PHYSIOLOGY AND BIOPHYSICS, MASTER OF SCIENCE (M.S.)

Program goal
The master's program in physiology and biophysics is designed to provide students with the skills required to advance to positions as physiology and bioscience researchers and trainers in a broad spectrum of positions. The structure of the program provides a framework for the progressive development of a mastery of the current state of the subject matter of physiology and bioscience, as well as an ability to synthesize this information and apply this foundation to the identification of key areas of investigation and experimentation in bioscience. 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, students 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.grad.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-reg/)

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/)

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/)

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 elsewhere in this chapter of the Graduate Bulletin.
Admission requirements

Degree: M.S.

Semester(s) of entry: Fall preferred

Deadline dates: Apr 1

Test requirements: GRE, MCAT or DAT

In addition to the general admission requirements of the VCU Graduate School, successful applicants will typically have the following credentials:

1. Baccalaureate degree or its equivalent at the time of enrollment with a minimum overall GPA of 3.0
2. Combined GRE scores of at least 300 for the verbal plus quantitative (1200 based on the previous scale) and 4.0 analytical score
3. Test of English as a Foreign Language examination with a minimum score of 100 (IBT), 250 (CBT) or 600 (PBT), or 6.5 on the IELTS for foreign applicants who do not use English as their native language

Although there are no absolute course requirements for admission, fundamental knowledge of general and organic chemistry and biology are considered necessary to pursue advanced studies, and upper-level courses in molecular and cellular biology are desirable. Previous research experience or demonstration of a serious interest in research-oriented career is also desirable. A personal statement describing the applicant's research experience and interests as well as letters of reference from previous supervisors are helpful in determining an applicant's suitability for this curriculum. Official transcripts of all graduate and undergraduate records must be mailed from the college or university registrar.

Basic science, research-intensive, non-thesis curriculum for medical students

Individuals who are participants in medical training (the Doctor of Medicine program) at VCU may be eligible for enrollment in a research-intensive, non-thesis graduate curriculum. This basic science option builds on the core of disciplinary material embedded in the first two years of training in the medical school curriculum. Additional exposure is provided to specialized areas in basic science disciplines in concert with an intensive research experience leading to the preparation of a report in the form of a manuscript suitable for publication. The program is designed to be completed within 12 to 15 months. Subject matter related to the core material and/or suitable elective courses taken in the didactic phase of medical training correspond to a minimum of the equivalent of 24 graduate credit hours. The equivalent of 12 credit hours may be applied to the M.S. degree program in which the student is enrolled in accordance with Graduate School policy. Medical students interested in the basic science option should contact the M.S. graduate program director for additional information.

Degree requirements

The Department of Physiology and Biophysics offers courses of study leading to the Master of Science and the Doctor of Philosophy. A combined M.D./Ph.D. degree program is also available through this department and the School of Medicine. It is generally recommended that students intending to pursue careers as professional physiologists should attempt to earn the Ph.D. Work done in partial or complete fulfillment of the requirements for the master's degree may be applied toward the Ph.D. provided that it is of adequate quality.

Graduate education in physiology and biophysics is a highly individualized enterprise, of which the formal course requirements comprise only a portion. The degree program described here provides an opportunity for apprenticeship in research and, through this, the development of a capacity for scholarship. The essence of this type of education lies in the development of a close relationship between the student and the faculty adviser. The adviser and the student, jointly and with the approval of the department chair and the associate dean of medicine for graduate education, select the student's graduate advisory committee.

The M.S. degree program includes a first year comprising mainly didactic course work and a second year largely devoted to the completion of an independent research project in a chosen lab. Many applicants who are admitted to this master's program have successfully completed VCU's Certificate in Pre-medical Graduate Health Sciences. Since a number of the certificate program's courses overlap with the first-year didactic requirements or electives of this master's program, many students start their master's training in the summer following completion of the certificate program. Additional information may be found on the department's website or applicants may contact the graduate program director.

Writing a thesis based on this work and a successful oral defense of this thesis, as well as completion of the core course work, is essential to earning the degree.

In addition to the general VCU Graduate School graduation requirements, students must complete a minimum of 30 graduate credit hours for the M.S. in Physiology and Biophysics.

Teaching experience

M.S. students also have the opportunity to acquire teaching experience and financial support by serving as teaching assistants for PHIZ 206 for undergraduates. Contact the program coordinator or graduate program director in advance of the beginning of classes for additional information.

Curriculum requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
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<tbody>
<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>IBMS 600</td>
<td>Laboratory Safety</td>
<td>1</td>
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<tr>
<td>OVPR 601</td>
<td>Scientific Integrity</td>
<td>1</td>
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<tr>
<td>or OVPR 602</td>
<td>Responsible Scientific Conduct</td>
<td>1</td>
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<tr>
<td>or OVPR 603</td>
<td>Responsible Conduct of Research</td>
<td>1</td>
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<tr>
<td>PHIS 501</td>
<td>Mammalian Physiology</td>
<td>5</td>
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<tr>
<td>PHIS 690</td>
<td>Physiology Research Seminar (one-credit course taken twice)</td>
<td>2</td>
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Additional program courses

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<tr>
<th>Course</th>
<th>Title</th>
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<tr>
<td>PHIS 697</td>
<td>Directed Research in Physiology (variable credit course; required each semester)</td>
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</table>
Elective (optional): Any graduate-level PHIS or other basic science (ANAT, BIOC, BIOS, HGEN, IBMS, MICR, PHTX) courses or additional directed research credits may apply.

Total Hours

The minimum total of graduate credit hours required for this degree is 30.

Advanced electives (optional)

Advanced elective courses currently offered by the Department of Physiology and Biophysics include the list below. However, other graduate-level courses outside the department are permitted to apply toward the degree with the graduate program director’s approval. Students should inquire ahead of the registration deadline. Note: Several of these courses are not offered every term; students should inquire for more information ahead of registration.

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>PHIS 501</td>
<td>Mammalian Physiology</td>
<td>5</td>
</tr>
<tr>
<td>PHIS 512</td>
<td>Cardiac Function in Health and Disease</td>
<td>3</td>
</tr>
<tr>
<td>PHIS 604</td>
<td>Cell Physiology: Cardiovascular and Respiratory</td>
<td>3</td>
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<tr>
<td>PHIS 606</td>
<td>Molecular Basis for Disease</td>
<td>3</td>
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<tr>
<td>PHIS 607</td>
<td>Cell Physiology: GI and Endocrine</td>
<td>3</td>
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<tr>
<td>PHIS 612</td>
<td>Cardiovascular Physiology</td>
<td>3</td>
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<tr>
<td>PHIS 615</td>
<td>Signal Detection in Sensory Systems</td>
<td>3</td>
</tr>
<tr>
<td>PHIS 619</td>
<td>Mitochondrial Pathophysiology and Human Diseases</td>
<td>3</td>
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<tr>
<td>PHIS/PHTX 620</td>
<td>Ion Channels in Membranes</td>
<td>3</td>
</tr>
<tr>
<td>PHIS 631</td>
<td>Electrophysiology and Photonic Methods</td>
<td>2</td>
</tr>
<tr>
<td>PHIS 650</td>
<td>Critical Thinking in Physiology</td>
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</tr>
<tr>
<td>PHIS 691</td>
<td>Special Topics in Physiology ((003))</td>
<td>3</td>
</tr>
<tr>
<td>PHIS 692</td>
<td>Special Topics</td>
<td>1-4</td>
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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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Additional contacts
Carlos Escalante, Ph.D.
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(804) 628-1202

Christina Kyrus
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Program website: physiology.vcu.edu (http://www.physiology.vcu.edu)