

## Molecular, Cellular and Systemic Physiology

physiology.siu.edu  
physiology@siu.edu

### SCHOOL OF MEDICINE

#### Graduate Faculty:

**Arbogast, Lydia A.**, Professor, Ph.D., Indiana University, 1988; 1996. Molecular aspects of reproductive neuroendocrinology.

**Banerjee, Chandra**, Professor, *Emeritus*, M.D., University of Calcutta, 1955, Ph.D., Medical College of Virginia, 1967; 1974.

**Bany, Brent M.**, Associate Professor, Ph.D., University of Western Ontario, 1997; 2003. Reproductive Physiology; Embryo implantation; Fertility.

**Bartke, Andrzej**, Professor, *Emeritus*, Ph.D., University of Kansas, 1965; 1984.

**Browning, Ronald A.**, Professor, *Emeritus*, Ph.D., University of Illinois Medical Center, Chicago, 1971; 1973.

**Cai, Xiang**, Assistant Professor, Ph.D., Sun-Yat Sen University, China, 2000; 2011. Mechanisms underlying chronic stress-induced depression and the molecular basis of the therapeutic effect of antidepressants.

**Cheatwood, Joseph**, Associate Professor, Ph.D., University of Florida, 2004; 2009. Mechanisms of neuroprotection and recovery of function following central nervous system injury.

**Clough, Richard W.**, Professor, Ph.D. University of Nebraska, 1983; 1987. Concussive brain injury and recovery of behavioral function following injury.

**Collard, Michael W.**, Associate Professor, *Emeritus*, Ph.D., Washington State University, 1987; 1993.

**Coulson, L. Richard**, Professor, *Emeritus*, Ph.D., University of Toronto, Canada, 1971; 1978.

**Cox, Thomas C.**, *Emeritus*, Professor, Ph.D., Arizona State University, 1979; 1982.

**Dunagan, Tommy T.**, Professor, *Emeritus*, Ph.D., Purdue University, 1960; 1962.

**Ellert, Martha**, Associate Professor, *Emerita*, Ph.D., University of Miami, 1967; 1975.

**Ellsworth, Buffy S.**, Associate Professor, Ph.D., Colorado State University, 2002; 2007. Endocrinology, pituitary gland development.

**Falvo, Richard E.**, Professor, *Emeritus*, Ph.D., University of Wyoming, 1970; 1973.

**Ferraro, James S.**, Associate Professor, Ph.D., The Chicago Medical School, 1984; 1987. Physiological and behavioral aspects of circadian rhythmicity; reproduction and sexuality.

**Hales, Dale Buchanan**, Professor and *Chair*, Ph.D., University of Colorado Health Sciences Center, Denver, 1983; 2009. Reproductive endocrinology, role of oxidative stress and inflammation in hormonal carcinogenesis, ovarian cancer, steroid biochemistry, male reproduction.

**Hayashi, Kanako**, Assistant Professor, Ph.D., Iwate University, Japan, 2002; 2008. Reproductive biology and cancer biology.

**Huggenvik, Jodi I.**, Associate Professor, *Emerita*, Ph.D., Washington State University, 1985; 1993.

**Hunter, William S.**, Associate Professor, *Emeritus*, Ph.D.,

Michigan State University, 1971; 1975.

**Jensik, Philip**, Assistant Professor, Ph.D., Southern Illinois University, 2009; 2016. Transcription factor deformed epidermal autoregulatory factor 1 (DEAF1).

**Maclea, James A.**, Associate Professor, Ph.D., University of Missouri-Columbia, 2000; 2007. Reproductive biology, spermatogenesis, gene regulation.

**Murphy, Laura**, Professor, *Emerita*, Ph.D., Medical College of Georgia, 1984; 1987.

**Myers, Hurley**, Professor, *Emeritus*, Ph.D., University of Tennessee, 1969; 1971.

**Narayan, Prema**, Associate Professor, Ph.D., University of Minnesota, 1984; 2005 Mouse models of gonadotropin receptor function, reproductive endocrinology.

**Nequin, Lynn**, Associate Professor, *Emerita*, Ph.D., University of Illinois Medical Center, Chicago, 1970; 1976.

**Patrylo, Peter R.**, Associate Professor, Ph.D., Rutgers University—UMDNJ/RWJMS, 1991; 2001. Plasticity and regulation of local neuronal networks during aging and following injury, particularly in the context of epileptogenesis.

**Pond, Amber**, Assistant Professor, Ph.D., Mississippi University, 1995. Ion Channel Biochemistry.

**Rose, Gregory M.**, Professor, Ph.D., University of California, Irvine 1980; 2009. Understanding the basis of and developing treatments for age-related learning and memory disorders.

**Sarko, Diana K.**, Assistant Professor, Ph.D., University of Florida, Neuroscience, 2006. Systems Neuroscience, Neuroanatomy, Neurophysiology.

**Shanahan, Michael F.**, Professor, *Emeritus*, Ph.D., University of Michigan, 1976; 1985.

**Steger, Richard W.**, Professor, *Emeritus*, Ph.D., University of Wyoming, 1974; 1985.

**Strader, April D.**, Associate Professor, Ph.D., University of Wisconsin-Milwaukee, 2002; 2005 Neuroendocrine regulation of body weight regulation.

**Wade, David**, Associate Professor, *Emeritus*, Ph.D., Cambridge University, 1967; 1974.

**Yau, William M.**, Professor, *Emeritus*, Ph.D., Medical College of Virginia, 1971, 1973.

**Zheng, Zhengui (Patrick)**, Assistant Professor, Ph.D., Shanghai University of Traditional Chinese Medicine, 1997; 2014. Developmental and molecular basis of sexual differentiation during vertebrate organogenesis.

Graduate courses in physiology may be taken leading to the Master of Science or the Doctor of Philosophy degrees with a major in molecular, cellular and systemic physiology. Graduate courses in molecular, cellular and systemic physiology may also contribute to a program leading to a Master of Science degree major in biological sciences or to a teaching specialty for the Master of Science in Education degree major in secondary education or in higher education.

The Department of Physiology offers advanced training in mammalian physiology, aging, cancer biology, cell physiology, molecular biology, molecular endocrinology, neuro-endocrinology, neurophysiology, neuropharmacology, reproductive biology, and reproductive endocrinology, metabolism and human anatomy. Students entering the graduate training program are advised to plan the course work so as to acquire a broad knowledge of the field before

emphasizing one of these sub-disciplines. The advisory system in the department is set up to help students in planning their work. All graduate training programs in the department are subject to approval of the graduate program committee (GPC) of the department.

Each term the student must be engaged in a training assignment which supplements formal course work and will consist of research or teaching or both. The student is required to have participated in both types of activities, research and teaching, as a graduate student at SIU as a condition for receiving a graduate degree.

Prerequisites for graduate training in molecular, cellular and systemic physiology include an undergraduate degree in one of the biological, physical, or behavioral sciences, preferably with one year each of physics, mathematics, and chemistry.

### Financial Assistance

The Department of Physiology offers financial assistance to qualified applicants accepted by the department. The funds which provide this assistance come from a variety of sources which include: teaching assistantships from the department; University fellowships which are applied for directly by the student; and research assistantships from grants obtained by the graduate program faculty. Students interested in financial assistance should fill out the Financial Support Form available online and in the Department of Physiology office. Additional financial aid information may be found at the SIU Financial Aid Office web page. Financial assistance depends on availability and the student's qualifications and academic status. Continued financial support is contingent upon the student's progress toward the degree and good academic standing.

The department may support master's students for up to 24 months and Ph.D. students for 48 months on department teaching assistantships. However, every effort will be made to encourage the student and his/her adviser to find alternative sources of funding. Continuation of support will be conditioned on satisfactory performance in areas of academics, research, and teaching. Academic performance will be based on good standing in the Graduate School (3.0 GPA) and passage of the preliminary exam by the end of the third year (Ph.D. students only). Satisfactory research performance will be based on the filing of an approved research proposal by the end of the (Ph.D. students only) calendar year and after that time by an annual memo from the student's advisory committee indicating progress in the area of research. It will be the student's responsibility to provide this documentation to the GPC. Evaluation of teaching effectiveness will be carried out by the GPC from sources possibly but not limited to the course coordinator, student evaluations and by direct observation of classes by the GPC.

A departmental stipend for graduate student research will be available to molecular, cellular and systemic physiology graduate students working in laboratories of regular physiology department faculty members provided that the student is making satisfactory progress in their research program and remains in good academic standing (as defined above).

### Research Tools

Doctoral students must acquire competence in one research tool and are encouraged to attain competence with two tools. The requirements for a research tool may be satisfied by establishing proficiency in advanced statistics, computer science, electronics,

advanced mathematics, electron microscopy, foreign language (with suitability of a particular language being determined by the student's committee), or some technique which is acceptable to the student's advisory committee. Courses which are normally part of a track requirement or are highly recommended for students in that track. Approval of a given tool by the student's committee will be granted only if the student has demonstrated proficiency by taking a formal course and receiving a grade (preferably *B* or better) or by passing a formal examination given by an expert in that field (preferably a faculty member in the University department where the subject is normally taught).

### Master's Degree

The application should be submitted online through the Graduate School. All applicants must submit a brief (300-600 words) statement of goals and ambitions indicating why they wish to do graduate work and three letters of recommendation submitted by individuals who can comment on their academic abilities, character, and potential for doing research. The Graduate Record Exam (GRE) is required, and the score on the general part must be submitted with the application.

This program requires a nonrefundable \$65 application fee that must be submitted with the application for Admissions to Graduate Study in Molecular, Cellular and Systemic Physiology. Applicants may pay this fee by credit card.

The Graduate School requires an earned grade point average (GPA) of 2.70 or better (*A* = 4.0) on all undergraduate work. A minimum GPA of 3.00 (*A* = 4.0) in all undergraduate and graduate work is needed for serious consideration.

The graduate program committee of the department will normally examine the credentials, which include the application form, transcript(s), letters of recommendation, goal statement, and GRE scores, only after all materials have been received.

International students must take the TOEFL exam and obtain a score greater than 550 (paper score) or 220 (computer score) to qualify for admission by the Graduate School, and must pass a Test of Spoken English prior to the awarding of teaching assistantships by the Department of Physiology.

### Advisory Committee

The Director of Graduate Studies will act as an advisor to new graduate students until a research advisor is selected. The choice of a research advisor is a very important step and should be carefully considered. During the first semester, most students rotate through four research laboratories to get acquainted with faculty members and research programs before selecting an advisor who will direct the thesis research and help plan course work.

The functions of the research advisor are:

1. To provide guidance in the student's research and the use of facilities.
2. To provide mentorship in conducting, evaluating, and publishing scientific research.
3. To serve as chair of the Advisory Committee and consultant for the selection of the other members of the Advisory Committee (at least three additional members from the graduate faculty, including one from outside the department).

Members of the Advisory Committee should provide expertise in or complementary to the research area and provide guidance in the selection of course work. The student should meet with the committee yearly or as needed to discuss research and academic progress.

Following the selection of a research advisor and the Advisory Committee, the Graduate Faculty Committee Approval Form (available online and in the department office) must be filled out with the names and signatures of committee members and filed with the department secretary. The completed form will then be forwarded to the Graduate School for final approval.

### Total Hours Required

A total of 30 semester hours at the 400- and 500-level is required for the master's degree. Of the total hours completed, at least 21 of these must be graded (*A, B, C*) hours. At least 15 of the total 30 must be 500-level courses taken at SIU. Of these 15, a *minimum* of 3 hours of PHSL 599 (thesis) is *required*. More than three hours of 599 may be taken, however only six may be counted toward the 500-level requirement.

### Thesis

The thesis should represent a competent piece of original research carried out on a specific physiological problem or area under the research advisor's supervision. It should include an adequate review of the literature, a statement of the hypothesis, a set of experiments testing the hypothesis by whatever methods are appropriate, an analysis of the results, and an interpretation of the work and its significance. Upon completion of the thesis research, a final department seminar is presented followed by an oral examination. The examination will be conducted by the Advisory Committee and will cover the subject of the thesis and other matters related to the discipline.

### Doctoral Program

The Graduate School requires a grade point average in previous graduate work of at least 3.0 and acceptance by the academic unit offering the Ph.D. program. See the following pages for accelerated and direct entry options.

The application should be submitted online through the Graduate School. All applicants must submit a brief (300-600 words) statement of goals and ambitions indicating why they wish to do graduate work and three letters of recommendation submitted by individuals who can comment on their academic abilities, character, and potential for doing research. The Graduate Record Exam (GRE) is required, and the score on the general part must be submitted with the application.

This program requires a nonrefundable \$65 application fee that must be submitted with the application for Admissions to Graduate Study in Molecular, Cellular and Systemic Physiology. Applicants may pay this fee by credit card.

The graduate program committee of the department will examine the credentials which include the application form, transcript(s), letters of recommendation, goal statement and GRE scores (if applicable) only after all materials have been received.

International students must take the TOEFL exam and obtain a score greater than 550 (paper score) or 220 (computer score) to qualify for admission by the Graduate School, and must pass a Test of Spoken English prior to the awarding of teaching assistantships by the Department of Physiology.

### Ph.D. Direct Entry Option

This option is presently available for admission to the Graduate School. Contact the Department of Physiology for further information regarding this option. The Department of Physiology may accept a post-baccalaureate student directly into a Ph.D. program provided that the student has:

1. A cumulative undergraduate grade point average of 3.25 ( $A = 4.0$ ).
2. Sufficient undergraduate course work in biology, chemistry, physics, and mathematics or an outstanding score on the Graduate Record Exam (GRE) on: (a) the general part or (b) the advanced part in biology, chemistry, physics, or mathematics.

A student admitted to the doctoral program under this option is subject to the admissions requirements stated above and all other requirements of the doctoral degree, including: course work, retention, residency, examinations, research proposal, dissertation, and all applicable time limits. The Advisory Committee may adjust the course work and requirements of the student based on the student's background and research area. Students who have taken one or more core courses at another accredited university may be given credit toward their core requirements if such courses are deemed equivalent to our core courses by the Graduate Program Committee and department grade requirements are met.

### Ph.D. Accelerated Entry Option

The Department of Physiology offers the Ph.D. accelerated entry option to a graduate student in the Master's program who demonstrates the intellect, research aptitude, and commitment for pursuing a doctoral degree. At the end of at least one year of studies at the master's level, the student may request that their Advisory Committee review their qualifications and performance in order to establish eligibility for entry into the doctoral program under this option. The student must have a GPA of at least 3.25 ( $A = 4.0$ ) in graduate course work and letters of reference attesting to the student's abilities and potential to perform doctoral level research. The Advisory Committee must establish that the student is prepared and able to conduct research at the doctoral level, which may be established by publications; presentations at meetings; depth of understanding; and quality of seminars, presentations, and research proposal. The Advisory Committee will make a recommendation that the student should either continue in the Master's program or advance into the doctoral program.

After the student's eligibility has been established, the research advisor and/or the Advisory Committee will prepare a written review of the student's qualifications and submit it to the Graduate Program Committee for approval. The Graduate Program Committee will then submit a recommendation to the Chair of the Department of Physiology, who will in turn submit a letter to the Graduate School requesting a waiver of a master's degree or master's equivalency and entry into the doctoral program.

The student will need to submit the following items to the Graduate School: a letter of acceptance into the doctoral program from Graduate Program Committee Chair, a Graduate School application form (indicating Ph.D.), and a completed Notification of Accelerated Entry Option Students Form.

A student admitted to the doctoral program under this option is subject to all requirements of the doctoral degree, including: course work, retention standards, residency, examinations, research proposal, dissertation, and all applicable time limits.

Please note that only courses taken after admission to the doctoral program will count toward residency.

### Advisory Committee

The Director of Graduate Studies will act as an advisor to new graduate students until a research advisor is selected. The choice of a research advisor is a very important step and should be carefully considered. During the first semester, most students rotate through four research laboratories to get acquainted with faculty members and research programs before selecting an advisor who will direct the dissertation research and help plan course work.

The functions of the research advisor are:

1. To provide guidance in the student's research and the use of facilities.
2. To provide mentorship in conducting, evaluating, and publishing scientific research.
3. To serve as chair of the Advisory Committee and consultant for the selection of other members of the Advisory Committee (at least four additional members from the graduate faculty, including one from outside the department).

Members of the Advisory Committee should provide expertise in or complementary to the research area and provide guidance in the selection of course work. The student should meet with the committee yearly or as needed to discuss research and academic progress.

Following the selection of a research advisor and the Advisory Committee, the Graduate Faculty Committee Approval Form (available in the department office) must be filled out with the names and signatures of committee members and filed with the department secretary. The completed form will then be forwarded to the Graduate School for final approval.

### Total Hours Required

The requirements for the Ph.D. degree are those established by the Graduate School, the Guide to Graduate Studies and the student's advisory committee. The Graduate School requires 24 semester hours prior to candidacy and 24 semester hours of dissertation credit. Of the total hours completed, at least 10 of these must be graded (A, B, C) hours.

### Preliminary Examination

Preliminary examinations for doctoral students consist of a set of written exams covering the student's research area and course work, a research proposal in the area of the dissertation research project, and an oral defense of the proposal. In most cases, the written exams are taken in early August after completion of the second year of study. After passing the written exams, the student will have one month to write the research proposal. The student's Advisory Committee will evaluate the research proposal and if it is found acceptable, the oral defense of the proposal will be scheduled with the Advisory Committee. Details of the preliminary examinations are available from the Graduate Program Committee.

### Dissertation

The dissertation should represent a competent piece of original research carried out on a specific physiological problem or area under the advisor's supervision. It should include an adequate review of the literature, a statement of the hypothesis, a set of experiments testing the hypothesis by whatever methods are appropriate, an analysis of the results, and an interpretation of the work and its significance. The research should be of sufficient quality and quantity to merit publications in peerreviewed journals. Upon completion of the dissertation research, a final department seminar is presented followed by an oral examination. The examination will be conducted by the Advisory Committee and will cover the subject of the dissertation and topics related to the discipline.

### Certificate in Anatomy

The purpose of the anatomy certificate is to allow graduate students to become proficient in anatomy teaching. This will allow them to compete more effectively for jobs in this field. Students are eligible for the anatomy certificate if they are in an existing anatomically-based master's or Ph.D. program (e.g. Physiology, Anthropology, or Zoology). Additional prerequisites (e.g., embryology, basic vertebrate anatomy) are preferred. Students lacking such prerequisites will be encouraged to obtain them prior to admission into the anatomy certificate program. The Graduate Program Committee of the Department of Physiology will review all applications. In addition to graduate coursework in anatomy, students in the anatomy certificate program will obtain experience teaching gross anatomy to undergraduates and medical students. A minimum of 17-18 graduate credit hours are required for fulfillment of the certificate requirements. They are: Advanced Human Anatomy with lab, (PHSL 401A,B, 10 hours), Vertebrate Histology, (ZOO 409, 4 hours) and either Neuroanatomy, (PHSL 573, 3 hours) or Vertebrate Anatomy Lab, (ZOO 418, 3 hours). Where appropriate, these courses may also count for credit toward the master's or Ph.D. degree. The Graduate Program Committee in the Department and the student's advisory committee will make recommendations for other coursework and oversee the student's progress. In addition to graduate coursework in anatomy, students in the anatomy certificate program will obtain experience teaching gross anatomy to undergraduates and medical students. Students supported by assistantships will have the same teaching obligations as all other departmentally supported students. Students will be required to teach at least two semesters of gross anatomy assisting Physiology and Anatomy Department faculty in the Medical School.

For more information, contact:

Director of Graduate Studies  
Department of Physiology, School of Medicine  
Southern Illinois University  
Carbondale, IL 62901-6512  
Telephone: 618-453-1544  
Email: physiology@siu.edu

### Courses (PHSL)

**PHSL 401A-5 Advanced Human Anatomy with Laboratory.** A-B sequence. Laboratory dissection of the human body with lectures as needed. Primarily for students majoring in physiology, biological sciences, anthropology or pre-medical fields.

Prerequisite: PHSL 301. Enrollment by consent of instructor. Lab fee: \$20.

**PHSL 401B-5 Advanced Human Anatomy with Laboratory.** A-B sequence. Laboratory dissection of the human body with lectures as needed. Primarily for students majoring in physiology, biological sciences, anthropology or pre-medical fields. Prerequisite: PHSL 301. Enrollment by consent of instructor. Lab fee: \$20.

**PHSL 420A-3 Principles of Pharmacology.** Examines basic principles of pharmacology (pharmacokinetics) and the action of various classes of drugs on living organisms. Drug classes covered include those affecting most organ systems of the human body, such as the nervous, cardiovascular, gastrointestinal and renal systems as well as drugs used for antibiotic and cancer chemotherapy. Three lectures per week. Prerequisite: PHSL 310 or 410, CHEM 340 and 342 (or equivalent).

**PHSL 420B-3 Principles of Pharmacology.** Examines basic principles of pharmacology (pharmacokinetics) and the action of various classes of drugs on living organisms. Drug classes covered include those affecting most organ systems of the human body, such as the nervous, cardiovascular, gastrointestinal and renal systems as well as drugs used for antibiotic and cancer chemotherapy. Three lectures per week. Prerequisite: PHSL 310 or 410, CHEM 340 and 342 (or equivalent).

**PHSL 426-3 Comparative Endocrinology.** (Same as ANS 426, ZOOL 426) Comparison of mechanisms influencing hormone release, hormone biosynthesis, and the effects of hormones on target tissues, including mechanisms of transport, receptor kinetics, and signal transduction. Prerequisites: PHSL 310 or ANS 331 or ZOOL 220 with a grade of C. Laboratory/Field Trip Fee: \$15.

**PHSL 430-3 Cellular and Molecular Physiology.** This course will examine the molecular and cellular aspects of physiology, with special emphasis on the experiments used to examine the regulation of gene expression, protein activities, and cellular functions in eukaryotes. Topics include: mechanisms regulating gene expression, signaling pathways, cancer biology, and the use of experimental model organisms. Required of Physiology majors. Prerequisite: BIOL 211 & BIOL 213 or CHEM 350 & 351.

**PHSL 433-3 Comparative Animal Physiology.** (Same as ZOOL 433) Variations of the physiological processes in animal phyla, comparison with human physiology, and review of basic physiology principles and comparative aspects of mechanism and function. Prerequisite: BIOL 211, BIOL 212 & BIOL 213 or PHSL 310 with a grade of C or better.

**PHSL 440A-3 Biophysics.** Biomathematics, biomechanics and biotransport. Three lectures per week. Prerequisites: MATH 141 or 150; PHSL 310; PHYS 203 A&B and 253 A&B or PHYS 205 A&B and 255 A&B. May be taken in B,A sequence with consent of instructor.

**PHSL 440B-3 Biophysics.** Bioelectrics and bio-optics applied to physiological problems. Three lectures per week. Prerequisites: MATH 141 or 150; PHSL 310; PHYS 203 A&B and 253 A&B or PHYS 205 A&B and 255 A&B. May be taken in B,A sequence with consent of instructor.

**PHSL 450-3 Advanced Human Sexuality.** (Same as WGSS 449) Advanced, comprehensive course intended to supplement and expand the critical examination of topics covered in PHSL 320, Reproduction and Sexuality. The objectives of this class are

to examine the physiological and behavioral basis of human reproduction and sexuality. Examining how humans reproduce from a physiological perspective including all aberrations and clinically relevant dysfunctions, as well as, the spectrum of human sexual behaviors including typical and atypical sexual behavior, paraphilias and diversity of human relationships. Prerequisite: PHSL 320.

**PHSL 460-2 Electron Microscopy.** Lecture course designed to introduce the student to the theory and principles of electron microscopy. Two lecture hours per week. Restricted to senior standing or permission of instructor.

**PHSL 462-3 Biomedical Instrumentation.** Diagnostic and therapeutic modalities related to engineering. Cardiovascular, neural, sensory and respiratory instrumentation. Special approval needed from the instructor.

**PHSL 470-3 Biological Clocks.** Study of the temporal aspects of diverse physiological and behavioral functions which possess diurnal and seasonal periodicity. Species covered will include many eukaryotic organisms including plants, but will mainly stress mammals. Oscillations in sleep-wake cycle, locomotion, reproduction, hormonal secretion and numerous other processes will be explored. In addition, the effects of biological clocks in humans and the effect of jet lag and depression will be examined. Prerequisite: PHSL 310.

**PHSL 500-1 to 6 (1 per semester) Advanced Seminar in Physiology.** Presentation of research and current literature in physiology. Required of all graduate students in physiology. Graded S/U only.

**PHSL 501-1 Presentation of Physiological Data.** Research areas and special topics requisite for conducting scientific research will be presented. Students will learn how to organize a talk on experimental findings in physiology, prepare slides, and communicate effectively in an oral presentation format. Graded S/U only.

**PHSL 510-3 Experimental Methods in Physiology.** The main objectives of this course are to acquaint the student with the techniques and the equipment used in modern research laboratories and to provide instruction in the principles and practice of scientific experimentation. Restricted to Physiology (MCSP) graduate students only.

**PHSL 511A-1 to 5 Advanced Mammalian Physiology.** Physical and chemical organization and function in mammals, with emphasis on the human. Physiology of blood and circulation, respiration, digestion, metabolism, excretion, endocrines, sensory organs, nervous system, muscle and reproduction. Four lectures and one seminar per week. Seminar will consist of primary literature discussion and student presentation on areas covered in lecture. Principal lecturer for each of the area topics will lead discussion and assign the primary literature. May be taken in any sequence. Restricted to consent of department. Special approval needed from the instructor.

**PHSL 511B-1 to 5 Advanced Mammalian Physiology.** Physical and chemical organization and function in mammals, with emphasis on the human. Physiology of blood and circulation, respiration, digestion, metabolism, excretion, endocrines, sensory organs, nervous system, muscle and reproduction. Four lectures and one seminar per week. Seminar will consist of primary literature discussion and student presentation on areas covered in lecture. Principal lecturer for each of the area topics will lead discussion and assign the primary literature. May be

taken in any sequence. Restricted to consent of department. Special approval needed from the instructor.

**PHSL 520-4 Reproductive Function and Sexual Behavior.**

Advanced, comprehensive course examining the physiological and behavioral basis of human reproduction and sexuality. Topics include physiology and pathophysiology of the human reproductive system and normal and atypical sexual behavior. Course topics will include didactic presentations and problem-based lab discussions selected by the students selected from lecture or related topics. The class will meet three times weekly for didactic presentations and once a week for a three hour extensive discussion and presentation utilizing self-directed learning strategies and knowledge in a problem-based format, similar to that used in the medical school curricula. Special approval needed from the instructor.

**PHSL 530-3 Advanced Cellular and Molecular Physiology.**

This course will examine the molecular and cellular aspects of mammalian physiology using the primary literature as the source of topics for oral presentations and discussions. Special approval needed from the instructor.

**PHSL 531-2 Advanced Cellular Physiology Laboratory.** One one-hour lecture and one three-hour laboratory per week, designed to be taken concurrently with PHSL 530. Basic experimental procedures used in studies in cellular physiology.

**PHSL 533-4 Advanced Comparative Physiology.** Advanced concepts and techniques used in current studies in comparative physiology. Three lectures and one discussion period per week.

**PHSL 540-3 Advanced Biophysics.** Survey of recent biophysical research with emphasis on historical development of current advances. Three lectures per week. Prerequisite: PHSL 440 or its equivalent.

**PHSL 560B-2 Physiological Technique.** Prerequisite: PHSL 560A.

**PHSL 570A-3 Advanced Physiological Topics-Biological Structure.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570B-3 Advanced Physiological Topics-Cardiovascular Physiology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570C-3 Advanced Physiological Topics-Respiratory Physiology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570D-3 Advanced Physiological Topics-Nerve-Muscle Physiology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570E-3 Advanced Physiological Topics-Metabolism.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570F-3 Advanced Physiological Topics-Gastrointestinal Physiology.** Studies of current research and literature in various

topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570G-3 Advanced Physiological Topics-Neurophysiology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570H-3 Advanced Physiological Topics-Radiation Physiology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570I-3 Advanced Physiological Topics-Environmental Physiology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570J-3 Advanced Physiological Topics-Biomathematics.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570K-3 Advanced Physiological Topics-Biomedical Computing.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570L-3 Advanced Physiological Topics-Endocrinology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570M-3 Advanced Physiological Topics-Animal Care.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570N-3 Advanced Physiological Topics-Biophysics.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570O-3 Advanced Physiological Topics-Pharmacology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570P-3 Advanced Physiological Topics-Special Topics.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570Q-3 Advanced Physiological Topics-Reproductive Physiology.** Studies of current research and literature in various topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 570R-3 Advanced Physiological Topics-Renal Physiology.** Studies of current research and literature in various

topic areas of physiology. One or more of the following list of topic sections will be offered each semester, so that each section will be available once every two or three years.

**PHSL 571-3 Research and Problems in Biological Transmission Electron Microscopy (TEM).** Laboratory course designed to provide experience in techniques for biological electron microscopy. Student, with the aid of the instructor, designs and carries out a project in transmission electron microscopy. Two three-hour laboratories per week. Prerequisite: PHSL 460 or special permission of instructor.

**PHSL 573-3 Neuroanatomy.** A detailed survey of human neuroanatomy. The course will include radiographic, cross-sectional and developmental anatomy of the nervous system. Dissection of the human brain will occur in general laboratory sessions. Three lectures per week.

**PHSL 574-3 Neuropharmacology.** (Same as PHRM 574) A detailed examination of the biochemical aspects of neuropharmacology with emphasis on neurotransmitters-their synthesis, storage, release and metabolism in the central and peripheral nervous system. Considerable emphasis is placed on major research developments (both past and present) that influence how one studies the action of drugs on the nervous system. Prerequisite: PHSL 410, and CHEM 450, or equivalent.

**PHSL 575-3 Neuroendocrinology.** Designed to investigate and discuss the current research and historical aspects of the field of neuroendocrinology. In addition, designed to have students examine and evaluate current literature in the field and through discussion have them present their analysis of the research. One hour of lecture, one hour of discussion of textual material, one hour of multiple reports on library research. Prerequisite: PHSL 410A, B or equivalent, or an undergraduate/graduate endocrinology course, or consent of instructor.

**PHSL 581A-3 Multimedia in Medical Education.** Students will participate in the daily discussions of a medical education multimedia corporation. Emphasis will be on process and instructional design. Students will be supervised by team members in the production of commercial educational packages. Skills to be acquired include the ability to digitize images and sound, and to create a Power Point presentation on a topic of the student's choice.

**PHSL 581B-6 Advanced Multimedia in Medical Education.** Intended to be a "hands on" course which contributes significantly to the development of multimedia teaching materials for medical education. Students will be assigned to a project as part of a development team. Under supervision of the team leader, they will assist in software design, material preparation and assembly. Prerequisite: PHSL 581A.

**PHSL 582-3 Clinical Application/Radiology.** The study of human anatomy through imaging techniques such as standard x-rays, computer assisted tomography (CT) and magnetic resonance imaging (MRI). The course will include individualized work with clinical specialists in a hospital setting for 1/2 day per week with times to be arranged. Restricted to graduate status, acceptance into anatomy certificate program. Graded S/U.

**PHSL 590-1 to 4 Readings or Research in Current Physiological Topics.** By special arrangement with the instructor with whom the student wishes to work. Graded S/U only.

**PHSL 598-1 to 48 (1 to 12 per semester) Research.** The credit hours selected for this course registration will be determined by the major professor of the student. In a typical semester no more

than six hours will be taken by a student except under special circumstances. Graded S/U only. Special approval needed from the instructor.

**PHSL 599-1 to 6 Thesis Research.** Research for thesis for Master's degree.

**PHSL 600-1 to 32 (1 to 16 per semester) Dissertation Research.** Research for dissertation for Ph.D. degree.

**PHSL 601-1 per semester Continuing Enrollment.** For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded S/U or DEF only.

**PHSL 699-1 Postdoctoral Research.** Must be a Postdoctoral Fellow. Concurrent enrollment in any other course is not permitted.