

# Genetics & Genomic Sciences

The UAB Undergraduate Program in Genetics and Genomic Sciences (GGS) is an interdisciplinary major between the Department of Genetics in the Heersink School of Medicine and the Department of Biology in the College of Arts and Sciences. Genetics refers to study of genes and their roles in inheritance, while genomics describes investigations of large sets of genes or gene products, up to and including the entire genome. Genetics is one of the most important fields in biological sciences, and affects all aspects of our lives. There have been major breakthroughs in the fields of genetics and genomics during the last decade, and this has created a significant need for individuals with training in these cutting-edge disciplines.

The central goals of the GGS undergraduate major is to provide students with a strong educational and research background and prepare them to become accomplished research scientists, clinicians, and health-care professionals who will be equipped with the knowledge to contribute to future discoveries in genetics and genomics. Our faculty, through their strong academic and research experience and expertise in the fields of genetics and genomic sciences, will help students accomplish these goals through the following mechanisms:

- *Academic coursework* - students are provided with a strong academic and intellectual foundation through coursework in biology, chemistry, mathematics, physics, genetics, and genomics.
- *Authentic research experience* – Qualified students are offered opportunities to perform laboratory research under the direction of faculty mentors to learn cutting-edge experimental approaches and innovative methods in genetics and genomics research.
- *Mentoring and career guidance* - students are provided with academic and career counseling to identify graduate and professional programs, or jobs most suited to their interests.

## Admissions

The GGS program is designed for graduating high school seniors and college freshmen or sophomores with a strong academic record and the motivation to pursue a career in the biomedical sciences.

### Advising and Information

Dr. Micky Edmonds  
Co-Director, Genetics and Genomic Sciences  
Assistant Professor, Department of Genetics  
(205) 975-7879  
[MickEdmonds@uab.edu](mailto:MickEdmonds@uab.edu) ([mickedmonds@uab.edu](mailto:mickedmonds@uab.edu))

Dr. Shahid K Mukhtar  
Co-Director, Genetics and Genomic Sciences  
Assistant Professor, Department of Biology  
(205) 934-8335  
[smukhtar@uab.edu](mailto:smukhtar@uab.edu)

## Bachelor of Science in Genetics and Genomic Sciences

For a BS degree in Genetics and Genomic Sciences, you must satisfactorily complete a minimum of 120 semester hours including the following:

Requirements	Hours	
BY 123 & 123L	Introductory Biology I and Introductory Biology I Laboratory	4
BY 124 & 124L	Introductory Biology II and Introductory Biology II Laboratory	4
CH 115 & CH 116	General Chemistry I and General Chemistry I Laboratory	4
CH 117 & CH 118	General Chemistry II and General Chemistry II Laboratory	4
PHL 116	Bioethics	3
BY 210	Genetics	3
BY 330	Cell Biology	3
CH 235 & CH 236	Organic Chemistry I and Organic Chemistry I Laboratory	4
MA 125	Calculus I	4
or MA 225	Calculus I - Honors	
CH 237 & CH 238	Organic Chemistry II and Organic Chemistry II Laboratory	4
MA 180	Introduction to Statistics	3
or PUH 250	Biostatistics	
CH 460	Fundamentals of Biochemistry	3
PSDO 200	Introduction to Research	1
PH 201 & 201L	College Physics I and College Physics Laboratory I	4
PH 202 & 202L	College Physics II and College Physics Laboratory II	4
GRD 300	Introduction to the Health Professions	1
<b>Genetics and Genomic Sciences courses <sup>1</sup></b>		<b>13</b>
GGSC 310	Genome Structure and Organization	
GGSC 320	Colloquium in Genetics and Genomics Science <sup>2</sup>	
GGSC 410	Genetic Basis of Human Disease	
GGSC 420	Applications of Bioinformatics	
GGSC 499	GGSC Program Final (Taken last term)	
<b>GGG/BY Electives (select at least 2 from the list below)</b>		<b>6</b>
GGSC 415	Aquatic Animal Models of Human Disease	
GGSC 435	Zebrafish as a Model for Biomedical Research	
GGSC 465	Research Techniques for Aquatic Animals of Human Diseases	
GGSC 470	Principles of Pharmacogenetics	
GGSC 490	Model Systems for Genetics Disorders	
GGSC 491	Personalized Genomic Medicine	
BY 431	Principles of DNA Technology	
<b>Capstone Requirement (Choose one of the following)</b>		<b>3</b>
GGSC 490	Model Systems for Genetics Disorders	
GGSC 491	Personalized Genomic Medicine	
GGSC 492	Undergraduate Research Seminar in Genetics and Genomic Sciences <sup>3</sup>	
GGSC 493	Honors Research Seminar in Genetics and Genomic Sciences <sup>3</sup>	

Total Hours

75

- <sup>1</sup> A minimum GPA of 2.0 is required
- <sup>2</sup> GGS majors must take the Colloquium in Genetics and Genomics course (GGSC 320; 1 credit hour per semester) at least 2 times.
- <sup>3</sup> Please contact the program director to discuss the Capstone requirements.

## Required for Genetics and Genomic Sciences Honors Students

To successfully complete the GGS Honors Program you will need to:

- Take 6 semester hours of GGSC 390 Honors Research in Genetics and Genomic Sciences. Each semester hour per term requires a minimum of 3 hours of laboratory work per week. Students may substitute 3 of the 6 required GGSC 390 credit hours with an equivalent research course (with prior approval of the program director).
- Complete the required Environmental Health and Safety (EH&S) training courses. Save the certificates.
- Take the Honors Research Seminar in Genetics and Genomic Sciences (GGSC 493) course during the junior or senior year. This course should be taken during the first semester after completion of the research project, or alternatively can be taken concurrently with GGS Honors Research in Genetics and Genomic Sciences (GGSC 390) during the student's final semester of supervised research. Can also be taken to fulfill the Capstone requirement.
- Form your Honors Thesis Committee consisting of your faculty mentor and another faculty member at least one semester in advance of your final defense.
- Submit your research report to your thesis committee in the form of a thesis in the final semester. The thesis should include a summary of the student's research findings incorporating an introduction, methods, and relevant literature review. Append the EH&S certificates at the end of your thesis. Discuss with the Program Directors about the detailed guidelines, if necessary.
- Defend the thesis in the final semester in front of your thesis committee.
- Submit an oral or poster presentation at Biology Research Day or the UAB Expo during their junior or senior year. Under special circumstances, the poster may be presented at other times of the year pending approval of the Program Directors.

## Honors Eligibility

To be accepted into the Genetics and Genomic Sciences Honors Program, you must:

- Have completed at least 45 credit hours
- Have a 3.5 GPA in GGSC and Biology courses
- Have a 3.2 GPA overall
- Have already completed BY 123 and 123L, BY 124 and 124L, BY 210, CH 115/116, and CH 117/118
- Honors Research in Genetics and Genomic Sciences can also be taken as part of the University Honors Programs. GGS majors generally enter their research labs in the fall semester of their junior year; however, they may begin their research work in the spring semester of their sophomore year or earlier with permission of the Program Directors.
- Qualified non-Honors students will be encouraged, but not required to participate in research as part of their GGS BS degree. Non-Honors

students must receive permission from the Program Directors before entering a research lab. In addition, they must complete the course requirements listed above. However, these students will register for the GGSC 380 Undergraduate Research in Genetics and Genomic Sciences and GGSC 492 Undergraduate Research Seminar in Genetics and Genomic Sciences courses.

Freshman			
First Term	Hours	Second Term	Hours
CAS 112		1 BY 124 & 124L	4
BY 123 & 123L		4 CH 117 & CH 118	4
CH 115 & CH 116		4 EH 102	3
EH 101		3 PHL 116	3
Core Curriculum Area II or IV		3 GRD 300	1
	15		15
Sophomore			
First Term	Hours	Second Term	Hours
BY 210		3 GGSC 310	3
GGSC 320 <sup>1</sup>		1 GGSC 320 <sup>1</sup>	1
CH 235 & CH 236		4 BY 330	3
MA 125		4 CH 237 & CH 238	4
Core Curriculum Area II or IV		3 Core Curriculum Area II or IV	3
		PSDO 200	1
	15		15
Junior			
First Term	Hours	Second Term	Hours
GGSC 420		3 GGSC 410	3
GGSC 380 or 390 (or a General Elective Course)		3 GGSC 380 or 390 (or General Elective Course)	3
MA 180 or PUH 250		3 CH 460	3
General Elective Course		3 General Elective Course	3
Core Curriculum Area II or IV		3 Core Curriculum Area II or IV	3
	15		15
Senior			
First Term	Hours	Second Term	Hours
Approved GGSC/BY 400 Level Course <sup>2</sup>		3 Approved GGSC/BY 400 Level Course <sup>2</sup>	3
GGSC 492 or 493 (or a General Elective Course)		3 PH 202 or 222	4
PH 201 or 221		4 Core Curriculum Area II or IV	3
Core Curriculum Area II or IV		3 General Elective Course	4
General Elective Course		3	
	16		14

Total credit hours: 120

<sup>1</sup> GGSC majors must take GGSC 320 the Colloquium in Genetics & Genomics at least 2 times.

<sup>2</sup> Approved GGSC/BY 400-level courses: BY 431, GGSC 415, GGSC 435, GGSC 465, GGSC 470, GGSC 490, and GGSC 491. One of the following courses must be taken to fulfill the Capstone Requirement: GGSC 490, GGSC 491, GGSC 492, or GGSC 493. These courses may also be used to fulfill the Approved GGSC/BY 400 Level Course or General Elective Course requirements.

## Courses

### **GGSC 101. Your Genome. 3 Hours.**

Advances in genetics and genomics, and especially the sequencing of the human genome, are making it possible to customize medical care to the specific needs of an individual. This course will introduce students to basic concepts in genetics and genomic sciences, as well as familiarize them with the various tools available that enable personalization of healthcare. Students from a wide range of disciplines with minimum scientific background can participate, and there is no required textbook. This course is intended for non-Genetics and Genomic Sciences majors.

### **GGSC 201. Research Experience in Molecular Genetics. 3 Hours.**

A course-based authentic research experience with genomic technologies such as CRISPR-Cas9 (programmable nucleases) to make genetic modifications in a model organism.

### **GGSC 250. Special Topics in Genetics and Genomics Sciences. 1-3 Hour.**

Covers different topics including fundamentals and applications in the fields of genetics and genomics.

### **GGSC 310. Genome Structure and Organization. 3 Hours.**

This course will cover the general concepts of genomics including gene structure and function, genomic technologies and their applications, and comparative genomics.

**Prerequisites:** [BY 210](#) [Min Grade: C] and [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C]

### **GGSC 320. Colloquium in Genetics and Genomics Science. 1 Hour.**

Faculty-led seminar course that exposes students to cutting edge research topics and career opportunities in the fields of genetics and genomics. Students will read assigned articles and be prepared for discussion.

### **GGSC 330. Principles and Practice of Precision Medicine. 3 Hours.**

Students in this CURE course (Course-Based Undergraduate Research Experiences), will participate in the work-up of real (but de-identified), active PMI cases. Starting from a genetics report, students will research possible molecular mechanisms underlying an individual's disease, write summary reports of the scientific and medical literature, and present their findings to the PMI team and potentially to the physicians responsible for making treatment decisions. Cases incorporated into the class are current active cases, and therefore will be new for every class.

**Prerequisites:** [BY 210](#) [Min Grade: C]

### **GGSC 350. Special Topics in Genetics and Genomics Sciences. 1-3 Hour.**

Covers different topics including fundamentals and applications in the fields of genetics and genomics.

### **GGSC 355. Independent Study in Genetics and Genomics Sciences. 1-3 Hour.**

In-depth study of fundamentals and applications in the fields of genetics and genomics under the direct supervision of a faculty member.

Permission of Instructor Only.

### **GGSC 380. Undergraduate Research in Genetics and Genomics Sciences. 1-3 Hour.**

Research project for non-GGS Honors students under the supervision of a faculty sponsor. May be repeated for a total of 9 semester credit hours in a 2 or 3 semester period.

### **GGSC 390. Honors Research in Genetics and Genomics Sciences. 1-3 Hour.**

Research project for GGS Honors students under the supervision of a faculty sponsor. May be repeated for a total of 9 semester credit hours in a 2 or 3 semester period.

### **GGSC 410. Genetic Basis of Human Disease. 3 Hours.**

This course will focus on the medical applications of genetics and genomic technologies. Topics covered include, but are not limited to major forms of chromosomal abnormalities, mutations and genetic disorders, genetic risk assessment and population genetics, and genomic approaches to diagnosis.

**Prerequisites:** [BY 210](#) [Min Grade: C] and [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C] and ([GGSC 310](#) [Min Grade: C] or [BY 311](#) [Min Grade: C])

### **GGSC 415. Aquatic Animal Models of Human Disease. 3 Hours.**

This course will cover the basic anatomy, biology, life history, husbandry, and research applications for a variety of aquatic organisms used as animal models of human disease in biomedical research. Species discussed will include zebrafish, Medaka, Xiphorous, Onchorynchus, Xenopus, and Axolotls.

**Prerequisites:** [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C] and [BY 210](#) [Min Grade: C] and [GGSC 310](#) [Min Grade: C]

### **GGSC 420. Applications of Bioinformatics. 3 Hours.**

Introduction to computational tools and bioinformatics databases used in the fields of genetics and genomic sciences. This course will cover a wide variety of different bioinformatics applications, which will be taught through use of available on-line bioinformatics resources. Topics covered include large-scale genomic databases, sequence analysis systems, protein sequence analysis, structural bioinformatics, protein folding, and homology modeling.

**Prerequisites:** [BY 210](#) [Min Grade: C] and [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C] and ([GGSC 310](#) [Min Grade: C] or [BY 311](#) [Min Grade: C])

### **GGSC 435. Zebrafish as a Model for Biomedical Research. 3 Hours.**

This course will focus on the biology, husbandry, and management of zebrafish used as an animal model of human disease in biomedical research. Topics will include anatomy, physiology, systems design, water quality management, behavior and enrichment, spawning and larviculture, nutrition and live feeds, diseases, quarantine, biosecurity, and regulatory compliance.

**Prerequisites:** [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C] and [BY 210](#) [Min Grade: C] and [GGSC 310](#) [Min Grade: C]

### **GGSC 465. Research Techniques for Aquatic Animals of Human Diseases. 4 Hours.**

This course will focus on the techniques and procedures used for research with aquatic animal models of human disease. Lecture and lab approaches are used.

**Prerequisites:** [GGSC 415](#) [Min Grade: C] or [GGSC 435](#) [Min Grade: C]

**GGSC 470. Principles of Pharmacogenetics. 3 Hours.**

Most of the drugs that we use today were developed with the assumption that the same drug will work equally well in all the patients that have the same disease. However, there is considerable variability between individual patients - both in the therapeutic response and the adverse effects of the same drug - that is largely determined by the differences in their genotypes. Pharmacogenetics and pharmacogenomics study the genetic determinants of drug response, with the goal to identify genetic variants that can be used to predict the efficacy of a particular drug in a particular patient and to avoid adverse drug reactions. This will ultimately enable implementation of personalized treatment options, by selecting the drugs that will have the best efficacy and the least toxicity for each individual patient. This course will introduce students to the basic principles of pharmacogenetics, demonstrate examples of drug/genotype interactions, highlight the available pharmacogenetic resources, and discuss the potential benefits, as well as limitations and challenges of pharmacogenetics and personalized medicine.

**Prerequisites:** [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C] and [BY 210](#) [Min Grade: C] and [GGSC 310](#) [Min Grade: C]

**GGSC 490. Model Systems for Genetics Disorders. 3 Hours.**

Invertebrate and non-human vertebrate species are commonly used in scientific research work to provide significant insights into human genetic processes and disease. This course focuses on the different methods and strategies by which researchers use these systems for genetic and genomic analyses of human biology and relevant disorders. Model organisms covered include, but are not limited to nematodes (*C. elegans*), fruit flies (*Drosophila* sp.), zebrafish (*Danio rerio*), and mice (*Mus musculus*). Capstone course (GGS majors). Students that enroll in this class as their capstone experience are expected to do writing or presentation assignments to fulfill their capstone requirement.

**Prerequisites:** [BY 210](#) [Min Grade: C] and [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C] and ([GGSC 310](#) [Min Grade: C] or [BY 311](#) [Min Grade: C])

**GGSC 491. Personalized Genomic Medicine. 3 Hours.**

Significant developments in the fields of genetics and genomics are making it possible to tailor medical care to the specific needs of patients. New diagnostic tests, up to and including whole genome sequencing, provide increasingly powerful tools for the identification of the genetic basis of both rare and common disorders. Better understanding of the causes of disease are permitting drugs to be developed that precisely target disease mechanisms, increasing the efficacy and avoiding side effects. These and other new advanced are leading to major changes in healthcare delivery and provide the consumer with new opportunities and complex choices. This course will focus on exploring state-of-the-art genetic, genomic, and informatic tools now available to enable personalization of healthcare. Capstone course (GGS majors). Students that enroll in this class as their capstone experience are expected to do writing or presentation assignments to fulfill their capstone requirement.

**Prerequisites:** [BY 210](#) [Min Grade: C] and [CH 117](#) [Min Grade: C] and [CH 118](#) [Min Grade: C] and ([GGSC 310](#) [Min Grade: C] or [BY 311](#) [Min Grade: C])

**GGSC 492. Undergraduate Research Seminar in Genetics and Genomic Sciences. 3 Hours.**

Elective course for non-GGS Honors students who perform at least two semesters of [GGSC 380](#). Over the course of the semester, students will learn how to develop and complete a paper or thesis on their research work while working closely with a supervising faculty member. In addition, the course will prepare them to present their research findings in a seminar format. Through these activities, students will develop effective skills in both written and oral scientific communication. Students will present a formal seminar on their research at the end of the course. This course can be taken the first semester following the completion of the research project, or alternatively can be taken concurrently with Undergraduate Research in Genetics and Genomic Sciences ([GGSC 380](#)) during the student's final semester of supervised research. Designated a Capstone course (GGS majors).

**GGSC 493. Honors Research Seminar in Genetics and Genomic Sciences. 3 Hours.**

All GGS Honors students are required to take this weekly course. Over the course of the semester, students will learn how to develop and complete a paper or thesis on their research work while working closely with a supervising faculty member. In addition, the course will prepare them to present their research findings in a seminar format. Through these activities, students will develop effective skills in both written and oral scientific communication. Students will present a formal seminar on their research at the end of the course. This course can be taken the first semester following the completion of the research project, or alternatively can be taken concurrently with Honors Research in Genetics and Genomic Sciences ([GGSC 390](#)) during the student's final semester of supervised research. Can be taken as a Capstone course (GGS majors).

**GGSC 499. GGSC Program Final. 0 Hours.**

This 0-credit hour course includes two self-paced components: One career counseling recorded video and data collection from students via CV submission and an automated exit interview for documenting learning essentials of GGSC students towards GGSC program evaluation. Students will register for [GGSC 499](#) during their last semester as a requirement for graduation with GGSC major. The GGSC program director(s) will be the faculty instructor(s) with assistance from the GGSC program manager and student advisor.