MASTER OF SCIENCE IN BIOTECHNOLOGY

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The Master of Science in Biotechnology is designed to broaden student understanding of the biological sciences and to prepare students for a professional career in Biotechnology or for doctoral study. Classes are usually held in the evenings and include lectures, laboratory experiences, research methodology, and seminars in current topics. Research, analytical, and communication skills are developed through original research, culminating in a written thesis and defense. In addition to the matriculated program, courses are open to students who hold a Bachelor’s degree in a biological subject, biotechnology, or chemistry.

A combined B.S./M.S. program is available for Worcester State University students majoring in Biotechnology. Please see the Undergraduate Catalog for further information on this program.

Prerequisites for Admission to the Program
To be admitted to the program, a candidate must meet the Worcester State University general admission requirements for the degree of Master of Science. To view these requirements please go to: http://worcester.edu/apply

The program is open to graduates of accredited institutions of higher education who have been awarded a baccalaureate degree in Biology, Biotechnology, Chemistry, or a similar science major. Graduate study in Biotechnology at Worcester State University assumes sound undergraduate training and evidence of academic capability. Applicants are expected to have completed courses in Chemistry I and II, Organic Chemistry I, Physics I and II, Microbiology, Cell and/or Molecular Biology (all with a laboratory component), Organic Chemistry II lecture course (no lab requirement), and math coursework up to the level of Pre-calculus. The applicant should have achieved a minimum grade point average of 2.75 in all undergraduate work and an average of 3.00 in all course work within his/her major and in the ancillary courses.

Items Needed to Apply:
• Online application found at www.worcester.edu/apply
• Essay explaining reason for pursuing this degree program
• Application fee
• General GRE test scores
• Two letters of recommendation from professional or academic sources
• Official transcripts from ALL colleges and universities attended showing a bachelor’s degree from a regionally accredited institution in Biology, Biotechnology, Chemistry, or a similar science major
• Official transcript evaluation for any transcript from outside the United States
• An English language proficiency test if the student’s academic background is not in English
• Prerequisite courses: Chemistry I and II, Organic Chemistry I, Physics I and II, Microbiology, Cell and/or Molecular Biology (all with a laboratory component), and math coursework up to the level of Pre-Calculus

Program of Study for the Degree
The program of study includes 35 graduate credits in required and elective courses, research in biology/biotechnology culminating in an acceptable written thesis and thesis defense.

Of the 35 credits required for the degree, at least 22 credits must be earned as a matriculated graduate student at Worcester State University. Credits for which students have earned a “B-” or higher within a two year period immediately prior to the date of their acceptance into the program are transferable from an accredited institution, including credits earned at Worcester State University. A maximum of 12 such transfer credits may be accepted. Matriculated students who do not maintain a GPA 3.0 or higher or have two grades below a “B-” will be terminated from the program. All work for the degree must be completed within a period of six years from the date of admission to the program.

Degree Requirements required of all students

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BI-921</td>
<td>Biotechnology and DNA</td>
<td>4</td>
</tr>
<tr>
<td>BI-927</td>
<td>Tissue Culture Techniques</td>
<td>4</td>
</tr>
<tr>
<td>BI-930</td>
<td>Biological Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>BI-942</td>
<td>Biostatistical Analysis</td>
<td>3</td>
</tr>
<tr>
<td>or BI-943</td>
<td>Experimental Design</td>
<td>3</td>
</tr>
<tr>
<td>BI-996</td>
<td>Thesis Research I</td>
<td>3</td>
</tr>
<tr>
<td>BI-997</td>
<td>Thesis Research II</td>
<td>4</td>
</tr>
<tr>
<td>BI-998</td>
<td>Thesis Writing</td>
<td>2</td>
</tr>
<tr>
<td>BI/CH 900-Level Biology or Chemistry electives. One elective may include a Business course from the list below.</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Total Credits</td>
<td></td>
<td>35</td>
</tr>
</tbody>
</table>

Elective Courses are from this list or others when approved by the faculty:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BI-915</td>
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<tr>
<td>BI-923</td>
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<td>3</td>
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<tr>
<td>BI-925</td>
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<td>4</td>
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<tr>
<td>BI-935</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>BI-936</td>
<td>Immunology</td>
<td>3</td>
</tr>
<tr>
<td>BI-937</td>
<td>Molecular Virology</td>
<td>3</td>
</tr>
<tr>
<td>BI-938</td>
<td>Toxicology</td>
<td>3</td>
</tr>
<tr>
<td>BI-980</td>
<td>Selected Topics: Advanced Biology</td>
<td>1-4</td>
</tr>
<tr>
<td>BI-981</td>
<td>Independent Study in Biology/ Biotechnology</td>
<td>1-6</td>
</tr>
<tr>
<td>BI-985</td>
<td>Graduate Internship in Biology/ Biotechnology</td>
<td>3-4</td>
</tr>
<tr>
<td>CH-990</td>
<td>Special Problems in Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>CH-991</td>
<td>Independent Study</td>
<td>1-4</td>
</tr>
<tr>
<td>CH-996</td>
<td>Internship: Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>BA-914</td>
<td>Organizational Behavior</td>
<td>3</td>
</tr>
<tr>
<td>BA-961</td>
<td>Organizational Development and Change</td>
<td>3</td>
</tr>
<tr>
<td>BA-960</td>
<td>Leadership Theory and Skills</td>
<td>3</td>
</tr>
<tr>
<td>BA-962</td>
<td>Ethics and Social Responsibility of Leadership</td>
<td>3</td>
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To fulfill requirements for the Program the candidate must complete 9 credits of Thesis Research and Writing coursework (BI 996, BI 997 and BI 998). Laboratory investigations are supervised by faculty in the laboratories at Worcester State University or by arrangement at another institution. The candidate must adhere to the form specified for the thesis by the Biology Department graduate faculty. The thesis will be defended in an oral examination conducted by the faculty.

During the semester in which the candidate anticipates receiving the degree, the following timetable for the thesis completion and defense shall apply:

A minimum of four weeks prior to the defense, the completed written thesis must be presented to the candidate's graduate research advisor. The comprehensive exam/thesis defense will be scheduled with the candidate's thesis committee, comprised of the thesis advisor, the program coordinator and another member of the program graduate faculty.

A minimum of two weeks prior to the defense, the final copy of the thesis, with approval by the candidate's graduate research advisor, will be submitted to the members of the candidate's thesis committee.

**Comprehensive Examination/Thesis defense**

The Master of Science in Biotechnology candidate is required to pass a comprehensive examination/thesis defense in the candidate's area of specialization. At least twenty-four approved graduate credits must be earned before the candidate can submit a request for the scheduling of a comprehensive exam/thesis defense. If the candidate fails the examination, he/she will be granted one additional opportunity to fulfill this requirement. All work for the degree must be completed within a period of six years from the date of admission to the program.

**Graduate Biotechnology Courses**

**BI-921 Biotechnology and DNA**
Applications of recombinant DNA technology, together with business and industry information and government regulations. Includes a three hour laboratory. Every year. 4 Credits

**BI-927 Tissue Culture Techniques**
Presents the most important techniques used for mammalian tissue culture by lecture and laboratory demonstration and practice. The course also includes topics in plant tissue culture. (Prereq: BS in biological science) Spring only and every year. 4 Credits

**BI-930 Biological Chemistry**
Concerns the physical, chemical, and biological properties and metabolism of carbohydrates, proteins, lipids, DNA and RNA. 3 Credits

**BI-936 Immunology**
Recent advances in understanding the immune system will be covered. B.S. in a biological science is required. This course integrates both lecture and lab activities. 3 Credits

**BI-937 Molecular Virology**
A study of virus families with emphasis on replication and and regulation of gene expression. B.S. in biology science required. This course integrates both lecture and lab activities. 3 Credits

**BI-938 Toxicology**
A theoretical course presenting the principles and mechanisms of toxic damage to cells, organs and organisms. 3 Credits

**BI-942 Biostatistical Analysis**
**Prerequisites:** Undergraduate degree in Biology, Chemistry or related field
Math at the level of college-level pre-calculus or higher. Provides a foundation in biological data analysis and interpretation. Topics include probability, distribution, estimation, hypothesis testing, analysis of variance, simple and multiple regression, basic multivariate techniques and vital statistics. Fall only and every 2-3 years. 3 Credits

**BI-943 Experimental Design**
**Prerequisites:** Undergraduate degree in Biology, Chemistry or related field
Completion of a college course in statistics and completion of math which includes pre-calculus or higher level courses. The underlying principles of how scientific investigations are conducted in order to maximize the validity of the results will be discussed. This course will cover the philosophy of science as it pertains to experiments, methods of experimental design, statistical inference, analysis and presentation of data, and clear communication of scientific results. Fall only and every 2-3 years. 3 Credits

**BI-950 Physiological Ecology**
Considers the physiological adjustments which animals make in response to environmental factors; emphasizes the physiological basis of animal evolution and distribution. 3 Credits

**BI-980 Selected Topics: Advanced Biology**
Each topic is a timely and exciting new lecture and/or laboratory course. Topics will be announced in advance and will service needs in growth areas; e.g., biotechnology. 1-4 Credits

**BI-981 Independent Study in Biology/ Biotechnology**
Independent study or directed study on a topic of interest to both the student(s) and the instructor. Other or on demand. 1-6 Credits

**BI-985 Graduate Internship in Biology/ Biotechnology**
Requires successful completion of a minimum of twelve graduate credits toward the degree and approval of the Biology faculty. Provides Master of Science candidates the chance to gain practical experience at off-campus agencies where technical and analytical skills can be gained. 3-4 Credits

**BI-990 Seminar in Biology/Biotechnology**
Study and discussion of current researches, books, and periodicals in the field of biology; includes reports of research in progress. 3 Credits

**BI-995 Research in Biology/Biotechnology**
Original research in biology under faculty supervision. Requires an acceptable written thesis or paper in publishable format. 1-6 Credits
BI-996 Thesis Research I
Prerequisites: Completion of at least four courses in the program, completion of BI-942 Biostatistical Analysis or BI-943 Experimental Design (or taken concurrently) and permission of the Program Coordinator. Matriculated students only.
Original research in biology or biotechnology under faculty supervision, leading to a thesis, written in an approved format. A research problem will be identified and a literature search conducted. Experiments will be designed, planned and preliminary research work performed.
Fall and Spring and every year. 3 Credits

BI-997 Thesis Research II
Prerequisites: BI-996 Thesis Research I, permission of Program Coordinator. Matriculated students only.
Original research in biology or biotechnology under faculty supervision, leading to a thesis, written in an approved format. Experimental laboratory work will be performed and results evaluated. This course is a continuation of BI 996 Thesis Research I.
Fall and Spring and every year. 4 Credits

BI-998 Thesis Writing
Prerequisites: BI-997 Thesis Research II, permission of Program Coordinator. Matriculated students only.
Original research in biology or biotechnology under faculty supervision, leading to a thesis, written in an approved format. The results of the project experiments will be organized and the findings will be communicated by writing a thesis in the approved format and presenting in an oral defense. This course is a continuation of BI 997 Thesis Research II.
Fall and Spring and every year. 2 Credits

BT-901 Directed Study: Biotechnology
Directed study offers graduate students, who because of unusual circumstances may be unable to register for a course when offered, the opportunity to complete an existing course with an established syllabus under the direction and with agreement from a faculty member. Variable credits.
Fall and Spring and every year. 1-12 Credits

- Demonstrate the advanced body of scientific knowledge as applied to biotechnology, including the following core content areas:
  - Cellular & molecular biology and biochemistry
  - Biostatistics and experimental design
  - Applications of cells and organisms for industrial and research purposes
- Demonstrate knowledge by critically applying analytical skills to biotechnological problems
  - Identify and formulate appropriate experiments to test a hypothesis
  - Gather, organize, interpret and evaluate data
  - Employ reason and logic, analyze pros and cons, and evaluate the validity of conclusions in experiments and scientific literature
- Perform laboratory techniques and practices used in the biotechnology industry
  - Proper use of tools, equipment/instrumentation, and materials
  - Demonstration of safety procedures and proper techniques
  - Conduct experiments independently and work effectively in a group or team environment
- Effectively communicate scientific results and information to appropriate target audiences using well-structured written and oral forms of communication, including:
  - Written material (laboratory reports, standard operating procedures, posters)
  - Oral presentations provided in a professional format
  - Exhibit awareness of the social implications and impacts of biotechnology on society, including the ethical considerations for biotechnology, by addressing
    - The effect of biotechnology on the environment, business, and human health
    - The ethical issues that influence decisions related to biotechnology and society