DEVELOPMENTAL BIOLOGY

Emeritus: (Professor) David S. Hogness
Chair: Roeland Nusse (Autumn), Matthew Scott (Winter, Spring, Summer)
Associate Chair: Matthew Scott (Autumn), Roeland Nusse (Winter, Spring, Summer)
Professors: Gerald Crabtree, Margaret Fuller, A. Dale Kaiser, Roeland Nusse, Matthew Scott, Lucy Shapiro, James Spudich, Irving Weissman
Associate Professors: Ben Barres, Stuart Kim, David Kingsley, Ellen Porzig
Assistant Professors: Seung Kim, William Talbot, Anne Villeneuve

A fundamental problem in biology is how the complex set of multicellular structures that characterize the adult animal is generated from the fertilized egg. Advances at the molecular level, particularly with respect to the genetic control of development, have been explosive. These advances represent the beginning of a major movement in the biological sciences toward the understanding of the molecular mechanisms underlying developmental decisions and the resulting morphogenetic processes. This new thrust in developmental biology derives from the extraordinary methodological advances of the past decade in molecular genetics, immunology, and biochemistry. However, it also derives from groundwork laid by the classical developmental studies, the rapid advances in cell biology and animal virology, and from models borrowed from prokaryotic systems. Increasingly, the work is directly related to human diseases, including oncogene function and inherited genetic disease.

The Department of Developmental Biology includes a critical mass of scientists who are leading the thrust in developmental biology and who can train new leaders in the attack on the fundamental problems of development. Department labs work on a wide variety of organisms from microbes to worms, flies, and mice. The dramatic evolutionary conservation of genes that regulate development makes the comparative approach of the research particularly effective. Scientists in the department labs have a very high level of interaction and collaboration. The discipline of developmental biology draws on biochemistry, cell biology, genetics, and molecular biology.

The department is located in the Beckman Center for Molecular and Genetic Medicine within the Stanford University Medical Center.

GRADUATE PROGRAM

MASTER OF SCIENCE

Students in the Ph.D. program in Developmental Biology may apply for an M.S. degree, assuming completion of their course requirements and preparation of a written proposal. The master's degree awarded by the Department of Developmental Biology does not include the possibility of minors for graduate students enrolled in other departments or programs.

Students are required to take, and satisfactorily complete, at least three lecture courses offered by the department, including 210, Developmental Biology. In addition, students are required to take three courses outside the department. Students are also expected to attend Developmental Biology seminars and journal clubs. In addition, the candidate must complete a research paper proposing a specific experimental approach and background in an area of science relative to developmental biology.

DOCTOR OF PHILOSOPHY

University requirements for the Ph.D. are described in the "Graduate Degrees" section of this bulletin.

The graduate program in Developmental Biology leads to the Ph.D. degree. The department also participates in the Medical Scientists Training Program in which individuals are candidates for both the M.D. and Ph.D. degrees.

Students are required to take, and satisfactorily complete, at least six courses, including Developmental Biology (210); Advanced Genetics (203); Frontiers in Biological Sciences (215); and an advanced molecular biology, biochemistry, or biophysics course. Students are also expected to attend Developmental Biology seminars and journal clubs.

Successful completion of a qualifying examination is required for admission to Ph.D. candidacy. The examination consists of two parts. One proposal is on a subject different from the dissertation research and the other proposal is on the planned subject of the thesis. The final requirements of the program include the presentation of a Ph.D. dissertation as the result of independent investigation and constituting a contribution to knowledge in the area of developmental biology. The student must then successfully pass the University oral examination which is taken only after the student has substantially completed his or her research. The examination is preceded by a public seminar in which the research is presented by the candidate. The oral examination is conducted by a dissertation reading committee.

COURSES

Course work and lab instruction in the Department of Developmental Biology conform to the Policy on the Use of Vertebrate Animals in Teaching Activities as stated in the front of this catalog.

44Q. Stanford Introductory Seminar: How the Brain is Built—A Molecular View of Development and Evolution—Preference to sophomores. Recent pioneering research into the molecular and genetic mechanisms that guide normal development of the mammalian brain. The initial events that create neural cells, how distinct functional domains are formed in the brain, and how the initial "wiring" of the brain during development is accomplished. How studies of brain development using a variety of animals are informative about our own brain development. Molecules that control brain development from an evolutionary perspective and from a systems design perspective. The medical consequences of malfunctions in those mechanisms, and the implications of recent research for regeneration and therapy.

3 units, Spr (Scott)

203. Advanced Genetics—(Same as Genetics 203, Biological Sciences 203.) Explores the genetic toolbox. Examples of analytic methods and modern synthetic genetic manipulation, including original papers. Emphasis is on use of genetic tools in dissecting complex biological pathways, developmental processes, and regulatory systems. Graduate students in biological sciences welcome; those with minimal experience in genetics should prepare themselves by working out problems in Suzuki, et al, or Hartl, et al.

4 units, Aut (Botstein, Kim, Stearns, Villeneuve, Sidow)

204. More Advanced Genetics—Offered upon request of students. Continuation of 203; basic concepts and experimental design in modern genetics. Emphasis is on studying genetic systems in detail from original papers, and the impact of genomics on experimental design and practice. Prerequisite: 203.

3 units, Win (Botstein, Kim, Stearns, Villeneuve)

206. Development and Disease Mechanisms—Focus is on the mechanisms that direct human development, from conception to birth. Conserved molecular and cellular pathways regulate tissue and organ development in humans and other species. Errors in these pathways result in congenital anomalies, and common human diseases. Topics: molecules regulating development, cell induction, developmental gene regulation, cell migration, programmed cell death, pattern formation, stem cells, cell lineage, and development of major organ systems. Emphasis is on links between development and clinically significant topics, including infertility, assisted reproductive technologies, contraception, prenatal diagnosis, multiparity, teratogenesis, inherited birth defects, and fetal therapy. Lectures connect fundamental discoveries in developmental biology to advances in disease diagnosis, therapy, and prevention in clinical medicine.

2 units, Aut (Scott, Seung Kim, Kingsley, Porzig)

210. Developmental Biology—Acquaints graduate students and advanced undergraduates (with consent of instructor only) with important current areas of research in developmental biology. How organismic

complexity is generated during embryonic and post-embryonic development. The roles of genetic hierarchies, induction events, cell lineage, maternal inheritance, cell-cell communication, and hormonal control in developmental processes in well-studied organisms (e.g., mammals, zebrafish, insects, and nematodes). Team taught. Students meet with faculty to discuss current papers from the literature, in depth. Recommended: familiarity with basic techniques and experimental rationales of molecular biology, biochemistry, and genetics.

5 units, Spr (Talbot, Fuller, Crabtree, Kingsley, Nusse, Scott, Seung Kim)

215. Frontiers in Biological Research—(Same as Biochemistry 215.) Faculty-student discussion, emphasizing how to critically evaluate primary research literature in different areas of biological research. Held in conjunction with a seminar series, hosted in alternate weeks by the departments of Biochemistry, Genetics, and Developmental Biology. Each Wednesday, distinguished investigators present their current work at the frontiers of biological research. Before the seminar, students and course faculty meet and discuss in depth one or more papers from the primary research literature on a related topic. After the seminar, students have the opportunity to meet informally with the seminar speaker to discuss their research and future directions. The techniques most commonly used to study problems in biology, and a comparison between the genetic and biochemical approaches in biological research.

1 unit, Aut, Win (D. Kingsley, P. Harbury, Stuart Kim)

217. Mammalian Developmental Genetics—(Same as Genetics 217.) Topics: imprinting; early development and implantation; germ cell allotment; phenotypic consequences of targeted knockouts of developmental, hox, and other developmental genes in mammals; tumorigenesis; coat color mutations; classical mutations and positional cloning; mutagenesis and insertional and gene traps; growth controls and Igfs; muscle and limb development; sex determination; classical genetics and gene mapping and inbred strains; segregation and T locus; and germ and embryonic stem cells and teratocarcinomas. Weekly lecture, plus guest lecture or a literature discussion.

2 units, Win (Barsh, Nusse) alternate years, not given 2001-02

225. Molecular Motor Proteins and the Cytoskeleton—(Same as Biochemistry 225.) The molecular basis of energy transduction that leads to movements generated by microfilament-based and microtubule-based motors. In-depth analysis of forms of myosin, dynein, and kinesin and their roles in the cell as a model for understanding the structural, biochemical, and functional properties of biological machines in general. Topics: structure of the molecular motors and their accessory proteins, regulation of the function of motile assemblies in cells; spatial and temporal controls on the formation of motile assemblies in cells. Experimental approaches: genetic analysis, DNA cloning and expression, reconstitution of functional assemblies from purified proteins, x-ray diffraction, three-dimensional reconstruction of electron microscope images, spectroscopic methods, and high-resolution light microscopy. How a complex cellular process is analyzed at the molecular level by a multifaceted approach using biochemical, biophysical, and genetic techniques. Prerequisites: knowledge of basic biochemistry and cell biology.

3 units (Fuller, Spudich) not given 2000-01

237. Introduction to Biotechnology—(Same as Biochemistry 237, Chemical Engineering 450, Civil Engineering 237, Structural Biology 237.) Faculty from the departments of Biochemistry, Biological Sciences, Chemical Engineering, Civil Engineering, Developmental Biology, Structural Biology, and invited industrial speakers review the interrelated elements of modern biotechnology. Topics: protein structure and dynamics, protein engineering, biocatalysis, gene expression, cellular metabolism and metabolic engineering, fermentation technology, and purification of biomolecules. Prerequisite: graduate student or upper-division undergraduate in the sciences or engineering.

3 units, Spr (Robertson, Swartz)

399. Research—Must register by section numbers.

1-18 units, any quarter (Staff)

459. Frontiers in Interdisciplinary Biosciences—(Cross-listed in multiple departments in the schools of Humanities and Sciences, Engineering, and Medicine; students should enroll directly through their affiliated department, if at all possible.) Introduction to cutting-edge research involving interdisciplinary approaches to bioscience and biotechnology; for specialists and non-specialists. Associated with Stanford's Clark Center for Interdisciplinary Bioscience, and held in conjunction with a seminar series meeting twice monthly during 2000-01. Leading investigators from Stanford and throughout the world speak on their research; students also meet separately to present and discuss the ever-changing subject matter, related literature, and future directions. Prerequisite: keen interest in all of science, with particular interest in life itself. Recommended: basic knowledge of biology, chemistry, and physics.

2 units, Aut, Win, Spr (S. Block)