PHYSIOLOGY AND BIOPHYSICS, DOCTOR OF PHILOSOPHY (PH.D.)

Program goals
1. The program is designed to provide students with the skills required to advance to positions as bioscience researchers and trainers in a broad spectrum of positions.
2. The structure of the program provides a framework for the progressive development of a mastery of the current state of the subject matter of bioscience, an ability to synthesize this information and apply this foundation to the identification of key areas of investigation and experimentation in bioscience.
3. The program relates the above framework to the development of the ability to design, implement and interpret experimental approaches which address the questions identified.
4. In addition, the program will develop skills in the various means of communicating both the core of bioscience knowledge and the expression of experimental design, results and interpretation to a variety of potential audiences.

Student learning outcomes
1. Problem-solving skills: Degree candidates will demonstrate an appropriate level of skill in the identification and selection of meaningful problems to be addressed in bioscience research, including the ability to defend said identifications and to design and develop appropriate methods to solve said problems as measured by rubric.
2. General knowledge of sciences: Degree candidates will demonstrate an appropriate level of knowledge of the current elements of the biosciences 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.
3. Communication skills: Degree candidates will demonstrate that an appropriate level of oral, written and visual communication skills have been acquired.
   a. Oral communication skills: Degree candidates 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.
   b. Written communication skills: Degree candidates 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.
4. Experimental design: Degree candidates 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.

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.vcu.edu/grad) 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-reg/grad/index.html)

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-reg/grad/candidacy/index.html)

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-reg/grad/graduation-info/index.html)

Other information
Department handbook

Applicants and students may request a handbook with additional information, which is also summarized on the departmental website (physiology.vcu.edu/education/phd/physiology.vcu.edu/education/phd/).
education/phd/). Please feel free to contact the graduate program coordinator with any questions.

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://wwwgraduate.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.</td>
<td>Fall</td>
<td>Jan 17</td>
<td>GRE, MCAT or DAT</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.

In addition to the general admission requirements of the VCU Graduate School (https://www.vcu.edu/admissions/apply/graduate/), 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, two semesters of upper-level biology courses, two semesters of physics and two semesters of college-level mathematics recommended (Example courses: cell biology, molecular biology, biochemistry, genetics, neuroscience, physiology, biophysics, etc.)

Degree requirements

Graduate study in the Department of Physiology and Biophysics in the School of Medicine is a highly individualized undertaking, of which required course work is 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 scholarship.

Opportunities for research experience begin in the first year, when students spend time working in several faculty laboratories of their choice. These lab rotations enable students to examine current faculty research projects and choose their areas of specialization. In the second and subsequent years, increasingly more time is devoted to independent research under the guidance of a faculty adviser. Department-sponsored seminars give students opportunities to discuss their research interests with visiting scientists and many students present their work at national professional meetings.

The Ph.D. program in physiology and biophysics normally takes at least four years to complete. The first two years are devoted mainly to course work. The first year consists primarily of required courses, while the second is geared toward electives and research. On satisfactory completion of two years of course work, students must pass written and oral comprehensive examinations to qualify for degree candidacy. Following admission to candidacy, each student must conduct a substantial original research project, prepare a written dissertation and defend it successfully in an oral examination.

In addition to the general VCU Graduate School graduation requirements (http://bulletin.vcu.edu/academic-regs/grad/graduation-info/), students must complete a minimum of 66 credit hours for the Ph.D., including directed research. Note: Based on the medical curriculum, the following courses are typically waived for M.D./Ph.D. students: BIO 503, BIO 504, BIO 691, IBMS 610, PHIS 501, PHIS 650, PHIS 691 and PHIS 692.

Curriculum requirements

Ph.D. students are expected to acquire teaching experience by serving as teaching assistants for PHIZ 206 for one semester. (Requirement typically is waived for M.D./Ph.D. students who will gain relevant experience during clinical training.)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBMS 600</td>
<td>Laboratory Safety</td>
<td>1</td>
</tr>
<tr>
<td>IBMS 620</td>
<td>Laboratory/Clinical Rotations</td>
<td>2</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>
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</table>

Program core

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOC 503</td>
<td>Biochemistry, Cell and Molecular Biology</td>
<td>5</td>
</tr>
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<td>BIOC 504</td>
<td>Biochemistry, Cell and Molecular Biology</td>
<td>5</td>
</tr>
<tr>
<td>PHIS 501</td>
<td>Mammalian Physiology</td>
<td>5</td>
</tr>
<tr>
<td>PHIS 604</td>
<td>Cell Physiology: Cardiovascular and Respiratory</td>
<td>3</td>
</tr>
<tr>
<td>or PHIS 607</td>
<td>Cell Physiology: GI and Endocrine</td>
<td></td>
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<tr>
<td>PHIS 650</td>
<td>Critical Thinking in Physiology</td>
<td>1</td>
</tr>
<tr>
<td>PHIS 689</td>
<td>Physiology Preseminar Highlights (one-credit course, required each term)</td>
<td>4</td>
</tr>
<tr>
<td>PHIS 690</td>
<td>Physiology Research Seminar (one-credit course, required each term)</td>
<td>4</td>
</tr>
<tr>
<td>PHIS 695</td>
<td>Research in Progress (5-credit course, required each term)</td>
<td>3</td>
</tr>
<tr>
<td>PHIS 697</td>
<td>Directed Research in Physiology (variable credit course, required each semester)</td>
<td>26</td>
</tr>
</tbody>
</table>

Additional program courses

Select six credits from:

| PHIS 512 | Cardiac Function in Health and Disease                              | 6     |
Physiology and Biophysics, Doctor of Philosophy (Ph.D.)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>PHIS 606</td>
<td>Molecular Basis for Disease</td>
</tr>
<tr>
<td>PHIS 612</td>
<td>Cardiovascular Physiology</td>
</tr>
<tr>
<td>PHIS 615</td>
<td>Signal Detection in Sensory Systems</td>
</tr>
<tr>
<td>PHIS 620</td>
<td>Ion Channels in Membranes</td>
</tr>
<tr>
<td>PHIS 630</td>
<td>Methods in Molecular Biophysics: A Practical Approach</td>
</tr>
</tbody>
</table>

Other basic science department courses (ANAT, BIOC, BIOS, HGEN, IBMS, MICR and PHTX) or CCTR

Other courses as approved by the program

Total Hours: 66

Neuroscience degree seeking students working in the physiology and biophysics department lab should register for their degree department’s directed research course, NEUS 697.

The minimum total of graduate credit hours required for this degree is 66.

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.

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Program website: physiology.vcu.edu (http://physiology.vcu.edu)