

# MEDICINE, DOCTOR OF (M.D.)/ NEUROSCIENCE, DOCTOR OF (PH.D.) [DUAL DEGREE]

Graduate study in the neuroscience program in the School of Medicine 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 neuroscience 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 pharmaceutical industry, research institutes and government agencies as clinicians, scientists, educators and administrators.
- Students will gain a progressive mastery of concepts in neuroscience 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 neuroscience 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, faculty positions in academic medical centers, and 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 in the neuroscience Ph.D. program page (<http://bulletin.vcu.edu/graduate/school-medicine/neuroscience-phd/>) 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 (<http://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 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 6 to 8 weeks 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 coursework, 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 at national professional meetings.

**The Ph.D. component of training in neuroscience for M.D.-Ph.D. students normally takes at least three years to complete.** Courses taken during the M1 and M2 years of medical school satisfy a number of core 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. 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 (<http://bulletin.vcu.edu/academic-regs/grad/graduation-info/>), students must complete a minimum of 69 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 and MEDI 250 during the M1 and M2 years, 14 credits for the Ph.D. are satisfied (for BIOC 503, BIOC 504, ANAT 610, BIOC 661). Courses taken to satisfy Ph.D. requirements do not satisfy M.D. requirements.

| Course                               | Title                                         | Hours |
|--------------------------------------|-----------------------------------------------|-------|
| <b>M1 year</b>                       |                                               |       |
| Fall semester (MEDI 100): 20 weeks   |                                               |       |
|                                      | Orientation 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                          |       |
| Spring semester (MEDI 150): 21 weeks |                                               |       |
|                                      | Marrow and Movement                           |       |
|                                      | Gastrointestinal                              |       |
|                                      | Endocrine                                     |       |
|                                      | Reproduction                                  |       |
|                                      | Practice of Clinical Medicine                 |       |
|                                      | Patient, Physician and Society                |       |
|                                      | Population Health and Evidence Based Medicine |       |
|                                      | Ultrasound                                    |       |
|                                      | Diagnostic Reasoning                          |       |
| <b>M2 year</b>                       |                                               |       |
| Fall semester (MEDI 200): 22 weeks   |                                               |       |
|                                      | Cardiovascular                                |       |
|                                      | Pulmonary                                     |       |
|                                      | Renal                                         |       |
|                                      | Mind, Brain and Behavior                      |       |
|                                      | Practice of Clinical Medicine                 |       |
|                                      | Patient, Physician and Society                |       |
|                                      | Population Health and Evidence Based Medicine |       |
|                                      | Ultrasound                                    |       |
|                                      | Diagnostic Reasoning                          |       |
| Spring semester (MEDI 250): 12 weeks |                                               |       |
|                                      | Step 1 Study                                  |       |

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| <b>M3 year</b>                                                           |  |  |
| Fall and spring semesters (MEDI 300): 50 weeks                           |  |  |
| M3 Transitions to Clerkships Workshops                                   |  |  |
| Internal Medicine Clerkship                                              |  |  |
| Surgery Clerkship                                                        |  |  |
| OB/GYN Clerkship                                                         |  |  |
| Pediatrics Clerkship                                                     |  |  |
| Family Medicine Clerkship                                                |  |  |
| Neurology Clerkship                                                      |  |  |
| Psychiatry Clerkship                                                     |  |  |
| Ambulatory Clerkship                                                     |  |  |
| Foundational Career Exploratory Elective (FE)                            |  |  |
| Patient, Physician and Society                                           |  |  |
| Population Health                                                        |  |  |
| <b>M4 year</b>                                                           |  |  |
| Fall and spring semesters (MEDI 400): 49 weeks                           |  |  |
| Two acting internships, one ward and one critical care (four weeks each) |  |  |
| Step 2 Clinical Knowledge and Clinical Skills exams                      |  |  |
| Five specialty electives (four weeks each)                               |  |  |
| Up to five non-clinical electives (four weeks each)                      |  |  |
| Population Health                                                        |  |  |
| Interprofessional Critical Care Simulations                              |  |  |
| M4 Capstone Course                                                       |  |  |

## Curriculum requirements for the Ph.D.

Based on the equivalent knowledge acquired by successfully completing MEDI 100, MEDI 150, MEDI 200 and MEDI 250 during the M1 and M2 years, 14 credits are satisfied (for BIOC 503, BIOC 504, ANAT 610, BIOC 661). M.D.-Ph.D. students complete six credits of IBMS 697 in the summers after M1 and M2 to satisfy the six credits of IBMS 620 required for the Ph.D. degree. Students are required to take additional credits of M.D.-Ph.D.-specific courses listed below.

| Course                       | Title                                                                                                            | Hours |
|------------------------------|------------------------------------------------------------------------------------------------------------------|-------|
| <b>Required core courses</b> |                                                                                                                  |       |
| ANAT 610                     | Systems Neuroscience (satisfied by M1/M2 study)                                                                  | 4     |
| ANAT 615                     | Techniques in Neuroscience and Cell Biology                                                                      | 3     |
| ANAT 620                     | Scientific Writing and Grantsmanship                                                                             | 2     |
| ANAT 630                     | Research Presentations (one-credit course, required each semester in graduate phase for a minimum four credits)  | 4     |
| BIOC 503                     | Biochemistry, Cell and Molecular Biology (satisfied by M1/M2 study)                                              | 5     |
| BIOC 504                     | Biochemistry, Cell and Molecular Biology (satisfied by M1/M2 study)                                              | 5     |
| BIOC 661                     | Critical Thinking (one-credit course, required each fall and spring semester; two credits satisfied by IBMS 651) | 2     |
| IBMS 600                     | Laboratory Safety                                                                                                | 1     |
| NEUS 609                     | Cellular and Molecular Neuroscience                                                                              | 4     |

|          |                                                                                                                        |   |
|----------|------------------------------------------------------------------------------------------------------------------------|---|
| NEUS 690 | Neuroscience Research Seminar (one-credit course, required each semester in graduate phase for a minimum four credits) | 4 |
|----------|------------------------------------------------------------------------------------------------------------------------|---|

- 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**

|                                        |                                                                                                                                               |   |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---|
| <b>Additional required courses</b>     |                                                                                                                                               |   |
| 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; satisfies BIOC 661)                                      | 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 IBMS 620)                         | 6 |
| OVPR 601<br>or OVPR 602<br>or OVPR 603 | Scientific Integrity<br>Responsible Scientific Conduct<br>Responsible Conduct of Research                                                     | 1 |

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

**Contact**

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**Program website:** [medschool.vcu.edu/education/phd\\_programs/neuroscience/](https://medschool.vcu.edu/education/phd_programs/neuroscience/)  
[https://medschool.vcu.edu/education/phd\\_programs/neuroscience/](https://medschool.vcu.edu/education/phd_programs/neuroscience/)

|                                                                                                                                           |  |   |
|-------------------------------------------------------------------------------------------------------------------------------------------|--|---|
| <b>Elective courses</b>                                                                                                                   |  |   |
| Select six credits from the following or as recommended by the graduate advisory committee and approved by the graduate program director: |  | 6 |

|          |                                                       |  |
|----------|-------------------------------------------------------|--|
| ANAT 625 | Anatomy of Risk and Resilience: The Biology of Stress |  |
| BIOS 543 | Graduate Research Methods I                           |  |
| IBMS 635 | Cellular Signalling                                   |  |
| NEUS 640 | Neurobiology of CNS Diseases                          |  |
| PHIS 615 | Signal Detection in Sensory Systems                   |  |
| PHIS 620 | Ion Channels in Membranes                             |  |
| PHTX 548 | Drug Dependence                                       |  |
| PHTX 632 | Neurochemical Pharmacology                            |  |
| PHTX 633 | Behavioral Pharmacology                               |  |
| PHTX 636 | Principles of Pharmacology                            |  |

|                              |                                                                    |    |
|------------------------------|--------------------------------------------------------------------|----|
| <b>Dissertation research</b> |                                                                    |    |
| NEUS 697                     | Directed Research (variable credit course, required each semester) | 18 |

|             |    |
|-------------|----|
| Total Hours | 69 |
|-------------|----|

The minimum number of graduate credit hours required for this degree is 69.

## 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)