MOLECULAR BIOPHYSICS • biological chemistry • cancer biology • cell regulation • genetics and development • immunology • integrative biology • molecular microbiology • neuroscience

MOLECULAR BIOPHYSICS

CHAIR, GRADUATE PROGRAM

Kevin H. Gardner, Ph.D.

DEGREE OFFERED

Doctor of Philosophy

FACULTY AND RESEARCH INTERESTS

Joseph P. Albanesi, Professor
Ph.D., Duke University, 1980
Structure and assembly of neuronal cytoskeletal proteins; kinetics of force-generating enzymes; molecular basis of biomembrane fusion.

Steven J. Altshuler, Associate Professor
Ph.D., University of California, San Diego, 1990
Self-organizing principles underlying cell prolarization and migration; single-cell diversity in cancer.

Richard J. Auchus, Associate Professor
M.D., Ph.D., Washington University, St. Louis, 1988
Biochemistry, physiology and structure/function studies of enzymes in steroid hormone biosynthesis and metabolism.

Paul Blount, Associate Professor
Ph.D., Washington University School of Medicine, St. Louis, 1990
Molecular mechanisms of channels that gate in response to membrane tension.

Chad A Brautigam, Assistant Professor
Ph.D., Yale University, 1998
Basic processes in living organisms at the atomic level using X-ray crystallography, analytical ultracentrifugation, isothermal titration calorimetry and other biophysical techniques.

Yuh Min Chook, Associate Professor
Ph.D., Harvard University, 1994
Structures and mechanisms of nuclear transport and the nuclear pore complex.

David R. Corey, Professor
Ph.D., University of California, Berkeley, 1990
Engineering proteins and nucleic acids for novel function.

Johann Deisenhofer, Professor
Ph.D., Technical University of Munich and Max-Planck Institute for Biochemistry, Germany, 1974
Crystallography of biological macromolecules; structure and function of proteins.

Kevin H. Gardner, Professor
Ph.D., Yale University, 1995
Biophysical and biochemical studies of photosensors and other environmental sensory proteins.

Elizabeth J. Goldsmith, Professor
Ph.D., University of California, Los Angeles, 1972
Crystallographic studies of signal-transducing proteins.

Nick V. Grishin, Associate Professor
Ph.D., UT Southwestern Medical Center, 1998
Computational biology; analysis of protein sequences and structures.

Qiu-Xing Jiang, Assistant Professor
Ph.D., Yale University, 2002
Structure and function of large membrane assemblies, including ion channels and transporters, using electron cryo-microscopy and crystallographic analysis to generate 3-D structures and perform functional studies in in vitro or in vivo systems.

Youxing Jiang, Associate Professor
Ph.D., Yale University, 1997
Structure and function of ion channels/transporters using X-ray protein crystallography and electrophysiological tools.

Ege T. Kavalali, Associate Professor
Ph.D., Rutgers University, 1995
Synaptic functional architecture and dynamics of presynaptic specializations.

Hanzhung Lu, Assistant Professor
Ph.D., Johns Hopkins University, 2004
Magnetic resonance studies of vascular physiology and metabolism of the brain.

Xuelian Luo, Assistant Professor
Ph.D., Tufts University, 1997
Protein structure determination by NMR spectroscopy; protein folding; cell-cycle checkpoints and cancer.

Craig R. Malloy, Professor
M.D., University of California, San Francisco, 1977
The analysis of metabolism in intact tissues by NMR

spectroscopy; development of new methods to understand metabolic processes in functioning cells.

Ralph P. Mason, Professor
Ph.D., University of Cambridge, England, 1986
Development of novel techniques for prognostic radiology with emphasis on tumor oxygenation, pH and efficacy of gene therapy; NMR, bioluminescence, PET and SPECT.

Zbyszek Otwinowski, Professor
Ph.D., University of Chicago, 1989
Three-dimensional structures of biological molecules.

Alexander Pertsemlidis, Assistant Professor
Ph.D., University of California, Berkeley, 1995
MicroRNA regulation of lung cancer pathogenesis; genetic determinants of cardiovascular disease.

Margaret A. Phillips, Professor
Ph.D., University of California, San Francisco, 1988
Polyamine and pyrimidine metabolism in trypanosome and malaria parasites.

Rama Ranganathan, Professor
Ph.D., M.D., University of California, San Diego, 1992, 1994
The evolutionary design of proteins and cellular signaling networks.

Luke Rice, Assistant Professor
Ph.D., Yale University, 2000
Integrating structure, kinetics and computation to understand the molecular determinants and regulatory mechanisms of microtubule dynamics.

José Rizo-Rey, Professor
Ph.D., University of Barcelona, Spain, 1988
Biophysical studies of the mechanisms of neurotransmitter release and intracellular membrane function.

Michael Rosen, Professor
Ph.D., Harvard University, 1993
Structural, biochemical and cell biological mechanisms of signal transduction that control the actin cytoskeleton.

Elliott M. Ross, Professor
Ph.D., Cornell University, 1975
Mechanisms of G-protein signaling; amplification, selectivity, response timing; structure/function of GTPase-activating proteins and associated receptors.

Gürol Süel, Assistant Professor
Ph.D., UT Southwestern Medical Center, 2003
Systems-level analysis of cellular decision-making and differentiation circuits.

Philip J. Thomas, Professor
Ph.D., University of South Dakota, 1988
Structure, function and folding of membrane proteins.

Diana Tomchick, Associate Professor
Ph.D., University of Wisconsin, Madison, 1990
Basic processes in living organisms at atomic level using X-ray crystallography, NMR spectroscopy and other biophysical techniques.

Marc Turcotte, Assistant Professor
Ph.D., McGill University, Canada, 1986
Systems biology modeling and simulation; cell signaling; G proteins; complex systems (nonlinear dynamics); graph, network and control theory.

E. Sally Ward, Professor
Ph.D., University of Cambridge, England, 1985
Genetic manipulation of antibodies and T-cell receptors; autoimmune disease.

Lani F. Wu, Associate Professor
Ph.D., University of California, San Diego, 1990
Self-organizing principles underlying cell polarization and migration; single-cell diversity in cancer.

Hongtao Yu, Professor
Ph.D., Harvard University, 1995
Molecular mechanisms of cell-cycle progression and mitotic checkpoints; structure determination of cell-cycle regulatory proteins.

Hong Zhang, Associate Professor
Ph.D., University of Illinois at Urbana-Champaign, 1994
Structural enzymology; NAD biosynthesis and regulation; structure-based drug design.

Xuewu Zhang, Assistant Professor
Ph.D., Albert Einstein College of Medicine, 2003
Biochemical and structural studies of regulatory mechanisms for signaling proteins, especially receptor-mediated signaling pathways in neuronal development and axonal guidance.

Objectives

Molecular biophysics is concerned with interpretation of biological phenomena in terms of mathematical, physical and chemical principles with sufficient rigor to allow development of quantitative predictive models. The mission of the Molecular Biophysics Graduate Program is to provide students with conceptual tools and research experiences that will prepare them to apply the principles and techniques of the physical sciences to biomedical research problems. The research interests of the faculty are diverse, providing students opportunities to immerse themselves in a variety of biophysical research problems. Areas of research interest include structural analysis of macromolecules, particularly proteins, by X-ray crystallography, solution NMR and fluorescence spectroscopy.

Biological phenomena of interest include visual signal transduction; chemo-mechanical, voltage and allosteric gating of ion channels; folding and function of membrane proteins; calcium regulation of synaptic vesicle exocytosis and transport mechanisms; signaling by G proteins and their receptors and by protein kinase cascades; mechanisms of axonal transport and the assembly of the cytoskeleton; energy generation at the membrane; and the biophysical basis of cell-cycle progression. In addition, faculty members are developing instrumentation and methods for high-throughput genomics and expression analysis, algorithms and methods in bioinformatics and protein-fold taxonomy, and NMR methods to examine metabolic processes in functioning cells.

Special Requirements for Admission

In general, conditions for admission to the program are good academic standing within the Division of Basic Science of the graduate school and an interest in pursuing a research and training program in molecular biophysics. Students with strong backgrounds in the physical sciences and mathematics will be well-prepared to join the program. A course in mathematical methods is provided during the summer for students to supplement their background in this subject.

Students ordinarily apply for formal admission to the program after completion of the first-year curriculum but are encouraged to participate in the program informally at any time after admission into the Division of Basic Science. It is not necessary that a student within the program choose a dissertation research mentor who is a member of the faculty of the program, provided the student has sound reasons for this choice.

Curriculum

Biophysics is a field defined by its application of physical principles and techniques to investigation of key biological problems. Optimal training for a career in molecular biophysics includes exposure to the theoretical basis for physical properties and interactions of biological molecules, the technical approaches that are available to investigate biological systems, and the results of studies in which biophysics has contributed to an understanding of the biological characteristics of system behavior. The Molecular Biophysics Graduate Program includes course work in each of these three areas.

Core Course

The first-year Core Course, required of all students in the Division of Basic Science, offers training in the broad issues faced by contemporary biological science. This course provides 15 hours of course credit toward the minimum of 24 hours required for graduation. Beginning partway through the first year and continuing into the second, physical approaches to contemporary biology are considered in a series of advanced courses.

Advanced Courses

All students in the Molecular Biophysics Graduate Program are required to take Physical Biochemistry I, Molecular Biophysics: Spectroscopy, Modern Methods in Structural Biology and Quantitative Modeling of Biochemical Signaling Systems I. In addition, students must choose 1.5 credit hours from the advanced Biophysics courses plus 1.5 credit hours of elective courses offered in this or other programs in the Division of Basic Sciences.

Physical Biochemistry II
Advanced NMR Spectroscopy
Protein Structure and Folding
Structure and Function of Ion Channels
Advanced X-ray Crystallography
Computational Approaches in Protein Science
Computational Methods in the Biological Sciences
Bioinformatics and DNA Microarray Analysis
Quantitative Analysis of Genes and Genomes

Although the third and subsequent years will be devoted largely to research on a dissertation topic, students may take additional graduate courses. Course descriptions are listed in the Division of Basic Science chapter.

BIOPHYSICS JOURNAL CLUB AND DISCUSSION GROUP

The Biophysics Journal Club offers students an opportunity to keep abreast of recent research results in the literature, to sharpen critical acumen and to develop public-speaking skills. Every student in the graduate program is expected to attend the journal club and to participate actively. In addition, each student is required to present one journal article or work-in-progress per year.

Students also are strongly encouraged to attend meetings of the Molecular Biophysics Discussion Group and presentations of interest to biophysicists occurring in the numerous seminar series offered by UT Southwestern and its various basic science departments. The Molecular Biophysics Discussion Group and the annual Molecular Biophysics Research Symposium provide forums for presentation of the students' own research, as well as acquainting them with recent research results from other laboratories on campus and from invited speakers.

QUALIFYING EXAMINATION

Admission to candidacy for the Ph.D. requires that students prepare and defend a written research proposal, modeled on an NIH-R01 grant proposal. A student may choose a topic that is related to his or her own prospective dissertation research or may select an unrelated biophysical topic. The student is expected to write a hypothesis-driven proposal. Students who choose to defend an invention or new method must devise suitable controls to demonstrate feasibility. Proposals based on anticipated dissertation research are expected to address fundamental issues; these may, in some cases, extend beyond those encompassed by the dissertation itself. Both the written proposal and the oral defense will be judged for clarity and originality of thought and for the degree of mastery of experimental design and analysis of data expected for a student at the end of the second year of graduate school. During the oral examination, the student also is expected to respond to questions of general knowledge in molecular biophysics.

The ad hoc examination committee is composed of four faculty members, at least two of whom belong to the Molecular Biophysics Graduate Program. The student's mentor is not eligible to serve on the committee. Committee members and the committee chair will be chosen by the chair of the Molecular Biophysics Student Evaluation Committee in consultation with the student's mentor. These choices are based primarily upon expertise in the field of study to be examined.

Dissertation Committee

Following successful completion of the qualifying examination, the student proposes a dissertation committee comprising at least four members of the faculty, three of whom are members of the Molecular Biophysics Graduate Program. The constitution of the dissertation committee must be approved by the program chair.

Within 30 days after forming the dissertation committee, the student presents to the committee a written summary of his or her proposed topic and preliminary research progress toward the project's goals. This initial meeting generally involves a 30-minute oral presentation by the student, followed by discussion and suggestions from the members of the committee.

Every student must hold at least one meeting of his or her dissertation committee each year. After the third year, meetings are held every six months. Additional meetings may be called at any time by the student or by the committee. The dissertation committee monitors the student's progress based on research accomplished, course grades, and journal club and other presentations.

Dissertation Defense

A complete copy of the dissertation must be approved by the dissertation committee before a public dissertation defense can be scheduled. The defense is composed of a public lecture describing the main observations of the research, followed by an oral examination by the dissertation committee. Attendance during the oral examination is restricted to faculty of the graduate school, and participation is restricted to the examination committee.