BIOCHEMISTRY (BIOC)

BIOC 101. Frontiers in Biochemistry. 1 Unit.
The goal of this course is to introduce first- and second-year students to the field of biochemistry as a fundamental discipline in the biomedical sciences. The course will present basic concepts in biochemistry and highlight recent advances. It will also emphasize the way that biochemistry forms a foundation for research in many other areas of the basic and clinical biomedical sciences and provides the molecular basis for new therapies. Finally, the course will feature an introduction to the practice of biochemistry, including research and careers in biochemistry. This course is an excellent introduction for students who are considering majoring in Biochemistry. Material will be presented in a format that is accessible to students who have taken high school biology and chemistry.

BIOC 285. Honors Readings in Biochemistry. 1 Unit.
This course for students in the Biochemistry Honors Research track will introduce students to biochemistry through weekly one-on-one meetings with a faculty mentor. Students will read and discuss articles from the scientific literature and work with the mentor to find a placement for their undergraduate research. There will also be sessions on the responsible conduct of research. Open by permission to students in the Biochemistry Research Honors Track.

BIOC 307. Introduction to Biochemistry: From Molecules To Medical Science. 4 Units.
Overview of the macromolecules and small molecules key to all living systems. Topics include: protein structure and function; enzyme mechanisms, kinetics and regulation; membrane structure and function; bioenergetics; hormone action; intermediary metabolism, including pathways and regulation of carbohydrate, lipid, amino acid, and nucleotide biosynthesis and breakdown. The material is presented to build links to human biology and human disease. One semester of biology is recommended. Offered as BIOC 307 and BIOC 407. Prereq: CHEM 223 and CHEM 224.

BIOC 308. Molecular Biology. 4 Units.
An examination of the flow of genetic information from DNA to RNA to protein. Topics include: nucleic acid structure; mechanisms and control of DNA, RNA, and protein biosynthesis; recombinant DNA; and mRNA processing and modification. Where possible, eukaryotic and prokaryotic systems are compared. Special topics include yeast as a model organism, molecular biology of cancer, and molecular biology of the cell cycle. Current literature is discussed briefly as an introduction to techniques of genetic engineering. Recommended preparation: BIOC 307. Offered as BIOC 308 and BIOC 408. Prereq: BIOL 214 and BIOL 215 and (CHEM 223 or CHEM 323).

BIOC 310. Microbial Physiology and Therapeutic Opportunities. 3 Units.
This course will cover the physiology and metabolic pathways of microbes, with a biomedical emphasis on bacteria and archaea and a brief discussion of fungi and other eukaryotic organisms. We will emphasize how physiological and metabolic characteristics can either be targeted (in the case of infectious disease) or utilized/exploited (in the case of, for instance, antibiotics and other bioactive natural products and fermentation products). Offered as BIOC 310 and BIOC 410. Prereq: BIOL 215 and (CHEM 223 or CHEM 323).

BIOC 311. Antimicrobial Therapies and Resistance. 3 Units.
This course focuses on the biochemistry and molecular biology of antimicrobial compounds. This includes antibiotics, the drugs clinically used to treat diseases caused by bacteria, antifungals, antiparasitic agents, and antivirals. We will examine the history of antibiotic development; characteristics of chemicals used as antiseptics and disinfectants but unable to be used as therapies; and then survey synthetic and naturally-occurring antibiotic, antiviral, antifungal, and antiparasitic compounds. The biochemical mechanisms of action of different classes of each type of drug and mechanisms of resistance that have evolved over time will also be discussed. Potential alternative therapies (e.g., phage therapy, antibodies, oligonucleotides) and preventatives (e.g., vaccines) will also be covered. Offered as BIOC 311 and BIOC 411. Prereq: BIOL 215 and (CHEM 223 or CHEM 323).

BIOC 312. Proteins and Enzymes. 3 Units.
Aspects of protein and nucleic acid function and interactions are discussed, including binding properties, protein-nucleic acid interactions, kinetics and mechanism of proteins and enzymes, and macromolecular machines. Recommended Preparation: CHEM 301. Offered as BIOC 312 and BIOC 412. Prereq: BIOC 307.

BIOC 315. Biological Membranes and Their Proteins. 3 Units.
This course will focus on the architecture and maintenance of biological membranes and membrane proteins, with emphasis on eukaryotic cells. The theory and experimental evidence of the fluid mosaic model of membranes will be a core theme as we discuss the plasma membrane, Golgi apparatus, and endoplasmic reticulum as part of the eukaryotic protein secretion system. Dynamics of vesicle transit, exocytosis and endocytosis, and metabolism of membrane lipids will be discussed through this course. This course will also examine the structure and function of membrane proteins that maintain the plasma membrane's integrity, polarity, and permeability. This will include the mechanisms of active and passive transport of molecules and ions, and how dysregulation can cause disease. The mechanism and effect of drugs and toxins on specific membrane protein targets and the downstream consequences of the action of these compounds will also be considered throughout the course. Offered as BIOC 315 and BIOC 415. Prereq: BIOC 307.

BIOC 334. Structural and Computational Biology. 3 Units.
This course introduces the major techniques used to study high resolution three-dimensional structures of proteins, and their applications to biomedically-relevant problems and drug discovery. The experimental techniques covered include cryo-electron microscopy, X-ray crystallography, and multi-dimensional solution nuclear magnetic resonance (NMR). Computational/bioinformatics topics include nucleotide and amino acid sequence analysis, protein structure analysis and prediction, and structure-based drug design. Principles of these techniques along with impactful biomedical and drug discovery case studies will be discussed. Recommended preparation: BIOC 307. Offered as BIOC 334 and BIOC 434. Prereq: BIOL 215 and (CHEM 223 or CHEM 323).

BIOC 344. Molecular Endocrinology. 3 Units.
A detailed biochemical examination of the hormonal signaling system of the human body and associated diseases. This includes mechanisms of glandular sensing and secretion, including metabolic signaling pathways (insulin and glucagon; leptin and ghrelin), the thyroid and thyroidisms, hypothalamus and pituitary gland, vitamin D and calcium homeostasis, among others. Molecular-level analysis of extra- and intra-cellular signaling pathways will be covered and critical differences in canonical pathways in specific tissue types will be emphasized. Additional topics will include amine neurotransmitters and affective disorders, steroid hormones and nuclear receptors, and circadian rhythm and sleep. Offered as BIOC 344 and BIOC 444. Prereq: BIOC 307.

BIOC 345. Metabolic Dysregulation and Human Disease. 3 Units.
A molecular examination of the processes and regulation of the synthesis of biomolecules, their mechanistic roles in human biochemistry, and how dysfunction of these processes can lead to disease. We will discuss the dynamic maintenance of chemical homeostasis and health, specifically in terms of cellular energy demands, redox balance, and detection and mitigation of foreign substances. The diseases caused by dysregulation and failure of these systems, and the current state of knowledge will be integrated throughout the course. The metabolically critical small molecules (B-vitamins, among others) and trace elements important to health will be discussed in regard to absorption, transport, deficiency, and toxicity; as well as enzyme mechanisms for which they are cofactors. We will also discuss weaknesses in current understanding of human-specific metabolism and controversial supplementation as student-led discussions and presentations. Offered as BIOC 345 and BIOC 445. Prereq: BIOC 307.

BIOC 350. Molecular Basis of Cancer. 3 Units.
This course will examine the molecular basis of the initiation, progression, and treatment of cancer. We will accomplish this by examining the dysregulation of normal cellular processes involved in several common types of cancer from genotype to phenotype. We will also explore the techniques used to understand and detect cancer, the pharmacology of current therapies, FDA approved drugs and their targets, as well as a brief look at drug design. A second important aspect of this course is actively and critically engaging with the current scientific literature. Recent publications from high impact journals will be presented weekly to develop skills in interpretation and communication of the primary data and conclusions that build on and contribute to our current understanding of cancer. Offered as BIOC 350 and BIOC 450. Prereq: BIOC 307. Prereq or Coreq: BIOC 308.

BIOC 353. Biochemical Pathways in Cancer Therapeutics. 3 Units.
This is an advanced course that covers the biochemical mechanisms of action of major classes of common cancer therapeutics. The course will start with a review of fundamental cellular and biochemical mechanisms relevant to the initiation and progression of cancer. A common gastrointestinal cancer such as colon cancer, and a common hormone dependent cancer such as breast cancer, will be used as common threads during the rest of the course. The role of biomarker testing in disease prevention, cancer diagnosis, and specific treatment design will be discussed. The biochemical mechanisms of major classes of cancer therapeutics will be covered. Examples of current treatment approaches using chemotherapeutic agents, hormones, and immunotherapy will be used. Finally, emerging and developing new technologies and approaches in cancer screening and prevention, diagnosis, and treatment will be discussed. Offered ass BIOC 353 and BIOC 453. Prereq: BIOL 215 and (CHEM 223 or CHEM 323).

BIOC 360. Advanced Technologies for Cancer Research. 3 Units.
This course provides an overview of advanced technologies that are used by many laboratories to study the initiation, progression, and treatment of cancer. We accomplish this by providing lectures on advanced technologies (e.g., gene sequencing, proteomics, microscopy, and imaging) that are utilized routinely by both basic science and translational cancer investigators. We will present these technologies in a thematic format (e.g., advanced technologies in breast cancer research and therapy) to provide a more integrated learning environment. A secondary but equally important aspect of this course is actively and critically engaging with the current scientific literature. Recent publications from high impact journals will be presented weekly to develop skills in interpretation and communication of the primary data and conclusions that build on and contribute to our current understanding of these technologies and their respective roles in cancer research. Offered as BIOC 360 and BIOC 460. (Prereq: BIOC 307 and Coreq: BIOC 308) or Prereq: BIOL 114 or BIOL 116 or EBME 201.

BIOC 373. Biochemistry SAGES Seminar. 3 Units.
Discussion of current topics in biochemical research using readings from the scientific literature. The goals are for the student: 1) to discuss and critically analyze selections from the biochemical literature; 2) to gain a broader understanding of important topics not formally covered in the didactic courses; and 3) to learn to write in the style of journals in the field of biochemistry. Counts as a SAGES Departmental Seminar course. Prereq: BIOC 307 and BIOC 308. Restricted to majors in Biochemistry.

BIOC 391. Research Project. 3 Units.
Expected effort for three credits is approximately 10 hours/week engaged in laboratory research.

BIOC 392. Research Project. 1 - 9 Units.
Expected effort is at least three hours per week engaged in laboratory research for each one credit hour of enrollment. Biochemistry students are expected to complete BIOC 391. BIOC 392 enrollment is by instructor permission for students who have already completed BIOC 391 and request enrollment in less than three credit hours or more than three credit hours. Students who intend to enroll in three credit hours of Biochemistry Research Project should enroll in BIOC 391. Prereq: BIOC 391.

BIOC 393. Senior Capstone Experience. 3 Units.
Students will complete their Capstone Projects, begun in BIOC 391. Pertinent research activities will depend on the nature of the student's project. The student will meet regularly with their Capstone adviser, at least twice monthly, to provide progress reports, discuss the project, and for critique and guidance. By the end of this course, the student will have completed their SAGES Senior Capstone research project, written a project report in the form of a manuscript, and presented their project reports orally in the department and at the Senior Capstone Fair, or its equivalent. Counts as a SAGES Senior Capstone course. Prereq: BIOC 307 and BIOC 308.

BIOC 393H. Biochemistry Honors Senior Capstone. 3 Units.
This course for students in the Biochemistry Honors Research track will fulfill the senior capstone requirement for students in the BA and BS programs. Students in this course will write an article describing their capstone research in the form of a scientific manuscript and make an oral presentation describing their results. Students will also write a short review article covering the area of scientific research in which they have been working. Open by permission to students in the Biochemistry Research Honors Track. Counts as a SAGES Senior Capstone course. Prereq: BIOC 307 and BIOC 308.

BIOC 405. Principles of Biochemistry: An Introduction to the Molecules of Life. 3 Units.
This summer course provides an introduction to the macromolecules and small molecules that are the foundation of living systems. The focus is on mammalian biochemistry, with links to human biology and human disease. Topics include: protein structure and function; enzyme mechanisms, kinetics and regulation; membranes; hormone action; bioenergetics; intermediary metabolism, including pathways and regulation of carbohydrate, lipid, amino acid, and nucleotide biosynthesis and breakdown. One semester of biology is recommended. Suitable for students interested in careers in the health professions. This course is not open to undergraduate Biochemistry majors or Biochemistry graduate students. Prereq: CHEM 223 and CHEM 224.

BIOC 407. Introduction to Biochemistry: From Molecules To Medical Science. 4 Units.
Overview of the macromolecules and small molecules key to all living systems. Topics include: protein structure and function; enzyme mechanisms, kinetics and regulation; membrane structure and function; bioenergetics; hormone action; intermediary metabolism, including pathways and regulation of carbohydrate, lipid, amino acid, and nucleotide biosynthesis and breakdown. The material is presented to build links to human biology and human disease. One semester of biology is recommended. Offered as BIOC 307 and BIOC 407. Prereq: CHEM 223 and CHEM 224.

BIOC 408. Molecular Biology. 4 Units.
An examination of the flow of genetic information from DNA to RNA to protein. Topics include: nucleic acid structure; mechanisms and control of DNA, RNA, and protein biosynthesis; recombinant DNA; and mRNA processing and modification. Where possible, eukaryotic and prokaryotic systems are compared. Special topics include yeast as a model organism, molecular biology of cancer, and molecular biology of the cell cycle. Current literature is discussed briefly as an introduction to techniques of genetic engineering. Recommended preparation: BIOC 307. Offered as BIOC 308 and BIOC 408.

BIOC 410. Microbial Physiology and Therapeutic Opportunities. 3 Units.
This course will cover the physiology and metabolic pathways of microbes, with a biomedical emphasis on bacteria and archaea and a brief discussion of fungi and other eukaryotic organisms. We will emphasize how physiological and metabolic characteristics can either be targeted (in the case of infectious disease) or utilized/exploited (in the case of, for instance, antibiotics and other bioactive natural products and fermentation products). Offered as BIOC 310 and BIOC 410.

BIOC 411. Antimicrobial Therapies and Resistance. 3 Units.
This course focuses on the biochemistry and molecular biology of antimicrobial compounds. This includes antibiotics, the drugs clinically used to treat diseases caused by bacteria, antifungals, antiparasitic agents, and antivirals. We will examine the history of antibiotic development; characteristics of chemicals used as antiseptics and disinfectants but unable to be used as therapies; and then survey synthetic and naturally-occurring antibiotic, antiviral, antifungal, and antiparasitic compounds. The biochemical mechanisms of action of different classes of each type of drug and mechanisms of resistance that have evolved over time will also be discussed. Potential alternative therapies (e.g., phage therapy, antibodies, oligonucleotides) and preventatives (e.g., vaccines) will also be covered. Offered as BIOC 311 and BIOC 411.

BIOC 412. Proteins and Enzymes. 3 Units.
Aspects of protein and nucleic acid function and interactions are discussed, including binding properties, protein-nucleic acid interactions, kinetics and mechanism of proteins and enzymes, and macromolecular machines. Recommended Preparation: CHEM 301. Offered as BIOC 312 and BIOC 412.

BIOC 415. Biological Membranes and Their Proteins. 3 Units.
This course will focus on the architecture and maintenance of biological membranes and membrane proteins, with emphasis on eukaryotic cells. The theory and experimental evidence of the fluid mosaic model of membranes will be a core theme as we discuss the plasma membrane, Golgi apparatus, and endoplasmic reticulum as part of the eukaryotic protein secretion system. Dynamics of vesicle transit, exocytosis and endocytosis, and metabolism of membrane lipids will be discussed through this course. This course will also examine the structure and function of membrane proteins that maintain the plasma membrane's integrity, polarity, and permeability. This will include the mechanisms of active and passive transport of molecules and ions, and how dysregulation can cause disease. The mechanism and effect of drugs and toxins on specific membrane protein targets and the downstream consequences of the action of these compounds will also be considered throughout the course. Offered as BIOC 315 and BIOC 415.

BIOC 420. Current Topics in Cancer. 3 Units.
The concept of cancer hallmarks has provided a useful guiding principle in our understanding of the complexity of cancer. The hallmarks include sustaining proliferative signaling, evading growth suppressors, enabling replicative immortality, activating invasion and metastasis, inducing angiogenesis, resisting cell death, deregulating cellular energetics, avoiding immune destruction, tumor-promoting inflammation, and genome instability and mutation. The objectives of this course are to (1) examine the principles of some of these hallmarks, and (2) explore potential therapies developed based on these hallmarks of cancer. This is a student-driven and discussion-based graduate course. Students should have had some background on the related subjects and have read scientific papers in their prior coursework. Students will be called on to present and discuss experimental design, data and conclusions from assigned publications. There will be no exams or comprehensive papers but students will submit a one-page critique (strengths and weaknesses) of one of the assigned papers prior to each class meeting. The course will end with a full-day student-run symposium on topics to be decided jointly by students and the course director. Grades will be based on class participation, written critiques, and symposium presentations. Offered as BIOC 420, MBIO 420, PATH 422, and PHRM 420. Prereq: IBMS 453 and IBMS 455.

BIOC 432. Current Topics in Vision Research. 3 Units.
Vision research is an exciting and multidisciplinary area that draws on the disciplines of biochemistry, genetics, molecular biology, structural biology, neuroscience, and pathology. This graduate level course will provide the student with broad exposure to the most recent and relevant research currently being conducted in the field. Topics will cover a variety of diseases and fundamental biological processes occurring in the eye. Regions of the eye that will be discussed include the cornea, lens, and retina. Vision disorders discussed include age-related macular degeneration, retinal ciliopathies, and diabetic retinopathy. Instructors in the course are experts in their field and are members of the multidisciplinary visual sciences research community here at Case Western Reserve University. Students will be exposed to the experimental approaches and instrumentation currently being used in the laboratory and in clinical settings. Topics will be covered by traditional lectures, demonstrations in the laboratory and the clinic, and journal club presentations. Students will be graded on their performance in journal club presentations (40%), research proposal (40%), and class participation (20%). Offered as NEUR 432, PATH 432, PHRM 432 and BIOC 432.

BIOC 434. Structural and Computational Biology. 3 Units.
This course introduces the major techniques used to study high resolution three-dimensional structures of proteins, and their applications to biomedically-relevant problems and drug discovery. The experimental techniques covered include cryo-electron microscopy, X-ray crystallography, and multi-dimensional solution nuclear magnetic resonance (NMR). Computational/bioinformatics topics include nucleotide and amino acid sequence analysis, protein structure analysis and prediction, and structure-based drug design. Principles of these techniques along with impactful biomedical and drug discovery case studies will be discussed. Recommended preparation: BIOC 307. Offered as BIOC 334 and BIOC 434. Prereq: Graduate student standing.

BIOC 444. Molecular Endocrinology. 3 Units.
A detailed biochemical examination of the hormonal signaling system of the human body and associated diseases. This includes mechanisms of glandular sensing and secretion, including metabolic signaling pathways (insulin and glucagon; leptin and ghrelin), the thyroid and thyroidisms, hypothalamus and pituitary gland, vitamin D and calcium homeostasis, among others. Molecular-level analysis of extra- and intra-cellular signaling pathways will be covered and critical differences in canonical pathways in specific tissue types will be emphasized. Additional topics will include amine neurotransmitters and affective disorders, steroid hormones and nuclear receptors, and circadian rhythm and sleep. Offered as BIOC 344 and BIOC 444.

BIOC 445. Metabolic Dysregulation and Human Disease. 3 Units.
A molecular examination of the processes and regulation of the synthesis of biomolecules, their mechanistic roles in human biochemistry, and how dysfunction of these processes can lead to disease. We will discuss the dynamic maintenance of chemical homeostasis and health, specifically in terms of cellular energy demands, redox balance, and detection and mitigation of foreign substances. The diseases caused by dysregulation and failure of these systems, and the current state of knowledge will be integrated throughout the course. The metabolically critical small molecules (B-vitamins, among others) and trace elements important to health will be discussed in regard to absorption, transport, deficiency, and toxicity; as well as enzyme mechanisms for which they are cofactors. We will also discuss weaknesses in current understanding of human-specific metabolism and controversial supplementation as student-led discussions and presentations. Offered as BIOC 345 and BIOC 445.

BIOC 450. Molecular Basis of Cancer. 3 Units.
This course will examine the molecular basis of the initiation, progression, and treatment of cancer. We will accomplish this by examining the dysregulation of normal cellular processes involved in several common types of cancer from genotype to phenotype. We will also explore the techniques used to understand and detect cancer, the pharmacology of current therapies, FDA approved drugs and their targets, as well as a brief look at drug design. A second important aspect of this course is actively and critically engaging with the current scientific literature. Recent publications from high impact journals will be presented weekly to develop skills in interpretation and communication of the primary data and conclusions that build on and contribute to our current understanding of cancer. Offered as BIOC 350 and BIOC 450. Prereq: BIOC 407. Prereq or Coreq: BIOC 408.

BIOC 452. Nutritional Biochemistry and Metabolism. 3 Units.
Mechanisms of regulation of pathways of intermediary metabolism; amplification of biochemical signals; substrate cycling and use of radioactive and stable isotopes to measure metabolic rates. Recommended preparation: BIOC 307 or equivalent. Offered as BIOC 452 and NTRN 452.

BIOC 453. Biochemical Pathways in Cancer Therapeutics. 3 Units.
This is an advanced course that covers the biochemical mechanisms of action of major classes of common cancer therapeutics. The course will start with a review of fundamental cellular and biochemical mechanisms relevant to the initiation and progression of cancer. A common gastrointestinal cancer such as colon cancer, and a common hormone dependent cancer such as breast cancer, will be used as common threads during the rest of the course. The role of biomarker testing in disease prevention, cancer diagnosis, and specific treatment design will be discussed. The biochemical mechanisms of major classes of cancer therapeutics will be covered. Examples of current treatment approaches using chemotherapeutic agents, hormones, and immunotherapy will be used. Finally, emerging and developing new technologies and approaches in cancer screening and prevention, diagnosis, and treatment will be discussed. Offered ass BIOC 353 and BIOC 453.

BIOC 460. Advanced Technologies for Cancer Research. 3 Units.
This course provides an overview of advanced technologies that are used by many laboratories to study the initiation, progression, and treatment of cancer. We accomplish this by providing lectures on advanced technologies (e.g., gene sequencing, proteomics, microscopy, and imaging) that are utilized routinely by both basic science and translational cancer investigators. We will present these technologies in a thematic format (e.g., advanced technologies in breast cancer research and therapy) to provide a more integrated learning environment. A secondary but equally important aspect of this course is actively and critically engaging with the current scientific literature. Recent publications from high impact journals will be presented weekly to develop skills in interpretation and communication of the primary data and conclusions that build on and contribute to our current understanding of these technologies and their respective roles in cancer research. Offered as BIOC 360 and BIOC 460. Prereq: BIOC 407. Coreq: BIOC 408.

BIOC 475. Protein Biophysics. 3 Units.
This course focuses on in-depth understanding of the molecular biophysics of proteins. Structural, thermodynamic and kinetic aspects of protein function and structure-function relationships will be considered at the advanced conceptual level. The application of these theoretical frameworks will be illustrated with examples from the literature and integration of biophysical knowledge with description at the cellular and systems level. The format consists of lectures, problem sets, and student presentations. A special emphasis will be placed on discussion of original publications. Offered as BIOC 475, CHEM 475, PHOL 475, PHRM 475, and NEUR 475.

BIOC 500. Biotechnology Laboratory: Molecular Biology Basics. 1 Unit.
This course provides basic hands-on laboratory experience in molecular biology with a focus on handling and manipulating DNA in bacterial systems. Specific topics include: General laboratory safety, buffers, media, and other reagent preparation, sterile technique, transformation and culture of bacterial cells, DNA molecular biology techniques including DNA isolation and purification, polymerase chain reaction (PCR), restriction digests, ligation, agarose gel electrophoresis, and sequence analysis. Prereq: Biochemistry Graduate student or Requisites Not Met permission.

BIOC 501. Biochemical and Cellular Techniques for Biotechnology. 3 Units.
This lecture course covers the basics of common, essential laboratory and analytical techniques used in biomedical research and the biotechnology industry. The course will cover recombinant protein production and characterization, mammalian cell culture, molecular and cell biology, and mass spectrometry. Specific topics include: general laboratory safety, record keeping, preparation of research reports, manipulation of bacteria, protein overexpression and purification, enzyme assays, high-throughput techniques, high performance liquid chromatography (HPLC) and mass spectrometry, mammalian cell culture, Western blotting, protein-protein interactions, reverse transcription-quantitative polymerase chain reaction (RT-qPCR), immunofluorescence microscopy and assays for gene expression. This course is suitable for Biochemistry MS students interested in pursuing careers in academia or biotechnology. It is also recommended for undergraduate students to enhance their technical skills and position them for productive research experiences. Graduate students in other programs within or outside the School of Medicine are permitted to enroll. Prereq: (BIOL 215L and CHEM 113) or Graduate standing. Coreq: CHEM 233 or Graduate standing.

BIOC 502A. Biotechnology Laboratory: Molecular Biology and Biochemical Techniques. 2 Units.
This spring course provides hands-on laboratory experience in bacterial recombinant protein biochemistry and molecular and cell biology. Specific topics include: General laboratory safety, good laboratory practices (GLP), standard operating procedures (SOPs), buffers, media, and other reagent preparation, sterile technique, manipulation of bacterial cells, work with DNA including polymerase chain reaction (PCR), molecular cloning, and site-directed mutagenesis, protein overexpression and purification, enzyme activity and biophysical assays, DNA and protein gel electrophoresis, and high performance liquid chromatography (HPLC). This course, together with BIOC 502B and 502C, comprise a one-semester lab course that provides students with a comprehensive introduction to skills used in modern biotechnology laboratories. Students may take one, two, or three of these courses in a single semester. Suitable for biochemistry MS students interested in biotechnological and/or industry careers. All other graduate students and/or undergraduate students must contact the instructor for permission to enroll. Prereq: BIOC 500 and BIOC 501 or Requisites Not Met permission.

BIOC 502B. Biotechnology Laboratory: Eukaryotic Molecular and Cellular Biology. 2 Units.
This spring course provides hands-on laboratory experience in mammalian cell culture and molecular and cell biology. Specific topics include: General laboratory safety, good laboratory practices (GLP), standard operating procedures (SOPs), buffers, media, and other reagent preparation, sterile technique, manipulation of mammalian cells, mammalian cell culture, work with DNA and RNA, polymerase chain reaction (PCR) techniques including quantitative reverse transcription (RT-qPCR) and molecular cloning, reporter assays, transfection, immunoprecipitation, immunofluorescence, and protein gel electrophoresis and blotting. This course, together with BIOC 502A and 502C, comprise a one-semester lab course that provides students with a comprehensive introduction to skills used in modern biotechnology laboratories. Students may take one, two, or three of these courses in a single semester. Suitable for biochemistry MS students interested in biotechnological and/or industry careers. All other graduate students and/or undergraduate students must contact the instructor for permission to enroll. Prereq: BIOC 500 and BIOC 501 or Requisites Not Met permission.

BIOC 502C. Biotechnology Laboratory: Mass Spectrometry Techniques. 1 Unit.
This spring course provides hands-on laboratory experience in mass spectrometry with an emphasis on biomolecules. Specific topics include analysis of small molecules and biomolecules using high performance liquid chromatography (HPLC) and mass spectrometry. This course, together with BIOC 502A and 502B, comprise a one-semester lab course that provides students with a comprehensive introduction to skills used in modern biotechnology laboratories. Students may take one, two, or three of these courses in a single semester. Suitable for biochemistry MS students interested in biotechnological and/or industry careers. All other graduate students and/or undergraduate students must contact the instructor for permission to enroll. Prereq: BIOC 500 and BIOC 501 or Requisites Not Met permission.

BIOC 503. Biotechnology Laboratory - CRISPR. 2 Units.
This course provides advanced hands-on laboratory experience in molecular biology, with a focus on using CRISPR as a tool to manipulate eukaryotic systems. Students will master the laboratory techniques involved in the establishment, verification, and analysis of a CRISPR-edited eukaryotic system, as well as learn the theory behind designing such systems. Topics include: molecular cloning and plasmid preparation; human cell culture, transfection, and DNA extraction; fluorescence microscopy; PCR analysis and guide RNA design. Prereq: BIOC 502B.

BIOC 511. Practice and Professionalism in Biotechnology. 1 Unit.
This course provides an overview of a variety of topics that are relevant to biotechnology research and development in academic and industrial settings. It also provides an opportunity for students to develop professional written and oral communication skills. Specific topics include: Professional communications by email, letters, reports, and oral presentations; data documentation, security, and confidentiality; laboratory safety, certification, and regulation; intellectual property protection and patents; the drug discovery pipeline and approval process; financial aspects of research and development. Prereq: Graduate Student in Biochemistry.

BIOC 528. Contemporary Approaches to Drug Discovery. 3 Units.
This course is designed to teach the students how lead compounds are discovered, optimized, and processed through clinical trials for FDA approval. Topics will include: medicinal chemistry, parallel synthesis, drug delivery and devices, drug administration and pharmacokinetics, and clinical trials. A special emphasis will be placed on describing how structural biology is used for in silico screening and lead optimization. This component will include hands-on experience in using sophisticated drug discovery software to conduct in silico screening and the development of drug libraries. Each student will conduct a course project involving in silico screening and lead optimization against known drug targets, followed by the drafting of an inventory disclosure. Another important aspect of this course will be inclusion of guest lectures by industrial leaders who describe examples of success stories of drug development. Offered as BIOC 528, PHOL 528, PHRM 528, and SYBB 528.

BIOC 601. Biochemical Research. 1 - 3 Units.
The Biochemistry Department requires Ph.D. students, and provides opportunities for M.S. students, to engage in laboratory research for course credit. This course is taken by Biochemistry Ph.D. students before they pass their qualifying exam, and is available to Biochemistry M.S. students during any semester in the program.

BIOC 610. Internship in Experimental Biotechnology. 3 Units.
This course is the culminating experience of the Biotechnology MS program. It gives students a substantive hands-on experience in biotechnology research, providing with real-world experience to enhance their resumes and future employment prospects. The internship may be completed in a laboratory at a university or biotechnology company and must include some hands-on benchwork. The internship will strengthen the skills students have learned in the laboratory-focused coursework in the Biotechnology MS program. The goals are to i) enhance their laboratory research skill set, ii) learn about the responsibilities of laboratory workers, iii) learn how research problems are formulated and approached by research teams, iv) hone interpersonal skills and learn how research is done by collaborative teams, and v) gain insights into the careers of biotech workers and the careers they would like to pursue. This course is open only to students in the Biotechnology MS program. Offered as BIOC 610, NEUR 610, and PHRM 610.

BIOC 611. Biochemistry Seminar I. 1 Unit.
Student presentations of topics from the current scientific literature unrelated to the student's research project. Participants are required to present a seminar.

BIOC 612. Biochemistry Seminar II. 1 Unit.
Discussion of current research.

BIOC 641. Proposition I. 2 Units.
Design of research proposal.

BIOC 651. Thesis M.S.. 1 - 6 Units.
(Credit as arranged.)

BIOC 701. Dissertation Ph.D.. 1 - 9 Units.
(Credit as arranged.) Prereq: Predoctoral research consent or advanced to Ph.D. candidacy milestone.