BIOTECHNOLOGY M.S.

Overview
Master of Science in Biotechnology

The Master of Science in Biotechnology has two formats: a two (2) year master's degree and an accelerated 4+1 undergraduate and graduate combined program. The 4+1 BS/MS program is a combined Biotechnology BS major/Biotechnology MS degree that students complete in 5 years.

The Biotechnology degree is geared for those seeking a career in the biotechnology industry. Students in the program take core classes in both biotech science-related and bio-entrepreneurship curricula. This program combines molecular biology rigor with soft skills to provide the essential background for interfacing research with successful workplace interactions in the biotech industry. Our mission is to provide motivated students with the knowledge and skills needed to successfully enter or advance their careers in the biotechnology industry.

Admission Requirements and Application to the 4+1 Accelerated Program:

Students must meet the following criteria to be considered for the 4+1 accelerated PSM:

1. Students must apply after their sophomore year in the BS program (Most students apply in the spring semester of their sophomore year.)
2. Maintain a GPA of 3.2 or above in their BS work (both overall and in their major)
3. Submit an essay up to 500 words that describes their interest in the program and future career plans
4. Complete 90 credits by the end of their sixth semester or 60 credits by the end of the fourth semester in the BS
5. Submit an official copy of their transcripts
6. Submit one (1) letter of recommendation from a professor in their major
7. Please note: The GRE is waived for 4+1 applicants.

Applications may be obtained from the Biological Sciences Department.

Advantages of the 4+1 Program:

- Once accepted into the PSM program, students can transfer up to 14 credits from their undergraduate courses to the MS degree, provided:
  - They have more than the required 120 credits for their undergraduate degree
  - Students obtain a grade of B or better in each course.
- Students can take up to two graduate-level (400 level or above) science courses during each of their final three semesters.
- Students are charged the undergraduate tuition rate for graduate courses taken during the final three semesters of their undergraduate program.

Application to the Two-Year MS in Biotechnology Program:

Formal admission is required for the program through the Graduate Admissions Department. Potential students may apply for admission in the fall semester.

Admission Requirements:

Applicants should have a Bachelor's degree in biology or a related field. Applicants with a significant background in biology and chemistry, but who have majored in other fields will be considered. However, we require applicants to have taken no fewer than 4 biology courses and 1 year of General Chemistry, if they do not possess a degree in biology or a related field, in order to be considered a candidate for admission. Students will be selected for admission based on their academic background as evidenced in grades, recommendation letters, and adequate relevant science expertise. An overall 3.0 GPA or above is preferred.

Application Packet:

1. Transcripts from all post secondary educational institutions, including non-degreed programs
2. Resume
3. Two letters of recommendation to be submitted by those with knowledge of your professional ability and potential (professor / research supervisor / employer, etc.) on official letterhead of the organization or department.
4. One-page statement of academic purpose of the career you want to pursue and why you want to study biotechnology at Vanguard University.
5. In-person interview for qualified, selected applicants.

Requirements
Biotechnology Master of Science (2 year) Requirements:

Code	Title	Units
BIOL-540	Techniques in Molecular Biology	3
BIOL-540L	Techniques in Molecular Biology	1
BIOT-503	Advanced Research Methods in Biotech	3
BIOT-505	Bioinformatics	3
BIOT-505L	Bioinformatics Laboratory	1
BIOT-508	Legal and Social Ethics in Science	3
BIOT-511	Regulations and Quality Management	2
BIOT-513	Cell Culture Techniques	3
BIOT-515	Experimental Design and Statistical Analysis	3
BIOT-600	Bioinnovation/Entrepreneurship/Biotech	2
BIOT-603	Bus Analytics and Proffessional Comm	3
BIOT-699	Graduate Seminar	1
PSOG-505	Intro to Psychology and Behavior in Org In Organizations	3
Advanced Project Options (8 units, may be spread over multiple terms):		8
BIOT-550	Internship Program	

BIOT-685	Independent Advanced Research	
Total Units		**39**

Courses

BIOT-200 Introduction to Biotechnology 3 Credits
An introductory course to the field of biotechnology and application of biotechnology methodologies in emerging areas. Topics of discussion will include microbial biotechnology, animal biotechnology, forensic biotechnology, agriculture biotechnology, bioremediation and medical biotechnology. Emphasis will be placed on ethical and social considerations and opportunities for improvements in the field.
Pre- or Co-Requisite: BIOL-111/BIOL-111L and BIOT-200L

BIOT-200L Introduction to Biotechnology Laboratory 1 Credit
An introductory laboratory course to the field of biotechnology and application of biotechnology methodologies in emerging areas. Laboratories include aseptic technique, pipetting and measurement, NNA extration and restriction digestion, gel electrophoresis nad PCR. Lab fee required.
Prerequisite: BIOL-111/BIOL-111L
Pre- or Co-Requisite: BIOT-200

BIOT-403 Adv. Research Methods in Biotechnology 3 Credits
Methodology and application in biotechnology. The following topics will be covered: genetic engineering techniques for introducing a gene for a desired protein into a cell with vectors, techniques for growing bacteria and yeast to produce a desired protein, cell transformation by electroporation, blue/white screening for selection of a colony with successful transformation with the desired vector, identification of a plasmid with PCR and DNA sequencing, use of enzyme assays to measure protein concentration in solutions, fed-batch yeast fermentation, mammalian cell culture techniques, and analysis of protein expression by Western blot. Lab fee.
Prerequisite: BIOT-200

BIOT-405 Bioinformatics 3 Credits
Introduction to bioinformatic resources/methods for biologists. Topics include: biological databases, sequence alignment, gene and protein structure prediction, molecular phylogenetics, genomics and proteomics. Students will gain practical experience with bioinformatics tools and develop basic skills in the collection and presentation of bioinformatics data.
Prerequisite: DSCI-100C, DSCI-100CL
Co-Requisite: BIOT-405L

BIOT-405L Bioinformatics Laboratory 1 Credit
Introduction to bioinformatic resources/methods for biologists. Topics include: biological databases, sequence alignment, gene and protein structure prediction, molecular phylogenetics, genomics and proteomics. Students will gain practical experience with bioinformatics tools and develop basic skills in the collection and presentation of bioinformatics data. This lab course must be taken concurrently with lecture BIOL-405.
Prerequisite: DSCI-100C, DSCI-100CL
Co-Requisite: BIOT-405

BIOT-413 Cell Culture Techniques 3 Credits
This course is primarily lab based and will focus on teaching the techniques necessary to maintain mammalian cells in culture and manipulating stem cells. Exercises will include hands-on training isolating, maintaining, characterizing, cryopreserving, and manipulating in vitro cells in addition to independent research experience. Additional skills will include Basic Aseptic Technique; Media Preparation; Cell counting; Survival assays, Live Cell Identification and Transfection. These skills are crucial for individuals seeking career opportunities in the biotechnology field.
Prerequisite: BIOL-309, BIOL-309L

BIOT-500 Career Prep/Biosci Industry Engagement 1 Credit
Preparation for PSM Program and Bioscience Industry Engagement. Career preparation for successful entry and development in biotechnology. Community and interactive discussion topics including the business of science, career opportunities, industry and workforce trends, and overview of the biotechnology industry. Intended to help students identify career values and goals and get them on track for being successful in finding a meaningful project for their capstone experience. Students will research potential internship sites and develop a plan for securing a project. In addition to writing a resume and cover letter, students will develop interviewing and networking skills, set goals and learning objectives, and learn skills that will ensure their success in their internships or research projects.

BIOT-503 Advanced Research Methods in Biotech 3 Credits
Methodology and application in biotechnology. This course is primarily lab based and will prepare students for independent research project. The following topics will be covered: genetic engineering techniques for introducing a gene for a desired protein into a cell with vectors, techniques for growing bacteria and yeast to produce a desired protein, cell transformation by electroporation, blue/white screening for selection of a colony with successful transformation with the desired vector, identification of a plasmid with PCR and DNA sequencing, use of enzyme assays to measure protein concentration in solutions, fed-batch yeast fermentation, mammalian cell culture techniques, and analysis of protein expression by Western blot. Lab fee.

BIOT-505 Bioinformatics 3 Credits
Introduction to bioinformatic resources/methods for biologists. Topics include: biological databases, sequence alignment, gene and protein structure prediction, molecular phylogenetics, genomics and proteomics. Students will gain practical experience with bioinformatics tools and develop basic skills in the collection and presentation of bioinformatics data.

BIOT-505L Bioinformatics Laboratory 1 Credit
Introduction to bioinformatic resources/methods for biologists. Topics include: biological databases, sequence alignment, gene and protein structure prediction, molecular phylogenetics, genomics and proteomics. Students will gain practical experience with bioinformatics tools and develop basic skills in the collection and presentation of bioinformatics data. This lab course must be taken concurrently with lecture BIOT-505.

BIOT-508 Legal and Social Ethics in Science 3 Credits
A seminar course that examines the ethical implications of decisions made in biotechnology as well as the responsibilities of life scientists in the biomedical development process, including industry, government, and healthcare authorities and in their communities. Course discussions include stewardship and environmental impacts of biomanufacturing as well as ethical use of laboratory animals. Students examine ethical issues related to biomedical product advancement and use, and specific areas of science are also explored from a Christian ethics viewpoint through lectures, student oral presentations, team debate, and final written projects.

BIOT-511 Regulations and Quality Management 2 Credits
A course designed for science professionals to develop and apply skills and knowledge for managing business operations. Real-world business cases are used to develop students' management capacity and capability. Areas of focus include the process view of organizations, performance measures, products and product attributes, production processes, process competencies, procurement and supply chain management and regulatory requirements. The laws and regulations enforced by the Food and Drug Administration and other regulatory agencies related to the biotechnology, pharmaceutical, and medical device industries are surveyed. Included is the U.S. legal regulatory system, Food, Drug, and Cosmetic Act and related laws, Freedom of Information Act, regulation affecting foods, drugs, biologics, veterinary products, diagnostics, and devices, FDA enforcement, product liability, and import/export requirements. Reviews the impact of quality systems and the functions, roles, and responsibilities on Quality Assurance and Quality Control.

BIOT-513 Cell Culture Techniques 3 Credits
This course is primarily lab based and will focus on teaching the techniques necessary to maintain mammalian cells in culture and manipulating stem cells. Exercises will include hands-on training isolating, maintaining, characterizing, cryopreserving, and manipulating in vitro cells in addition to independent research experience. Additional skills will include Basic Aseptic Technique; Media Preparation; Cell counting; Survival assays, Live Cell Identification and Transfection. These skills are crucial for individuals seeking career opportunities in the biotechnology field.

BIOT-515 Experimental Design and Statistical Analysis 3 Credits
Introduces advanced statistical concepts and analytical methods for the experimental needs and data encountered in biotechnology and biomedical sciences. Experimental design/conduct, quantitative analysis of data, and statistical inferences and interpretations are studied for scientific hypothesis testing, as well as clinical trials. Explores methodological approaches to bioassay development/testing and provides a foundation for critically evaluating information to support research findings, product claims, and technology opportunities. Students are recommended to be familiar with Python programming.
Terms Typically Offered: Fall.

BIOT-550 Internship Program 1-4 Credits
This course may be taken for a maximum of four (4) units in one term. A maximum of eight (8) combined credit units apply to graduation. This course is designed with the purpose of providing students the opportunity to conduct research off-campus at STEM companies in the community. This course promotes early entry into the workplace for the student through part-time employment. This course requires actual work experience be sought in a biotech or STEM-focused business firm providing an opportunity to integrate classroom teaching in practical application under the direct supervision of the assigned instructor. Students are responsible for completing a project report and presenting their research results in BIOT-699.

BIOT-600 Bioinnovation/Entrepreneurship/Biotech 2 Credits
A seminar course that develops skills in managing bioentrepreneurship projects in the bioscience and biomedical device fields. Students learn how to be responsive team members as well as communicative team leaders. This course also investigates issues and decisions that inventor / scientists, investors, founders, business people, lawyers, and others might typically encounter when they are considering the application and commercialization of early stage scientific discoveries. And how to sustain innovation in organizations and team dynamics.

BIOT-603 Bus Analytics and Proffessional Comm 3 Credits
A course that focuses on oral and written communication for both scientific and nonscientific audiences for a variety of sources in biotechnology, including journals, investor relations, and regulatory documentation. Topics include uses and management of information; decision tools and concepts; quality control.

BIOT-685 Independent Advanced Research 4-6 Credits
Students conduct supervised, independent research in Biotechnology. The student and faculty supervisor together develop a course outline, with a proposal for original research and the method of evaluation, including a formal research paper. Outline must be approved by the department before the student is permitted to register. Students will present their work in oral and written format. A maximum of eight (8) combined units apply to graduation.

BIOT-699 Graduate Seminar 1 Credit
Seminar series with invited biology speakers including many prominent scientists and leaders working at biotechnology companies. Students will be expected to present their research at these Seminars. Graduate students are to take this course every Spring. This course is repeatable to a maximum of 3 units.
Prerequisite: BIOT-550 or BIOT-685