# Summary of Interdisciplinary PhD Programs & Course Catalog

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## Course Descriptions

- **Interdisciplinary Biomedical Sciences**                        | 5      |
- **Cell Biology and Molecular Physiology**                        | 6 – 7  |
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- **Immunology**                                                   | 10 – 11|
- **Molecular Genetics and Developmental Biology**                 | 11 – 12|
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Interdisciplinary Biomedical Graduate Program

Core Requirements
INTBP 2000 Foundations of Biomedical Sciences (Fall) 8 Credits
INTBP 2005 Foundations Conference (Fall) 4 Credits
INTBP 2290 Scientific Ethics (Summer) 1 Credit
BIOST 2041 Introduction to Statistical Methods (Summer) 3 Credits
INTBP 2010 Laboratory Research Rotation (All) 1 Credit (3 Rotations Required)

After preliminary evaluation at end of year 1, students transfer into one of six specialized PhD programs

Program-specific Requirements
See Table below for course listings

Electives
See Table below for details

Comprehensive Exam
See individual programs for details

Teaching Practicum
See individual programs for details

PhD Thesis Proposal
See individual programs for details

PhD Dissertation Research (All, 1-14 credits)

32 credits of course work required for PhD

40 credits of research required for PhD
72 total credits required for PhD
### PhD Program Requirements

**Program Requirements**

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<th>CBMP</th>
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| MSCBMP 2880 (Sp) 3 Cr Cell Biology of Normal and Disease States  
And either  
MSCBMP 2830 (Sp) 2 Cr Cell & Molecular Physiology  
Or  
MSCBMP 2840 (Su) 1 Cr Regulation of Membrane Traffic  
Or  
MSCBMP (Fall) Imaging Cell Biology in Living Systems  
MSCBMP 2851-56 (A) 1 Cr Research Seminars | MSCMP 2730 (Sp) 3 Cr Molecular Mechanisms of Tissue Growth & Differentiation  
MSCMP 2750 (F&Sp) 1 Cr (5 semester required) Research Seminar  
Formal Grant Writing Training (suggested students take MSIMM 3240) | MSIMM 2210 (Sp) 2 Cr Comprehensive Immunology  
MSIMM 2230 (Sp) 2 Cr Experimental Basis of Immunology  
MSIMM 2250 (Sp) 2 Cr Teaching Assistant: Medical Microbiology  
MSIMM 3220 (F&Sp) 1 Cr Contemporary Topics in Immunology | MSBMG 2520 (Sp) 2 Cr Molecular Genetics of Model Organisms  
MSBMG 2525 (Sp) 2 Cr Developmental Mechanisms of Human Disease  
MSBMG 2550 (F&Sp) 1 Cr Research Seminar | MSMPHL 2310 (Sp) 3 Cr Principles of Pharmacology  
MSMPHL 2360 (Sp) 3 Cr Biology of Signal Transduction  
MSMPHL 3360 (F) 2 Cr Molecular Pharmacology  
Either  
MSMPHL 3310 (F) 3 Cr Cancer Biology & Therapeutics  
Or  
MSMPHL 3375 (Sp) 3 Cr Neuropharmacology  
Or  
MSMPHL 2370 (Sp) 3 Cr Drug Discovery | MSMVM 2410 (Sp) 2 Cr Molecular Virology  
MSMVM 2430 (Sp) 1 Cr Microbiology Teaching Assistant  
MSMVM 2450 (F&Sp) 1 Cr Research Seminar  
MSMVM 2470 (F&Sp) 1 Cr Contemporary Topics  
MSMVM 3410 (Sp) 2 Cr Microbial Pathogenesis |

**Electives**

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| MSCBMP 2860 (Sp) 3 Cr Multiparametric Microscopic Imaging  
MSCBMP 2870 (Sp) 5 Cr Histology | MSCMP 2760 (Sp) 3 Cr Introduction to Tissue Engineering  
MSCMP 2770 (Sp) 3 Cr Biomaterials & Biocompatibility  
MSCMP 3715 (F) 1 Cr Bioinformatics in Cancer Biology & Therapeutics  
MSCMP 3730 (F&Sp) 1 Cr Topics in Experimental Neuropathology  
MSCMP 3740 (F) 3 Cr Stem Cells  
MSCMP 3750 (Sp) 3 Cr Angiogenesis | MSIMM 2240 (F) 2 Cr Immunobiodevelopmental Immunology  
MSIMM 3240 (Su) 1 Cr Graduate Student Writing Seminar  
MSIMM 3250 (Sp) 2 Cr Transplantation Immunology | MSBMG 2560 (Sp) 3 Cr Biology of Signal Transduction  
MSBMG 3510 (F) 3 Cr Advanced Topics in Gene Expression  
MSBMG 2530 (Sp) 3 Cr DNA Repair, Mutagenesis & Carcinogenesis | MSMPHL 2370 (Sp) 3 Cr Drug Discovery  
MSMPHL 3315 (F) 1 Cr Bioinformatics in Cancer Biology & Therapeutics  
MSMPHL 3330 (Sp) 2 Cr DNA Repair: Biochemistry to Human Disease (only offered in even years-i.e. 2008, 2010)  
MSMPHL 3375 (Sp) 3 Cr Neuropharmacology  
MSMPHL 3310 (F) 3 Cr Cancer Biology & Therapeutics | MSMVM 2420 (Sp) 1 Cr Experimental Virology  
MSMVMV 3420 (F) 2 Cr Viral Pathogenesis  
MSMVMV 3435 (Alt F) 2 Cr Tumor Virology  
MSMVM 3440 (AltSp) 2 Cr Vaccines and Immunology  
MSMVM 3455 (Alt F) 2 Cr Antimicrob Therapeutics  
MSMVM 3480 (Alt F) 2 Cr Immunology of Infectious Disease  
MSMVM 3485 (Sp) 1 Cr Emerging Pathogens |
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<th>PhD Program</th>
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<td>Molecular Pharmacology</td>
<td>Molecular Virology &amp; Microbiology</td>
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<td>Electives continued</td>
<td>MSCMP 3760 (F&amp;Sp) 1 Cr Research Seminar in Regenerative Medicine</td>
<td>MSCMP 3770 (Su) 3 Cr Cell Therapy</td>
<td>MSCMP 3780 (F) 2 Cr Systems Approaches to Inflammation</td>
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<td>MSMVM 3465 (Alt Sp) 2 Cr Gene Delivery</td>
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<td>Teaching Practicum</td>
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INTERDISCIPLINARY BIOMEDICAL SCIENCES (INTBP)

2000 Foundations of Biomedical Science (Fall) 8 Credits
Course Directors: Daniel Altschuler, Judith Klein-Seetharaman, Christine Milcarek, Michael Tsang
Primary objectives of the course are to explore mechanisms controlling cell, tissue and organ function, and to develop an understanding of the experimental evidence supporting these concepts through an integrated presentation of material from biochemistry, cell biology, genetics, immunology, microbiology, neurobiology, pathology, pharmacology, and physiology. The development of critical thinking skills will be emphasized through an evaluation of experimental evidence and reading of the primary literature.

2005 Foundations Conference (Fall) 4 Credits
Course Directors: Daniel Altschuler, Judith Klein-Seetharaman, Christine Milcarek, Michael Tsang
Contemporary approaches to problem-solving in biology, as well as principles underlying modern methods of biomedical research will be integrated with the lecture component of the course through an analysis of mechanisms underlying biological phenomena. Students will present papers, critically analyze data and devise experimental approaches to biomedical problems considered in lecture.

2010 Laboratory Research Rotation (All) 1 Credit
Course Director: John Horn
This lab is designed to introduce the student to relevant laboratory methods as well as the layout and conceptualization of experiments. The course will serve to acquaint the student with the laboratory process, and to facilitate his/her selection of a lab for dissertation research. Students are required to register for and complete rotations through three different laboratories, thereby ensuring broad exposure to method and practice.

2011 Lab Research Rotation Supplement (All) 2 to 4 Credits
Course Director: John Horn
Course supplement to INTBP 2010 for those students initiating their first rotation in summer.

2030 Introduction to Biocomputing (Spring) 2 Credits
Course Director: Martin Schmidt
This course will provide students with the skills needed to prepare written and oral scientific presentations. Topics to be covered include web browsers, Library database searches, use of bibliographic management software, proper citation usage, electronic journal access, use and manipulation of PDF files, PowerPoint presentations, molecular biology databases available on the web, construction and use of relational databases, blast searches, nucleic acid sequence analysis programs and molecular structure programs.

2090 Directed Study (All) 1 to 9 Credits
Course Director: John Horn
This course provides the student an opportunity to carry out a specific laboratory project in any area of interest in degree-granting programs under the Interdisciplinary Biomedical Graduate Program.

2290 Scientific Ethics (Summer) 1 Credits
Course Director: John Horn
The course is an introduction to the basic ethical issues that arise in the course of conducting scientific research. It is intended for graduate students and fellows in the biomedical sciences who have completed at least one year of graduate work. The course will composed of informal lecture presentations followed by discussion of issues in small groups.
**Cell Biology and Molecular Physiology (MSCBMP)**

**2800 MS Thesis Research (All)** 1 to 14 Credits  
*Course Director: William Walker*  
A directed research project, which results in a thesis for a master's degree.

**2830 Cell and Molecular Physiology (Spring)** 2 Credits  
*Course Director: Raymond Frizzell*  
This course consists of lectures, problem-solving sessions, and examination of original papers. A main focus will be on the application of modern biophysical and molecular-genetic approaches in the analysis of cellular function. Topics include: 1. Membrane transport: pumps, channels, and bioelectrical potentials; 2. Excitable Membranes; 3. Regulation of Ia Channels; 4. Absorptive and secretory functions of epithelia; 5. Signal transduction; 6. Molecular motors, cell motility, and muscle contraction.  
**Note**: CBMP Students are required to take either Cell & Molecular Physiology OR Regulation of Membrane Traffic.

**2840 Regulation of Membrane Traffic (Summer)** 2 Credits  
*Course Director: Gerard Apodaca and Ora Weisz*  
Course analyzes membrane/protein traffic along both the biosynthetic & endocytic pathways. Emphasis placed on how this traffic is regulated. Topics include the role of g-proteins (both heterotrimeric & small), coat proteins (coatamer 1 & 2 & adaptations), signal transduction cascades (PKC, PKA, IP3, etc.), & snare complexes in protein trafficking. Also, we will discuss the role of the cytoskeleton in transporting cargo & signal transduction. Membrane traffic in several specialized cell types will be covered including polarized epithelial cells, cells of the immune system, & neurons.  
**Note**: CBMP Students are required to take either Cell & Molecular Physiology OR Regulation of Membrane Traffic.

**2851 Research Seminar/Cellular Physiology (Fall & Spring)** 1 Credit  
*Course Director: Dan Devor*  
Advanced research seminar with journal club format specializing in current aspects of cellular physiology.

**2852 Research Seminar/Membrane Trafficking (Fall & Spring)** 1 Credit  
*Course Director: Gerard Apodaca*  
Advanced research seminar with journal club format specializing in current aspects of membrane trafficking.

**2853 Research Seminar/Reproductive Physiology (Fall & Spring)** 1 Credit  
*Course Director: Tony Plant*  
Advanced research seminar with journal club format specializing in current aspects of reproductive physiology.

**2855 Research Seminar/Molecular Physiology (Fall & Spring)** 1 Credit  
*Course Directors: Raymond Frizzell & Tom Kleyman*  
Advanced research seminar with journal club format specializing in current aspects of molecular and cellular physiology.

**2860 Multiparametric Microscopic Imaging (Summer)** 3 Credits  
*Course Director: Donna Beer-Stolz*  
A lecture/lab course which immerses students in the theory and practical aspects of modern microscopic imaging. The fields will cover the theory and implementation of all types of light and electron microscopy and computer aided imaging. Students will expected to reach a functional capability in a selected technology.

**2870 Histology (Spring)** 5 Credits  
*Course Director: Georgia Duker*  
The objective of this lecture/lab course is student comprehension of the relationship between cell structure and organ function, and the application of the knowledge to the identification of light and electronmicroscopic images of cells and organs.

**2875 Experiments and Logic in Cell Biology (Fall & Spring)** 1 Credit  
*Course Director: Peter Drain*  
In this course students will review and critique data presented by their colleagues using an internet chat room and physical meetings to be held monthly. Students will independently critically evaluate and provide constructive suggestions on the experimental data and design, in terms of alternative rationales, interpretations, and next experiments.
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2880 Cell Biology of Normal & Disease States (Spring) 3 Credits
Course Directors: Gerard Apodaca
The semester-long course in cell biology and physiology of normal and disease states will explore three exciting topics in current day cell biology and physiology. The course, which meets twice a week (1.5 h each session), will be taught through both lectures and in class discussions of primary literature and will cover basic biology, the cellular basis of disease processes, and recent advances in translational research that may lead to cures for common disease processes. The section on stem cell biology, diabetes, and translational research will focus on understanding how cells divide and how all of the body’s different tissues stem from a master cell with the potential to generate all of the different cell types present in the body. In addition to understanding normal stem cell biology, the potential for use of stem cells to regenerate organs and to cure ailments such as diabetes will be explored. The section on cellular polarity will explore early events in polarity establishment including endocytic signaling and establishment of specialized membrane domains in epithelia and neurons. Further discussion will focus on disease processes such as autosomal dominant kidney disease, an ailment characterized by altered and dysfunctional polarity. The third section will examine ion channels and disease: CFTR and cystic fibrosis. This section will explore the role of RAD in protein quality control, the traffic and transport of CFTR, the functional role of CFTR and the epithelial sodium channel in the lung, and promising new therapies to alleviate the morbidity and mortality associated with CFTR mutations.

TBA Imaging Cell Biology in Living Systems (Fall) 3 Credits
Course Director: Simon Watkins
The focus of this course will be to study relevant problems in Cell Biology, Immunology, Developmental Biology and Neurobiology and how they have been solved using imaging approaches. The use of techniques such as TIRF and high speed confocal microscopy to address basic problems in endocytosis will be discussed at the organism level. Multiphoton, confocal, FRET, and other approaches will be discussed to understand aspects of cell biology in cell polarity, respiration and organ development in c. elegans, drosophila, zebra fish and mice. In each case the application will focus on how imaging tools are used to study defined problems in living systems. The course will follow Lecture/Demo/Journal Club format. Lectures will be two part, the first 1/3 will be a description of the technology, how it was developed and how it works (10-15 minutes) followed by description of the scientific problem and how it was solved. This will be followed by lab demonstrations showing the approach in action. Lectures will be interspersed with a journal club discussion of a relevant paper on each technology. Students will prepare the Journal Club presentations in an alternating fashion. Examination will be a combination of class participation, journal club and written exam.

2890 Directed Study (All) 1 to 9 Credits
Course Director: William Walker
This course provides the students an opportunity to carry out a specific laboratory project in any area of interest in cell biology and physiology.

3800 PhD Dissertation Research (All) 1 to 14 Credits
Course Director: William Walker
After advancement to candidacy for the PhD degree, students enroll in this course to pursue original experimental laboratory research, the results of which will provide the substance of their doctoral dissertation. A minimum of 40 credits of this course are required for the PhD degree in the School of Medicine.

CELLULAR AND MOLECULAR PATHOLOGY
(MSCMP)

2700 MS Thesis Research (All) 1 to 14 Credits
Course Director: Wendy Mars
A directed research project, which results in a thesis for a master’s degree.

2730 Molecular Mechanisms Tissue Growth & Differentiation (Spring) 3 Credits
Course Directors: Aaron Bell & Sikhandar Katyal
The course covers the anatomy, embryology, histology, function, and growth regulation (growth factors, receptors, and signaling pathways) of various differentiated tissues (central nervous system, lung, liver, pancreas, urinary and reproductive systems, breast, endocrine system, skin, bone, skeletal muscle, bone marrow). Multidisciplinary lectures are given by the members of the various departments including pathology, cell biology and physiology, medicine, and surgery who have on going research given by the members of the various departments including pathology, cell biology and physiology, medicine, and surgery who have on going research given by the members of the various departments including pathology, cell biology and physiology, medicine, and surgery who have on going research given by the members of the various departments including pathology, cell biology and physiology, medicine, and surgery who have on going research given by the members of the various departments including pathology, cell biology and physiology, medicine, and surgery who have on going research given by the members of the various departments including pathology, cell biology and physiology, medicine, and surgery who have on going research.

**Note: This is a required course for CMP students.

2740 Molecular Pathobiology (Spring) 3 Credits
Course Director: Tim Oury & Lisa Robinson
This course is structured to introduce students to the integration between basic and clinical research on the molecular pathogenesis of relevant human diseases. The course will provide students with an overview of the natural history of selected diseases, their diagnosis and clinical management. This will be followed by in-depth discussions concerning the pathologic substrate of the disease, with particular attention focused on the molecular mechanisms of disease progression. In addition to current basic
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science research, students will be exposed to the clinical impact of basic science discoveries upon the development of new therapeutic interventions. Discussions of current research trends and factors that enhance fundability of research projects will ensue. Each disease module will contain lectures from the faculty followed by presentations of current research papers by the students. These research presentations/discussions will be peer reviewed by fellow students and the faculty, and form the basis of the final grade.

2750 Research Seminar (Fall & Spring) 1 Credit
Course Directors: Marie DeFrances & Wendy Mars
Students present their research (allowed one time) or a recent research article from a broad range of topics selected by the student in consultation with a faculty advisor. The course meets weekly. Emphasis is placed on a careful analysis and critical evaluation of the manuscript as well as the development of teaching and speaking skills needed for scientific presentation. The student is expected to elucidate issues relevant to the topic and to answer questions from other graduate students and faculty.

**Note: CMP students are required to take this a minimum of 5 semesters.**

2760 Introduction to Tissue Engineering (Spring) 3 Credits
Course Director: Kacey Marra
The purpose of this course is to introduce students to tissue engineering. Tissue engineering is defined as the development and manipulation of laboratory-grown molecular, cells, tissues, or organs to replace and/or support the function of injured body parts. Tissue engineering is highly interdisciplinary and therefore crosses numerous engineering and medical specialties. Upon completing this course, the graduate and undergraduate students should: understand the basic principles behind human cell and tissue biology; be familiar with the general types of biomaterials used in tissue engineering; understand techniques utilized to design, fabricate, and functionally assess tissue engineering systems; be able to apply the combined knowledge of tissue organization and tissue engineering strategies to design a unique, reasonable tissue engineering solution. This five-part course covers cell and tissue biology, biomaterials, drug delivery, engineering methods and design, and clinical implementation.

2770 Biomaterials & Biocompatibility (Spring) 3 Credits
Course Director: Wendy Mars
This course serves as an introduction to biomaterials and biocompatibility and assumes some background in organic chemistry and biology. The first half of the course connects biomaterial applications. The second part of the course introduces biocompatibility issues as they follow from protein adsorption, thrombosis, inflammation and infections. Throughout the course ties are made between the topics of students and clinically relevant materials and device performance.

2780 Special Topics (Fall & Spring) 3 Credits
Course Director: Wendy Mars
One or more student(s) will focus on a selected topic (usually defined by the students) in cellular and molecular pathology and discuss the primary literature pertaining to the topic. Students will be evaluated on their discussions and presentations, and write a paper under the direction of a faculty advisor.

2790 Directed Study (All) 1 to 9 Credits
Course Director: Wendy Mars
This course provides the students an opportunity to carry out a specific laboratory project in any area of interest in cellular and molecular pathology.

3700 PhD Dissertation Research (All) 1 to 14 Credits
Course Director: Wendy Mars
After advancement to candidacy for the PhD degree, students enroll in this course to pursue original experimental laboratory research, the results of which will provide the substance of their doctoral dissertation. A minimum of 40 credits of this course are required for the PhD degree in CMP from the School of Medicine.

3710 Cancer Biology and Therapeutics (Fall) 3 Credits
Course Directors: Reza Zarnegar & Thomas Kensler
This course presents biochemical and clinical aspects of cancer biology and therapy, and is designed for graduate students training in the basic sciences or medicine. The lectures cover: the biology of normal and neoplastic cells; mechanisms of neoplastic transformation; chemical and environmental carcinogenesis; viral oncogenesis; breast and prostate cancer; chemotherapy; radiotherapy; gene therapy; tumor immunology; and nutrition and cancer.

**Note: CMP students are required to take Molecular Pathobiology OR Cancer Biology and Therapeutics.**

3715 Bioinformatics in Cancer Biology and Therapeutics (Fall) 1 Credit
Course Director: James Lyons-Weiler
This course involves the reading and discussion of bioinformatics resources available for enhancing research in cancer biology and therapeutics. We will discuss bioinformatics databases and other resources related to: regulatory networks and signal transduction pathways, genes associated with cancer risk and the progression of cancer; cytogenetics, sources of...
information on the distribution of cancer occurrence and trends in the US population, databases DNA repair genes, their structure & function, models of cancer progression & responses to therapy, biomarkers for cancer detection, treatment & prevention.

3730 Topics in Experimental Neuropathology (Fall & Spring) 1 Credit
Course Director: Clayton Wiley
This course critically evaluates the latest scientific literature concerning diseases of the central nervous system. Emphasis will be placed on methodologies as they are applied to the study of human neurologic diseases. Participants will present scientific papers and lead the classroom discussions. This course is open to students of all levels and will include both basic scientists and clinicians (residents, faculty).

3740 Stem Cells (Fall) 3 Credits
Course Director: Paul Monga
The course entitled “Stem Cells” will provide a comprehensive overview on this intriguing and highly debated topic. The course will focus on the biology of stem cells and their role in health and disease with emphasis on development, carcinogenesis and tissue engineering. Lectures on various aspects of stem cells from renowned experts will cover both embryonic and adult stem cells. Specific lectures will include stem cells in the blood, liver, brain, muscle, kidney, pancreas, prostate, lung, gut, skin and eye. Students will also be educated on therapeutic cloning as well as bio-ethical issues and existing laws governing stem cell research. Letter grades will be based on midterm and final exams as well as on the attendance in the lectures.

3750 Angiogenesis (Spring) 3 Credits
Course Director: Shiyuan Cheng
This course will provide extend basic knowledge of developmental, cellular, molecular biology of angiogenesis and most recent advancements in its clinical applications. Topics include: 1. Angiogenesis in physiological and pathological processes; 2. Molecular and cellular regulation of angiogenesis; 3. Current advance in angiogenic therapies. Recent outstanding research publications will also be discussed.

3760 Research Seminar: Regenerative Medicine (Fall & Spring) 1 Credit
Course Director: Paul Monga
Research seminar in regenerative medicine is geared towards providing updated information on topics in the field of regenerative medicine, tissue engineering and stem cell applications. Through biweekly seminars, the students will be acquainted to the recent advances in the ever-growing field of regenerative medicine. Experienced faculty will deliver lectures in this seminar series.

3770 Cell Therapy (Summer) 3 Credits
Course Director: Stephen Strom
This course is meant to be unlike any other in the graduate curricula, showcasing cell therapy from theory to practice, from the bench to the bedside. For each area of cell transplantation the lectures will be given by faculty who have implemented cell transplantation techniques and moved them into clinical therapy. Most of the lectures in the course and all clinical application lectures will be given by those who actually do the patient transplants. Immunology and pharmacology will be addressed as it directly relates to cellular therapy. Gene therapy and stem cell biology will not be addressed individually, but will be raised in the context of specific applications. Course meetings will consist of approximately 2 lectures per discussion session. The first lecture will present the basic research leading into a particular area of cell therapy area such as animal models used for preclinical studies, and the second will focus on the clinical application of that particular cell therapy for specific disease(s). The grade for the course results from attendance at lectures and the submission of a paper in an area relevant to Cell Transplantation / Cell Therapy. At the conclusion of this course students should: be able to critically read and review the literature in the field of cellular therapy; know the mechanisms of rejection of cellular transplants from both allogeneic and autologous sources and be familiar with strategies to avoid transplant rejection; be familiar with the application of cellular therapy techniques to a variety of disease states; have a perspective and be conversant on relevant ethical issues associated with the field of cellular therapy.

3780 Systems Approach to Inflammation (Fall) 2 Credits
Course Director: Yoram Vodovoz
This course is focused on particular topics of great biologic complexity in critical illness, where modeling has the potential to translate in improved patient care. Lectures are provided by basic (biological and mathematical sciences) and clinical faculty, in conjunction with members of industry and speakers from outside institutions. This information will be communicated within the framework of defined themes that describe the complexity of inflammation in acute and chronic illnesses. Grading is based on participation in discussions and on a semester-long, interdisciplinary group project. Each group includes students with a predominantly biology background along with students who are more facile with mathematics and/or simulation. This project therefore requires the students to work with others from outside of their main discipline, to learn from them, and gain practical experience in team-based modeling of biological processes.
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**IMMUNOLOGY (MSIMM)**

**2200 MS Thesis Research** (All) 1 to 14 Credits  
*Course Director: Lawrence Kane*  
A directed research project which results in a thesis for a master’s degree.

**2210 Comprehensive Immunology** (Spring) 2 Credits  
*Course Director: Lisa Borghesi*  
This is a lecture course that will introduce the students to the fundamental concepts of modern immunology. The course will cover cells, tissues and organs of the immune system. Furthermore in depth analysis of the development, activation, effector functions and regulation of immune response will be presented in this course.

**2230 Experimental Basis of Immunology** (Spring) 2 Credits  
*Course Director: Kyle McKenna*  
This course will expose the students to classical and contemporary literature in modern immunology. Emphasis will be on paper analysis and critical evaluation of primary data. This course will parallel the topics presented in comprehensive immunology lecture course which must be taken before or simultaneously with experimental basis of immunology.

**2240 Introduction to Immunobiotherapeutics** (Fall) 2 Credits  
*Course Director: Nick Giannoukakis*  
This course will provide a comprehensive overview of the principles and the technology upon which immunobiotherapeutics are based. The course will focus on the overall aims of using small molecules, antibodies, genes and cells as immunotherapeutic agents. It will cover the use of viral and non-viral agents as gene delivery vehicles, cells as therapeutic agents and small molecules as delivery and therapeutic vehicles. The course will also cover diseases and disorders in which immunobiotherapy has proven safety and demonstrated successful outcomes like cancer, mendelian disorders and autoimmunity. Lectures and student presentations will cover: Genes and cells as drugs, peptides, antibodies and small molecules as therapeutics and delivery vehicles, viral and non-viral vectors, stem cells, and specific diseases where immunotherapy has shown safety and efficacy. Students may also be educated on bioethical issues and existing laws governing biotechnology and molecular medicine approaches.

**2250 TA: Immunology** (Spring) 1 Credit  
*Course Director: Lawrence Kane*  
The course will provide Immunology graduate students with the opportunity to serve as a teaching assistant in the undergraduate Immunology course BIOSC 1760 or Medical Microbiology MED 5116. The curriculum is designed to provide valuable teaching skills to the professional scientist.  
**NOTE:** Immunology students are required to take this course two semesters.

**2260 Immunology Seminar** 1 Credit  
*Course Director: Lawrence Kane*  
Graduate Students and Faculty present their current research in a seminar format.

**2290 Directed Study** (All) 1 to 9 Credits  
*Course Director: Lawrence Kane*  
This course provides the students an opportunity to carry out a specific laboratory project in any area of interest in immunology.

**3200 PhD Dissertation Research** (All) 1 to 14 Credits  
*Course Director: Lawrence Kane*  
After advancement to candidacy for the PhD degree, students enroll in this course to pursue original experimental laboratory research, the results of which will provide the substance of their doctoral dissertation. A minimum of 40 credits of this course are required for the PhD degree in the School of Medicine.

**3220 Contemporary Topics – Immunology** (Fall & Spring) 1 Credit  
*Course Director: Lawrence Kane*  
This is an advanced level course in which students will read, present and evaluate the primary literature in immunology. Each semester will feature an integrated set of papers addressing a current issue of interest to modern immunologists. The course may be taken more than once by each student, since the topic addresses will change each semester.  
**NOTE:** Immunology students are required to take this course four semesters.

**3230 Immunology and Human Disease** (Spring) 2 Credits  
*Course Director: Lisa Butterfield/Robert Binder*  
This course surveys basic immunological principles as they impact our understanding of the causes or treatments of human disease. The course consists of a series of lecture blocks. Background reading is required and the course relies heavily on the reading of original articles. Classes are
regularly devoted to paper discussions, and each student will responsible for introducing one paper.

3240 Graduate Student Writing Seminar (Summer) 1 Credits
Course Director: Robert Ferris
This course teaches fundamental grantmanship skills using actual NIH training grant submissions. Students construct a competitive research training grant and are instructed on methods to identify funding sources. This course consists of introductory lectures followed by a series of workshops staffed by the Immunology Training Faculty. Workshops cover peer scientific review and study section operation, avoidance of common pitfalls in grant writing, grant writing ethics and scientific community service.

3250 Transplantation Immunology (Spring) 2 Credits
Course Director: Angus Thomson
Transplantation is a rapidly-expanding area of basic and applied immunology, with great potential for the cure of many human diseases. This course will focus on contemporary issues in transplantation immunobiology, including immunogenetics, aspects of ischemia-reperfusion injury, the role of innate and adaptive immunity, antigen-presenting and T cell biology, including T cell memory, tolerance, acute and chronic rejection, humoral rejection the biology of transplant infectious disease, cell transplantation (including pancreatic islet cell transplantation), xenotransplantation, and novel immunosuppressive/tolerogenic regimens.

3260 Immunity and the Neuroendocrine Axis 2 Credits
Course Director: Nick Giannoukakis
This Course will consider the interaction among the immune, nervous and endocrine systems. It will prepare the students for an understanding of how endocrine organs and the hormones they produce affect immune cell function, how the nervous system and neuropeptides/neurohormones and neurotransmitters modify immunity and how the immune system (cells and their secreted molecules) affect the endocrine and the nervous system. The course will also introduce the students to how psychology and stress affect immunity, how drug therapy aimed at immunostimulation or immunosuppression may be affected by psychological and neuroendocrine factors and how the neuroendocrine axis is considered in immunotherapies.

MOLECULAR GENETICS AND DEVELOPMENTAL BIOLOGY (MSBMG)

2500 MS Thesis Research (All) 1 to 14 Credits
Course Director: N. Hukriede
A directed research project, which results in a thesis for a master's degree.

2520 Molecular Genetics of Model Organisms (Spring) 2 Credits
Course Director: N. Hukriede & Staff
Topics in this course currently include molecular mechanisms of DNA replication, cell cycle control, oncogene and tumor suppressor gene function, DNA damage response pathways, signal transduction pathways controlling gene expression and programmed cell death, and the connections between chromatin structure, RNA splicing and gene expression. Prerequisites: Foundations of Biomedical Science or permission of the course director.

2525 Developmental Mechanisms of Human Disease (Spring) 2 Credits
Course Director: N. Hukriede & Staff
This course covers principles of developmental biology and how embryonic developmental pathways impinge on human disease. Topics include congenital organ related disease, stem cell based reproductive events relating to disease. Prerequisites: Foundations of Biomedical Science or permission of the course director.

2530 DNA Repair, Mutagenesis & Carcinogenesis (Spring) 3 Credits
Course Directors: Laura Niedernhofer & Staff
This course covers molecular genetic principles that apply to all cancers and then move to current examples of these principles in specific types of human cancers from the literature. Topics include loss of heterozygosity in tumor suppressor genes, oncogene activation, and genetic instability caused by mutator genes. Some discussion of the possible hierarchy of genomic instability as it occurs in tumor formation versus tumor progression (and chemotherapy drug resistance) will be discussed.

2550 Research Seminar (Fall & Spring) 1 Credit
Course Director: Jared Evans
A weekly Research In Progress Seminar presented by students and post-doctoral fellows. Weekly attendance and participation by all MGDB students is required.
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**2560 Biology of Signal Transduction (Spring) 3 Credits**
*Course Director: Baskaran Rajasekaran & Guillermo Romero*
This course explores different types of signaling pathways activated by receptor-ligand interactions. Topics to be covered include, but are not limited to: G-protein linked receptors, adenylate cyclases, small GTPases, kinases and phosphatases, nitric oxide, phospholipases, steroid hormone signaling, and pharmacological applications of signaling pathways.

**2590 Directed Study (All) 1 to 9 Credits**
*Course Director: N. Hukriede*
This course provides the students an opportunity to carry out a specific laboratory project in any area of interest in biochemistry and molecular genetics.

**3500 PhD Dissertation Study (All) 1 to 14 Credits**
*Course Director: N. Hukriede*
After advancement to candidacy for the PhD degree, students enroll in this course to pursue original experimental laboratory research, the results of which will provide the substance of their doctoral dissertation. A minimum of 40 credits of this course are required for the PhD degree in the School of Medicine.

**3510 Advanced Topics in Gene Expression (Fall) 3 Credits**
*Course Director: D. Scott & Staff*
This course consists of lectures and class presentations on recent advances in the molecular genetics. The emphasis of the course is on the regulation of gene expression at the DNA, RNA and protein levels. Regulation in eukaryotes is emphasized, including yeast, protozoan, and mammalian.

**MOLECULAR PHARMACOLOGY (MSMPHL)**

**2310 Principles of Pharmacology (Spring) 3 Credits**
*Course Directors: Yu Jiang & Alessandro Bisello*
This course consists of a series of lectures and tutorial sessions that focus on the general principles of pharmacology. Major topics are principles of pharmacokinetics (including drug absorption, distribution, and metabolism), pharmacodynamics (quantitation of drug-receptor interactions) and mechanisms of action of cardiovascular and autonomic drugs. In addition, this course will include both animal laboratory and human simulator demonstrations that illustrate important pharmacological principles discussed in class.

**2355 Pharmacology Summer Seminar (Summer) 1 Credit**
*Course Director: Patrick Pagano*
Beginning in the third year of the program students will be required to participate annually in the Departmental Summer Seminar Series. These seminars will be held once a week throughout the summer and will be focused on the student's research plans and recent results. This presentation will be made to an audience with diverse research interests and should therefore include a brief summary of general background information.

**2360 Biology of Signal Transduction (Spring) 3 Credits**
*Course Directors: Baskaran Rajasekaran & Guillermo Romero*
This course will explore different types of signaling pathways activated by receptor-ligand interactions. Topics to be covered include, but are not limited to: G-protein linked receptors, adenylate cyclases, small GTPases, kinases and phosphatases, nitric oxide, phospholipases, steroid hormone signaling, and pharmacological applications of signaling pathways.

**2370 Drug Discovery (Spring) 3 Credits**
*Course Directors: Lans Taylor, Bruce Freeman, Barry Gold and Ivet Bahar*
Drug discovery is an interdisciplinary science that identifies small molecule and/or biologic modulators of cell and tissue function. This course will discuss various topics that are relevant to current approaches and principles in drug discovery including target validation, drug origins, cell-based screening, high throughput screening, proteomic approaches to drug discovery, computational biological aspects of drug discovery, and pharmacoinformatics, as well as topics in preclinical drug development and intellectual property. The course will include case studies intended to aid students in a full understanding of the drug discovery process.

**2390 Directed Study (All) 1 to 9 Credits**
*Course Director: Patrick Pagano*
This course provides the students an opportunity to carry out a specific laboratory project in any area of interest in pharmacology.

**3300 PhD Dissertation Research (All) 1 to 14 Credits**
*Course Director: Patrick Pagano*
After advancement to candidacy for the PhD degree, students enroll in this course to pursue original experimental laboratory research, the results of which will provide the substance of their doctoral dissertation. A minimum of 40 credits of this course are required for the PhD degree in the School of Medicine.
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3310 Cancer Biology and Therapeutics (Fall) 3 Credits
Course Directors: Reza Zarnegar & Thomas Kensler
This course presents biochemical and clinical aspects of cancer biology and therapy, and is designed for graduate students training in the basic sciences or medicine. The lectures cover the biology of normal and neoplastic cells, mechanisms of neoplastic transformation, chemical and environmental carcinogenesis, viral oncogenesis, breast and prostate cancer, radiotherapy, tumor immunology chemotherapy and chemoprevention.

3315 Bioinformatics in Cancer Biology and Therapeutics (Fall) 1 Credit
Course Director: James Lyons-Weiler
Reading and discussion on bioinformatics resources available to enhance research on cancer biology and therapeutics. We will discuss bioinformatics databases and other resources related to: regulatory networks and signal transduction pathways, genes associated with cancer risk and the progression of cancer; cytogenomics, sources of information on the distribution of cancer occurrence and trends in the US population, databases DNA repair genes, their structure & function, models of cancer progression & responses to therapy, biomarkers for cancer detection, treatment & prevention.

3320 Journal Club (Fall & Spring) 1 Credit
Course Director: Patrick Pagano
Journal Club presentations will be held each week that the department hosts a seminar speaker. Students will be required to present a recent research article related to the topic area of the Departmental Seminar once each year but must attend a minimum of 80% of the Journal Clubs in order to receive credit for the course.

3330 DNA Repair: Biochemistry to Human Disease (Spring) 2 Credits
Course Directors: Robert Sobol & Laura Niedernhofer
(only offered in even years-i.e. 2008, 2010)
Cellular responses to DNA damage impact cell cycle control, transcription, replication, cell division, signal transduction and evolution. More than 40 distinct human diseases are caused by defects in DNA repair, including syndromes of impaired development, cancer predisposition or premature aging. This course will emphasize the biochemistry of DNA repair, placing these mechanisms into the context of other cellular processes such as DNA replication, transcription and damage signaling. Sources of DNA damage, both environmental and endogenous will be discussed, as well as the importance of DNA repair mechanisms during development and to prevent cancer and aging.

The course will follow the 2005 edition of the text DNA Repair and Mutagenesis, 2nd edition (ASM press), co-authored by Dr. Richard D. Wood (see Below). The format will include 1 hr of lecture per week based on selected material from the book and 1 hr of interactive discussion covering human disease, animal models, experimental systems to measure DNA damage and repair, and the latest literature. Lecturers will include faculty from the University of Pittsburgh who are engaged in laboratory research at the forefront of the DNA repair field. Several visiting special guest lecturers may also participate in the course.

3360 Molecular Pharmacology (Fall) 2 Credits
Course Director: Ferruccio Galbiati
This course examines molecular mechanisms of drug interactions with an emphasis on drugs that modulate cell signaling, cellular responses to drugs. The course will include student participation through presentations and discussion of relevant contemporary scientific literature. Topics include: cell cycle checkpoints and anti-cancer drugs, therapeutic control of ion channels, and blood glucose, anti-inflammatory agents and nuclear receptor signaling.

3375 Neuropharmacology (Spring) 3 Credits
Course Director: Michael Palladino
This course will examine the molecular mechanism of drug action for different classes of drugs including, but not limited to, antidepressants, antipsychotics, antiviral drugs, drugs to relieve pain, diuretics, drugs affecting the cardiovascular system and drugs affecting endocrine systems. In addition, lectures will highlight the most recent developments for treatments of neurodegenerative diseases and psychiatric disorders.

MOLECULAR VIROLOGY AND MICROBIOLOGY (MSMVM)

2400 MS Thesis Research (All) 1 to 14 Credits
Course Director: Neal DeLuca
A directed research project which results in a thesis for a Master’s degree.

2410 Molecular Virology (Spring) 2 Credits
Course Director: Fred Homa
This course stresses basic concepts of animal virology. Subjects include different viruses, the expression and regulation of viral genes, the mechanisms of viral-induced cytopathology, latency, and cell
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transformation, and the nature of viroids and prions. Supplementary reading assignments are required.

2420 Experimental Virology (Spring) 1 Credit
Course Director: Paul Kinchington
This course is designed to teach students entering graduate research projects involving viruses to critically evaluate the scientific literature in terms of experimental strategies, presentation and interpretation of data, justification of conclusions made in published articles. Paper discussion format. Completion or concurrent registration in Molecular Virology (or equivalent) required. This course is coordinated with, but independent from Molecular Virology lectures.

2430 Microbiology Teaching Assistant (Spring) 1 Credit
Course Director: Gerry Nau
The purpose of this course is to introduce graduate students of the Integrated Biomedical Sciences Graduate Program to the principles of teaching. The students will be trained in basic teaching techniques as well as provided material for teaching students specific concepts. As part of this course, students will participate in teaching first-year medical students the fundamentals of microbiology, in conjunction with the Laboratory and Problem Based Learning sections of the Molecular Pathogenesis of Infectious Disease course of Basic Science Medical School block. Each student will be responsible for 8-10 medical students in a laboratory setting. The student will present basic laboratory techniques, explain concepts of microbiology and infectious disease, including diagnostic tests, interpretation of results, and data management. In addition, the student will assist the Faculty Facilitator in the Problem Based Learning Sessions where they will review laboratory findings with the students.

2450 Research Seminar (Fall & Spring) 1 Credit
Course Director: Jared Evans
The course is a weekly seminar in which the student presents an annual research progress report. Emphasis is placed on a careful analysis and critical evaluation of experimental strategies, data analysis, and the development of skills needed for scientific presentation. The student is expected to elucidate issues relevant to the topic and to answer questions from other graduate students and faculty.

2470 Contemporary Topics in Molecular Virology and Microbiology (Fall & Spring) 1 Credit
Course Directors: Neal DeLuca & Paul Kinchington
This research paper discussion course is designed to teach students to critically evaluate and present published data in contemporary scientific research articles. Students, in consultation with the course director, select published articles for presentation and discussion. A topic is chosen for each semester. Restricted to MVM graduate students or by special permission of instructor.

2490 Directed Study (All) 1 to 9 Credits
Course Director: Neal DeLuca
This course provides the students an opportunity to carry out a specific laboratory project in any area of interest in molecular virology and microbiology.

3400 PhD Dissertation Research (All) 1 to 14 Credits
Course Director: Neal DeLuca
After advancement to candidacy for the PhD degree, students enroll in this course to pursue original experimental laboratory research, the results of which will provide the substance of their doctoral dissertation. A minimum of 40 credits of this course are required for the PhD degree in the School of Medicine.

3410 Microbial Pathogenesis (Spring) 2 Credits
Course Director: Joanne Flynn
This course is an introduction to the molecular basis of bacterial and parasitic pathogenesis. Topics include 1) intro to microbial pathogens 2) molecular and classical koch's postulates, 3) pathogen adhesion strategies 4) molecular mechanisms of invasion 5) microbial strategies for immune evasion 6) genetics and action of bacterial toxins 7) coordinate regulation of virulence factors 8) antibiotics and antibiotic resistance 9) host responses to infection 10) vaccines.

3420 Viral Pathogenesis (Fall) 2 Credits
Course Director: Phalguni Gupta
The goal of this course is to integrate the lectures given on a particular virus in the comprehensive virology course with two additional lectures which expand the basic biology of the virus in the virus life cycle to the level of virus-host interactions. The first lecture will address the pathogenic properties of the virus from the perspective of disease manifestations, immunology, and the natural history of infection. This will be followed by a second lecture, which will address the molecular basis of viral pathogenesis and current advances in antiviral research.

3435 Tumor Virology (Every other Fall) 2 Credits
Course Director: Ole Gjoerup
This course introduces students to viruses known or suspected of causing tumors, with special emphasis on viruses casually linked to human cancer, including polyomaviruses, Epstein-Barr virus, Kaposi's sarcoma-associated herpesvirus, adenoviruses, papillomaviruses, hepatitis viruses, human T-cell lymphotropic virus. Topics focus on establishing causality between specific virus infections and cancer, oncogenes, tumor suppressors, oncogenic cofactors, disruption of innate/adaptive immune responses,
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latency, viral mimicry/piracy of cellular regulatory genes, genomic instability and role of non-coding RNAs in viral pathogenesis.

3440 Vaccines and Immunity (Every other Spring) 2 Credits
Course Director: Ted Ross
The course will cover the current and experimental vaccines for infectious agents, cancer, and other human diseases. The students will be expected to 1) understand the immunity elicited by current vaccines, 2) understand the strategies used to design effective vaccines against various diseases, 3) expand and integrate their understanding of innate and adaptive immune responses in order to improve vaccines, and 4) design new regimens to tackle agents without vaccines and understand the challenges in designing these strategies.

3455 Antimicrobial Therapeutics (Every other Fall) 2 Credits
Course Director: Michael Parniak
The course will provide detailed information at the molecular level describing the development and mechanism of action of antimicrobial drugs. Topics to be discussed include anti-bacterial, anti-fungal, anti-parasitic, and anti-viral (including anti-retroviral) agents. Some emphasis will be placed on diseases with significant public health impact. The course will encompass aspects of medicinal chemistry, biochemistry, and molecular biology.

3465 Gene Delivery (Every other Spring) 2 Credits
Course Director: Hiroyuki Nakai
The prospect of using genetically engineered viruses to infect human cells has led to the development of the science of viral vectors. This course will discuss the basic strategies for the development of viral vectors as well as their molecular biology and biochemistry. Lecture/paper discussion format.

3480 Immunology of Infectious Disease (Every other Fall) 2 Credits
Course Director: JoAnne Flynn & Karen Norris
This course examines the immune responses to pathogens, as well as on immune evasion of microbes. The organisms studied include bacteria, parasites, and viruses. Topics focus on host-pathogen interaction and include innate immunity, modulation of antigen processing and presentation, pathogenic strategies for subversion of immune responses, effector functions of immune cells, and immunopathology. Graduate level immunology is a prerequisite. Lecture/paper discussion format.