HUMAN GENETICS, DOCTOR OF PHILOSOPHY (PH.D.)/GENETIC COUNSELING, MASTER OF SCIENCE (M.S.) [DUAL DEGREE]

Program accreditation
Accreditation Council of Genetic Counseling

Program goal
Provide training in human and molecular genetics and competency in genetic counseling

The program is designed to provide students with the skills required to advance to positions as researchers and trainers in a broad spectrum of positions in human and molecular genetics. The structure of the 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, the program 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.

Eligibility for certification by the American Board of Genetic Counseling

To prepare individuals for careers in genetic counseling and human genetics, successful candidates will demonstrate competency in all four genetic counseling domains: I – genetics expertise and analysis; II – interpersonal, psychosocial and counseling skills; III – education; and IV – professional development and practice.

The Department of Human and Molecular Genetics offers training that combines preparation for a career as a genetic counselor with research-based doctoral training in a coordinated program that integrates the complementary aspects of these two degree categories. In order to be admitted to this dual-degree program, an applicant must be accepted into both the M.S. and Ph.D. programs.

Student learning outcomes

1. Oral communication skills: The candidate will demonstrate the achievement of an appropriate level of oral communication skills with respect to the content, organization, logical flow, presentation and appropriate use of language incorporating the use of visual aids, as measured by rubric. This is also achieved by evaluations of clinical rotations, both written and verbal, that are based on the competencies established by the American Board of Genetic Counseling and the scope of practice as set forth by the National Society of Genetic Counselors.

2. Written communication skills: The candidate will demonstrate the achievement of an appropriate level of written communication skill with respect to grammar, syntax, spelling and use of vocabulary to effectively present information including the use of figures, tables and citations as measured by rubric.

3. Experimental design: The candidate will demonstrate the achievement of an appropriate level of competence in the ability to appraise, modify and/or create, and implement experimental protocols and to design and develop experiments as measured by rubric.

4. Problem-solving skills: The candidate will demonstrate an appropriate level of skill in the identification and selection of meaningful problems to be addressed in research in human and molecular genetics, including the ability to defend said identifications and to design and develop appropriate methods to solve said problems as measured by rubric.

5. Integrated knowledge of human and molecular genetics: The candidate will demonstrate an appropriate level of knowledge of the current elements of human and molecular genetics as related to disciplinary specialization and a more detailed understanding of the individual area of scholarship, including an appropriate familiarity with the research literature and the ability to evaluate and critique publications as measured by rubric.

6. Competency in practice: The candidate should demonstrate development of competency in the responsible practice of genetic counseling. This will be assessed in the clinical setting by certified genetic counselors and medical geneticists. The assessment is based upon the core clinical competencies established by the the Accreditation Council for Genetic Counseling (ACGC). These competencies are documented with written and oral evaluations at the completion of each of the seven clinical rotations by the rotation supervisor.

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 (http://www.graduate.vcu.edu) 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. (http://bulletin.vcu.edu/academic-regels)

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. (http://bulletin.vcu.edu/academic-regs/grad/candidacy)

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. (http://bulletin.vcu.edu/academic-regs/grad/graduation-info)

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 in the Graduate Bulletin at Master's programs (http://bulletin.vcu.edu/graduate/school-medicine/graduate-programs/masters); information on doctoral programs can be found at P (http://www.pubapps.vcu.edu/Bulletins/about/?uid=10046&iid=30114) Ph.D. programs (http://bulletin.vcu.edu/graduate/school-medicine/graduate-programs/phd).

To qualify as a dual-degree student in any of the training paradigms which appear in the Bulletin, a student must have evidence of having been simultaneously enrolled in one or more courses of both of the programs constituting the "dual degree" for at least one semester.

Apply online at graduate.admissions.vcu.edu (http://www.graduate.admissions.vcu.edu).

Admission requirements

<table>
<thead>
<tr>
<th>Degree:</th>
<th>Semester(s) of entry:</th>
<th>Deadline dates:</th>
<th>Test requirements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ph.D. and M.S.</td>
<td>Fall</td>
<td>Jan 15</td>
<td>GRE within five years of application (MCAT or DAT is not acceptable in lieu of GRE.)</td>
</tr>
</tbody>
</table>

Special requirements
- Applications for the program must be submitted to the Biomedical Sciences Doctoral Portal — School of Medicine — Ph.D. selected from the drop-down menu of programs on the VCU online application form. The dual degree box on the application must also be checked.
- International applicants must score 100 or greater on the TOEFL.
- It is recommended that all prerequisite courses have been completed within 10 years of application.

Applicants must meet all general admission requirements of the VCU Graduate School (http://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements). In order to be admitted to this dual-degree program, an applicant must apply to and be accepted into both the M.S. and the Ph.D. programs.

Human Genetics, Doctor of Philosophy
Successful applicants will typically have the following credentials:
1. A baccalaureate degree or its equivalent at the time of enrollment, with an undergraduate GPA of 3.5
2. Current GRE scores (taken within the past five years), with scores at the 75th percentile or greater preferred
3. TOEFL scores of 600 (pBT), 250 (cBT) or 100 (iBT) for individuals for whom English is a second language; or 6.5 on the IELTS (To report GRE or TOEFL score, use VCU Code 5570.)
4. Personal statements, which should include: long-term career goals to assess reasons behind the candidate’s application; how a Ph.D. in biomedical science helps achieve those goals; the factors motivating a career in research; research experience, including dates, places and duration
5. Three letters of recommendation that speak to the scientific competency and experience of the applicant
6. The equivalent of two semesters of general chemistry, two semesters of organic chemistry and two semesters of upper-level biology courses (e.g. cell biology, molecular biology, biochemistry, genetics, neuroscience, physiology, biophysics, etc.)

The Department of Human and Molecular Genetics offers a comprehensive program in graduate study leading to a Doctor of Philosophy 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 Ph.D. 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. Once core course work requirements have been completed, the student’s course plan is tailored to meet individual needs with regard to the area of research focus. A concentration in quantitative human genetics is available for those planning a career in this area. For more detailed information on the program visit gen.vcu.edu/graduate-programs/phd-in-human-genetics (http://gen.vcu.edu/graduate-programs/phd-in-human-genetics).

Genetic Counseling, Master of Science (M.S.)
Applicants should have successfully completed undergraduate training and hold a baccalaureate degree. Prerequisites for admission include six credit hours each of biology, chemistry and behavioral science (psychology, anthropology, sociology, religion and philosophy) and three credit hours each of biochemistry, statistics and genetics. Students accepted to the program are generally drawn from applicants with an undergraduate minimum grade point average of 3.0 (on a 4.0 scale or equivalent), with an average GPA of 3.3 to 3.5 for matriculating students. The Graduate Record Examination is required for admission; VCU does not substitute with the MCAT. Matriculating students generally have GRE verbal scores at or above 153, quantitative scores at or above 144 and a performance above a score of 3.5 on the analytical section. Applicants holding an undergraduate degree from foreign institutions must display an acceptable level of English proficiency by achieving a
score of 250 on the computer-based TOEFL examination or 600 on the written version. (The program participates in the Association of Genetic Counseling Program Directors program match. Please see the National Society of Genetic Counselors website for information for prospective students at nsgc.org/p/cm/l/d/fid=44#accept [http://nsgc.org/p/cm/l/d/fid=44%23accept].)

Additionally, successful applicants often have experience with shadowing genetic counselors and medical geneticists, interviewing genetic counselors and exposure to individuals with physical and cognitive disabilities. Exposure to crises hotlines, support groups and community activities related to individuals with disability and genetic conditions is also helpful.

In the last five certification cycles (2007 to 2012) VCU graduates have an 86 percent pass rate on the American Board of Genetic Counseling/Accreditation Council of Genetic Counseling national certification examination.

Degree requirements

In addition to the general VCU Graduate School graduation requirements (http://bulletin.vcu.edu/academic-regs/grad/graduation-info), the Ph.D. degree requires at least three years of study for students entering with a baccalaureate degree and must be completed within eight years. Students in the dual-degree program must complete a minimum of 90 graduate credit hours.

The training programs in human and molecular genetics are intended to set the tone for a career and lifelong learning in human and molecular genetics by developing the student’s knowledge of the field and skills in writing, laboratory techniques, critical thinking, data interpretation, study design, literature research and review, and integration of data from multiple disciplines while fostering the student’s development as an independent researcher, laboratory director or teacher. These programs also seek to provide students with a core foundation of knowledge that will equip them to carry out translational research and for later work leading to certification by the American Board of Medical Genetics.

Students working toward the Ph.D. degree in Human Genetics pass through two stages of graduate study. The first stage consists primarily of course work recommended by the department and the student’s graduate committee; the second stage consists of original research leading to the doctoral dissertation. Ph.D. students are expected to complete the required course work within four semesters and one summer, and they are intended to set the tone of a lifelong research career. In order to be considered in good academic standing, a student must maintain a 3.0 grade point average. The focus then shifts to the student’s development as an independent researcher with emphasis being placed upon the development and execution of an original research project leading to the doctoral dissertation.

After the second year of study, students will take the Ph.D. candidacy examination. This exam comprises two parts, a departmental comprehensive examination and a written NIH-style application with an oral examination administered by the student’s graduate committee. Upon successfully completing the departmental comprehensive and the oral comprehensive exam, the student is admitted to Ph.D. candidacy. At this point, students are expected to develop and conduct dissertation research projects and to write and defend their dissertations describing their dissertation research.

Curriculum requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>ANAT 612</td>
<td>Human Embryology</td>
<td>2</td>
</tr>
<tr>
<td>ANAT 620</td>
<td>Scientific Writing and Grantsmanship</td>
<td>2,3</td>
</tr>
<tr>
<td>BIOS 543</td>
<td>Graduate Research Methods I</td>
<td>3</td>
</tr>
<tr>
<td>or CCTR 702</td>
<td>Statistics for Genetic Studies I</td>
<td></td>
</tr>
<tr>
<td>HGEN 501</td>
<td>Introduction to Human Genetics</td>
<td>1,3</td>
</tr>
<tr>
<td>HGEN 502</td>
<td>Advanced Human Genetics</td>
<td>1,3</td>
</tr>
<tr>
<td>HGEN 510</td>
<td>Classic Papers in Human Genetics</td>
<td>1</td>
</tr>
<tr>
<td>HGEN 525</td>
<td>Practice of Genetic Counseling</td>
<td>3</td>
</tr>
<tr>
<td>HGEN 526</td>
<td>Practice of Genetic Counseling</td>
<td>3</td>
</tr>
<tr>
<td>HGEN 527</td>
<td>Medical Genetics</td>
<td>3</td>
</tr>
<tr>
<td>HGEN 528</td>
<td>Medical Genetics</td>
<td>3</td>
</tr>
<tr>
<td>HGEN 600</td>
<td>Clinical Genetics</td>
<td>15</td>
</tr>
<tr>
<td>HGEN 607</td>
<td>Processes in Genetic Counseling I</td>
<td>1</td>
</tr>
<tr>
<td>HGEN 608</td>
<td>Processes in Genetic Counseling II</td>
<td>1</td>
</tr>
<tr>
<td>HGEN 610</td>
<td>Current Literature in Human Molecular Genetics</td>
<td>7</td>
</tr>
<tr>
<td>HGEN 611</td>
<td>Data Science I</td>
<td>3</td>
</tr>
<tr>
<td>HGEN 614</td>
<td>Pathogenesis of Human Genetic Disease</td>
<td>3</td>
</tr>
<tr>
<td>or HGEN 603</td>
<td>Mathematical and Statistical Genetics</td>
<td></td>
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<tr>
<td>HGEN 615</td>
<td>Techniques in Genetic Counseling</td>
<td>3</td>
</tr>
<tr>
<td>HGEN 622</td>
<td>Cancer Genetic Counseling</td>
<td>1</td>
</tr>
<tr>
<td>HGEN 690</td>
<td>Genetics Research Seminar</td>
<td>1,3,5</td>
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<tr>
<td>HGEN 697</td>
<td>Directed Research in Genetics (variable 1-15 credits)</td>
<td>10</td>
</tr>
<tr>
<td>IBMS 600</td>
<td>Laboratory Safety</td>
<td>1</td>
</tr>
<tr>
<td>IBMS 620</td>
<td>Laboratory/Clinical Rotations (two-credit course taken for three rotations)</td>
<td>6</td>
</tr>
<tr>
<td>OVPR 601</td>
<td>Scientific Integrity</td>
<td>1</td>
</tr>
<tr>
<td>or OVPR 602</td>
<td>Responsible Scientific Conduct</td>
<td></td>
</tr>
<tr>
<td>or OVPR 603</td>
<td>Responsible Conduct of Research</td>
<td></td>
</tr>
<tr>
<td>PATH 691</td>
<td>Special Topics in Modern Instrumental Methods</td>
<td>2</td>
</tr>
</tbody>
</table>

Total Hours: 90

1. M.S. in Genetic Counseling requirement
2. HGEN 614 fulfills this requirement
3. Ph.D. in Human Genetics requirement
4. HGEN 610 should be taken every fall and spring semester beginning the spring term of the first year but not required in the last year of study.
5. HGEN 697 should be taken every fall and spring semester
6. HGEN 697 should be taken every semester following the first year of study
7. This course is divided into two distinct sections — a cytogenetics section and a molecular genetics section. The intent of this rotation is for students to learn the behind-the-scenes wet lab activities that lead to
genetic information relevant for clinical counseling. Some dual-degree students may choose a thesis project that specializes in wet lab research, either cytogenetics or molecular genetics. With permission from the adviser and the genetic counseling program director, part or all of this rotation may not be required.

**Electives (optional)**
No electives are required for the dual-degree program. If the student chooses to take electives, however, suggested electives include the following:

<table>
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<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Select 0-3 credits from IDDS 602, PATH 670, courses at the 500-level or above in ANAT, BIOC, BIOL, BIOS, BNFO, HGEN, LFSC, MICR, NEUS, PHTX and PHIS, excluding laboratory courses, courses specifically for professional programs, directed research, independent study, seminar, current topic courses, MICR 608 and MICR 609</td>
<td></td>
<td>0-3</td>
</tr>
</tbody>
</table>

**Total graduate credit hours required (minimum) 90**

**Typical plan of study**
Many students often end up taking more than the minimum number of hours required for a degree program. The total number of hours may vary depending upon the program, nature of research being conducted or in the enrollment or funding status of the student. The program requires at least three years of study for students entering with a B.S. or B.A. degree and must be completed within eight years. Students complete these degree programs on average within six years. Students should refer to their program websites (https://gen.vcu.edu/graduate-and-training-programs/dual-degree-program-in-human-genetics--genetic-counseling) and talk with their graduate program directors or advisers for information about typical plans of study and registration requirements.

**Graduate program director**
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**Additional contacts**
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John M. Quillin, Ph.D.
Director, dual-degree program (M.S. in Genetic Counseling/Ph.D. in Human Genetics)
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(804) 628-1925

**Program website:** gen.vcu.edu (http://www.gen.vcu.edu)