

BIOTECHNOLOGY, MASTER OF SCIENCE

MS in Biotechnology (<https://advanced.jhu.edu/academics/graduate/ms-biotechnology/>)

The Master of Science in Biotechnology program prepares students for a career in the field and allows biotechnology professionals to further hone their skills toward career advancement. The program provides a solid grounding in theory and delivers real-world skills and practice. Students can meet their individual career goals through the selection of a concentration or get a more customized experience by choosing their own set of six elective classes.

This 10-course degree program is thesis-optional and can be pursued part time or full time, onsite, online, or through a combination of onsite and online courses.

Admissions Criteria for All Advanced Academic Programs (<https://e-catalogue.jhu.edu/arts-sciences/advanced-academic-programs/Admission/#admissionrequirements>)

PROGRAM-SPECIFIC REQUIREMENTS

In addition to the materials and credentials required for all programs, the MS in Biotechnology program requires an undergraduate degree in the natural sciences or engineering with a grade point average of at least 3.0 on a 4.0 scale. Meeting the minimum GPA requirement does not guarantee admission. Other requirements for applicants are:

- **Resume**
- **Statement of purpose:** Please provide a statement, up to one page in length, describing your personal background and/or a part of your life experience that has shaped you or your goals. Feel free to elaborate on personal challenges and opportunities that have influenced your decision to pursue a graduate degree at Johns Hopkins.
- **Program-specific prerequisite courses:**
 - Two semesters of biology
 - Two semesters of chemistry
 - One semester of organic chemistry
 - One semester of biochemistry
 - One semester of molecular biology

Program Requirements

Students pursuing the MS in Biotechnology must complete 10 courses:

- Four required core courses
- Six elective courses

| Code | Title | Credits |
|---------------------------------|------------------------------|-----------|
| Core Courses - Required: | | 16 |
| AS.410.603 | Advanced Cell Biology | |
| AS.410.604 | Cellular Signal Transduction | |

| | | |
|---|--|-----------|
| AS.410.606 | Emerging Applications in Biotechnology | |
| AS.410.607 | The Biotechnology Enterprise | |
| Electives | | |
| Select six elective courses ^{1, 2} | | 24 |
| Total Credits | | 40 |

¹ See course listings page (https://e-catalogue.jhu.edu/course-descriptions/_biotechnology/).

² Many electives have the core courses as a prerequisite

Course requirements differ for the certificate (no longer admitting new students) and concentration programs.

MS in Biotechnology with Thesis Option

Students interested in pursuing the MS in Biotechnology with thesis are required to take 11 courses. The thesis requires a two-semester research project. Students complete AS.410.800 Independent Research in Biotechnology, and then AS.410.801 Biotechnology Thesis the following semester. Students interested in this option should consult with the program adviser.

MS in Biotechnology Concentrations (Optional)

Students wishing to focus on a specialized discipline within the MS in Biotechnology program may enroll in one of six optional concentrations after being accepted into the program:

Concentration in Biodefense

The biodefense concentration integrates basic and translational science to train the next generation of professionals for employment in academia, industry, and government. The curriculum provides students with a solid foundation in basic science, and investigates the various applications of medical science and biotechnology for detection, identification, and response to biothreats.

Specific disciplines of study include molecular biology, infectious diseases, bioinformatics, immunology, epidemiology, molecular diagnostics, and policy. **The core courses for this concentration are different from the general MS in Biotechnology**, including two laboratory courses and coursework in Cell Biology, Immunology, Bioinformatics, Forensics, and Policy. You may also select three electives (i.e. any AS.410.6xx course not already taken).

| Code | Title | Credits |
|--|---|---------|
| Core Courses Required: | | |
| Core requirements differ for this concentration. | | 24 |
| AS.410.603 | Advanced Cell Biology | |
| AS.410.606 | Emerging Applications in Biotechnology | |
| AS.410.613 | Principles of Immunology | |
| AS.410.633 | Introduction to Bioinformatics | |
| AS.410.692 | Biological & Chemical Threat Response & Forensics | |
| AS.410.693 | Science, Medicine & Policy in Biodefense | |
| Core Courses - Customizable: | | |
| Select one of the following: | | 4 |
| Must be completed onsite | | |
| AS.410.625 | Industrial Microbiology | |

| | | |
|------------------------|--|-----------|
| AS.410.652 | Mammalian Cell Culture Techniques | |
| AS.410.656 | Recombinant DNA Laboratory | |
| AS.410.658 | Biodefense & Infectious Disease Laboratory Methods | |
| AS.410.659 | | |
| AS.410.660 | Immunological Techniques in Biotechnology | |
| AS.410.733 | | |
| AS.410.752 | High Throughput Screening & Automation Lab | |
| AS.410.780 | Stem Cell Culture Laboratory Methods | |
| Electives | | |
| Select three electives | | 12 |
| Total Credits | | 40 |

Concentration in Bioinformatics

Given the vast amount of information generated from studies on humans and other organisms, and the need for scientists and researchers to access and manipulate these data, the biotechnology program offers courses that can either be sampled individually or taken together to complete a concentration in bioinformatics.

In addition to the four core courses, degree candidates must complete any four bioinformatics concentration courses from the list below and two electives (i.e. any AS.410.6xx course not already taken):

| Code | Title | Credits |
|-------------------------------|---|-----------|
| Bioinformatics Courses | | |
| Select four of the following: | | 16 |
| AS.410.633 | Introduction to Bioinformatics | |
| AS.410.634 | Practical Computer Concepts for Bioinformatics | |
| AS.410.635 | Bioinformatics: Tools for Genome Analysis | |
| AS.410.639 | Protein Bioinformatics | |
| AS.410.640 | Molecular Phylogenetic Techniques | |
| AS.410.645 | Biostatistics | |
| AS.410.666 | | |
| AS.410.671 | Gene Expression Data Analysis and Visualization | |
| AS.410.709 | Cancer Genomics | |
| AS.410.712 | Advanced Practical Computer Concepts for Bioinformatics | |
| AS.410.713 | | |
| AS.410.733 | | |
| AS.410.734 | Practical Introduction to Metagenomics | |
| AS.410.736 | Genomic and Personalized Medicine | |
| Electives | | |
| Select two electives | | 8 |
| Total Credits | | 24 |

Concentration in Biotechnology Enterprise

For research discoveries to reach the public, an understanding of the overall enterprise of biotechnology is essential. Success in this industry requires two distinct sets of skills and perspectives: understanding the science and understanding the business.

In addition to the four core courses, degree candidates must complete any four Biotechnology Enterprise concentration courses from the list below and two electives (i.e. any AS.410.6xx course not already taken).

| Code | Title | Credits |
|---|--|-----------|
| Biotechnology Enterprise Concentration Courses | | |
| Select four of the following: | | 16 |
| AS.410.627 | Translational Biotechnology: From Intellectual Property to Licensing | |
| AS.410.637 | Bioethics | |
| AS.410.643 | Managing and Leading Biotechnology Professionals | |
| AS.410.644 | Marketing Aspects of Biotechnology | |
| AS.410.645 | Biostatistics | |
| AS.410.646 | Creating a Biotechnology Enterprise | |
| AS.410.648 | Clinical Trial Design and Conduct | |
| AS.410.649 | Introduction to Regulatory Affairs - Medical Products | |
| AS.410.651 | Clinical Development of Drugs and Biologics | |
| AS.410.680 | Finance for Biotechnology | |
| AS.410.655 | Ethical & Legal Issues in Data Science | |
| AS.410.684 | Technology Transfer & Commercialization | |
| AS.410.687 | Ethical, Legal & Regulatory Aspects of the Biotechnology Enterprise | |
| AS.410.688 | Project Management in Biotechnology | |
| AS.410.689 | Leading Change in Biotechnology | |
| AS.410.704 | | |
| AS.410.703 | Strategic Planning for the Biotechnology Enterprise | |
| AS.410.705 | Problem Solving and Innovation | |
| AS.410.706 | Building and Leading Teams in Health Care | |
| AS.410.804 | Practicum in Biotechnology Enterprise & Entrepreneurship | |
| Electives | | |
| Select two electives | | 8 |
| Total Credits | | 24 |

Concentration in Molecular Targets and Drug Discovery

Within the biotechnology industry, there is a need for highly skilled professionals who possess an in-depth understanding of the structures and activities of biological molecules and their variants formed during the production of biopharmaceutical drugs, and the laboratory skills necessary to advance this high-throughput screening and clinical development. Graduates of this concentration will fill key positions in clinical, industry, and research laboratories that are doing pharmaceutical drug discovery and development.

In addition to the four core courses, students must complete the four concentration courses and two electives (i.e. any AS.410.6xx course not already taken).

| Code | Title | Credits |
|-------------------------------------|--|---------|
| Concentration Courses | | |
| Complete all four of the following: | | 16 |
| AS.410.696 | Bioassay Development | |
| AS.410.750 | Molecular Targets & Cancer | |
| AS.410.751 | Drug Design and Chemical Libraries | |
| AS.410.752 | High Throughput Screening & Automation Lab | |
| Elective Courses | | |

| | |
|----------------------|-----------|
| Select two electives | 8 |
| Total Credits | 24 |

Concentration in Regulatory Affairs

Developed in consultation with representatives from the Food and Drug Administration, the Regulatory Affairs Professional Society, and the biotechnology industry, this concentration provides students with the knowledge and understanding required for companies and organizations to comply with federal and state regulatory statutes for the development, approval, and commercialization of drugs, biologics, foods, and medical devices.

In addition to the four core courses, degree candidates must complete any four Regulatory Affairs concentration courses from the list below and two electives (i.e. any AS.410.6xx course not already taken).

| Code | Title | Credits |
|---|---|-----------|
| Regulatory Affairs Concentration Courses | | |
| Select four of the following: | | 16 |
| AS.410.627 | Translational Biotechnology: From Intellectual Property to Licensing | |
| AS.410.648 | Clinical Trial Design and Conduct | |
| AS.410.649 | Introduction to Regulatory Affairs - Medical Products | |
| AS.410.651 | Clinical Development of Drugs and Biologics | |
| AS.410.673 | Biological Processes in Regulatory Affairs | |
| AS.410.675 | International Regulatory Affairs | |
| AS.410.676 | Food And Drug Law | |
| AS.410.683 | Introduction to cGMP Compliance | |
| AS.410.686 | Regulation of Good Food Production Practices | |
| AS.410.687 | Ethical, Legal & Regulatory Aspects of the Biotechnology Enterprise | |
| AS.410.694 | FDA Premarket Applications | |
| AS.410.701 | Introduction to Regulatory Affairs-Food, Cosmetics, Alcohol and Tobacco | |
| AS.410.702 | AI and Software Regulation in Biomedical Science | |
| AS.410.715 | Medical Device Regulation | |
| AS.410.719 | Regulation of Dietary Supplements | |
| AS.410.721 | Cannabis Food Safety Regulations | |
| AS.410.739 | Traceability Outbreaks and Recalls | |
| AS.410.802 | Independent Studies in Biotechnology | |
| Electives | | |
| Select two electives | | 8 |
| Total Credits | | 24 |

Students may choose any two science electives for which they have met the prerequisites.

Concentration in Regenerative and Stem Cell Technologies

Within the biotechnology industry, there is increasingly a need for highly skilled professionals in the area of regenerative technologies. The professionals must possess an in-depth understanding of stem cells, gene therapy, regenerative medicine, and the laboratory skills necessary to advance this rapidly expanding field of research and clinical development. Graduates of this concentration will fill key positions in

clinical, industry, and research laboratories that use cell therapies for treatment of diseases.

In addition to the four core courses, students must complete the four concentration courses and two electives (i.e. any AS.410.6xx course not already taken).

| Code | Title | Credits |
|-------------------------------------|--|-----------|
| Concentration Courses | | |
| Complete all four of the following: | | 16 |
| AS.410.630 | Gene Therapy | |
| AS.410.653 | Regenerative Medicine: from Bench to Bedside | |
| AS.410.753 | Stem Cell Biology | |
| AS.410.780 | Stem Cell Culture Laboratory Methods | |
| Electives | | |
| Select two electives | | 8 |
| Total Credits | | 24 |

Program Learning Outcomes

By the end of this program, students will be able to:

- Assess diverse methods and technologies and their applications in biochemistry.
- Apply up-to-date knowledge and skills in molecular biology in real-world settings.
- Employ key concepts in cellular biology to solve real-world issues.
- Critique scientific information from various subdisciplines of biotechnology.
- Demonstrate ability to communicate scientifically both orally and in writing.
- Demonstrate the ability to collaborate in a diverse group to achieve an objective.