

GENETICS AND GENOMICS, BS

This program explores how genetic material shapes life – from the cellular level to the population level – and prepares students to solve some of society’s most pressing challenges in the fields of medicine, biotechnology, biomedical research, and agriculture. Genetics and genomics are at the heart of many important issues of the day, including genetic testing, genetic therapies, genome sequencing, evolution, and the genetic engineering of humans, plants, and animals.

Students who major in genetics and genomics take courses in biology, chemistry, physics, statistics, and introductory genetics, and then delve into specialized genetics topics focused on humans, plants, populations, cancer, biological development, neurology, and epigenetics. They gain laboratory research experiences by taking laboratory courses and conducting independent research projects in faculty labs.

The genetics and genomics major provides a solid foundation for careers in medicine, public health, research, life sciences, agriculture, biotechnology, education, law, and science communication – in the private, public, and non-profit sectors. Many students choose to pursue graduate and professional studies, including research-focused PhD programs, medical school, veterinary school, and law school. Alumni go on to be physicians, medical directors, genetic counselors, epidemiologists, research scientists, data analysts, plant breeders, veterinarians, professors, teachers, attorneys, and science writers.

LEARN THROUGH HANDS-ON, REAL-WORLD EXPERIENCES

All genetics and genomics majors participate in hands-on research, which equips them with real-world skills valued by graduate and professional schools and employers. In addition to laboratory coursework, students have numerous opportunities to conduct independent research in faculty labs, where they receive mentoring from faculty, staff, and graduate students.

BUILD COMMUNITY AND NETWORKS

Students get to know faculty and instructors through small classes, and they can grow their networks by getting involved in student organizations or participating in undergraduate research experiences mentored by faculty. The Undergraduate Genetics Association (<https://win.wisc.edu/organization/UGA/>), a club for students interested in genetics and genomics, provides professional development, volunteer, and social opportunities for members. The Pre-Genetic Counseling Organization (<https://win.wisc.edu/organization/pregeneticcounseling/>), a club for students interested in genetic counseling, specializes in bringing counseling opportunities and information to undergraduates. Students can also participate in the Genetics and Genomics Peer Mentorship Program, which connects incoming students with those further along in their college careers.

MAKE A STRONG START

A course for first-year students introduces new majors to faculty researchers and fellow classmates and makes campus connections. It also

prepares them to work in research labs, teaches study skills needed to succeed in college, and provides peer networking opportunities.

CUSTOMIZE A PATH OF STUDY

Students have many options to pursue coursework that meets their career goals. They also may pursue honors in research, an option that includes conducting hands-on research in campus labs.

GAIN GLOBAL PERSPECTIVE

Majors can choose from a variety of study abroad programs including short-term field experiences, summer research opportunities, and semester-long exchange programs at top universities around the world. A study abroad program in Costa Rica specifically tailored for genetics and genomics majors is typically offered each spring and is led by genetics program faculty from UW–Madison. Students can explore studying abroad as a genetics and genomics major by utilizing the Genetics and Genomics Major Advising Page. Students work with their advisor and the CALS study abroad office to identify appropriate programs.

HOW TO GET IN

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To declare this major, students must be admitted to UW–Madison and the College of Agricultural and Life Sciences (CALS). For information about becoming a CALS first-year or transfer student, see Entering the College (<http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#enteringthecolletext>).

Students who attend Student Orientation, Advising, and Registration (SOAR) with the College of Agricultural and Life Sciences have the option to declare this major at SOAR. Students may otherwise declare after they have begun their undergraduate studies. For more information, contact the advisor listed in the Contact Box for the major.

REQUIREMENTS

UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (<http://guide.wisc.edu/undergraduate/#requirementsforundergraduatestudytext>) section of the *Guide*.

General Education	• Breadth—Humanities/Literature/Arts: 6 credits
	• Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits
	• Breadth—Social Studies: 3 credits
	• Communication Part A & Part B *
	• Ethnic Studies *
	• Quantitative Reasoning Part A & Part B *

* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

COLLEGE OF AGRICULTURAL AND LIFE SCIENCES REQUIREMENTS

In addition to the University General Education Requirements, all undergraduate students in CALS must satisfy a set of college and major requirements. Courses may not double count within university requirements (General Education and Breadth) or within college requirements (First-Year Seminar, International Studies, Science, and Capstone), but courses counted toward university requirements may also be used to satisfy a college and/or a major requirement; similarly, courses counted toward college requirements may also be used to satisfy a university and/or a major requirement.

COLLEGE REQUIREMENTS FOR ALL CALS BS DEGREE PROGRAMS

Code	Title	Credits
	Quality of Work: Students must maintain a minimum cumulative grade point average of 2.000 to remain in good standing and be eligible for graduation.	
	Residency: Students must complete 30 degree credits in residence at UW–Madison after earning 86 credits toward their undergraduate degree.	
	First year seminar (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#CALSThirdYearSeminarCourses)	1
	International studies (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#CALSIInternationalStudiesCourses)	3
	Physical science fundamentals	4-5
CHEM 103	General Chemistry I	
or CHEM 108	Chemistry in Our World	
or CHEM 109	Advanced General Chemistry	
	Biological science	5
	Additional science (biological, physical, or natural)	3
	Science breadth (biological, physical, natural, or social)	3
	CALS Capstone Learning Experience: included in the requirements for each CALS major (see "major requirements") (http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#CALSCapstoneRequirement)	

MAJOR REQUIREMENTS

Code	Title	Credits
Mathematics and Statistics		
Complete one of the following:		5-10
MATH 221	Calculus and Analytic Geometry 1	
MATH 171 & MATH 217	Calculus with Algebra and Trigonometry I and Calculus with Algebra and Trigonometry II	
Complete one of the following:		3-4
STAT 371	Introductory Applied Statistics for the Life Sciences	
STAT 301	Introduction to Statistical Methods	
STAT 240	Data Science Modeling I	
Chemistry		
Complete one of the following:		5-9
CHEM 103 & CHEM 104	General Chemistry I and General Chemistry II	
CHEM 109	Advanced General Chemistry	
CHEM 115 & CHEM 116	Chemical Principles I and Chemical Principles II	
Complete one of the following:		3-6
CHEM 341	Elementary Organic Chemistry	
CHEM 343 & CHEM 345	Organic Chemistry I and Organic Chemistry II ¹	
Physics		
Complete one of the following:		10
PHYSICS 103 & PHYSICS 104	General Physics and General Physics (recommended)	
PHYSICS 201 & PHYSICS 202	General Physics and General Physics	
PHYSICS 207 & PHYSICS 208	General Physics and General Physics (recommended)	
Biology		
Complete one of the following options:		10
Option 1:		
BIOLOGY/ BOTANY/ ZOOLOGY 151 & BIOLOGY/ BOTANY/ ZOOLOGY 152	Introductory Biology and Introductory Biology (recommended)	
Option 2:		
BOTANY/ BIOLOGY 130	General Botany	
ZOOLOGY/ BIOLOGY 101 & ZOOLOGY/ BIOLOGY 102	Animal Biology and Animal Biology Laboratory	
Option 3:		
BIOCORE 381 & BIOCORE 383	Evolution, Ecology, and Genetics and Cellular Biology	
Select two of the following labs:		

BIOCORE 382	Evolution, Ecology, and Genetics Laboratory	
BIOCORE 384	Cellular Biology Laboratory	
BIOCORE 486	Principles of Physiology Laboratory	

Core Requirements

BIOCHEM 501	Introduction to Biochemistry ²	3
or BIOCHEM 507	General Biochemistry I	

Complete one of the following options: 6

Option 1:

GENETICS 467 & GENETICS 468	General Genetics 1 and General Genetics 2 (preferred)	
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Option 2:

GENETICS 466	Principles of Genetics (consult advisor)	
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additional 3 credit genetics depth course (see course list below)³

Select 2 credits from the following: 2

GENETICS 545	Genetics Laboratory	
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GENETICS 299	Independent Study ⁴	
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GENETICS 699	Special Problems ⁴	
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GENETICS 681	Senior Honors Thesis	
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GENETICS 682	Senior Honors Thesis	
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GENETICS 399	Coordinative Internship/ Cooperative Education	
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Genetics Depth 9

See course list below

Genetics Breadth 6

See course list below

Capstone

Select one of the following: 3-6

Option 1:

GENETICS/ BIOLOGY 522	Communicating Evolutionary Biology (Three-credit version only) ⁵	
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Option 2:

GENETICS 527	Developmental Genetics for Conservation and Regeneration (offered in fall semester) ⁵	
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Option 3:

GENETICS 566	Advanced Genetics (offered in spring semester)	
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Option 4:

GENETICS 564	Genomics and Proteomics (offered in spring semester) ⁵	
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Option 5 (must be taken concurrently):

GENETICS 699	Special Problems (offered in fall semester)	
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GENETICS 567	Companion Research Seminar (offered in fall semester)	
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Option 6 (must be taken concurrently):

GENETICS 681	Senior Honors Thesis	
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GENETICS 682	Senior Honors Thesis	
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GENETICS 567	Companion Research Seminar (offered in fall semester)	
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Total Credits 65-81

¹ If CHEM 343 is taken, it must be taken as a part of CHEM 343 & CHEM 345, the latter of which counts as a genetics breadth requirement.

² If BIOCHEM 507 is taken, it must be taken as a part of BIOCHEM 507 & BIOCHEM 508, the latter of which counts as a genetics breadth requirement.

³ Additional depth course will not count toward the 9-credit genetics depth requirement.

⁴ Consult with your advisor if genetics-related research will be performed in a department other than genetics.

⁵ May count for genetics depth or capstone, but not both.

GENETICS DEPTH & BREADTH COURSES**Depth**

Code	Title	Credits
GENETICS 520	Neurogenetics	3
GENETICS/ BIOLOGY 522	Communicating Evolutionary Biology	2-3
GENETICS 525	Epigenetics	3
GENETICS 527	Developmental Genetics for Conservation and Regeneration	3
GENETICS 528	Banking Animal Biodiversity: International Field Study in Costa Rica	1
GENETICS 548	The Genomic Revolution	3
GENETICS/HORT 550	Molecular Approaches for Potential Crop Improvement	3
GENETICS 564	Genomics and Proteomics	3
GENETICS/ MD GENET 565	Human Genetics	3
GENETICS 566	Advanced Genetics	3
GENETICS 588	Immunogenetics	3
GENETICS 605	Clinical Cases in Medical Genetics	3
GENETICS/ BIOCHEM/ MICROBIO 612	Prokaryotic Molecular Biology	3
GENETICS/ BIOCHEM/ MD GENET 620	Eukaryotic Molecular Biology	3
GENETICS/ CHEM 626	Genomic Science	2
GENETICS 627	Animal Developmental Genetics	3
GENETICS/ BIOCHEM 631	Plant Genetics and Development	3
GENETICS 633	Population Genetics	3
GENETICS/ BOTANY/M M & I/ PL PATH 655	Biology and Genetics of Fungi	3
GENETICS/ MD GENET 662	Cancer Genetics	3
GENETICS/ MD GENET 677	Advanced Topics in Genetics	1-3

Breadth

Code	Title	Credits
Physical Science:		
BIOCHEM 508	General Biochemistry II	3-4
BIOCHEM/ NUTR SCI 560	Principles of Human Disease and Biotechnology	2
CHEM 344	Introductory Organic Chemistry Laboratory	2
CHEM 345	Organic Chemistry II	3
Integrative Biology:		
BIOCHEM/ M M & I 575	Biology of Viruses	2
BIOCORE 485	Principles of Physiology	3
BIOCORE 587	Biological Interactions	3
BOTANY/ANTHRO/ ZOOLOGY 410	Evolutionary Biology	3
BOTANY/ PL PATH 563	Phylogenetic Analysis of Molecular Data	3
MICROBIO 303	Biology of Microorganisms	3
MICROBIO 304	Biology of Microorganisms Laboratory	2
MICROBIO 470	Microbial Genetics & Molecular Machines	3
MICROBIO/ ONCOLOGY 545	Topics in Biotechnology	1
MICROBIO 632		2
M M & I 341	Immunology	3
M M & I/PATH- BIO 528	Immunology	3
PHM SCI 490	Selected Topics in Pharmaceutical Sciences	1-4
PL PATH 622	Plant-Bacterial Interactions	2-3
PL PATH/M M & I/ ONCOLOGY 640	General Virology-Multiplication of Viruses	3
ZOOLOGY/ ENVIR ST/ F&W ECOL 360	Extinction of Species	3
ZOOLOGY 425	Behavioral Ecology	3
ZOOLOGY 470	Introduction to Animal Development	3
ZOOLOGY 555	Laboratory in Developmental Biology	3
ZOOLOGY 570	Cell Biology	3
Agricultural Ecosystems:		
AGRONOMY/ HORT 338	Plant Breeding and Biotechnology	3
AGRONOMY/ BOTANY/HORT 340	Plant Cell Culture and Genetic Engineering	3
AGRONOMY/ HORT 360	Genetically Modified Crops: Science, Regulation & Controversy	2
AGRONOMY/ HORT 501	Principles of Plant Breeding	3
AGRONOMY/ HORT 502	Techniques of Plant Breeding	1
AN SCI/DY SCI 361	Introduction to Animal and Veterinary Genetics	2

AN SCI/DY SCI 362	Veterinary Genetics	2
AN SCI/DY SCI 363	Principles of Animal Breeding	2
PL PATH/BOTANY/ ENTOM 505	Plant-Microbe Interactions: Molecular and Ecological Aspects	3

Computational Biology:

B M I/ COMP SCI 576	Introduction to Bioinformatics	3
BIOCHEM 570		3

UNIVERSITY DEGREE REQUIREMENTS

Total Degree To receive a bachelor's degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.

Residency Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. "In residence" means on the UW–Madison campus with an undergraduate degree classification. "In residence" credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.

Quality of Work Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.

LEARNING OUTCOMES

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1. Analyze the transmission of genes and chromosomes between cells during cell division and within pedigrees over generations.
2. Demonstrate a deep understanding of how information encoded in DNA can be mutated, epigenetically modified, transcribed into RNA, and translated for protein production, enabling this information to orchestrate the activities of cells singly or collectively throughout development in multicellular organisms.
3. Predict the impact of the forces of mutation, natural selection, chance, and genetic recombination on the amount of genetic variation in populations at the DNA and phenotypic levels using quantitative models.
4. Formulate research questions about the genetic control of biological processes and design experiments to answer these questions using appropriate genetic tools including model organisms.
5. Demonstrate team-work, interpersonal and problem-solving skills to address societal, ethical and scientific issues related to genetics, and communicate their findings through written, oral and multi-media reports.

FOUR-YEAR PLAN

FOUR-YEAR PLAN SAMPLE GENETICS AND GENOMICS FOUR-YEAR PLAN

Students must complete at least 120 total credits to be eligible for graduation.

First Year

Fall	Credits Spring	Credits
CHEM 103 or 109	4-5 CHEM 104	5
MATH 221 (or math placement)	5 Elective	3
GENETICS 155 (CALs First Year Seminar)	1 COMM A Course (if needed)	3
Humanities	3 Ethnic Studies	3
13-14		14

Second Year

Fall	Credits Spring	Credits
CHEM 343 or 341	3 CHEM 345 (if CHEM 343 completed)	3
ZOOLOGY/BIOLOGY/BOTANY 151 ¹	5 ZOOLOGY/BIOLOGY/BOTANY 152 ¹	5
STAT 371 or 301	3 GENETICS 299 (Independent Research)	1-3
Social Sciences	3 Electives	5
14		14-16

Third Year

Fall	Credits Spring	Credits
PHYSICS 103, 207, or 201 ²	4-5 PHYSICS 104, 208, or 202 ²	4-5
GENETICS 467	3 GENETICS 468	3
BIOCHEM 501 or 507	3 BIOCHEM 508 (or elective)	3-4
CALS International Studies	3 Genetics Depth/Breadth	6
13-14		16-18

Fourth Year

Fall	Credits Spring	Credits
Genetics Depth/Breadth	6 Genetics Depth/Breadth	3
Elective (research or thesis recommended) ³	2-3 Elective (research or thesis recommended) ³	2-3
Humanities	3 Genetics Capstone	3
Electives	6 Electives	6
17-18		14-15

Total Credits 115-123

¹ Instead of ZOOLOGY/BIOLOGY/BOTANY 151 and ZOOLOGY/BIOLOGY/BOTANY 152, students can take either BOTANY/BIOLOGY 130, ZOOLOGY/BIOLOGY 101 & ZOOLOGY/BIOLOGY 102, or BIOCORE 381, BIOCORE 383 & two labs (BIOCORE 382, BIOCORE 384, or BIOCORE 486).

² Physics could be taken in second year (consult your advisor).

³ If in CALS honors in research.

Notes:

- First-year students are recommended to take GENETICS 155 to fulfill the CALS first year seminar requirement.
- Study abroad is an enriching experience. Check with your advisor on how you can fulfill your curriculum and study abroad.

ADVISING AND CAREERS

ADVISING AND CAREERS ADVISING

Each student is assigned a professional academic advisor who works to understand student goals and helps to craft a path that best suits their needs. Additionally, students receive professional and scientific mentorship through interactions with faculty, staff, and graduate students.

CAREER OPPORTUNITIES

Alumni go on to a wide variety of careers in medicine, public health, research, life sciences, biotechnology, education, law, and science communication – in the private, public, and non-profit sectors. They hold professional positions as physicians, medical directors, genetic counselors, epidemiologists, research scientists, data analysts, plant breeders, veterinarians, professors, teachers, attorneys, and science writers.

PEOPLE

PEOPLE PROFESSORS

Francisco Pelegri (chair), Matthew Anderson, Jake Brunkard, Qiang Chang, Daniela Drummond-Barbosa, Audrey Gasch, Chris Hittinger, Aki Ikeda, Patrick Masson, Bret Payseur, Nicole Perna, John Pool, Tom Prolla, Claire Richardson, Steven Schroedi, David Schwartz, Nathaniel Sharp, Ahna Skop, Katie Vermillion Kalmon, David Wassarman, Donna Werling, Justin Wolter, Jerry Yin.

TEACHING FACULTY

Carin Loewen, Kit Tilmann, Nicholas Zumwalde

ADVISORS

Carin Loewen, Claire Minor, Kit Tilmann, Katie Vermillion Kalmon, Nicholas Zumwalde

GRADUATE PROGRAM MANAGER

Martha Reck

WISCONSIN EXPERIENCE

WISCONSIN EXPERIENCE RESEARCH EXPERIENCE

Many genetics and genomics majors conduct research in a faculty-led research lab where they receive direct mentorship from faculty, staff, and graduate students. With hundreds of faculty members on campus using genetic strategies in their labs, students have many research options.

STUDENT ORGANIZATIONS

The Undergraduate Genetics Association (<https://win.wisc.edu/organization/UGA/>), a club for all students interested in genetics and genomics, brings in guest speakers to discuss their research and career paths; provides guidance on finding campus research and internship opportunities; holds informational sessions on jobs and careers; and hosts networking, volunteer, and social events. The Pre-Genetic Counseling Organization (<https://win.wisc.edu/organization/pregeneticcounseling/>), for students interested in genetic counseling, hosts talks by genetic counselors, clinicians, and ethicists; informs students of advocacy opportunities; provides training in practical counseling skills; and offers networking, volunteer, outreach, and social events.

GLOBAL ENGAGEMENT

Genetics and genomics majors participate in study abroad programs in countries around the world, including in China, Costa Rica, England, Germany, Mexico, New Zealand, and Uganda. Students can find more information on the CALS study abroad advising page (<https://cals.wisc.edu/academics/undergraduate-students/studyabroad/study-abroad-advising/>).

COMMUNITY ENGAGEMENT AND VOLUNTEERING

Students have opportunities to engage in volunteer activities through the Undergraduate Genetics Association, including participating in campus' annual Darwin Day (<https://evolution.wisc.edu/darwin-day/>) science outreach event. The Pre-Genetic Counseling Organization also offers outreach opportunities.

INTERSHIPS

Majors are encouraged to participate in internships. With a large biotech industry presence in the Madison area, there are many opportunities for students to participate in genetically-relevant internship experiences. Students can use these internship opportunities to complete the research requirement for the genetics and genomics major.

A RICH HISTORY OF GENETICS AND GENOMICS

Established in 1910, the UW–Madison Department of Genetics is among the oldest genetics departments in the nation and is highly regarded for its research contributions in diverse areas of the field. Many of the greatest discoveries in Genetics and Genomics took place at UW–Madison, including cracking the genetic code, sequencing one of the first bacterial genomes, synthesizing the first gene, and developing targeted gene knockout methods in mice.

available for students who participate in certain genetics-focused study abroad programs.

RESOURCES

The Center for Pre-Health Advising (<https://prehealth.wisc.edu/>) provides information about health careers including pre-med, pre-nursing, pre-vet, and pre-physical therapy, and offers course suggestions.

RESOURCES AND SCHOLARSHIPS

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Students in the College of Agricultural and Life Sciences receive more than \$1.25 million in scholarships annually. Learn more about college scholarships (<https://cals.wisc.edu/academics/undergraduate-students/financing-your-education/cals-scholarships/>).

The genetics department offers a Genetics and Genomics Excellence in Research Award of up to \$6,000 to support undergraduate research in genetics- and genomics-related areas. There are also scholarships