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 Department of GDCB 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 Ecology, Evolution and Organismal Biology (EEOB) departments. The GDCB faculty, together with those in EEOB and the Department of Biochemistry, Biophysics and Molecular Biology (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 it 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	Biology Major Orientation	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 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 344	Human Reproduction	3
BIOL 350	Comprehensive Human Anatomy	4
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	Cell Biology	3
BIOL 436	Neurobiology	3
BIOL 490	Independent Study	1
BIOL 494	Biology Internship	1-3
BIOL 495	Undergraduate Seminar	1-3
BIOL 499	Undergraduate Research Experience	1-3
GEN 110	Genetics Orientation	1
GEN 112	Genetics Orientation for Transfer Students	0.5
GEN 349	The Genome Perspective in Biology	3
GEN 409	Molecular Genetics	3
GEN 410	Analytical Genetics	3
GEN 490	Independent Study	1-5
GEN 491	Undergraduate Seminar, Professional Practice in Genetics Disciplines	1
GEN 499	Genetics Research	1-5
BCBIO 110	BCBIO Orientation	0.5
BCBIO 322	Introduction to Bioinformatics and Computational Biology	3
BCBIO 401	Bioinformatics of Sequences	3
BCBIO 406	Bioinformatics of OMICS	3

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 GDCB 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. Faculty implement interactive and multidisciplinary approaches that bridge conventional boundaries, and they incorporate 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 and genomics; immunobiology; plant biology; interdisciplinary graduate studies; microbiology; molecular, cellular and developmental biology; neuroscience; and toxicology. Graduate work leading to degrees in the master of science (M.S.) and doctor of philosophy (Ph.D.) is 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 website (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 and research activities, and they are required to show adequate progress and professional development while pursuing their degree. Completion of either the M.S. or Ph.D. 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 website 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 website (www.gdcb.iastate.edu/ (http://www.gdcb.iastate.edu/)). 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 510: Transmission Genetics
(3-0) Cr. 3. F.
Prereq: GEN 410 or graduate standing
In-depth investigations of 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, genetic mapping, epigenetic inheritance, human genetic analysis.

GDCB 511: Advanced Molecular Genetics
(Cross-listed with MCDB). (3-0) Cr. 3. S.
Prereq: BIOL 313 and BBMB 405
Mechanisms of molecular genetic processes in eukaryotes and prokaryotes, including DNA replication and repair, transcription, translation and regulation of gene expression. Critical evaluation and discussion of current primary literature, methodologies and experimental data.

GDCB 513: Plant Metabolism
(Cross-listed with PLBIO). (2-0) Cr. 2. Alt. F., offered even-numbered years.
Prereq: BIOL 330, PHYS 131, CHEM 331; one semester of biochemistry recommended
Photosynthesis, respiration, and other aspects of plant metabolism.

GDCB 528: Advances in Molecular Cell Biology
(Cross-listed with MCDB). (3-0) Cr. 3. Alt. F., offered even-numbered years.
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 533: Advances in Developmental Biology
(Cross-listed with MCDB). (3-0) Cr. 3. Alt. F., offered odd-numbered years.
Prereq: BIOL 314 or Biol 423
Fundamental principles in multicellular development. Emphasis on cellular and molecular regulation of developmental processes, and experimental approaches as illustrated in the current literature.

GDCB 536: Statistical Genetics
(Cross-listed with STAT). (3-0) Cr. 3.
Prereq: STAT 401 or STAT 587; STAT 447 or STAT 588; 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, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S.SS.
Sessions in basic molecular biology techniques and related procedures. Offered on a satisfactory-fail basis only.

GDCB 542A: Introduction to Molecular Biology Techniques: DNA Techniques
(Cross-listed with B M S, BBMB, EEOB, FS HN, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S.
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, BBMB, EEOB, FS HN, HORT, NREM, NUTRS, VDPAM). Cr. 1. Repeatable. S.SS.
Prereq: Graduate classification
Techniques. Includes: fermentation, protein isolation, protein purification, SDS-PAGE, Western 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 Techniques
(Cross-listed with B M S, BBMB, EEOB, FS HN, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.S.
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, BBMB, EEOB, FS HN, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. S.
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: Introduction to Molecular Biology Techniques: Proteomics
(Cross-listed with B M S, BBMB, EEOB, FS HN, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.
Includes: two-dimensional electrophoresis, laser scanning, mass spectrometry, and database searching. Offered on a satisfactory-fail basis only.

GDCB 542F: Introduction to Molecular Biology Techniques: Metabolomics
(Cross-listed with B M S, BBMB, EEOB, FS HN, HORT, NREM, NUTRS, V MPM, VDPAM). Cr. 1. Repeatable. F.
Includes: metabolomics and the techniques involved in metabolite profiling. For non-chemistry majoring students who are seeking analytical aspects into their biological research projects. Offered on a satisfactory-fail basis only.

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

GDCB 544: Fundamentals of Bioinformatics
(Cross-listed with BCB, COM S, CPR E). (4-0) Cr. 4. Alt. F., offered odd-numbered years.
Prereq: MATH 165 or STAT 401 or equivalent
A practical, hands-on overview of how to apply bioinformatics to biological research. Recommended for biologists desiring to gain computational molecular biology skills. Topics include: sequence analysis, genomics, proteomics, phylogenetic analyses, ontology enrichment, systems biology, data visualization and emergent technologies.

GDCB 545: Plant Molecular, Cell and Developmental Biology
(Cross-listed with MCDB, PLBIO). (3-0) Cr. 3. Alt. F., offered odd-numbered years.
Prereq: Biol 313, BIOL 314, BIOL 330 or BBMB 405
Plant nuclear and organelle genomes; regulation of gene expression; hormone signaling; organization, function, and development of plant cells and subcellular structures; regulation of plant growth and development.

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

GDCB 557: Rotations in Neuroscience
(Cross-listed with NEURO). (2-0) Cr. 2. F.S.
Rotation experiences in various neuroscience research methods and techniques related to our current faculty specialties.

GDCB 568: Statistical Bioinformatics
(Cross-listed with BCB, COM S, STAT). (3-0) Cr. 3. S.
Prereq: BCB 567 or (BIOL 315 and one of STAT 430 or STAT 483 or STAT 583), credit or enrollment in GEN 409
Statistical models for sequence data, including applications in genome annotation, motif discovery, variant discovery, molecular phylogeny, gene expression analysis, and metagenomics. Statistical topics include model building, inference, hypothesis testing, and simple experimental design, including for big data/complex models.

GDCB 569: Structural Bioinformatics
(Cross-listed with BBMB, BCB, COM S, CPR E). (3-0) Cr. 3. F.
Prereq: BCB 567, BBMB 316, GEN 409, STAT 430
Molecular structures including genes and gene products: protein, DNA and RNA structure. Structure determination methods, structural refinement, structure representation, comparison of structures, visualization, and modeling. Molecular and cellular structure from imaging. Analysis and prediction of protein secondary, tertiary, and higher order structure, disorder, protein-protein and protein-nucleic acid interactions, protein localization and function, bridging between molecular and cellular structures. Molecular evolution.

GDCB 570: Systems Biology
(Cross-listed with BCB, COM S, CPR E, STAT). (3-0) Cr. 3. S.
Prereq: BCB 567 or COM S 311, COM S 228, GEN 409, STAT 430 or STAT 483 or STAT 583
Algorithmic and statistical approaches in computational functional genomics and systems biology. Analysis of high throughput biological data obtained using system-wide measurements. Topological analysis, module discovery, and comparative analysis of gene and protein networks. Modeling, analysis, and inference of transcriptional regulatory networks, protein-protein interaction networks, and metabolic networks. Dynamic systems and whole-cell models. Ontology-driven, network based, and probabilistic approaches to information integration.

GDCB 585: Fundamentals of Predictive Plant Phenomics
(Cross-listed with BCB, M E). Cr. 4. F.
Principles of engineering, data analysis, and plant sciences and their interplay applied to predictive plant phenomics. Transport phenomena, sensor design, image analysis, graph models, network data analysis, fundamentals of genomics and phenomics. Multidisciplinary laboratory exercises.

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

Courses for graduate students:

GDCB 661: Advanced Topics in Neuroscience
(Cross-listed with BBMB, KIN, NEURO). (3-0) Cr. 3. Repeatable. Alt. S., offered even-numbered years.
Prereq: NEURO 556 (or comparable course) or permission of instructor
Students will present three journal articles and two overview lectures on topics in neuroscience that are related but outside of their own research interest.

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, FOR, HORT, PLBIO). Cr. 1. Repeatable.
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. 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.