# BIOPHYSICS PROGRAM

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*Director:* William I. Weis
*Professors:* Richard W. Aldrich (Molecular and Cellular Physiology), Russ Altman (Genetics, Medical Informatics), Steve Block (Applied Physics, Biological Sciences), Steven Boxer (Chemistry), Axel Brunger (Molecular and Cellular Physiology), Douglas Brutlag (Biochemistry), Gilbert Chu (Oncology), Mark Davis (Microbiology and Immunology), Sebastian Doniach (Physics, Applied Physics), James Ferrell (Molecular Pharmacology), Philip C. Hanawalt (Biological Sciences), Daniel Herschlag (Biochemistry), Keith O. Hodgson (Chemistry), Wray H. Huestis (Chemistry), Chaitan Khosla (Chemical Engineering, Chemistry), Eric Kool (Chemistry), Ron Kopito (Biological Sciences), Roger D. Kornberg (Structural Biology), Michael Levitt (Structural Biology), David B. McKay (Structural Biology), Uel J. McMahan (Neurobiology), Tobias Meyer (Molecular Pharmacology), W. E. Moerner (Chemistry), Norbert Pelc (Bio-engineering, Radiology), Joseph D. Puglisi (Structural Biology), Stephen Quake (Bioengineering), Stephen J. Smith (Molecular and Cellular Physiology), Edward I. Solomon (Chemistry), James A. Spudich (Biochemistry, Developmental Biology), James Swartz (Bioengineering, Chemical Engineering), William I. Weis (Structural Biology), Richard N. Zare (Chemistry)
*Associate Professors:* Judith Frydman (Biological Sciences), K. Christopher Garcia (Microbiology and Immunology, Structural Biology), Pehr Harbury (Biochemistry), Peter Jackson (Pathology), Julie Theriot (Biochemistry)
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Courses given in Biophysics have the subject code BIOPHYS. For a complete list of subject codes, see Appendix.

The Biophysics Program offers instruction and research opportunities leading to the Ph.D. in Biophysics. Students admitted to the program may perform their graduate research in any appropriate department.

## GRADUATE PROGRAM

For information on the University's basic requirements for the Ph.D. degree, see the "Graduate Degrees" section of this bulletin.

A small number of highly qualified applicants are admitted to the program each year. Applicants should present strong undergraduate backgrounds in the physical sciences and mathematics. The graduate course program, beyond the stated requirements, is worked out for each student individually with the help of appropriate advisers from the Committee on Biophysics. The requirements and recommendations for the Ph.D. degree include:

1. Training in physics or chemistry equivalent to that of an undergraduate physics or chemistry major at Stanford.
2. Completion of the following background courses or their equivalents at other institutions:
   a) CHEM 131, 171, 173, and 175
   b) BIOC 200, 201
3. Completion of the following courses or their equivalents:
   a) SBIO 241 and 242
   b) at least four additional graduate level courses in physical or biological science
   c) BIOPHYS 250
   d) MED 255
4. Opportunities for teaching are available during the first nine quarters, at the discretion of the advising committee.
5. The student must prepare a dissertation proposal defining the research to be undertaken, including methods of procedure. This proposal should be submitted by Winter Quarter of the third year, and it must be approved by a committee of at least three members including the principal research adviser and at least one member from the Biophysics Program. The candidate must defend the dissertation proposal in an oral examination. The dissertation reading committee normally evolves from the dissertation proposal review committee.
6. The student must present a Ph.D. dissertation as the result of independent investigation and expressing a contribution to knowledge in the field of biophysics.
7. The student must pass the University oral examination, taken only after the student has substantially completed the research. The examination is preceded by a public seminar in which the research is presented by the candidate.

## COURSES

**BIOPHYS 205. DNA Repair and Genomic Stability**—(Enroll in BIOSCI 205.)
*3 units, Spr (Hanawalt, Ford)*

**BIOPHYS 210. Advanced Topics in Membrane Trafficking**—(Enroll in BIOC 210.)
*3 units (Pfeffer) not given 2005-06*

**BIOPHYS 210A. Molecular Physiology of Cells**—Recommended for all MCP graduate students; open to graduate and medical students; advanced undergraduates with consent of instructor. Dynamic aspects of cell function, including cellular energetics, gas exchange, solute transport, absorption and secretion in epithelia, ionic and electrical signaling in nerve and muscle, and sensory physiology. Emphasis is on the cellular function of ion channels and transporters, joining experimental and analytical approaches. Lectures, in-class readings, discussions, student presentations, and the use of mathematical models of cell function. Recommended: MCP 255; basic cell and molecular biology.
*4 units, Spr (Lewis, Goodman)*

**BIOPHYS 211. Biophysics of Sensory Transduction**—(Enroll in BIOSCI 211.)
*4 units (S. Block) not given 2005-06*

**BIOPHYS 227. Functional MRI Methods**—(Same as RAD 227.) Functional magnetic resonance neuroimaging, including data acquisition, analysis, and experimental design. Journal club sections. Cognitive neuroscience and clinical applications. Prerequisites: basic physics, mathematics. Recommended: neuroscience.
*3 units, Aut (Glover)*

**BIOPHYS 228. Computational Structural Biology**—(Same as SBIO 228.) Online class. Interatomic forces and interactions such as electrostatics and hydrophobicity, and protein structure in terms of amino acid properties, local chain conformation, secondary structure, domains, and families of folds. How protein motion can be simulated. Bioinformatics introduced in terms of methods that compare protein via their amino acid sequences and their three-dimensional structures. Structure prediction via simple comparative modeling. How to detect and model remote homologues. Predicting the structure of a protein from knowledge of its amino acid sequence.
*3 units, Aut, Spr (Levitt)*

**BIOPHYS 232. Advanced Imaging Lab in Biophysics**—(Same as BIOSCI 132/232, MCP 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 fiberoptic methods. Limited enrollment. Recommended: basic physics, Biological Sciences core or equivalent, and consent of instructor. GER:DB-NatSci

*4 units, Spr (S. Block, Schnitzer, S. Smith, Stearns)*

**BIOPHYS 241. Biological Macromolecules**—(Enroll in SBIO 241.)

*3-5 units, Aut (Puglisi, Weis, Block, Herschlag, Ferrell, McKay, Pande, Garcia)*

**BIOPHYS 242. Methods in Molecular Biophysics**—(Enroll in SBIO 242.)

*3 units (Weis, Puglisi) not given 2005-06*

**BIOPHYS 250. Seminar in Biophysics**—Required of Biophysics graduate students. Presentation of current research projects and results by faculty in the Biophysics program. May be repeated for credit.

*1 unit, Aut, Win (Staff)*

**BIOPHYS 255. The Responsible Conduct of Research**—A forum for scientists to familiarize themselves with institutional policies/practices and professional standards that define scientific integrity. Overview of ethics in research, authorship, patents, and human interest at the academic-commercial interface, and small group sessions for more extended discourse between students and faculty. Completion fulfills NIH/ADAMHA requirement for instruction in the ethical conduct of research. Required course for incoming students.

*1 unit, Win (Staff)*

**BIOPHYS 297. Bio-Inorganic Chemistry**—(Same as CHEM 297.) Overview of metal sites in biology. Metalloproteins as elaborated inorganic complexes, their basic coordination chemistry and bonding, unique features of the protein ligand, and the physical methods used to study active sites. Active site structures are correlated with function. Prerequisites: 153 and 173, or equivalents.

*3 units (Solomon) not given 2005-06*

**BIOPHYS 300. Research**

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

**BIOPHYS 399. Directed Reading**

*1-18 units (Staff)*

**BIOPHYS 450. Introduction to Biotechnology**—(Enroll in CHEM-ENG 450.)

*3 units, Spr (Khosla)*