PHYSIOLOGY & BIOPHYSICS (PHOL)

PHOL 351. Independent Study. 1 - 6 Units.
This course is a guided program of study in physiology textbooks, reviews, and original articles. Guided laboratory projects to reproduce and extend classical physiological experiments are offered to the undergraduate science major. This course is being offered in conjunction with the Graduate level course PHOL 451. Students are required to consult with the faculty member whose work they have interest in and plan their individual experience.

PHOL 401A. Physiology and Biophysics of Molecules and Cells. 2 Units.
Physiology and Biophysics of Molecules and Cells is a graduate-level introductory course designed to provide the fundamental principles of modern physiology, protein science and structural biology, and to prepare students for advanced courses in the biomedical sciences. The course is divided into 2 blocks that can be taken independently as PHOL 401A or PHOL 401B (2 credit hrs each) during the Spring semester of each year. The first block will cover the structure and function of proteins and lipids, and the organization of cellular membranes. Topics will include primary, secondary, tertiary and quarternary protein structure and analysis, enzyme kinetics, allostery and cooperativity, lipid membrane organization and domain structure, and protein-protein and protein-lipid interactions. The second block will cover molecular pathways and processes critical for cellular homeostasis, function, and signaling. Topics will include molecular mechanisms of transport across biological membranes and cellular compartments, ionic basis of the resting membrane potential, action potential generation and propagation, osmosis and Gibbs-Donnan equilibria, regulation of voltage-gated channels and electrogenic transporters, cellular pH regulation, and the biophysics of epithelial transport. Format will be a combination of lecture, discussion-based problem sets, journal paper presentations, and computer lab exercises and demonstrations. Grading will be based on performance on two essay-type exams administered in the middle and at the end of each block (80%), and on class participation (20%).

PHOL 401B. Physiology and Biophysics of Molecules and Cells. 2 Units.
Physiology and Biophysics of Molecules and Cells is a graduate-level introductory course designed to provide the fundamental principles of modern physiology, protein science and structural biology, and to prepare students for advanced courses in the biomedical sciences. The course is divided into 2 blocks that can be taken independently as PHOL 401A or PHOL 401B (2 credit hrs each) during the Spring semester of each year. The first block will cover the structure and function of proteins and lipids, and the organization of cellular membranes. Topics will include primary, secondary, tertiary and quarternary protein structure and analysis, enzyme kinetics, allostery and cooperativity, lipid membrane organization and domain structure, and protein-protein and protein-lipid interactions. The second block will cover molecular pathways and processes critical for cellular homeostasis, function, and signaling. Topics will include molecular mechanisms of transport across biological membranes and cellular compartments, ionic basis of the resting membrane potential, action potential generation and propagation, osmosis and Gibbs-Donnan equilibria, regulation of voltage-gated channels and electrogenic transporters, cellular pH regulation, and the biophysics of epithelial transport. Format will be a combination of lecture, discussion-based problem sets, journal paper presentations, and computer lab exercises and demonstrations. Grading will be based on performance on two essay-type exams administered in the middle and at the end of each block (80%), and on class participation (20%).

PHOL 401C. Human Physiology: A Molecular Understanding of Organ System Function. 2 Units.
This course is designed to integrate effectively with PHOL 401A and PHOL 401B, bringing the knowledge of the PhD students to the next level of integration and organ function. Structured on a 2 hour lecture per week, the course will cover the main molecular determinant and signaling components (e.g. neurotransmitters, hormones, adipokines, etc.) that regulate the integrated functioning of our main organ systems: respiratory, renal, cardiovascular, gastrointestinal, central and autonomic nervous systems, and integrated metabolism. The main topics relative to these 6 blocks will be covered in class through lectures, leaving ample opportunity for the students to engage in an interactive discussion with the instructor or among themselves throughout the lecture and at the end of it. Upon completion of each organ system, the students will elaborate on an assigned research article as part of their home-assignment. The intent of this 2-page essay is to assess the application of the knowledge provided in-class to the research topic discussed in the paper, and further integrate the student's knowledge of the academic material discussed. The course will conclude with a final mini-essay exam. Prereq or Coreq: PHOL 401A and PHOL 401B.

PHOL 402A. Physiological Basis for Disease. 3 Units.
Physiological Basis for Disease is a graduate-level course designed to provide the fundamental physiology of a select group of organ systems and examples of how the molecular basis of disease affects physiological function of these systems. As such, PHOL402 will prepare students for future study in advanced biomedical sciences. The course is 3 credit hours and will be offered in the both the Fall (402A) and Spring (402B) semesters of each academic year. Course content of PHOL402 builds on knowledge learned in Medical Physiology-- PHOL481 and PHOL482, and is designed to be taken concurrently or in series with Medical Physiology courses. Topics to be covered during the Fall (402A) semester include pathophysiology of cancer, and select diseases of the central nervous system, cardiovascular system, and urinary/renal system. Topics to be covered in the Spring (402B) semester include select diseases of the respiratory, gastrointestinal, and endocrine systems. The format will be a combination of lectures, in class discussions, and take-home problem sets to facilitate student-directed learning. Grading will be based on problem sets (30%) and weekly quizzes (70%). Due to the course format and large class size, this course is intended primarily for master's students. PhD students that desire to take this course must first seek approval from their graduate program directors.

PHOL 402B. Physiological Basis for Disease. 3 Units.
Physiological Basis for Disease is a graduate-level course designed to provide the fundamental physiology of a select group of organ systems and examples of how the molecular basis of disease affects physiological function of these systems. As such, PHOL402 will prepare students for future study in advanced biomedical sciences. The course is 3 credit hours and will be offered in the both the Fall (402A) and Spring (402B) semesters of each academic year. Course content of PHOL402 builds on knowledge learned in Medical Physiology-- PHOL481 and PHOL482, and is designed to be taken concurrently or in series with Medical Physiology courses. Topics to be covered during the Fall (402A) semester include pathophysiology of cancer, and select diseases of the central nervous system, cardiovascular system, and urinary/renal system. Topics to be covered in the Spring (402B) semester include select diseases of the respiratory, gastrointestinal, and endocrine systems. The format will be a combination of lectures, in class discussions, and take-home problem sets to facilitate student-directed learning. Grading will be based on problem sets (30%) and weekly quizzes (70%). Due to the course format and large class size, this course is intended primarily for master's students. PhD students that desire to take this course must first seek approval from their graduate program directors.

PHOL 410. Basic Oxygen & Physiological Function. 3 Units.
On-line lecture only course which explores the significance and consequences of oxygen and oxygen metabolism in living organisms. Topics to be covered include transport by blood tissues, oxygen toxicity, and mitochondrial metabolism. Emphasis will be placed on mammalian physiology with special reference to brain oxidative metabolism and blood flow as well as whole body energy expenditure and oxidative stress related to disease. The course will cover additional spans of physiology, nutrition and anatomy. Offered as NTRN 410 and PHOL 410.

PHOL 419. Applied Probability and Stochastic Processes for Biology. 3 Units.
Applications of probability and stochastic processes to biological systems. Mathematical topics will include: introduction to discrete and continuous probability spaces (including numerical generation of pseudo random samples from specified probability distributions), Markov processes in discrete and continuous time with discrete and continuous sample spaces, point processes including homogeneous and inhomogeneous Poisson processes and Markov chains on graphs, and diffusion processes including Brownian motion and the Ornstein-Uhlenbeck process. Biological topics will be determined by the interests of the students and the instructor. Likely topics include: stochastic ion channels, molecular motors and stochastic ratchets, actin and tubulin polymerization, random walk models for neural spike trains, bacterial chemotaxis, signaling and genetic regulatory networks, and stochastic predator-prey dynamics. The emphasis will be on practical simulation and analysis of stochastic phenomena in biological systems. Numerical methods will be developed using a combination of MATLAB, the R statistical package, MCell, and/or URDME, at the discretion of the instructor. Student projects will comprise a major part of the course. Offered as BIOL 319, ECSE 319, MATH 319, SYBB 319, BIOL 419, EBME 419, MATH 419, PHOL 419, and SYBB 419.

PHOL 421. Introduction to Aerospace Physiology I. 3 Units.
Introduction to Aerospace I is organized into five blocks clustering around concepts of cell biology, neural systems, cardiopulmonary functions, and renal adaptation. Scenarios in acute, sub-acute, and chronic responses to the challenge of the aerospace environment illustrate useful physiology and unique responses relevant to high performance aircraft and space exploration. Block I: Physiology of Cells and Molecules Genes, proteins, cellular communication and organ system functions are building blocks of human physiologic responses. These are modified by such aerospace exposures such as microgravity. Immediate adjustments are the result of connected physiology by cell-to-cell contact, neuronal connection, and hormone release, but sub-acute and chronic exposures engage remodeling from experience, mitigation by pre-flight activities, or achievement of a new steady state. After Aerospace Physiology I, the student will be able to name the cellular sequences of gene expression to functional proteins, identify how an environmental exposure can be sensed and initiate a response, and list ways that cells communicate to produce systemic effects. Some relevant examples will include microgravity and radiation effects on bone loss and muscle functions, skeletal muscle contraction, smooth muscle regulation in blood vessels, and cardiac contraction. Block II: Neurophysiology The purpose of the neural system is in recognition and reaction of the brain and nervous system to the environment stress and the transduction of the sensory experience, resulting in both conscious and unconscious responses to adjust to the perturbation. Sometimes these are smooth but in aerospace environments, initial human responses (dizziness, loss of situational awareness, and fatigue) are detrimental to optimal performance. After Introduction to Aerospace Physiology I, the learner will be able to list the anatomic features of the nervous system, its neural efferent and afferent information trafficking, the function of the autonomic nervous system, and neural circuits in the brain and spinal cord. Block III: Cardiovascular Physiology The ability to tolerate the 6G acceleration in high performance aircraft is in large part due to the capacity and limitation of the cardiovascular system (one designed to adjust to earth's atmosphere-1G) to respond to changes in posture, flight-or-flight, or volume loss like hemorrhage. The temporary and episodic changes with added physical pressures are extreme and require technologic support to permit performance in high altitude maneuvers. How well these support systems work depends upon an understanding of the physiology. After Aerospace Physiology I, the learner will be able to describe the organization of the cardiovascular system including the role of the heart in the circulation to the atrial and from the venous vessel system, and the special consideration for aerospace in the integrated responses to space and high performance. Block IV: Pulmonary Physiology Humans acutely exposed to altitude adjust homeostatically to the low oxygen environment with primarily ventilatory adjustments. Over time, the human response can reduce the impact of the altered environment by acid-base adjustments, increases in oxygen carrying capacity, and cardiac output. The former is relevant for air travelers and pilots and the latter to prolonged travel. After Aerospace Physiology I, the learner will describe the sequence of gas exchange from the alveolar blood vessel (V/Q) interface in the lungs to the cells, in the context of the control systems that regulate tidal volume and frequency. Block V: Renal Physiology The kidney is a regulator primarily of acid-base and electrolyte levels. Per se it is not affected by barometric pressures or environmental forcing. However, it is key to volume balance, responding to changes in cardiac output and blood pressure, and may misbehave in the instance of hyperventilation to hypoxia. The renal adjustment is slow an

PHOL 422. Introduction to Aerospace Physiology II. 3 Units.
Introduction to Aerospace Physiology II expands on basic physiologic principles in Introduction to Aerospace Physiology I to explore in four blocks areas of expertise, focusing on skills as well as knowledge. Whole body effects of individual environmental challenges (acceleration, hypoxia and hyperoxia, special disorientation, radiation and thermal challenges) and methods to identify and promote resilience will be considered. Forward leaning incident investigations require appreciation of behavioral interventions, measurable and modifiable human factors, and physiologic forensics and root cause analysis. Block I: Normal Physiology in Abnormal Environments This block uses examples of integrative physiology that result from the effects of acceleration, hypoxia and imposed hyperoxia, radiation exposures from high altitude and space travel, and adverse thermal environments. Block II: Enhancing Resilience to the Physiological Stressors of Aerospace Environments This block considers the behavioral factors that might enhance or mitigate human responses including nutrition, exercise, adequate sleep, and drug mitigation. Block III: Human Factors within Extreme Environments This block presents the "Human Factors" as found in the FAA Classification system and its utility in examining errors or incidents. Such issues lead to a formal approach to the root causes for an unexpected problem or accident, including the impacts of fatigue, cognitive processing, physiologic capability, and the human interface with technology. Block IV: Aerospace Forensics This block expands on Block III to address the forensic process rather than error assessment. Operational mishaps initiate a rather formal process of investigation and a 360 degree consideration of proximal cause. Examples of such events are presented to teams who will come to their conclusion and compare it with the final outcome, contrasting and accepting alternative explanatory models. Prereq: PHOL 421 or (PHOL 481 and PHOL 482).

PHOL 423. Lab Research Rotation: Aerospace Physiology. 3 Units.
This is a one semester lecture/laboratory experience in the Center for Aerospace Physiology in the Department of Physiology and Biophysics. The course is designed to introduce the student to aspects of research methods including the design, execution and analysis of original experimental work relevant to Aerospace Physiology. Hands-on experiences will reinforce the strengths and limitations of current measures for human physiology. Nine laboratory experiments will be conducted during the 7th and 8th weeks of the course. Weeks 1-6 and 9-15 are designed to prepare the students for the laboratories and then to review the collected data and discuss current relevant literature, respectively. Prereq: PHOL 421 or (PHOL 481 and PHOL 482).

PHOL 426. Human Factors in the Aerospace Environment. 3 Units.
The study of the psychological and physiological limitations of humans operating in complex environments is essential for reducing the incidence of errors in the aviation and space arenas. This course will provide a basic understanding of human factors concepts relevant to the aerospace environment including the importance of effective communication, situational awareness, decision-making, team effectiveness, crew/cockpit resource management, and safety management. Students will gain proficiency in identifying the various aspects of human sensory, motor, and cognitive attributes influencing human performance. Topics to be discussed will include physiologic contributors to human error including fatigue and stress, as well as life events, mission demands, technology, system design, administrative policies, and environmental influences. Mitigation and countermeasures to decrease risk will be discussed. A critical analysis of selected NTSB aircraft accident reports will serve as examples for students to evaluate ways to detect, prevent, and manage various human factors issues that sustain, enhance, and optimize human performance and safety.

PHOL 427. Physiological Contributions to Aviation Mishaps. 3 Units.
This course will cover major principles of the scientific method with an application to mishap investigation. Students will gain an understanding of the human, environmental, technological, and material factors which directly or indirectly contribute to manned and unmanned aviation and space mishaps. Special Emphasis is placed on aerospace-related physiologic contributors covered in PHOL 422, such as hypoxia and spatial disorientation. Additional topics will include proper classification of incidents; establishment of investigation teams and their roles and responsibilities; preservation of evidence based on industry accepted standards; hypothesis development and analysis; accurate data management; root cause analysis, and corrective actions influencing administrative policy and guidance changes. Analysis of selected past aviation and space craft mishaps will facilitate determination of possible causal and non-causal factors and how they relate to the incident origin. The importance of mishap prevention efforts such as data extraction, identifying trends, educational efforts to the operators, and other mitigation strategies such as automation, mission preparedness, crew composition, and predictive and real time risk assessments are reviewed. Related concepts include the contribution of human factors, site safety for the investigator, defining safety privilege, casualty identification, and the aeromedical role in investigations.

PHOL 429. Biophysical Modeling and Simulation of Cellular Transport. 1 - 3 Units.
This course is designed to provide hands on experience in computational modeling of the neural regulation of digestive and renal epithelia through a lecture-based module and supervised modeling projects that make use of datasets, maps and models assembled and made available through the Stimulating Peripheral Activity to Relieve Conditions (SPARC) program of the National Institutes of Health (NIH). The SPARC program is a large NIH project aimed at understanding the anatomy and physiology of the autonomic nervous system (ANS) and its connections to develop new therapies based on the emerging science of neuromodulation. The Lecture program will provide talks and small group tutorials introducing SPARC, concepts of open science, and modeling methodologies relevant to epithelial cells (including transporters & channels) and their control by the autonomic and enteric nervous systems. Students can take this first part as a 1 credit hour. The Research program will provide students with a mentored experience in the development, testing, and textbook-linked publication of a Findable, Accessible, Interoperable, Reusable (FAIR) model that simulates epithelial transport. These models will be generated using SPARC data and models, and leveraging SPARC infrastructure. The outcome of this reproducibility project will be submitted to an online repository. Students will be given the opportunity to publish their models in the Physiome journal (or another journal that publishes computational models). Physiome is an open access journal, launched by the International Union of Physiological Sciences (IUPS) that publishes reproducible and reusable mathematical models of physiological processes, where the experimental details and model validation have been published in a recognized 'primary' peer-reviewed journal. For the FAIR DOs ('Findable, Accessible, Interoperable, Reusable Development of Open Simulations') educational Physiome papers, the Medical Physiology textbook by Boron & Boulpaep will be regarded as the primary publication. Dr. Peter Hunter is the Editor-in-Chief of Physiome and Dr. Walter Boron is a co-editor of Medical Physiology. Drs. Nickerson & Occhipinti are members of the Editorial Board of Physiome.

PHOL 451. Independent Study. 1 - 18 Units.
Guided program of study using physiology textbooks, research reviews, and original research articles. An independent laboratory research project may also be included.

PHOL 466. Cell Signaling. 3 Units.
This is an advanced problem set and research paper-based discussion format course that covers cell signaling mechanisms; there are no lectures. Included are discussions of neurotransmitter-gated ion channels, growth factor receptor kinases, cytokine receptors, G protein-coupled receptors, steroid receptors, heterotrimeric G proteins, ras family GTPases, second messenger cascades, protein kinase cascades, second messenger regulation of transcription factors, signals for regulation of cell growth, division, tissue development and cell death. Offered as CLBY 466, NEUR 466, PHOL 466 and PHRM 466.

PHOL 467. Topics in Evolutionary Biology. 3 Units.
The focus for this course on a special topic of interest in evolutionary biology will vary from one offering to the next. Examples of possible topics include theories of speciation, the evolution of language, the evolution of sex, evolution and biodiversity, molecular evolution. The graduate level offerings of this course will require a longer, more sophisticated term paper, and additional class presentation. Offered as ANTH 367, BIOL 368, EEPS 367, PHIL 367, ANAT 467, ANTH 467, BIOL 468, EEPS 467, PHIL 467 and PHOL 467.

PHOL 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.

PHOL 477. Human Physiology. 4 Units.
This lecture/seminar experience is meant to enhance the student's fundamental knowledge in human physiology with an emphasis on physiologic concepts in relationship to health, disease and illnesses. The course will provide students with an understanding of the function, regulation and integration of the major organ systems.

PHOL 479. Clinical Reasoning: Applied Medical Physiology. 3 Units.
Physicians, detectives, scientists and mechanics all use deductive reasoning with multiple hypotheses to solve problems. The primary objective of this course is to help students apply their knowledge of medical physiology to solving clinical problems. The second objective is to develop an overall view of the clinical reasoning process as a problem-solving method. This will be done primarily through problem-based case studies of patients with cardiovascular, pulmonary and renal disease. Case studies will be supplemented by video presentations of patient history and physical exam, and student-led presentations. Prereq: PHOL 482 and PHOL 484.

PHOL 481. Medical Physiology I. 6 Units.
Physiology is the dynamic study of life. It describes the vital functions of living organisms and their organs, cells, and molecules. For some, physiology is the function of the whole person. For many practicing clinicians, physiology is the function of an individual organ system. For others, physiology may focus on the cellular principles that are common to the function of all organs and tissues. Medical physiology deals with how the human body functions, which depends on how the individual organ systems function, which depends on how the component cells function, which in turn depends on the interactions among subcellular organelles and countless molecules. Thus, it requires an integrated understanding of events at the level of molecules, cells, and organs. Medical Physiology I is a lecture course (3, 2 hr. lectures/week). It is the first of a two-part, comprehensive survey of physiology that is divided into four blocks: Block 1 covers the physiology of cells and molecules, signal transduction, basic electrophysiology, and muscle physiology; Block 2 covers the nervous system; Block 3 covers the cardiovascular system, and; Block 4 covers the respiratory system. Grading in the course will be based on performance on multiple choice/short essay examinations administered at the end of each block with each examination weighted according to the number of lectures contained in that block.

PHOL 482. Medical Physiology II. 6 Units.
Physiology is the dynamic study of life. It describes the vital functions of living organisms and their organs, cells, and molecules. For some, physiology is the function of the whole person. For many practicing clinicians, physiology is the function of an individual organ system. For others, physiology may focus on the cellular principles that are common to the function of all organs and tissues. Medical physiology deals with how the human body functions, which depends on how the individual organ systems function, which depends on how the component cells function, which in turn depends on the interactions among subcellular organelles and countless molecules. Thus, it requires an integrated understanding of events at the level of molecules, cells, and organs. Medical Physiology II is a lecture course (3, 2hr. lectures/week). It is the second of a two-part, comprehensive survey of physiology that is divided into five blocks: Block 5 covers the physiology of the urinary system; Block 6 covers the gastrointestinal system; Block 7 covers the endocrine system; Block 8 covers reproduction; and Block 9 covers the physiology of everyday life. Grading in the course will be based on performance on multiple choice/short essay examinations administered at the end of each block with each examination weighted according to the number of lectures contained in that block

PHOL 483. Translational Physiology I. 3 Units.
Physiology is the dynamic study of life, describing the vital functions of living organisms and their organs, cells, and molecules. For some clinicians, physiology is the function of an individual organ system. For others, it focuses on the cellular principles that are common to the function of all organs and tissues. Medical physiology deals with how the human body functions, which depends on individual organ systems function, which depends on cellular function, which in turn depends on molecular interactions. Translational Physiology I will explore examples of how the latest basic research in physiology and biophysics is being applied to the treatment of human disease. For example, while the students are studying the basic principles of cardiovascular physiology, they will also be investigating how these principles are being applied to treat/cure human cardiovascular disorders such as congestive heart failure, coronary artery disease, etc. Translational Physiology I is a lecture course (1, 2hr lecture/week, and 1, 1hr lecture/week) taught by clinical and basic science faculty. The 2 hour lecture will be given primarily by clinical faculty and is focused on applying physiological principles to clinical cases of pathophysiology. The 1 hour lecture will be given primarily by basic science faculty and will expose students to the process of translating fundamental basic science research to the clinic, that is bench-to-bedside. It is the first of a two-part course that follows the topics being simultaneously covered in the Medical Physiology I course. It is divided into 4 blocks: Block 1 covers the physiology of cells and molecules, signal transduction, basic electrophysiology, and muscle physiology; Block 2 covers the nervous system; Block 3 covers the cardiovascular system, and; Block 4 covers the respiratory system. Grading in the course will be based on performance on multiple choice examinations administered at the end of each block with each examination weighted according to the number of lectures contained in the block.

PHOL 484. Translational Physiology II. 3 Units.
Physiology is the dynamic study of life, describing the vital functions of living organisms and their organs, cells, and molecules. For some clinicians, physiology is the function of an individual organ system. For others, it focuses on the cellular principles that are common to the function of all organs and tissues. Medical physiology deals with how the human body functions, which depends on how the individual organ systems function, which depends on how the component cells function, which in turn depends on the interactions among subcellular organelles and countless molecules. Translational Physiology II will explore examples of how the latest basic research in physiology and biophysics is being applied to the treatment of human disease. For example, while the students are studying the basic physiology of the urinary system, they will also be investigating how these principles are being applied to treat/cure human kidney disorders such as renal failure, high blood pressure, glomerular disease, etc.. Translational Physiology II is a lecture course (1, 2hr lecture/week, and 1, 1hr lecture/week) taught by clinical and basic science faculty. The 2 hour lecture will be given primarily by clinical faculty and is focused on applying physiological principles to clinical cases of pathophysiology. The 1 hour lecture will be given primarily by basic science faculty and will expose students to the process of translating fundamental basic science research to the clinic, that is bench-to-bedside. It is the second of a two-part course that follows topics being simultaneously covered in the Medical Physiology II course. It is divided into 4 blocks: Block 5 covers the physiology of the urinary system; Block 6 covers the gastrointestinal system and metabolism; Block 7 covers the endocrine system and reproduction, and, Block 8 covers the physiology of everyday life. Grading in the course will be based on performance on multiple choice examinations administered at the end of each block with each examination weighted according to the number of lectures contained in the block. Coreq: PHOL 482.

PHOL 485. Comparative and Evolutionary Physiology. 3 Units.
This course presents physiological concepts from the comparative and evolutionary perspective. Aspects of vertebrate and mammalian evolution will be considered with respect to the generation of adaptive advantages for organisms to changing environmental challenges since the Cambrian. Comparative physiological concepts include scaling, variations in nutrition, energy metabolism and work efficiency. The important influences of time, temperature, water and energy on mammalian biology will be presented. The course is a lecture based course that can be taken in person or on-line. Evaluations will be by regular quizzes, a mid-term and a final exam, all MCQ. Offered as PHOL 485 and ORIG 485.

PHOL 486. Physiology of Movement: An Introduction to Exercise Physiology. 3 Units.
This course is designed to provide an understanding of the fundamentals of the physiological principles of exercise physiology. This course will prepare students for future study in advanced biomedical, physiological, and exercise-based sciences. Topics to be covered include metabolism, cellular physiology, and the physiology of the following organ systems: cardiovascular, respiratory, renal, neural, and musculoskeletal. The application of exercise to the aforementioned systems plus the integration of thermoregulation, extreme environments, and nutrition will also be covered.

PHOL 487. Exercise Physiology for Health and Disease. 3 Units.
Lifestyle Medicine is a graduate level course designed to provide an understanding of the fundamentals of the physiological and biochemical principles of exercise physiology and the application of these principles in health and disease. As such, this course will prepare students for future study in advanced biomedical sciences. The course is three credit hours and will be offered in the both the Fall and Summer semesters of each academic year. Course content builds on knowledge learned in Medical Physiology and is designed to be taken concurrently or in series with Medical Physiology courses. Topics to be covered include physiology of exercise, metabolism, and the application of exercise to select diseases of the musculoskeletal, gastrointestinal, neurological, and cardiovascular systems.

PHOL 488. Physiologic Basis of Treatment for Addiction and Neurobiological Diseases. 3 Units.
Physiologic Basis of Treatment for Addiction and Neurobiological Diseases is a graduate-level course designed to provide an understanding of the fundamentals of the physiological and biochemical principles underlying addiction and neurobiological diseases and the application of these principles in the treatment of health and disease. As such, this course will prepare students for future study in advanced biomedical sciences. The content of this course builds on knowledge learned in Medical Physiology I and II. Topics to be covered include physiology and treatment of addiction, including amphetamines, benzodiazepines and barbiturates, alcohol, opioids, and CNS stimulants; metabolism, and the biochemical and physiologic principles underlying neurobiological diseases, such as major depressive disorders, schizophrenia, anxiety disorders, ADHD, Alzheimer's Disease, Parkinson's Disease, headaches, and movement disorders.

PHOL 492. Clinical Reasoning II. 3 Units.
The objective of this course is to help students use principles of medical physiology to solve clinical problems. The second objective is to develop an overall view of clinical reasoning and improve critical thinking skills. The topics in Clinical Reasoning II are neurology, gastroenterology and endocrine/metabolic diseases. PHOL 479 Clinical Reasoning I, which covers cardiovascular, pulmonary and renal diseases, is not required. I anticipate that you will learn to: - Recognize physiologic mechanisms underlying abnormal physical findings, laboratory tests and imaging. - Use signs, symptoms, physical findings, laboratory tests and imaging to generate patient problem lists. - Develop and refine diagnostic hypotheses, i.e., differential diagnosis. - Understand the physiological basis of appropriate treatment plans. Prereq: PHOL 481.

PHOL 493. Clinical Reasoning III. 3 Units.
This course is a graduate-level course designed to provide an understanding of the fundamentals of the physiology, pathophysiology, and pathologies that most commonly affect the human endocrine glands (Block 1 of the course), and blood cells (Block 2 of the course). The course is designed along the lines of the already established Clinical Reasoning I and Clinical Reasoning II offered by the same instructor in the Fall semester and the Spring semester, respectively. The clinical topics covered in Clinical Reasoning III are different from and complementary to those presented in the other two Clinical Reasoning courses. Clinical Reasoning I covers the Cardiac, Respiratory, and Renal systems. Clinical Reasoning II covers the Neurology, Gastro-Intestinal, and Oncology systems.

PHOL 497A. Neurology Grand Rounds. 1 Unit.
This course is a weekly seminar series offered summer, fall, and spring semesters by the Department of Neurology at University Hospitals Case Medical Center. To earn a Passing grade in this course, students must attend at least 75% of the grand rounds offered by the Department of Neurology during the semester (signing in at the session) and submit to the course director within the week following the Grand Rounds, a one page report containing: 1) the name of the presenter and their professional affiliation; 2) the title of the presentation; 3) time and place of the Grand Rounds; 4) a one paragraph synopsis of the content of the presentation. Recommended Preparation: Pass the NBME Subject Exam in Physiology and Neurophysiology. Prereq: PHOL 481, PHOL 482, PHOL 483, PHOL 484, PHOL 498A and PHOL 498B.

PHOL 497B. Neurology Grand Rounds. 1 Unit.
This course is a weekly seminar series offered summer, fall, and spring semesters by the Department of Neurology at University Hospitals Case Medical Center. To earn a Passing grade in this course, students must attend at least 75% of the grand rounds offered by the Department of Neurology during the semester (signing in at the session) and submit to the course director within the week following the Grand Rounds, a one page report containing: 1) the name of the presenter and their professional affiliation; 2) the title of the presentation; 3) time and place of the Grand Rounds; 4) a one paragraph synopsis of the content of the presentation. Recommended Preparation: Pass the NBME Subject Exam in Physiology and Neurophysiology. Prereq: PHOL 481, PHOL 482, PHOL 483, PHOL 484, PHOL 497A, PHOL 498A and PHOL 498B.

PHOL 498A. Physiology and Biophysics Departmental Seminar. 1 Unit.
Weekly one-hour reviews by invited speakers of their research. Students present literature reviews or summaries of their research.

PHOL 498B. Physiology Seminar B (Spring Semester). 1 Unit.
Weekly one-hour reviews by invited speakers of their research. Offered spring semester.

PHOL 498C. Physiology and Biophysics Department Seminar for Medical Physiology Students. 1 Unit.
Weekly one-hour research reviews offered by various speakers, upon invitation. Students will present literature reviews or summaries of their own research throughout the course. Grades will be determined by quizzes based on the research presented.

PHOL 498D. Physiology MSMP Seminar B (Spring Semester). 1 Unit.
Weekly one-hour research reviews offered by various speakers, upon invitation. Students will present literature reviews or summaries of their own research throughout the course. Grades will be determined by quizzes based on the research presented. Offered spring semester.

PHOL 505. Laboratory Research Rotation. 1 Unit.
Six week experience in a selected faculty research laboratory designed to introduce the student to all aspects of modern laboratory research including the design, execution and analysis of original experimental work. Recommended preparation: Consent of instructor and scheduled laboratory.

PHOL 519. Cardio-Respiratory Physiology. 3 Units.
This course is designed to integrate systemic, cellular and molecular aspects of cardio-respiratory systems in physiological and pathophysiological states. The course requires prior knowledge of basic physiology of the cardiovascular systems. Extensive student participation is required. Instructors provide a brief overview of the topic followed by presentation and critical appraisal of recent scientific literature by students.

PHOL 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.

PHOL 601. Research. 1 - 18 Units.
Cellular physiology laboratory research activities that are based on faculty and student interests.

PHOL 610. Oxygen and Physiological Function. 1 Unit.
Lecture/discussion course which explores the significance and consequences of oxygen and oxygen metabolism in living organisms. Topics to be covered include oxygen transport by blood tissues, oxygen toxicity, and mitochondrial metabolism. Emphasis will be placed on mammalian physiology with special reference to brain oxidative metabolism and blood flow as well as whole body energy expenditure and oxidative stress related to disease. The course will cover additional spans of physiology, nutrition and anatomy. Offered as ANAT 610, NTRN 610, and PHOL 610.

PHOL 614. Sleep Physiology - Neurobiology of Sleep/Wake. 3 Units.
Participants in this course will gain an understanding of the neural mechanisms contributing to the states of sleep and wakefulness. Contemporary theories regarding why humans need to sleep will be reviewed. We will also review how perturbations within specific neurotransmitter systems become manifest as sleep related disorders and the pharmacological interventions used to normalize activity within those neural pathways. Prereq: PHOL 481 and PHOL 482 or requisites not met permission.

PHOL 620A. Clinical Observer: Neurology Service. 2 Units.
This course is a 2 week intensive experience offered summer, fall, and spring semesters on a schedule set by the Department of Neurology at University Hospitals Case Medical Center. Students are expected to be present and observe at all of the times set forth by the house staff and attending, generally a 40 hour week minimum. The Objective of the course is to provide the students with the experience of observing patient care provided by 3rd year medical students on a clinical rotation under direct supervision by house staff and attending on an active acute Neurology Service. The PGY-2 Neurology Resident and PGY-3 Chief Resident will always be available for immediate supervision. Students round as Clinical Observers with the CWRU medical students according to their daily schedule. They will learn the basics of neurological history-taking, neurological examination, neurodiagnostic studies, and neurological therapeutics. Didactic sessions covering a wide range of neurologic and neurosurgical topics are covered by faculty members from both departments. The lectures cover the gamut of neurological and neurosurgical disease processes and treatments. Neurosurgery lectures include such topics as cerebrovascular disease, brain tumors, hydrocephalus, spinal disorders, and head trauma as well as doctor-patient communication. Unlike the medical students on the rotation, a Clinical Observer will only observe procedures and will not actively take part in any health care; he/she will act strictly as an observer, but will act as a physiological consultant to the team responsible for providing basic science input to the clinical cases. Prereq: PHOL 481, PHOL 482, PHOL 483, PHOL 484, PHOL 498A and PHOL 498B.

PHOL 620B. Clinical Observer: Stroke Service. 2 Units.
This course is a 2 week intensive experience offered summer, fall, and spring semesters on a schedule set by the Department of Neurology at University Hospitals Case Medical Center. Students are expected to be present and observe at all of the times set forth by the house staff and attending, generally a 40 hour week minimum. The Objective of the course is to provide the students with the experience of observing patient care provided by 3rd year medical students on a clinical rotation under direct supervision by house staff and attending on an active acute Neurology Service. The PGY-2 Neurology Resident and PGY-3 Chief Resident will always be available for immediate supervision. Students round as Clinical Observers with the CWRU medical students according to their daily schedule. They will learn the basics of neurological history-taking, neurological examination, neurodiagnostic studies, and neurological therapeutics. Didactic sessions covering a wide range of neurologic and neurosurgical topics are covered by faculty members from both departments. The lectures cover the gamut of neurological and neurosurgical disease processes and treatments. Neurosurgery lectures include such topics as cerebrovascular disease, brain tumors, hydrocephalus, spinal disorders, and head trauma as well as doctor-patient communication. Unlike the medical students on the rotation, a Clinical Observer will only observe procedures and will not actively take part in any health care; he/she will act strictly as an observer, but will act as a physiological consultant to the team responsible for providing basic science input to the clinical cases. Prereq: PHOL 481, PHOL 482, PHOL 483, PHOL 484, PHOL 498A and PHOL 498B.

PHOL 620C. Clinical Observer: Epilepsy Service. 2 Units.
This course is a 2 week intensive experience offered summer, fall, and spring semesters on a schedule set by the Department of Neurology at University Hospitals Case Medical Center. Students are expected to be present and observe at all of the times set forth by the house staff and attending, generally a 40 hour week minimum. The Objective of the course is to provide the students with the experience of observing patient care provided by 3rd year medical students on a clinical rotation under direct supervision by house staff and attending on an active acute Neurology Service. The PGY-2 Neurology Resident and PGY-3 Chief Resident will always be available for immediate supervision. Students round as Clinical Observers with the CWRU medical students according to their daily schedule. They will learn the basics of neurological history-taking, neurological examination, neurodiagnostic studies, and neurological therapeutics. Didactic sessions covering a wide range of neurologic and neurosurgical topics are covered by faculty members from both departments. The lectures cover the gamut of neurological and neurosurgical disease processes and treatments. Neurosurgery lectures include such topics as cerebrovascular disease, brain tumors, hydrocephalus, spinal disorders, and head trauma as well as doctor-patient communication. Unlike the medical students on the rotation, a Clinical Observer will only observe procedures and will not actively take part in any health care - he/she will act strictly as an observer, but will act as a physiological consultant to the team responsible for providing basic science input to the clinical cases. Prereq: PHOL 481, PHOL 482, PHOL 483, PHOL 484, PHOL 498A and PHOL 498B.

PHOL 620D. Clinical Observer: Neurology (Neuromuscular). 2 Units.
This course is a 2 week intensive experience offered summer, fall, and spring semesters on a schedule set by the Department of Neurology at University Hospitals Case Medical Center. Students are expected to be present and observe at all of the times set forth by the house staff and attending, generally a 40 hour week minimum. The Objective of the course is to provide the students with the experience of observing patient care provided by 3rd year medical students on a clinical rotation under direct supervision by house staff and attending on an active acute Neurology Service. The PGY-2 Neurology Resident and PGY-3 Chief Resident will always be available for immediate supervision. Students round as Clinical Observers with the CWRU medical students according to their daily schedule. They will learn the basics of neurological history-taking, neurological examination, neurodiagnostic studies, and neurological therapeutics. Didactic sessions covering a wide range of neurologic and neurosurgical topics are covered by faculty members from both departments. The lectures cover the gamut of neurological and neurosurgical disease processes and treatments. Neurosurgery lectures include such topics as cerebrovascular disease, brain tumors, hydrocephalus, spinal disorders, and head trauma as well as doctor-patient communication. Unlike the medical students on the rotation, a Clinical Observer will only observe procedures and will not actively take part in any health care. He/she will act strictly as an observer, but will act as a physiological consultant to the team responsible for providing basic science input to the clinical cases. Prereq: PHOL 481, PHOL 482, PHOL 483, PHOL 484, PHOL 498A, and PHOL 498B. Coreq: PHOL 620A, PHOL 620B, or PHOL 620C.

PHOL 651. Thesis M.S.. 1 - 18 Units.
(Credit as arranged.)

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