

BIOCHEMISTRY AND MOLECULAR BIOLOGY

<http://bm.med.miami.edu>

Overview

Biochemistry and Molecular Biology are sciences at the epicenter of modern biomedical research. Understanding basic biochemical pathways is key to gaining new knowledge for the prevention and combating of disease, allowing for the expansion of current boundaries in medicine and science. In addition to medical applications, molecular biology is indispensable for the development of tools implemented for environmental and bionanotechnology problems. The Department of Biochemistry and Molecular Biology (BMB) at the University of Miami is committed to maintaining our discipline as a central science and strives for excellence by sustaining the current areas of strength, fostering interdisciplinary and clinical translational research, and expanding the research portfolio to evolving areas of inquiry and discovery. Our expertise in RNA biology, understanding DNA stability and repair, studying the biophysical nature of biomolecules, and gaining insight into cellular signaling pathways has been recently expanded by the arrival of researchers specialized in the design of natural and semi-synthetic biomolecules, as well as molecular-based devices that can be employed in translational medicine and other bionanotechnology applications. The commitment of the Miller School to increase growth in the basic sciences will continue to provide our department with new and exciting opportunities to enhance our prominence in biomedical research.

A chief mission of our department is to educate future generations of investigators and medical students to become critical thinkers and the leaders in their fields. The diverse composition of our department in regards to research interests creates a unique and intellectually stimulating learning environment for students at the undergraduate, graduate, and postgraduate levels. We offer a host of courses to fulfill the curriculum to obtain a BS in Biochemistry, a MS and a PhD in Biochemistry, as well as the basic science requirements for MD and MD / PhD students. Our courses address the basic principles of biochemistry and molecular biology as well as the emerging science and future of the fields.

The department serves the worldwide scientific community through leadership roles and active participation in national and international conferences, serving in study sections and on federal agency panels. Additionally, our department's faculty roster encompasses editors of journals and members of editorial boards, as well as board members of national and international governmental centers and members of advisory boards of companies in the private sector. Moreover, the Department is committed to serve the community by participating in a variety of outreach events to promote awareness of the importance of science and technology in relation to public health and the environment.

Our department is also unique for hosting the internationally recognized annual Miami Winter Symposium, created by Professor William Whelan, the first leader and Chair of the Department. The Miami Winter Symposium is currently managed by Nature Publishing and features world-renowned speakers in emerging areas of science and technology. This event cements our department's goal of furthering education and discovery in biochemistry and molecular biology on an international level.

Admission Requirements

Applicants to biomedical programs should have a bachelor's degree in biological science or related discipline (e.g., psychology, chemistry, engineering, physics). Although there are no required prerequisites, courses in general biology, cell/molecular biology, calculus, general physics, organic chemistry, physical chemistry, and biochemistry are encouraged.

Competitive Candidates Will Have the Following:

- Excellent academic record (minimum overall cumulative GPA = 3.0). The average GPA of registrants is 3.6, with top grades in science courses.
- A GRE is no longer required. Competitive GRE exam scores (top 50th percentile) may be submitted through BiomedCas as additional information.
- Research experience in a wet laboratory setting. A minimum of 1,000 hours of lab experience is expected. Computer-based research is acceptable for students with strong interests in bioinformatics
- Publications of abstracts and/or papers. At least 2/3 of the registrants have 1 or more co-authorships in peer-reviewed journals in biomedical sciences
- Co-authorship in a peer-reviewed journal is expected for all foreign applicants
- Strong letters of recommendation from scientists who know the candidate well in a research setting
- Motivation to pursue state-of-the-art biomedical research and realistic plans for a career in science.

Full application instructions can be found online (<http://biomed.med.miami.edu/apply/>).

Master's Programs

- M.S. in Biochemistry and Molecular Biology (<http://bulletin.miami.edu/graduate-academic-programs/medicine/biochemistry-molecular-biology/biochemistry-and-molecular-biology-ms/>)

Doctoral Programs

- Ph.D. in Biochemistry and Molecular Biology (<http://bulletin.miami.edu/graduate-academic-programs/medicine/biochemistry-molecular-biology/biochemistry-and-molecular-biology-phd/>)
- Executive Ph.D. in Biochemistry and Molecular Biology (Online) (<http://bulletin.miami.edu/graduate-academic-programs/medicine/biochemistry-molecular-biology/biochemistry-and-molecular-biology-phd-executive/>)

BMB 601. Research Journal Club. 1 Credit Hour.

All MS students must participate in the BMB Journal Club course. In this course, pre-doctoral trainees are required to critically review published paper(s) of their choice in the BMB topic area in Fall semester and present their research findings in Spring semester. The MS students will participate in this course and will write summary of the presentation.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

BMB 602. BMB Graduate Research Seminars. 1 Credit Hour.

The Biochemistry and Molecular Biology (BMB) department has an active seminar program that meets every Friday at noon. In this program seminars are presented by the BMB faculty (primary and secondary), invited speakers within the University of Miami, and from other Universities, government agencies, and industry. Topics presented cover many aspects in the field of biochemistry and biomedical sciences. All BMB Graduate Students enrolled in this course will be required to attend seminars and engage in informal interactions with speakers, allowing for discussions and exchanging of ideas on seminar day.

Components: SEM.

Grading: GRD.

Typically Offered: Fall & Spring.

BMB 605. Principles of Biochemistry and Molecular Biology. 3 Credit Hours.

This course is divided into three parts. Part 1, examine the biochemical composition and structure of the four basic types of biological macromolecules: (i) carbohydrates, (ii) nucleic acids, (iii) proteins, and (iv) lipids. In addition, students will learn the composition and function of dietary nutrients and vitamins. Part 2, study how genetic information flows from its storage as DNA sequence to its expression as functional RNA and protein molecules. A particular emphasis will be towards understanding control of gene expression by various epigenetic and signaling mechanisms. Part 3, learn how metabolic pathways are used to convert food molecules into energy and chemical intermediates used for biosynthesis of our own cellular materials.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

BMB 610. Advanced Topics in Biochemistry and Molecular Biology. 3 Credit Hours.

This is a special-topics course for graduate students and advanced undergraduate students. This course will focus on nanotechnology and its applications in medicine. This course offers an introductory concept of an interdisciplinary field of nanotechnology for students with physical, chemical, biological, medical, and engineering background. This course will be focused on nanomaterials, engineering of nanomaterials, cellular and intracellular interactions of nanoparticles, nanotechnology-based drug delivery systems, nano-based diagnosis, nanotoxicology, and clinical translational aspects of nanomedicines. Unique properties, which are offered by the materials at the nanoscale, will be discussed. Nanotechnology in sensing and diagnostics will be discussed. The topics to be discussed are of considerable interest across a broad range of areas in medicine, chemistry, biology, physics, pharmacy, medicine, mathematics, and engineering.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

BMB 612. Medical Genetics. 3 Credit Hours.

This course will provide the learner with greater knowledge and current understanding the human genome, the mechanisms by which variations and environmental factors contribute to human phenotypes. Examples of potential topics include chromosome aberrations, phenotype-genotype correlations, cytogenetics, multifactorial traits, population genetics, risk assessment, multi-generation Epigenetics, reprogramming and gene therapy. Importantly, students will learn the new developments in Epigenetics. Epigenetics is considered by many to be the "new genetics". The effects of epigenetics are vast

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 614. Molecular Genetics. 3 Credit Hours.

There are 4 major sub-disciplines of genetics. This course will focus on the first three and leave assessment of quantitative traits as needed for students work. The sub-disciplines include, 1. transmission genetics: basic principles of genetics and how traits are passed from one generation to the next. 2. Molecular genetics: the chemical nature of genes and genomes; how genetic information is encoded, replicated, and expressed. It includes the cellular processes of replication, transcription, and translation - by which genetic information is transferred from one molecule to another – and gene regulation - the processes that control the expression of genetic information. 3. population genetics: the genetic composition of groups of individual members of the same species and how that composition changes over time and geographic space, and 4. quantitative genetics: deals with phenotypes that vary continuously (in characters such as height or mass) – as opposed to discretely identifiable phenotypes and gene-products (such as eye color, or the presence of a particular biochemical).

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

BMB 615. Structural Biology and Applications to Drug Discovery (Masters). 2 Credit Hours.

This course provides an introduction to structural biology and illustrates how understanding the relationship between structure and function of biological macromolecules drives drug discovery. The course will be in three parts, with the first covering experimental and computational tools of structural biology – X-ray crystallography, cryo-electron microscopy and molecular modeling. The second part of the course will look at examples where structural biology has influenced drug design. The final part of this course will look at structures of nucleic acid (DNA and RNA) binding proteins and how they inform drug discovery.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 616. Basis of Mitochondrial Medicine. 2 Credit Hours.

Overall, the course aims to integrate basic knowledge in mitochondrial structure and function with our current understanding of the role mitochondria play in human health and disease. The first part of the course provides a core introduction to the major aspects of mitochondrial biology, including mitochondrial metabolism, genetics and biogenesis. The second part of the course focus on the role of mitochondrial and metabolic dysfunction in specific human disorders.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 618. Scientific Communications & Journal Review. 1 Credit Hour.

This course will train students in how to communicate science to different audiences. The lectures will focus on training students on how to make effective power point and poster presentations. Lectures will also guide on how to write manuscripts and grant applications. Training in data science as well as patents and inventions will be provided. Students will get understanding on academic career. Each student will prepare presentation on their research and will be guided by the instructor on how to improve it.

Components: LEC.

Grading: GRD.

Typically Offered: Fall, Spring, & Summer.

BMB 619. Epigenetic Control of Gene Expression. 4 Credit Hours.

This course will provide thorough understanding of Epigenetics and the interaction of nutrients and the epigenome. Epigenetics is considered by many to be the new genetics because of the overwhelming evidence of the contribution of non-genetic factors such as nutrition, environment, and chemical exposure on gene expression. The effects of epigenetics are vast, including tissue/organ regeneration, X-chromosome inactivation, and stem cell differentiation and genomic imprinting and aging. Aberrations of epigenetics influence many diseases for which clinical intervention is already in place, and many novel epigenetic therapies for cancer, immune disorders, neurological and metabolic disorders, and imprinting diseases are on the horizon.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

BMB 621. Clinical Diagnostics and Biosensors. 3 Credit Hours.

This course will focus on training students in diagnostic methods and the fundamentals and design of biosensors that are used in clinical diagnostics. Several biosensors are currently in use in diagnostic applications. They range from glucose sensors to PCR-based pathogen detection. The topics covered in this course will give students background on how these biosensors are designed, what are the biological recognition elements used, how to design portable platforms, what characteristics are needed for clinical use, how to use it, etc. An example of the target such as glucose, COVID-19, blood chemistry, will be used to explain constructions and fundamentals of biosensors. A background on recombinant DNA methods and protein chemistry, reporter probes, biological recognition elements, miniaturized analytical devices, point of care diagnostics. immunoassays, nucleic acid sensing, etc. will be covered in the course. The course will also cover culturing methods and detection of heavy metal in clinical samples. The topics covered in this course train students in multi-disciplinary fields including biochemistry, medicine, diagnostics, chemistry, and biology.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 630. Research in Biochemistry and Molecular Biology I. 1-9 Credit Hours.

This will form the most significant portion of the MS student's degree program. Students will perform research with a mentor that they choose depending upon their research interest. A committee consisting of 3 faculty from the graduate program will be formed to evaluate student for the final oral comprehensive examination. The final oral exam will be scheduled in the last semester of the study. This oral comprehensive exam will involve the review of all experimental data and the entire presentation. During the examination, the mentor is responsible for allotting appropriate time for questions by all participants. Students are expected to understand the significance of their findings, display adequate knowledge of the relevant literature and know the theory and limitations of methods employed. Students must demonstrate the ability to independently design, execute and interpret original experiments. This group will make a decision to pass or fail a student's oral comprehensive exam.

Components: RSC.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 633. Capstone project in Biochemistry and Molecular Biology. 1-3 Credit Hours.

This course will help students learn how to prepare presentations as well as write reports and publications. Students will also learn about the latest advances in the biochemistry field and upcoming topics of interest to the field to help them prepare for their careers. Students will write a report-based on the industrial internship. They will also prepare a presentation about the work performed. The students' mentor/course instructor will provide guidance as needed in writing the report and presentation.

Components: THI.

Grading: SUS.

Typically Offered: Offered by Announcement Only.

BMB 634. Research in Biochemistry and Molecular Biology II. 1-9 Credit Hours.

BMB 634 is a continuation of the 15-credit course requirement for completion of the Master of Science in Biochemistry and Molecular Biology. The overall goal of the BMB research is to provide students with an opportunity for hands-on exposure to scientific research and mentorship. (Required-fall, spring and summer)

Prerequisite: BMB 630.

Components: RSC.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 635. Research In Biochemistry and Molecular Biology III. 1-9 Credit Hours.

BMB 635 is a continuation of the 15-credit course requirement for completion of the Master of Science in Biochemistry and Molecular Biology. The overall goal of the BMB research is to provide students with an opportunity for hands-on exposure to scientific research and mentorship. (Required-fall, spring and summer)

Prerequisite: BMB 630 And BMB 634.

Components: RSC.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 641. Essentials of Biotechniques I & II. 4 Credit Hours.

Students will be introduced to variety of techniques used in biotechnology research. The course will be a combination of lectures and hands-on technique experience. The course will teach students both traditional and new techniques used in BMB.

Components: LAB.

Grading: GRD.

Typically Offered: Fall.

BMB 642. Essentials of Biotechniques II. 3 Credit Hours.

Students will be introduced to variety of techniques used in biotechnology research. The course will be a combination of lectures and hands-on technique experience. The course will teach students both traditional and new techniques used in BMB.

Components: LAB.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

BMB 644. Independent Studies in BMB Scientific Research. 1-6 Credit Hours.

The overall goal of the BMB research is to provide students with an opportunity for independent learning with exposure to scientific research. Students in this course may conduct individual projects focused on research, literature review, or extension/enhancement of other coursework. All work is conducted under supervision and evaluation of a departmental faculty member. Departmental approval is required prior to enrollment.

Components: IND.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 680. Responsible Conduct of Research. 1 Credit Hour.

In this course, ethical case studies are discussed, and an introduction to laboratory management is provided. Short lectures and discussion are conducted to provide students with the ability to tackle dilemmas and pitfalls associated with the responsible conduct of research. Information is provided on regulatory requirements of conducting research, including safety issues and the use of humans, animals, and radioactive/bio hazardous material. The obligations of scientists with respect to public policy and advocacy are also discussed. In addition, students will participate in an online RCR training course (RST-401/501/601 sections) offered by the Collaborative Institutional Training Initiative (CITI) Program at UM. A CITI Program RCR course typically requires around 4 hours to complete. These students receive an "S" (satisfactory) grade for a CITI RCR course after the completion of the online module. This online training course will serve as yearly continuation of RCR training after completion of the Research Ethics course. Additionally, every semester faculty in the department present a seminar related to topics in research ethics. Students also attend an online training in RCR. Several professional skills workshop such as grant writing workshop, career workshops, and seminars by professional scientists related to career are organized by the BMB department as well as the Office of Graduate studies. Students will attend these series of events.

Components: LEC.

Grading: SUS.

Typically Offered: Offered by Announcement Only.

BMB 701. Research Journal Club.. 1 Credit Hour.

All registered BMB students must participate in the Journal Club/Seminar. Students are required to critically review published paper(s) of their choice and describe in detail the findings described therein. Senior students will present their own research.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 702. Biochemical Science Seminar. 1 Credit Hour.

The Biochemistry and Molecular Biology (BMB) department has an active seminar program that meets on every Friday at noon. In this program seminars are presented by the BMB faculty (primary and secondary), invited speakers within the University of Miami and from other universities, government agencies, and industry. All BMB Graduate Students enrolled in this course will be required to attend this seminar and will have informal interactions with speaker, and exchange ideas at lunch on the seminar day.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 705. Principles of Biochemistry and Molecular Biology. 4 Credit Hours.

This course is divided into three parts. In Part 1, you will examine the biochemical composition and structure of the four basic types of biological macromolecules: (i) carbohydrates, (ii) nucleic acids, (iii) proteins, and (iv) lipids. In addition, you will learn the composition and function of dietary nutrients and vitamins. Most important, you will be introduced to nature's catalytic substances termed enzymes, paying special attention to their mechanisms of action and regulation. In Parts 2 and 3, you will learn how metabolic pathways are used to convert food molecules into energy and chemical intermediates used for biosynthesis of our own cellular materials. In Part 4, you will study how genetic information flows from its storage as DNA sequence to its expression as functional RNA and protein molecules. Here, you will give particular emphasis towards understanding control of gene expression by various epigenetic and signaling mechanisms. You are expected to finish this course with rigorous understanding of the biochemical composition, structure, and cellular metabolism of proteins, carbohydrates, lipids, and nucleic acids. This will enable you to read and understand advancing topics and applications in a vast array of biomedical specialties.

Components: DIL.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 707. Proteins-Structure, Function and Biology. 3 Credit Hours.

Proteins are the central functional macromolecules of life. This course surveys the structures, functions and biology of proteins with a strong structural perspective. The course has four modules. Module 1 covers the building blocks of proteins and how they come together to form intricate structures. Module 2 discusses practical methods to produce and characterize proteins, as well as contemporary experimental techniques to understand their 3D structure. Module 3 looks at the functions of proteins through the lens of enzymes. Finally, module 4 looks at proteins in biology – how they are made, folded, processed and modified in cells, and their diverse roles as switches, motors, membrane proteins, and large complexes. The course uses lectures and student presentations of 8-10 research papers to cover these topics. Students also write a short review on an assigned protein as a term paper.

Components: DIL.

Grading: GRD.

Typically Offered: Fall & Spring.

BMB 709. Advanced Biochemistry and Molecular Biology. 3 Credit Hours.

This course is a continuation course for BMB 616. It covers essentially the same topics as BMB 616 but at a more advanced level. It brings the student to the forefront of research in Molecular Biology. The course material is discussed exclusively in the form of original research papers. Based on this experience, students are required to propose experimental approaches to biological problems and defend them.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 710. Advanced Topics in Biochemistry and Molecular Biology. 1-5 Credit Hours.

This course is offered by various faculty members in the department on a rotating basis depending upon their expertise. For example, an advanced topic course in Nanomedicine offered by Dr. Deo and Dr. Dhar covers these topics through lectures.

Components: DIL.

Grading: GRD.

Typically Offered: Spring.

BMB 711. Best Practices in BMB Instruction. 1-3 Credit Hours.

Graduate students in the basic sciences will explore different approaches to science course development, implementation and assessment. This includes identifying gaps in the curriculum, creating classroom structure that reflects the content and execution of classroom activities, identifying and gathering appropriate material from the primary research literature, instructing undergraduates in how to become highly interactive self-directed learners, providing formative feedback to improve student achievement throughout a course, proper design and implementation of assessment tools, student communication, classroom management and ethics.

Components: DIS.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

BMB 712. Human Genetics. 3 Credit Hours.

This course will provide the learner with greater knowledge and current understanding the human genome, the mechanisms by which variations and environmental factors contribute to human phenotypes. Examples of potential topics include chromosome aberrations, phenotype-genotype correlations, cytogenetics, multifactorial traits, population genetics, risk assessment, multi-generation Epigenetics, reprogramming and gene therapy. Importantly, students will learn the new developments in Epigenetics. Epigenetics is considered by many to be the "new genetics". The effects of epigenetics are vast, including tissue/organ regeneration, X-chromosome inactivation, and stem cell differentiation and genomic imprinting and aging. This course will discuss the overwhelming evidence of the contribution of non-genetic factors, such as nutrition, environment, and chemical exposure, on gene expression.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 714. Molecular Genetics. 4 Credit Hours.

This course deals with mechanisms and fundamental concepts of genetic inheritance. The first part of the course is devoted to the genetics of bacteria and bacteriophages. Topics include genetic implementation, recombination, suppression, transposition, conjugation, transformation, transaction, and regulation of prokaryotic gene expression. The second part of the course covers selected topics in eukaryotic genetics (including molecular genetics of yeast, mitochondria, Drosophila, mice and humans). Problem solving is emphasized in homework and exams. The objective of the course is to provide students with an appreciation of the value of molecular genetics as a tool they can use to solve a wide variety of problems in bio-medical research.

Components: DIL.

Grading: GRD.

Typically Offered: Fall.

BMB 715. Structural Biology and Applications to Drug Discovery. 2 Credit Hours.

This course focuses on the relationships between structure and function in biological macromolecules, and how this knowledge has led to the discoveries of new drugs.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 716. Bioinformatics of Gene Regulation and Protein Function. 3 Credit Hours.

Among the skills required to become a successful interdisciplinary life scientist is the ability to navigate biological databases to better understand gene and protein function. Genome sequences contain the signals that guide differential gene expression and encode structural RNAs, regulatory RNAs and proteins. This course will introduce the tools, databases and evolutionary considerations that help us understand the regulation of gene expression and predict protein function. The biochemical and regulatory functions encoded in genomic DNA sequences will be explored using bioinformatics techniques including gene finding, BLAST searches, PubMed searches, high-throughput dataset mining, multiple alignments, phylogenetic analysis, identification of conserved functional domains and motifs, assessment of protein-protein and protein-ligand interactions, gene context and co-occurrence analysis. secondary and tertiary structural analysis, metabolic and cellular modeling, and phenotypic analysis. The databases, tools and tutorials available at websites developed by the National Center for Biotechnology Information, EMBL-EBI, the Protein Data Bank, and others will be used as supporting course materials. Each week will have a set of online videos and instructions to complete before the weekly live lecture. The live lecture consist of a one hour slide presentation and one half-hour of Q&A discussions. Competency in bioinformatics will be assessed by a midterm and a final exam.

Components: DIL.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

BMB 717. Nutrients, Enzymes, and Metabolic Flux. 3 Credit Hours.

Students learn how macronutrients (carbohydrates, protein, and lipids) and (ii) micronutrients (vitamins and minerals) are obtained in the diet, digested, absorbed, and assimilated. Then, students learn to formulate mechanisms of enzyme catalysis and inhibition. Such analytical skills are then used to more rigorously examine enzymes that control specific points of metabolic flux. Students finish this course with thorough mechanistic understanding of (i) macronutrient composition, intake, and energy production and (ii) requirements of micronutrients and hormones in controlling metabolic balance.

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

BMB 718. Scientific Communication. 3 Credit Hours.

This course will train students in how to communicate science to different audiences. The lectures will focus on training students on how to make effective power point and poster presentations. Lectures will also guide on how to write manuscripts and grant applications. Training in data science as well as patents and inventions will be provided. Students will get understanding on academic career. Each student will prepare presentation on their research and will be guided by the instructor on how to improve it.

Components: LEC.

Grading: GRD.

Typically Offered: Offered by Announcement Only.

BMB 719. Fundamentals of Epigenetics. 3 Credit Hours.

The influence of nutrition on gene expression through modification of DNA and proteins in chromatin is described (i.e., epigenetics). Also, genetic variations, as well as the influence of bacterial flora of the digestive tract, are considered with respect to abilities to metabolize various dietary components. Students learn how to gather information about course topics and present their findings

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

BMB 721. Clinical Diagnostics and Biosensors. 2 Credit Hours.

This course will focus on training students in diagnostic methods and the fundamentals and design of biosensors that are used in clinical diagnostics. Several biosensors are currently in use in diagnostic applications. They range from glucose sensors to PCR-based pathogen detection. The topics covered in this course will give students background on how these biosensors are designed, what are the biological recognition elements used, how to design portable platforms, what characteristics are needed for clinical use, how to use it, etc. An example of the target such as glucose, COVID-19, blood chemistry, will be used to explain constructions and fundamentals of biosensors. A background on recombinant DNA methods and protein chemistry, reporter probes, biological recognition elements, miniaturized analytical devices, point of care diagnostics. immunoassays, nucleic acid sensing, etc. will be covered in the course. The course will also cover culturing methods and detection of heavy metal in clinical samples. The topics covered in this course train students in multi-disciplinary fields including biochemistry, medicine, diagnostics, chemistry, and biology.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 723. Systems and Network Biology. 2 Credit Hours.

The course is designed to cover the principles of systems biology at the molecular level. It will emphasize on the particular understanding of the properties of biological systems as profiles and heavily interconnected networks. We will explore how "omics" data, e.g. RNA-sequencing, can be used to extract biological insight beyond merely the differentially expressed genes and pathways. We will study how expression and other omic profiles are snapshots of dynamic biological states, how we can infer (gene) regulatory networks, fluxes and how biological systems are organized in networks with specific topological properties. We will further explore how single-cell methodologies reveal the dynamics of cell state transitions as well as how machine learning (artificial intelligence; AI) is utilized to extract novel and higher-order biological inter-dependencies. Overall, the course's aim is to describe biological systems, not from a reductionist analysis of the components (e.g. genes, proteins, metabolites), but from studying the dynamic interrelationships among the biological components. Specific topics to be covered: DNA/RNA-sequencing, MS-based proteomics and metabolomics, Machine learning, Classification algorithms, Network biology, Gene and protein regulatory/signaling networks, Biological organization, Stochasticity in biology, Modeling biological systems, Mathematical Biology, Format: Two 60-minutes sessions per week. Each session will be in the form of a lecture from the instructor or invited speaker on a specific topic within the overall theme of the course. Every fourth week, students will be assigned a research paper that's relevant to the context presented in the previous three weeks and will be asked to present. Students will be graded based on their presentation, understanding and critical thinking on the concepts relevant to the course. Expectations: Students will learn the properties of network topology, systems biology as well as dynamic and mathematical biology. They will further learn how multivariate statistical methods, including dimensionality reduction and clustering algorithms as well as more advanced machine learning tools are applied in biological data. Successful completion of the course will allow students to critically assess these concepts in the published literature and also apply them in their research projects. Suggested textbooks A first course in systems biology, 3rd edition Eberhard Voit, Melissa Kemp Garland Science, 2025 Handbook of systems biology: concepts and insights Marian Walhout, Marc Vidal, Job Dekker Academic Press, 2013

Components: LEC.

Grading: GRD.

Typically Offered: Fall.

BMB 726. Basis of Mitochondrial Medicine. 2 Credit Hours.

This course aims to integrate basic knowledge in mitochondrial structure and function with our current understanding of the role mitochondria play in human health and disease. The first part of the course provides a core introduction to the major aspects of mitochondrial biology, including mitochondrial metabolism, genetics, and biogenesis. The second part of the course focus on the role of mitochondrial and metabolic dysfunction in specific human disorders.

Components: LEC.

Grading: GRD.

Typically Offered: Spring.

BMB 730. Data Science Practitioner. 3 Credit Hours.

This course is an implementation of the IBM Skills Academy program. It will introduce the students with the fundamentals of Data Science and make them familiar with data processing and artificial intelligence (AI) paradigm concepts. Students will learn how to process data and run AI tasks using python. Students will work with different types of data, including applications in medicine and biology. For content information, please refer to the course topics section at the end of the syllabus.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Spring.

BMB 731. Special Work. 1-3 Credit Hours.

Special work, lecture, or laboratory or a combination of these, as determined by advisor in accord with student's individual interest.

Components: LEC.

Grading: GRD.

Typically Offered: Fall & Summer.

BMB 810. Master's Thesis. 1-6 Credit Hours.

The student working on his/her master's thesis enrolls for this credit. In most departments not to exceed six credits, as determined by his/her advisor.

Components: THI.

Grading: SUS.

Typically Offered: Offered by Announcement Only.

BMB 830. Doctoral Dissertation. 1-12 Credit Hours.

Required of all candidates for the Ph.D. The student will enroll for credit as determined by his/her advisor but not for less than a total of 24. Not more than 12 hours of BMB 730 may be taken in a regular semester, nor more than six in a summer session. Where a student has passed his/her (a) qualifying examinations, and (b) is engaged in an assistantship, he/she may still take the maximum allowable credit stated above.

Components: THI.

Grading: SUS.

Typically Offered: Fall & Summer.

BMB 840. Doctoral Dissertation- Post Candidacy. 1-12 Credit Hours.

Required for all PhD candidates. The student will enroll for credits as determined by the Office of Graduate and Postdoctoral Studies.

Components: DIL.

Grading: SUS.

Typically Offered: Fall & Summer.

BMB 850. Research in Residence. 1 Credit Hour.

Used to establish research in residence for the Ph.D., after the student has been enrolled for the permissible cumulative total in appropriate doctoral research. Credit not granted. May be regarded as full-time residence as determined by the Dean of the Graduate School.

Components: THE.

Grading: SUS.

Typically Offered: Fall & Summer.