

**GRADUATE CURRICULUM IN BIOCHEMISTRY
GUIDELINES AND POLICIES
Revised: Oct. 2012
Virginia Commonwealth University**

Application for Graduate Study in Biochemistry

Applicants interested in a PhD in Biochemistry are admitted by The Biomedical Sciences Doctoral Portal (BSDP) (<http://www.medschool.vcu.edu/graduate/phd/index.html#bsdpr>). The BSDP admits students into the first year of their Ph.D. training in six departments: [Anatomy and Neurobiology](#), [Biochemistry and Molecular Biology](#), [Human and Molecular Genetics](#), [Microbiology and Immunology](#), [Pharmacology and Toxicology](#) or [Physiology and Biophysics](#). In addition, the portal admits students into the first year of three interdisciplinary training programs in [Neuroscience](#), [Molecular Biology and Genetics](#) and [Interdisciplinary Biomedical Sciences](#). Students seeking a Ph.D. spend their first year rotating in laboratories selected from any department. With the help of an academic advisor, students also select courses from any department, which are chosen to complement their research interests or in some cases explore potential research interests. At the end of the first year, students select a dissertation advisor and enter his or her department for their Ph.D. research. Doctoral students thus have a flexible and tailored curriculum during their first year of graduate school, which is drawn from existing laboratories and graduate courses within the School of Medicine. This flexibility extends beyond the School of Medicine to laboratories and courses in other VCU graduate programs, e.g., biology, chemistry, or engineering. The first year is designed for cross-departmental flexibility, yet students are free to specialize in a particular discipline beginning in their first year by electing courses and laboratories exclusively in a particular program. Official entry to the Department of Biochemistry and Molecular Biology takes place at the end of the first year. [Domestic Applications](#) may be submitted to the [VCU Graduate School](#) at any time, but before January 17 for full consideration for financial support for the Ph.D. International students are directed to the [VCU Office of International Education](#). The minimum stipend is \$23,100, plus tuition, fees, and VCU student health insurance.

Application forms can be accessed at:

http://www.vcu.edu/graduate/ps/apply_domestic.html (domestic)

http://www.vcu.edu/oie/ia/ia_app_grad.html (international)

Successful applicants will typically have the following credentials:

- Baccalaureate degree or its equivalent at the time of enrollment, with an undergraduate GPA of 3.5
- 1250 (verbal plus quantitative) and 4.0 (analytical) GRE scores
- Individuals for whom English is a second language must take the “Test of English as a Foreign Language” (TOEFL) examination and achieve a score of 100 (IBT), 250 (CBT), or 600 (PBT).

For combined-degree students, the Medical College Admission test or Dental Admission Test may be substituted for the Graduate Record Examination.

Applicants interested in a MS in Biochemistry are admitted by the Graduate Program Committee (GPC) of the Department of Biochemistry and Molecular Biology.

Domestic Applications may be submitted to the VCU Graduate School while International students are directed to the VCU Office of International Education. Applications should be submitted by June 30th.

Application forms can be accessed at:

http://www.vcu.edu/graduate/ps/apply_domestic.html (domestic)

http://www.vcu.edu/oie/ia/ia_app_grad.html (international)

Successful applicants will typically have the following credentials:

- Baccalaureate degree or its equivalent at the time of enrollment, with an undergraduate GPA of 3.0
- 1150 (verbal plus quantitative) and 4.0 (analytical) GRE scores
- Individuals for whom English is a second language must take the “Test of English as a Foreign Language” (TOEFL) examination and achieve a score of 100 (IBT), 250 (CBT), or 600 (PBT).

For combined-degree students, the Medical College Admission test or Dental Admission Test may be substituted for the Graduate Record Examination.

For further information contact:

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General Information about the MS and PhD Programs in Biochemistry

Graduate Program Committee

The Graduate Program Committee (GPC) is responsible for implementation and management of the Biochemistry curriculum, as described in this document, and for formulating new or amended policies and practices that are subject to approval by vote of the graduate faculty. The GPC also monitors student progress and entertains all requests for deviations from the Program Guidelines. The GPC consists of at least four members: the director of the graduate program, the director of admissions, the department chair, and at least one additional faculty member selected by the faculty.

Research Rotations

Students seeking a Ph.D. spend their first year rotating in laboratories selected from any department within the School of Medicine. At the end of the first year, students select a dissertation advisor and enter his or her department for their Ph.D. research.

MS students will select one rotation advisor, but have the option of doing more rotations. The course director, in consultation with the chair and with the approval of the faculty members and the student, will assign the rotation laboratories. Rotation activities are a two-credit course for the fall, spring, and summer semesters of the first year (BIOC 505).

Selection of a Thesis Advisor

Following the rotations, students identify a faculty whose lab they would be interested in joining. After consulting with both the chosen faculty members and the student, the Chair formally appoints a single thesis advisor. In agreeing to accept a student into his/her lab, a faculty member is agreeing to assume fiscal responsibility for that student for the duration of his or her graduate studies. Once this choice has been made, a **Thesis Advisor Selection Form** must be submitted to the graduate program director. The research portion of the student's program and development of the dissertation will be performed in the laboratory of the thesis advisor.

Formation of a Graduate Committee

The thesis advisor and student select a Graduate Committee that advises and examines the student throughout the graduate program. After the committee has been formed, the **Graduate Student Advisory Committee** must be submitted for approval. This information is submitted by the student through GradTrak (<https://www.apps.som.vcu.edu/gradtrak/login/login.aspx>). For PhD students, the Graduate Committee will consist of the thesis advisor, two faculty members from the Department of Biochemistry, and two faculty members from outside departments. For MS students, the Graduate Committee will consist of the thesis advisor, one faculty member from the Department of Biochemistry, and one faculty member from an outside department. The Graduate Advisory Committee meets regularly (at least once per year) with the student to assess progress. The Graduate Advisory Committee functions to assist the student in determining their course plan, helps in the finalization of a dissertation project, and eventually, approves the dissertation and conducts the final examination. **The Graduate Advisory Committee must meet during the semester in which the student intends to defend.** As written approval of the Graduate Advisory Committee is required before a Graduation

Application can be filed, an additional committee meeting should be scheduled during the penultimate semester in the program. At the end of each semester, the advisor as chair of the Student's Graduate Advisory Committee shall submit to the director of the graduate program a letter and evaluation form describing the overall achievement and development of the student.

Once committee members have been selected, the student must input this information into his/ her profile in GradTrak (<https://www.apps.som.vcu.edu/gradtrak/login/login.aspx>). Graduate Student Advisory Committee and Course Plan form must be approved by the advisor, graduate program director and Associate Dean for Graduate Education.

Student's Progress

The Graduate Program Director will call a GPC Meeting at least twice each academic year, at the end of each semester: to discuss students' progress; to vote on promotion of graduate students; to discuss and/or vote on policy development or changes proposed by the GPC. The student's advisor will convey to the student in writing reports of their progress with a copy to the Graduate Program Director. The Director of the Graduate program will update the student's personal file including the Graduate Progress Form. The GPC will review the Graduate Progress Forms at least once per semester.

Seminars

MS and Ph.D. students participate in Biochemistry Seminar (BIOC 690.901) and at least one "journal club" course throughout their tenure in the graduate program. First year MS students enroll in BIOC 691.904 (Critical Scientific Thinking). Students in years 02-04 enroll in Special Topics in Biochemistry (Student Journal Club, BIOC 691.901), a journal club that offers broad coverage of biochemistry and related disciplines. After the fourth year, students can opt to enroll in discipline-specific journal clubs in lieu of Student Seminar. PhD students participate in BIOC 690.902 (Biochemistry Student Seminar) each semester while in the program and are required to present their research in years 02 and beyond.

Ph.D. Program in Biochemistry

Program Description

The Ph.D. program is designed to prepare students for a research-oriented career in academia or the private sector. The core of this degree program is an original independent research project under the supervision of a faculty advisor. While emphasizing independent research in biochemistry and molecular biology, the program also provides a background of courses designed to match the needs and interests of each student. A recommended schedule of courses is shown below. Selection of an independent research project, leading to a final thesis and dissertation, is facilitated by a series of "rotations". PhD students are expected to enroll as full-time graduate students.

Comprehensive Examinations

By three (3) months prior to taking written comprehensive exams, a Graduate Student Advisory Committee and Course Plan form must be submitted through GradTrak (<https://www.apps.som.vcu.edu/gradtrak/login/login.aspx>) and approved by the advisor, graduate program director, and Associate Dean for Graduate Education.

The comprehensive examinations and all other requirements for admission to candidacy should be completed prior to the end of the third year in the Program.

The comprehensive examination will consist of two parts: a written examination consisting of a research proposal and an oral examination consisting of a defense of the proposal. The grant proposal is prepared in the format of an NIH predoctoral fellowship by the student in an independent manner. In the case where a similar proposal is being sent to a granting agency as part of a pre-doctoral fellowship application, **the proposal submitted for the written comprehensive examination must be a version that has been written by the student with only minor input from her/his advisor.** No part of the student's proposal should come from a grant proposal written by the advisor. The student's advisor will certify to the student's advisory committee, in the form of a letter, that the student has been the primary and only writer of the proposal and that no part of the proposal has been taken from her/his grant applications.

Students are subject to the VCU Honor code when preparing the grant proposal (consult the following link for details http://www.provost.vcu.edu/pdfs/Honor_system_policy.pdf).

The student's advisory committee will score the proposal on a 5 point NIH scale (1-1.5= outstanding; 1.5-2= excellent; 2-2.5=very good; 2.5-3=good; 3-3.5= marginal; below 3.5=poor). Students must achieve an average score of 3 or better to pass the proposal. **Students with scores between 3-3.5 are allowed one opportunity to revise the grant proposal based on the comments and criticisms of the committee.** The revision must be completed within one month of receiving a non-passing grade. Failure to pass the proposal the second time will result in termination from the program. A student must pass the proposal before scheduling the oral examination. A Documentation of Completion of Written Exam form (<http://www.biochemistry.vcu.edu/education/forms/default.htm>) should be submitted to the graduate program director once the exam is completed.

The oral comprehensive must be completed within 6 months of completing the written examination. Thus, students should take the oral comprehensive exam no later than the third year. The oral examination uses a grant proposal, prepared independently by the student in the

format of an NIH predoctoral fellowship (or other comparable) application. The proposal is viewed as a departure point for questioning by the examining committee. **The examination tests knowledge related to the grant proposal as well as general knowledge of biochemistry, cell, and molecular biology.** The School requires that the Office of Graduate Education schedule this examination no later than 10 days before the exam date. The student should schedule the exam using an Exam Scheduling Form (available on GradTrak <https://www.apps.som.vcu.edu/gradtrak/login/login.aspx>). A Dean's representative must be present at the examination. This individual should be a member of the graduate faculty who does not hold a primary appointment in the Department of Biochemistry. **The Dean's representative manages the examination. The student's advisor may attend the examination but does not ask questions or contribute to the examination in any way.** The oral comprehensive examination is open to all members of the faculty. The time and place of the examination shall be posted at least 10 working days in advance. Faculty members in attendance may ask questions of the candidate, but their questions shall not be presented until after the Student's Examining Committee has completed its questions. Faculty members other than those on the examining committee shall not vote on the success or failure of the candidate. A favorable vote of the student's Examining Committee with no more than one negative vote is required to pass. Upon passing the oral comprehensive examination, the student's Graduate Advisory Committee will review the progress of the student and recommend to the Graduate Program Director that the student be admitted to candidacy for the Ph.D. degree. This documentation requires signatures on a form that will be obtained from the Dean's Representative. A copy of the signed form should be delivered to the graduate program director as documentation that the oral comprehensive examination has been completed. If failed, this exam must be retaken within 30 days following approval of the Graduate Program Director and the MCV Graduate Committee. If the exam is failed a second time the student will be dismissed from the Ph.D. program.

The written proposal should be submitted to the Graduate Advisory Committee by January 1st of the second year in the program and both comprehensive examinations must be completed by the end of the third year in the program. **Students who do not complete the examinations within this timeframe will be administratively terminated from the program for noncompliance.**

Dissertation

Upon completion of their research project, the student writes and defends a dissertation which is reviewed by the Graduate Advisory Committee. **The Graduate Advisory Committee must meet during the semester in which the student intends to defend and approve the student's request to file a graduation application.** In addition, the committee must approve of the dissertation before the final exam scheduling form can be submitted and approved by the Program Director. The student should schedule the exam using an Exam Scheduling Form (available on GradTrak <https://www.apps.som.vcu.edu/gradtrak/login/login.aspx>). The student **must** submit the dissertation to his/ her Committee at least 10 working days before submission of the final exam scheduling form which, in turn, must be submitted at least 10 working days before the defense. **As such, students should allow approximately 20 working days between submission of the dissertation and the date of the final defense.** Departmental permission forms for filing of the graduation application and final exam scheduling form are

available at <http://www.biochemistry.vcu.edu/education/forms/default.htm>. The dissertation is then defended in a final oral examination which is open to the public, but only the student's Graduate Advisory Committee votes on passage of the exam. It is expected that students will present reports of their work at scientific meetings and publish their findings in scientific journals.

Teaching

Students will have the opportunity to assist in the teaching of courses offered by the Department.

Biochemistry PhD Program Support/Stipends

All applicants who are selected for admission to the Ph.D. graduate program in Biochemistry are eligible for financial support. Assistantships and fellowships are awarded on a competitive basis. Tuition and fees are also paid for students receiving fellowships and assistantships. Currently, all of our doctoral students receive a yearly stipend (\$23,100 as of fall 2010). No special application for financial aid is necessary. Details of the financial arrangements are communicated directly to the students at the time of acceptance into the graduate program.

PhD Curriculum in Biochemistry

Ph.D. students in Biochemistry take courses designed for graduate students with an emphasis on research design and experimentation. Usually, a student will have earned about 30 semester hour credits before taking the written examination. For students holding the MD, DDS, or other professional degrees, successful completion of biochemistry/cell biology is equivalent to the BIOC 503-504 series.

The following graduate courses are **required**:

- a. BIOC 690.901: Biochemistry Seminar (each semester)
- b. BIOC 690.902: Biochemistry Student Seminar (each semester)
- c. BIOC 691.901: Special Topics in Biochemistry/student journal club (each semester years 02-04 in the program)

The following graduate courses are **recommended**:

- a. Laboratory rotation (typically year 01, arranged through the BSDP admissions portal)
- b. BIOC 503: Biochemistry, Cellular, and Molecular Biology I (typically year 01)
- c. BIOC 504: Biochemistry, Cellular, and Molecular Biology II (typically year 01)
- d. BIOC 602: Physical Properties of Macromolecules (1-4 modules, typically year 01)
- e. BIOC 604: Enzymology (1-3 modules, typically year 02)*
- f. BIOC 605: Advanced Topics in Molecular Biology (typically year 02)
- g. MICR 507: Techniques in Molecular Biology and Genetics (typically year 02)
- h. BIOC 691.904: Special Topics in Biochemistry: Critical Thinking (typically year 01)
- i. MICR 512: Laboratory Safety (typically year 01)
- j. MICR 510: Scientific Integrity (typically year 02)
- k. BIOC 697: Directed research in Biochemistry (each semester)
- l. BIOC 606, Control Processes & Signal Transduction
- m. BIOC 601, Lipids & Membranes
- n. MICR 605, Prokaryotic Molecular Genetics
- o. ANAT 615, Techniques in Neuroscience and Cell Biology
- p. MICR 653, Adv. Molecular Genetics: Bioinformatics

- q. GEN 501, Human Genetics
- r. MICR 505, Immunology
- s. PHTX 691.803, Research Design Analysis (statistics)

Students select courses from this panel, with guidance from their advisors and committees. While there is no minimum credit requirement for graduation, PhD students must enroll full-time (minimum 9 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 project.

A typical course plan for the full-time Ph.D. student is described below.

First Fall Semester

BIOC 503, Biochemistry, Cellular & Molecular Biology I	5
MICR 512, Laboratory Safety	1
BIOC 690.901, Biochemistry Seminar	1
BIOC 690.902, Biochemistry Student Seminar	1
BIOC 691.904, Critical Scientific Thinking	1
BIOC 505, Experimental Biochemistry (Laboratory Rotation)	2

First Spring Semester

BIOC 504, Biochemistry, Cellular & Molecular Biology II	5
BIOC 602, Physical Properties of Macromolecules	1-4
BIOC 690.901, Biochemistry Seminar	1
BIOC 690.902, Biochemistry Student Seminar	1
ANAT 691, Scientific Writing	2
BIOC 691.904, Critical Scientific Thinking	1
BIOC 505, Experimental Biochemistry (Laboratory Rotation)	2

Second Fall Semester

BIOC 605, Advanced Topics in Molecular Biology	3
BIOC 604, Enzymology	1-3
MICR 507, Techniques in Molecular Biology & Genetics	2
OVPR 601 (Scientific Integrity) or OVPR 602 (Responsible Scientific Conduct) or OVPR 603 (Responsible Conduct of Research)	1
BIOC 690.901, Biochemistry Seminar	1
BIOC 690.902, Biochemistry Student Seminar	1
BIOC 691, Student Journal Club	1
BIOC 697, Directed Research In Biochemistry	variable

Second Spring Semester

BIOC 690.901, Biochemistry Seminar	1
BIOC 690.902, Biochemistry Student Seminar	1
BIOC 691, Student Journal Club	1
BIOC 697, Directed Research in Biochemistry	variable
Optional Course	

Approximately 30 credit hours exclusive of research credit are generally required to complete the PhD.

PhD Student Learning Outcomes

- 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.
- 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.
- 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.
- 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.
- 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.

Training in the Responsible Conduct of Research

All PhD students are required to complete the following training in the responsible conduct of research:

1. OVPR 601 (Scientific Integrity) or OVPR 602 (Responsible Scientific Conduct) or OVPR 603 (Responsible Conduct of Research)
2. Collaborative Investigator Training Initiative (CITI): this is an on-line course that provides training in Human Subjects Research. The course must be completed during the Fall Semester of year 02. Students should submit the "Certificate of Completion" before starting the Spring Semester of year 02. Consult the following link to access the course: <http://www.research.vcu.edu/irb/education.htm>
3. Research Training. Org: this is an on-line course that provides training in Animal Subjects Research. The course must be completed during the Fall Semester of year 02. Students should submit the "Certificate of Completion" before starting the Spring Semester of year 02. Consult the following link to access the course: <http://www.research.vcu.edu/iacuc/lata.htm>

Master of Science (M.S.) Curriculum

Program Description

The Department of Biochemistry offers a graduate program leading to the M.S. degree. This is a research-oriented degree program comprised of graduate course work and supervised research leading to a Master's thesis. The Master of Science program involves approximately one year of course work and a research thesis performed under the supervision of a faculty advisor. The M.S. degree can be completed on a part-time basis. After consultations with faculty and the Chair, students should choose an advisor as quickly as possible. The Advisor assists the student with selection of a **Graduate Advisory Committee** which consists of the Faculty Advisor, at least one member of the Biochemistry faculty and at least 1 member from another department. The Graduate Advisory Committee assists the student with their course plan, advises on the thesis project, approves the thesis, and conducts the final examination. After the committee has been formed, the **Graduate Student Advisory Committee** must be submitted for approval. This information is submitted by the student through GradTrak (<https://www.apps.som.vcu.edu/gradtrak/login/login.aspx>). Full-time students can begin immediately to carry out supervised research in the laboratory of their advisor. A thesis project should be chosen by the student by the end of the first semester in consultation with the advisor.

Final Oral Examination

MS candidates must pass a final oral examination. **The Graduate Advisory Committee must meet during the semester in which the student intends to defend and approve the student's request to file a graduation application.** The student's advisory committee must approve of the filing of a graduation application before the graduate program director can sign the graduation application. Departmental approval forms can be obtained from <http://www.biochemistry.vcu.edu/education/forms/default.htm>). A Dean's representative must be present at the final MS examination. This individual should be a member of the graduate faculty who does not hold a primary appointment in the Department of Biochemistry. The student should schedule the Final Oral Examination using an Exam Scheduling Form (available on GradTrak <https://www.apps.som.vcu.edu/gradtrak/login/login.aspx>). A written thesis approved by the student's Graduate Advisory Committee completes the requirements leading to the M.S. degree.

Thesis

Upon completion of their research project, the student writes a thesis which is reviewed by the Graduate Advisory Committee. In addition, the committee must approve of the thesis before the final exam scheduling form can be submitted and approved by the Program Director. The student **must** submit the thesis to his/her Committee at least 10 working days before submission of the final exam scheduling form which, in turn, must be submitted at least 10 working days before the defense. **As such, students should allow approximately 20 working days between submission of the thesis and the date of the final defense.** Departmental permission forms for filing of the graduation application and final exam scheduling form are available at <http://www.biochemistry.vcu.edu/education/forms/default.htm>. The thesis

is then defended in a final oral examination which is open to the public, but only the student's Graduate Advisory Committee votes on passage of the exam.

Biochemistry MS Program Support/ Financial Aid

Students in the M.S. program do not receive financial support from the Department of Biochemistry, although a student working on a thesis project can be employed as a research assistant on their advisor's research grant. In addition, various forms of financial aid are available for graduate students through the University Services/Financial Aid Office. A form to request financial aid through that mechanism is included in the application package.

MS Curriculum in Biochemistry

MS students in Biochemistry take courses designed for graduate students with an emphasis on research design and experimentation. **MS students must amass at least 24 credit hours (exclusive of research credits).** The VCU School of Graduate Studies stipulates that "Generally, a maximum of one third of the didactic hours required for a master's degree or any graduate certificate program may be transferred from another VCU program or outside institution. Acceptance of transfer credit is made at the school level." The GPC will review all requests for transfer of credit and forward them to the School of Graduate Studies for approval. For students holding the MD, DDS, or other professional degrees, successful completion of biochemistry/ cell biology is equivalent to the BIOC 503-504 series.

The following graduate courses are required and constitute the core courses of the curriculum:

- a. BIOC 505: Experimental biochemistry/ research rotation (typically year 01)
- b. BIOC 503: Biochemistry, Cellular, and Molecular Biology I (typically year 01)
- c. BIOC 504: Biochemistry, Cellular, and Molecular Biology II (typically year 01)
- d. BIOC 602: Physical Properties of Macromolecules (1-4 modules, typically year 01)*
- e. BIOC 604: Enzymology (1-3 modules, typically year 02)*
- f. BIOC 690: Biochemistry Seminar (each semester)
- g. BIOC 691.901: Special Topics in Biochemistry/student seminar (each semester)
- h. BIOC 691.904: Special Topics in Biochemistry: Critical Thinking (typically year 01)
- i. MICR 512: Laboratory Safety (typically year 01)
- j. MICR 510: Scientific Integrity (typically year 02)
- k. BIOC 697: Directed research in Biochemistry (each semester)

* Students will select modules from 602 and 604 to get 4 credits (at least 1 credit from each)

The core set of required courses can be supplemented with elective courses offered by the department of Biochemistry or other departments. Electives may include: Enzymology, Advanced Topics in Molecular Biology, Signal Transduction, Techniques in Molecular Biology & Genetics, Bioinformatics, Statistics, Immunology, Microbiology, Molecular Genetics, Mammalian Physiology, Advanced Organic and Physical Chemistry, among others.

A typical course plan for the full-time M.S. student is described below.

First Fall Semester

BIOC 503, Biochemistry, Cellular & Molecular Biology I	5
MICR 512, Laboratory Safety	1
BIOC 690, Biochemistry Seminar	1

BIOC 691.904, Critical Scientific Thinking	1
BIOC 505, Experimental Biochemistry (Laboratory Rotation)	2

First Spring Semester

BIOC 504, Biochemistry, Cellular & Molecular Biology II	5
BIOC 602, Physical Properties of Macromolecules	1-4
<i>Students will select modules from 602 and 604 to get 4 credits (at least 1 credit from each)</i>	
BIOC 690, Biochemistry Seminar	1
ANAT 691, Scientific Writing	2
BIOC 691.904, Critical Scientific Thinking	1
BIOC 505, Experimental Biochemistry (Laboratory Rotation---Optional)	2

Second Fall Semester

BIOC 604, Enzymology	1-3
<i>Students will select modules from 602 and 604 to get 4 credits (at least 1 credit from each)</i>	
MICR 507, Techniques in Molecular Biology & Genetics	2
OVPR 601 (Scientific Integrity) or OVPR 602 (Responsible Scientific Conduct) or OVPR 603 (Responsible Conduct of Research)	1
BIOC 690, Biochemistry Seminar	1
BIOC 691, Student Seminar	1
BIOC 697, Directed Research In Biochemistry	variable

Second Spring Semester

BIOC 690, Biochemistry Seminar	1
BIOC 691, Student Seminar	1
BIOC 697, Directed Research in Biochemistry	variable

MS candidates are required to amass 24 credit hours (exclusive of research credits). More advanced or other courses can be added by approval of the student's advisor.

Masters Student Learning Outcomes

- 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.
- 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.
- 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.
- 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.

- **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.

Training in the Responsible Conduct of Research

All MS students are required to complete the following training in the responsible conduct of research:

1. OVPR 601 (Scientific Integrity) or OVPR 602 (Responsible Scientific Conduct) or OVPR 603 (Responsible Conduct of Research)
2. Collaborative Investigator Training Initiative (CITI): this is an on-line course that provides training in Human Subjects Research. The course must be completed during the Fall Semester of year 02. Students should submit the "Certificate of Completion" before starting the Spring Semester of year 02. Consult the following link to access the course: <http://www.research.vcu.edu/irb/education.htm>
3. Research Training. Org: this is an on-line course that provides training in Animal Subjects Research. The course must be completed during the Fall Semester of year 02. Students should submit the "Certificate of Completion" before starting the Spring Semester of year 02. Consult the following link to access the course: <http://www.research.vcu.edu/iacuc/lata.htm>

Continuing for the Ph.D.

Students who plan to eventually work towards the Ph.D. degree in biochemistry at VCU should apply directly to our Ph.D. program and forego the M.S. degree. 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 our M.S. program. Outstanding performance in our M.S. program can help students gain admittance to a doctoral program at VCU or elsewhere. MS students wishing to gain admission to the PhD program should submit the following documents to the Graduate Program Director: (1) letter making this request which should include justification for the request, career goals, name of proposed PhD advisor, and brief description of proposed PhD research project, (2) VCU graduate transcript, and (3) letter of support from proposed PhD advisor. Additional admissions requirements include (1) Grade of "A" in BIOC 691.904, Critical Scientific Thinking, (2) Grade of "A" in BIOC 505, Experimental Biochemistry (laboratory rotation), (3) final score in the top 50% of scores in BIOC 503 and BIOC 504 (Biochemistry, Cell, and Molecular Biology), and (4) GRE scores of at least 1150 (verbal + quantitative)/ 4.0 (analytical).

Certificate student who wish to transition to MS

Certificate students who continue into a second year for the M.S. degree (CERT/MS) program in Biochemistry need to identify an individual faculty member. In their second year, CERT/MS students focus almost exclusively on experiments in their mentor's laboratory, with minimal course work.

The following courses are required:

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|------------------|----------------------|-----------------|
| a. BIOC 690. | Biochemistry Seminar | (each semester) |
| b. BIOC 691.901. | Student Seminar | (each semester) |

Course Descriptions

BIOC 503-504/MIC 503-504, Biochemistry, Cell and Molecular Biology. I, II. Continuous course; 5 lecture hours. 5 credits. Prerequisites: Undergraduate organic and physical chemistry, or permission of instructor. A comprehensive introductory course that describes basic biochemistry and reviews current concepts of modern cell and molecular biology.

BIOC 505, Experimental Biochemistry (Rotation). I, II, III. Continuous course; 4 laboratory hours. 2 credits. Laboratory work, including theory and practice of advanced biochemical research methods.

BIOC 690.901, Biochemistry Seminar. All semesters; 1 credit. Lectures, presentations of research reports and topics of current interests through the departmental seminar series. Includes special assignments in selected areas of advanced study not available in other courses.

BIOC 690.902, Biochemistry Student Seminar. All semesters; 1 credit. Student research in progress presentations.

BIOC 602, Physical Properties of Macromolecules. II. Semester course; 3 lecture hours. 3 credits. Physicochemical approaches to the determination of the structure and conformation of macromolecules.

BIOC 691.901, Special Topics in Biochemistry/ Student Seminar. All Semesters; 1 credit. Reports on recent biochemical literature and research by students with faculty guidance.

BIOC 691.904 Critical Scientific Thinking, I. Semester course; 1 lecture hour, 1 credit. First and second semesters of MS or PhD program, 1 credit. Intensive reading course that provides basic instruction in the critical evaluation of scientific literature.

BIOC 604, Enzymology. II. Semester course; 1-3 lecture hours. 1-3 credits. Physical and Chemical properties and mechanism of action of enzymes. Treatment of chemical catalysis, enzyme kinetics, and correlation of enzyme structure to mechanisms.

BIOC 605, Advanced Topics in Molecular Biology. I. Semester course; 2 lecture hours, 2 credit hours. Eukaryotic replication, transcription, RNA processing, control of gene expression by methylation, translation, cell cycle, oncogenes and tumor suppressors, viral vectors, and gene therapy.

BIOC 606 /PMC 637, Signal Transduction. II. Semester course; 3 lecture hours. 3 credits. Understanding mechanisms of cellular communication: current concepts of signal transduction.

OVPR 601, Scientific Integrity. 1 credit classroom based course with 11 sessions (approximately 15 contact hours). Surveys contemporary issues relating to scientific integrity and responsible conduct in research. Topics include ethical scientific conduct, scientific fraud and misconduct, authorship and peer review, use of humans and animals in biomedical

research, ownership of data, intellectual property, conflict of interest, scientific record keeping, academic honor codes, and the ethics of genetic technology. The course consists of interactive lectures followed by small group discussion of cases.

OVPR 602, Responsible Scientific Conduct. 1 credit; hybrid with approximately 6 hours of classroom meeting (3 sessions) that include case discussions. online component of the course includes reading and 2 writing assignments that include student interaction.

OVPR 603, Responsible Conduct of Research. 1 credit classroom based course with 11 sessions (approximately 15 contact hours). 1 credit; hybrid with 2-3 in-class sessions that include case discussions; online portion requires weekly interactive writing assignments.

MICR 512, Laboratory Safety. I, Semester course, 1 lecture hour, 1 credit. The course consists of lectures and hands-on activities and provides training in chemical, laboratory, fire, and radiation safety.

ANAT 691, Scientific Writing, II, Semester course, 2 lecture hours, 2 credits. This course provide basic instruction in grant and manuscript writing as well as other means of scientific communication.