Chair and Professor: Thomas Anderson
Professors: Anderson, Austin, Bowyer, Delehanty, Finney, Keeley, Magnuson, Meldrum, C. Peterson, Rose, Sheridan, R. Smith, Winston
Associate Professors: Baxter, Bearden, Evilia, Groome, Hill, Lohse, Loxterman
Assistant Professors: Aho, Pilarski, Reinhardt
Research Assistant Professors: Castro, Hale
Lecturers: Abbruzzese, Black, Frank, Rhett, Shurley

Department Mission
The mission of the Department of Biological Sciences is to promote learning and discovery in the life sciences through high-quality public education and research.

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
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 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>Course</th>
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<th>Credits</th>
</tr>
</thead>
<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 (second semester for M.S. students; third semester for doctoral students)</td>
<td>1</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.

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:

<table>
<thead>
<tr>
<th>Courses required of all biology graduate students</th>
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<tbody>
<tr>
<td>BIOL 6691 Seminar</td>
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<td>BIOL 6648 Graduate Problems</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 6693 Seminar in College Teaching</td>
<td>2</td>
</tr>
<tr>
<td>BIOL 6694 Advanced Study in College Teaching</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 7700 Supervised Teaching Internship</td>
<td>1-9</td>
</tr>
<tr>
<td>BIOL 8850 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 (https://www.isu.edu/bios/degree-programs/graduate-degrees) 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

The degree of Doctor of Philosophy is granted for proven ability, independent investigation, and scholarly attainment in a special field. Although it is primarily a research degree and is not granted solely on the completion of a certain number of credits, there are specific course requirements that must be met. The training of a Ph.D.-level Microbiologist is based on a strong foundation in Mathematics, Chemistry, Genetics, Molecular Biology, and Biochemistry in addition to extensive coursework in the various disciplines within the field of Microbiology. This base is built upon advanced course work in the major sub-disciplines of Microbiology (Molecular Biology, Biochemistry and Physiology, Genetics, Biotechnology, Virology, Industrial and Environmental Microbiology, and Medical Microbiology) as the student focuses his/her area of interest.

Admission Requirements

Application to the Ph.D. program in Microbiology requires:

1. At least a 3.0 grade point average (GPA) for all upper division credits taken in the previous degree program,
2. Scores in the 35th percentile or higher on the verbal and quantitative sections of the Graduate Record Exam (GRE),
3. Submission of scores for the GRE Biology or Biochemistry subject area exam, and
4. Completed application forms for the Graduate School and Department of Biological Sciences, including three letters of recommendation.

Scores in the verbal, quantitative, and analytical sections of the GRE must be submitted before entrance can be considered. International students may be accepted without GRE scores, with the requirement that they take the GRE during their first semester in residence. Individuals for whom English is a second language must meet the Graduate School minimal TOEFL score.

Applicants who do not meet the minimum GPA and/or GRE requirements may be admitted under “Classified (w/PR)” status. The conditions of acceptance will be specified on the applicant’s Approval for Admission to Graduate School form. In some cases, students may be required to retake the GRE during their first semester in residence. Students admitted under “Classified (w/PR)” status because of low/missing GRE scores will be transferred to “Classified” status if new GRE scores that meet the minimal requirement are submitted. Failure to meet the minimum GRE standards during the first year of residence may result in expulsion from the program. Students under “Classified (w/PR)” status must petition the Graduate Programs Committee for transfer to “Classified” status after a year of graduate work and successful remediation of any deficiencies in coursework or GRE scores. This petition will include a recommendation from the student’s Advisory Committee signed by the research advisor. Continuation in the Microbiology Ph.D. program is contingent upon approval of transfer to “Classified” status. In rare cases, the Graduate Programs Committee may grant approval for a student to remain on “Classified (w/PR)” status for a second year. Any student with “Classified (w/PR)” status who has not been approved for transfer to “Classified” status by the end of his/her second year will be dismissed from the program. Acceptance into the Microbiology Ph.D. program must be approved by the Microbiology Graduate Program committee.

For applicants who hold only a Bachelor’s degree, acceptance into the Microbiology Ph.D. program requires a minimum of a 3.0 GPA for all undergraduate work, scores in the 50th percentile or higher on the verbal and quantitative sections of the GRE, and submission of scores for the GRE Biology or Biochemistry subject area exam. No waiver of GRE scores is allowed except in the case of students for whom English is a second language who receive a lower verbal GRE score; these individuals must meet the Graduate School minimal TOEFL score. The application must include three letters of recommendation. The application must be approved by the Departmental Microbiology Program 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 Microbiology Graduate Program Committee. Application for change must include:

1. A letter from the student that provides a rationale for the status change and
2. A letter of support from the research advisor.

**Prerequisites**
The following courses are recommended for the Microbiology Ph.D. program. It is expected that applicants to the program will have a broad background in Biology, and will have completed coursework at the undergraduate level in the following areas:

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

The Microbiology Ph.D. program will be tailored to the requirements of the student’s program of study (as determined by the student’s Advisory Committee), and will include coursework to rectify any deficiencies as determined by the Microbiology Graduate Program Committee. Deficiencies will be made up in the first year of study.

**Graduate Coursework in the Microbiology Ph.D. program**
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 coursework guidelines. The three core areas in the Microbiology Ph.D. program are:

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

**Core Courses for Biology Graduate Programs**
All students in the graduate programs in Biology and Microbiology will take the following courses:

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Students in the Microbiology Ph.D. program will take at least 30 credits of formal graduate coursework (at least 15 credits will be at the 6600-level). The following courses are not to be considered part of this 30 credits of formal graduate coursework: BIOL 5581 Independent Problems, BIOL 5582 Independent Problems; BIOL 6648 Graduate Problems; BIOL 6650 Thesis; BIOL 8850 Doctors Dissertation. Six credits will consist of BIOL 6695 Seminar in Microbiology. Six credits of courses will be taken in each of the three Microbiology core areas (18 credits total). The remaining 6 credits will be taken in any one of the three core areas or in subject areas recommended by the student’s Advisory Committee. It is expected that students in the Microbiology Ph.D. program will complete the majority of their coursework by the end of their 4th semester (or equivalent) in the program. Students in the Microbiology Ph.D. program may be required to take other courses (as determined by recommendation of the student’s Graduate Advisory Committee). The 6 credits of Graduate Seminar in Microbiology may be taken at any time during the student’s residence in the Microbiology Ph.D. program, but it is recommended that the student start taking Graduate Seminar no later than their 5th semester (or equivalent) in the program. The specific course list for each student will be determined by the student’s Graduate Advisory Committee based on the criteria outlined in this document. Students 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 credits is subject to approval by the Graduate Programs Committee.

**Course Requirements**

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<tr>
<td>BIOL 6695</td>
<td>Seminar in Microbiology</td>
<td>1-3</td>
</tr>
<tr>
<td>Microbiology Core Area Courses</td>
<td>(6 credits each area)</td>
<td>18</td>
</tr>
<tr>
<td>Advisory Committee recommended courses</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Total Credits</td>
<td></td>
<td>25-27</td>
</tr>
</tbody>
</table>

**Residency Requirements**
The equivalent of at least four years of full-time study (minimum of 75 graduate credits) is required and the research upon which it is based should compose a substantial portion of the program and involve original work. Part of the work may be completed elsewhere with the approval of a student’s Advisory Committee, but two consecutive regular semesters of full-time study must be taken in residence at this university.

**Advisory Committee**
The student’s Advisory Committee will consist of the graduate research advisor and (at least) three additional members of the graduate faculty who are chosen by the student in consultation with the research advisor. It is the student’s responsibility to contact members of the faculty to ascertain their willingness to serve. The Advisory Committee may include individuals from other departments or persons from outside the University who hold affiliate rank in the Department, with the approval of the Dean of the Graduate School, but the majority of any committee must consist of regular departmental faculty.

The final member of the student’s Advisory Committee is a Graduate Faculty Representative (GFR) from outside the Department who is appointed by the Dean of the Graduate School. The Dean will automatically appoint a GFR to participate in the defense of the dissertation if one has not been appointed before that time. However, it has been traditional for the GFR to be an active member of the Advisory Committee who participated in committee meetings and the Comprehensive Examination. In such cases, the student must submit a request in writing to the Dean of the Graduate School that a particular individual be appointed. The GFR must be a member of the Graduate Faculty of Idaho State University.

**Comprehensive Examination and Research Proposal Seminar**
Before submission of the final program of study, the student must pass a Comprehensive Examination intended to test his/her knowledge of the relevant sub-disciplines within the field of Microbiology that pertain to the dissertation research project(s). The student will be admitted to this examination when the student is considered by his/her Advisory Committee to be adequately prepared. This is to be interpreted as allowing the student to take the Comprehensive Exam,
even though some courses remain to be taken for the completion of the student’s program of study.

The Comprehensive Examination should be taken following the 2nd semester (or equivalent) of residence in the Microbiology Ph.D. program, and prior to the end of the student’s 5th semester (or equivalent) in the program. Several months (3 to 6) prior to the intended date for examination, the student should meet with his/her Advisory Committee to seek approval to schedule the exam. If approval is given, the student may at that time ascertain from the committee which topical areas will be covered and which committee member will be responsible for each. Students should meet individually with committee members to determine more specifically what materials will be pertinent and how to prepare for the exam. The examination will consist of a written and an oral portion, which will be administered during a closed session following the student’s public Research Proposal Seminar. Both portions must be passed satisfactorily in order to complete the comprehensive requirements.

The written portion of the Comprehensive Exam should not be less than 25 hours nor more than 40 hours of actual writing time. Normally the written exams will be completed within the span of one week. The written portion of the Comprehensive Examination generally will involve the student applying the knowledge gained through graduate coursework and readings suggested by the Advisory Committee. The examination will consist of five sections, each meant to be answered by a five-hour essay. The specific topic areas covered will be determined by the student’s Advisory Committee. Grading on the written portion will be on a Pass/Fail basis with four of the five sections graded satisfactory required for a Pass. If the student fails two or more sections of the written portion of the exam, the student’s Advisory Committee will convene to determine if the student will be allowed to remain in the program. The student’s Advisory Committee may recommend one of three options:

- dismissal from the program;
- transfer from the Microbiology Ph.D. program to the Microbiology M.S. program; or
- re-examination of the failed sections of the written exam.

Failed sections may be repeated once, at a time designated by the student’s Advisory Committee, but within a year of the original examination. If a student has not passed all the written sections after repeating the failed sections once, that student will be dismissed from the program. The completed and graded written portion of the Comprehensive Exam is to be deposited in the student’s department file.

Students pursuing the Microbiology Ph.D. are required to present a Seminar based on their Research Proposal to the Department of Biological Sciences prior to the end of their 5th semester (or equivalent) in the program. The seminar will be given during a scheduled meeting time of the Graduate Seminar in Microbiology (BIOL 6695) and will be considered part of the course requirements for that student. The purposes of Research Proposal Seminar is to assess the student’s potential for graduate study at the doctoral level, to determine areas in which the student shows strength or weakness, and to assess the student’s ability to assimilate, evaluate, and synthesize subject matter. Immediately after the seminar, the student will meet in closed session with his/her Advisory Committee to review and critique the Research Proposal Seminar and the written portion of the Comprehensive Exam. This will qualify as the oral portion of the Comprehensive Exam. The purpose of the oral portion of the examination following the Research Proposal Seminar is to provide an opportunity to clarify and explore further implications of the written examination as well as to present the student with new questions in the same general subject areas as those covered by the written exams, but it can also cover other areas that are relevant to the student’s graduate program. The oral portions should not be given until after the written examination has been evaluated by all of the committee members, but no later than four weeks after completion of the written portion. The student must pass the written portion of the Comprehensive Exam prior to taking the oral portion of the Comprehensive Exam. The oral exam must be passed by simple majority vote of the Advisory Committee. Once a student has passed both the written and oral portions of the Comprehensive Exam, the student will be admitted to Candidacy in the Microbiology Ph.D. program. When the student has passed both written and oral portions of the Comprehensive Exam, the Advisory Committee should finalize and approve the student’s Final Program of Study. The Advisory Committee may recommend additional coursework to strengthen the student’s background in areas in which the student was considered weak. In case of failure, the student may be allowed to retake all or part of the oral examination at the discretion of his/her Advisory Committee. If a student fails the oral exam a second time, that student will be dismissed from the program.

**Doctoral Dissertation**

Every student working toward the Microbiology Ph.D. degree must submit a dissertation embodying the results of original and creative 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. Students may register for dissertation credit only after completion of all formal course work. After the dissertation, in substantially final form, has been approved for format and content by the research advisor, and not later than two weeks before the date of the final examination, the student must personally deliver a copy of the dissertation to each member of the Advisory Committee.

**Final Examination**

The final examination of the dissertation will be conducted by the student’s Advisory Committee including the GFR. Students are required to give a departmental seminar on the dissertation immediately preceding the final examination. The examination is concerned primarily with the student’s research as embodied in the dissertation, but it may be broader and extend over fields of study related to the dissertation. Questions may be asked by committee members and those visitors specifically invited to do so by mutual agreement of the student’s Advisory Committee and the Dean of the Graduate School. A majority of the examining committee must approve the dissertation and the final examination.

**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 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. 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 hour)

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

The intent of the Microbiology M.S. program is to produce scientists with the ability to conduct independent research and to be fluent in the scientific literature. As a terminal degree, the Master of Science in Microbiology qualifies students for technical research positions in academia, industry and government research facilities. It also prepares students to progress into doctoral programs in Microbiology and related areas.

Admissions

Acceptance to the Microbiology M.S. program requires that a faculty member agree to serve as the candidate’s advisor. Candidates must have at least a 3.0 GPA for all upper division credits taken in the previous degree program. Scores in the verbal, quantitative, and analytical portions of the GRE must be submitted; scores in the 35th percentile or higher are required on the verbal and quantitative portions of the GRE. If either the GPA or GRE requirement is not met, the Microbiology Graduate Programs Committee may choose to admit the candidate to “Classified (w/PR)” status.

Prerequisites

It is expected that applicants to the program will have a broad scientific background, and will have completed coursework at the undergraduate level in the following areas:

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

The Microbiology M.S. program will be tailored to the requirements of the student’s program of study (as determined by the student’s Advisory Committee), and will include coursework to rectify any deficiencies as determined by the student’s Advisory Committee.

Coursework taken at the undergraduate level to satisfy deficiencies does not count toward the graduate degree; however, such coursework must appear on the student’s Planned Program of Study. Coursework taken at the undergraduate level to satisfy deficiencies must be taken for letter grades and the grades earned must be “C” or better.

Graduate Coursework in the Microbiology M.S. program

The M.S. program requires a substantial, original research project that culminates in a thesis; a minimum of 30 credits (including research and thesis) earned in graduate courses and seminars and expertise in one or more conceptual areas of the major sub-disciplines of Microbiology. The student’s Advisory Committee will direct the student to specific course offerings to satisfy the coursework guidelines.

The three core areas in the Microbiology M.S. program are:

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

Core Courses for Biology Graduate Programs

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

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

Thirty total graduate credits approved by the Microbiology Graduate Programs Committee and the Graduate School are required to complete the Microbiology M.S. degree program. At least 15 of these credit hours must be earned at the 6600 level. Students must take a minimum of 3 credits of BIOL 6648 Graduate Problems and 3 credits of BIOL 6650 Thesis. During the second semester of their first year in the program, students in the Microbiology M.S. program will present their research proposal in a public forum as part of BIOL 6695 Seminar.
in Microbiology. Students in the Microbiology M.S. program will also take 2 additional credits of Seminar in Microbiology (BIOL 6695).

**Course Requirements**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 6610</td>
<td>Principles of Molecular Biology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 6648</td>
<td>Graduate Problems</td>
<td>3</td>
</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>
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<td>6</td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td></td>
<td><strong>18</strong></td>
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</tbody>
</table>

**Advisory Committee**

The Advisory Committee consists of a minimum of three members of the Idaho State University Graduate Faculty, including a Graduate Faculty Representative (GFR). The student, in consultation with the major advisor, selects at least one additional faculty member with expertise related to the student’s research area. At least one of the advisory committee must be a member of the Microbiology Graduate Programs Committee. The GFR is appointed by the Dean of the Graduate School, who is open to recommendations from the major advisor. The GFR need only participate in the thesis defense, but may be involved throughout the student’s program. The initial committee meeting should be held during the first semester of the student’s graduate program.

**Written Proposal, Proposal Seminar, and Proposal Defense**

During the second semester of the first year in the program, Microbiology M.S. students must submit a research proposal to the student’s Advisory committee two weeks prior to a formal seminar presentation of the proposed research. This proposal will:

1. be at least 5 pages in length, with citations appended,
2. be retained in the student’s departmental file.

Students will present a seminar on their proposed thesis research as part of BIOL 6695. At least one week prior to the seminar, students must submit an abstract to the seminar organizer. Immediately following the proposal seminar, the student will defend the proposal in a closed session with their Advisory Committee. A revised proposal addressing questions raised at the defense must be approved by the advisory committee by the end of the semester in which the seminar was given.


Each Microbiology M.S. applicant must submit a thesis embodying the results of original and creative research. The thesis must demonstrate the student’s ability in scientific investigation. The thesis must include a comprehensive review of the literature on the topic, and must demonstrate an organized, coherent development of ideas, with a clear exposition of results and creative discussion on the conclusions. The form and style of the thesis should comply with the format prescribed by the national or international-level journal in which the student intends to publish the material and must meet the requirements of “Instructions for Preparing Theses, Dissertations, D.A. Papers, and Professional Projects,” which is available from the Graduate School. Within the framework of these constraints, however, the format of the thesis can vary in the number and arrangement of chapters. After the thesis has been approved for format and content by the major professor, and not later than two weeks before the date of the final examination, the student must deliver a copy of the thesis to each member of the advisory committee.

Following completion of the written thesis, the student will present the research findings in a public seminar. The thesis presentation will be followed by an oral defense conducted by the Advisory Committee. The student is responsible for scheduling the defense with the Graduate School and advertising the thesis seminar, with notices posted in the Life Sciences Building and in the Department newsletter, at least one week in advance of the seminar date. Please refer to https://www.isu.edu/bios/ for the manual, Instructions for Preparing Theses, Dissertations, Doctor of Arts Papers, and Professional Projects, for thesis clearance instructions.

**Residency Requirements**

The equivalent of at least two years of full-time study is required. Part of the work may be completed elsewhere with the approval of a student’s Advisory Committee, but two consecutive regular semesters of full-time study must be taken in residence at this university.

**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 completing the graduation requirements for a B.S. degree, these students should have met all of the coursework requirements for admission to the M.S. program.

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.

**Summer following Junior Year**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 5581</td>
<td>Independent Problems</td>
<td>2</td>
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</tbody>
</table>

**Spring Semester of Senior Year**

<table>
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<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 6692</td>
<td>Seminar</td>
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</tbody>
</table>

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 5500.

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. COREQ: BIOL 5505.

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 5506.

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. COREQ: BIOL 5508.

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 5512.

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 5516. 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.
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.

BIOL 5522 Environmental Protection: 3 semester hours.
Focus 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 5523 General Parasitology: 3 semester hours.
Study of parasitic symbiOLes 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.
Biology 5526 General Entomology: 3 semester hours.  
The biology of arthropods: lecture topics include evolutionary history, functional morphogenesis, physiological ecology, and biogeography. Laboratory and field trips cover identification, life history, and collecting techniques. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5526L.

Biology 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.

Biology 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.

Biology 5529 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 5529.

Biology 5530 Ichthyology: 3 semester hours.  
The study of fish species; 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 5530L.

Biology 5531 General Entomology: 3 semester hours.  
Study of the collection, 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.

Biology 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.

Biology 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.

Biology 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.

Biology 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.

Biology 5534 Microbial Diversity: 3 semester hours.  
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.

Biology 5534L Microbial Diversity Lab: 1 semester hour.  
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. Equivalent to BIOL 5534. PREREQ: BIOL 5533 or BIOL 5534.

Biology 5535 Vertebrate Paleontology: 4 semester hours.  
Study of the origin, evolution, structure, habits, adaptations, distribution, and classification of birds, fishes, mammals, and reptiles. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5535L. PREREQ: BIOL 5535 or GEOL 5535.

Biology 5536 Vertebrate Paleontology Lab: 1 semester hour.  
Laboratory exercises in comparative paleontology of vertebrates with emphasis on North American forms. Field trips. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. COREQ: BIOL 5536L.

Biology 5537 Experimental Biochemistry: 1 semester hour.  
Laboratory course including both qualitative and quantitative experiments. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus. Equivalent to BIOL 5537. PREREQ: BIOL 5537 or BIOL/CHM 5537.

Biology 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. PREREQ or COREQ: BIOL 5538 or BIOL/CHM 5538.

Biology 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.

Biology 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.

Biology 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 5540L.

Biology 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 Selected Topics in Physiology: 1 semester hour.
Selected topics in physiology for dental students: blood coagulation-complement-kinin systems, prostaglandin and related substances, vitamins, steroids, mucopolysaccharides, collagen and other extracellular matrix molecules and cyto- and molecular genetics. Specific, evaluated graduate-level activities and/or performances are identified in the course syllabus.

BIOL 5547 Biochemistry II: 3 semester hours.
Functional 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 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 5537/ CHEM 5538. COREQ: BIOL/ CHEM 5547.

BIOL 5549 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 5525.

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 5552 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, 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. COREQ: 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 Gen 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 exccretory 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 5576 Medical Microbiology 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 5576.

BIOL 5577 Bacterial 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, urinary, 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.
Theory 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.

BIOL 6653 Advanced Studies in Vertebrate Zoology: 2-6 semester hours.
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.