

GENETICS

Scott Nelson, Chair, Genetics Major Committee

Genetics is the scientific study of heredity. Understanding the basis of heredity is fundamental to all aspects of the life sciences, from the most basic molecular study to applied studies of agricultural species. At Iowa State University the study of the life sciences is interdepartmental, involving faculty in the basic, agricultural, and veterinary sciences. Faculty in 20 different departments are involved in genetics research. This large group of faculty presents a broad range of possibilities for students to learn from faculty who are at the forefront of research in many areas of genetics.

Undergraduate Study

Undergraduate study in genetics is jointly administered by three departments: the Roy J. Carver Department of Biochemistry, Biophysics, and Molecular Biology; the Department of Genetics, Development, and Cell Biology; and the Department of Ecology, Evolution, and Organismal Biology. Undergraduate degrees are offered through both the College of Agriculture and Life Sciences and the College of Liberal Arts and Science. Programs of study for genetics majors leading to a B.S. degree are available.

Training in genetics may lead to employment in teaching, research, or a variety of health-related professions. Although some students find employment directly after their baccalaureate training, many students continue their education in graduate or professional programs. Students with the B.S. degree may find employment in the biotechnology, health, or food industries. Recent graduates have also developed careers in conservation biology, technical writing, science journalism, technical sales, and business.

The required course work and associated electives provide students with the foundation in basic life sciences, mathematics, chemistry, and physics that is essential for professions involving modern biological/ biomedical sciences. As part of these courses students develop skills in problem solving, critical thinking, writing, and research-related activities in the biological sciences.

Specific entrance requirements for medical and health-related professions are established by the professional schools. Students interested in fulfilling pre-professional requirements for such professions as dentistry, human medicine, genetic counseling, optometry, pharmacy, physical therapy, physicians assistant, and veterinary medicine can major in genetics while fulfilling the pre-professional requirements.

Curriculum in Genetics - Requirements

Total Degree Requirement: 120 cr.

A maximum of 65 cr. from a two-year institution can be applied that may include up to 16 technical cr.; up to 9 Pass-Not Pass cr. of free electives can be applied; a cumulative GPA of at least 2.0 is required for graduation. Program-approved lists can be found on the Genetics website.

1. Genetics and Life Sciences

A grade of C- or better is required in all Genetics and Life Science courses.

A. Courses required of all Genetics majors

GEN 110	Genetics Orientation	1
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
GEN 313	Principles of Genetics	3
GEN 313L	Genetics Laboratory	1
BIOL 314	Principles of Molecular Cell Biology	3
BIOL 315	Biological Evolution	3
One of the following:		3-4
GEN 322	Introduction to Bioinformatics and Computational Biology	
GEN 349	The Genome Perspective in Biology	
GEN 444	Bioinformatic Analysis	
BCBIO 402	Fundamentals of Systems Biology and Network Science	
GEN 409	Molecular Genetics	3
GEN 410	Analytical Genetics	3
One of the following:		3
GEN 462	Evolutionary Genetics	
EEOB 561	Evolutionary and Ecological Genomics	
EEOB 563	Molecular Phylogenetics	
GEN 491	Undergraduate Seminar, Professional Practice in Genetics Disciplines	1
MICRO 302	Biology of Microorganisms	3
Total Credits		35-36

B. Course required of majors in the College of Agriculture and Life Sciences only

A minimum of 3 cr. of coursework in the area of environmental science from program approved list

Total Credits 3

2. Advanced Sciences Electives: 6 cr. from program approved list

A grade of C- or better is required in each course. No more than 3 cr. of GEN 490, 490R, 490H, 492, 496, 499, or 499H may be used to meet this requirement.

3. Mathematical Sciences

Complete at least one calculus course from MATH, minimum of 4 credits. 4

MATH 160	Survey of Calculus	
MATH 165	Calculus I	

Complete at least one course from STAT, minimum of 3 credits. 3-4

STAT 101	Principles of Statistics	
STAT 104	Introduction to Statistics	

Complete at least one additional course from MATH or STAT, minimum of 4 credits. 4

MATH 166	Calculus II	
STAT 301	Intermediate Statistical Concepts and Methods	

Total Credits 11-12

4. Supporting Sciences

CHEM 177	General Chemistry I	4
CHEM 177L	Laboratory in General Chemistry I	1
CHEM 178	General Chemistry II	3
CHEM 178L	Laboratory in College Chemistry II	1
CHEM 331	Organic Chemistry I	3
CHEM 331L	Laboratory in Organic Chemistry I	1
CHEM 332	Organic Chemistry II	3
CHEM 332L	Laboratory in Organic Chemistry II	1
PHYS 111	General Physics	5
or PHYS 221	Introduction to Classical Physics I	
PHYS 112	General Physics	5
or PHYS 222	Introduction to Classical Physics II	

Choose one of the following options 6-7

Option 1

BBMB 404	Biochemistry I	
And one of the following:		
BBMB 405	Biochemistry II	
BBMB 411	Techniques in Biochemical Research	
CHEM 211 & 211L	Quantitative and Environmental Analysis and Quantitative and Environmental Analysis Laboratory	
CHEM 325	Chemical Thermodynamics	

Option 2

BBMB 420	Mammalian Biochemistry	
And one of the following:		
BBMB 411	Techniques in Biochemical Research	
CHEM 211 & 211L	Quantitative and Environmental Analysis and Quantitative and Environmental Analysis Laboratory	
CHEM 325	Chemical Thermodynamics	

Total Credits 33-34

5. International Perspectives: 3 cr. from university approved list

This course can satisfy **both** the university requirement for International Perspectives and the college requirement for a General Education elective (item 8) if the selection appears on both lists of approved courses.

6. U.S. Diversity: 3 cr. from university approved list

This course can satisfy **both** the university requirement for U.S. Diversity and the college requirement for a General Education elective (item 8) if the selection appears on both lists of approved courses.

7. Communications/Information Literacy

A. Courses required of all Genetics majors

Grades of C or better are required in ENGL 250 and advanced writing. (The College of Agriculture and Life Sciences requires a C or better in ENGL 150, as well.)

ENGL 150	Critical Thinking and Communication	3
ENGL 250	Written, Oral, Visual, and Electronic Composition	3
or ENGL 250H	Written, Oral, Visual, and Electronic Composition: Honors	
LIB 160	Information Literacy	1
One advanced English writing course from program approved list		3

Total Credits 10

B. Course required of majors in the College of Agriculture and Life Sciences only.

A grade of C or better is required by the college.

SP CM 212	Fundamentals of Public Speaking	3
or AGEDS 311	Presentation and Sales Strategies for Agricultural Audiences	

Total Credits 3

8. General Education electives

Courses from college approved lists that also appear on university approved lists of U.S. Diversity or International Perspectives courses can be used to satisfy both requirements.

A. College of Agriculture and Life Sciences

Humanities course from college approved list	3
Social Science course from college approved list	3
Ethics course from college approved list	3
Total Credits	9

B. College of Liberal Arts and Sciences

Humanities courses from college approved list; one of these should be a Science/Humanities bridge course from program approved list	12
Social Science courses from college approved list	9
Students must have completed 3 years of a single world language in high school or take 4-8 credits of World Languages at the university level.	
Total Credits	21

Undergraduate Minor

The minor in Genetics may be earned by completing the following courses. At least 9 cr. must be used **only** to fulfill the requirements of the minor and not be applied to any other major, college, or university requirement.

GEN 313	Principles of Genetics	3
GEN 313L	Genetics Laboratory	1
BIOL 314	Principles of Molecular Cell Biology	3
GEN 410	Analytical Genetics	3
GEN 409	Molecular Genetics	3
Two or more additional credits in Genetics at the 300 level or above.		2
Total Credits		15

Genetics, B.S.

Freshman

Fall	Credits	Spring	Credits
GEN 110	1	BIOL 211	3
BIOL 212	3	BIOL 211L	1
BIOL 212L	1	CHEM 178	3
CHEM 177	4	MATH/ STAT or college requirement choice	3-4
CHEM 177L	1	ENGL 250 or college requirement choice	3

MATH/ STAT choice	3-4	LIB 160	1
ENGL 150 or 250	3 (or semester 1 with ENGL 250)		
LIB 160 (if taking ENGL 250)	1	Consider Research	1-2

17-18

15-17

Sophomore

Fall	Credits	Spring	Credits	Summer	Credits
BIOL 313	3	BIOL 314	3	Consider Internship, Study Abroad	
BIOL 313L	1	CHEM 332	3		
CHEM 331	3	CHEM 332L	1		
CHEM 331L	1	MICRO 302, BIOL 315, or Bioinformatics/ Genomics Choice	3		
College requirement or Elective	3	MATH/ STAT or college requirement choice	3-4		
MATH/ STAT choice	3-4	College Requirement or Elective	3		

14-15

16-17

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Junior

Fall	Credits	Spring	Credits
GEN 409 or 410	3	GEN 409 or 410	3
PHYS 111 or 221*	5	PHYS 112 or 222*	5
BBMB 404*	3	BBMB 405*	3
MICRO 302 or BIOL 315	3	MICRO 302 or BIOL 315	3

or bioinformatics/ genomics choice College Requirement or Elective	or bioinformatic/ genomics choice 3 GEN 491	1
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	17	15
Senior		
Fall	Credits	Spring Credits
GEN 462	3 Advanced Science Elective(s)	3-6
Advanced science elective or STAT 301	3-4 College Requirement or Elective	3
College Requirement or Elective	1-6 Elective or STAT 301	3-4
Advanced Writing (ENGL 302-316)	3 College Requirement or Elective	3
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	10-16	12-16

* Summer. Students taking the MCAT need to have completed biochemistry and physics by this time. Others can complete during the senior year.

Courses primarily for undergraduates:

GEN 110: Genetics Orientation

(1-0) Cr. 1. F.

This course is intended for first year students and others new to the genetics major. Discussion of university policies and resources, requirements of the major, career opportunities, and other topics related to the first year experience.

GEN 112: Genetics Orientation for Transfer Students

(0.5-0) Cr. 0.5. S.

Eight-week course for external transfer students and internal change of major students. Discussion of university policies and resources, requirements of the major, and career opportunities. Only one of GEN 110 or 112 may count toward graduation.

GEN 298: Cooperative Education

Cr. R. F.S.SS.

Prereq: Permission of department cooperative education coordinator; sophomore classification

Required of all cooperative education students. Students must register for this course prior to commencing each work period.

GEN 313: Principles of Genetics

(Cross-listed with BIOL). (3-0) Cr. 3. F.S.SS.

Prereq: BIOL 211, BIOL 211L, BIOL 212, and BIOL 212L

Introduction to the principles of transmission and molecular genetics of plants, animals, and bacteria. Recombination, structure and replication of DNA, gene expression, cloning, quantitative genetics, and population genetics. Students may receive graduation credit for no more than one of the following: Gen 260, Gen 313 and 313L, Gen 320, Biol 313 and 313L, and Agron 320.

GEN 313L: Genetics Laboratory

(Cross-listed with BIOL). (0-3) Cr. 1. F.S.

Prereq: Credit or enrollment in BIOL 313

Laboratory to accompany 313. Students may receive graduation credit for no more than one of the following: Biol 313 and 313L, Gen 260, Gen 313, Gen 320, and Agron 320.

GEN 320: Genetics, Agriculture and Biotechnology

(Cross-listed with AGRON). (3-0) Cr. 3. F.S.

Prereq: BIOL 212

Transmission and molecular genetics with an emphasis on applications in agriculture, the structure and expression of the gene, how genes behave in populations and how recombinant DNA technology can be used to improve agriculture. Credit for graduation will not be allowed for more than one of the following: Gen 260, 313, 320 and Biol 313 and 313L.

GEN 322: Introduction to Bioinformatics and Computational Biology

(Cross-listed with BCBIO, BIOL). (3-0) Cr. 3. F.

Prereq: BIOL 212

Genome sequencing, assembly, structural and functional annotation, and comparative genomics. Investigating these topics will develop skills in programming and scripting (Perl and/or Python), the use of biological databases, sequence alignment, similarity search, identification of sequence patterns, construction of phylogenetic trees, and comparative genomics.

GEN 340: Human Genetics

(3-0) Cr. 3. F.S.SS.

Prereq: BIOL 313 or GEN 313

Fundamental concepts and current issues of human genetics. Human chromosome analysis, pedigree analysis, gene mapping, the human genome project, sex determination, genetics of the immune system, genetics of cancer, gene therapy, the genetic basis of human diversity, eugenics.

GEN 349: The Genome Perspective in Biology

(Cross-listed with BIOL). (2-2) Cr. 3. S.

Prereq: GEN 313 or GEN 320

Analysis of genome, RNA, and protein data using computer technology to answer biological questions on topics ranging from microbial diversity to human health. An introduction for students in the life sciences to the fields of genomics, bioinformatics and systems.

GEN 398: Cooperative Education

Cr. R. F.S.SS.

Prereq: Permission of department cooperative education coordinator; junior classification

Required of all cooperative education students. Students must register for this course prior to commencing each work period.

GEN 402: Microbial Genetics and Genomics

(Cross-listed with MICRO). (3-0) Cr. 3. Alt. F., offered even-numbered years.

Prereq: MICRO 302, Biol 313

The fundamental concepts of bacterial and bacteriophage genetics including mutagenesis, mechanisms of vertical and horizontal genetic information transfer and gene regulation are covered, along with genetic and genomic-based approaches to study these and other cellular processes of microorganisms. Review and discussion of research literature to examine experimental design, methodology, and interpretation of both historical and contemporary relevance to microbial genetics and genomics.

GEN 409: Molecular Genetics

(3-0) Cr. 3. F.S.

Prereq: BIOL 313 or GEN 313

Principles of molecular genetics and analysis of gene expression, including elements of the Central Dogma (DNA replication, transcription, and translation) and gene regulation. Utilizing examples from the primary literature to illustrate experimental design, data analysis, and interpretation.

GEN 410: Analytical Genetics

(3-0) Cr. 3. F.S.

Prereq: BIOL 313 or GEN 313

The principles and practice of genetic analysis. Mendelian genetic analysis, mutational, transgenic, and genomic analysis of gene function, linkage and gene mapping, chromosomal aberrations, aneuploidy and polyploidy, extrachromosomal inheritance, analysis of genetic pathways.

GEN 444: Bioinformatic Analysis

(Cross-listed with BCB, BCBO, BIOL, COM S, CPR E). (4-0) Cr. 4. F.

Prereq: MATH 165 and Introductory Statistics (STAT 101, STAT 104, STAT 105, STAT 201, or STAT 330).

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: bioinformatic data processing, Python programming, genome assembly, database search, sequence alignment, gene prediction, next-generation sequencing, comparative and functional genomics, and systems biology.

GEN 462: Evolutionary Genetics

(Cross-listed with BIOL). (3-0) Cr. 3. F.

Prereq: BIOL 315

The genetic basis of evolutionary processes in eukaryotic organisms. The role of genetic variation in adaptation, natural selection, adaptive processes, and the influence of random processes on evolutionary change.

GEN 490: Independent Study

Cr. 1-5. Repeatable, maximum of 9 credits.

Prereq: GEN 313, junior or senior classification, permission of instructor

Independent study in any area of genetics. Students may use no more than 9 credits of university-wide 490 credits (including Gen 490) toward the total of 120 credits required for graduation.

GEN 491: Undergraduate Seminar, Professional Practice in Genetics Disciplines

(1-0) Cr. 1. F.S.

Prereq: BIOL/GEN 313; credit or enrollment in GEN 409 or GEN 410; Junior Classification

Intended to develop career objectives and obtain positions appropriate to the goals of students, in particular juniors, in preparation for position searches in the senior year. Discussion of various career paths in genetics disciplines; identification of experiences to enhance entry to specific careers; exposure to professional practices not covered elsewhere including literature database management, scientific figure preparation for publication, the peer-review journal system, the federal competitive grants system, laboratory budgets and management, authorship and collaborations, etc.; preparation of effective curricula vitae and application letters; and verbal scientific discourse appropriate to interview interactions and other professional settings.

GEN 492: Undergraduate Teaching Experience

Cr. 1-2. Repeatable, maximum of 9 credits. F.S.

Prereq: BIOL 212, junior or senior classification, permission of instructor

For students registering to be undergraduate laboratory or classroom assistants. Offered on a satisfactory-fail basis only. No more than 2 credits of GEN 492 may be applied toward the Genetics advanced course requirement.

GEN 495: Special Topics in Genetics

(1-0) Cr. 1-3. Repeatable, maximum of 3 credits. F.S.

Prereq: GEN 313; permission of instructor

Content varies from year to year. Genetics students may use no more than 9 credits of university-wide 490-499 credits toward the total of 120 credits required for graduation.

GEN 496: Attendance and Critique of Genetics Seminars

Cr. 1. Repeatable, maximum of 3 credits. F.S.

Prereq: GEN 313, junior or senior classification, permission of instructor

Attendance and critique of departmental seminars in BBMB, GDCB, or EEOB. Offered on a satisfactory-fail basis only. Genetics students may use no more than 9 credits of university-wide 490 - 499 credits toward the total of 120 credits required for graduation.

GEN 498: Cooperative Education

Cr. R. F.S.SS.

Prereq: Permission of department cooperative education coordinator; senior classification

Required of all cooperative education students. Students must register for this course prior to commencing each work period.

GEN 499: Genetics Research

Cr. 1-5. Repeatable, maximum of 9 credits. F.S.SS.

Prereq: GEN 313, junior or senior classification, permission of instructor

Independent research in any area of genetics. Genetics students may use no more than 9 credits of university-wide 490-499 credits toward the total of 120 credits required for graduation.

GEN 499H: Genetics Research for Honors

Cr. 1-5. Repeatable, maximum of 9 credits. F.S.SS.

Prereq: GEN 313, junior or senior classification, permission of instructor

Independent research in any area of genetics; for Honors students only. Genetics students may use no more than 9 credits of university-wide 490-499 credits toward the total of 120 credits required for graduation.