NEUROSCIENCE, DOCTOR OF PHILOSOPHY (PH.D.)

Program mission
The program offers an interdepartmental, integrated curriculum for graduate study leading to the Ph.D. in Neuroscience. The program prepares students to teach in the neuroscience disciplines at a university or academic health center and is distinguished by its objective to prepare students to function as independent research investigators.

Program goals
Upon completion of the Ph.D. in Neuroscience degree program, students will have:

1. Demonstrated a mastery of neuroscience and related bioscience knowledge.
2. Developed effective oral, written and electronic communication skills.
3. Demonstrated the ability to formulate, design, implement and interpret experimental approaches.
4. Reached a level of competency to advance to positions as neuroscience researchers and teachers in a broad spectrum of academic, industrial and government employment venues.
5. Successfully obtained employment in a neuroscience-related position.

Student learning outcomes

1. Acquire the core knowledge of neuroscience: Students will demonstrate acquisition of core knowledge presented in required and elective courses.
2. Demonstrate knowledge of the neuroscience scientific literature: Students will demonstrate the ability to integrate and comprehensively review the scientific literature.
3. Acquire competency in oral communication: Students will prepare and deliver effective seminars and poster presentations.
4. Acquire competency in written communication: Students will generate an original dissertation and written comprehensive exam, as well as prepare and publish high quality scientific manuscripts.
5. Demonstrate the ability to design experiments: Students will evaluate existing scientific knowledge related to their project, identify a scientific question and formulate testable hypotheses.
6. Demonstrate the ability to conduct and interpret experiments: Students design experiments to test their hypotheses, carry out those experiments and interpret their results.
7. Obtain employment upon graduation: Student will successfully obtain employment in a neuroscience-related position upon graduation.

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/academicregs)

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/academicregs/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/academicregs/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 doctoral programs is available elsewhere in this chapter of the Graduate Bulletin.

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

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.
Admission requirements

Degree: Ph.D.  Semester(s) of entry: Fall  Deadline dates: Applications received prior to Jan 15 given priority consideration  Test requirements: GRE, MCAT or DAT TOEFL if international

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.

In addition to the general admission requirements of the VCU Graduate School (http://bulletin.vcu.edu/graduate/study/admission-graduate-study/admission-requirements), successful applicants will typically have the following credentials:

1. Baccalaureate degree or its equivalent at the time of enrollment, with an undergraduate GPA of 3.5
2. GRE > 153 quantitative, 156 verbal (or combined 1,250 on previous scale) and 4.0 analytical scores
3. TOEFL score of 600 (pBT), 250 (cBT) or 100 (iBT; or 6.5 on the IELTS scale) for individuals for whom English is a second language
4. Personal statements, including:
   a. Long-term career goals to assess reasons behind application
   b. How a Ph.D. in biomedical science helps achieve those goals
   c. Initial motivating factors for a career in research
   d. Research experience, including dates, places and duration
5. 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 or biophysics)

Degree requirements

In addition to the general VCU Graduate School graduation requirements (http://bulletin.vcu.edu/academic-regs/grad/graduation-info), students in the Ph.D. program must complete a minimum of 69 graduate credit hours.

Students must maintain a minimum cumulative GPA of 3.0 and must receive a minimum grade of B for all required courses. A student who receives a grade of C in a required course shall repeat the course. A second grade of C in a required course shall result in dismissal from the program.

At the end of the second year of required and elective course work, students will take written and oral comprehensive examinations. The written examination is an open-book written exam which is designed to: (1) assess the student’s ability to integrate course material and (2) demonstrate critical thinking and evaluation of the literature in the basic health sciences related to the student’s area of research. This part is based on a question provided to the student by their adviser and graduate advisory committee. The answer should be 25 to 35 pages in length and must represent the student’s unaided work. This section of the exam is graded as pass/fail and must be completed by June 30 of the second year.

After passing the written comprehensive examination, students will schedule the proposal defense within six months. For the proposal defense, students will prepare an NIH-style grant proposal based on their research plans. The proposal will form the basis of the oral candidacy exam. Students are strongly encouraged to submit their proposals for extramural funding (e.g., NIH predoctoral fellowships) where appropriate.

After successful completion of both parts of the written candidacy exam, the student's graduate advisory committee will administer the oral candidacy examination, which entails an oral defense of the student’s grant proposal as well as the topics covered in part one of the written candidacy exam. The oral candidacy exam covers: (1) course work related to the student’s proposed research; (2) the literature cited in or related to the proposal; and (3) the hypotheses, research techniques and procedures presented in the proposal.

Successful completion of the oral candidacy exam advances the student to candidacy for the doctoral degree. The oral candidacy exam must be completed prior to the beginning of the third year. Beginning with the spring semester the third year in the graduate program, students will devote their full time to conducting research in their advisers’ laboratories. Students also register for neuroscience research seminar and journal club each semester.

At the appropriate time in their research, students will prepare a dissertation and schedule a final oral defense of the thesis. The final oral examination (defense of the dissertation) will be limited to the subject of the candidate's dissertation and related basic science.

It is anticipated that students will complete the program in four to five years. All requirements for the Ph.D. degree must be completed within eight years from the date of matriculation in the degree program. Extensions may be approved in extenuating circumstances.

Curriculum requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<tr>
<td>ANAT 610</td>
<td>Systems Neuroscience</td>
<td>4</td>
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<tr>
<td>ANAT 615</td>
<td>Techniques in Neuroscience and Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>ANAT 620</td>
<td>Scientific Writing and Grantsmanship</td>
<td>2</td>
</tr>
<tr>
<td>ANAT 630</td>
<td>Research Presentations</td>
<td>8</td>
</tr>
<tr>
<td>BIOC 503</td>
<td>Biochemistry, Cell and Molecular Biology</td>
<td>5</td>
</tr>
<tr>
<td>BIOC 504</td>
<td>Biochemistry, Cell and Molecular Biology</td>
<td>5</td>
</tr>
<tr>
<td>BIOC 691</td>
<td>Special Topics in Biochemistry (critical thinking)</td>
<td>1</td>
</tr>
<tr>
<td>IBMS 600</td>
<td>Laboratory Safety</td>
<td>1</td>
</tr>
<tr>
<td>IBMS 610</td>
<td>Laboratory Opportunities</td>
<td>0.5</td>
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<tr>
<td>IBMS 620</td>
<td>Laboratory/Clinical Rotations</td>
<td>6</td>
</tr>
<tr>
<td>IBMS 680</td>
<td>Proposal Preparation</td>
<td>1</td>
</tr>
<tr>
<td>NEUS 609</td>
<td>Cellular and Molecular Neuroscience</td>
<td>4</td>
</tr>
<tr>
<td>NEUS 690</td>
<td>Neuroscience Research Seminar</td>
<td>8</td>
</tr>
<tr>
<td>NEUS 697</td>
<td>Directed Research</td>
<td>variable</td>
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</tbody>
</table>

Select one of the following:

- Repeat the following course:
  - NEUS 609
- Repeat the following one-credit course:
  - IBMS 506
  - IBMS 691
- Repeat the following two-credit course:
  - IBMS 620
  - IBMS 680
  - NEUS 609
- Repeat the following one-credit course:
  - NEUS 690
  - NEUS 697
  - IBMS 691
- IBMS 697
  - Directed Research
Select two elective courses from the list below 6-8
Take credits in the following course to reach the required minimum of 69 credits
NEUS 697 Directed Research

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select two of the following (others may be approved by the graduate program director):</td>
<td></td>
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<tr>
<td>ANAT 608</td>
<td>Functional and Clinical Neuroanatomy</td>
<td></td>
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<tr>
<td>ANAT 617</td>
<td>Developmental Neurobiology</td>
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<tr>
<td>BIOC 605</td>
<td>Molecular Biology</td>
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<tr>
<td>BIOS 543</td>
<td>Graduate Research Methods I</td>
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<tr>
<td>or STAT 543</td>
<td>Statistical Methods I</td>
<td></td>
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<tr>
<td>IBMS 635</td>
<td>Cellular Signalling</td>
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<tr>
<td>NEUS 619</td>
<td>Synaptic Organization of the Brain</td>
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<tr>
<td>PHIS 604</td>
<td>Cell Physiology: Cardiovascular and Respiratory</td>
<td></td>
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<tr>
<td>PHIS 606</td>
<td>Molecular Basis for Disease</td>
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<tr>
<td>PHIS 619</td>
<td>Mitochondrial Pathophysiology and Human Diseases</td>
<td></td>
</tr>
<tr>
<td>PHIS/PHTX 620</td>
<td>Ion Channels in Membranes</td>
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<tr>
<td>PHIS 631</td>
<td>Electrophysiology and Photonic Methods</td>
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<tr>
<td>PHTX 536</td>
<td>Principles of Pharmacology and Toxicology</td>
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<tr>
<td>PHTX 537</td>
<td>Principles of Pharmacology and Toxicology</td>
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<tr>
<td>PHTX 548</td>
<td>Drug Dependence</td>
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<tr>
<td>PHTX 632</td>
<td>Neurochemical Pharmacology</td>
<td></td>
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</tbody>
</table>

Total Hours 6-8

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 by a study or in the enrollment or funding status of the student. Students should refer to their program websites 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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Program website: neuroscience.vcu.edu (http://www.neuroscience.vcu.edu)