

**UNIVERSITY OF PUERTO RICO  
MEDICAL SCIENCES CAMPUS  
SCHOOL OF MEDICINE  
DEPARTMENT OF BIOCHEMISTRY**

***PROGRAM OF GRADUATE STUDIES***

*This document describes the rules, regulations and detailed content of the Ph.D. and M.S. Programs of the Department of Biochemistry, and is intended to complement the document entitled “Requirements at the University of Puerto Rico Medical Campus in Partial Fulfillment towards the Master of Sciences and Doctor of Philosophy Degrees”.*

**PROGRAM DESCRIPTION AND FACILITIES**

The graduate program in Biochemistry began in 1960 starting with the offering of Masters in Science (M.S.) and doctor in Philosophy (Ph.D.) degrees in Biochemistry and Nutrition. The name of the department was changed in 1992 to Department of Biochemistry. The graduates of our program can be found throughout the industrial, academic and government environment in Puerto Rico, the U.S. mainland and in Latin America. The department faculty actively seeks external funds to support our graduate students and has been able to improve our research facilities with state of the art instrumentation.

The Department of Biochemistry is located on the sixth floor of the University of Puerto Rico, Medical Sciences Campus Building at the Río Piedras Medical Center. Available Research Facilities include Molecular Biology, Tissue Culture Core Facilities and the Center for Environmental and Toxicological Research. Also available are the Flow Cytometry and Electron Microscopy Units, the Campus Computer Center, the Animal Laboratory Resources Center, the Institute of Neurobiology and the Caribbean Primate Center. These resources complement the facilities offered by the individual investigators in their respective laboratories.

The Department of Biochemistry characterizes itself by conducting research in the areas of Biochemistry, Molecular and Cell Biology, Genetics, and Biotechnology including topics in: Molecular and Genetic Alterations in Disease, Biochemistry of Proteins, Protein Structure/Function Relationships, Biochemistry of Glycoconjugates and Cellular Differentiation, Interactions between Nutrition and Disease, Aging and Oxidative Stress, Ocular Biochemistry, Clinical Biochemistry, Analytical Biochemistry, Biochemical and Molecular Toxicology, Biochemical Pharmacology and Cancer Biology. Individual faculty members also participate as mentors in the Intercampus Ph.D. program in Biology and in other Ph.D. programs at the UPR level.

The graduate student of the Department of Biochemistry should be able to practice his/her profession in a research, academic or industrial environment either in Puerto Rico, the National, or International level. It is expected that the graduate of the Biochemistry department contribute to the economic, social and cultural development of Puerto Rico. In order to achieve this goal the mission of the graduate program in Biochemistry is to prepare professionals with

the fundamental and essential knowledge in the discipline of Biochemistry. In a wider context, the mission of the Biochemistry program is to prepare professionals that will practice their profession with the firm purpose to advance basic and applied knowledge in the field of Biochemistry, through their professional and scholarly activities contributing in solving the daily health related problems of our society which results in human benefit. It is expected that the biochemistry graduate practice their profession with the highest ethical principles, proper of the discipline they have chosen and that they set a solemn example for the future generations.

## **ADMISSION REQUIREMENTS**

All applicants must fulfill the general requirements of the Graduate Division of the Medical Sciences Campus (Described in the document of Requirements and Regulations for Master of Science and Doctor of Philosophy Degrees by the Graduate School of Biomedical Sciences, 1997 Revision).

1. The applicant must take the GRE General Test and the Subject Test in their major area. The following guides for consultation are available:  
  
GRE Practicing to take the General Test Big Book  
GRE Practicing to take the Biology Test 3<sup>rd</sup> edition  
GRE Practicing to take the General Test 9<sup>th</sup> edition  
GRE Practicing to take the Cell and Molecular Biology Test  
GRE Practicing to take the Biochemistry Test
2. It is desirable that applicants have a B.S. degree in Biology or Chemistry, however, applicants with majors in other areas of Science are strongly encouraged to apply.
3. Applicants must have a minimum G.P.A. and G.P.S. of 3.0 using the 4.0 grading system.
4. Required undergraduate courses are: General Chemistry, Analytical Chemistry (or Quantitative Chemistry\*), General Biology, Organic Chemistry, Physical Chemistry\*\*, General Physics and Integral Calculus. Recommended courses are Cell Biology, Biochemistry, and Genetics.

NOTE: \* At the discretion of the department, this requirement may be waived if the required course is taken during the first year of graduate studies.

\*\* At the discretion of the department, this requirement may be waived if the departmental Physical Chemistry of Macromolecules course (BCHM 8517) is taken during the course of their graduate studies.

## **FINANCIAL AID**

Students can apply for Teaching or Research Assistantships during the first year. However, priority will be given to those students who are carrying out their research projects. Assistantships can be requested for 10-20 hrs/wk. Approval is granted depending on justifications and availability of funds. Financial aid through other programs such as, RISE, NIH, EPA, or NSF predoctoral fellowships as well as support through individual federal or local grants may be available through the individual researchers or under the guidance of individual faculty members. Information on other financial aid is available through the Division of Graduate Studies, the Dean of Students Financial Aid Office, and through each individual researcher.

## **ACCREDITATION OF COURSES**

Students can request the accreditation of specific courses to be substituted for other courses, however, the final accreditation of these courses will depend on the nature of the course content and will be decided by the Department Faculty. Only graduate courses approved with A or B (or their equivalent) in fully accredited institutions and which have been taken no longer than four years before entering the graduate program can be considered for transfer. A maximum of fifteen (15) credits taken in another graduate program at an accredited institution may be approved for transfer by the faculty of the Department of Biochemistry. BCHM 8531-36 cannot be substituted by any other course.

Only courses that were not accredited towards a degree can be considered for transfer. In order to consider a request for accreditation of courses to students transferring from other institutions or other graduate programs, the student must write a letter stating his/her specific request. In addition he/she must submit an official transcript of his/her academic record and the description of the courses according to the catalog from the University where these were approved. The student also needs to provide a certified letter from the registrar of the University indicating that the courses to be transferred were not used for any other degree. All information needs to be supplied to the Department Graduate Student Coordinator. This request will be forwarded to the Departmental Faculty and processed according to the rules and regulations of the Registrar's Office of the University of Puerto Rico Medical Sciences Campus.

M.D. students enrolled in the Biochemistry graduate program may be exempted from taking BCHM 8511 and BCHM 8512 if they have previously passed MPRI 7119 with an "A" or "B" grade. The corresponding credits must be substituted with an equal number of credits from other Biochemistry elective courses. Also, M.D. students that are enrolled in graduate programs of other biomedical departments at the UPR School of Medicine and have approved MPRI 7119 with "A" or "B" may be exempted from taking BCHM 8511 and BCHM 8512 if they substitute an equal number of credits with other Biochemistry elective courses. Alternatively, these students may enroll in BCHM 8511 and BCHM 8512 and retake the full graduate courses or optionally take only the partial exams. Students who obtained a grade below "B" in MPRI 7119 will not be exempted from taking the full BCHM 8511 and BCHM 8512 courses.

Applicants who have completed a Master's Degree in Biochemistry at the Medical Sciences Campus in the University of Puerto Rico School of Medicine can transfer up to twenty-four (24) credit hours, taken during the course of studies within five (5) years of the application date to the Doctoral Program. Persons with continuous exposure to the field of Biochemistry after obtaining their Master's Degree can request in writing a waiver of this 5-year time limit on Biochemistry courses to the Departmental Graduate Studies Coordinator and the Departmental Chairman. This waiver will be evaluated by the Departmental Faculty and informed to the Graduate School Committee for approval before final submission to the Registrar's Office. The final transfer of credits and the substitution of courses will be done following the procedures described by the Registrar's Office Manual ("Manual de Normas y Procedimientos de la Oficina del Registrador"). Only graduate courses approved with **A** or **B** will be considered for transfer. However, the following courses will not be transferred under any condition: Seminars (BCHM 8531-36), Thesis Proposal (BCHM 8526), and Masters Thesis (BCHM 8595).

Applicants who have completed an M.D. degree at the UPR School of Medicine need to take the GRE general and GRE subject exams. They can transfer up to 12 credits towards the M.S. or Ph.D. degree with the approval of the Department of Biochemistry Faculty. A course program will be designed for these students by the student's mentor in collaboration with the Graduate Student Coordinator and requiring final approval by the Department Chairperson.

Graduate courses taken with a special permit (Permiso Especial) may be accredited towards the degree if the student in question is admitted to the program, with the restriction that the total number of credits that may be transferred from the special permit transcript to the graduate transcript may not exceed 1/3 of the total course credits required for the degree. As specified in the regulations of the UPR-MSR Registrar's office, a maximum of 8 credits may be taken with a special permit per semester and the maximum total number of credits taken with special permit may not exceed 16. A student may not apply grades obtained from any departmental courses taken with a special permit to increase GPA or GPS for the purpose of admission to the departmental graduate program. To obtain approval of a special permit to take departmental courses the applicants must have obtained a B.S. degree or equivalent number of credits, a GPS greater or equal to 2.9, have previously taken an undergraduate biochemistry course if they wish to take advanced courses, and the application must be pre-approved by the department faculty.

## STUDY PROGRAM FOR DOCTOR OF PHILOSOPHY (Ph.D.) DEGREE

A full-time study load is required at all times for a student within the program for a maximum of at least three (3) years in order to comply with the minimum residency requirements. A full-time study load consists of at least nine (9) semester credit hours of courses as indicated in “Requirements at the University of Puerto Rico Medical Sciences Campus in Partial Fulfillment Towards Master of Science and Doctor of Philosophy Degrees” (Section IV, D., 3 a) or a combination of course and research work which amounts to forty (40) clock-hours per week. It is strongly encouraged that students **will not seek** outside employment that would interfere with their exclusive dedication to fulfilling the requirements of the graduate program. Four (4) years of full-time study load is the expected minimum time for completion of all requirements for a Ph.D. Degree. The maximum time limit for the completion of all requirements for the Ph.D. Degree is listed in the Registrar’s Office Manual (“Manual de Normas y Procedimientos de la Oficina del Registrador”) as five years for students that have a Master Degree upon entering the Ph.D. Program and seven years for students having a Bachelor’s Degree.

A total of 45 semester credits of course work plus fifteen (15) semester credits of dissertation research (BCHM 8599) is the minimum required for the completion of the Ph.D. Program. Only courses approved with a grade of **A**, **B** or **P** will be taken into account for the total number of credits of course work. The required general Biochemistry courses (BCHM 8511 and BCHM 8512) have to be approved with **B** (80.0%) or higher grade. If the student obtains a **C** grade in the courses, he/she can request a reposition exam, which he/she has to pass with a minimum grade of **B**. This reposition exam will be given before the last date of late registration. Evidence of the approval of the reposition exam, must be submitted by the Graduate Biochemistry Course Coordinator to the Graduate Program Coordinator before the next registration period. Failure to pass the general Biochemistry courses BCHM 8511 and BCHM 8512 with a **B** grade will result in placement of the student on probation and the student will be required to repeat the course. GPA status requirements discussed below will be applied. Failure to pass the general Biochemistry course the second time will result in suspension from the Departmental Graduate Program. A student that obtains a **C** grade in any of the required courses must repeat it. If the **C** is in an elective course the student is required to repeat the course or substitute it for another course with prior approval from the Departmental Graduate Coordinator and the Department Chair. The grade that will be considered towards the departmental requirements will be highest grade while the **C** will only count towards the GPA. A student whose GPA falls below 3.0 will immediately be put on probation. The student must raise his/her GPA above 3.0 before the end of the semester in which he/she is put on probation. If this requirement is not met, the student will be dismissed from the Graduate Program. The Departmental Graduate Coordinator and the Department Chair must approve any course substitution. The student’s individual course curriculum will be planned taking into consideration the student’s research interests and the Departmental course requirements.

Other advanced graduate level courses (Departmental or from another Department/School or University) may be taken to substitute for only one of the elective courses shown below, upon approval by the Departmental Graduate Studies Coordinator and the Departmental Chairperson. This course substitution will be done according to the procedure

detailed in the Registrar's Office Manual ("Manual de Normas y Procedimientos de la Oficina de Registrador"). It must be noted that course substitution implies that the courses in question are comparable in course content (e.g. Protein Chemistry course for another Protein Chemistry Course).

Graduate courses offered by other departments of the School of Medicine, by the Intercampus Ph.D. Biology Program and other graduate courses offered by graduate science programs of the University of Puerto Rico can also be considered towards fulfilling the 45 semester credit course requirement, pending approval by the Departmental Graduate Studies Coordinator and the Departmental Chairperson. Courses taken in US mainland or foreign universities during the course of graduate studies can be transferred following the procedures detailed by the registrar's office.

### **Recommended Course Schedule for the Ph.D. Program**

Course work throughout the program can be modified with the consent of the Graduate Student Coordinator and the Department Chairperson. The sequence can vary depending availability of the professors.

#### **Courses for first year**

<b>First Semester Course ID</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8511	3	Graduate Biochemistry-I
BCHM 8531	1	First Graduate Seminar
BCHM 8551	2	Bioch. Lab. Techniques-I
BCHM 8552	2	Bioch. Lab. Techniques-II
CBIO 8500	3	Introduction to Biostatistics
<b>TOTAL</b>	<b>11</b>	

<b>Second Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8512	3	Graduate Biochemistry-II
BCHM 8532	1	Second Graduate Seminar
BCHM 8507	3	Laboratory Rotations
BCHM 8502	3	Molecular Biology
BCHM 8504	3	Biochemistry of Proteins
<b>TOTAL</b>	<b>13</b>	

<b>Courses for the second year</b>
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<b>First Semester Course ID</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8533	1	Third Graduate Seminar
BCHM 8517	3	Physical Chemistry of Macromolecules
BCHM 8515	2	Enzyme Reaction Kinetics and Mechanisms
BCHM Electives:	6 recommended	
<b>TOTAL</b>	<b>12 minimum</b>	

<b>Second Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8534	1	Fourth Graduate Seminar
BCHM Electives	8 minimum	
<b>TOTAL</b>	<b>9 minimum required</b>	

<b>Courses for the third year:</b>
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<b>First Semester Course ID</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8535	1	Fifth Graduate Seminar
BCHM 8526 (Thesis Proposal)	3	
<b>TOTAL</b>	<b>4</b>	

<b>Second Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8536	1	Sixth Graduate Seminar
BCHM 8599	15	Dissertation
<b>Following Semesters</b>		
Dissertation Research (BCHM 8599)	0	
<b>TOTAL credits for Ph.D. degree</b>	<b>63 minimum required</b>	

<b>Required Courses for the PHD degree</b>
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**(49 credits)**

<b>Course</b>	<b>crs.</b>
BCHM 8511 General Biochemistry-I	<b>3</b>
BCHM 8512 General Biochemistry-II	<b>3</b>
BCHM 8531 Seminar	1
BCHM 8532 Seminar	1
BCHM 8533 Seminar	1
BCHM 8534 Seminar	1
BCHM 8502 Molecular Biology	3
BCHM 8504 Biochem of Proteins	3
BCHM 8517 Phys Chem of Macromolecules	3
BCHM 8515 Enzyme Kinetics and Mechanisms	2
BCHM 8507 Special Biochemical Laboratory Techniques I	3
BCHM 8551 Methods in Protein and Nucleic Acid Biochemistry	2
BCHM 8552 Methods in Lipid and Carbohydrates Biochemistry, Nutrition and Biochemical Pharma	2
CBIO 8500 Intro to Biostatistics	3
BCHM 8526 Proposal	3
BCHM 8599 Dissertation	15

**PHD Degree  
(14 elective credits minimum)**

<b>Course</b>	<b>crs.</b>
BCHM 8506 (Membrane Bioch)	<b>3</b>
BCHM 8525 (Recent Adv Bioch)	<b>2</b>
BCHM 8530 (Genetic Regulation)	<b>3</b>
BCHM 8595 (Special Topics in Biochemistry)	<b>3</b>
BCHM 8558-8583 Investigations in...	<b>6</b>
FISA 8540 (Mol & Cell Phys)	<b>3</b>
MICR 8540 (Immunology)	3

## COMPREHENSIVE OR QUALIFYING EXAMINATION

### Guidelines for the Comprehensive Examination

1. The Faculty of the Department of Biochemistry will select an Exam Committee consisting of at least four (4) members among its faculty.
2. The Committee will be responsible for the entire examination process including direct communication with the student, writing the questions, establishing the dates for the written and oral components, grading both components, informing the student and the Faculty about the date of the oral component, and informing the Graduate Student Coordinator, the Department Chairperson and the Biomedical Graduate School about the results. The Committee will select a Chairperson among its members. The Chairperson cannot be the Dissertation Advisor of the student taking the exam.
3. Students must request the Comprehensive or Qualifying exam to the Department Chairperson after completing satisfactorily the minimum of 45 credit hours. The request must have the approval of the Graduate Student Coordinator, which certifies that the student meets all the requirements. The exam will be scheduled during the first semester of the third year of graduate studies. Alternative dates may be set in special cases such as when students engage in research internships outside of Puerto Rico during this period.
4. The exam will have two components, written and oral.

The written and oral components will cover the following general topics in biochemistry: metabolism, protein biochemistry, nucleic acids biochemistry and enzyme kinetics. The exam will have a take-home format and the questions will be problem-solving type. The student will have from 8:00 a.m. of day one to 4:30 p.m. of day two to answer the questions. (See format below).

The oral component will include topics related to the area of study of the student as well as general topics in biochemistry (mentioned above). In the oral exam, the Committee members may also clarify doubts found in the written component and the student may expand the explanations offered in the written component. The oral exam will be carried out by faculty members designated to the Exam Committee. The Committee members will be responsible for the final evaluation and grading of the student. The oral component will extend from 2-4 hours. All proceedings must be documented in minutes and signed by all committee members.

5. Example of the examination format:

Day 1 (8:00 A.M.) Take home exam: The student will receive the written questions from the committee Chairperson; two questions from each committee member (8 questions in

total). The student will select one question from each of the committee members (4 questions in total representing four different topics).

Day 2 (4:30 P.M.) The student should provide the committee Chairperson with the answers to the exam questions.

Day 3 The Committee members will grade the written component. Each committee-member should have established criteria as to the minimal acceptable answer for passing the written component prior to grading the exam.

Day 4 or 5 Oral examination.

This schedule will change only if a medical illness is confirmed in writing by a licensed Physician.

5. The final evaluation will be using the Pass or Fail criteria. The students will obtain two grades, pass or fail from each Committee member, one from the written component and the other in the oral. To pass the exam the student will have seven passes out of eight. If the student does not provide a correct answer to a question or questions, another Committee member will also grade the question or questions. A grade of 80% will be considered as the passing cutoff for each component. The evaluation criteria will be a demonstration of a broad understanding in the areas examined.
6. The results of the exam will be given to the student at the end of the oral examination.
  - If it is approval, the student will be admitted to candidacy if all other requirements for candidacy have been met.
  - If the student fails one topic (see item 2 above) he or she will be allowed to repeat the topic within one month of receiving the notification.
  - If the student fails in two or more topics (see item 2 above), he or she will fail the exam. The student will be allowed to repeat the exam within one year of the date that he/she received the notification of failure. This will be his/her last opportunity to take the exam.
  - If the student fails the exam for the second time he or she will be dismissed from the Ph.D. graduate program and will be allowed to finish a M.S. degree. A written record of the evaluation results must be made and signed by all of the exam committee members.
7. The Committee Chairperson will present the final results in writing by to the Director of the Graduate School, through the Departmental Chairperson and Graduate Coordinator with copy to the student.

<b>REQUIREMENTS FOR ADMISSION TO CANDIDACY</b>
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A pre-doctoral student will be admitted to candidacy when he/she has completed the following:

1. Grade Requirements:

Obtained satisfactory grades in their courses, maintaining a minimum of 3.0 point average on a scale of 4.0 during their graduate studies.

2. Credit Requirements:

Accumulated a minimum of 45 semester credit hours in graduate courses and satisfactorily completed all of the required courses.

3. Qualifying Exam:

Students must request the Comprehensive or Qualifying exam to the Department Chairperson after completing the minimum of 45 credit hours. The request must have the approval of the Graduate Student Coordinator, which certifies that the student meets all the requirements. The exam will be scheduled at the beginning of the third year of graduate studies (May or September depending on the date in which the student was admitted to the Graduate School).

4. Selection of Dissertation Advisor:

Student must have selected a Faculty Dissertation Advisor and informed of his/her selection, (submit letter to Department Chairperson indicating the selection with a written approval or signature of the Advisor accepting the student). After selecting the Advisor, the student must select his/her dissertation committee and write the dissertation proposal submitting a signed copy to the Graduate School of Biomedical Sciences.

5. Research and Dissertation Guidelines:

The student should select a Research Advisor from among the departmental members by the end of his/her first year of studies. The Dissertation Advisor chosen by the student must comply with all the qualifications described in the "Requirements at the University of Puerto Rico, Medical Sciences Campus, in partial fulfillment towards the MS and Doctor of Philosophy Degrees". The Departmental Chairperson has the responsibility of notifying the Graduate School, in writing, that the student's Dissertation Advisor has been selected after receiving the notification from the advisor.

The student will select a dissertation committee of at least 5 members in consultation with the Dissertation Advisor. The Dissertation Committee will consist of the Research Advisor as President, at least 3 faculty members from within the department including the Advisor, and at least one faculty member from outside the department of the candidate and advisor. Adjunct faculty within the student's department will be considered as departmental

members of the thesis committee. The Dissertation Advisor will be responsible for monitoring the student's research. The Departmental Chairperson will inform the composition of the dissertation committee to the Graduate School. The dissertation committee shall be selected no later than the 30<sup>th</sup> of November of the third year of studies.

The dissertation project should be defined as soon as the student begins to work in his/her chosen research laboratory. Nevertheless, according to the "Requirements at the University of Puerto Rico Medical Sciences Campus in Partial Fulfillment towards the Master of Science and Doctor of Philosophy Degrees", the student cannot officially register in dissertation research until all other requirements for candidacy have been met. However, it is expected that the student will begin working on his/her dissertation research during the second year of studies and no later than the beginning of the third year.

**A dissertation proposal of no less than 5 pages** in addition to the bibliography should be prepared by the student and submitted for approval to the dissertation committee before being admitted to candidacy. A student shall enroll for full time study in dissertation research for the Ph.D. only after his/her research proposal has been approved by the dissertation committee as stated in the "Requirements at the University of Puerto Rico Medical Sciences Campus in partial fulfillment towards Master of Science and Doctor of Philosophy Degrees". Students are encouraged to submit their proposals to scholarship programs in the United States during their third semester (or as soon as possible) of graduate studies so they may increase the probability of obtaining a fellowship or an award.

The dissertation committee will monitor the progress of the student according to the "Requirements at the University of Puerto Rico, Medical Sciences Campus, in partial fulfillment towards Master Science and Doctor of Philosophy Degrees". **The student will be required to give an oral progress report to the committee and the faculty and students of the Department at the end of each year.**

The research work of a Ph.D. candidate must lead to the preparation of at least one publication in an internationally recognized scientific journal in their area of expertise. This manuscript must be submitted for publication prior to the graduation date. Written evidence of submission of the paper will be required before approval of the final dissertation defense.

#### 6. Candidacy:

Admission to candidacy will be requested after the student has fulfilled all of the following requirements:

- a. Satisfactory completion of all the required courses and the minimum credit requirements of the Department.
- b. Completion of a minimum of 45 semester credit hours with a minimum 3.0 general average on a 4.0 scale (no C permitted in the program).
- c. Maintenance of a minimum of 3.0 average in the required courses of the Department.

- d. Accumulation of a minimum of 3 years of residency in the Department.
- e. Satisfactory completion of the qualifying examination.
- f. Submission and Approval of the dissertation proposal.

7. Dissertation Defense and Final Approval:

The dissertation defense and requirements for final approval will be carried out as described in Requirements at the University of Puerto Rico Medical Sciences Campus in Partial Fulfillment towards the Master of Science and Doctor of Philosophy Degrees. The oral examination does not consist of the performance of the student in the public seminar presentation of his/her research but on his/her ability to demonstrate to his/her committee complete dominion and understanding of his/her work. His/her ability to address, approach and design future research projects that will lead to answers of critical questions that might still remain. The inability to produce satisfactory answers to related questions will constitute a failure of this requirement.

8. Student's responsibility:

- a) It is the student's responsibility to understand and comply with the rules and regulations of the Doctoral Program of Biochemistry as well as those stated in the Graduate School of Biomedical Sciences. The Dissertation Advisor, as well as the student, has the responsibility to make sure that the student has complied with the requirements for the degree.
- b) Each student is required to attend all departmental seminars as a part of their graduate training.
- c) Students must fill out the course checklist prior to registration each year.

**STUDY PROGRAM FOR MASTER OF SCIENCE (M.S.) DEGREE**

A full-time study load is required at all times for a student within the program for a maximum of at least two (2) years in order to comply with the minimum residency requirements. A full-time study load consists of at least nine (9) semester credit hours of courses as indicated in “Requirements at the University of Puerto Rico Medical Sciences Campus in Partial Fulfillment Towards Master of Science and Doctor of Philosophy Degrees” (Section IV, D., 3 a) or a combination of course and research work which amounts to forty (40) clock-hours per week. The evening Masters Degree in Biochemistry program will require a minimum of six (6) semester credit hours of courses to maintain full-time student status. Two years (2) of full-time study load in the regular diurnal program and three years (3) in the evening program is the expected minimum time for completion of all requirements for a M.S. degree. The maximum time limit for the completion of all requirements for the M.S. Degree is listed in the Registrar’s Office Manual (“Manual de Normas y Procedimientos de la Oficina del Registrador”) as five years for students that are in the Master Degree program.

A total of 24 semester credits of course work plus six (6) semester credits of thesis research (BCHM 8595) is the minimum requirement for the completion of the M.S. Program. Only courses approved with a grade of **A**, **B** or **P** will be taken into account for the total number of credits of course work. The general Biochemistry BCHM 8511 and BCHM 8512 course requirements have to be approved with **B** (80.0%) or higher grade. If the student obtains a **C** grade in the course, he/she can request a reposition exam, which he/she has to pass with a minimum grade of **B**. This reposition exam will be given before the last date of late registration. Evidence of the approval of the reposition exam, must be submitted by the Graduate Biochemistry Course Coordinator to the Graduate Program Coordinator before the next registration period. Failure to pass the general Biochemistry BCHM 8511 and BCHM 8512 courses with a **A** or **B** grade will result in placement of the student on probation and the student will be required to repeat the course. GPA status requirements discussed below will be applied. Failure to pass the general Biochemistry course the second time will result in suspension from the Departmental Graduate Program. A student that obtains a **C** grade in any of the required courses must repeat it. If the **C** is in an elective course the student is required to repeat the course or substitute it for another course with prior approval from the Departmental Graduate Coordinator and the Department Chair. The grade that will be considered towards the departmental requirements will be highest grade while the **C** will only count towards the GPA. A student whose GPA falls below 3.0 will immediately be put on probation. The student must raise his/her GPA above 3.0 before the end of the semester in which he/she is put on probation. If this requirement is not met, the student will be dismissed from the Graduate Program. Any course substitution must be approved by the Departmental Graduate Coordinator and the Department Chair. The student’s individual course curriculum will be planned taking into consideration the student’s research interests and the Departmental course requirements.

The student’s individual course curriculum will be planned taking into consideration the student’s research interests and the departmental course requirements. Other departmental advanced courses may be taken to substitute for only one of the elective courses shown below, upon approval by the Departmental Graduate Studies Coordinator and the Departmental Chairperson. This course substitution will be done according to the procedure detailed in the

Registrar's Office Manual ("Manual de Normas y Procedimientos de la Oficina del Registrador").

Graduate courses offered by other departments of the School of Medicine and by the Inter-campus Biology Program and other graduate courses offered by graduate science programs of the University of Puerto Rico can also be considered towards fulfilling the part of the elective requirement courses, pending approval by Graduate Studies Coordinator and the Department Director, graduate courses taken in mainland or foreign universities during the course of the graduate studies can be transferred following the procedures detailed by the registrar's office upon approval by the Departmental Faculty.

<b>Recommended Course Schedule for the M.S. Program (Regular program)</b>
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This program can be modified with the consent of the Graduate Studies Coordinator and the Department Director and their sequence may vary depending upon availability of the professor.

<b>Courses for the first year</b>
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<b>First Semester Course ID</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8511	3	Graduate Biochemistry-I
BCHM 8531	1	First Graduate Seminar
BCHM 8551	2	Bioch. Lab. Techniques I
BCHM 8552	2	Bioch. Lab. Techniques II
CBIO 8500	3	Biostatistics
<b>TOTAL</b>	<b>11</b>	

<b>Second Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8512	3	Graduate Biochemistry-II
BCHM 8532	1	Second Graduate Seminar
BCHM 8507	3	Laboratory Rotations
BCHM 8502	3	Molecular Biology
BCHM 8504	3	Biochemistry of Proteins
<b>TOTAL</b>	<b>13</b>	

<b>Courses for the second year</b>
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<b>First Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8595	6	Thesis Research
BCHM 8533	1	Third Graduate Seminar
Elective	2 minimum	
<b>TOTAL</b>	<b>9</b>	

<b>Second semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8595	0	Thesis Research
BCHM 8534	1	Fourth Graduate Seminar
<b>TOTAL</b>	<b>1</b>	

<b>Following Semesters</b>		
BCHM 8595	(0)	Thesis Research
<b>Total credits for degree</b>	<b>33 minimum</b>	

<b>REQUIRED AND ELECTIVE COURSES for the M.S. Degree <u>thesis option</u></b>
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Required Courses (30 credits)

Course	crs
BCHM 8511	3
BCHM 8512	3
BCHM 8551	2
BCHM 8552	2
BCHM 8531	1
BCHM 8532	1
BCHM 8502	3
BCHM 8504	3
BCHM 8595	6
CBIO 8500	3
BCHM 8507	3

Elective Courses: (3 credits minimum)

Course	crs
BCHM 8517	3
BCHM 8515	2
BCHM 8506	3
BCHM 8530	3
BCHM 8533	1
BCHM 8525	2
BCHM8995	3
FISA 8540	3
MICR 8540	3
BCHM 8534	1

<b>Recommended Course Schedule for the M.S. Program (Evening program non-thesis degree)</b>
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<b>Courses for the first year</b>
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<b>First Semester Course ID</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8500	6	Graduate Biochemistry
<b>TOTAL</b>	<b>6</b>	

<b>Second Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8995	1	Design of Experiments-I (DOE I)
BCHM 8551	2	Bioch. Lab. Techniques I
BCHM 8552	2	Bioch. Lab. Techniques II
CBIO 8500	3	Biostatistics
<b>TOTAL</b>	<b>8</b>	

<b>Courses for the second year</b>
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<b>First Semester Course ID</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8502	3	Molecular Biology
BCHM 8504	3	Biochemistry of Proteins
BCHM 8995	1	Design of Experiments-II (DOE-II)
Elective	1 minimum	Special Topics in Biochemistry
<b>TOTAL</b>	<b>8</b>	

<b>Second Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8515 (Elective)	2	Enzyme Kinetics and Mechanism
BCHM 8517 (Elective)	3	P. Chem. Macromolecules
Elective	1 minimum	Special Topics in Biochemistry
<b>TOTAL</b>	<b>6</b>	

<b>Courses for the third year</b>
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<b>First Semester</b>	<b>Credit hrs</b>	<b>Description</b>
BCHM 8558-83 [select only 1]	6	Investigation Course
BCHM 8526	3	Proposal
<b>TOTAL</b>	<b>9</b>	

Total credits required for this degree = 37

**Required Courses for the MS Degree (non-thesis option)**  
**35 credits**

<b>Course</b>	<b>crs.</b>
BCHM 8500- Graduate Biochemistry	<b>6</b>
BCHM 8551-Biochem Lab-I	2
BCHM 8552-Biochem Lab-II	2
CBIO 8500-Intro. to Biostatistics	3
BCHM 8995-Special Topics- Design of Experiments-I	1
BCHM 8995-Special Topics- Design of Experiments-II	1
BCHM 8504-Protein Biochemistry	3
BCHM 8517-Physical Chemistry of Macromolecules	3
BCHM 8515- Enzyme Kinetics and Mechanism	2
BCHM 8502- Molecular Biology	3
BCHM 8526 -Proposal	3
BCHM 8558-8583- Investigation course	6

**Elective Courses for the MS Degree (non-thesis option):**  
 2 credits minimum

<b>Course</b>	<b>Crs.</b>
BCHM 8995 - Special Topics in Biochemistry- Response Surface Methods	1
BCHM 8995-Special Topics in Biochemistry- Quality Assurance Methods	1
BCHM 8995-Special Topics in Biochemistry (other topics)	1-3

## GENERAL REQUIREMENTS

Candidates for an M.S. degree (thesis option) are required to complete a minimum of 24 credits in addition to 6 thesis credits. Cost is currently \$100.00 (U.S.) per graduate credit for the Regular M.S. Program. A minimum of 37 credits are required to complete the M.S. Degree (non-thesis option) in the Evening M.S. Program. The cost of the Evening M.S. program is currently \$3,000.00 (U.S.) per semester.

### 1. Grade Qualifications

Obtained satisfactory grades in their courses, maintaining a minimum of 3.0 average on a scale of 4.0 during their graduate studies.

### 2. Credit Requirements

Accumulate a minimum of 24 semester credit hours in graduate courses for the M.S. Regular Program or 37 credits for the M.S. Evening Program and satisfactorily complete all required courses.

### 3. Selection of Thesis Advisor (Regular Program Only)

Selected a faculty thesis advisor (submit letter to Department Chairperson indicating the selection with a written approval or signature of the Advisor accepting the student) and committee.

### 4. Research and Thesis

After selection of his/her field of choice, the student will consult with the professor in charge as to the possibilities of doing research in a particular field. The student will always be encouraged to select his/her field of research at the end of the first year of study. The student will select a research advisor from among the departmental members by the end of his/her first year of studies and the advisor will inform the Graduate School Committee through the Departmental Chairperson of this selection (this is normally done before the first semester of the second year). The Thesis Advisor chosen by the student must comply with all the qualifications described in the "Requirements at the University of Puerto Rico, Medical Sciences Campus, in partial fulfillment towards the MS and Doctor of Philosophy Degrees". The Departmental Chairperson has the responsibility of notifying the Graduate School, in writing, that the student's Thesis Advisor has been selected after receiving the notification from the student.

The student will select a thesis committee of 3 members in consultation with the Thesis Advisor. The Thesis Committee will consist of the Research Advisor as President, at least one additional faculty member from within the department including the advisor, and a minimum of one faculty member from outside the department, however, the three members can be from the same department. The thesis advisor will be responsible for monitoring the student's research. The composition of the thesis committee will be informed to the Graduate

School by the Departmental Chairperson. The thesis committee shall be selected no later than the third semester of studies.

The thesis project should be defined as soon as the student begins to work in his(her) chosen research laboratory. Nevertheless, according to the “Requirements at the University of Puerto Rico Medical Sciences Campus in Partial Fulfillment towards the Master of Science and Doctor of Philosophy Degrees”, the student cannot officially register in thesis research until the minimum credit requirements for candidacy have been met. However, it is expected that the student will begin working on his/her thesis research no later than the 3<sup>rd</sup> semester of studies.

A thesis proposal of no less than 5 pages in addition to the bibliography should be prepared by the student and submitted for approval to the thesis committee no later than the 3<sup>rd</sup> semester of studies. A student shall enroll for full time study in research for the M.S. only after his/her research proposal has been approved by the thesis committee as stated in the “Requirements at the University of Puerto Rico Medical Sciences Campus in partial fulfillment towards Master of Science and Doctor of Philosophy Degrees”. We encourage students to submit their proposals to scholarship programs in the United States so they may increase the probability of obtaining a fellowship or an award.

The thesis committee will monitor the progress of the student according to the “Requirements at the University of Puerto Rico, Medical Sciences Campus, in partial fulfillment towards Master Science and Doctor of Philosophy Degrees”. The student will be required to give a written and an oral progress report to the committee at least each year.

## 5. Graduation Requirements

Admission to candidacy will be requested after the student has fulfilled all of the following requirements:

- a. Satisfactory completion of all the required courses and the minimum credit requirements of the Department.
- b. Completion of the required credit hours with a minimum 3.0 general average on a 4.0 scale (no C permitted in the program).
- c. Maintenance of a minimum of 3.0 average in the required courses of the Department.
- d. Accumulation of a minimum of 2 years of residency in the Department.
- e. Approval of the thesis proposal. (not required for Evening M.S. Program)
- f. Provide evidence of paper article submission. (Ph.D. program only)

## 6. Thesis Defense and Final Approval

The thesis defense and requirements for final approval will be carried out as described in Requirements at the University of Puerto Rico Medical Sciences Campus in Partial Fulfillment towards the Master of Science and Doctor of Philosophy Degrees. The oral examination does not consist of the performance of the student in the public seminar

presentation of his research but on his ability to demonstrate to the committee his complete dominion and understanding of his/her work, ability to address, approach and design of future research to answer critical questions that might still remain. The inability to produce satisfactory answers to related questions will constitute a failure of this requirement.

#### 7. Student's responsibility

- a) It is the student's responsibility to understand and comply with the rules and regulations of the Masters in Sciences Program of Biochemistry as well as those stated in the Graduate School of Biomedical Sciences. The Thesis Advisor and student coordinator, as well as the student, have the responsibility to make sure that the student has complied with the requirements for the degree.
- b) Each student is expected to attend all departmental seminars as a part of their graduate training.
- c) Students must fill out the course checklist prior to registration each year.

#### 8. Requirements for transfer from the MS degree program to the Ph.D. Program

A student that was admitted to the M.S. Program in Biochemistry (\*thesis option only) may request a transfer to the Ph.D. Program by submitting a written request to the Department Chair and Graduate Coordinator. They will submit the matter to the department faculty for consideration of the request. If the student qualified for admission to the Ph.D. program but opted to enter the M.S. program first, the request may be considered without additional documentation. If the student did not qualify for admission to the Ph.D. program, in addition to the letter, the request must include the following documents.

- 1- Evidence that the student achieved an overall percentile score of 25 on a recent GRE subject exam in Biochemistry.
- 2- Must present a minimum of two letters of recommendation from Biochemistry department faculty members that enthusiastically support his/her request.
- 3- Include an official transcript as evidence for a minimum 3.5 GPA in graduate courses since admission.

\*Students enrolled in the M.S. Evening Program in Biochemistry (non-thesis option) must complete their degree before applying to the Ph.D. program.

**ACADEMIC PROGRAM****Course Description:**

BCHM 8511 – Biochemistry (3). This course is designed specifically for graduate and professional students with interests in laboratory research. The course deals with the structural and functional characteristics of the human genome, the mechanisms of replication and repair of the genetic material, transcription, translation and regulation of the expression of genetic information (molecular biology), the alteration of genetic material (mutations), and its consequences (genetic diseases and molecular evolution), and the modern methods and techniques of molecular biology (recombinant DNA technology, gene therapy, and cloning). Basic concepts of human nutrition are also discussed.

BCHM 8512 – Biochemistry (3). This course is designed specifically for graduate and professional students with interests in laboratory research. The course deals with the structural and functional characteristics of the human genome, the mechanisms of replication and repair of the genetic material, transcription, translation and regulation of the expression of genetic information (molecular biology), the alteration of genetic material (mutations), and its consequences (genetic diseases and molecular evolution), and the modern methods and techniques of molecular biology (recombinant DNA technology, gene therapy, and cloning). Basic concepts of human nutrition are also discussed.

BCHM 8500 - Biochemistry (6). This course is designed specifically for graduate and professional students enrolled in the Evening Masters Program in Biochemistry non-thesis option. This will be a lecture course in general biochemistry. Topics to be covered include catabolic and anabolic pathways in living organisms, nucleic acid, protein, carbohydrate, and lipid structures and functions, the basics of DNA, RNA, and protein synthesis, enzyme kinetics, photosynthesis, electron transport, biochemical endocrinology, physiological biochemistry (including excitable membranes, blood biochemistry, and allosteric effectors), and organ specific biochemistry.

BCHM 8502 - Molecular Biology (3). A research oriented lecture course in molecular biology. Topics to be covered include biophysics of macromolecules; recombinant DNA and biotechnology; regulation of transcription, including considerations of promoters, DNA binding proteins and oncogenes; the processing of RNA including capping, splicing, polyadenylation and editing, translation including targeting, frame shifting, folding and post translational modifications; and applications of biochemical genetics and cell biology. Resource material will be scholarly scientific publications. (For a state of art, research oriented course, the specific topics to be considered will vary from one semester to the next in order to enable the most important and latest scientific discoveries to be covered.

BCHM 8504 - Biochemistry of Proteins (3). The structure and function of various proteins (i.e. antibodies, enzymes, nucleic acid, binding proteins, cytoskeletal proteins, and membrane associated proteins) will be examined in detail. Protein folding, denaturation, and refolding will be reviewed. Applications of site directed mutagenesis, nuclear magnetic resonance, X-ray crystallography, and molecular modeling will be covered. Enzyme kinetics will be examined in

detail with emphasis on the analyses of catalytic mechanisms, subunit interactions, allosteric effectors, and inhibitors. Sieve, affinity, and high-pressure liquid column chromatography, Western blotting, mass spectrometry, Edman degradation, composition analyses, SDS gel electrophoresis, isoelectric focusing, and pKa determinations, and other procedures that are used in the purification and analysis of proteins will be considered.

BCHM 8506 - Membrane Biochemistry (3). This is an advanced biochemistry course focusing on biomembranes. The following topics will be discussed: 1) membrane structure; 2) approaches to study membrane dynamics; 3) membrane transport (influx/efflux) and transporter protein; 4) excitable membrane, pump, and ion channel; 5) membrane component biogenesis and their trafficking; and finally 6) liposomes for targeted delivery of membrane impermeable drugs, macromolecules, etc. of therapeutic interest. This is a highly specialized course dealing with membranes from higher eukaryotic cells. The students will be engaged in classroom lectures/exercises for 3 hours per week. (Pre-requisite: BCHM 8511 and BCHM 8512 and/or completed graduate level BCHM 8500 or other biochemistry, physiology, microbiology, pharmacology or biology course).

BCHM 8507 - Special Biochemical Laboratory Techniques I (3). This is a tutorial type exposure to laboratory experiences. The student rotates through different departmental laboratories where research work is being conducted by faculty members and familiarizes with techniques at the same time that performs introductory experiments. The rotation is intended to expose the student to the research project of his choice. At the end of this experience, the student is supposed to be ready to follow a research project of interest to him/her and begin writing his thesis proposal. The course is open only to students registered in the Department of Biochemistry.

BCHM 8515 - Enzyme Kinetics and Mechanism (2). In this course the students will work with the concepts and applications of enzyme mechanisms with emphasis on the key kinetic and thermodynamic concepts that rule the activity of enzymes, steady state kinetics, transient kinetics, mechanisms of catalysis, and mechanisms of inhibition. Methods to elucidate kinetic and chemical mechanisms will be explored such as kinetic isotope effect, spectroscopy and stopped-flow techniques. The students will have hands-on experience in the analysis of data by using software for kinetics research.

BCHM 8517 - Physical Chemistry of Macromolecules (3). This course may be taken by graduate students in order to fulfill a Physical Chemistry deficiency in the required prerequisites for admission to graduate Programs in Biochemistry. This course consists of lectures and class discussions about the methodology used in the characterization of macromolecules biological interest, and the theory upon which this methodology is based. Topics to be covered include classical thermodynamics, thermodynamic properties of solutions, viscosity, osmotic pressure, diffusion, sedimentation theory, and applications of electromagnetic radiation, including atomic absorption, fluorescence, optical rotatory dispersion, circular dichroism and light scattering. Also, this course will cover investigations involving nuclear magnetic resonance, mass spectrometry, molecular crystallization, and X-ray diffraction from the point of view of both theory and practical applications. The last section of the course will focus on methods used to determine protein composition and sequence.

BCHM 8521 - Practice and Teaching of Biochemistry (3). Students registered in this course conduct class discussions under the supervision of a faculty member. These discussion groups are made of a minimum of twelve first year dental or medical students and are part of the course work required in the respective biochemistry courses offered to dental or medical students. Graduate students in charge of the discussions lead the group, prepare self-evaluation quizzes for the students, report to faculty members about their observations as to the proficiency of students under their supervision. Two group discussions per week. This course is open only to graduate students registered in the Department of Biochemistry.

BCHM 8525 - Recent Advances in Biochemistry and Molecular Biology (2). Recently published scientific literature will be discussed on a weekly basis through oral presentations made by the course participants followed by group discussions. Topics relevant to diverse aspects of Biochemistry and Molecular Biology will be discussed.

BCHM 8526 - Proposal (3). This course is a graduate course in which the students will plan, develop, and submit a proposal for their dissertation or other research project. During the course, under the supervision of a faculty member, the student will select a research theme, write the objectives of the research, and develop the proposal. They will submit the written proposal to the supervising faculty member who will approve or disapprove the completed proposal prior to its submission to the thesis committee. This course, in conjunction with a graduate seminar confers regular student status.

BCHM 8995 - Special Topics in Biochemistry (1-3 credits). These will be short courses in the case of 1- or 2-credit options (but with a minimum of 16 hours of class time per credit) or semester intensive courses on a special topic in Biochemistry that may be offered by visiting professors. Recent research findings will be emphasized. The format may vary from lectures to lectures with assigned reading, discussions, and/or laboratory exercises.

BCHM 8530 - Genetic Regulation of Gene Expression (3). This is an advanced course designed for graduate students pursuing a Master or a Ph.D. degree in Biochemistry, Cell Biology, Physiology, Microbiology, Pharmacology or other biology based discipline. It requires either of the following courses: general biochemistry, molecular biology or microbial biochemistry. The course is based on the review of the latest molecular mechanisms of control of gene expression described in the scientific literature of the last two years. Emphasis is made on regulatory mechanisms associated to chromatin remodeling, transcription, mRNA stability, translation and postranslational modifications. Transcription factors required for basic transcription, regulatory nuclear factors of the steroid, retinoid, thyroid and Vitamin D3 receptor superfamily, proteins involved in the regulation of the cell cycle and the basic mechanisms of cell development and differentiation are discussed in detail. The course is centered on students, who will be required to prepare and present material for open discussions.

BCHM 8531-8536 - Biochemistry, Pharmacology & Physiology Seminar Series (1 credit per semester). This seminar series will meet an average of once per week throughout the semester, for approximately 1.0-1.5 hours during which doctoral level scientists will give presentations about their research investigations or about subjects relevant to pursuing a career in science.

BCHM 8551 - Methods in Protein and Nucleic Acid Biochemistry (2). This laboratory course will meet once a week during which there will be a one hour lecture followed by a minimum of a 2-3 hour laboratory exercise with possible follow-up requirements. Procedures to be covered include the purification of proteins and nucleic acids, restriction analysis of DNA, Polymerase Chain Reaction (PCR) sieve and/or ion exchange chromatography, HPLC chromatography, gel electrophoresis, ultra centrifugation, UV/visible spectrophotometry, and scintillation spectrometry.

BCHM 8552 - Methods in Lipid and Carbohydrates Biochemistry, Nutrition and Biochemical Pharmacology (2). This laboratory course will meet once a week during which there will be a one hour lecture followed by a minimum of a 2-3 hour laboratory exercise with possible follow-up requirements. Focus will be directed toward metabolic aspects of lipid and carbohydrate chemistry including nutrition. Techniques employed will include use of radioisotopes, radio-immunoassay, differential centrifugation, spectrophotometry, and dietary analysis utilizing computerized programs. Other procedures covered will be separations of mono-, di-, and oligosaccharides, digestion of exo- and endo-glycosidases, thin layer chromatography, molecular sieve and/or ion exchange chromatography, HPLC, periodic acid-Schiff's (PAS) staining, and lectin blots.

BCHM 8558 - Investigations in the Biochemistry of Aging (6). This course will involve training in how to design, conduct, and analyze independent research on the biochemistry of aging using the ocular lens as a model. In this course students will investigate post translational modifications in lens proteins that are associated with human disease and/or aging. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8559 - Investigations in Angiogenesis I (6). This course will involve training in how to design, conduct, and analyze independent research to study the biochemistry of Angiogenesis. For this course the student will study the biochemistry of differentiation of capillary endothelial cells. Studies will include screening of angiogenic factors affecting capillary endothelial cell proliferation, the mapping of cell cycle, and the characterization of factors responsible for cell proliferation and differentiation. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8560 - Investigations in Angiogenesis II (6). This course will involve training in how to design, conduct, and analyze independent research to study the biochemistry of Angiogenesis. For this course the student will identify the gene products responsible for endothelial cell proliferation and capillary formation. Translational regulation of the process will be studied and any modification at the pre-golgi compartment will be examined. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8561 - Investigations in Complex Carbohydrate Biochemistry I (6). This course will involve training in how to design, conduct, and analyze independent research in complex carbohydrate biochemistry. For this course the student will identify a glyco-conjugate and its glycan structure as a complex, high-mannose or hybrid type will be determined. Enzymatic and chemical methods will be followed for the structural studies and the role of the carbohydrate residues for biological function will be determined. These studies will be expected to answer

new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8562 - Investigations in Complex Carbohydrate Biochemistry II (6). This course will involve training in how to design, conduct, and analyze independent research in complex carbohydrate biochemistry. For this course the enzymatic synthesis and subsequent processing of the glycan chains in the post-golgi compartment and network will be investigated. In vitro assays of glycosyltransferases will also be performed to understand the regulatory events. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8563 - Investigations in Enzyme Biochemistry I (6). This course will involve training in how to design, conduct, and analyze independent research in enzyme biochemistry. For this course the student will purify and study a native or recombinant enzyme. Studies will include specific activity determinations during purification and analyses of the steady state kinetics of enzyme catalyzed reaction for the purified enzyme. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8564 - Investigations in Enzyme Biochemistry II (6). This course will involve training in how to design, conduct, and analyze independent research in enzyme biochemistry. For this course the student will use various screening procedures, enzyme assays, and kinetic studies to identify potential ligands and inhibitors of an enzyme. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8565 - Investigations in Filamentous Proteins I (6). This course will involve training in how to design, conduct and analyze independent research in the structure and function of filamentous proteins. This course will include studies in identification, isolation, and mutagenesis of selected DNA regions encoding a portion of a filamentous protein. These selected DNA fragments will be obtained by PCR techniques from a cloned DNA template. Mutations generated will be confirmed by direct DNA sequencing of the mutated DNA fragment. The resulting experiments will inquire into the role of specific amino acids in the function and control of filamentous proteins. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8566 - Investigations in Filamentous Proteins II (6). This course will involve training in how to design, conduct and analyze independent research in the structure and function of filamentous proteins. Mutated filamentous protein gene(s) will be used for generating chromosomal mutants. This course will include studies in the functional analysis of filamentous protein mutants through assays for secretory function, distribution of cell polysaccharides and cytoskeletal proteins, protein phosphorylation of the mutant protein, and effects on cell division. The course will incorporate the techniques of fluorescence microscopy, for analysis of immunochemical and other protein specific dyes, and immunoprecipitation of radiolabelled

filamentous proteins. These experiments will generate novel information on the function of filamentous proteins in non-muscle cell systems.

BCHM 8567 - Investigations in Hybridomas I (6). This course will involve training in how to design, conduct, and analyze independent research in the preparation of hybridomas. For this course the student will use a purified antigen to immunize a mouse whose lymphocytes will subsequently be fused with tumor cells and these hybridomas will be cloned. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8568 - Investigations in Hybridomas II (6). This course will involve training in how to design, conduct and analyze independent research in the utilization of hybridomas. For this course students will screen hybridoma clones for those producing monoclonal antibodies, to a specific antigen. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8569 - Investigations in Membrane Biochemistry I (6). This course will involve training in how to design, conduct, and analyze independent research in membrane biochemistry. This course will provide training in the procedures to investigate cell membrane fluidity, chemical composition, and external factors that modify these parameters (i.e. diet, drugs, ethanol and/or toxic agents). EPR and lipid analysis by HPLC will be used. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8570 - Investigations in Membrane Biochemistry II (6). This course will involve training in how to design, conduct and analyze independent research in membrane biochemistry. This course will give students the opportunity to prepare membrane cell components such as mitochondria, plasma membranes and microsomes or membrane derivatives such as liposomes, synaptosomes or synaptoneuroosomes and to study the biological activities of proteins (i.e. receptors, ion channels) associated with the membranes. Ligand binding, ion uptake, enzyme activity, HPLC and EPR will be among the procedures employed for these investigations. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8571 - Investigations in Molecular Genetics I (6). This course will training in how to design, conduct and analyze experiments in Molecular Genetics. For this course, students will learn and acquire hands on experience in bacterial culture and the use of prokaryotic and eukaryotic cloning vectors. Cloning from a genomic or cDNA library, and physical characterization of selected DNA will be performed using procedures such as restriction mapping and DNA sequencing. Computer aided analysis of DNA and amino acid sequences will be used. These studies will provide information leading to the identification of gene sequences from a variety of organisms. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed above.

BCHM 8572 - Investigations in Molecular Genetics II (6). This course will involve training in how to design, conduct and analyze experiments in Molecular Genetics. In this course, students

will participate in the generation of mutant cells by site specific recombination of mutant constructs introduced into diploid yeast cells. The mutant gene constructs will be generated by the students in the laboratory by the deletion and/or insertion of DNA or DNA markers respectively into a selected target gene clone. Traditional transformation and electroporation techniques will be used for generation of mutants. Candidate mutant cells will be analyzed by diagnostic Southern blot and PCR analysis of genomic DNA. Techniques for genetic analysis of gene function through analysis of haploid cells will be applied. The results of these experiments will generate novel mutants that will reveal information on gene structure-function relationships.

BCHM 8573 - Investigations in Nucleic Acid Biochemistry I (6). This course will involve training in how to design, conduct and analyze independent research in nucleic acid biochemistry. For this course the student will clone and sequence a gene or cDNA of interest. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8574 - Investigations in Nucleic Acid Biochemistry II (6). This course will involve training in how to design, conduct and analyzed independent research in nucleic acid biochemistry. For this course the student will purify and study a native or recombinant nucleic acid. Studies may involve the synthesis, evaluation and/or probing of a genomic or cDNA library. These studies will be expected to answer new questions and to generate novel data as opposed to reproducing experiments that have been performed above.

BCHM 8575 - Investigations in Nutritional Biochemistry I (6). This course will involve training in how to design, conduct and analyze independent research in nutritional biochemistry. Methods employed will be computer assisted dietary evaluations and performance of dietary interviews. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8576 - Investigations in Nutritional Biochemistry II (6). This course will involve training in how to design, conduct and analyze independent research in nutritional biochemistry. Methods employed will be analysis of nutrients in blood using HPLC and enzymatic techniques. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8577 - Investigations in Ocular Biochemistry I (6). This course will involve training in how to design, conduct and analyze independent research on the biochemistry of eye tissues and fluids. For this course students will specifically investigate natural antioxidants (i.e. ascorbic acid, glutathione, vitamins and proteins) and free radicals as related to the protection of ocular tissues against photo-oxidative stress. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed above.

BCHM 8578 - Investigations in Protein Structure/Function I (6). This course will involve training in how to design, conduct and analyze independent research in protein structure/function relationships. Methods employed will involve investigations of the functional roles of specific amino acids in substrate binding and catalytic mechanism of a recombinant enzyme using

techniques such as site directed mutagenesis. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8579 - Investigations in Protein Structure/Function II (6). This course will involve training in how to design, conduct and analyze independent research in protein structure/function relationships. In this course students will learn to grow X-ray diffraction quality protein crystals. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8580 - Investigations in Tumorigenesis I (6). This course will involve training in how to design, conduct and analyze independent research in the area of tumorigenesis. In this course students will search for genetic alterations during development of the malignant phenotype. Methods employed will involve state of the art procedures in molecular biology. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8581 - Investigations in Tumorigenesis II (6). This course will involve training in how to design, conduct and analyze independent research in the area of tumorigenesis. In this course students will search for molecular alterations during development of the malignant phenotype. Methods employed will involve state of the art procedures in molecular biology. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed before.

BCHM 8582 - Investigations in Vaccine Development I (6). This course will involve training in how to design, conduct and analyze independent research in the area of vaccine development. In this course students will use a variety of selection procedures to identify potential vaccine antigens for the treatment of human disease. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed above.

BCHM 8583 - Investigations in Vaccine Development II (6). This course will involve training in how to design, conduct and analyze independent research in the area of vaccine development. In this course students will investigate potential vaccine in animal models of human disease. These studies will be expected to answer new questions and to generate novel data, as opposed to reproducing experiments that have been performed above.

BCHM 8595 - Research for Masters Thesis (6). This is a requirement for all students registered for a Master of Science with concentration in Biochemistry. The proposed research must be pre approved by the student's advisory committee.

BCHM 8599 - Research for Doctoral Dissertation (15). This is a requirement for all students registered for a Doctor of Philosophy with concentration in Biochemistry. The proposed research must be pre approved by the student's advisory committee.

### **Time Table for the Ph.D. Degree**

- Year 01      Discuss class program with Graduate Coordinator during registration week and begin course work. Conduct rotations in department laboratories in second semester.
- Year 02      Select Thesis Advisor and Thesis Committee Advisor, inform Department Chairperson. Begin preliminary experiments for thesis research. Complete credit requirements by the end of this year.
- Year 03      Take comprehensive exam, present a thesis proposal for approval by the Advisor during the first semester, obtain committee's approval of thesis proposal during the second semester, and formally initiate thesis research during second semester.
- Year 04-05    Complete thesis research, submit a minimum of one manuscript to a scientific journal, and defend the Thesis Dissertation.

### **Time Table for the M.S. Degree (thesis option)**

- Year 01      Discuss class program with Graduate Coordinator during registration week and complete all required course work. Conduct rotations in department laboratories in second semester. Select Thesis Advisor and Committee, write and submit proposal to Thesis Committee.
- Year 02      Begin your preliminary experiments during the summer of year 02. Complete credit requirements and continue thesis experiments during first semester. Formally complete thesis research during second semester and defend the Thesis Dissertation.

### **Time Table for the M.S. Degree (non-thesis option)**

- Years 01-02    Discuss class program with Graduate Coordinator during registration week and complete required course work.
- Year 03      Present a written proposal for a research experience project to the designated faculty mentor. Complete the proposed laboratory experiments by the end of the first semester. Complete the credit requirements for the M.S. degree.

Last revised August 4, 2016  
JRRM