

# Medical Pharmacology and Physiology

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Pharmacology and Physiology  
School of Medicine  
MA415 Medical Sciences Building  
573-882-4957

<https://medicine.missouri.edu/departments/medical-pharmacology-physiology/about> (<https://medicine.missouri.edu/departments/medical-pharmacology-physiology/about/>)

The joining of these two disciplines provides a powerful way to address modern questions of biology.

The department offers MS and PhD degree programs in Pharmacology and Physiology. These programs are designed to prepare students for rewarding teaching and/or research careers in academia, government or the pharmaceutical and biotechnical industries.

## Faculty

**Professor** F. Booth\*\*, D. Bowles\*, S. Chen\*\*, M. Davis\*\*, W. Durante\*\*, W. Fay\*\*, K. Gillis, K. Gruber, C. Hardin, E. Hasser\*, M. Hill\*\*, T. Hwang\*, J. Ibdah, K. Kattesh, Z. Liu\*\*, L. Martinez-Lemus\*\*, K. McDonald\*\*, S. Segal\*\*, S. Shukla\*\*, M. Thakkar\*\*

**Associate Professor** C. Baines, T. Domeier\*\*, S. Halenda, M. Krenz\*\*, R. Lim\*, A. Parrish\*\*, L. Polo-Parada\*\*, G. Sowa\*\*, P. Wilden\*

**Assistant Professor** E. Boerman\*\*, B. Bostick\*\*, C. Hans\*, C. Norton\*\*, A. Upendran\*\*, S. Zawieja\*\*

**Professor Emeritus** E. Blaine\*, E. L. Forker\*, L. Forte\*, L. Holland\*, T. Hurley\*, V. Huxley\*\*, M. James-Kracke\*, A. Jones\*, R. Korthuis\*, G. Meininger\*, M. Milanick\*\*, M. Rovetto\*, R. Russell\*, J. Turner

\* Graduate Faculty Member - membership is required to teach graduate-level courses, chair master's thesis committees, and serve on doctoral examination and dissertation committees.

\*\* Doctoral Faculty Member - membership is required to chair doctoral examination or dissertation committees. Graduate faculty membership is a prerequisite for Doctoral faculty membership.

## Undergraduate

While MU does not offer undergraduate degrees specifically in medical pharmacology and physiology, the University does offer baccalaureate opportunities in a number of related areas in the other Schools and Colleges that make up the University. The catalog provides a complete list of these degree options (<http://catalog.missouri.edu/degreesanddegreeprograms/>).

## Graduate

- MS in Medical Pharmacology and Physiology (<http://catalog.missouri.edu/schoolofmedicine/medicalpharmacologyphysiology/ms-medical-pharmacology-physiology/>)
- PhD in Medical Pharmacology and Physiology (<http://catalog.missouri.edu/schoolofmedicine/medicalpharmacologyphysiology/phd-medical-pharmacology-physiology/>)

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The joining of these two disciplines provides a powerful way to address modern questions of biology. The department offers MS and PhD degree programs in Pharmacology and Physiology. These programs are designed to prepare students for rewarding teaching and/or research careers in academia, government or the pharmaceutical and biotechnical industries.

## Pharmacology

Pharmacology is a basic medical science that deals with actions of drugs, hormones and neurotransmitters on living processes. Knowledge based on the results of pharmacological research leads to increased effectiveness and safety in the treatment of diseases in man and animals. Pharmacology is different from pharmacy, which is a profession concerned with the preparation and dispensing of drugs.

## Physiology

The discipline of Physiology focuses on understanding the integrative function of living organisms from the molecular to the organismal level. As such, physiological research addresses how genes, organelles, cells, tissues and organs are integrated to accomplish the complex functions of living organisms. From a medical perspective, understanding normal function is a prerequisite to understanding disease.

## Areas of Study

Regardless of their final degree objectives, students admitted into the departmental graduate programs will participate in a core curriculum during the first year and choose a specific tract leading to either a degree in Pharmacology or in Physiology following successful completion of the first year. The department also offers specially designed curriculum for individuals interested in a combined MD/graduate degree or who have previous relevant medical education.

## Departmental Research

The departmental faculty has expertise in a variety of mammalian systems, with emphases in cardiovascular and endocrine physiology and molecular and cellular pharmacology. Individual labs utilize a number of different experimental models ranging from the whole animal studies to cellular, subcellular, biochemical and modern molecular approaches. Human research is also emphasized.

Research problems under current investigation include microvascular control of blood flow; modulation of vascular function by the extracellular matrix; role of the microcirculation in inflammation and diabetes; mechanisms involved in angiogenesis membrane regulation and ion transport; barriers separating circulating blood and tissue; energetics and metabolism of vascular smooth and cardiac muscle; electrophysiology of isolated cardiac vascular smooth muscle and endothelial cells; exercise physiology and regulation of contractile protein functions; and hormonal induction of genetic transcription, intracellular signaling mechanisms and genetic regulation of cell proliferation, cell cycle, cell differentiation and apoptosis; and the pathogenetic mechanisms of alcohol on liver cells.

## Partnerships

Cooperative interactions exist with other clinical and basic science departments in the School of Medicine as well as with the Truman Veterans Hospital, the Dalton Cardiovascular Research Center, the College of Veterinary Medicine, Nutrition and Exercise Department and various campus-wide programs in Molecular Biology and Food for the 21st Century. The cooperative research atmosphere encourages staff and students to work across departmental lines and provides a unique opportunity for interdisciplinary training of the students.

## Teaching Experience

In addition to course work and research training, all graduate students are required to participate as teaching assistants in laboratory or lecture instruction offered by the department. Such experience enhances the students' presentation and teaching skills, contributes to their professional maturity, and reinforces a sense of collegiality between students and faculty.

## Financial Aid from the Program

Financial support in this program for qualified graduate students is available from several sources. Students also may be eligible for institutional teaching and research assistantships. In addition, there are a number of fellowship awards from the Graduate School and the campus-wide Life Science Program available on a competitive basis through nominations by the Department.

Deadlines for these fellowships are January to mid-February each year. Applicants do not directly apply for these fellowships. Rather the department applies on behalf of successful applicants for admission. Therefore a prospective candidate should submit an application for admission to the department in the preceding fall. Finally, some of our students are supported by research grants of individual faculty members or by predoctoral fellowships from extramural sources.

### MPP 1111: How to Inquire and Investigate

In this course we will be interviewing faculty members from different departments to learn about their area of research and they will also be interviewing me about my area of research. How does one learn about a new subject with all its technical language (jargon)? What are common themes and approaches in different disciplines? What are conceptual and viewpoint differences in different disciplines?

**Credit Hour:** 1

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### MPP 2010: The Science of Sex, Drugs and Rock'n'Roll

This course will examine the data and theories for how drugs affect the body, for the physiology of reproduction and, for how sound affects the body. These topics will be used to motivate an understanding, and provide training in applying, the key scientific principles. Graded on A-F basis only.

**Credit Hour:** 1

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### MPP 2015: Toxins, The Good, The Bad, and the Beautiful

In this course, the students will explore toxins. We will discuss how toxins are formed, the "value" of the toxin to the organism that makes it, how the toxin is delivered, the effect of the toxin on the target animal and on humans. In addition, we will discuss how toxins have led to new therapies and drugs. We will also analyze some famous cases of apparent toxin poisoning. In all cases, the students will be urged to critically evaluate the data and the theories and encouraged to think of novel uses of toxins and

of experiments that would provide important new information about the toxins and their effects.

**Credit Hours:** 3

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### MPP 2015H: Toxins, The Good, The Bad, and the Beautiful - Honors

In this course, the students will explore toxins. We will discuss how toxins are formed, the "value" of the toxin to the organism that makes it, how the toxin is delivered, the effect of the toxin on the target animal and on humans. In addition, we will discuss how toxins have led to new therapies and drugs. We will also analyze some famous cases of apparent toxin poisoning. In all cases, the students will be urged to critically evaluate the data and the theories and encouraged to think of novel uses of toxins and of experiments that would provide important new information about the toxins and their effects.

**Credit Hours:** 3

**Prerequisites:** Honors eligibility required

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### MPP 2015W: Toxins, The Good, The Bad, and the Beautiful - Writing Intensive

In this course, the students will explore toxins. We will discuss how toxins are formed, the "value" of the toxin to the organism that makes it, how the toxin is delivered, the effect of the toxin on the target animal and on humans. In addition, we will discuss how toxins have led to new therapies and drugs. We will also analyze some famous cases of apparent toxin poisoning. In all cases, the students will be urged to critically evaluate the data and the theories and encouraged to think of novel uses of toxins and of experiments that would provide important new information about the toxins and their effects.

**Credit Hours:** 3

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### MPP 2020: Bodily Fluids and Functions

In this course, the students will study body fluids. We will learn about how the fluids are formed and the functions of the fluids. We will also critically evaluate some theories about the formation and function of the fluids.

**Credit Hours:** 3

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### MPP 2020W: Bodily Fluids and Functions - Writing Intensive

In this course, the students will study body fluids. We will learn about how the fluids are formed and the functions of the fluids. We will also critically evaluate some theories about the formation and function of the fluids.

**Credit Hours:** 3

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### MPP 2222: Let's Do Experiments for Research

This course is designed to provide students a hands on opportunity to do experiments in the first part of the semester, students will be working primarily on two projects that they chose from a list developed by the previous class; the second half of the semester will be not only working on those projects, but developing the choice of projects for students to start for the next time the course is offered. The projects can be basic science, translational science, or developing education activities/experiments or a combination of these. Some of the choices will involve safe materials and will require no additional training. Other choices may involve human subjects, animal tissues, or hazardous chemicals in which case, the students will need to obtain the appropriate training and that can be done to fulfill part of this course's requirements.

**Credit Hours:** 3

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**MPP 3202: Elements of Physiology**

Beginning course for sophomore and above designed to cover the basic functional aspects of major organ systems of the body.

**Credit Hours:** 5

**Prerequisites:** sophomore standing

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**MPP 3202H: Elements of Physiology - Honors**

Beginning course for sophomore and above designed to cover the basic functional aspects of major organ systems of the body.

**Credit Hours:** 5

**Prerequisites:** sophomore standing; honors eligibility required

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**MPP 3290: Undergraduate Research**

Laboratory experience and opportunity to explore research in medical pharmacology and physiology.

**Credit Hour:** 1-3

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**MPP 3333: Fundamentals of Human Physiology**

This course presents the basic concepts of physiology using a problem based approach. The major organs systems are discussed with the relevance to everyday physiology as well as clinical and animal applications discussed.

**Credit Hours:** 3

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**MPP 3333H: Fundamentals of Human Physiology - Honors**

This course presents the basic concepts of physiology using a problem based approach. The major organs systems are discussed with the relevance to everyday physiology as well as clinical and animal applications discussed.

**Credit Hours:** 3

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**MPP 3337: Human Physiology Laboratory**

This lab course will involve experiments to illustrate basic physiology concepts.

**Credit Hours:** 2

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**MPP 3500: Sports Performance Physiology**

This is an online course that will introduce students to the basic concepts in sports performance physiology, with a focus on the integrated function of organ system in homeostasis and human health. Several sections of the course will expose students to important issues in sports performance physiology, specifically the impact of physical activity on cardiovascular and metabolic functions.

**Credit Hours:** 3

**Recommended:** Cell Biology, Biochemistry

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**MPP 3550: Physiology for Engineers**

This is an online course that will introduce students to the basic concepts of physiology, with a focus on the integrated function of organ systems in homeostasis and human health. Several sections of the course will expose students to important issues from engineering perspective with emphasis in the analytical and quantitative engineering skills applicable to different physiological systems.

**Credit Hours:** 3

**Recommended:** Cell Biology, Biochemistry, Basic Mathematics

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**MPP 4001: Undergraduate Topics in Medical Pharmacology and Physiology**

Selected topics not in regularly offered courses.

**Credit Hour:** 1-3

**Prerequisites:** instructor's consent

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**MPP 4085: Undergraduate Problems in Medical Pharmacology and Physiology**

This course is designed to provide well-qualified undergraduate students the opportunity to engage in advanced study in topics in pharmacology or physiology with individual faculty members. Topics will be drawn from recent primary literature. Graded on A-F basis only.

**Credit Hour:** 1-3

**Prerequisites:** instructor's consent

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**MPP 4085W: Undergraduate Problems in Medical Pharmacology and Physiology - Writing Intensive**

This course is designed to provide well-qualified undergraduate students the opportunity to engage in advanced study in topics in pharmacology or physiology with individual faculty members. Topics will be drawn from recent primary literature. Graded on A-F basis only.

**Credit Hour:** 1-3

**Prerequisites:** instructor's consent

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**MPP 4202: Medical Physiology**

(cross-leveled with MPP 7422). Medical Physiology is intended for health scientists. Fat, bone, digestion, nutrition, appetite and brain health will be emphasized for health reform and updates for nervous, muscle, heart, vasculature, liver, renal, lung and endocrine systems with analysis for preventative medicine. May be repeated for credit. Graded on A-F basis only.

**Credit Hours:** 4

**Prerequisites:** Nutrition or Biochemistry

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**MPP 4202H: Medical Physiology - Honors**

(cross-leveled with MPP 7422). Medical Physiology is intended for health scientists. Fat, bone, digestion, nutrition, appetite and brain health will be emphasized for health reform and updates for nervous, muscle, heart, vasculature, liver, renal, lung and endocrine systems with analysis for preventative medicine. May be repeated for credit. Graded on A-F basis only.

**Credit Hours:** 4

**Prerequisites:** Nutrition or Biochemistry. Honors eligibility required

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**MPP 4204: Medical Pharmacology**

(cross-leveled with MPP 7424). Medical pharmacology teaches the science of drug actions in medicine today, and principles of pharmacokinetics/dynamics. Future health professionals will learn prescription judgment and quality/cost improvements for patient safety. An online laboratory will teach drug database information technology.

**Credit Hours:** 4

**Prerequisites or Corequisites:** BIO\_SC 3700 or MPP 3202 or MPP 4202 or equivalent physiology course from other colleges

**Recommended:** nutrition or biochemistry courses are recommended but not required

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**MPP 4204H: Medical Pharmacology-Honors**

Medical pharmacology teaches the science of drug actions in medicine today, and principles of pharmacokinetics/dynamics. Future health professionals will learn prescription judgment and quality/cost improvements for patient safety. An online laboratory will teach drug database information technology.

**Credit Hours:** 4

**Prerequisites or Corequisites:** BIO\_SC 3700 or MPP 3202 or MPP 4202 or equivalent physiology course from other colleges; Honors eligibility required

**Recommended:** nutrition or biochemistry courses are recommended but not required

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**MPP 4417: Diagrams, Figures and Graphs**

(cross-leveled with MPP 7717). In this course, we will examine what features optimize the drawing of diagrams, figures and graphs for communication to different audiences. Graded on A-F basis only.

**Credit Hour:** 1

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**MPP 7302: Drug Discovery and Action**

This course is designed to provide the student with an in depth knowledge of specific aspects of cardiovascular physiology with major emphasis on cardiac structure and function. Topics are covered in 1, 3-4 hour session per week and are based on reading assignments from the literature. The following topics have been addressed in previous offerings but the specific topics may vary from year to year: Heart muscle structure related to function; Contractile proteins structures and function; Regulation of protein synthesis; Regulation of myocardial hypertrophy; Regulation of myocardial metabolism; Myocardial mechanics systolic and diastolic function; Mechanisms of length dependent contraction; Control of electrical-mechanical coupling processes; Mechanisms for adrenergic regulation of myocardial function.

**Credit Hour:** 1

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**MPP 7422: Medical Physiology**

(cross-leveled with MPP 4202). Medical Physiology is intended for health scientist. Fat, bone, digestion, nutrition, appetite and brain health will be emphasized for health reform and updates for nervous, muscle, heart, vasculature, liver, renal, lung and endocrine systems with analysis for preventive medicine. May be repeated for credit. Graded on A-F basis only.

**Credit Hours:** 4

**Prerequisites:** Nutrition or Biochemistry

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**MPP 7424: Medical Pharmacology**

(cross-leveled with MPP 4204). Pharmacology teaches the science of drug actions in medicine today and principles of pharmacokinetics/dynamics. Future medical researchers will learn molecular probes for medical research and translational science to improve health care. An online laboratory will teach drug database information technology. Graded on A-F basis only.

**Credit Hours:** 4

**Prerequisites or Corequisites:** BIO\_SC 3700 or MPP 3202 or MPP 4202 or equivalent physiology course from other colleges

**Recommended:** nutrition or biochemistry courses are recommended but not required

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**MPP 7717: Diagrams, Figures, and Graphs**

(cross-leveled with MPP 4417). In this course, we will examine what features optimize the drawing of diagrams, figures and graphs for communication to different audiences. Graded on A-F basis only.

**Credit Hour:** 1

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**MPP 8000: Scientific Discovery Leading to Life Science Innovations**

(same as BIOL\_EN 8000). This course explains the scientific discovery process from idea to product release, examining problem identification, need validation, and commercialization. Clinical, business and engineering perspectives are examined to understand translating innovation into clinical practice. May be repeated for credit. Graded on A-F basis only.

**Credit Hours:** 3

**Prerequisites:** must be enrolled in a graduate degree program

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**MPP 8004: Regulatory Issues in Clinical Research and Clinical Trials**

(same as BIOL\_EN 8004). The goal of the course is to highlight key FDA regulatory issues for conducting human clinical trials and clinical research. For clinical trials, FDA has set up several compliance programs and guidance documents as a part of human subject protection (HSP)/ Bioresearch Monitoring (BIMO) initiatives. The aim of the program was to strengthen FDA oversight and protection of subjects in clinical trials and to preserve confidentiality of data. The HSP/BIMO initiative comprehends all FDA regulated clinical trials including human drugs and biological drug products, devices, foods, and veterinary medicine. The course is designed for students in medical professions, management, biomedical engineering, and related areas. Adequate knowledge regarding FDA guidance in conducting human clinical trials and clinical research will help professionals steer drug/device development and commercialization in their respective field. This course will be offered online only. An introduction to essential disciplines for conducting clinical trials and clinical research will be provided. The basics of good clinical practices (GCPs), biostatistics and clinical epidemiology in relation to clinical trials will be presented. Several relevant case studies for conducting clinical trials, both nationally and internationally, will be discussed. The importance of data collection and data management while conducting clinical trials will be explained. Graded on A-F basis only.

**Credit Hours:** 3

**Recommended:** Knowledge in biomedical sciences, clinical sciences

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**MPP 8050: Non-Thesis Research in Medical Pharmacology and Physiology**

Opportunities for graduate research in physiology or pharmacology not leading to dissertation. Graded on A-F basis only.

**Credit Hour:** 1-5

**Prerequisites:** instructor's consent

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**MPP 8085: Graduate Problems in Medical Pharmacology and Physiology**

Guided study to strengthen knowledge in physiology and pharmacology. Graded on A-F basis only.

**Credit Hour:** 1-3

**Prerequisites:** instructor's consent

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**MPP 8090: Thesis Research in Medical Pharmacology and Physiology**

Research for Master's Students in physiology or pharmacology, leading to dissertation. Graded on a S/U basis only.

**Credit Hour:** 1-99

**Prerequisites:** instructor's consent

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**MPP 8100: Design and Development of Biomedical Innovations**

(same as BIOL\_EN 8100, ENGINR 8100). The overarching goal of this course is to help participants understand the design and development (drug or device) process in biomedical innovation. This course will help participants to understand the process of choosing unmet clinical needs, articulate a need statement without integrating solution, design and develop a solution. Participants will learn to assess the commercial potential of clinical needs by performing market analysis and valuing customer needs. A conceptual understanding about development of a prototype for a device and also drug development by different brainstorming process will be provided. Details of regulatory, reimbursement, patenting process required for product development will be explained with examples. An overview about how to evaluate preliminary designs, define product specifications, comply with manufacturing principles and methods, costs, cGMP requirements will be explained. Quality control and Quality assurance necessities for drug/device will be elucidated with case studies. Participants will gain knowledge about different business models for drug and devices, estimate market penetration and how to make profitable, patient-driven products. Graded on A-F basis only,

**Credit Hours:** 3

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**MPP 8200: Medical Pharmacology I**

This course is the first of two courses; Students will be able to understand the basic concepts of pharmacology and the pharmacological basis of therapeutics. Students will be introduced to the core principles of drug action in terms of bioavailability, pharmacokinetics, pharmacodynamics, and the mechanism of action of drugs in the treatment of diseases.

**Credit Hours:** 3

**Recommended:** Cell Biology, Biochemistry

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**MPP 8250: Medical Pharmacology II**

This course is the second of two courses; Students will be able to understand the basic concepts of pharmacology and the pharmacological basis of therapeutics. Students will be introduced to the core principles of drug action in terms of bioavailability, pharmacokinetics, pharmacodynamics, and the mechanism of action of drugs in the treatment of diseases.

**Credit Hours:** 3

**Recommended:** Cell Biology, Biochemistry

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**MPP 8300: Medical Physiology I**

In this first two courses students will be able to understand the basic concepts of physiology and ensure that they understand how the body works. Students will be able to understand the function, regulation, and integration of human body organ systems.

**Credit Hours:** 3

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**MPP 8350: Medical Physiology II**

In this second of two courses students will be able to understand the basic concepts of physiology and ensure that they understand how the body works. Students will be able to understand the function, regulation, and integration of human body organ systems.

**Credit Hours:** 3

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**MPP 8375: Medical Pharmacology and Physiology Laboratory**

The main aim of this laboratory is to link several key aspects of general human physiology functions necessary for everyday living with fundamental aspects of pharmacology.

**Credit Hours:** 3

**Recommended:** Pharmacology, Physiology

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**MPP 8411: Mammalian Pharmacology and Physiology**

An integrated course covering the basic concepts in physiology and pharmacology of the cardiovascular, gastrointestinal, endocrine, renal, and respiratory systems with an emphasis of applying the key concepts to clinically relevant examples. Graded on A-F basis only.

**Credit Hours:** 5

**Prerequisites:** instructor's consent

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**MPP 8412: Seminar in Medical Pharmacology and Physiology**

Instruction in critical evaluation, review, and summary of scientific data and practice in oral presentation of scientific research seminar. Taught in conjunction with weekly department seminar series.

**Credit Hour:** 1

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**MPP 8415: Responsible Conduct of Research thru Engagement, Enactment and Empowerment NIH and other Federal Age**

The emphasis is on the scientific research ethics problems in interdisciplinary work. Student involvement can include designing mock misconduct trials or writing advocacy letters to change current policy.

**Credit Hours:** 2

**Prerequisites:** instructor's consent

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**MPP 8417: Scientific Communication**

A course to foster and improve students ability to communicate orally and in writing. Student enrolled in the course will be expected to write a report and present a seminar on a topic related to one of the lab rotation projects to the mentor of the rotation and other interested faculty members and students. Graded on A-F basis only.

**Credit Hours:** 2

**Prerequisites:** instructor's consent

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**MPP 8420: Skills in Biomedical Research**

This course focuses on introducing graduate students to the basics of biomedical research. Course objectives are to provide new graduate students with a basic understanding of laboratory safety issues and fundamental skills that are integral to research including principles of experimental design, theory and practical application of modern research techniques, written and oral communication of research information, and scientific record keeping standards. Graded on S/U basis only.

**Credit Hours:** 2

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**MPP 9090: Thesis Research in Medical Pharmacology and Physiology**

Research for PhD students in physiology or pharmacology, leading to dissertation. Graded on a S/U basis only.

**Credit Hour:** 1-99

**Prerequisites:** instructor's consent

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**MPP 9422: Medical Pharmacology and Physiology Journal Club**

On a weekly basis, individual students are assigned current high profile journal articles to present to their fellow students and faculty in a journal club setting. Each student in the course is required to read the paper in advance and participate in discussions of the figures and general topics that is being presented. Graded on S/U basis only.

**Credit Hour:** 1

**Prerequisites:** enrolled in MPP PhD graduate program

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**MPP 9426: Transmembrane Signaling**

This course is for advanced level graduate students. The course is designed to develop state of the art knowledge and understanding of current research issues in the cell signaling. The major emphasis is on receptor and non-receptor mediated transmembrane signaling events underlying physiological and pharmacological responses of the cells. Students are also involved in class presentations, and the development and critical review of new research proposals, all focused on cellular signaling.

**Credit Hours:** 4

**Prerequisites:** basic courses in biochemistry and or cell and molecular biology or equivalent

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**MPP 9429: Principles and Frontiers of Molecular Pharmacology**

An in-depth examination of pharmacodynamics, structure-activity relationships, pharmacokinetics/drug metabolism, and toxicology, followed by a consideration of emerging concepts regarding membrane receptors and channels and their role in biology and medicine.

**Credit Hours:** 5

**Prerequisites:** Students must have completed a physiology, biochemistry or cell biology course

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**MPP 9430: Cardiovascular Physiology**

This course is designed to provide the student with an in depth knowledge of specific aspects of cardiovascular physiology with major emphasis on cardiac structure and function. Topics are covered in 1, 3-4 hour session per week and are based on reading assignments from the literature. The following topics have been addressed in previous offerings but the specific topics may vary from year to year: Heart muscle structure related to function; Contractile proteins structures and function;

Regulation of protein synthesis; Regulation of myocardial hypertrophy; Regulation of myocardial metabolism; Myocardial mechanics systolic and diastolic function; Mechanisms of length dependent contraction; Control of electrical-mechanical coupling processes; Mechanisms for adrenergic regulation of myocardial function.

**Credit Hours:** 3

**Prerequisites:** MPP 4310 and MPP 8411 or the equivalent (e.g., UM first year medical school curriculum, V\_BSCI 8421, or BIO\_SC 3700 with supporting courses)

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**MPP 9431: Control of Energy Metabolism**

(same as V\_BSCI 9431). This advanced elective is in a lecture/discussion format using primary literature to explore how cells organize and regulate metabolism to meet energy demands.

**Credit Hours:** 3

**Prerequisites:** instructor's consent

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**MPP 9432: Mammalian Membrane Physiology**

This course is designed to stimulate active learning of the concepts of modern membrane physiology. Throughout the course, a balance will be maintained between examining classic papers in the field and current literature, including not only theories that have held up over time, but areas in which there is current dispute as the best model that describes the observations.

**Credit Hour:** 1-3

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**MPP 9434: Microvascular Physiology**

(same as V\_BSCI 9425). An in-depth study of microcirculatory structure and function in various organs with emphasis on understanding the mechanisms involved in the regulation of local blood flow, nutrient supply, lymphatic function, and tissue fluid balance.

**Credit Hours:** 4

**Prerequisites:** V\_BSCI 8420 and V\_BSCI 8421 or equivalent and instructor's consent

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**MPP 9435: Molecular Exercise Biology**

(same as V\_BSCI 9435). Skeletal muscle mechanics, contractions theories, transgenic models, development, gene expression regulation, adaptation to exercise, aging, metabolic functions, and inactivity induced chronic diseases.

**Credit Hour:** 1-3

**Prerequisites:** course director's consent required for enrollment

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**MPP 9437: Neural Cardiorespiratory Control**

(same as V\_BSCI 9467). Course objectives include developing a general understanding of CNS mechanisms in the regulation of the cardiovascular and respiratory system, including autonomic, neurohumoral and body fluid homeostatic mechanisms, gaining knowledge of the major advances and topics in the field and becoming familiar with some of the methods used to study CNS cardiorespiratory regulation. Graded on A-F basis only.

**Credit Hours:** 3

**Prerequisites:** instructor's consent

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