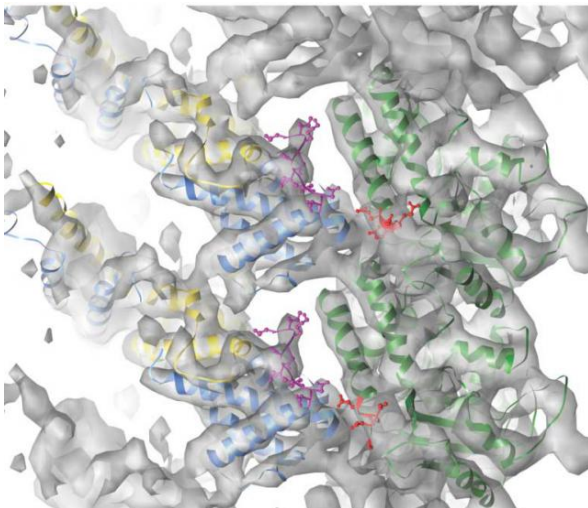


The Molecular and Cell Biology major has 5 emphases, [Biochemistry and Molecular Biology \(BMB\)](#), [Cell & Developmental Biology \(CDB\)](#), [Genetics, Genomics & Development \(GG&D\)](#), [Immunology & Pathogenesis](#), and [Neurobiology](#). A descriptive paragraph or two for each shows below, with the [course requirements](#) on another web page.

Biochemistry & Molecular Biology (BMB) Emphasis

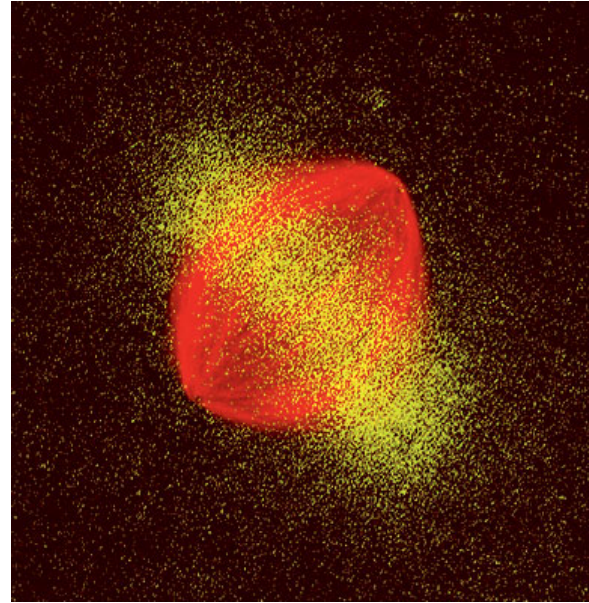


Housed within the Division of Biochemistry, Biophysics, & Structural Biology, the biochemistry and molecular biology emphasis explores one of the most rapidly advancing and exciting areas in biology today. One of the unique characteristics of BMB is the natural and complementary fusion of incredibly powerful molecular biological methodologies such as cloning, gene splicing and gene expression with biophysical and biochemical strategies for dissecting structure and function of macromolecules. A major emphasis which distinguishes BMB is the rigorous and reductionist approach to defining living systems in biochemical terms. Recently, our ability to take apart complex biological processes and machinery such as those governing DNA replication, transcription, transposition, recombination, protein synthesis, and RNA processing, have greatly advanced our understanding of the living cell. Moreover, the molecular visualization capabilities of X-ray crystallography, 2-D NMR, cryo-electron microscopy and other structural biology techniques have opened new horizons and greatly extended our mechanistic understanding of important biological molecules. The combined approaches of molecular biology and biochemistry have consequently played a major role in unraveling many

complex biological processes such as development, differentiation, mutagenesis, gene regulation, pathogenesis, oncogenesis, and aging. Perhaps the most exciting and invigorating aspect of these studies is that they can be done by individual students armed with keen interest and curiosity.

The major program has two tracks. Track 1, Biochemistry & Molecular Biology, comprises 6 upper-division courses. Track 2, Biological Chemistry comprises 7 upper-division courses.

Cell & Developmental Biology (CDB) Emphasis



Cell biology and developmental biology are two closely related disciplines at the very heart of the biological sciences. Cell biology focuses on understanding the mechanisms by which the basic functions of homeostasis, gene regulation, ion transport, growth and division, secretion, signalling and locomotion are achieved at the molecular and cellular levels. Thus, cell biology links the more reductionist fields of biochemistry, genetics, molecular biology and structural biology to the study of organ systems and whole organisms in the fields of developmental biology, immunology, neurobiology and physiology.

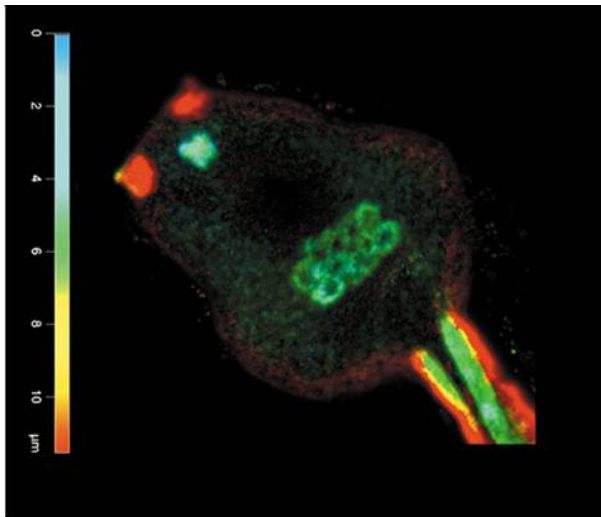
Because cell biologists seek to understand how cells function both under normal conditions and in disease states such as cancer, cystic fibrosis, diabetes and muscular dystrophy, the CDB emphasis constitutes a “middle road” for those planning medical careers. In addition to the standard techniques of biochemistry and molecular biology, cell biologists employ a powerful array of optical and physiological techniques to measure and manipulate the location and concentration of ions and molecules within living cells and subcellular organelles, and even the forces exerted by cells on their surroundings.

Developmental biologists seek to provide an explanation for how mature organisms arise from a single cell, i.e. the fertilized egg. To succeed in this will ultimately require understanding how all the basic cell biological processes are orchestrated, with stunning intricacy and precision, by

dynamic arrays of cells in the developing embryo. Another central issue in biology is that of how developmental processes in ancient life forms were modified during evolution to give rise to the diversity of modern plants and animals. To approach this question, it is necessary to compare developmental processes in different organisms. In this department, developmental studies are carried out on annelids, arthropods, chordates, echinoderms, nematodes and yeast.

This major has two tracks, Cell & Systems Biology (Track 1) and Medical Biology & Physiology (Track 2), each requiring six upper-division courses.

Genetics, Genomics & Development (GGD) Emphasis



The Division of Genetics, Genomics and Development represents the biological disciplines most transformed by the genome sequences of an ever-increasing spectrum of life. The research and courses of this Division stress the mechanisms these genomes use to program the orderly development of diverse organisms including humans, classical model organisms (bacteria, yeast, worms, flies, fish, frogs) and other species representing pivotal nodes in evolution. In addition, GG&D explores how sequence variation leads to phenotypic differences among individuals, and how these differences are inherited and fixed by natural selection. Emerging foci of the division concern how changes in the sequences that control animal development have contributed to the diversification of animal form and function, and dissecting how cells with the same genome can stably and heritably express different portions of their genomes.

Many advanced genomic methods have been developed and widely adopted within the Division. Methodologies such as RNA, homologous gene knockouts, transposon tagging,

transgenics, antisense-mediated translational silencing, genome sequencing, expression profiling, mass spectrometry and computational biology are transforming the fields of cellular and organismal biology. These experimental methods place even the most complex problems within reach of the functional analysis that puts genetic studies at the forefront of modern biology.

Recent research advances in the Division include revealing the mechanism of sex determination in *Drosophila* and *C. elegans*, identifying and dissecting regulatory sequences that govern gene activation, providing insight into vertebrate germ layer specification and segmentation, working out the molecular basis of pattern formation in invertebrates and chordates, deciphering the mechanism of heterochromatin formation, understanding the regulation of transposon activity, describing the control of cell migrations in development, and discovering a new mode of gene regulation using alternative splicing and mRNA degradation.

The students and faculty of this Division will play critical roles in addressing the central problems that biology faces in this century, such as interpreting the variation in human and other genomes, learning the circuitry by which organisms develop, defining how specialized chromatin structures template their own replication, genetically manipulating organisms for scientific, health, and practical interests, and developing an active interface between computation and experimentation to exploit the enormous size and complexity of datasets characteristic of modern biology. Join us in unraveling some of modern biology's most exciting problems!

This major program has two tracks. Track 1, Genetics, Genomics, & Development, comprises 6 upper-division courses, as does Track 2, Developmental Genetics.

Immunology & Pathogenesis (IMM) Emphasis

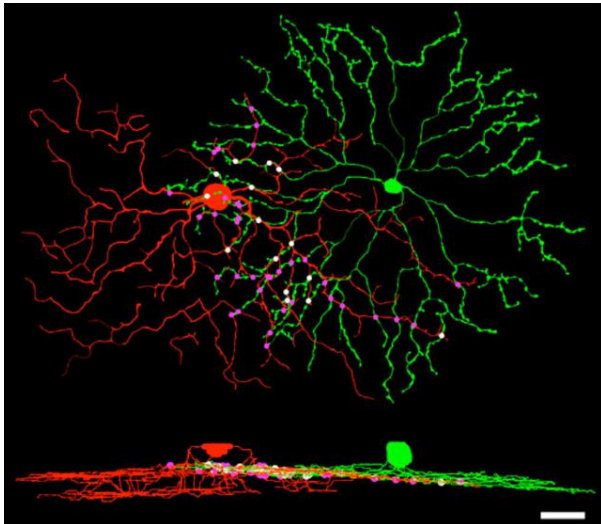


Humans inhabit an environment teeming with microbes and their toxins. The omnipresent threat of infection and the emergence of new infectious diseases has catapulted immunology to the forefront of modern biomedical science. Immunology is the study of the cellular and biochemical mechanisms which protect us from these threats. Infectious agents such as human immunodeficiency virus which causes AIDS and immune-based diseases such as asthma have increased the public awareness about the importance of immunology in examining the causes and treatments of these diseases. Immunology is unique amongst the natural sciences in that it covers and integrates aspects of modern biological science including cell and developmental biology, biochemistry, genetics, and molecular biology.

Using approaches from many disciplines and techniques as diverse as recombinant DNA, flow cytometry, physical chemistry, mouse transgenesis, and targeted mutation in mice, immunologists have made major advances and striking discoveries leading to an ever-growing understanding of the immune system. We continue to explore questions such as how the immune system distinguishes self from non-self, how antibodies, T cells and natural killer cells specifically recognize and distinguish millions of different foreign invaders, why some individuals are more susceptible to the development of autoimmune diseases, and how the immune system rejects transplanted organs but often fails to reject tumors. In addition, immunologists study questions of broader biological significance including how gene expression is regulated during animal development, the biochemistry and regulation of gene rearrangement, the mechanism and function of immune surveillance, and the control of programmed cell death.

These recent advances in basic knowledge have in turn led to potential treatments for autoimmune diseases and cancers, new approaches to the design of effective vaccines, strategies to combat AIDS, and treatments to prevent tissue transplant rejection. Students with an emphasis in Immunology will be exposed not only to the unique aspects of the immune system but also to a broad array of disciplines across the full spectrum of modern biomedical sciences.

This major program has two tracks. Track 1, Immunology, comprises 6 upper-division courses, as does Track 2, Infectious Diseases.



Neurobiology (NEU) Emphasis

Neurobiology is the study of the brain and nervous system, which are the cells and tissue that generate sensation, perception, movement, learning, emotion, and many of the functions that make us human. In the past decades, neurobiological research has made tremendous advances in understanding how this complex organ works, and what goes wrong in neurological disease. Neurobiology is intrinsically multi-disciplinary, spanning from molecular biology and gene regulation in neurons, to chemical and electrical signaling in neurons, to information processing by neural circuits and brain regions, to nervous system development and plasticity. Knowledge at each of these levels is merged to generate a mechanistic, molecular-to-systems level understanding of animal and human behavior. Active research areas in neurobiology include: What is the genetic program that makes a neuron? Can new neurons be created to treat disease? How do ion channels work that mediate electrical signaling in neurons? How do synapses work, and how do they store information during learning? How do networks of neurons process information and perform computations for behavior? How does the brain develop, and how is it specialized through evolution to generate species-specific behavior? Why do neurons die in neurodegenerative disease, and how can they be saved?

Recent research advances within the Division include understanding how voltage-gated ion channels function, development of new optical approaches to monitor and control activity in specific neurons, how taste sensation works in *Drosophila*, how neural activity is homeostatically controlled via novel gene regulation pathways, how the retina and cerebral cortex processes sensory information, and how sensory use alters synapses to store sensory information in the brain. Overall, 50 faculty at Berkeley (in MCB and other departments) conduct neurobiology research, reflecting the diversity and importance of this field within modern biology.

The Neurobiology emphasis prepares students for careers in medicine, including in medical specialties involving the nervous system (neurology, pharmacology, psychiatry, neuropsychiatry, ophthalmology, otolaryngology, optometry), in scientific research in

neurobiology (postgraduate study), in biotechnology (including technical and research oriented careers), and in other biology-related careers (nursing, pharmacy, physical therapy). All Neurobiology majors receive essential coursework in molecular and cell biology, as well as rigorous training in specific neurobiology courses. We are distinguished from other MCB emphases by the multi-level, multi-disciplinary approach, and by the focus on the brain. We are distinguished from Psychology and Cognitive Science by emphasizing a mechanistic, molecular, cellular and circuit-level understanding of behavior and disease.
