## Summary of Interdisciplinary PhD Programs & Course Catalog

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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)

(19 credits completed during year 1)

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

(6 - 11 credits during years 1 and 2)

Electives
See Table below for details

(typically 3 – 9 credits during years 1 and 2)

32 credits of course work required for PhD

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)

40 credits of research required for PhD

72 total credits required for PhD
### Program Requirements

**BMG**
- MSBMG 2510 (Sp) 2 Cr Biochemistry of Macromolecules
- MSBMG 2520 (Sp) 2 Cr Eukaryotic Molecular Genetics
- MSBMG 2550 (F&Sp) 1 Cr Research Seminar
- MSBMG 2570 (F&Sp) 1 Cr Contemporary Topics in Biochemistry and Molecular Genetics

**CBMP**
- MSCBMP 2880 (Sp) 3 Cr Cell Biology of Normal and Disease States
- MSCBMP 2830 (Sp) 2 Cr Cell & Molecular Physiology
- MSCBMP 2840 (Su) 1 Cr Regulation of Membrane Traffic
- MSCBMP 2851-56 (A) 1 Cr Research Seminars in Cellular Physiology, Membrane Trafficking, Molecular Physiology, Reproductive Physiology & Stem Cells

**CMP**
- MSCMP 2730 (Sp) 3 Cr Molecular Mechanisms of Tissue Growth & Differentiation
- MSCMP 2740 (Sp) 3 Cr Molecular Pathobiology
- MSCMP 3710 (F) 3 Cr Cancer Biology & Therapeutics

**IMM**
- MSIMM 2210 (Sp) 2 Cr Comprehensive Immunology
- MSIMM 2230 (Sp) 2 Cr Experimental Basis of Immunology
- MSIMM 2250 (Sp) 1 Cr Teaching Assistant: Medical Microbiology
- MSIMM 3220 (F&Sp) 1 Cr Contemporary Topics in Immunology
- MSIMM 3230 (Sp) 2 Cr Immunology & Human Disease

**MPHL**
- MSMPHL 2310 (Sp) 3 Cr Principles of Pharmacology
- MSMPHL 2360 (Sp) 3 Cr Biochemistry of Macromolecules
- MSMPHL 2375 (Sp) 3 Cr Neuropharmacology

**MVM**
- MSMVM 2410 (Sp) 2 Cr Molecular Virology
- MSMVM 2450 (F&Sp) 1 Cr Research Seminar

**Electives**
- Students may take electives from their program and from others. They should consult with their advisor and program director in designing their plan of study.

### Electives

**BMG**
- MSBMG 2560 (Sp) 3 Cr Biology of Signal Transduction
- MSBMG 3510 (F) 3 Cr Advanced Topics in Gene Expression
- MSBMG 3530 (Sp) 3 Cr DNA Repair: Biochemistry to Human Disease

**CBMP**
- MSCBMP 2860 (Sp) 3 Cr Introduction to Tissue Engineering
- MSCBMP 2870 (Sp) 5 Cr Histology

**CMP**
- MSCMP 2760 (Sp) 3 Cr Introduction to Tissue Engineering
- 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
- MSCMP 3760 (F&Sp) 1 Cr Research Seminar in Regenerative Medicine
- MSCMP 3770 (Su) 3 Cr Cell Therapy
- MSCMP 3780 (F) 2 Cr Systems Approaches to Inflammation

**IMM**
- MSIMM 2240 (F) 2 Cr Cancer Biology & Therapeutics
- MSIMM 3240 (Su) 1 Cr Graduate Student Writing Seminar
- MSIMM 3250 (Sp) 2 Cr Transplantation Immunology

**MPHL**
- MSMPHL 2370 (Sp) 2 Cr Drug Discovery
- MSMPHL 3340 (F) 3 Cr Bioinformatics in Cancer Biology & Therapeutics
- MSMPHL 3350 (Sp) 3 Cr DNA Repair: Biochemistry to Human Disease
- MSMPHL 3375 (Sp) 3 Cr Neuropharmacology
- MSMPHL 3310 (F) 3 Cr Cancer Biology & Therapeutics

**MVM**
- MSMVM 2420 (Sp) 1 Cr Experimental Virology
- MSMVM 2430 (Sp) 1 Cr Experimental Microbial Pathogenesis
- MSMVM 3420 (F) 2 Cr Viral Pathogenesis
- MSMVM 3430 (AltSp) 2 Cr Retrovirology
- MSMVM 3440 (AltSp) 2 Cr Vaccines and Immunity
- MSMVM 3450 (AltSp) 2 Cr Herpes Virology
- MSMVM 3460 (Alt F) 2 Cr Antimicrob Therapeutics
- MSMVM 3480 (Alt F) 2 Cr Immunology of Infectious Disease
- MSMVM 3485 (Sp) 1 Cr Emerging Pathogens
- MSMVM 3465 (AltSp) 2 Cr Gene Delivery
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**University of Pittsburgh School of Medicine - 2008**

Updated January 10, 2008
INTERDISCIPLINARY BIOMEDICAL SCIENCES (INTBP)

2000 Foundations of Biomedical Science (Fall) 8 Credits
Course Directors: Daniel Altschuler, Michael Cascio & Linton Traub
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, Michael Cascio & Linton Traub
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.

2040 Using PERL for Bioinformatics (Fall) 3 Credits
Course Director: Martin Schmidt
This course will provide students with an introduction to computer programming using PERL language with particular emphasis on its use for tasks in bioinformatics. Topics to be covered include: programming basics, working with DNA sequences and strings, PERL data structures, pattern matching with “regular expressions”, finding complex motifs in DNA and protein sequences, using PERL to parse records, annotations in GenBank, and BLAST output.

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: Russell Delude
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.

BIOCHEMISTRY AND MOLECULAR GENETICS (MSBMG)

2500 MS Thesis Research (All) 1 to 14 Credits
Course Director: Martin Schmidt
A directed research project which results in a thesis for a master’s degree.
2510 Biochemistry of Macromolecules  (Spring) 2 Credits  
**Course Director: Rebecca Hughey**  
Topics covered in this course include the experimental determination of macromolecular structure, protein; DNA interactions, protein; protein Interactions, protein modification and empirical prediction of macromolecular structure.

2520 Eukaryotic Molecular Genetics  (Spring) 2 Credits  
**Course Director: J. Richard Chaillet**  
This course covers topics on DNA replication in eukaryotes, the structure and function of human chromosomes, inheritance patterns and the phenotypic consequences of mutations in humans, the mapping and isolation of human genes, animal models of human diseases, regulation of the mammalian cell cycle, and current aspects of gene therapy.

2550 Research Seminar  (Fall & Spring) 1 Credit  
**Course Director: Fred Homa**  
Students present their research 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 during which the student presents his/her research in progress or an article of his/her choice. 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.

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.

2570 – Contemporary Topics in Biochemistry & Molecular Genetics  (Fall & Spring) 1 Credit  
**Course Director: Michael Tsang & Neil Hukriede**  
Contemporary topics in biochemistry and molecular genetics: This is a course in which students will read, present, and evaluate the primary literature in biochemistry and molecular genetics. Each semester will focus on a current topic of interest. The course may be taken more than once by each student, since the topics addressed will continue to change each semester.

2590 Directed Study  (All) 1 to 9 Credits  
**Course Director: Martin Schmidt**  
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: Martin Schmidt**  
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: Neil Hukriede**  
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 systems.

3530 DNA Repair: Biochemistry to Human Disease  (Spring) 3 Credits  
**Course Directors: Laura Niedernhofer, Robert Sobol & Richard Wood**  
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.

**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  
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 heterothrimetic & small), coat proteins (coatamer 1 & 2 & adaptions), 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:** Allan Zhao  
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:** Simon Watkins  
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.
University of Pittsburgh School of Medicine - 2008

2880 Cell Biology of Normal & Disease States (Spring) 3 Credits
Course Directors: Gerard Apodaca & Raymond Frizzell
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.

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 ongoing research in these areas. The course is designed to offer detailed information on specific tissues, tissue-tissue interactions, and overlapping cellular and molecular pathways that exist in multiple tissues.

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

2740 Molecular Pathobiology (Spring) 3 Credits
Course Director: Tim Oury
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 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.
University of Pittsburgh School of Medicine - 2008

2760 Introduction to Tissue Engineering (Spring-odd years) 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.

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.

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 stems 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 bed-side. 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 allotypic and xenotypic 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 Vodovotz
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 about and from interdisciplinary exchange, and gain practical experience in team-based modeling of biological processes.

IMMUNOLOGY (MSIMM)

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

2210 Comprehensive Immunology (Spring) 2 Credits
Course Directors: Penelope Morel & 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: Penelope Morel
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.
**University of Pittsburgh School of Medicine - 2008**

**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: Russell Salter*

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.

**2290 Directed Study** (All) 1 to 9 Credits  
*Course Director: Russell Salter*

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: Russell Salter*

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*

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 Credit  
*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.
MOLECULAR PHARMACOLOGY (MSMPHL)

2310 Principles of Pharmacology (Spring) 3 Credits
Course Director: Yu Jiang
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: Donald DeFranco
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) 2 Credits
Course Director: John Lazo
Drug discovery is an emerging pharmacological science that seeks to identify small molecular probes and to understand at the molecular level how compounds affect macromolecular processes. 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.

2390 Directed Study (All) 1 to 9 Credits
Course Director: Donald DeFranco
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: Donald DeFranco
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.

3310 Cancer Biology and Therapeutics (Fall) 3 Credits
Course Directors: Sirkander Katyal & Jack Yalowich
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 Directors: 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: Donald DeFranco
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
3330 DNA Repair: Biochemistry to Human Disease  
(Spring) 3 Credits  
Course Directors: Laura Niedernhofer, Robert Sobol & Richard Wood  
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 Directors: Ferruccio Galbiati & John Lazo  
This course examines molecular mechanisms 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: Michael Parniak  
A directed research project which results in a thesis for a master's degree.

2410 Molecular Virology  
(Spring) 2 Credits  
Course Directors: Neal DeLuca & Todd Reinhart  
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 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 for graduate students training in molecular virology research and is designed to provide a more in-depth study of molecular virology through a critical analysis by the student of seminal research publications in various systems. Paper discussion format.

2450 Research Seminar  
(Fall & Spring) 1 Credit  
Course Director: Fred Homa  
Students present their research 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 during which the student presents his/her research in progress or an article of his/her choice. 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.

2470 Contemporary Topics in Molecular Virology and Microbiology  
(Fall & Spring) 1 Credit  
Course Directors: Sharon Hillier & Ronald Montelaro  
This is a course in which students will read, present, and evaluate the primary literature in molecular virology and microbiology. Each student will feature an integrated set of papers addressing a current issue of interest. The course may be taken more than once by each student, since the topics addressed will continue to change each semester.
2490 Directed Study  (All) 1 to 9 Credits
Course Director: Michael Parniak
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: Michael Parniak
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.

3415 Experimental Microbial Pathogenesis  (Spring) 1 Credit
Course Director: Gerry Nau
This course is designed to teach students entering graduate research projects involving microbial pathogenesis 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 microbial pathogenesis (or equivalent) required. This course is coordinated with but independent from microbial pathogenesis lectures. May be taken only one time for credit.

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.

3430 Retrovirology  (Every other Spring) 2 Credits
Course Directors: Kelly Cole & Velpondi Ayyavoo
Retroviruses such as HIV-1, the virus that causes AIDS, are currently of extreme medical significance. In this course, the complex molecular biology and biochemistry of retroviruses will be examined. The student completing this course will have an indepth understanding of the current retrovirus literature. Virology and molecular biology background required.

3440 Vaccines and Immunity  (Every other Spring) 2 Credits
Course Director: Ted Ross
Vaccines are widely regarded as one of the major contributors to increased life expectancy. The purpose of this course is to (1) explore the history of vaccines; (2) underscore the successful role of current vaccines in the management of infectious disease; (3) present strategies for a new generation of safe and effective molecular vaccines; and (4) discuss the ethical and economic realities of vaccine use and development.

3450 Herpes Virology  (Every other Spring) 2 Credits
Course Director: Frank Jenkins
The focus of this course will be molecular biology and pathogenesis of the 8 known herpes viruses that infect and cause disease in man. It will cover the molecular details of the life cycles of these viruses, including attachment, entry, gene expression, replication, assembly, latency, immunology, and pathogenesis. There will be discussions concerning antiviral approaches, vaccines and the use of herpes viruses as gene transfer vectors. Class participation in paper discussions is essential, and will constitute a large part of the final grade, two take-home exams constitute the remainder.

3455 Antimicrobial Therapeutics  (Every other Fall) 2 Credits
Course Director: Michael Parniak
The development and mechanism of action of antimicrobial drugs, including anti-bacterials, anti-fungals, anti-parasitics and antivirals will be described at the molecular level with some emphasis on diseases with significant public health impact (HIV, Malaria, Tuberculosis, etc.) Aspects of medicinal chemistry, biochemistry and molecular biology will be considered in drug development. Primarily lecture format with student presentations of selected papers as warranted. Some emphasis on chemistry, but accessible to students without a strong chemistry background.
MSMVM 3465 Gene Delivery (Every other Spring) 2 Credits
Course Director: Hiroyuki Nakai
The course presents an introduction to various gene delivery systems (viral and non-viral), recent advances in delivering genes to and/or engineering cellular genomes in various types of cells including stem cells, applications of gene delivery technologies for basic research and gene therapy of various inherited and acquired diseases, and current issues in human gene therapy. The course consists of lectures by experts in the relevant fields. Lecture/paper discussion format.

3480 Immunology of Infectious Disease (Every other Fall) 2 Credits
Course Director: JoAnne Flynn & Karen Norris
General mechanics of immunity to microbial pathogens and common strategies of immune evasion will be discussed with emphasis on detailed examples from viral, bacterial and parasitic systems. An in depth examination of survival strategies of pathogens in intracellular and extracellular host environments will be addressed, as well as the consequences of inadequate and inappropriate immune responses.

3485 Emerging Pathogens (Spring) 1 Credit
Course Director: Gerry Nau
Infectious diseases have a profound impact on society. Many infectious agents are well-recognized and have been studied for years. Others, however, have only recently been recognized because of advances in diagnostics or because of human exposure to new agents. The MVM course emerging pathogens will explore the pathobiology and recent literature surrounding newly-recognized or resurgent infectious agents. Organisms and the diseases they cause will be reviewed and papers will be discussed to highlight developments in understanding virulence, host defenses, and strategies to diagnose, treat or prevent infection.

NEUROBIOLOGY

MSNBIO 2005 Biol Basis of Neuropsychiatric Disorders (Every other Spring) 3 Credits
This course is designed to provide a survey of some of the major neurological and psychiatric disorders for the non-clinician. Each session will focus on a particular disorder and will include a patient presentation (live or by videotape), and a discussion of the etiology, epidemiology, pathophysiology, and treatment of that disorder.

MSNBIO 2008 Pro-Seminar (Fall & Spring) 1 Credit
Course Director: Gonzalo Torres
Members of the Center for Neuroscience faculty presents an overview of the research on which he/she works. Critical analysis of experiments and of research is emphasized.

MSNBIO 2010 Scientific Ethics (Summer) 1 Credit
Course Director: Joe Yip
The course is an introduction to basic ethical issues that arise in the course of conducting scientific research. It is intended for graduate students in the Center for Neuroscience who have completed at least one year of graduate work. The course will be composed of informal lecture presentations followed by class discussion of issues.

MSNBIO 2100 Cellular and Molecular Neurobiology I (Fall) 4 Credits
Course Director: Carl Lagenaur
This course is the first component of the introductory graduate sequence designed to provide an overview of cellular and molecular aspects of neuroscience. This course covers nerve cell biology, protein chemistry, regulation of gene expression, receptor function, and second messenger signaling in a lecture format. A background in basic biology or permission of the instructor is required.

MSNBIO 2101 Cellular and Molecular Neurobiology II (Fall) 4 Credits
Course Director: Carl Lagenaur
This course is the second component of the introductory graduate sequence designed to provide an overview of cellular and molecular aspects of neuroscience. This course covers the electrical properties of neurons, synaptic transmission and neural development. A background in basic biology or permission of the instructor is required.

MSNBIO 2102 Systems Neurobiology (Spring) 6 Credits
Course Director: Dan Simons
This course is a component of the introductory graduate sequence designed to provide an overview of neuroscience. This course provides an introduction to the structure of the mammalian nervous system and to the functional organization of sensory systems, motor systems, regulatory systems, and systems involved in higher brain functions. It is taught primarily in a lecture format with some laboratory work.

MSNBIO 2135 Historical Perspectives in Neuroscience (Summer) 2 Credits
Course Director: Cary Balaban
This seminar course explores the origins and evolution of modern neuroscientific concepts between the 17th and mid-20th centuries. Discussions of primary and secondary source material focus on understanding the role of contemporary philosophical, scientific, social, and technological factors in the development of neuroscientific thought. A further goal is to develop an appreciation of their contributions to current neuroscientific dogma.

**MSBNIO 2612 Advanced Developmental Biology (Fall)**
2 Credits  
*Course Directors: Cynthia Lance-Jones*
This course will examine selected topics in developmental biology at an advanced level. Topics may include pattern formation in insects, cell lineage analysis, cell-cell interactions and the specification of cell fates, cell adhesion molecules, genetic approaches to mammalian embryogenesis and the extracellular matrix in development. An individual subject will be introduced with a lecture by a faculty member. Within each subject, significant research papers will be assigned and discussed. Emphasis will be placed on the critical reading of papers and classroom discussion. Students may act as discussion leaders. Prerequisite: INTBP 2000 (Foundations in Biomedical Science), or BIOSCI 2010 thru 2023 (Current Topics in Molecular, Cellular, and Developmental Biology), or #03-350 (CMU Developmental Biology course), or permission of the instructor.

**MSNBIO 2650 Journal Club (Fall & Spring)**
1 Credit  
*Course Director: Dan Simons*
Papers will be selected from current periodicals in neuroscience for presentation. Emphasis is placed on a critical evaluation of experimental procedure, interpretation and presentation of data. Grade is based on the satisfactory completion of a journal or research presentation as determined by the facilitator and attendance at other presentations.

**MSNBIO 2660 Neurobiology Seminar Series (Fall & Spring)**
1 Credit  
*Course Director: Dan Simons*
This is a special series intended for graduate students. Special lectures are given by national and international investigators in the field of neuroscience. Discussions of the lectures will follow the presentation.

**MSNBIO 2690 Directed Study (All)**
1 to 9 Credits  
*Course Director: Dan Simons*
Students doing laboratory research with a training faculty member should register for this course.

**MSNBIO 3600 PhD Dissertation Research (All)**
1 to 14 Credits

*Course Director: Dan Simons*
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.

**NROSCI 2005 Cognitive Neuroscience (Fall)**
3 Credits  
*Course Director: Carl Olson*
This course will cover fundamental findings and approaches in cognitive neuroscience, with the goal of providing an overview of the field at an advanced level. Topics will include high-level vision, spatial cognition, working memory, long-term memory, learning, language, executive control, and emotion. Each topic will be approached from a variety of methodological directions, for example, computational modeling, cognitive assessment in brain-damaged humans, non-invasive brain monitoring in humans, and single-neuron recording in animals. Lectures will alternate with sessions in seminar format. Prerequisite: Permission of Instructor.

**NROSCI 2011 Functional Neuroanatomy (Fall)**
4 Credits  
*Course Director: Susan Sesack*
This course covers the basic structure of the central nervous system from spinal cord to cerebral cortex. The major sensory, motor and integrative neural systems of the human brain are discussed. Based on an understanding of normal neural connections and brain function, the anatomical and physiological basis of various neurological disorders of the nervous system will be explored.

**NROSCI 2070 Human Physiology (Fall)**
4 Credits  
*Course Director: Billy Joe Yates*
This course includes lectures and reading on the following: (1) functions of the cardiovascular system; (2) respiration; (3) digestion and absorption in the gut; (4) kidney function and the regulation of body fluids; (5) the regulation of metabolism; and (6) reproduction.

**NROSCI 3059 Neural Plasticity in Sensory and Motor Systems (Spring)**
3 Credits  
*Course Director: Nathaniel Urban*
Each course meeting will center around the discussion of classic and recent papers in the area of neuronal plasticity. Topics covered in the course will include 1) Basic mechanisms of synaptic plasticity 2) Developmental specification and plasticity 3) Activity dependent regulation of connectivity and circuitry 4) Mechanisms of adult plasticity.