

**GRADUATE CURRICULUM IN BIOCHEMISTRY
GUIDELINES AND POLICIES**

Revised: Aug. 2006

**Virginia Commonwealth University
Richmond, VA 23298**

General Information about the MS and PhD Programs in Biochemistry

Application for Graduate Study in Biochemistry

Admission to graduate study in Biochemistry requires approval and recommendation of the Graduate Program Committee, School of Medicine. Although applications will be considered on a continuing basis, full consideration for PhD financial support for the fall semester can be ensured only for applications submitted by March 1. Selections are made after consideration of individual qualifications. Although there are no absolute course requirements for admission, a knowledge of fundamentals of chemistry, biology and mathematics are considered necessary to pursue advanced studies, and upper level courses in molecular and cellular biology are desirable. Scores of at least 1200 for the combined GRE (verbal plus quantitative) and an overall GPA above 3.3 (3.0 in science and math courses) are expected for competitive students. Previous research experience or demonstration of a serious interest in a research oriented career is desirable. A letter describing the applicant's research experience and interests and letters of reference from previous supervisors are necessary and are helpful in determining an applicant's suitability for this curriculum. Foreign applicants who do not use English as their native language must take the "Test of English as a Foreign Language" (TOEFL) examination and achieve a score of 600 or higher.

Applicants must have earned a baccalaureate degree or its equivalent at the time of enrollment. Organic chemistry is the only specific course requirement. For combined-degree students, the Medical College Admission test or Dental Admission Test may be substituted for the Graduate Record Examination. Applications may be filed at any time but preferably before March 1 for the next academic year, which begins in the latter part of August. Late applications limit the possibility of receiving financial aid. For further information contact:

Committee for Graduate Studies
Department of Biochemistry
Virginia Commonwealth University
P.O. Box 980614
Richmond, VA 23298-0614
Telephone: (804) 828-9762
Email: biochemgrad@vcu.edu

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)

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

Laboratory rotations provide an opportunity to interact closely with faculty in order to determine a suitable match so that an informed decision can be made to join a particular research laboratory. PhD students are required to complete three research rotations. The rotation course director selects the first research rotation for PhD students. After brief research presentations by the faculty, PhD students will select two additional research projects, each in the laboratory of a different faculty member, in different research areas, so that the student will be exposed to a broad spectrum of possible topics for the development of a thesis. 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. At the end of each rotation, students present the results of their projects in a short seminar at a departmental mini-symposium. 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

Students will be required to speak with all interested faculty members during the first semester of residence as part of the Research Rotation Course. Following the rotations, students will be advised to identify, through discussion with faculty, reading papers, etc., at least three faculty whose labs they would be interested in joining. These selections, ranked in order of preference, will be submitted to the department Chair. After consulting with both the chosen faculty members and the student, the Chair formally appoints a single thesis advisor, usually the student's first choice. 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, a **Graduate Student Advisory Committee and Course Plan** form should be submitted to the graduate program director (http://www.medschool.vcu.edu/gp/committeepan_med.pdf). 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.

A Graduate Student Advisory Committee and Course Plan form must be signed by the advisor, the department head and the program director and sent to the Office of Graduate Education for the School of Medicine (Sanger Hall 1st floor) for approval by the Office of the Dean. Graduate Student Advisory Committee and Course Plan form must be signed by the advisor, the department head and the program director and sent to the Office of Graduate Education for the School of Medicine (Sanger Hall 1st floor) for approval by the Office of the Dean. Information and required forms may be obtained at the School of Medicine web site <http://www.medschool.vcu.edu/gp/procedures.html>.

Student's Progress

The Graduate Program Director will call a Graduate Faculty 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) and Special Topics in Biochemistry (BIOC 691.901) throughout their tenure in the graduate program.

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", in which the student is introduced to ongoing research in the Department of Biochemistry. 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 signed by the advisor, the department head and the program director and sent to the Office of Graduate Education for the School of Medicine (Sanger Hall 1st floor) for approval by the Office of the Dean.

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.

Students who matriculated in the program before Fall 2004 must follow PLAN A as the format for the written comprehensive examination.

Students who matriculated in the program in 2004 or 2005 may opt for PLAN A or PLAN B as the format for the written comprehensive examination.

Students who matriculate in the program after Fall 2005 must follow PLAN B as the format for the written comprehensive examination.

PLAN A: The comprehensive examination will consist of three parts; a written examination, a research proposal, and an oral examination including defense of the proposal. **The written examination** will consist of questions written by the student's Graduate Advisory Committee and will be designed to test the student's ability to work creatively, (ie: essay or problem solving questions requiring interpretation or synthesis and extrapolation by the individual student). The questions are usually open book and may be related to but not necessarily limited to the specific area of research of the student. Students are subject to the VCU Honor code when completing this examination (consult the following link for details <http://www.students.vcu.edu/rg/policies/rg7honor.html>). The GPC will assure that the test is administered on a timely basis and approve the questions before they are administered. Each examiner will specify the time allotted to complete his/ her question (typically 24-48 hours). The advisor will distribute the questions one at a time and the student will respond within the specified time frame. Although the student can take time off between questions, the entire examination must be completed within two weeks. The questions will be scored by the student's Graduate Advisory Committee, which will recommend to the

GPC whether the student passes or must retake the entire exam or selected portions. The passing grade on each question is 70% and student must pass all questions. Students are not allowed to rewrite questions that they do not pass. A student who does not pass will be given a second opportunity to take another question from the same examiner. Failure to pass the examination the second time will result in termination from the program. A student must pass the written examination prior to taking the oral comprehensive examination. A **Documentation of Completion of Written Exam** (<http://www.vcu.edu/biochem/students/g-forms.shtml>) form should be submitted to the graduate program director once the exam is completed.

PLAN B: 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.students.vcu.edu/rg/policies/rg7honor.html>).

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.vcu.edu/biochem/students/g-forms.shtml>) should be submitted to the graduate program director once the exam is completed.

Note: format of the oral comprehensive examination is the same for all students (PLANS A & B).

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. A member of the graduate program committee (GPC) must be present at the exam. This individual is present as an observer and does not ask questions or vote. The GPC representative may be a standing member of the student's advisory committee. In addition, 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 at 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.

For Plan A, both comprehensive examinations must be completed by the end of the third year in the program. For Plan B, 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 second 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 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 dissertation before the defense can be scheduled. The student's advisory committee must approve of the filing of a graduation application and of the dissertation document before the graduate program director can sign the graduation application or final examination scheduling forms (<http://www.vcu.edu/biochem/students/g-forms.shtml>).** 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 2006). 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.

The following graduate courses are required:

- a. BIOC 505: Experimental biochemistry/ research rotation (typically year 01, three rotations required)
- b. BIOC 690: Biochemistry Seminar (each semester)
- c. BIOC 691.901: Special Topics in Biochemistry/ student seminar (each semester)
- d. MICR 512: Laboratory Safety (typically year 01)
- e. MICR 510: Scientific Integrity (typically year 02)
- f. BIOC 697: Directed research in Biochemistry (each semester)

The following graduate courses are recommended:

Biochemistry, Cellular & Molecular Biology I (BIOC 503)
Biochemistry, Cellular & Molecular Biology II (BIC 504)
Physical Properties of Macromolecules (BIOC 602)
Enzymology (BIOC 604)
Advanced Topics in Molecular Biology (BIOC 605)
Signal Transduction (BIOC 606 /PMC 637)

Some graduate courses listed above may be taken after the comprehensive examination.

The core set of required courses can be supplemented with elective courses offered by the department of Biochemistry or other departments. Electives may include: Techniques in Molecular Biology & Genetics, Bioinformatics, Statistics, Immunology, Microbiology, Molecular genetics, Mammalian physiology, Advanced organic and physical chemistry, among others.

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.

Course Title		Credits
Fall, Year 1		
BIOC 503	Biochemistry, Cell and Molecular Biology	5
BIOC 505	Experimental Biochemistry ("Rotation")	2
BIOC 690	Biochemistry Seminar	1
BIOC 691.901	Special Topics in Biochemistry	1
MICR 512	Laboratory Safety	1
BIOC 697	Directed Research in Biochemistry	variable

Spring

BIOC 504	Biochemistry, Cell and Molecular Biology	5
BIOC 505	Experimental Biochemistry ("Rotation")	2
BIOC 602	Physical Properties of Macromolecules	3
BIOC 690	Biochemistry Seminar	1
BIOC 691.901	Special Topics in Biochemistry	1
BIOC 697	Directed Research in Biochemistry	variable

Summer

BIOC 697	Directed Research in Biochemistry	6
BIOC 505	Experimental Biochemistry ("Rotation") <i>first year students only</i>	2

Fall, Year 2

BIOC 605	Advanced Topics in Molecular Biology	2
BIOC 604	Enzymology	3
BIOC 690	Biochemistry Seminar	1
BIOC 691.901	Special Topics in Biochemistry	1
MICR 510	Scientific Integrity	1
BIOC 697	Directed Research in Biochemistry	variable

Spring

BIOC 606	Signal Transduction	3
BIOC 690	Biochemistry Seminar	1
BIOC 691.901	Special Topics in Biochemistry	1
BIOC 697	Directed Research in Biochemistry	variable

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

Training in the Responsible Conduct of Research

Beginning in Fall 2005, all PhD students are required to complete the following training in the responsible conduct of research:

1. MICR 510, Scientific Integrity, 2 cr, Fall Semester, year 02
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. After consultations with faculty and the Chair, students should choose an advisor as quickly as possible. 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. Before the start of the second semester, the student selects a Graduate Advisory Committee (The student's advisory committee must approve of the filing of a graduation application and of the dissertation document before the graduate program director can sign the graduation application or final examination scheduling forms (<http://www.vcu.edu/biochem/students/g-forms.shtml> for the form) 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.

Final Oral Examination

MS candidates must pass a final oral examination. 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. In addition, the M.S. degree can be completed on a part-time basis. 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 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 thesis before the defense can be scheduled. The student's advisory committee must approve of the filing of a graduation application and of the dissertation document before the graduate program director can sign the graduation application or final examination scheduling forms (<http://www.vcu.edu/biochem/students/g-forms.shtml>).** 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.

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:

- a. BIOC 505: Experimental biochemistry/ research rotation (typically year 01, one rotation required)
- b. BIOC 690: Biochemistry Seminar (each semester)
- c. BIOC 691.901: Special Topics in Biochemistry/ student seminar (each semester)
- d. MICR 512: Laboratory Safety (typically year 01)
- e. MICR 510: Scientific Integrity (typically year 02)
- f. BIOC 697: Directed research in Biochemistry (each semester)

The following graduate courses are recommended:

- Biochemistry, Cellular & Molecular Biology I (BIOC 503)
- Biochemistry, Cellular & Molecular Biology II (BIOC 504)
- Physical Properties of Macromolecules (BIOC 602)

Some graduate courses listed above may be taken after the comprehensive examination.

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.

Course Title		Credits
Fall, Year 01		
BIOC 503	Biochemistry, Cell and Molecular Biology	5
BIOC 505	Experimental Biochemistry ("Rotation")	2
BIOC 690	Biochemistry Research Seminar	1
BIOC 691.901	Special Topics in Biochemistry	1
MICR 512	Laboratory Safety	1

BIOC 697 Directed Research in Biochemistry variable

Spring, Year 01

BIOC 504 Biochemistry, Cell and Molecular Biology 5
BIOC 602 Physical Properties of Macromolecules 3
BIOC 606 Signal Transduction 3
BIOC 690 Biochemistry Research Seminar 1
BIOC 691.901 Special Topics in Biochemistry 1
BIOC 697 Directed Research variable

Summer

BIOC 697 Directed Research in Biochemistry 6

Fall, Year 02

BIOC 605 Advanced Topics in Molecular Biology 2
BIOC 697 Directed Research in Biochemistry variable
BIOC 604 Enzymology 3
BIOC 690 Biochemistry Research Seminar 1
BIOC 691.901 Special Topics in Biochemistry 1
MICR 510 Scientific Integrity 1

Spring, Year 02

BIOC 697 Directed Research in Biochemistry variable
BIOC 690 Biochemistry Research Seminar 1
BIOC 691.901 Special Topics in Biochemistry 1

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.

Training in the Responsible Conduct of Research

Beginning in Fall 2005, all MS students are required to complete the following training in the responsible conduct of research:

1. MICR 510, Scientific Integrity, 2 cr, Fall Semester, year 02
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 could help gain admittance to a doctoral program at VCU or elsewhere.

Pre-Medical Basic Health Sciences Certificate

Program Description

The Post-Baccalaureate Certificate Program in Biochemistry provides graduate training in the life sciences for qualified students without the necessity of completing a research project and writing a thesis. The Certificate Program offers the opportunity for advanced graduate level training for those seeking to enhance their background in the basic health sciences prior to entry into a professional school. In this Certificate Program, students take one year (two semesters) of graduate level courses in order to improve their academic qualifications for application to medical or dental school. Students are awarded certificates at the end of the spring semester if they have completed 27 credit hours with a cumulative grade point average in the program of at least 3.0. The Department does not guarantee acceptance to medical or dental school upon successful completion of this program. However, a strong academic performance in the Certificate Program will substantially strengthen the student's basic background for the MCAT/DCAT and medical/dental school.

Admission Requirements

Applicants should have successfully completed undergraduate training and hold a baccalaureate degree. Chemistry, including organic chemistry, is required. Applicants are generally admitted with an undergraduate grade point average above 2.80 (on a 4.0 scale or equivalent), Graduate Record Examination combined score above 1600 (V+Q+A); a performance above a score of 1100 on the verbal and quantitative sections, or a quantitative score on the MCAT examination greater than 22. Those with undergraduate degrees from recognized foreign institutions must display an acceptable level of English proficiency by achieving a score of 600 on the TOEFL examination.

Course Requirements

The curriculum for the certificate program is shown below. 27 credit hours are required with a cumulative grade point average of at least 3.0 (on a 4.0 scale). The curriculum should be completed in successive full academic terms (typically the Fall and Spring semester). The primary goal of the student seeking to enhance their record should be to excel in these required courses. Electives should be selected that expand the student's background; however, they should not compromise the primary goal.

Recommended Schedule of Courses

	Credit Hours
Fall	
BIOC 503 Biochemistry, Cell and Molecular Biology	5
PHIS 501 Mammalian Physiology	5
Spring	
BIOC 504 Biochemistry, Cell and Molecular Biology	5
PHIS 604 Cell Physiology	4

The required courses total 19 credit hours. Another 8 hours of electives will fulfill the requirement of 27 hours.

One consideration in selecting electives is that the student may have considered the two-year MS program as an alternative to the two-semester certificate program. Choice of the proper electives allows the student to defer this decision until the end of the first semester. Specifically, including the two biochemistry seminar courses allows the student to switch into the MS program or remain in the certificate program for the second semester.

Appropriate first semester electives

	Credit Hours
BIOC 690 Biochemistry Seminar	1
BIOC 691.901 Special Topics in Biochemistry/ student seminar	1
BIOS 543 Biostatistics	3
PHTX 548 Drug Dependence	3

Second semester electives for the certificate program

BIOC 690 Biochemistry Research Seminar	1
BIOC 691.901 Special Topics in Biochemistry/ Student Seminar	1
BIOS 543 Biostatistics	3
PHTX 535 Introduction to Toxicology	4

Other suggested electives

MICR 518 Molecular Mechanisms of Bacterial Pathogenesis	3
MICR 505 Immunobiology	3
BIOC 602 Physical Properties of Macromolecules	3
PHTX 537 Principles of Pharmacology	5
BIOC 605 Advanced Topics in Molecular Biology	3
BIOC 606 Signal Transduction	3
PHTX 509 Introduction to Neuroscience	3

The Certificate Program is an approved VCU graduate program. Thus, students in this program can apply for financial aid through the usual channels.

Continuing for the Masters or PhD Degree

Students who elect to seek admission to advanced degree (M.S., Ph.D.) programs in biochemistry during or after completion of the Certificate Program should consult with the Program Director.

Credits earned during the Certificate Program can be applied towards the MS degree in Biochemistry. Certificate students who are interested in this option should contact the graduate program

director who will facilitate the transfer process. As most of their coursework has been completed, most former certificate students can complete the MS within one academic year. All Biochemistry MS students are required to complete a research-oriented thesis. Students who transfer to the MS program are encouraged to select their research advisors and start their project during the summer following the certificate program. MS students can enroll as part time or full time students. The following is the **minimal** course load for a MS student who has successfully completed the certificate program.

		Credit Hours
Fall Semester:		
BIOC 505	Experimental Biochemistry	2
MICR 512	Laboratory Safety	1
MICR 510	Scientific Integrity	1
BIOC 690	Biochemistry Research Seminar	1
BIOC 691.901	Special Topics Biochemistry Seminar	1
Spring Semester		
BIOC 690	Biochemistry Research Seminar	1
BIOC 691.901	Special Topics Biochemistry Seminar	1
BIOC 697	Directed Research	2

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, 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 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 604, Enzymology. I. Semester course; 3 lecture hours. 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.

MICR 510, Scientific Integrity. I, Semester course, 2 lecture hours, 2 credits. 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.

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.