BIOCHEMISTRY, DOCTOR OF PHILOSOPHY (PH.D.)

Program goal
The Ph.D. program in biochemistry prepares students for research-oriented careers as independent scientists in academia, government and biotechnology. The core of this degree program is an original independent research project under the supervision of a faculty adviser. The Department of Biochemistry and Molecular Biology has research efforts of international stature in several areas, including cellular and molecular signaling, tumor biology, structural biology, eukaryotic molecular biology, lipid and membrane biochemistry and molecular genetics, using state-of-the-art approaches in enzymology, genomics, proteomics and lipidomics.

While emphasizing independent research in biochemistry and molecular biology and training in the responsible conduct of research, the program also provides a background of courses designed to match the needs and interests of each student. The program is designed to provide students with the skills required to advance to positions as bioscience researchers/trainers in a broad spectrum of positions. The program provides a framework for the progressive development of a mastery of the current state of the subject matter of biochemistry, cell and molecular biology, 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, 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. Oral communication skills: The candidate 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.
2. Written communication skills: The candidate 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.
3. Experimental design: The candidate 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.
4. Problem-solving skills: The candidate 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.
5. General knowledge of science: The candidate 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.

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.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 Graduate study section for additional information on academic regulations for graduate students. (http://bulletin.vcu.edu/graduate/study/general-academic-regulations-graduate-students)

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 Graduate study section for additional information on degree candidacy requirements. (http://bulletin.vcu.edu/graduate/study/general-academic-regulations-graduate-students/degree-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 Graduate study section for additional information on graduation requirements. (http://bulletin.vcu.edu/graduate/study/general-academic-regulations-graduate-students/graduation-requirements)

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).

**Admission requirements**

<table>
<thead>
<tr>
<th>Degree</th>
<th>Semester(s) of entry</th>
<th>Deadline dates</th>
<th>Test requirements</th>
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<tbody>
<tr>
<td>Ph.D.</td>
<td>Fall</td>
<td>Applications received prior to Jan 15 given priority consideration</td>
<td>GRE, MCAT or DAT</td>
</tr>
</tbody>
</table>

**Special requirements**

- MCAT or DAT acceptable in lieu of GRE for combined professional/academic degree programs.
- 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-requirements), 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. A personal statement that includes: long-term career goals to assess reasons behind the 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 and two semesters of upper-level biology courses (e.g. cell biology, molecular biology, biochemistry, genetics, neuroscience, physiology, biophysics, etc.)

Students who plan to eventually work toward the Ph.D. degree in biochemistry at VCU should apply directly to the Ph.D. program and forego the master's degree. However, applicants who are unsure if they want to earn a Ph.D. and desire experience in biomedical research before making this decision will be well-served by the M.S. program. Outstanding performance in the M.S. program can help students gain admittance to a doctoral program at VCU or elsewhere. Master's students who wish to gain admission to the Ph.D. program should submit the following documents to the graduate program director:

1. A letter making this request, which should include justification for the request, career goals, the name of a proposed Ph.D. adviser and a brief description of proposed Ph.D. research project
2. VCU graduate transcript
3. A letter of support from proposed Ph.D. adviser

Additional admissions requirements include (1) a grade of A in BIOC 501 (section 904: Critical Scientific Thinking), (2) a grade of A in BIOC 505 (laboratory rotation), (3) a final score in the top 50 percent of scores in BIOC 503 and BIOC 504 and (4) minimum GRE scores of 158 (verbal), 158 (quantitative) and 4.0 analytical.

**Degree requirements**

In addition to the general VCU Graduate School graduation requirements (http://bulletin.vcu.edu/graduate/study/general-academic-regulations-graduate-students/graduation-requirements), students must complete a minimum of 41 graduate credit hours.

Ph.D. students are expected to enroll as full-time graduate students. During the first year, students pursue research rotations, take formal course work and become familiar with current research topics through seminars, discussion groups and lectures by distinguished scientists. By the end of the first year, students choose a faculty adviser and begin dissertation research. Following completion of the research project and defense of the doctoral dissertation, graduates are equipped to participate in virtually any area of current biomedical research in the most prestigious laboratories.

**Training in the responsible conduct of research**

All Ph.D. students are required to complete the following training in the responsible conduct of research:

1. OVPR 601, OVPR 602 or OVPR 603
2. Collaborative Investigator Training Initiative: an online course that provides training in human subjects research. The course must be completed during the fall semester of year two. Students must submit the certificate of completion before starting the spring semester of year two. Consult the following link to access the course: research.vcu.edu/human_research/citi_requirements.htm
3. Animal research training: Students are required to complete an online training course for the conduct of animal subjects research. The training must be completed during the fall semester of year two. Students must submit the certificate of completion before starting the spring semester of year two. Consult the following link, which provides training in human subjects research. The course must be completed during the fall semester of year two. Sign in using the following link, which provides access and guidance to the course: https://www.vcu.edu/research/acup/index.htm

**Curriculum requirements**

<table>
<thead>
<tr>
<th>Required courses</th>
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<tr>
<td>IBMS 600</td>
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<tr>
<td>IBMS 610</td>
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<tr>
<td>IBMS 620</td>
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<tr>
<td>BIOL 680</td>
<td>1</td>
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<tr>
<td>OVPR 601</td>
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<tr>
<td>OVPR 602</td>
<td>2</td>
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<tr>
<td>OVPR 603</td>
<td>3</td>
</tr>
</tbody>
</table>

Take one or both of the following for a total of two credits.

Select one of the following:

- Critical Thinking
- Critical Thinking

Take the following courses each fall and spring throughout the program.

- Biochemistry Journal Club 1 variable
BIOC 690  Biochemistry Seminar (.901)  variable
BIOC 690  Biochemistry Seminar (.902)  variable

**Directed research**
BIOC 697  Directed Research in Biochemistry (to be taken each fall and spring semester)  variable

**Electives**
Select a minimum of two elective courses drawn from the list of recommended electives below.

1. After year four, students may select any journal club offered by departments in the School of Medicine.
2. Students register for a combination of directed research and elective credit hours to amass a minimum of 41 total credit hours.

### Total graduate credit hours required (minimum) 41 credits

#### Recommended electives
Students select courses from this list, with guidance from their advisers and committees. Ph.D. students must enroll full-time (minimum nine credits) to be eligible for a stipend. Some graduate courses listed above may be taken after the comprehensive examination. Most of this course work should be taken during the first two years of the program. Students are encouraged to take additional courses that relate to their personal research projects.

- ANAT 615  Techniques in Neuroscience and Cell Biology  3
- BIOC 503  Biochemistry, Cell and Molecular Biology  1-5
- BIOC 504  Biochemistry, Cell and Molecular Biology  1-5
- BIOC 601  Membranes and Lipids  3
- BIOC 602  Physical Properties of Macromolecules  1-4
- BIOC 604  Enzymology  1-3
- BIOC 605  Molecular Biology  2
- HGEN 501/BIOL 530  Introduction to Human Genetics  3
- IBMS 635  Cellular Signalling  3
- MICR 505  Immunobiology  3
- MICR 605  Prokaryotic Molecular Genetics  3
- MICR 607  Techniques in Molecular Biology and Genetics  2
- MICR/BNFO 653  Advanced Molecular Genetics: Bioinformatics  3
- PHTX 691  Special Topics in Pharmacology  1-4

#### Typical plan of study
Many students often take 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 student or in the enrollment or funding status of the student. Students should refer to their program websites and talk with their graduate program directors and advisers for information about typical plans of study and registration requirements.

**Graduate program director**
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(804) 828-0771

**Program website**: biochemistry.vcu.edu (http://www.biochemistry.vcu.edu)