

# MOLECULAR AND CELLULAR PHYSIOLOGY

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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 Madison, 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 such as 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. Preference to sophomores. 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**—Investigations sponsored by individual faculty members. Prerequisite: consent of instructor.

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

**MCP 200. 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 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, Win (Goodman, M; Clanindin, T)*

**MCP 222. Imaging: Biological Light Microscopy**—(Same as BIOSCI 152, NBIO 222.) 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; Dolmetsch, R)*

**MCP 232. Advanced Imaging Lab in Biophysics**—(Same as BIOSCI 132/232, BIOPHYS 232.) Laboratory and lectures. Advanced microscopy and imaging, emphasizing hands-on experience with state-of-the-art techniques. Students construct and operate working apparatus. Topics include microscope optics, Koehler illumination, contrast-generating mechanisms (bright/dark field, fluorescence, phase contrast, differential interference contrast), and resolution limits. Laboratory topics vary by year, but include single-molecule fluorescence, fluorescence resonance energy transfer, confocal microscopy, two-photon microscopy, and optical trapping. 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 256. How Cells Work: Energetics, Compartments, and Coupling in Cell Biology**—Open to graduate and medical students, and advanced undergraduates. Dynamic aspects of cell behavior and function, including cellular energetics, homeostasis, heterogeneity of membranes, structure and function of organelles, solute and water transport, signaling and motility. Emphasis is on the principles of how coupling of molecular processes gives rise to essential functions at the cellular level. Mathematical models of cell function. Student presentations.

*4 units, Spr (Goodman, M; Maduke, M)*

**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**—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)*

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