

# MEDICINE, DOCTOR OF (M.D.)/ INTEGRATIVE LIFE SCIENCES, DOCTOR OF (PH.D.) WITH A CONCENTRATION IN BEHAVIORAL AND STATISTICAL GENETICS [DUAL DEGREE PROGRAM]

Graduate study in the Ph.D. in Integrative Life Sciences with a concentration in behavioral and statistical genetics is a highly individualized undertaking and required course work represents only one component. Each student's program is tailored to meet his or her particular interests, with the primary emphasis on developing research skills and the capacity for independent scholarship and with the recognition that career goals for many M.D.-Ph.D. physician-scientists are distinct from those of most Ph.D. trainees.

## Program goals

The objectives of this dual degree program are:

- Students in the M.D.-Ph.D. program in integrative life sciences with a concentration in behavioral and statistical genetics will acquire the foundational skills to allow them, after further clinical specialty and postdoctoral research training, to become independent physician-scientists. Program graduates ultimately pursue careers in academic medicine, biotechnology and the pharmaceutical industry, research institutes, and government agencies as clinicians, scientists, educators and administrators.
- Students will gain a progressive mastery of concepts in behavioral and statistical genetics and related disciplines, an understanding of the current state of research investigations in the field, an ability to synthesize information and apply foundational concepts to identify key areas for innovative investigation and experimentation, and the knowledge to design, execute and interpret experiments and publish studies that address the questions identified.
- Students will develop skills in various means of communicating core knowledge in the field and the details of experimental design, results and interpretation to a variety of potential audiences.

Among the many benefits offered by participation in the dual degree program are the following:

- Students will have the foundation and training in behavioral and statistical genetics and in medicine to conduct basic and translational research that will enable them to take bedside observations to the bench and the results of bench research to the bedside to advance both the underlying science and patient health.
- Students have the opportunity to participate in clinical research during the M4 year.
- Students with M.D.-Ph.D. training are highly competitive for positions in leading physician-scientist clinical training programs and faculty positions in academic medical centers; they are well-positioned to ultimately take on leadership roles in academic medicine, industry and government.
- Tuition, fees and a stipend are provided throughout both the medical and graduate phases of training.

The diplomas for this dual degree program are awarded simultaneously upon completion of the requirements for both degrees.

## Student learning outcomes

The student learning outcomes described on the integrative life sciences Ph.D. program page (<https://bulletin.vcu.edu/graduate/vcu-life-sciences/integrative-life-sciences-phd-concentration-behavioral-statistical-genetics/>) also apply to M.D.-Ph.D. students.

## Admission requirements

To be considered for the VCU M.D.-Ph.D. program, prospective students must apply to the medical school through the American Medical College Application Service (<https://students-residents.aamc.org/applying-medical-school/applying-medical-school-process/applying-medical-school-amcas/>). Please designate "Combined Graduate/Medical Degree" on your AMCAS application. The deadline for application to the program for admission in the fall semester is listed on the AMCAS web site.

In rare situations when resources allow, students matriculated in the medical school class may be considered for admission to the M.D.-Ph.D. program, usually near the start of the M1 academic year. For additional details, see the M.D.-Ph.D. dual degree opportunities page (<https://bulletin.vcu.edu/professional-studies/medicine/md-phd-opportunities/>).

## Degree requirements

The dual degree program is designed to allow students to complete the first two years of medical school and the USMLE Step 1 examination (M1, M2) before undertaking graduate training (G1 and subsequent years). After successfully defending the Ph.D. dissertation, students complete the remaining clinical years (M3, M4) of medical training. Nevertheless, important aspects of dual degree training are integrated across the program. These include M.D.-Ph.D.-specific graduate courses taken during M1 and M2 that supplement the medical curriculum and emphasize research and translational aspects of M.D. course topics and required M3 clinical rotations integrated into the graduate phase. Opportunities for research experience begin prior to entering the graduate phase (pre-matriculation and summers after M1 and M2), when students spend time working in several faculty laboratories of their choice. These laboratory rotations enable students to examine faculty research projects, experimental approaches and laboratory environments, and to select an area for specialization. After completing M2, students are required to take the USMLE Step 1 exam, followed by one or two required M3 clinical rotations lasting six to eight weeks in total. They then transition into graduate studies.

During the first year of graduate training (G1), students take graduate courses selected to optimize their training and devote time to independent research under the guidance of a faculty adviser. During G2 and subsequent years, most effort is devoted to independent research, as part of the course requirements are satisfied by the M1 and M2 M.D. curriculum (see below). On satisfactory completion of course work, students must pass written and oral comprehensive examinations to qualify for degree candidacy. Candidacy examinations for the dual M.D.-Ph.D. are normally completed during G2. Following admission to candidacy, each student must conduct a substantial original research project, prepare a written dissertation, present their work in a seminar and defend it successfully in an oral examination. Department-sponsored seminars and other activities give students opportunities to discuss their research interests with visiting scientists and to present their research both internally and at national professional meetings.

**The Ph.D. component of training in integrative life sciences with a concentration in behavioral and statistical genetics for M.D.-Ph.D. students normally takes at least four years to complete.** Courses taken during the M1 and M2 years of medical school satisfy a number of course requirements, and additional elective courses are completed in the G1 year. M.D.-Ph.D. students, if eligible under NIH rules, are required to prepare and submit an NIH F30 predoctoral training grant application, which is usually based on the dissertation proposal defended during the comprehensive examinations. M.D.-Ph.D. students also are encouraged to submit predoctoral training grant applications to other funding sources. Acceptance of a peer-reviewed first-author (or co-first-author) manuscript in a scientific journal indexed in PubMed or Web of Science that is based on experimental research conducted during Ph.D. training (rather than a review, commentary, case note or similar publication) is required of all M.D.-Ph.D. students prior to returning to the M3 phase of medical school.

In addition to completing VCU School of Medicine requirements for the M.D. degree and the general VCU Graduate School graduation requirements (<https://bulletin.vcu.edu/academic-regs/grad/graduation-info/>), students must complete a minimum of 64 credit hours for the Ph.D., including directed research.

## Curriculum requirements for the M.D.

Based on the equivalent knowledge acquired by successfully completing MEDI 100, MEDI 150, MEDI 200, MEDI 250 and IBMS 653 during the M1 and M2 years, eight credits are satisfied (LFSC 631, EPID 646 and HGEN 501) for the Ph.D. Courses taken to satisfy Ph.D. requirements do not satisfy M.D. requirements.

Course	Title	Hours
<b>M1 year</b>		
Fall semester (MEDI 100)	Transition to Medical School	
Practice of Clinical Medical Bootcamp	Molecular Basis of Health and Disease	
Principles of Physiology	Principles of Autonomics and Pharmacology	
Immunity and Infection	Foundations of Disease	
Practice of Clinical Medicine	Patient, Physician and Society	
Population Health and Evidence Based Medicine	Ultrasound	
Diagnostic Reasoning	Geriatrics	
Spring semester (MEDI 150)	Marrow (Hematology / Oncology)	
Movement (Musculoskeletal)	Gastrointestinal	
Endocrine	Reproduction	
Practice of Clinical Medicine	Patient, Physician and Society	
Population Health and Evidence Based Medicine	Ultrasound	
Diagnostic Reasoning	Geriatrics	

IPEC 502	Interprofessional Quality Improvement and Patient Safety	1
<b>M2 year</b>		
Fall semester (MEDI 200)	Cardiovascular	
Pulmonary	Renal	
Neuroscience	Practice of Clinical Medicine	
Patient, Physician and Society	Population Health and Evidence Based Medicine	
Ultrasound	Diagnostic Reasoning	
Geriatrics	Spring semester (MEDI 250)	
Behavioral Sciences	Practice of Clinical Medicine	
Step 1 Study	<b>M3 year</b>	
Fall and spring semesters (MEDI 300)	M3 Transition to Clerkships	
Internal Medicine Clerkship	Surgery Clerkship	
OB/GYN Clerkship	Pediatrics Clerkship	
Family Medicine Clerkship	Neurology Clerkship	
Psychiatry Clerkship	Ambulatory Clerkship	
Foundational Career Exploratory electives	Patient, Physician and Society	
Population Health	Telehealth	
<b>M4 year</b>		
Fall and spring semesters (MEDI 400)	Transition to M4 - Clinical Concentrations	
Two acting internships, one ward and one critical care (four weeks each)	Step 2 Clinical Knowledge exam	
28 weeks of clinical electives	Up to 20 weeks of non-clinical electives	
Patient, Physician and Society	Interprofessional Critical Care Simulations	
IPEC 561	IPE Virtual Geriatric Case	2
Transition to Residency		

## Curriculum requirements for the Ph.D.

Based on the equivalent knowledge acquired by successfully completing MEDI 100, MEDI 150, MEDI 200, MEDI 250 and IBMS 653 during the M1 and M2 years, eight credits are satisfied (for LFSC 631, EPID 646 and HGEN 501) for the Ph.D. Students are required to take additional credits of M.D.-Ph.D.-specific courses listed below. M.D.-Ph.D. students should consult with the ILS-BSG program director.

Course	Title	Hours
<b>Required core courses</b>		
LFSC 630	Integrative Life Sciences Research	2
LFSC 631	Student Seminar in Integrative Life Sciences (one-credit course taken for two semesters; satisfied by IBMS 653)	2
LFSC 690	Research Seminar in Integrative Life Sciences (one-credit course taken for two semesters)	2
<b>Additional required courses</b>		
CCTR 702 or HGEN 651	Statistics for Genetic Studies I	3
CCTR 703 or HGEN 652	Statistics for Genetic Studies II	3
EPID 646	Epidemiology of Psychiatric and Substance Use Disorders (satisfied by M1/M2 study)	3
HGEN 501	Introduction to Human Genetics (satisfied by M1/M2 study)	3
HGEN 502	Advanced Human Genetics	3
HGEN 610	Current Literature in Human Genetics (one-credit course taken for two semesters)	2
HGEN 611	Data Science I (technologies course)	3
HGEN 620	Principles of Human Behavioral Genetics	3
IBMS 624	Research Reproducibility and Transparency	1
IBMS 651	M.D.-Ph.D. Journal Club (one-credit course, required fall and spring semester of M1)	2
IBMS 652	M.D.-Ph.D. Science and Disease	1
IBMS 653	M.D.-Ph.D. Research Seminar (0.5 credit course, required fall and spring of M1, fall of M2, and during G phase except in semester of defense)	2
IBMS 697	M.D.-Ph.D. Directed Research (three credits taken each summer following M1 and M2; satisfies six credits of LFSC 697)	6
OVPR 601 or OVPR 602 or OVPR 603	Scientific Integrity Responsible Scientific Conduct Responsible Conduct of Research	1
<b>Elective courses</b>		
Select six credit hours from the following or other courses as recommended by the graduate advisory committee and approved by the graduate program director:		6
GRAD 614	Introduction to Grant Writing	
HGEN 517	Introduction to R Programming for Statistical Genetics	
HGEN 603	Mathematical and Statistical Genetics	
HGEN 612	Data Science II	
HGEN 619	Quantitative Genetics	
<b>Directed research</b>		

LFSC 697	Directed Research in Integrative Life Sciences (variable credit course; six credits satisfied by IBMS 697)	28
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**Total Hours 64**

The minimum number of graduate credit hours required for this degree is 64.

## Plan of study timeline

The dual-degree program blends medical and graduate training supplemented with M.D.-Ph.D.-specific course work and opportunities during the medical (M) and graduate (G) phases of the curriculum that culminates in the simultaneous awarding of the M.D. and Ph.D. degrees. The timeline of medical and graduate training is as follows:

### Year 1 (M1): Mostly preclinical medical course work, some research

- Preclinical medical courses
- M.D.-Ph.D. Journal Club (two semesters)
- M.D.-Ph.D. Seminar (two semesters)
- Research rotations (and pre-matriculation research opportunity)

### Year 2 (M2): Mostly preclinical medical course work, some research and clinical rotation

- Preclinical medical courses
- M.D.-Ph.D. Science and Disease (one semester)
- M.D.-Ph.D. Seminar (one semester)
- Research rotations
- Preparation for USMLE Step 1
- Required M3 clinical rotation(s) (one or two, lasting six to eight weeks total)

### Year 3 (G1): Graduate course work and research, some clinical experiences

- Graduate program course work
- M.D.-Ph.D. Seminar (two semesters)
- Directed research (begin dissertation research)
- Opportunities for clinical experience

### Years 4-5 (G2-G3) and additional year if needed: Primarily research, some clinical experiences

- Ph.D. Qualifying Examination, admission to candidacy
- Submit NIH F30 fellowship application
- Directed research (completion of dissertation research)
- Graduate program course work
- M.D.-Ph.D. Seminar
- Required M3 ambulatory care rotation
- Publication of peer-reviewed first-author paper
- Dissertation defense

### Years 6-7: M3-M4: Completion of clinical training, clinical research experience

- Clinical rotations
- Clinical and non-clinical elective

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- Preparation for USMLE Step 2
- M4 Clinical research capstone project

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