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
Assistant Professors: Seung Kim, William Talbot, Anne Villeneuve
Associate Professor (Teaching): Ellen Porzig

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 and lab instruction in the Department of Developmental Biology 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.

203. Advanced Genetics—(Same as Biological Sciences 203, Genetics 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)

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)

211. Development in Microorganisms—(Same as Biochemistry 211.) Cell differentiation and multicellular development in microorganisms. Microbes are attractive subjects for molecular studies of the regulation of development and morphogenesis because they can be manipulated easily by genetic and biochemical techniques. Moreover, their genome sequences are known. Topics: sporulation; organelle morphogenesis; bacterial cell cycle; cell-cell communication; pattern formation; multicellular development. Tutorial format/readings and discussion of current literature.
2 units, Aut (Kaiser, Shapiro)

215. Frontiers in Biological Research—(Same as Biochemistry 215.) Literature discussion on how to critically evaluate biological research. Held in conjunction with a seminar series, hosted in alternate weeks by Biochemistry, Developmental Biology, and Genetics. 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 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, S. 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 (Barsh, Nusse) alternate years, not given 2002-03

220. Molecular Mechanisms of Cell Growth, Death, and Morphogenesis—(Same as Biochemistry 220). Explores how cell growth, programmed cell death, and cellular and intercellular morphogenesis generate the sophisticated three-dimensional structures of tissues and organs. This will include topics such as: regulation of cell growth and programmed cell death pathways; mechanisms of cytoplasmic outgrowth and cell migration; cell adhesion and morphogenesis of epithelia. Lectures will be followed by group discussions of papers from the literature. Prerequisite: Genetics 203 or permission of the instructors.

4 units, Win (Krasnow, Kim)

225. Molecular Motor Proteins and the Cytoskeleton—(Same as Biochemistry 225). The molecular basis of energy transduction leading to movements generated by microfilament-based and microtubule-based motors. 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; functions of molecular motors 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. Focus is on 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 (Spudich) not given 2001-02

237. Introduction to Biotechnology—(Same as Biochemistry 237, Chemical Engineering 450, Civil and Environmental Engineering 237, Structural Biology 450.) Stanford faculty from the schools of Medicine, Humanities and Sciences, Engineering and invited industrial speakers review the interrelated elements of modern biotechnology. Topics: development of recombinant protein pharmaceuticals, bacterial fermentation and scale-up, mammalian cell culture and scale-up, transgenic animals, transgenic protein production in plants, isolation and purification of protein pharmaceuticals, formulation and delivery of pharmaceutical proteins, environmental biotechnology, metabolic engineering, industrial enzymes, diagnostic devices, transciptomics and proteomics, drug delivery systems. Prerequisite: graduate student or upper-division undergraduate in the sciences or engineering.

3 units, Spr (Robertson, Swartz)

299. Directed Reading—Prerequisite: consent of instructor. See faculty list for section numbers.

1 to 18 units, any quarter, by arrangement

399. Research—Allows for qualified students to undertake investigations sponsored by individual faculty members. Prerequisite: consent of instructor. See faculty list for section numbers.

1 to 18 units, any quarter, by arrangement

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 listed, otherwise enroll in ChE 459.) An introduction to cutting-edge research involving interdisciplinary approaches to bioscience and biotechnology; for specialists and non-specialists. Organized and sponsored by the Stanford BioX Program. Three seminars each quarter address a broad set of scientific and technical themes related to interdisciplinary approaches to important issues in bioengineering, medicine, and the chemical, physical, and biological sciences. Leading investigators from Stanford and throughout the world present the latest breakthroughs and endeavors that cut broadly across many core disciplines. Pre-seminars introduce basic concepts and provide background for non-experts. Registered students attend all pre-seminars in advance of the primary seminars, others welcome. Prerequisite: keen interest in all of science, engineering, and medicine with particular interest in life itself. Recommended: basic knowledge of mathematics, biology, chemistry, and physics.

1 unit, Aut, Win, Spr (Robertson)

399. Research—Must register by section numbers.

1-18 units, any quarter (Staff)

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