MOLECULAR AND CELLULAR PHYSIOLOGY

Chair: Richard S. Lewis
Professors: Axel T. Brunger, Brian K. Kobilka, Richard S. Lewis, W. James Nelson, Stephen J. Smith, Richard W. Tsien, William Weis
Associate Professors: Christopher Garcia, V. Daniel Madison
Assistant Professors: Miriam Goodman, Merritt Maduke
Courtesy Associate Professor: Stefan Heller, John Huguenard, Anson W. Lowe, Tony Ricci
Courtesy Assistant Professor: Richard J. Reimer
Department Offices: Beckman Center, B100
Mail Code: 94305-5345
Phone: (650) 725-7554
Email: schantae@stanford.edu
Web Site: http://mcp.stanford.edu

Courses given in Molecular and Cellular Physiology have the subject code MCP. For a complete list of subject codes, see Appendix.

The Department of Molecular and Cellular Physiology is located in the Beckman Center for Molecular and Genetic Medicine.

A central goal of physiology in the post-genomic era is to understand how thousands of encoded proteins serve to bring about the highly coordinated behavior of cells and tissues. Research in the department approaches this goal at many levels of organization, ranging from single molecules and individual cells to multicellular systems and the whole organism. The faculty share common interests in the molecular mechanisms of cell signaling and behavior, with a special focus on structure/function analysis of ion channels and G-protein coupled receptors, and their roles at the cellular, organ, and whole-organism levels; the molecular basis of sensory transduction, synaptic transmission, plasticity and memory; the role of ion channels and calcium in controlling gene expression in neural and immune cells; and the regulation of vesicle trafficking and targeting, cell polarity, and cell-cell interactions in the nervous system and in epithelia. Research programs employ a wide range of approaches, including molecular and cell biology, biochemistry, genetics, biophysics, x-ray crystallography and solution NMR, electrophysiology, and *in vitro* and *in vivo* imaging with confocal and multi-photon microscopy.

GRADUATE PROGRAMS

The department offers required and elective courses for students in the School of Medicine and is also open to other qualified students with the consent of the instructor. Training of medical, graduate, and postdoctoral students is available. The program offers a course of study leading to the Ph.D. degree. No B.S. is offered, and an M.S. is offered only in the unusual circumstance where a student completes the course work, rotation, and the written section of the qualifying exam, but is unable to complete the requirements for the Ph.D.

DOCTOR OF PHILOSOPHY

Students with undergraduate or master's degrees who have completed a year each of college chemistry (including lectures in organic and physical chemistry), physics, calculus, and biology are considered for admission to graduate study. Applicants submit a report of scores from the Graduate Record Examination (verbal, quantitative, analytical, and an advanced subject test in one of the sciences) as part of the application.

Students who do not speak English as their native language must submit scores from TOEFL unless waived by Graduate Admissions, the Registrar's Office.

Study toward the Ph.D. is expected to occupy five years, including summers. A minimum of six quarter-long courses is required. These include four graduate-level courses (200-300 series) and a choice of two out of these three courses: MCP 221, MCP 255, and MCP 256. Students are also required to take the Molecular and Cellular Physiology seminar/Research In Progress series. Each student presents a talk on research in progress to the department at least every other year, starting their second year. Acceptable grades for all course work must be a minimum of 'B-', and at least two grades equal to 'A-' or above are necessary (but not sufficient) for continuation in the program.

Qualifying Examination—At the end of the second year in residence as a graduate student, each Ph.D. candidate presents a written thesis proposal to be defended at an oral comprehensive examination. The examinations may be taken only after all course work has been completed by the required standard. Students undertake individual research studies as early as possible after consultation with their preceptor. Upon passing this exam, the student is advanced to candidacy for the Ph.D.

Dissertation and University Oral Examination—The results of independent, original work by the students are presented in a dissertation. The oral examination is largely a defense of the dissertation.

Advisers and Advisory Committees—A graduate advisory committee, currently Professors Lewis and Aldrich, advises students during the period before the formation of their qualifying committees.

Financial Aid—Students may be funded by their advisers' research grants, by training grants, by department funds, or by extramural funds. Students are encouraged to obtain funding from outside sources (e.g., NIH and NSF).

COURSES

Course and lab instruction in the Department of Molecular and Cellular Physiology conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www.stanford.edu/dept/DoR/rph/8-2.html.

MCP 100Q. The Hippocampus as a Window to the Mind—Stanford Introductory Seminar. Electrical physiology of the brain using the hippocampus as a model system. The seminar builds from basic anatomical and electrical principles of brain structure and function, through the electrical properties of individual neurons and simple neuronal circuits, to the nature of behaviors that emerge from these more basic properties. Also discusses other brain regions where the hippocampal model provides insight into specific neuronal functions. Culminates in a discussion of neuronal disorders such as epilepsy, drug addiction, and obsessive-compulsive disorder that can be better understood on a basis of knowledge of the hippocampal model.
3 units, Spr (Madison, V)

MCP 199. Undergraduate Research—Allows for qualified students to undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

MCP200. Cardiovascular Physiology—Offered jointly with the Department of Medicine. Lectures, small group instruction, clinical presentations, and lab demonstrations of normal and disordered human cardiovascular physiology. Prerequisite: understanding of general biochemistry.
5 units, Spr (Kobilka, B)

MCP 213. Special Topics in Molecular and Cellular Physiology—Introductory and advanced physiological topics agreed on by an instructor and students. Prerequisite: consent of instructor.
1-18 units, Aut, Win, Spr, Sum (Staff)

MCP 215. Synaptic Transmission—Primarily for graduate students with an interest in synaptic function; interested medical students and advanced undergraduates may enroll. The anatomical, physiological, and biochemical basis of synaptic function in the peripheral and central nervous system. Research papers.
5 units, Aut (Staff)

MCP 216. Genetic Analysis of Behavior—(Same as NBIO 216.) Advanced seminar. Findings and implications of behavioral genetics as applied to invertebrate and vertebrate model systems. Topics include biological clocks, and sensation and central pattern generators. Relevant genetic techniques and historical perspective. Student presentation.
4 units, not given this year

MCP 218. Transmembrane Signal Transduction—The molecular mechanisms of signal transduction for a variety of structurally and functionally different plasma membrane receptors. Topics: the structure of receptors and the interaction of the receptor protein with the lipid bilayer; ligand binding and ligand mediated changes in receptor structure; and cytosolic, cytoskeletal, and membrane proteins that interact with receptors. Recent research developments and the value of experimental approaches for the study of receptors.

2 units, not given this year

MCP 222. Imaging: Biological Light Microscopy—(Same as BIOSCI 152.) Survey of instruments which use light and other radiation for analysis of cells in biological and medical research. Topics: basic light microscopy through confocal fluorescence and video/digital image processing. Lectures on physical principles; involves partial assembly and extensive use of lab instruments. Lab. Prerequisites: some college physics, Biological Sciences core.

3 units, Spr (Smith, S)

MCP 232. Advanced Imaging Lab in Biophysics—(Same as BIOSCI 132/232, BIOPHYS 232.) Laboratory and lectures. Microscopy, emphasizing hands-on experience with a range of apparatus and techniques. Topics include microscope optics, Koehler illumination, contrast-generating mechanisms (bright/dark field, fluorescence, phase contrast, differential interference contrast), and resolution limits. Advanced topics vary by year, but include single-molecule fluorescence, fluorescence resonance energy transfer, confocal microscopy, two-photon microscopy, optical trapping, and fiber optic methods. Limited enrollment. Recommended: basic physics, Biological Sciences core or equivalent, and consent of instructor.

4 units, Spr (Block, S; Schnitzer, M; Smith, S; Stearns, T)

MCP 255. Molecular Physiology of Membranes—Recommended for MCP graduate students; open to graduate and medical students; advanced undergraduates with consent of instructor. Structure and mechanisms of the molecules underlying transmembrane processes. Topics include structure of membrane proteins, energetics of membranes, transmembrane signaling (receptors and channels), transport (transporters and pumps), single molecule methods and theory, and membrane complexes. Lectures introduce concepts; student activities and small group discussion emphasize application of concepts to research the literature. Recommended: BIOC/SBIO 214 or equivalent.

4 units, not given this year (Maduke, M)

MCP 256. How Cells Work: Energetics, Compartments, and Coupling in Cell Biology—Dynamic aspects of cell behavior and function, including cellular energetics, homeostasis, heterogeneity of membranes, structure & function of organelles, solute and water transport, signaling and motility. Emphasis on understanding the principles of how coupling of molecular processes gives rise to essential functions at the cellular level. Lectures, discussions, readings, student presentations, and use of mathematical models of cell function. Open to graduate, medical, and advanced undergraduate students.

4 units, Spr (Maduke, M; Lewis, R)

MCP 258. Information and Signaling Mechanisms in Neurons and Circuits—(Same as NBIO 258.) How synapses, cells, and neural circuits process information relevant to a behaving organism. How phenomena of information processing emerge at several levels of complexity in the nervous system, including sensory transduction in molecular cascades, information transmission through axons and synapses, plasticity and feedback in recurrent circuits, and encoding of sensory stimuli in neural circuits.

5 units, Aut (Tsien, R; Baccus, S)

MCP 299. Directed Reading in Molecular and Cellular Physiology—Prerequisite: consent of instructor.

1-18 units, Aut, Win, Spr, Sum (Staff)

MCP 399. Graduate Research—Allows for qualified students to undertake investigations sponsored by individual faculty members. Research fields include endocrinology, neuroendocrinology, and topics in molecular and cellular physiology. Prerequisite: consent of instructor.

1-18 units, Aut, Win, Spr, Sum (Staff)