

# GENETICS AND GENOMICS, B.S.

Genetics and genomics is a bachelor's program for students seeking to understand how genes shape life, from fundamental cellular functions to population dynamics, and for students preparing to apply genetic and genomic concepts in such areas as medicine, biotechnology, biomedical research, agriculture, journalism, and public policy.

Advances in genome sequencing, bioinformatics, and our ability to manipulate the DNA of many organisms, including humans, have brought genetics to the forefront of many issues facing our society. These advances drive the growing need for health care providers, scientists and other professionals with a strong foundation in genetic and genomic analysis. Through coursework and diverse research opportunities, genetics and genomics majors gain broad insight into inheritance, gene function, genome organization, evolution, cutting-edge genetic technologies and therapies, and more.

A B.S. degree with a major in genetics and genomics positions students for many jobs in the biotechnology industry. Genetics and genomics majors are well prepared to pursue research-focused Ph.D. programs that provide further training for careers in biomedical and agricultural research. Genetics and genomics majors are highly competitive for admission to top medical schools, where there is a growing focus on personalized medicine, and genetic counseling programs.

## HOW TO GET IN

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/#enteringthecollegertext>).

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 under the Advising and Careers tab.

## 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 | <ul style="list-style-type: none"> <li>• Breadth—Humanities/Literature/Arts: 6 credits</li> <li>• 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</li> <li>• Breadth—Social Studies: 3 credits</li> <li>• Communication Part A &amp; Part B *</li> <li>• Ethnic Studies *</li> <li>• Quantitative Reasoning Part A &amp; Part B *</li> </ul> |
|-------------------|--|

\* 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 B.S. 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 ( <a href="http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext">http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext</a> )	1
	International Studies ( <a href="http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext">http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext</a> )	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") ( <a href="http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext">http://guide.wisc.edu/undergraduate/agricultural-life-sciences/#requirementstext</a> )		

### MAJOR REQUIREMENTS

Code	Title	Credits
<b>Mathematics and Statistics</b>		
	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	
STAT 371	Introductory Applied Statistics for the Life Sciences	3
or STAT 301	Introduction to Statistical Methods	

**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	Introductory Organic Chemistry and Intermediate Organic Chemistry	

**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 or BIOCHEM 507	Introduction to Biochemistry <sup>1</sup> General Biochemistry I	3
-------------------------------	---	---

Complete one of the following options: 6

Option 1:

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

Option 2:

GENETICS 466	Principles of Genetics (consult advisor (467 & 468 preferred))	
	additional 3 credit Genetics depth course (see course list below) <sup>2</sup>	

Select 2 credits from the following: 2

GENETICS 545	Genetics Laboratory	
GENETICS 299	Independent Study <sup>3</sup>	
GENETICS 699	Special Problems <sup>3</sup>	
GENETICS 681	Senior Honors Thesis	
GENETICS 682	Senior Honors Thesis	
GENETICS 399	Coordinative Internship/Cooperative Education	

**Genetics Depth** 9

See course list below

**Genetics Breadth** 6

See course list below

**Capstone**

Select one of the following: 3-9

Option 1:

GENETICS/ BIOLOGY 522	Communicating Evolutionary Biology (Three-credit version only) <sup>4</sup>	
--------------------------	---	--

Option 2:

GENETICS 527	Developmental Genetics for Conservation and Regeneration (offered in fall semester) <sup>4</sup>	
--------------	--	--

Option 3:

GENETICS 566	Advanced Genetics (offered in spring semester)	
--------------	--	--

Option 4:

GENETICS 564	Genomics and Proteomics (offered in spring semester) <sup>4</sup>	
--------------	---	--

Option 5 (must be taken concurrently):

GENETICS 699	Special Problems (offered in fall semester)	
GENETICS 567	Companion Research Seminar (offered in fall semester)	

Option 6 (must be taken concurrently):

GENETICS 681	Senior Honors Thesis	
GENETICS 682	Senior Honors Thesis	
GENETICS 567	Companion Research Seminar (offered in fall semester)	

**Total Credits** 65-83

<sup>1</sup> If BIOCHEM 507 is taken, it must be taken as a part of BIOCHEM 507 General Biochemistry I & BIOCHEM 508 General Biochemistry II, which counts as Genetics Breadth requirement.

<sup>2</sup> Additional Depth course will not count toward the 9-credit Genetics Depth requirement.

<sup>3</sup> Consult with your advisor if genetics-related research will be performed in a department other than Genetics.

<sup>4</sup> 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 562		2
GENETICS 564	Genomics and Proteomics	3
GENETICS/ MD GENET 565	Human Genetics	3
GENETICS 566	Advanced Genetics	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 631	Plant Genetics	2
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
<b>Physical Science:</b>		
BIOCHEM 508	General Biochemistry II	3-4
BIOCHEM 550	Principles of Human Disease and Biotechnology	2
BMOLCHEM 504	Human Biochemistry Laboratory	3
CHEM 344	Introductory Organic Chemistry Laboratory	2
CHEM 345	Intermediate Organic Chemistry	3

#### Integrative Biology:

BIOCORE 485	Principles of Physiology	3
BIOCORE 587	Biological Interactions	3
BOTANY/ANTHRO/ ZOOLOGY 410	Evolutionary Biology	3
BOTANY 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	Industrial Microbiology/ Biotechnology	2
M M & I 341	Immunology	3
M M & I 460	Techniques in DNA Science for Microbiologists	3
M M & I/PATH- BIO 528	Immunology	3
PL PATH 622	Plant-Bacterial Interactions	2-3
PL PATH/ 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
<b>Agricultural Ecosystems:</b>		
AGRONOMY/ HORT 338	Plant Breeding and Biotechnology	3
AGRONOMY/ BOTANY/HORT 340	Plant Cell Culture and Genetic Engineering	3
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
HORT/PATH-BIO 500	Molecular Biology Techniques	3
PL PATH/BOTANY/ ENTOM 505	Plant-Microbe Interactions: Molecular and Ecological Aspects	3
<b>Computational Biology:</b>		
B M I/COMP SCI 576	Introduction to Bioinformatics	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.

Electives (Humanities, Social Science, Ethnic Studies)	3 Electives (Humanities, Social Science, Ethnic Studies)	3
<b>13-14</b>		<b>14</b>

### Total Credits 27-28

#### Sophomore

Fall	Credits	Spring	Credits
CHEM 343 or 341		3 CHEM 345 (if CHEM 343 completed)	3
ZOOLOGY/BIOLOGY/BOTANY 151 <sup>1</sup>		5 ZOOLOGY/BIOLOGY/BOTANY 152 <sup>2</sup>	5
STAT 371 or 301		3 Electives (Humanities, Social Science, Ethnic Studies)	5
Electives (Humanities, Social Science, Ethnic Studies)		3 GENETICS 299 (Independent Research)	2
<b>14</b>		<b>15</b>	

### Total Credits 29

#### Junior

Fall	Credits	Spring	Credits
PHYSICS 103, 207, or 201 <sup>3</sup>		4-5 PHYSICS 104, 208, or 202 <sup>3</sup>	4-5
GENETICS 467 or 466 (& BIOCORE 485 if applicable)		3 GENETICS 468 (or Genetics Depth elective & BIOCORE 587 if applicable)	3
BIOCHEM 501 or 507		3 BIOCHEM 508 (or elective)	3
Electives		5 Genetics Breadth/Depth	6
<b>15-16</b>		<b>16-17</b>	

### Total Credits 31-33

#### Senior

Fall	Credits	Spring	Credits
Genetics Breadth/Depth		6 Genetics Breadth/Depth	3
Senior Thesis (681-Research) <sup>4</sup>		2-3 Senior Thesis (682-Research) <sup>4</sup>	2-3
Electives (Humanities, Social Sciences)		3 Genetics Capstone	3
Electives		6 Electives	6
<b>17-18</b>		<b>14-15</b>	

### Total Credits 31-33

- <sup>1</sup> Instead of BIOLOGY/BOTANY/ZOOLOGY 151 Introductory Biology, students can take either (BIOCORE 381 Evolution, Ecology, and Genetics & BIOCORE 382 Evolution, Ecology, and Genetics Laboratory) or (ZOOLOGY/BIOLOGY 101 Animal Biology & ZOOLOGY/BIOLOGY 102 Animal Biology Laboratory).
- <sup>2</sup> Instead of BIOLOGY/BOTANY/ZOOLOGY 152 Introductory Biology, students can take either (BIOCORE 383 Cellular Biology & BIOCORE 384 Cellular Biology Laboratory) or BOTANY/BIOLOGY 130 General Botany.
- <sup>3</sup> Physics could be taken in Sophomore year (consult your advisor).

## LEARNING OUTCOMES

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

##### Freshman

Fall	Credits	Spring	Credits
CHEM 103 or 109		4-5 CHEM 104 (or elective course)	5
MATH 221 (or math placement)		5 International Studies	3
GENETICS 155 (Freshman Seminar)		1 COMM A Course (if needed)	3

<sup>4</sup> If in CALS Honors in Research.

#### Notes:

- 120 total credits required for bachelor's degree—aim for 15 credits per semester.
- Students who have not maintained a GPA of at least 2.5 by the end of their first two years, or transfer students by the end of their first year in residence, need to evaluate their major and career options with an advisor.
- Freshmen are recommended to take GENETICS 155 Freshman Seminar in Genetics, 1-credit freshman seminar course offered in the fall to fulfill the first year seminar requirement.
- Study Abroad is an enriching experience. Check with your advisor on how you can fulfill your curriculum and study abroad.
- UGA (Undergraduate Genetics Association): check out the club's website: [facebook.com/groups/UGA.UWMadison](https://www.facebook.com/groups/UGA.UWMadison/) (<https://www.facebook.com/groups/UGA.UWMadison/>)

## ADVISING AND CAREERS

### UNDERGRADUATE ADVISORS

Tilman, Kit; Vermillion Kalmon, Katie; Loewen, Carin; Foley, Lauren

Students should make advising appointments through the Starfish App on MyUW.

### CAREERS

The biotechnology industry has exploded within the last decade, providing many diverse career opportunities for our graduates. A strong background in genetics will prepare you for careers in research technical support, technical writing, quality control, assay development, technical services, and sales or marketing. Entry level job titles: Research Laboratory Technician, Assistant Scientist, Clinical Research Associate, Agricultural Consultant, Science Writer

Many of our graduates continue their education by pursuing an advanced degree. Our students are competitive for admission to medical schools, veterinary schools, and graduate schools throughout the country. Students may elect a Ph.D. in genetics to prepare them for careers in research, academia, and industry. Others may elect an M.S. program for a career in genetics counseling.

## PEOPLE

### PROFESSORS

Pelegri, Francisco (chair); Gasch, Audrey; Ikeda, Aki; Doebley, John; Masson, Patrick; Payseur, Bret; Perna, Nicole; Prolla, Tom; Schwartz, David; Skop, Ahna; Wassarman, David; Yin, Jerry

### ASSOCIATE PROFESSORS

Chang, Qiang; Hittinger, Chris; Pool, John

### ASSISTANT PROFESSORS

Brunkard, Jake; Richardson, Claire; Schroedi, Steven; Sharp, Nathaniel; Werling, Donna; Zhong, Xuehua

### FACULTY ASSOCIATES;

Tilman, Kit; Vermillion Kalmon, Katie; Loewen, Carin

### UNDERGRADUATE ADVISORS

Tilman, Kit; Vermillion Kalmon, Katie; Loewen, Carin; Foley, Lauren

## WISCONSIN EXPERIENCE

Students are highly encouraged to apply what they are learning in the classroom to out-of-classroom experiences, connect with other students in genetics and other biological science majors, and to build relationships with faculty and staff.

- A minimum of one semester of mentored research is required, and most students elect to participate in more. The Genetics website (<https://genetics.wisc.edu/>) and undergraduate advisors can help students find these experiences. Students conduct research experiences for course credit or pay, depending on the lab. Many students present their work during lab meetings, professional conferences, and campus events.
- The Undergraduate Genetics Association (UGA) (<https://www.facebook.com/groups/UGA.UWMadison/>) is the pre-professional student organization for majors in genetics or students interested in genetics. They provide professional development opportunities, networking, information about current genetic research, how to get involved in research or internships, and career and job information.
- Students are also involved in pre-health organizations, volunteer and shadowing opportunities, publishing in an undergraduate science journal, biotechnology and agricultural internships, and other related experiences on and off campus.