Genetics, Development and Cell Biology

The Department of Genetics, Development and Cell Biology (GDCB) is dedicated to biological discovery and excellence in undergraduate and graduate education. The research and teaching mission of the department is to achieve a greater understanding of fundamental principles of life by focusing on basic cellular and subcellular processes, including genome dynamics, cell structure and function, cellular response to environmental and developmental signals, and molecular mechanisms of development. Recognizing that student education is of paramount importance, GDCB strives for excellence in teaching and research. GDCB plays a leading role in undergraduate and graduate training through a variety of activities including traditional courses, undergraduate internships in research laboratories, and advanced graduate seminar and literature-based courses. Innovative approaches to learning are emphasized throughout the curriculum.

Undergraduate Study

The GDCB Department offers undergraduate majors in conjunction with other departments. Students interested in the areas of genetics, development and cell biology should major in Biology, Genetics or Bioinformatics and Computational Biology (BCBio). The Biology Major is administered and offered jointly by the GDCB and EEOB departments. The GDCB faculty, together with those in EEOB and BBMB, administer and offer the Genetics Major. Each of these majors is available through the College of Liberal Arts and Sciences or through the College of Agriculture and Life Sciences. BCBio is administered by GDCB and the Departments of Computer Science and Mathematics, and is available through the college of Liberal Arts and Sciences.

The Biology Major and the Genetics Major prepare students for a wide range of careers in biological sciences. Training in Biology or Genetics may lead to employment in teaching, research, or any of a variety of health-related professions. Some of these careers include biotechnology, human and veterinary medicine, agricultural sciences and life science education. BCBio majors are prepared for careers at the interfaces of biological, informational and computational sciences in the above fields. These majors are also excellent preparation for graduate study in bioinformatics, molecular genetics, cell and developmental biology, neuroscience and related fields. Faculty members in GDCB contribute to the undergraduate courses listed below. The full descriptions of these courses can be found in the Biology, Genetics and BCBio sections of the catalog.

BIOL 101	Introductory Biology	3
BIOL 110	Introduction to Biology	1
BIOL 111	Opportunities in Biology	0.5
BIOL 155	Human Biology	3
BIOL 211	Principles of Biology I	3
BIOL 211L	Principles of Biology Laboratory I	1
BIOL 212	Principles of Biology II	3
BIOL 212L	Principles of Biology Laboratory II	1
BIOL 255	Fundamentals of Human Anatomy	3
BIOL 255L	Fundamentals of Human Anatomy Laboratory	1
BIOL 256	Fundamentals of Human Physiology	3
BIOL 256L	Fundamentals of Human Physiology Laboratory	1
BIOL 258	Human Reproduction	3
BIOL 313	Principles of Genetics	3
BIOL 313L	Genetics Laboratory	1
BIOL 314	Principles of Molecular Cell Biology	3
BIOL 328	Molecular and Cellular Biology of Human Diseases	3
BIOL 330	Principles of Plant Physiology	3
BIOL 352	Vertebrate Histology	4
BIOL 394	International Field Trips in Biology	1-4
BIOL 423	Developmental Biology	3
BIOL 423L	Developmental Biology Laboratory	1
BIOL 428	Topics in Cell Biology	3
BIOL 436	Neurobiology	3
BIOL 444	Introduction to Bioinformatics	4
BIOL 490	Independent Study	1-6
BIOL 494	Biology Internship	1-3
BIOL 495	Undergraduate Seminar	1-3
GEN 110	Genetics Orientation	1
GEN 260	Human Heredity and Society	3
GEN 308	Biotechnology in Agriculture, Food, and Human Health	3
GEN 409	Molecular Genetics	3
GEN 410	Analytical Genetics	3
GEN 490	Independent Study	arr †
GEN 491	Undergraduate Seminar	1
BCBIO 110	BCBIO Orientation	0.5
BCBIO 211	Introduction to Bioinformatics and Computational Biology	3
BCBIO 401	Fundamentals of Bioinformatics and Computational Biology I	3
BCBIO 402	Fundamentals of Bioinformatics and Computational Biology II	3
BCBIO 444	Introduction to Bioinformatics	4

† Arranged with instructor.

Graduate Study

Understanding the genetic blueprint and the functions of cells is critical to virtually all aspects of biology. The basic mission of the Department of Genetics, Development and Cell Biology is to achieve a greater understanding of fundamental principles of life. The GDCB faculty and students conduct hypothesis-driven research into the biology of animals, plants and microbes. While research in GDCB is often based on discovery and analysis of molecular mechanisms of life processes, a true understanding of living organisms will ultimately require the integration of molecular mechanisms in the context of dynamic structural components of the living cell. Thus, research efforts within GDCB use molecular, genetic, biochemical, computational and imaging techniques to study systems at increasingly complex levels of organization.

GDCB faculty contribute to a broad but integrated array of cutting-edge research topics, implementing interactive and multidisciplinary approaches that bridge conventional boundaries, and incorporating experimental and computational biology as complementary approaches. Examples include using genetics and molecular biology to investigate the cellular basis of development, or combining biochemical and computational approaches to study basic subcellular functions, signal transduction or metabolism.

The faculty in the GDCB department train graduate students in several interdepartmental majors/programs including Bioinformatics and Computational Biology, Ecology and Evolutionary Biology, Genetics, Immunobiology, Plant Biology, Interdisciplinary Graduate Studies, Microbiology, Molecular, Cellular and Developmental Biology, Neuroscience and Toxicology. Graduate work leading to both Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) degrees are available.

Prospective graduate students need a sound background in the physical and biological sciences, as well as Mathematics and English. Interested students should check the links on the GDCB web site (www.gdcb.iastate.edu/) for specific admissions procedures and the latest information about individual faculty and their research programs. The interdepartmental majors and programs require submission of Graduate Record Examination (GRE) aptitude test scores. Advanced GRE scores are recommended. International students whose native language is other than English must also submit TOEFL scores with their application.

Students who are enrolled in the interdepartmental graduate majors and who have affiliations with GDCB are required to actively participate in seminars, research activities, and to show adequate progress and professional development while pursuing their degree. Completion of either the M.S. or Ph.D. degrees requires that research conducted by the student culminates in the writing and presentation of a thesis or dissertation. The Graduate College, the GDCB Faculty, and the individual student's major professor and Program of Study Committee provide requirements and guidelines for study. General information about graduate study requirements can be found at the web site for the Graduate College (www.grad-college.iastate.edu/) and requirements for the interdepartmental majors can be found by following the links from the GDCB web site above. Although not a formal requirement, the GDCB faculty recommends that students pursuing the Ph.D. include teaching experience in their graduate training.

Courses primarily for graduate students, open to qualified undergraduates:

GDCB 505. Entrepreneurship in Science and Technology.
(3-0) Cr. 3. F.
High level success at modern science requires entrepreneurship both in and outside the laboratory. Scientists are in a unique position to not only think, but to thrive, "outside of the box" and take unorthodox approaches to research that lead to positive paradigm shifts in our lives. Exploration of many facets of science, technology, industry and commerce, with frequent guest lectures from entrepreneurs.

GDCB 508. Biotechnology in Agriculture, Food, and Human Health.
(3-0) Cr. 3. *Prereq: BIOL 211 and BIOL 212*
Scientific principles and techniques in biotechnology. Products and applications in agriculture, food, and human health. Ethical, legal, and social implications of biotechnology. A research paper is required for graduate credit.

GDCB 510. Transmission Genetics.
(3-0) Cr. 3. F. *Prereq: GEN 410 or graduate standing*
An in-depth investigation of the modern research practices of transmission genetics. Designed for students interested in genetic research. Topics include: Mendelian genetic analysis, analysis of genetic pathways, mutational analysis of gene function, chromosomal mechanics, gene mapping, extranuclear inheritance, human genetic analysis.

GDCB 511. Molecular Genetics.
(Cross-listed with MCDB). (3-0) Cr. 3. S. *Prereq: BIOL 313 and BBMB 405*
The principles of molecular genetics: gene structure and function at the molecular level, including regulation of gene expression, genetic rearrangement, and the organization of genetic information in prokaryotes and eukaryotes.

GDCB 512. Plant Growth and Development.
(Cross-listed with MCDB, PLBIO). (2-0) Cr. 2. S. *Prereq: BIOL 330 or a course in developmental biology; GDCB 545 or BBMB 404, BBMB 405 or GDCB 520*
Plant growth and development and its molecular genetic regulation. Hormone biosynthesis, metabolism, and action. Signal transduction in plants.

GDCB 513. Plant Metabolism.
(Cross-listed with PLBIO). (2-0) Cr. 2. F. *Prereq: BIOL 330, PHYS 111, CHEM 331; one semester of biochemistry recommended*
Photosynthesis, respiration, and other aspects of plant metabolism.

GDCB 520. Genetic Engineering.
(Cross-listed with BBMB, MCDB). (3-0) Cr. 3. Alt. S., offered 2012. *Prereq: GEN 411 or BBMB 405*
Strategies and rationale of recombinant DNA technologies. The methodology of genetic engineering in basic research and implications for applied research will be considered. Topics include: basic tools of molecular cloning, targeted mutagenesis, fluorescent proteins, protein expression systems, and transgenic model systems.

GDCB 528. Advances in Molecular Cell Biology.
(Cross-listed with MCDB). (3-0) Cr. 3. Alt. F., offered 2012. *Prereq: Courses in general cell biology and biochemistry*
Cell biological processes including cell signaling, cell division, intracellular trafficking, biogenesis of organelles, cell adhesion and motility.

GDCB 529. Plant Cell Biology.
(Cross-listed with MCDB). (2-0) Cr. 2. Alt. F., offered 2011. *Prereq: BIOL 313, BIOL 314, BIOL 330 or BBMB 405*
Organization, function, and development of plant cells and subcellular structures.

GDCB 533. Principles of Developmental Biology.
(Cross-listed with MCDB). (3-0) Cr. 3. Alt. F., offered 2011. *Prereq: BIOL 314*
Fundamental principles in multicellular development. Emphasis on cellular and molecular regulation of developmental processes, and experimental approaches as illustrated in classical studies and current literature.

GDCB 536. Statistical Genetics.
(Cross-listed with STAT). (3-0) Cr. 3. Alt. F., offered 2012. *Prereq: STAT 401, STAT 447; GEN 320 or BIOL 313*
Statistical models and methods for genetics covering models of population processes: selection, mutation, migration, population structure, and linkage disequilibrium, and inference techniques: genetic mapping, linkage analysis, and quantitative trait analysis. Applications include genetic map construction, gene mapping, genome-wide association studies (GWAS), inference about population structure, phylogenetic tree construction, and forensic and paternity identification.

GDCB 542. Introduction to Molecular Biology Techniques.
(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S.SS. *Prereq: Graduate classification*
Sessions in basic molecular biology techniques and related procedures. Offered on a satisfactory-fail basis only.

GDCB 542A. Introduction to Molecular Biology Techniques: DNA.
(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S.SS. *Prereq: Graduate classification*
Includes genetic engineering procedures, sequencing, PCR, and genotyping. Offered on a satisfactory-fail basis only.

GDCB 542B. Introduction to Molecular Biology Techniques: Protein.
(Cross-listed with B M S, GDCB, EEOB, FS HN, HORT, NREM, NUTRS). Cr. 1. Repeatable. S.SS. *Prereq: Graduate classification*
Techniques. Includes fermentation, protein isolation, protein purification, SDS-PAGE, Wester blotting, NMR, confocal microscopy and laser microdissection, Immunophenotyping, and monoclonal antibody production. Sessions in basic molecular biology techniques and related procedures. Offered on a satisfactory-fail basis only.

GDCB 542C. Introduction to Molecular Biology Techniques: Cell.
(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S. *Prereq: Graduate classification*
Includes immunophenotyping, ELISA, flow cytometry, microscopic techniques, image analysis, confocal, multiphoton and laser capture microdissection. Offered on a satisfactory-fail basis only.

GDCB 542D. Introduction to Molecular Biology Techniques: Plant Transformation.
(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. S. *Prereq: Graduate classification*
Includes Agrobacterium and particle gun-mediated transformation of tobacco, Arabidopsis, and maize, and analysis of tranformants. Offered on a satisfactory-fail basis only.

GDCB 542E. Introducation to Molecular Biology Techniques: Proteomics..
(Cross-listed with B M S, GDCB, EEOB, FS HN, HORT, NREM, NUTRS). Cr. 1. Repeatable. F. *Prereq: Graduate classification*
Includes two-dimensional electrophoresis, laser scanning, mass spectrometry, and database searching. Sessions in basic molecular biology techniques and related procedures. Offered on a satisfactory-fail basis only.

GDCB 542F. Introducation to Molecular Biology Tecniques: Metabolomics.
(Cross-listed with B M S, GDCB, EEOB, FS HN, HORT, NREM, NUTRS). Cr. 1. Repeatable. F.S.SS. *Prereq: Graduate classification*
Metabolomics and the techniques involved in metabolite profiling. For non-chemistry majoring students who are seeking analytical aspects into their biological research projects. Sessions in basic molecular biology techniques and related procedures. Offered on a satisfactory-fail basis only.

GDCB 542G. Introduction to Molecular Biology Techniques: Genomic.
(Cross-listed with B M S, EEOB, FS HN, GDCB, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. S. *Prereq: Graduate classification*
Offered on a satisfactory-fail basis only.

GDCB 544. Introduction to Bioinformatics.
(Cross-listed with BCB, CPR E, COM S). (4-0) Cr. 4. F. *Prereq: MATH 165 or STAT 401 or equivalent*
Broad overview of bioinformatics with a significant problem-solving component, including hands-on practice using computational tools to solve a variety of biological problems. Topics include: database searching, sequence alignment, gene prediction, RNA and protein structure prediction, construction of phylogenetic trees, comparative, functional genomics, and systems biology.

GDCB 545. Plant Molecular Biology.
(Cross-listed with MCDB, PLBIO). (3-0) Cr. 3. Alt. F., offered 2011. *Prereq: BIOL 314, BIOL 330*
Organization and function of plant nuclear and organelle DNA; regulation of gene expression. Methods of generating novel genetic variation. Impact of plant biotechnology on agriculture.

GDCB 556. Cellular, Molecular and Developmental Neuroscience.
(Cross-listed with NEURO, B M S). (3-0) Cr. 3. F. *Prereq: BIOL 335 or BIOL 436; physics recommended*
Fundamental principles of neuroscience including cellular and molecular neuroscience, nervous system development, sensory, motor and regulatory systems.

GDCB 557. Advanced Neuroscience Techniques.
(Cross-listed with NEURO). (3-0) Cr. 3. Alt. S., offered 2015. *Prereq: Neuro 556 or equivalent course*
Research methods and techniques; lectures, laboratory exercises and/or demonstrations representing individual faculty specialties.

GDCB 568. Bioinformatics II (Advanced Genome Informatics).
(Cross-listed with BCB, STAT, COM S). (3-0) Cr. 3. S. *Prereq: BCB 567, BBMB 301, BIOL 315, STAT 430, credit or enrollment in GEN 411*
Advanced sequence models. Basic methods in molecular phylogeny. Hidden Markov models. Genome annotation. DNA and protein motifs. Introduction to gene expression analysis.

GDCB 570. Bioinformatics IV (Computational Functional Genomics and Systems Biology).
(Cross-listed with CPR E, COM S, BCB, STAT). (3-0) Cr. 3. S. *Prereq: BCB 567, BIOL 315, COM S 311 and either 208 or 228, GEN 411, STAT 430*
Algorithmic and statistical approaches in computational functional genomics and systems biology. Elements of experiment design. Analysis of high throughput gene expression, proteomics, and other datasets obtained using system-wide measurements. Topological analysis, module discovery, and comparative analysis of gene and protein networks. Modeling, analysis, simulation and inference of transcriptional regulatory modules and networks, protein-protein interaction networks, metabolic networks, cells and systems: Dynamic systems, Boolean, and probabilistic models. Multi-scale, multi-granularity models. Ontology-driven, network based, and probabilistic approaches to information integration.

GDCB 590. Special Topics.
Cr. arr. Repeatable. *Prereq: Permission of instructor*

GDCB 596. Genomic Data Processing.
(Cross-listed with COM S, BCB). (3-0) Cr. 3. F. *Prereq: Some experience in computation*
Study the practical aspects of genomic data processing with an emphasis on hands-on projects. Topics include base-calling, sequence cleaning and contaminant removal; fragment assembly procedures and EST clustering methods; genome closure strategies and practices; sequence homology search and function prediction; and annotation and submission of GenBank reports. Next-generation sequencing topics like model genome resequencing, short-read assembly and transcriptome abundance measurement will also be covered.

Courses for graduate students:

GDCB 661. Current Topics in Neuroscience.
(Cross-listed with NEURO, BBMB). (2-0) Cr. 2-3. Repeatable. Alt. S., offered 2014. *Prereq: NEURO 556 (or comparable course) or permission of instructor*
Topics may include molecular and cellular neuroscience, neurodevelopment, neuroplasticity, neurodegenerative diseases, cognitive neuroscience, sensory biology, neural integration, membrane biophysics, neuroethology, techniques in neurobiology and behavior.

GDCB 679. Light Microscopy.
(Cross-listed with MICRO, EEOB). (2-9) Cr. 5. *Prereq: Permission of instructor*
Current theories encompassing light optics and their applications for specimen preservation, paraffin and resin sectioning, general staining, histochemistry, cytophotometry, immunocytochemistry, autoradiography, image digitization, processing and presentation, and digital macro- and micrography. Limit of 10 students.

GDCB 680. Scanning Electron Microscopy.
(Cross-listed with MICRO, EEOB). (2-9) Cr. 5. *Prereq: Permission of instructor*
Current theories encompassing scanning electron optics and their applications for high and low vacuum microscopy, specimen chemical and cryopreservation methods, x-ray microanalysis, backscattered and topographic imaging, image digitization, processing and presentation. Limit of 10 students.

GDCB 681. Transmission Electron Microscopy.
(Cross-listed with MICRO, EEOB). (2-9) Cr. 5. *Prereq: GDCB 679 and permission of instructor*
Current theories encompassing electron optics and their applications for chemical and physical specimen preservation, ultramicrotomy, general staining and cytochemistry, immunocytochemistry, autoradiography, negative staining and shadowing, x-ray microanalysis, image digitization, processing and presentation.

GDCB 690. Seminar in GDCB.
Cr. 1. Repeatable.
Research seminars by faculty, invited speakers, and graduate students. Offered on a satisfactory-fail basis only.

GDCB 691. Faculty Seminar.
Cr. 1. Repeatable.
Faculty research series.

GDCB 696. Research Seminar.
(Cross-listed with AGRON, BBMB, PLBIO, HORT, FOR). Cr. 1. Repeatable. F.S.
Research seminars by faculty and graduate students. Offered on a satisfactory-fail basis only.

GDCB 698. Seminar in Molecular, Cellular, and Developmental Biology.
(Cross-listed with BBMB, MCDB, MICRO, V MPM). (2-0) Cr. 1-2. Repeatable. F.S.
Student and faculty presentations.

GDCB 699. Research.
Cr. arr. Repeatable.
Research for thesis or dissertation. Offered on a satisfactory-fail basis only.

GDCB 699I. Research.
(Cross-listed with A ECL, ANTHR, EEOB, IA LL). Cr. 1-4. Repeatable.