

# HUMAN GENETICS, MASTER OF SCIENCE (M.S.) WITH A CONCENTRATION IN GENOMIC DATA SCIENCE

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## Program goal

The genomic data science concentration is designed for students interested in the computational aspects of genetics and genomics research. The goal of this concentration is to provide students with training in broadly applicable analytical and computational skills from the emerging field of data science to address important questions in human and molecular genetics. The structure of the M.S. program provides a framework for the progressive development of a mastery of the current state of the subject matter in human and molecular genetics and an ability to synthesize this information and apply this foundation to the identification of key areas of investigation and experimentation in this discipline. The program relates the above framework to the development of the ability to design, implement and interpret experimental approaches which address the questions identified. In addition, students will develop skills in the various means of communicating both the core of human and molecular genetics knowledge and the expression of experimental design, results and interpretation to a variety of potential audiences.

## Student learning outcomes

1. Explain basic genetic principles and their biological basis
2. Assess the inheritance pattern of a disease or phenotype using pedigree data and calculate recurrence risk
3. Explain how different DNA variants and structural changes can affect the phenotype of an organism
4. Explain the methods used in genetic analyses and what each method can reveal
5. Clean and format large data sets for further analyses
6. Apply the appropriate statistical test in the analysis of data
7. Apply the principles of reproducibility of research such as the use of version control, access to computer code, transparency of analyses and data availability
8. Read and comprehend a primary journal article and be able to list the strengths and weaknesses of the research
9. Practice the highest ethical principles with responsible conduct in genetics research
10. Speak and present clearly to professional and lay audiences with respect to use of vocabulary and logical progression including the use of figures and tables to effectively present a research project, proposal, or findings and implications
11. Write clearly with respect to grammar, syntax, spelling, use of vocabulary and logical progression including the use of figures, tables and citations to effectively present a research project or proposal
12. Form a testable hypothesis, demonstrate the ability to design and develop experiments to test the hypothesis, collect and analyze data, and form conclusions from the analysis

## VCU Graduate Bulletin, VCU Graduate School and general academic policies and regulations for all graduate students in all graduate programs

The VCU Graduate Bulletin website documents the official admission and academic rules and regulations that govern graduate education for all graduate programs at the university. These policies are established by the graduate faculty of the university through their elected representatives to the University Graduate Council.

It is the responsibility of all graduate students, both on- and off-campus, to be familiar with the VCU Graduate Bulletin as well as the **Graduate School website** and academic regulations in individual school and department publications and on program websites. However, in all cases, the official policies and procedures of the University Graduate Council, as published on the VCU Graduate Bulletin and Graduate School websites, take precedence over individual program policies and guidelines.

**Visit the academic regulations section for additional information on academic regulations for graduate students.**

## Degree candidacy requirements

A graduate student admitted to a program or concentration requiring a final research project, work of art, thesis or dissertation, must qualify for continuing master's or doctoral status according to the degree candidacy requirements of the student's graduate program. Admission to degree candidacy, if applicable, is a formal statement by the graduate student's faculty regarding the student's academic achievements and the student's readiness to proceed to the final research phase of the degree program.

Graduate students and program directors should refer to the following degree candidacy policy as published in the VCU Graduate Bulletin for complete information and instructions.

**Visit the academic regulations section for additional information on degree candidacy requirements.**

## Graduation requirements

As graduate students approach the end of their academic programs and the final semester of matriculation, they must make formal application to graduate. No degrees will be conferred until the application to graduate has been finalized.

Graduate students and program directors should refer to the following graduation requirements as published in the Graduate Bulletin for a complete list of instructions and a graduation checklist.

**Visit the academic regulations section for additional information on graduation requirements.**

## Other information

### School of Medicine graduate program policies

The School of Medicine provides policies applicable to all programs administratively housed in the school. Information on **master's programs** is available elsewhere in this chapter of the Graduate Bulletin.

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## Admission requirements

Degree:	Semester(s) of entry:	Deadline dates:	Test requirements:
M.S.	Fall	May 1	GRE, MCAT or DAT

## Special requirements

- International applicants must achieve a minimum score of 100 on the TOEFL or a minimum of 6.5 on the IELTS.

In addition to the general admission requirements of the VCU Graduate School (<https://vcu-curr.courseleaf.com/graduate/study/admission-graduate-study/admission-requirements/>), applicants wishing to specialize in human genetics should have courses in biology, genetics, statistics and mathematics through calculus.

## Basic science, research-intensive, non-thesis curriculum for medical students

Individuals who are participants in medical training (the Doctor of Medicine program) at VCU may be eligible for enrollment in a research-intensive, non-thesis graduate curriculum. This basic science option builds on the core of disciplinary material embedded in the first two years of training in the medical school curriculum. Additional exposure is provided to specialized areas in basic science disciplines in concert with an intensive research experience leading to the preparation of a report in the form of a manuscript suitable for publication. The program is designed to be completed within 12 to 15 months. Subject matter related to the core material and/or suitable elective courses taken in the didactic phase of medical training correspond to a minimum of the equivalent of 24 graduate credit hours. The equivalent of 12 credit hours may be applied to the M.S. degree program in which the student is enrolled in accordance with Graduate School policy. Medical students interested in the basic science option should contact the M.S. graduate program director for additional information.

## Degree requirements

The Department of Human and Molecular Genetics offers a comprehensive program in graduate study leading to a Master of Science in Human Genetics. The program includes the completion of an original research project under the supervision of a faculty adviser and a background/foundation of courses that prepare students for research-oriented careers in the rapidly expanding field of human genetics. Major areas of study available to master's students in the program include clinical and molecular cytogenetics, molecular genetics, developmental genetics, cancer genetics, behavior genetics, population and quantitative genetics, genetic epidemiology, clinical genetics and genetic counseling.

In addition to the general VCU Graduate School graduation requirements (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info/>), the M.S. degree requires at least two years of full-time study for students entering with a B.S. or B.A. degree and must be completed within six years. Students must complete a minimum of 36 graduate credit hours. Students may be required to take an additional one hour of directed research after the second spring semester if needed.

Upon completing their thesis research, master's students must report their results in a thesis that is prepared in an acceptable form and style as detailed by the Graduate School. A final oral examination is scheduled after the student's thesis has been approved by the student's advisory

committee. This examination includes the subject matter of course work the student has completed as well as the thesis. It is administered by the student's graduate advisory committee who will vote on the student's performance in addition to rating them with regard to the rubrics defined by the School of Medicine.

## Curriculum requirements

Course	Title	Hours
<b>Required core courses</b>		
HGEN 501	Introduction to Human Genetics	3
HGEN 502	Advanced Human Genetics	3
HGEN 510	Classic Papers in Human Genetics	1
HGEN 605	Experimental Methods in Human Genetics (variable credit; taken two semesters for a minimum of five credits) <sup>1</sup>	5
HGEN 610	Current Literature in Human Genetics <sup>2</sup>	1
HGEN 611	Data Science I	3
HGEN 690	Genetics Research Seminar <sup>3</sup>	2
<b>Required additional courses</b>		
BIOS 543 or HGEN 651	Graduate Research Methods I Statistics for Genetic Studies I	3
BIOS 544 or HGEN 652	Graduate Research Methods II Statistics for Genetic Studies II	3
BIOS 567		3
HGEN 603	Mathematical and Statistical Genetics	3
HGEN 612	Data Science II	3
OVPR 601 or OVPR 602 or OVPR 603	Scientific Integrity Responsible Scientific Conduct Responsible Conduct of Research	1
<b>Thesis research</b>		
HGEN 697	Directed Research in Genetics <sup>4</sup>	2
Total Hours		36

1

The student and faculty member will design a project that can reasonably be completed in 10 weeks. The student will spend approximately 10 weeks in that laboratory for a minimum of eight hours a week. The student's performance in the laboratory will serve as the basis for the grade that is received for this course.

2

HGEN 610 should be taken every fall and spring semester beginning the spring term of the first year.

3

HGEN 690 should be taken every fall and spring semester.

4

HGEN 697 should be taken every semester following the first year of study.

**The minimum number of graduate credit hours required for this degree is 36.**

## Typical plan of study

The M.S. degree requires at least two years of full-time study for students entering with a B.S. or B.A. degree and must be completed within six years. Students complete this degree program on average within two years. Students should refer to their program websites (<https://gen.vcu.edu/graduate-and-training-programs/ms-in-human-genetics/curriculum/>) and talk with their graduate program directors or advisers for information about typical plans of study and registration requirements.

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**Program website:** [gen.vcu.edu](https://gen.vcu.edu) (<https://gen.vcu.edu/>)