

# PHYSIOLOGY AND BIOPHYSICS (PHIS)

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## **PHIS 206. Human Physiology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 101 and BIOZ 101, BIOL 151 and BIOZ 151, or BIOL 152 and BIOZ 152, each with a minimum grade of C. Functioning of the human body with emphasis on experimental procedures.

## **PHIS 301. Engaging in Undergraduate Research. 1 Hour.**

Semester course; 1 seminar hour. 1 credit. Prerequisite: PHIS 206, with a grade of A, or PHIS 309, with a minimum grade of B. This course will address the nature of research in the fields of physiology and biophysics and at the same time explore areas and laboratories at VCU that would offer undergraduate research opportunities.

## **PHIS 302. Engaging in Undergraduate Research II. 1 Hour.**

Semester course; 2 laboratory hours. 1 credit. Prerequisite: PHIS 301. This course permits students to actively engage in scientific research of interest in physiology and biophysics or in other selected areas of research. Graded as Satisfactory/Unsatisfactory.

## **PHIS 309. Introductory Quantitative Physiology I. 4 Hours.**

Semester course; 3 lecture hours and 3 laboratory hours. 4 credits. Prerequisite: calculus at the level of MATH 200 and MATH 201. The course is intended for majors in Biomedical Engineering. Other students may enroll with permission of the instructor. This course is a survey course in physiology with emphasis on physical principles. It is a systems analysis of cellular anatomy, physiology and biochemistry which leads into analysis of the nervous system, musculoskeletal system and the digestive system. It is meant to be taken as part of a two-semester series with PHIS 310.

## **PHIS 310. Introductory Quantitative Physiology II. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: calculus at the level of MATH 200 and MATH 201 and PHIS 309. The course is intended for majors in biomedical engineering. Other students may enroll with permission of the instructor. This course is the second semester of a survey course in physiology with emphasis on physical principles. It includes a systems analysis of the cardiovascular, respiratory, renal and endocrine systems. It is meant to be taken as part of a two-semester series with PHIS 309.

## **PHIS 403. Protein Structure and Function in Medicine. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. CHEM 403 and BIOL 300 highly recommended; otherwise seek permission from course director. In this course students will explore the diversity and wonder of the protein molecular machinery of life in the context of health and disease. They will first learn how proteins are built and folded to produce a diversity of shapes and functions. Students then will learn about the most common molecular graphics programs to view, analyze and study protein structures. The course will show how different types of protein malfunctions lead to diseases such as cancer, heart disease and neurodegeneration, among others, and reveal the role of protein structure in SARS-CoV2 vaccine development.

## **PHIS 461. Introduction to Human Physiology. 3 Hours.**

3 lecture hours. 3 credits. Prerequisites: biology, general chemistry and human anatomy. An introductory course to human physiology based on an analysis of organ systems.

## **PHIS 501. Mammalian Physiology. 5 Hours.**

Semester course; 5 lecture hours. 5 credits. A comprehensive study of the function of mammalian organ systems at the organ, cell and molecular level, designed for graduate and professional students. Successful students typically have high achievement in intermediate-level undergraduate biology, chemistry and physics.

## **PHIS 502. Mammalian Physiology II. 5 Hours.**

Semester course; 5 lecture hours. 5 credits. Students should have previous course work in biology, chemistry and physics. A comprehensive study of the function of mammalian organ systems, designed primarily for dental students.

## **PHIS 503. Predental Mammalian Physiology. 5 Hours.**

Semester course; 5 lecture hours. 5 credits. Enrollment requires permission of the instructor. A comprehensive study of the function of mammalian organ systems at the organ, cell and molecular level designed for predoctoral students planning to seek a D.D.S. or equivalent degree.

## **PHIS 512. Cardiac Function in Health and Disease. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: PHIS 501 or permission of instructor. A comprehensive study of cell and system cardiovascular physiology with pathophysiological implications, primarily designed for professional students.

## **PHIS 514. Cardiovascular Hemodynamics. 2 Hours.**

Semester course; 30 lecture/lab hours. 2 credits. Prerequisite: PHIS 501. Emphasizes the pathophysiological implications of cardiovascular hemodynamics. The rationale and principles of a variety of clinical and paraclinical examination methods used in cardiology will be studied and demonstrated. The pathophysiology of some of the major cardiovascular diseases will be explained by specialists.

## **PHIS 604. Cell Physiology: Cardiovascular and Respiratory. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: PHIS 501. Enrollment restricted to Ph.D. and M.S. students. This research-oriented course covers topics such as the cellular, molecular and structural bases for cardiovascular and pulmonary function, including detailed analyses of the behavior and regulation of diverse types of transmembrane ion channels at the molecular and cellular level; detailed studies of oxygen delivery by microcirculation; mechanisms of ischemia-reperfusion injury, novel cardio-protection strategies and heart failures; cholesterol homeostasis by macrophages in coronary artery disease; and airway inflammation and mucus secretion as a model for drug development.

## **PHIS 606. Molecular Basis for Disease. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Topics covered include an introduction to structure of macromolecules and biophysical methods of protein determination. The second part of the course includes research topics such as gene regulation, protein folding and ribosome biogenesis. The third section includes ion channel structure and function. Each section includes problem sets that students are required to complete, three exams and a written mini-grant chosen from the topics discussed in class.

## **PHIS 607. Cell Physiology: GI and Endocrine. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: PHIS 501. This course focuses on physiology at the levels of individual molecules, cells, organs and entire organisms. Molecular mechanisms, regulatory processes and diseases processes are considered. The course is designed for research-oriented students and focuses on taste, gut, intestines, endocrine and reproductive systems and is structured around the ongoing research activity of the participating faculty.

**PHIS 612. Cardiovascular Physiology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: PHIS 501. An in-depth study of the original literature in selected areas of cardiovascular physiology.

**PHIS 615. Signal Detection in Sensory Systems. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: PHIS 501 or permission of instructor. An in-depth study of cells and cell systems that serve as either internal or external environmental sensors. Topics will emphasize the physiology, anatomy and the biochemistry of mature sensing systems, the systems in normal development and their plasticity toward stresses during development or in maturity.

**PHIS 619. Mitochondrial Pathophysiology and Human Diseases. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Mitochondria are essential for eukaryotic life energy production in an oxygen environment, extensively modulate intracellular calcium signaling, are the major source of damaging oxygen free radicals, control activation of cell death pathways and are now known to be impaired in many human diseases of aging. For all these reasons, understanding mitochondrial physiology is essential for graduates of biomedical research programs in medical schools.

**PHIS 620. Ion Channels in Membranes. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Previous course work including basic concepts in electrophysiology, such as those covered in PHIS 501 or PHTX/PHIS/ANAT 509, is highly recommended. Detailed presentation of the fundamental biophysical properties of ionic channels in membranes including the elementary properties of pores, molecular mechanisms of ionic selectivity, mechanisms of drug block, structure-function relationships, and basis for channel gating. Discussion will encompass modern techniques for studying ion channel function. Crosslisted as: PHTX 620.

**PHIS 630. Methods in Molecular Biophysics: A Practical Approach. 2 Hours.**

Semester course; 2 lecture hours. 2 credits. The course will cover the theoretical and practical aspects of several techniques that are used to study the structure and function of biological macromolecules. In each section the theoretical background and practical application will be covered. The design of the course is to provide a basic familiarity of biophysical techniques used in structural biology and biochemistry laboratories to understand biological phenomena. Graded S/U/F.

**PHIS 631. Electrophysiology and Photonic Methods. 2 Hours.**

Semester course; 2 lecture hours. 2 credits. This course elaborates on the fundamentals of bioelectrical activity (resting and action potentials, electrical propagation and synaptic transmission) guiding the student to the use of equivalent circuits to model the electrical properties of cells design and the use of basic operational amplifiers for electrophysiological studies. The course develops a similar approach to understand the basis for fluorescence and phosphorescence techniques and how they can be applied to biophysical research.

**PHIS 650. Critical Thinking in Physiology. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Journal club format. Pre- or corequisite: PHIS 501. Enrollment restricted to students with graduate standing or by permission of instructor. This course introduces classical research papers and incorporates problem sets in areas that lend themselves to an analytical approach. Students read and present papers, contributing answers to questions about them.

**PHIS 651. MD/PhD Journal Club. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. May be repeated for credit. Enrollment restricted to students in the MD/PhD program. This course is intended for first-year MD/PhD students as a complement to the ongoing medical curriculum and is designed to expose MD/PhD students to research literature related to their ongoing course work. The objectives are to introduce students to original research papers from the current and classical literature and to provide practice and training in effectively identifying and discussing key hypotheses, methods, results and conclusions, as well as in evaluating the strengths and weaknesses of papers. Graded as Satisfactory/Unsatisfactory.

**PHIS 652. MD/PhD Science and Disease. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Enrollment restricted to students in the MD/PhD program. This course is intended for second-year MD/PhD students as a complement to the ongoing medical curriculum. Clinical faculty or physician-scientists present a patient and then either the physician-scientist or a basic science faculty member discusses the basic science underpinnings of the disease in question. The sessions are coordinated with the MS2B curriculum. Active student participation in the discussion of the case and scientific basis is expected and required. Faculty members are encouraged to present informal sessions designed to encourage student participation and engaged learning. Graded as Satisfactory/Unsatisfactory.

**PHIS 653. MD-PHD Research Seminar. 0.5 Hours.**

Semester course; 1 lecture hour (alternate weeks). .5 credits. May be repeated for credit. Enrollment is restricted to students enrolled in School of Medicine M.D.-Ph.D. training while in the medical or graduate phases. Course exposes M.D.-Ph.D. students to state-of-the-art research in a range of fields. The objectives are to (1) provide an opportunity for the students to attend formal research presentations by faculty experts, (2) participate in discussions of the underlying hypotheses, research methods, critical results and interpretation of data and (3) give formal presentations based on their own research and receive feedback. Graded as satisfactory/unsatisfactory.

**PHIS 689. Physiology Preseminar Highlights. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. May be repeated for credit. Designed to review research to be presented in the department's upcoming weekly seminar. Students present and discuss papers by that week's seminar speaker. Graded as Satisfactory/Unsatisfactory/Fail.

**PHIS 690. Physiology Research Seminar. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Presentation and discussion of research reports and topics of current interest to the departmental seminar or special group seminar.

**PHIS 691. Special Topics in Physiology. 1-4 Hours.**

Semester course; 1-4 credits. Prerequisite: PHIS 501 (or taken concurrently). **Special Topics in Physiology (Section 1)**  
 1-4 credits. Lectures, tutorial studies and/or library assignments in selected areas of advanced study not available in other courses or as part of the research training. **Special Topics: Student Seminar (Section 3)**  
 Semester course; 1 credit. Pre- or corequisite: PHIS 501. Designed to develop skills in preparing and delivering lectures and other oral presentations. Students present talks on topics in which they are particularly interested, and provide mutual constructive criticism. **Special Topics: Nutrition Research (Section 5)**  
 Semester course; 3 credits. Weekly discussion of selected topics in nutrition. Topics change yearly. Topics range from biochemical aspects of nutrition to International Nutrition, with selections from various levels of nutritional interest presented each year. Past topics have included nutrition and exercise, diet and cancer, total parenteral nutrition, alcohol nutrition, food safety, drug-nutrient interactions, nutrition and immunological response, cholesterol and nutrition, salty taste mechanisms, vitamin A, vitamin D, and intestinal calcium absorption.

**PHIS 692. Special Topics. 1-4 Hours.**

Semester course; 1-4 variable hours. 1-4 credits. Lectures, tutorial studies, library assignments in selected areas of advanced study or specialized laboratory procedures not available in other courses or as part of the research training. Graded S/U/F.

**PHIS 693. Methods in Molecular Biophysics: A Practical Approach. 2 Hours.**

Semester course; 1 lecture and 2 laboratory hours. 2 credits. Covers the theoretical and practical aspects of several techniques that are used to study the structure and function of biological macromolecules. In each section, theoretical background and practical applications will be covered. The course will provide a basic familiarity of biophysical techniques used in structural biology and biochemistry laboratories to understand biological phenomena. Graded S/U/F.

**PHIS 695. Research in Progress. 0.5 Hours.**

Semester course; .5 lecture hour. .5 credit. Restricted to Ph.D. students or, with permission of instructor, master's students. Student presentations and discussion of research results and contemplated research projects base on research rotations, thesis proposals and ongoing thesis research. Graded S/U/F.

**PHIS 697. Directed Research in Physiology. 1-15 Hours.**

Semester course; 1-15 credits. Research Leading to the M.S. or Ph.D. degree and elective research projects for other students.