Biotechnology (BIT)

BIT 2 200 Level Biotechnology** (0.33-12 credit hours)

BIT 100 Current Topics in Biotechnology (4 credit hours)
This course provides both science and non-science students an opportunity to learn about current issues in biotechnology that play a role in our society. Topic areas will include contemporary and historical applications of biotechnology. From alternative fuel sources to the ramifications of the elucidation of the human genome on health care issues, advances in biotechnology are constantly reshaping the world we live in. Students will give presentations and participate in discussions in the classroom, as well as be engaged in the laboratory on a variety of different topics in biotechnology that affects all our lives.

Prerequisite: High School Biology
GEP Interdisciplinary Perspectives, GEP Natural Sciences
Typically offered in Fall only

BIT 200 Early Research in Biotechnology (4 credit hours)
This course offers first-and second-year students an opportunity for a mentored research experience in a small class environment. Students will learn how to apply the scientific method to make new discoveries and contribute to scientific knowledge. Students may need to come to the lab outside class meeting times to complete work on occasion (flexible hours). Examples of research questions to be investigated in different sections: - Investigating bacteriophage for the management of American Floubrood Disease (AFS) of honey bees - Using planarian as a model system for studying genes important in stem cell differentiation and regeneration - Investigating the genetic potential of complex microbial populations. - Gene expression profiling in zebrafish embryos exposed to antibiotics and anti-acne compounds Freshmen and Sophomores only.

Prerequisite: High School Biology
GEP Natural Sciences
Typically offered in Fall and Spring

BIT 210/MB 210 Phage Hunters (3 credit hours)
This course offers first-year students an opportunity for mentored research. Students will apply the scientific method to make novel discoveries. Students will isolate and characterize naturally-occurring bacteriophage (viruses that infect bacteria, but not humans) from the environment. They will present their data to each other, and the genome of one phage will be sequenced. Students have the option to continue in a second semester to annotate that genome, culminating in a submission to genbank and a poster presentation. Students in the course are part of the National Genome Research Initiative funded by The Howard Hughes Medical Institute. Student should have had a high school biology course before taking this course.

GEP Natural Sciences
Typically offered in Fall only

BIT 211/MB 211 Phage Genomics (2 credit hours)
This course offers first-year students an opportunity for mentored research. Student will apply the scientific method to make novel discoveries. Students will build on the work they began in BIT/MB 210; The novel phage isolated in the previous semester will undergo genome sequencing over winter break, and in this course students will learn to analyze and annotate the genome sequence. This semester will culminate in a submission to genbank and a poster presentation. Students in the course are part of the national genome research initiative funded by the Howard Hughes Medical Institute.

Prerequisite: BIT(MB) 210
GEP Natural Sciences
Typically offered in Spring only

BIT 214 Biotechnology and Sustainability (3 credit hours)
While technological advances have made it easier to communicate, collaborate, and work online, we face global challenges with recycling discarded electronics such as cell phones and computers. What happens to that old computer or cell phone? In this course, we will dive into the misconceptions, social justice issues, and technologies that will be critical in addressing this challenge. We will explore biotechnologies and genomic data to ask: can we harness the power of microbes around us to recycle electronic waste? The BIT 214 Biotechnology & Sustainability course will empower you to be curious, interact with experts from various disciplines, and use powerful online resources to explore potential solutions. Explore, learn, and share as we use realistic scenarios, cloud-based tools, and biotechnologies to think about life on our electronics after we discard them.

GEP Interdisciplinary Perspectives
Typically offered in Fall and Spring

BIT 295 Special Topics in Biotechnology (1-3 credit hours)
Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

Typically offered in Fall, Spring, and Summer

BIT 402/BIT 502 Biotechnology Networking and Professional Development (1 credit hours)
This course provides students interested in the biotechnology field an opportunity to gain valuable network, job application, and interviewing skills. Over the course of the semester students will meet with ~20 biotechnology professionals in our area. In addition, students will learn from individuals in biotechnology jobs about the diverse careers options available and strategies for navigating the job market successfully.

Prerequisite: Graduate Standing
Typically offered in Fall and Spring

BIT 410 Manipulation of Recombinant DNA (4 credit hours)
Introduction to molecular biology and protein chemistry. Theory behind laboratory techniques and overview of cloning strategies starting from nucleic acid or protein sequence data. Laboratory sessions involve subcloning, preparation of competent cells, transformation, screening recombinant DNA by colony hybridization and PCR, SDS-PAGE of recombinant protein, affinity purification, and western blots.

Prerequisite: BIO 183 or ZO/BIO 160 and CH 223 or CH 227 with a C- or better
Typically offered in Fall, Spring, and Summer

BIT 455/BIT 555 Cancer Drug Discovery and Development (2 credit hours)
Understanding the molecular and cellular events involved in tumor formation, progression, and metastasis are crucial to the development of innovative therapies for individuals suffering from cancer. Basic research has provided much insight into these pathways through the use of biochemical, molecular, and genetic analyses in yeast, cell culture, mice and other model systems. In this course, we will explore the major discoveries in cancer biology, the laboratory tools and techniques used in cancer drug discovery, and the recent advances in cancer therapies with a focus on the primary scientific literature.

Prerequisite: BIT 410 or 510
Typically offered in Fall and Spring

BIT 456/BIT 556 Next Gen Forensic DNA Analysis (2 credit hours)
DNA forensics is on the brink of a revolution with novel approaches at the bench using next-generation sequencing (NGS), but also with computing using advanced bioinformatics. It is anticipated that applications of these new methods and approaches will help provide more investigative leads in cases, solve more crimes, and decide cold cases. Further, the analysis of biological materials commonly associated with forensic evidence but rarely analyzed using DNA-based approaches (e.g., plants, insects, fungi, bacteria), will become more accessible. This class is designed to a) introduce students to the diverse applications of NGS to both human and non-human forensic casework, and b) engage students in the hands-on preparation and analysis of NGS data for forensic applications. Finally, the applications and future of DNA forensics for crime fighting will be explored for ethics, application and practice.

Prerequisite: BIT 410 or Instructor Permission
Typically offered in Spring only

BIT 457/BIT 557 Introduction to Biological Electron Microscopy Techniques (2 credit hours)
Students will be introduced to the fundamental principles behind TEM and SEM instrumentation. Various biological specimen preparation techniques used for both types of instrument as well as cryo techniques will be discussed. Students will have the opportunity to prepare their own biological sample and use both instruments.

Prerequisite: BIT 410 or Instructor Permission
Typically offered in Spring only

BIT 458/BIT 558 Directed Evolution (2 credit hours)
Designing new enzymes and/or pathways for production of useful molecules is an important goal of biotechnology. However, a limited understanding of structure-function relationships and complete biological pathways makes rational design extremely challenging, even in the 21st century. Using a "survival of the fittest" scheme to have various possible enzymes and/or pathways compete can quickly yield useful results. We will discuss the approach to directing evolution towards particular goals through selective pressures and careful experimental design. In lecture, we will cover different approaches to and targets of directed evolution and how to validate a mutant phenotype created through this method. In lab, we will demonstrate approaches to directed evolution by using both specific protein and whole microbe targets.

Prerequisite: BIT 410 or BCH 454 or instructor permission
Typically offered in Spring only

BIT 459/BIT 559 Portable Genome Sequencing (2 credit hours)
The Portable Genome Sequencing course is a half-semester hands-on introduction to portable genome sequencing technologies. We will extend many concepts you learned in your molecular biology course to new situations, including the challenges and opportunities of using Oxford Nanopore Technologies for long-read sequencing in the field. We will also learn from case studies and videos. Effectively sequencing to obtain useful information requires consideration of sample preservation, nucleic acid extraction, library preparation, and data analyses. Together, we will learn and share resources using a series of lab experiments as examples.

Prerequisite: BIT 410
Typically offered in Spring only

BIT 464/BIT 564 Protein Purification (2 credit hours)
Comparison of several different chromatography techniques for protein purification. Construction of purification tables and SDS-and native-PAGE analysis. Cost-benefit analysis of industrial-scale procedures. This is a half semester course.

Prerequisite: BIT 410 or BIT 510 or BCH 454
Typically offered in Spring only
This course is offered alternate even years

BIT 465/BIT 565 Real-time PCR Techniques (2 credit hours)
Real time PCR is an evolving technique with its basis in the dynamic properties of the polymerase chain reaction and fluorescent detection. We will review current real-time theory, techniques, machinery, troubleshooting, tools, and advanced protocols for sequence detection including SYBR green, TaqMan, Beacons, multiplexing, and single nucleotide polymorphism analysis. Students will have the opportunity to utilize skills learned during lecture in a laboratory environment. At the conclusion of this course, students should feel comfortable with real-time experimental design, its tools, and analysis of generated data. This is a half-semester course. Student must register for both lecture and lab sections.

Prerequisite: BIT 410 or 510
Typically offered in Spring only

BIT 466/BIT 566 Animal Cell Culture Techniques (2 credit hours)
Introduction to animal cell culture techniques. Aseptic technique for vertebrate cell culture, media formulation, primary cell culture, long-term maintenance of cell lines, application of molecular techniques to in vitro situations. Half semester course, first part.

Typically offered in Fall, Spring, and Summer

BIT 467/BIT 567 PCR and DNA Fingerprinting (2 credit hours)
Introduction to polymerase chain reaction. Optimization of PCR reactions and primer design for DNA sequences using DNA databases available on the web. Laboratory sections include using rapid techniques for isolating and sequencing DNA from small amounts of sample and forensic identification of individuals using isolated human hairs. Credit is not allowed for both BIT 467 and BIT 567.

Prerequisite: BIT 410/510
Typically offered in Spring only

BIT 471/BIT 571 RNA Interference and Model Organisms (2 credit hours)
Introduction and history of RNA interference technology. Principles, mechanism, and applications of RNA interference in model organisms. Laboratory sessions include RNA interference-mediated silencing of genes in plants, C. elegeans, and mammalian cell culture. This is a half-semester course (8 weeks). Student may not earn credit for both BIT 471 and BIT 571.

Prerequisite: BIT 410 or BIT 510 or BCH 454
Typically offered in Spring only

BIT 473/BIT 573 Protein Interactions (2 credit hours)
The interactions of proteins mediate numerous biological processes of cells. This course focuses on ways to identify and study protein-protein interactions, focusing on the advantages and limitations of each technique and how to apply the methods in a laboratory setting. In lab, students will perform a yeast two-hybrid experiment and a co-immunoprecipitation from proteins expressed in mammalian cell culture to confirm detected interactions. This a half-semester course.

Prerequisite: BIT 410 or BCH 454
Typically offered in Fall only

BIT 474/BIT 574 Plant Genetic Engineering (2 credit hours)
This course covers fundamental hands-on techniques and strategies in plant genetic engineering. Plants are major sources of food, fiber and fuel and provide model systems for both fundamental and applied research. Students will learn techniques for stable and transient transformation of plants and plant cell cultures and selection and detection of transgene expression. Additional topics covered will include methods to generate and screen for mutants, synthetic biology and applications of plant genetic engineering. This is a half-semester course. Credit is not allowed for both BIT 474 and BIT 574.

Prerequisite: BIT 410 or BIT 510 or BCH 454 or PB 421
Typically offered in Fall and Spring

BIT 476 Applied Bioinformatics (2 credit hours)
The haploid human genome occupies a total of just over 3 billion DNA base pairs. This information is not contained in books, but stored in electronic databases. Computational biology utilizes infer function by comparative analysis. This course is designed for life scientists from all fields to introduce them to the power of bioinformatics and enable them to access and utilize biological information in databases for their own research.

Prerequisite: BIT 410 or BCH 454 or GN 311
Typically offered in Fall only
This course is offered alternate even years

BIT 477/BIT 577 Metagenomics (2 credit hours)
Participants will be introduced to a variety of methods for studying the complex microbial populations that surround us, including theory, applications, limitations, and health and legal implications. Students will apply deep sequencing techniques to mine the genetic diversity of complex microbial populations such as the rhizosphere, a swine lagoon sample, or even the communities of microbes growing happily inside your kitchen sink drain. This course will provide hands-on experience with molecular and computational tools that can be used to study the relationships between microbial communities and ecosystems or hosts.

Prerequisite: BIT 410 or 510
Typically offered in Fall only

BIT 479/BIT 579 High-Throughput Discovery (2 credit hours)
In this eight-week lab module, participants will be introduced to high-throughput (HT) discovery science and the underlying quantitative biology skills necessary for robust assay design. Participants will learn modern high-throughput screening approaches that will prepare them to design, validate, and perform cutting-edge screens. Different HT approaches will be discussed using authentic case studies and critical thinking scenarios based on published studies. Essential quantitative biology skills for the design and analysis of HT discovery science will be emphasized and tested regularly using "biomath" quizzes. The power of automation and robotics will be highlighted and hands-on experience with a liquid handler and the software used to operate it will be routine in the lab sessions. Participants will also be exposed to novel high-throughput approaches through discussions of new technologies and guest speakers who are experts in the field. Students will not receive credit for both BIT 479 and BIT 579.

Prerequisite: BIT 410 or 510
Typically offered in Spring only

BIT 480/BIT 580 Yeast Metabolic Engineering (2 credit hours)
Participants will be introduced to a variety of methods for using yeast to produce commercially relevant products. Topics will include cultivation, genetic manipulation to delete or replace genes, transformation, heterologous gene expression and codon optimization/gene synthesis. Various modern molecular cloning approaches and computational resources will be discussed. Students will apply gene manipulation approaches to engineer Saccharomyces cerevisiae to produce beta-carotene and/or other relevant biotechnology products. This will be accomplished by assembling a series of optimized genes in the biosynthetic pathway using the versatile genetic assembly system (VEGAS) that exploits the capacity of Saccharomyces cerevisiae to join sequences with terminal homology by homologous recombination. Expression will be compared by assembling libraries of transcriptional units with different promoters and using different genetic knock-outs as hosts. Additionally, computational modeling of metabolic processes will be used to assess perturbations to metabolic fluxes.

Prerequisite: BIT 410 or 510
Typically offered in Spring only

BIT 481/PB 481 Plant Tissue Culture and Transformation (2 credit hours)
Basic techniques in plant tissue culture and transformation. Empirical approaches to techniques in plant tissue culture, designing transgenes for expression in specific plant cell organelles and tissues, use of reporter genes to optimize transformation, and troubleshooting transformation. Laboratory sessions provide hands-on experience with plant tissue culture and transformation. Use of reporter genes, fluorescence microscopy and digital imaging. Half semester course, first part.

Typically offered in Spring only

BIT 482/BIT 582 Virus Biotechnology: Pathogens to Therapeutics (2 credit hours)
In this course, students will be introduced to concepts spanning principles in molecular virology through to engineering of viruses as molecular therapeutics. Students will be able to describe the basic tenets of molecular virology, articulate several principle uses of viruses in biotechnology applications, and perform data analysis on several fundamental virus assays.

Prerequisite: BIT 410
Typically offered in Fall and Spring

BIT 492 External Learning Experience (1-6 credit hours)
A learning experience in the area of biotechnology within an academic framework that utilizes facilities and resources which are external to the campus. Contact and arrangements with prospective employers must be initiated by student and approved by a faculty adviser, the prospective employer, and the departmental teaching coordinator prior to the experience. Project must be approved by the Academic Coordinator or Program Director of the Biotechnology Program.

Typically offered in Summer only

BIT 493 Special Problems in Biotechnology (1-6 credit hours)
A learning experience within an academic framework that utilizes campus facilities and resources. Contact and arrangements with prospective mentor(s) must be initiated by student and approved by a faculty adviser, the prospective mentor, and the departmental teaching coordinator prior to the experience. Project must be approved by the Academic Coordinator of Program Director of the Biotechnology Program.

Typically offered in Fall, Spring, and Summer

BIT 495 Special Topics in Biotechnology (1-3 credit hours)
Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

Typically offered in Fall, Spring, and Summer

BIT 501 Ethical Issues in Biotechnology (1 credit hours)
Students investigate and discuss current controversial issues in biotechnology. This course emphasizes thinking about new technologies in a rational and thoughtful way.

Typically offered in Fall and Spring

BIT 502/BIT 402 Biotechnology Networking and Professional Development (1 credit hours)
This course provides students interested in the biotechnology field an opportunity to gain valuable network, job application, and interviewing skills. Over the course of the semester students will meet with ~20 biotechnology professionals in our area. In addition, students will learn from individuals in biotechnology jobs about the diverse careers options available and strategies for navigating the job market successfully.

Prerequisite: Graduate Standing
Typically offered in Fall and Spring

BIT 510 Core Technologies in Molecular and Cellular Biology (4 credit hours)
Basic technologies of recombinant DNA procedures, gene expression, isolation and identification of nucleic acids and proteins.

Prerequisite: Equivalent of CH 223 and (MB 251 or GN 311) and Graduate standing
Typically offered in Fall, Spring, and Summer

BIT 555/BIT 455 Cancer Drug Discovery and Development (2 credit hours)
Understanding the molecular and cellular events involved in tumor formation, progression, and metastasis are crucial to the development of innovative therapies for individuals suffering from cancer. Basic research has provided much insight into these pathways through the use of biochemical, molecular, and genetic analyses in yeast, cell culture, mice and other model systems. In this course, we will explore the major discoveries in cancer biology, the laboratory tools and techniques used in cancer drug discovery, and the recent advances in cancer therapies with a focus on the primary scientific literature.

Prerequisite: BIT 410 or 510
Typically offered in Fall and Spring

BIT 556/BIT 456 Next Gen Forensic DNA Analysis (2 credit hours)
DNA forensics is on the brink of a revolution with novel approaches at the bench using next-generation sequencing (NGS), but also with computing using advanced bioinformatics. It is anticipated that applications of these new methods and approaches will help provide more investigative leads in cases, solve more crimes, and decide cold cases. Further, the analysis of biological materials commonly associated with forensic evidence but rarely analyzed using DNA-based approaches (e.g., plants, insects, fungi, bacteria), will become more accessible. This class is designed to a) introduce students to the diverse applications of NGS to both human and non-human forensic casework, and b) engage students in the hands-on preparation and analysis of NGS data for forensic applications. Finally, the applications and future of DNA forensics for crime fighting will be explored for ethics, application and practice.

Prerequisite: BIT 410 or Instructor Permission
Typically offered in Spring only

BIT 557/BIT 457 Introduction to Biological Electron Microscopy Techniques (2 credit hours)
Students will be introduced to the fundamental principles behind TEM and SEM instrumentation. Various biological specimen preparation techniques used for both types of instrument as well as cryo techniques will be discussed. Students will have the opportunity to prepare their own biological sample and use both instruments.

Prerequisite: BIT 410 or Instructor Permission
Typically offered in Spring only

BIT 558/BIT 458 Directed Evolution (2 credit hours)
Designing new enzymes and/or pathways for production of useful molecules is an important goal of biotechnology. However, a limited understanding of structure-function relationships and complete biological pathways makes rational design extremely challenging, even in the 21st century. Using a "survival of the fittest" scheme to have various possible enzymes and/or pathways compete can quickly yield useful results. We will discuss the approach to directing evolution towards particular goals through selective pressures and careful experimental design. In lecture, we will cover different approaches to and targets of directed evolution and how to validate a mutant phenotype created through this method. In lab, we will demonstrate approaches to directed evolution by using both specific protein and whole microbe targets.

Prerequisite: BIT 410 or BCH 454 or instructor permission
Typically offered in Spring only

BIT 559/BIT 459 Portable Genome Sequencing (2 credit hours)
The Portable Genome Sequencing course is a half-semester hands-on introduction to portable genome sequencing technologies. We will extend many concepts you learned in your molecular biology course to new situations, including the challenges and opportunities of using Oxford Nanopore Technologies for long-read sequencing in the field. We will also learn from case studies and videos. Effectively sequencing to obtain useful information requires consideration of sample preservation, nucleic acid extraction, library preparation, and data analyses. Together, we will learn and share resources using a series of lab experiments as examples.

Prerequisite: BIT 410
Typically offered in Spring only

BIT 564/BIT 464 Protein Purification (2 credit hours)
Comparison of several different chromatography techniques for protein purification. Construction of purification tables and SDS-and native-PAGE analysis. Cost-benefit analysis of industrial-scale procedures. This is a half semester course.

Prerequisite: BIT 410 or BIT 510 or BCH 454
Typically offered in Spring only
This course is offered alternate even years

BIT 565/BIT 465 Real-time PCR Techniques (2 credit hours)
Real time PCR is an evolving technique with its basis in the dynamic properties of the polymerase chain reaction and fluorescent detection. We will review current real-time theory, techniques, machinery, troubleshooting, tools, and advanced protocols for sequence detection including SYBR green, TaqMan, Beacons, multiplexing, and single nucleotide polymorphism analysis. Students will have the opportunity to utilize skills learned during lecture in a laboratory environment. At the conclusion of this course, students should feel comfortable with real-time experimental design, its tools, and analysis of generated data. This is a half-semester course. Student must register for both lecture and lab sections.

Prerequisite: BIT 410 or 510
Typically offered in Spring only

BIT 566/BIT 466 Animal Cell Culture Techniques (2 credit hours)
Introduction to animal cell culture techniques. Aseptic technique for vertebrate cell culture, media formulation, primary cell culture, long-term maintenance of cell lines, application of molecular techniques to in vitro situations. Half semester course, first part.

Typically offered in Fall, Spring, and Summer

BIT 567/BIT 467 PCR and DNA Fingerprinting (2 credit hours)
Introduction to polymerase chain reaction. Optimization of PCR reactions and primer design for DNA sequences using DNA databases available on the web. Laboratory sections include using rapid techniques for isolating and sequencing DNA from small amounts of sample and forensic identification of individuals using isolated human hairs. Credit is not allowed for both BIT 467 and BIT 567.

Prerequisite: BIT 410/510
Typically offered in Spring only

BIT 571/BIT 471 RNA Interference and Model Organisms (2 credit hours)
Introduction and history of RNA interference technology. Principles, mechanism, and applications of RNA interference in model organisms. Laboratory sessions include RNA interference-mediated silencing of genes in plants, C. elegeans, and mammalian cell culture. This is a half-semester course (8 weeks). Student may not earn credit for both BIT 471 and BIT 571.

Prerequisite: BIT 410 or BIT 510 or BCH 454
Typically offered in Spring only

BIT 572/BIO 572/CH 572 Proteomics (3 credit hours)
Introduction and history of the field of proteomics followed by the principles and applications of proteomics technology to understand protein expression and protein post-transitional modifications. Laboratory sessions include growing yeast with stable-isotope labeled amino acids, protein purification, Western blots, protein identification and quantification, and protein bioinformatic analysis. This is a half-semester course.

Prerequisite: BIT 410 or BIT 510 or BCH 454 (or approval from the instructor)
Typically offered in Spring only

BIT 573/BIT 473 Protein Interactions (2 credit hours)
The interactions of proteins mediate numerous biological processes of cells. This course focuses on ways to identify and study protein-protein interactions, focusing on the advantages and limitations of each technique and how to apply the methods in a laboratory setting. In lab, students will perform a yeast two-hybrid experiment and a co-immunoprecipitation from proteins expressed in mammalian cell culture to confirm detected interactions. This a half-semester course.

Prerequisite: BIT 410 or BCH 454
Typically offered in Fall only

BIT 574/BIT 474 Plant Genetic Engineering (2 credit hours)
This course covers fundamental hands-on techniques and strategies in plant genetic engineering. Plants are major sources of food, fiber and fuel and provide model systems for both fundamental and applied research. Students will learn techniques for stable and transient transformation of plants and plant cell cultures and selection and detection of transgene expression. Additional topics covered will include methods to generate and screen for mutants, synthetic biology and applications of plant genetic engineering. This is a half-semester course. Credit is not allowed for both BIT 474 and BIT 574.

Prerequisite: BIT 410 or BIT 510 or BCH 454 or PB 421
Typically offered in Fall and Spring

BIT 577/BIT 477 Metagenomics (2 credit hours)
Participants will be introduced to a variety of methods for studying the complex microbial populations that surround us, including theory, applications, limitations, and health and legal implications. Students will apply deep sequencing techniques to mine the genetic diversity of complex microbial populations such as the rhizosphere, a swine lagoon sample, or even the communities of microbes growing happily inside your kitchen sink drain. This course will provide hands-on experience with molecular and computational tools that can be used to study the relationships between microbial communities and ecosystems or hosts.

Prerequisite: BIT 410 or 510
Typically offered in Fall only

BIT 579/BIT 479 High-Throughput Discovery (2 credit hours)
In this eight-week lab module, participants will be introduced to high-throughput (HT) discovery science and the underlying quantitative biology skills necessary for robust assay design. Participants will learn modern high-throughput screening approaches that will prepare them to design, validate, and perform cutting-edge screens. Different HT approaches will be discussed using authentic case studies and critical thinking scenarios based on published studies. Essential quantitative biology skills for the design and analysis of HT discovery science will be emphasized and tested regularly using "biomath" quizzes. The power of automation and robotics will be highlighted and hands-on experience with a liquid handler and the software used to operate it will be routine in the lab sessions. Participants will also be exposed to novel high-throughput approaches through discussions of new technologies and guest speakers who are experts in the field. Students will not receive credit for both BIT 479 and BIT 579.

Prerequisite: BIT 410 or 510
Typically offered in Spring only

BIT 580/BIT 480 Yeast Metabolic Engineering (2 credit hours)
Participants will be introduced to a variety of methods for using yeast to produce commercially relevant products. Topics will include cultivation, genetic manipulation to delete or replace genes, transformation, heterologous gene expression and codon optimization/gene synthesis. Various modern molecular cloning approaches and computational resources will be discussed. Students will apply gene manipulation approaches to engineer Saccharomyces cerevisiae to produce beta-carotene and/or other relevant biotechnology products. This will be accomplished by assembling a series of optimized genes in the biosynthetic pathway using the versatile genetic assembly system (VEGAS) that exploits the capacity of Saccharomyces cerevisiae to join sequences with terminal homology by homologous recombination. Expression will be compared by assembling libraries of transcriptional units with different promoters and using different genetic knock-outs as hosts. Additionally, computational modeling of metabolic processes will be used to assess perturbations to metabolic fluxes.

Prerequisite: BIT 410 or 510
Typically offered in Spring only

BIT 581 Plant Transformation (2 credit hours)

BIT 582/BIT 482 Virus Biotechnology: Pathogens to Therapeutics (2 credit hours)
In this course, students will be introduced to concepts spanning principles in molecular virology through to engineering of viruses as molecular therapeutics. Students will be able to describe the basic tenets of molecular virology, articulate several principle uses of viruses in biotechnology applications, and perform data analysis on several fundamental virus assays.

Prerequisite: BIT 410
Typically offered in Fall and Spring

BIT 588/MB 588 Microbiome Analysis (3 credit hours)
Microbiomes are increasingly recognized for their important roles in ecosystem services ranging from human health to soil biogeochemical cycling. Studying these complex communities relies on DNA sequencing, which often generates large, sparse datasets. Students will be introduced to conceptual and practical aspects of how to analyze microbiome data, and will apply both bioinformatics and statistical approaches. Topics include identifying microbial sequence variants, exploratory analysis of microbial community diversity and structure, applying hypothesis testing to complex microbiome data, and reproducible research.

Prerequisite: Graduate Standing
Typically offered in Spring only

BIT 590 Independent Study in Biotechnology (1-3 credit hours)
Independent study in Biotechnology under the supervision of a Biotechnology faculty member. Restricted to graduate students in the Biotechnology Program with consent of the supervising faculty. May not be taken in the first semester of graduate study.

Typically offered in Fall, Spring, and Summer

BIT 595 Special Topics (1-6 credit hours)
Offered as needed to present materials not normally available in regular course offerings or for offering of new courses on a trial basis.

Typically offered in Fall, Spring, and Summer

BIT 685 Master's Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Master's students only
Typically offered in Fall and Spring

BIT 693 Master's Supervised Research (1-9 credit hours)
Instruction in research and research under the mentorship of a member of the Graduate Faculty.

Prerequisite: Master's student
Typically offered in Fall, Spring, and Summer

BIT 790 Independent Study in Biotechnology (1-3 credit hours)
Independent study in Biotechnology under the supervision of a Biotechnology faculty member. Restricted to graduate students in the Biotechnology Program with consent of the supervising faculty. May not be taken in the first semester of graduate study.

Typically offered in Fall, Spring, and Summer

BIT 811 Molecular Biotechnology Professional Development (2 credit hours)
In this course, students will be introduced to concepts and practices related to Professional Development for PhD-level biotechnology-focused careers in science and engineering (academia, industry, government).

Pre-requisite: BIT 510 Core Technologies in Molecular and Cellular Biology
Typically offered in Fall only

BIT 812 Capstone Biotechnology (3 credit hours)
In this course, students will be introduced to concepts and practices related to the biotechnology industry, how the stock market influences technology development, how technology transfer happens, and the process by which a technology company forms.

Prerequisite: BIT 510
Typically offered in Spring only

BIT 813 Research Ethics in Biotechnology (1 credit hours)
Students will be introduced to concepts and practices related to the Responsible Conduct of Research in the biotechnology field. Students will have the opportunity to engage in relevant group activities and several guest speakers will provide additional perspective.

Prerequisite: BIT 510 and Graduate standing
Typically offered in Fall only

BIT 814 Rigor & Reproducibility in Research (2 credit hours)
This course will engage graduate student researchers on issues related to rigor and reproducibility in biological and biotechnology research, including technical rigor, descriptions of methods and reagents, proper controls, and statistical analyses, through active discussions and literature examination.

Prerequisite: BIT 510 and Graduate Standing
Typically offered in Spring only

BIT 815 Advanced Special Topics (1-6 credit hours)
Intensive three-week or six-week courses in advanced technologies such as DNA sequencing, downstream processing, immunological techniques, construction of c-DNA libraries, mammalian embryo manipulation, plant transformation, bioreactor design, cloning in gram positive bacteria, electron microscopy or techniques in yeast molecular biology.

Prerequisite: BIT 510
Typically offered in Summer only

BIT 885 Doctoral Supervised Teaching (1-3 credit hours)
Teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of the assignment.

Doctoral students only (DR)
Typically offered in Fall and Spring