30 credit hours is required for graduation,
including at least 16 credits earned at the 6600 level in biology. In addition to
the courses required for all biology graduate students, M.S. students are required to
take the following courses:

- BIOL 6648 Graduate Problems (4 credit hours)
- BIOL 6650 Thesis (6 credit hours)
- BIOL 6692 Graduate Seminar (1 credit hours)

The remaining 14 credits may be earned at the 5500 or 6600 level, of which eight
credits may come from a related discipline. Courses, seminars, special projects,
or readings assigned by the student’s advisory committee will provide mastery in
core conceptual areas in the biological sciences, including genetics and evolution;
anatomy and physiology of animals or plants; cell biology, biochemistry, or
molecular biology; and ecology. Students are encouraged to develop a research
tool, which can be accomplished by taking classes in biometry, microscopy,
or a related field outside the biological sciences, such as geology, engineering,
economics, or computer science.

#### Research Requirements

A substantial, original research project is required, culminating in a written thesis
and oral presentation of the findings at a Biological Sciences department seminar.
A thesis proposal must be completed in the student’s second semester (typically
spring); a written proposal will be given to the advisory committee 1 week prior
to a proposal seminar (presented to the department as part of BIOL 6691), to be
followed by a proposal defense. The successful proposal defense will result in
the development and submission of a program of study to the program director. Graduate students may not sign up for BIOL 6650 (Thesis) until their thesis proposal has been presented to the department and approved by their advisory committee.

Following completion of an original thesis research project and written thesis, the student will present his or her research findings in a seminar presented to the department and followed by a satisfactory oral defense to the advisory committee.

Additional details regarding the graduate timeline and procedures are available on the ISU Department of Biological Sciences website (https://www.isu.edu/bios).

**Master of Science (M.S.) in Microbiology**

**Goals and Program Description**

The M.S. in Microbiology program aims to provide students an advanced understanding in microbiology, to promote technical competence in the fundamentals of research, and to foster creative and independent thinking. This degree prepares students to enter into advanced degree programs in Microbiology or other health-related fields or to compete successfully for employment in academia, industry, or government.

**Admission Requirements**

In addition to the Graduate School Admission requirements for other programs, acceptance into the Microbiology M.S. program requires:

- A suitable faculty advisor
- GPA of 3.0 or above for all upper division course credits taken in the last degree-earning program
- Competitive GRE General Test scores (verbal and quantitative sections in the 40th percentile or higher and analytical writing score of at least 3.5)

The following course work is also recommended for applicants applying to the Microbiology M.S. program:

- 1 year of General Biology (+lab)
- 1 year of General Chemistry (+lab)
- 1 year of Organic Chemistry (+lab)
- 1 year of Physics (+lab)
- 1 semester of Calculus (Calculus through Multivariable Calculus recommended)
- 1 semester of Quantitative Analysis, Analytical Chemistry, or Inorganic Chemistry (+lab)
- 1 semester of Statistics
- General Microbiology (+lab)
- Genetics (lab recommended)

If either the GPA or GRE requirement is not met, the Biological Sciences Graduate Programs Committee may choose to admit the candidate to "Classified (with performance requirements)" status. Applicants admitted as "Classified (with performance requirements)" status will be required to rectify any deficiencies as determined by the student's Advisory Committee.

**General and Course Requirements**

Incoming M.S. candidates are required to take a diagnostic assessment to evaluate the breadth of their knowledge within multiple biological science disciplines, and to help plan their Program of Study. The diagnostic assessment must be completed in the candidate's first semester as part of BIOL 6690.

An advisory committee, selected by the candidate in the first semester, will further guide the student in establishing a program of study based on the candidate's diagnostic assessment report, educational background, and research interests.

A minimum of 30 credits in graduate coursework, including at least 15 credits earned at the 6600 level, is required for graduation.

**Biology Core Course Requirements**

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<tr>
<td>BIOL 6605</td>
<td>Biometry (spring semester)</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 6691</td>
<td>Seminar (second semester for M.S. students; third semester for doctoral students)</td>
<td>1</td>
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</table>

**Microbiology Course Requirements**

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<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
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<tr>
<td>BIOL 6648</td>
<td>Graduate Problems</td>
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</tr>
<tr>
<td>BIOL 6650</td>
<td>Thesis</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 6695</td>
<td>Seminar in Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>Other course work</td>
<td></td>
<td>15</td>
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<td>*BIOL 6648 and BIOL 6650 may be repeated for a total of 9 and 6 credits, respectively.</td>
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</table>

**Research Requirements**

During the second semester, the candidate will submit and present a research proposal in a public forum as part of BIOL 6691. Immediately following the proposal seminar, the candidate will defend the research proposal in closed session with the Advisory Committee.

The M.S. in Microbiology degree will culminate when the candidate submits a written thesis embodying the results of original and creative research. The thesis must demonstrate the candidate's ability to understand and evaluate current literature within microbiology, to design experiments and conduct original research, and to interpret results and articulate them in a coherent manner. Following completion of the written thesis, the candidate will present her/his research findings in a public forum, followed by a satisfactory oral exam conducted by their Advisory Committee.

**Bachelor of Science/Master of Science**

The goal of this option is to allow academically strong students to begin work towards an M.S. degree after completing the Junior year. This will allow students to complete an M.S. degree, as well as a B.S. degree, with only one additional year in school. This option is only available to students who have demonstrated an interest in independent research before the end of the Junior year, who can meet the Biological Sciences GPA and GRE requirements for admission to the M.S. program, and who have worked with a member of the Graduate Faculty who has agreed to serve as the student’s Graduate Advisor. After being accepted into the M.S. program, students who pursue this option will have to spend at least two summers doing research and/or coursework. Given its compressed timeline and academic intensity, this option is only available to students who have demonstrated a high level of academic ability.

The student will be required to complete all of the graduation requirements for a B.S. degree in the Department of Biological Sciences. That degree will be awarded when those requirements are met, typically at the end of the 4th year. In
The student will be admitted Classified with Performance Requirements (w/PR) to the MS Program after completing the Junior year. Admission requires that the student meet the existing GPA requirement (at least 3.0 for the Sophomore and Junior years).

The M.S. degree will be awarded only after the student has completed all of the requirements for the M.S. program.

**Requirements**

These requirements are for undergraduate students admitted to the BS/MS Option ONLY. BS/MS students are restricted to a maximum of six graduate-level credits until after completion of the B.S. degree.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tr>
<td>BIOL 5581</td>
<td>Independent Problems</td>
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Other undergraduate and graduate credits, as required by the Department of Biological Sciences.

**Courses**

**BIOL 5500 Oral Histology and Embryology: 3 semester hours.**
The micro-anatomy and formative processes of the teeth and their surrounding structures. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5500L.

**BIOL 5500L Oral Histology and Embryology Lab: 0 semester hours.**
Assignments to apply principles from BIOL 5500. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5500L.

**BIOL 5504 Plant Physiology: 3 semester hours.**
Study of plant physiological processes including water relations, mineral nutrition, photosynthesis, respiration, translocation of photosynthate, secondary compounds and phytohormones. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5504L Plant Physiology Lab: 1 semester hour.**
Assignments to apply principles from BIOL 5504. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5505 Plant Form and Function: 3 semester hours.**
Integrated studies of anatomical and physiological adaptations of plants to their natural environment. Data collection and analysis will be emphasized. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5505L.

**BIOL 5505L Plant Form and Function Lab: 1 semester hour.**
Assignments to apply principles from BIOL 5505. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5506 Plant Diversity and Evolution: 4 semester hours.**
Study of the reproduction, structure, development, evolution, and classification of the fungi, algae, bryophytes, and vascular plants. Lectures, laboratories. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5506L.

**BIOL 5506L Plant Diversity and Evolution Lab: 0 semester hours.**
Assignments to apply principles from BIOL 5506. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5506L.

**BIOL 5508 Plant Ecology: 3 semester hours.**
Major factors limiting plant growth and distribution with emphasis on adaptation and response at the individual, population, and community levels. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5508L Plant Ecology Lab: 1 semester hour.**
Assignments to apply principles from BIOL 5508. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5512 Systematic Botany: 4 semester hours.**
Study of classification and evolution of flowering plants; techniques of phylogeny reconstruction based on molecular and morphological characters. Collection/identification of local flora. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5512L.

**BIOL 5512L Systematic Botany Lab: 0 semester hours.**
Assignments to apply principles from BIOL 5512. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5512L.

**BIOL 5513 Biology Teaching Methods: 3 semester hours.**
Planning, teaching and evaluating teaching activities. Practical experience in methods used in science classrooms and enhancing professional development. Required for secondary education major in biology. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: 16 credit-hours of Biology, or permission of instructor.

**BIOL 5514 Graduate Teaching Assistant Seminar: 2 semester hours.**
Introduction to college science teaching, with an emphasis on inquiry-based methods in the laboratory setting. Topics include how people learn, classroom management, professional ethics, peer evaluation of teaching. Required for all new graduate Teaching Assistants. Graded S/U. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5515L Human Neurobiology Lab: 1 semester hour.**
Detailed examination of the gross anatomy and pathways of the human central nervous system. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.

**BIOL 5516 Population Ecology: 3 semester hours.**
Introduces quantitative analysis of populations and communities, emphasizing demography, distribution, abundance, spatial and temporal dynamics, biodiversity, coexistence, and applications to conservation and land use decision-making. Includes data collection and analysis. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5516L. PREREQ: BIOL 2209.

**BIOL 5516L Population Ecology Lab: 1 semester hour.**
Assignments to apply principles from BIOL 5516. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5516L. PREREQ: BIOL 2209.

**BIOL 5517 Organic Evolution: 3 semester hours.**
An integrated study of evolution as a unifying concept in biology. An examination of patterns and processes that affect the origin and diversification of species through time. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.
BIOL 5518 Ecological Topics: 1 semester hour.
Flexible use of seminars, lectures, and laboratory/field work dealing with current issues in ecology. Topic/emphasis varies. May be repeated until a maximum of 3 credits is earned. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5519 Mammalian Histology: 4 semester hours.
Study of human animal tissues, including structural and functional characteristics of tissues and organs. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5519L.

BIOL 5519L Mammalian Histology Lab: 0 semester hours.
Assignments to apply principles from BIOL 5519. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5519.

BIOL 5520 Musculo-Skeletal Anatomy: 2 semester hours.
Study of human body structure emphasizing muscular system and its relationship to axial and appendicular skeleton. Focus on extremities, thorax, and pelvis with applications toward normal, diseased and rehabilitative functions. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5521 Ecological Concepts: 3 semester hours.
Major concepts in ecology in relation to environmental degradation, pollution, hazardous materials, and environmental management. Credit may not be used for a graduate degree in biology. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5523 General Parasitology: 3 semester hours.
Student of parasitic symbiBiologies of animals, plants and other organisms focusing on concepts, principles, and consequences of such interactions and the coevolutionary processes by which they are created. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5526 Herpetology: 3 semester hours.
The biology of amphibians and reptiles: lecture topics include evolutionary history, functional morphology, physiological ecology, biogeography, reproductive, and population ecology. Laboratories and field trips cover systematic, natural history, and collecting/sampling techniques. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5526L.

BIOL 5526L Herpetology Lab: 1 semester hour.
Assignments to apply principles from BIOL 5526. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5526.

BIOL 5527 Ichthyology: 3 semester hours.
The biology of fishes; lecture topics include evolutionary history, functional morphology, physiological ecology, and biogeography. Laboratory and weekend field trips cover identification, life history and collecting techniques. Emphasis on Idaho species. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5527L.

BIOL 5527L Ichthyology Lab: 1 semester hour.
Assignments to apply principles from BIOL 5527. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5527.

BIOL 5528 Medical Parasitology and Entomology: 3 semester hours.
Study of animal parasites, with an emphasis on protozoa, helminths and arthropods affecting human health and welfare by their presence or indirectly via pathogens they transmit. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5528L.

BIOL 5528L Medical Parasitology and Entomology Lab: 0 semester hours.
Assignments to apply principles from BIOL 5528. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5528.

BIOL 5529 Regional Anatomy and Histology: 4 semester hours.
Regional approach to gross human anatomy emphasizing the use of prospected materials and microscopic anatomy. Designed primarily for students in the Physician Assistant Program. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5529L.

BIOL 5529L Regional Anatomy and Histology Lab: 0 semester hours.
Assignments to apply principles from BIOL 5529. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5529.

BIOL 5531 General Entomology: 3 semester hours.
Study of structure, development, classification, and life histories of insects, including ecological, economic and management considerations. An insect collection may be required. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5531L.

BIOL 5531L General Entomology Lab: 1 semester hour.
Assignments to apply principles from BIOL 5531. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5531.

BIOL 5532 Biochemistry: 3 semester hours.
Comprehensive discussion/presentation of structure, function and metabolism of biological macromolecules and their constituents, including energetics, regulation, and molecular biology, with emphasis on critical analysis of biochemical issues. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Organic Chemistry or Introduction to Biology or permission of instructor.

BIOL 5533 Microbial Physiology: 3 semester hours.
Comparative physiology of microorganisms, including structure/function, metabolic diversity, enzyme mechanisms of microbial metabolism, and physiology of extreme organisms. Lectures, Class Exercises. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5533L. PREREQ: Microbiology and Bio-chemistry or permission of instructor.

BIOL 5533L Microbial Physiology Lab: 1 semester hour.
Laboratory exercises in comparative physiology of microorganisms. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5533.

BIOL 5534L Microbial Diversity Lab: 1 semester hour.
Enrichment, cultivation and isolation of prokaryotes from various metabolic groups and environments. Microorganisms will be identified using classical microbial techniques and modern molecular methodologies. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5534L. PREREQ: Microbiology and BIOL 5533 or permission of instructor.

BIOL 5534 Microbial Diversity: 3 semester hours.
Enrichment, cultivation and isolation of prokaryotes from various metabolic groups and environments. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5534.

BIOL 5535 Vertebrate Paleontology: 4 semester hours.
Phylogenetic history of the vertebrates outlined in the light of morphology, classification, evolution, paleoecology, and the significance of fossils. Field trips. Equivalent to GEOL 5535. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: GEOL 5531 or BIOL 3314 or equivalent.
BIOL 5537 Experimental Biochemistry: 1 semester hour.
Laboratory course including both qualitative and quantitative experiments. Equivalent to CHEM 5538. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ or COREQ: BIOL 5532 or BIOL/CHEM 5545.

BIOL 5538 Ornithology: 4 semester hours.
Study of the origin, evolution, structure, habits, adaptations, distribution, and classification of birds. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5539 Principles of Taphonomy: 3 semester hours.
Effects of processes which modify organisms between death and the time the usually fossilized remains are studied. Emphasis on vertebrates. Equivalent to ANTH 5539 and GEOL 5539. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.

BIOL 5540 Human Gross Anatomy: 4 semester hours.
Comprehensive regional study of gross human anatomy with emphasis on the upper limb, thorax, abdomen, pelvis and perineum. Designed for the first year dental students and complements BIOL 5550. Lecture and laboratory. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5540L.

BIOL 5540L Human Gross Anatomy Lab: 0 semester hours.
Assignments to apply principles from BIOL 5540. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5540.

BIOL 5541 Mammalogy: 3 semester hours.
General study of mammals including classification, identification, habits, ecology, economics, and techniques of study, with emphasis on North American forms. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5541L.

BIOL 5541L Mammalogy Lab: 1 semester hour.
Assignments to apply principles from BIOL 5541. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5541.

BIOL 5542 Plant-Animal Interactions: 3 semester hours.
Coevolution of plant and animal form and function emphasizing pollination, herbivory, parasitism, frugivory/seed dispersal, and optimal foraging. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5543 Endocrinology: 3 semester hours.
Study of the anatomy and physiology of the ductless glands and the properties and uses of natural and synthetic hormones. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5544 Cell and Molecular Biology: 4 semester hours.
Fundamental principles of molecular biology: DNA replication, repair, and recombination, transcriptional and post-transcriptional regulation of gene expression, RNA metabolism, protein synthesis, targeting and turnover, post-translational modifications, signal transduction, regulation of the cell division cycle, and molecular genetics of development. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Introductory Biology and Organic Chemistry. COREQ: BIOL 5544L.

BIOL 5544L Cell and Molecular Biology Lab: 1 semester hour.
Laboratory techniques in molecular biology, including cloning, PCR and DNA sequencing. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5544.

BIOL 5545 Biochemistry I: 3 semester hours.
Introduction to basic aspects of biochemical systems, including fundamental chemical and physical properties of biomolecules. Enzymology including allosterism, metabolic regulation, bioenergetics, and carbohydrate metabolism. Equivalent to CHEM 5545. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Introduction to Biology and Organic Chemistry or permission of instructor.

BIOL 5546 Advanced Experimental Biochemistry: 2 semester hours.
Advanced laboratory projects designed to emphasize techniques of qualitative and quantitative biochemical analysis. Equivalent to CHEM 5548. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: BIOL/CHEM 5545.

BIOL 5547 Biochemistry II: 3 semester hours.
Continuation of BIOL 5545. Lipid, amino acid and nucleotide metabolism. Emphasis is on metabolic regulation, metabolic dysfunction, biochemical mechanism of hormone action, biochemical genetics, protein synthesis, and metabolic consequences of genetic defects. Equivalent to CHEM 5547. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: BIOL/CHEM 5545.

BIOL 5548 Human Physiology I: 4 semester hours.
First of a two-course sequence. Physiology of the nervous, muscular, circulatory, respiratory, and excretory systems. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5550.

BIOL 5550 Head and Neck Anatomy: 4 semester hours.
Comprehensive presentation of the anatomy of the head and neck as it applies to the practice of dentistry. Lecture and laboratory. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5550L.

BIOL 5550L Head and Neck Anatomy Lab: 0 semester hours.
Assignments to apply principles from BIOL 5550. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5550.

BIOL 5551 Immunology: 3 semester hours.
Fundamental concepts of antibody-mediated and cell-mediated mechanisms of immunity. In-vivo and in vitro antigen-antibody interactions are discussed. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Microbiology or permission of instructor.

BIOL 5551L Immunology Laboratory: 1 semester hour.
Selected laboratory experiments to accompany BIOL 5551 Immunology. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. Open to non-majors by special permission. PREREQ or COREQ: BIOL 5551.

BIOL 5553 Foundations in Neuroscience: 3 semester hours.
Organizing principles in neuroscience including biological signaling of excitable cells, neuroanatomy and regional brain functions, and sensorimotor integration of behavior. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.
**BIOL 5554 Advanced Immunology: 3 semester hours.**
Detailed study of selected areas of immunobiology. Course content will vary with current demand. Students will lead discussions and present current literature. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: BIOL 5551 and permission of instructor.

**BIOL 5555 Pathogenic Microbiology: 3 semester hours.**
How the medically important bacteria, viruses and fungi interact with the host to produce disease, including microbe characteristics, pathogenesis, pathological processes, prevention, and treatment methods. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Microbiology or permission of instructor.

**BIOL 5555L Pathogenic Microbiology Laboratory: 2 semester hours.**
Will emphasize procedures for the isolation and identification of pathogenic bacteria. Clinical specimens will be provided for use in identification of unknowns. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ or COREQ: BIOL 5555.

**BIOL 5556 Human Physiology II: 4 semester hours.**
Physiology of gastrointestinal, endocrine, and reproductive systems. Includes studies of acid-base balance, peripheral circulation, shock, and temperature regulation. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: BIOL 5549 or equivalent.

**BIOL 5559 Fish Ecology: 3 semester hours.**
Study of the behavior, habitat use, population dynamics, and management of freshwater fishes, especially salmon and trout. Laboratory and weekend field trips emphasize sampling techniques and data analysis. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: BIOL 5559L. PREREQ: BIOL 5527.

**BIOL 5559L Fish Ecology Lab: 1 semester hour.**
Assignments to apply principles from BIOL 5559. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5559. PREREQ: BIOL 5527.

**BIOL 5560 Neuroscience: 4 semester hours.**
Comprehensive presentation of the anatomy of the central nervous system, the brain and spinal cord. Combined lecture and laboratory demonstration. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.

**BIOL 5560L Neuroscience Lab: 1 semester hour.**
Detailed examination of the gross anatomy and pathways of the human central nervous system. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.

**BIOL 5561 Advanced Genetics: 3 semester hours.**
Detailed and critical consideration of selected genetic topics with emphasis of recent advances. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.

**BIOL 5562 Freshwater Ecology: 3 semester hours.**
Study of the interaction of physical and biotic factors in aquatic communities. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5562L.

**BIOL 5562L Freshwater Ecology Lab: 1 semester hour.**
Assignments to apply principles from BIOL 5562. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5562.

**BIOL 5563 Human Pathophysiology: 4 semester hours.**
The study of basic processes underlying diseases with an emphasis on correlating anatomical, functional, and biochemical alterations with clinical manifestations. Laboratory required. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5563L.

**BIOL 5563L Human Pathophysiology Lab: 0 semester hours.**
Assignments to apply principles from BIOL 5563. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5563.

**BIOL 5564 Lectures in Human Physiology: 4 semester hours.**
Physiology of the nervous, muscular, circulatory, respiratory, and excretory systems. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5566 Medical Mycology: 3 semester hours.**
Lecture/Laboratory course addressing medically important fungi. Taxonomy, clinical disease, pathogenesis, immunological diagnosis and laboratory identification of contaminants, opportunists, superficial, cutaneous, subcutaneous and systemic mycoses. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5568 Oral Microbiology: 1 semester hour.**
Study of microbiology of plaque, caries, periodontal disease, immunobiology of oral disease and control of microorganisms with antimicrobial agents. Four periods devoted to laboratory study of medically important oral microbes. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ or PREREQ: BIOL 5555.

**BIOL 5569 Special Topics in Microbiology: 1-4 semester hours.**
Study of selected topics in microbiology. Course contents will vary with topics selected. May be repeated with departmental approval for non-repetitive course content. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.

**BIOL 5570 Cross-Sectional Anatomy: 2 semester hours.**
Applied regional anatomy as viewed in sectional planes, emphasizing topographic relationships of organs and surface anatomy, with interpretation of correlated CT and MRI imaging. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5571 Biological Imaging: 3 semester hours.**
Microscopy with an emphasis on image formation, documentation, interpretation and analysis relevant to experimental applications in the biological sciences. Lecture and laboratory with independent research component. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

**BIOL 5573 Applied and Environmental Microbiology: 3 semester hours.**
Concepts in applied microbiology and microbial ecology, including fermentation, biotechnology, and ecophysiology. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5573L.

**BIOL 5573L Applied and Environmental Microbiology Lab: 1 semester hour.**
Laboratory exercises in applied and environmental microbiology. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5573.

**BIOL 5574 Human Anatomy-Occupational Therapy and Physical Therapy: 5 semester hours.**
Applied regional anatomy emphasizing the development, histology and gross anatomy of the musculoskeletal, peripheral nervous, and cardiopulmonary systems. Includes laboratory with cadaver dissection. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor. COREQ: BIOL 5574L.

**BIOL 5574L Human Anatomy-Occupational Therapy and Physical Therapy Lab: 0 semester hours.**
Assignments to apply principles from BIOL 5574. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5574.
BIOL 5575 General Virology: 3 semester hours.
Introduction to the general principles of virology through consideration of structure, genetics, replication, and biochemistry of animal and bacterial viruses. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5577 Bacterial Virology Laboratory: 1 semester hour.
Designed to acquaint students with the techniques and experimental principles used in the study of bacterial viruses. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5575.

BIOL 5578 Animal Virology Laboratory: 1 semester hour.
Introduces tissue culture methods and other techniques employed in the study of animal viruses. Must be accompanied by BIOL 5575. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5580 Mentored Research Alliance: 2 semester hours.
Discovery research in life sciences conducted in a cooperative learning community that includes mentoring undergraduates. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. May be repeated. PREREQ: Permission of the instructor.

BIOL 5581 Independent Problems: 1-4 semester hours.
Individual problems will be assigned to students on the basis of interest and previous preparation. May be repeated. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: A minimum of two courses in Biological Sciences and permission of instructor.

BIOL 5582 Independent Problems: 1-4 semester hours.
Individual problems will be assigned to students on the basis of interest and previous preparation. May be repeated. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: A minimum of two courses in Biological Sciences and permission of instructor.

BIOL 5586 Human Systemic Physiology: 5 semester hours.
One semester human physiology course emphasizing the function and regulation of the muscular, skeletal, circulatory, respiratory, urinaiy, reproductive, and immune systems. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5586L.

BIOL 5586L Human Systemic Physiology Lab: 0 semester hours.
Assignments to apply principles from BIOL 5586. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5586.

BIOL 5588 Advanced Radiobiology: 3 semester hours.
An advanced-level class covering aspects of molecular radiobiology, teratogenesis, oncogenesis, and acute radiation illnesses. It also considers nonstochastic radiation effects and the epidemiology of radiation exposures. Equivalent to HPHY 5588. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. PREREQ: Permission of instructor.

BIOL 5589 Field Ecology: 4 semester hours.
An intensive field of study of at least one biogeographical region to increase students' knowledge of and skill with field sampling techniques, field-study design, data collection and analysis, and report preparation. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5590 Ecosystem Ecology and Global Change: 4 semester hours.
Examination of the structure and function of ecosystems and their responses to natural and anthropogenic changes emphasizing energy, water, carbon, and nitrogen cycling. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5595 Animal Behavior: 4 semester hours.
Behavior of animals and the evolutionary mechanisms that dictate behavioral patterns. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5598P Prof Development Workshop: 3 semester hours.
New methods and opportunities to enhance and supplement skills. Subject to the approval of the Dean of the student's college, a maximum of eight credits earned in workshops may be applied toward a degree; students taking the courses only for personal development may choose the 0-credit option; those seeking professional development must choose a for-credit option. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5599 Experimental Course: 1-6 semester hours.
This is an experimental course. The course title and number of credits are noted by course section and announced in the class schedule by the scheduling department. Experimental courses may be offered no more than three times. May be repeated. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 6601 Advanced Animal Behavior: 3 semester hours.
Behavior and social organization of animals with particular attention to the vertebrates. Lecture, laboratory, and field work. PREREQ: Graduate standing and permission of department.

BIOL 6602 Advanced Plant Physiology: 3 semester hours.
Study of interrelationships of soil, water, and minerals in the nutrition of plants. PREREQ: BIOL 5504.

BIOL 6603 Comparative Physiology: 3 semester hours.
Study of the ways in which organisms meet their functional requirements. Lecture and laboratory. PREREQ: Permission of department.

BIOL 6604 Advanced Ecology of Streams and Rivers: 3 semester hours.
Study of the ecology of streams; chemical, physical, and geological aspects in relation to biota. The production of organic matter in flowing water is emphasized, including the tracing of food chains and food webs and the construction of energy budgets. Field trips. PREREQ: Permission of instructor.

BIOL 6605 Biometry: 4 semester hours.
Application of descriptive and analytical statistical methods to experimental design and biological research.

BIOL 6606 Scientific Writing: 3 semester hours.
Review of basic principles of grammar, organization, style, and persuasive argument as applied to specific areas of scientific writing. Each student will write proposals, technical reports and review manuscripts, and reviews of proposals and manuscripts.

BIOL 6607 Environmental Physiology: 3 semester hours.
Study of the physiological mechanisms and interrelated behavioral patterns by which animals respond to environmental factors. PREREQ: Graduate standing and permission of instructor.

BIOL 6608 Stable Isotopes in Environmental Science: 4 semester hours.
Theory and use of stable isotopes in natural sciences, with an emphasis towards the fields of ecology, geology and archeology. Basic principles of stable isotope analysis and applications towards understanding cycles of C, N, S and water, food web analysis, and paleoclimate. Individual student laboratory projects developed and carried out.

BIOL 6610 Principles of Molecular Biology: 3 semester hours.
Introduction to subcellular biology and molecular genetics. DNA replication, cell division, the genetic code, transcription, translation, enzyme function, and control mechanisms in procaryotic and eucaryotic cells. PREREQ or COREQ: BIOL 5532.
Biol 6613 Biogeography: 3 semester hours.
Discussion of patterns of distribution of species and their historical and ecological causes. Includes research project.

Biol 6614 Evolutionary Ecology: 3 semester hours.
Evolutionary theory applied to ecological processes, including selection theory, ecological genetics, life-history evolution and coevolution. PREREQ: Biol 5517.

Biol 6616 Advanced Community Ecology: 4 semester hours.
Historical and contemporary concepts and methods in community ecology and its interface with other fields, including molecular biology, informatics, conservation, social sciences, and landscape and ecosystem ecology. Emphasizes quantitative models and data analysis.

Biol 6621 Advanced Methods in Microbiology: 3 semester hours.
PREREQ: Graduate standing and permission of instructor.

Biol 6623 Soil and Ground Water Bioremediation: 3 semester hours.
Theoretical and applied aspects of biological treatment for contaminated subsurface systems.

Biol 6624 Microbial Ecology: 3 semester hours.
Ecological principles applied to microorganisms. PREREQ: Course in Microbiology.

Biol 6628 Cytology and Cell Physiology: 4 semester hours.
Advanced study of the functions and structural components of cells. Lecture and laboratory. PREREQ: Permission of instructor.

Biol 6629 Basic Concepts in Biology: 3 semester hours.
Considerations of fundamental concepts of biology, their origin and development. PREREQ: Permission of the instructor.

Biol 6631 Advanced Systematic Botany: 3 semester hours.
Classification of plants as it rests on morphological, chemical, ecological, and genetic bases. PREREQ: Biol 5512.

Biol 6632 Advanced Systematic Botany: 3 semester hours.
Classification of plants as it rests on morphological, chemical, ecological, and genetic bases. PREREQ: Biol 5512.

Biol 6633 Advanced Microbial Physiology: 3 semester hours.
Advanced topics in microbial physiology and biochemistry. PREREQ: Biol 5532 and permission of instructor.

Biol 6634 Intermediary Metabolism: 3 semester hours.
Theory, reactions, and methods pertinent to research in intermediary metabolism. PREREQ: Biol 5532 and permission of instructor.

Biol 6636 Experimental Intermediary Metabolism: 2 semester hours.
Must be accompanied by or preceded by Biol 6634.

Biol 6641 Adv Topics in Immunology: 1-4 semester hours.
Current research and practice in immunology and immunohematology (transfusion medicine) including molecular approach to diagnosis and treatment. May be repeated for a maximum of 4 credits.

Biol 6648 Graduate Problems: 1-9 semester hours.
Thesis related research. May be repeated. Graded S/U. PREREQ: Graduate standing and permission of instructor.

Biol 6650 Thesis: 1-6 semester hours.
1 to 6 credits. May be repeated. Graded S/U.

Biol 6651 Advanced Studies in Ecology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with ecological relationships. May be repeated.

Biol 6652 Advanced Studies in Physiology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in physiology. May be repeated.

Flexible use of seminars, lectures, and laboratory work dealing with problems in vertebrate zoology. May be repeated.

Biol 6654 Advanced Studies in Invertebrate Zoology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in invertebrate zoology. May be repeated.

Biol 6655 Advanced Studies in Vertebrate Paleontology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in vertebrate paleontology. May be repeated.

Biol 6656 Advanced Studies in Systematic Biology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in systematic biology. May be repeated.

Biol 6657 Advanced Studies in Plant Biology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in plant biology. May be repeated.

Biol 6658 Advanced Studies in Limnology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in limnology. May be repeated.

Biol 6659 Advanced Studies in Genetics: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in genetics. May be repeated.

Biol 6660 Selected Topics in Biochemistry: 3 semester hours.
Detailed study of selected areas of biochemistry. Course content will vary with current demand. PREREQ: Biol 5532 or permission of instructor.

Biol 6661 Advanced Studies in Environmental Physiology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in environmental physiology. May be repeated.

Biol 6662 Advanced Studies in Developmental Biology: 2-6 semester hours.
Flexible use of seminars, lectures, and laboratory work dealing with problems in developmental biology. May be repeated.

Biol 6670 Selected Topics Microbiology: 1-4 semester hours.
Detailed study of selected areas of microbiology. Course content will vary with current demand. May be repeated. PREREQ: Permission of instructor.

Biol 6675 Advanced Bacterial Virology: 3 semester hours.
Detailed study of selected areas of bacterial virology. Course content will vary with current demand. PREREQ: Biol 5575 and permission of instructor.

Biol 6676 Advanced Animal Virology: 3 semester hours.
Detailed study of selected areas of animal virology. Course content will vary with current demand. PREREQ: Biol 5575 and permission of instructor.

Biol 6677 Environmental Science and Pollutants: 3 semester hours.
Structure and function of ecosystems, sources and characteristics of hazardous materials, mechanisms and pathways of pollutant transport and degradation, mechanisms of pollutant impact on ecosystems and human health. PREREQ: Biol 5521, an undergraduate or graduate ecology course or equivalent.

Biol 6690 Careers in Life Sciences: 1 semester hour.
An advanced level course required for all first year graduate students. A review of the principles and core areas of biology, and an overview of current hypotheses, approaches, and research in the field.

Biol 6691 Seminar: 1 semester hour.
Review of current research and literature. May be repeated until a maximum of 4 credits is earned. Graded S/U.

Biol 6692 Seminar: 1 semester hour.
Review of current research and literature. May be repeated until a maximum of 4 credits is earned. Graded S/U.
BIOL 6693 *Seminar in College Teaching*: 2 semester hours.
Review of current research and literature. Rotation of topics will include professional development, theory and practice of science education, and current issues in biology instruction. May be repeated for up to 6 credits. Graded S/U.

BIOL 6694 *Advanced Study in College Teaching*: 2-6 semester hours.
Rotating topics on practical approaches to teaching college-level biology and conducting research in science education. May be repeated for up to 6 credits.

BIOL 6695 *Seminar in Microbiology*: 1-3 semester hours.
Review of current research and literature in Microbiology. May be repeated until 6 credits are earned. Graded S/U.

BIOL 6699 *Experimental Course*: 1-6 semester hours.
This is an experimental course. The course title and number of credits are noted by course section and announced in the class schedule by the scheduling department. Experimental courses may be offered no more than three times. May be repeated.

BIOL 7700 *Supervised Teaching Internship*: 1-9 semester hours.
Up to 9 credits per semester. May be repeated. Graded S/U.

BIOL 8850 *Doctors Dissertation*: 1-12 semester hours.
Dissertation. Variable credit. May be repeated. Graded S/U.