



Biochemistry Graduate Program Student Handbook

Biochemistry Graduate Program

Student Handbook

Through a combination of coursework, seminars, and original research, you will complete a Graduate degree and acquire the skills needed to become an independent research scientist. Our major research training areas emphasize:

- Structural and Analytical Biochemistry
- Molecular and Systems Biology
- Metabolism and Disease

Brief Overview of Programs.

- A. The Bachelor of Science/Master of Science program is a 5-year dual degree program intended for undergraduate majors who wish to continue beyond the B.S. degree and receive additional training at the graduate level. Interested students who meet the minimum University GPA requirement are typically accepted into the program at the end of their junior year of undergraduate study. The Master's degree obtained after 5 years may be a Master of Biochemistry (non-thesis) or a Master of Science (thesis research) depending upon the selection made by the student.
- B. The Master of Biochemistry is a non-thesis alternative to the Master of Science degree in Biochemistry for students wishing to emphasize course work rather than thesis research. The Master of Biochemistry is a terminal graduate degree and is not appropriate for students intending to pursue a Ph.D. program.
- C. The Master of Science is a research degree that prepares students in Biochemistry for Ph.D. studies or provides training for technical employment.
- D. The objective of the Ph.D. program is to prepare students for careers as researchers primarily in academic, industrial, or government research environments.

Accelerated Bachelor of Science and Master's of Science Degree Program (ABM).

Description: This degree program is designed to provide an undergraduate student in Biochemistry a means of completing the requirements for both degrees on an accelerated schedule by allowing 12 credit hours to be counted towards both the B.S. and M.S. degree requirements. Consequently, only 18 credit hours must be completed as a graduate student. Three thesis options are available: a) research, b) scholarship, and c) teaching. Typically, students complete the dual degree program in approximately 5 years.

Admission Requirements for the Program:

- Must complete 92 credit hours by the end of their current semester, earn at least an overall GPA > 3.5
- a Biochemistry Major GPA of >3.5
- be positioned to complete the BS degree requirements by the end of their fourth year
- one letter of recommendation from the proposed faculty mentor, indicating the qualifications of the student and their willingness to serve as the MS advisor.

Formal application for admission to the Graduate School will be made in the fourth (senior) year.

Course Requirements: In addition to the standard University and Biochemistry requirements for a B.S. in Biochemistry, students must complete 30 credit hours at the graduate level for the Master's degree component. This is accomplished as outlined below:

Dual program courses (12 credits):

6 credit hours of 500 level courses in BCH:

BCH 552 (3 cr), BCH 553 (3 cr) or BCH 555 (3 cr)

6 credit hours of 400 level courses in other departments:

e.g. CH 431, CHM 433, BIO 414, BIO 421, GN 421, GN 441, PB 421

Required graduate courses (18 credits):

12 credit hours of 600/700 level courses:

BCH 701 (3 cr), BCH 703 (3 cr), and BCH 705 (3 cr) + one additional course (e.g. CHM 727, GN 701, BCH/GN 761, MB 714, MB 718, PO 757, etc)

6 credit hours of Research/Scholarship/Education:

BCH 695 (6), BCH 693 (6), or BCH 685 (6)

Thesis Requirements for the Accelerated BS/MS Program:

There are three possible tracks: Research, Scholarship and Education. In order to complete a significant body of work to include in the thesis, students are expected to identify a faculty mentor and select their desired track of inquiry while completing the undergraduate degree requirements. These decisions should occur no later than the end of the junior year, but preferably sooner to meet the accelerated schedule.

Research thesis (MS): will present novel, original research and provide evidence of mastery of biochemical technique(s). The thesis should be presented in the form of an original scientific manuscript, suitable for publication in a scientific journal.

Scholarship thesis (MR): will provide evidence of detailed understanding of biochemical techniques and their applications to help understand a particular scientific topic. The thesis should be presented in the form of an original review manuscript, suitable for publication.

Education thesis (MR): will provide evidence of understanding of educational techniques, innovations in pedagogy, and progress towards development of their educational skills. The thesis should be presented in the form of a teaching portfolio.

Master of Biochemistry Program (M.R.)

Description: Students in the MR degree program are required to complete the core curriculum and two advanced courses in biochemistry, chemistry, molecular biology, bioinformatics or computational biology, quantitative genetics, and/or other coursework as appropriate to their interests. The MR is a non-thesis degree program and does not require original research. Students complete and orally defend a written research review on a topic approved by their 3-member examination committee.

Admission Requirements for the Program:

- a four-year bachelor's degree (or equivalent) from a regionally accredited college or university in Biochemistry or closely related field.
- a GPA of at least 3.00 (on a 4.00 scale) in their undergraduate degrees.
- identified a faculty mentor, to serve as an advisor.

Course Requirements:

Required Core curriculum (16 credit hours; 12 graded):

BCH 590 Special Topics: Experimental Design and Application (3 credits) – Fall, year 1

BCH 701 Metabolism and Macromolecular Structure (3 credits) – Fall, year 1

BCH 703 Genome integrity and dynamics of gene expression (3 credits) – Spring, year 1

BCH 705 Signal transduction and cellular regulation (3 credits) – Fall, year 2

BCH 801 Biochemistry Departmental Seminar (2 credits) –Fall and Spring*

BCH 810 Biochemistry Student Seminar (2 credits) –Fall and Spring*

** BCH 801 and BCH 810 are required for all M.R. students in both Fall and Spring semester for two years, for a total of 4 credits each. To earn credit, students will consistently attend both the weekly Graduate Seminar / Journal Club (currently 11:30 Friday) AND the Biochemistry Departmental Seminar (currently 4pm Thursday).*

Advanced Courses (6 graded credit hours):

Selected courses approved by your faculty advisory. Potential courses include, but are not limited to, BCH 710, BCH/GN/PB 761, CH 727, CH 795, GN 702, GN 735, MB 714, MB 751, MB 758, PO/IMM 757, PP 707.

Additional Courses:

The Graduate School requires a minimum of 30 credit hours. At least 24 credit hours of letter-graded courses ("A," "B," "C", etc.) must be included in the program.

Thesis Requirements

The thesis will provide evidence of detailed understanding of biochemical techniques and their applications to help understand a particular scientific topic. The thesis should be presented in the form of an original review manuscript, suitable for publication.

Master of Science Program (M.S.)

Description: The Master of Science is a research degree that prepares students in Biochemistry for Ph.D. studies or provides training for technical employment.

Orientation

The Graduate Committee will assist you in your initial course selections and research rotation choices. You will have a guidance interview with the Graduate Committee to learn about the program in Biochemistry and choose courses for the first semester. You will meet with faculty members and/or members of their labs to find out about their research and get an overview of the active research areas in Biochemistry. This will help you think about choosing a research advisor and Supervisory Committee.

Thesis advisor selection

The major component of your graduate degree is a thesis that describes original research YOU conduct in the lab of a faculty advisor YOU select.

Students typically choose an advisor based on a shared research interest and/or a good rapport with that faculty member, who will be a mentor for your professional development in addition to an academic and research advisor. Many students entering the graduate program will have limited experience upon which to base this important career decision. We strongly suggest that you carefully consider your mentor selection, and to discuss expectations openly with them.

Supervisory committee

Sometime in your second semester, you will confer with your research mentor to form a Supervisory Committee. The approval form for the Supervisory Committee can be found on the Graduate Studies website. The purpose of this committee is to evaluate your progress in the degree program, to offer a support network within the University, and to assist you with practical guidance in your research project. Your three-member committee is chaired by your research advisor and two other Biochemistry faculty members. With approval of the Director of Graduate Programs, one faculty member may be from outside the Department.

Each year, you will schedule a meeting with your Supervisory Committee. Many students elect to hold their annual meeting following their yearly research presentation in BCH 801. At the meeting, you will present a 20-30-minute talk about your research progress to date, and your goals for the coming year. The Committee will question you during your presentation to ascertain your level of development as a scientist, and will advise the Director of Graduate Programs whether you are making satisfactory progress toward the degree objective. If progress is deemed insufficient, it is also the responsibility of the Supervisory Committee to forward recommendations for improvement, probation or termination where warranted. At least three members of your committee must be present for the annual meeting to approve your academic and research progress.

Courses

Core curriculum:

BCH 590 Special Topics: Experimental Design and Application (3 credits) – Fall, year 1
BCH 701 Metabolism and Macromolecular Structure (3 credits) – Fall, year 1
BCH 703 Genome integrity and dynamics of gene expression (3 credits) – Spring, year 1
BCH 705 Signal transduction and cellular regulation (3 credits) – Fall, year 2
BCH 801 Biochemistry Departmental Seminar (2 credits) –Fall and Spring*
BCH 810 Biochemistry Student Seminar (2 credits) –Fall and Spring*

** BCH 801 and BCH 810 are required for all M.S. students in both Fall and Spring semester for two years, for a total of 4 credits each. To earn credit, students will consistently attend both the weekly Graduate Seminar / Journal Club (currently 12:00 Friday) AND the Biochemistry Departmental Seminar (currently 4pm Thursday).*

Students in the MS program are required to complete the core curriculum. Additional advanced courses may be recommended or required by the student's supervisory committee. The MS is a research degree and students are required to defend their thesis research in a final oral examination.

All students in the M.S. program are required to register for the graduate seminar every semester throughout their program, receiving *one credit per semester* for a total of 4 credits over two years.

Other course requirements are arranged in consultation with your Supervisory Committee. You and your advisor then submit a Plan of Work that details your course work requirements to the Graduate School by the end of your first academic year (before one half of the courses are complete). Forms can be accessed through MyPackPortal under Student Self Service (Academic Records).

Successful completion of the M.S. degree requires a minimum of 30 credit hours. At least 18 credit hours of letter-graded courses ("A," "B," "C", etc.) must be included in the program.

Seminars

The development of oral communication skills is an essential component of professional development. Masters students give regular presentations in laboratory meetings, journal clubs, and other informal settings. The required credit hours in seminar courses (BCH 801) are expected to give you experience in formal presentations. M.S. students are required to give a formal, research-based, publicized seminar related to their dissertation research.

In addition to giving seminars, it is equally important for students to educate themselves by attending seminars. External speakers are regularly invited to present within several seminar series and annual symposia that we urge our students to attend. In particular, you should attend the weekly Biochemistry Departmental Seminar (BCH801) or other comparable departmental series, at which eminent speakers of international renown present their research at the invitation of our own faculty.

Teaching

Learning to communicate effectively in a teaching capacity is also critical to your future career as a scientist. To facilitate this aspect of your development, you will typically be required to assist with teaching/mentoring undergraduate and early stage graduate students within your research laboratory.

Dissertation requirements

1. The Graduate School requires all coursework to be completed with a grade point average of 3.0. The Department further requires that you achieve a grade of B- or better in all graduate core coursework.
2. Original research publications are the currency of your degree. Masters students are strongly encouraged to complete a first author or co-authored peer-reviewed manuscript submission prior to the dissertation defense.
3. All masters students complete a written thesis dissertation according to the requirements of the Graduate School.
4. The dissertation must be approved by your Supervisory Committee, presented in a public oral seminar, and defended in a final oral examination before your Supervisory Committee.

Timeline for M.S.

Average time to completion of a Ph.D. is ~ 2.0 years. How does that break down in milestones for students?

First year: complete core courses in Biochemistry; first year of seminar

- First semester: rotations and selection of a lab
- Second semester: selection and first meeting of supervisory committee; select coursework for second year of study.

Second year: continue/complete all coursework; continue meeting research and seminar requirements

- Second semester: second meeting of supervisory committee

Summer after Year 2: complete research; write thesis; final defense of thesis work; final examination by supervisory committee; M.S. conferred

Doctor of Philosophy Program (Ph.D.)

Description: The Ph.D. program in biochemistry is designed to prepare individuals for careers in research and/or teaching. Emphasis is placed primarily on laboratory research, where students work closely with faculty to develop expertise in desired techniques and are mentored in the scientific process. Students are also afforded the opportunity to mentor undergraduate students as teaching assistants as well as in the lab. The average time to completion of our Ph.D. program is just over five years.

Orientation: The Graduate Committee will assist you in your initial course selections and research rotation choices. You will have a guidance interview with the Graduate Committee to learn about the program in Biochemistry and choose courses for the first semester. You will meet with faculty members and/or members of their labs to find out about their research and get an overview of the active research areas in Biochemistry. This will help you think about choosing a research advisor and Supervisory Committee.

Thesis advisor selection: The major component of your graduate degree is a thesis that describes original research YOU conduct in the lab of a faculty advisor YOU select.

Students typically choose an advisor based on a shared research interest and/or a good rapport with that faculty member, who will be a mentor for your professional development in addition to an academic and research advisor. Many students entering the graduate program will have limited experience upon which to base this important career decision. We provide you the opportunity to do at least two “rotations” in your first semester, *i.e.*; work in a lab for a short time on a trial basis. The program is set up to allow you to rotate for two 8-week sessions during the semester. You will choose your first rotation after interviewing faculty whose research attracted you, and make your second choice at the end of the first four weeks when you have had an opportunity to acclimate. After the second rotation, all students will submit their choices for an advisor to the Graduate Committee, and final assignments will be made. Detailed instructions will be provided during orientation.

Supervisory committee: Sometime in your second semester, you will confer with your research mentor to form a Supervisory Committee. The approval form for the Supervisory Committee can be found on the Graduate Studies website. The purpose of this committee is to evaluate your progress in the degree program, to offer a support network within the University, and to assist you with practical guidance in your research project. Your committee is chaired by your research advisor(s) and must consist additionally of at least two other Biochemistry faculty and one faculty member from outside the Department (total of 5 members).

Each year, you will schedule a meeting with your Supervisory Committee. Many students elect to hold their annual meeting following their yearly research presentation in BCH801. At the meeting, you will present a 20-30-minute talk about your research progress to date, and your goals for the coming year. The Committee will question you during your presentation to ascertain your level of development as a scientist, and will advise the Director of Graduate Programs whether you are making satisfactory progress toward the degree objective. If

progress is deemed insufficient, it is also the responsibility of the Supervisory Committee to forward recommendations for improvement, probation or termination where warranted. At least three members of your committee must be present for the annual meeting to approve your academic and research progress.

Courses: All Biochemistry doctoral graduate students are required to take the following courses:

BCH 590 Special Topics: Experimental Design and Application (3 credits) – Fall, year 1

BCH 701 Metabolism and Macromolecular Structure (3 credits) – Fall, year 1

BCH 703 Genome integrity and dynamics of gene expression (3 credits) – Spring, year 1

BCH 705 Signal transduction and cellular regulation (3 credits) – Fall, year 2

BCH 801 Biochemistry Departmental Seminar (2 credits) –Fall and Spring*

BCH 810 Biochemistry Student Seminar (2 credits) –Fall and Spring*

** BCH 801 and BCH 810 are required for all Ph.D. students in both Fall and Spring semester for four years, for a total of 8 credits each. To earn credit, students will consistently attend both the weekly Graduate Seminar / Journal Club (currently 12:00 Friday) AND the Biochemistry Departmental Seminar (currently 4pm Thursday).*

All students in the Ph.D. program are required to register for the graduate seminar every semester throughout their program, receiving *one credit per semester* for a total of 8 credits over four years.

Other course requirements are arranged in consultation with your Supervisory Committee. You and your advisor then submit a Plan of Work that details your course work requirements to the Graduate School by the end of your first academic year (before one half of the courses are complete). Forms can be accessed through MyPackPortal under Student Self Service (Academic Records).

Successful completion of the Ph.D. degree requires a minimum of 72 credit hours.

Comprehensive Examination: Doctoral students in their fifth semester must pass a Comprehensive Examination consisting of written and oral components. The exact nature of this Exam is determined by the Supervisory Committee. Typically, for the written component of your exam, you are asked to write a research proposal in the style of an external grant application on a topic of your choosing. The topic must be different from your advisor's and your own research area. You will choose three potential topics and construct a Specific Aims page in the style of the funding agency selected by your committee. Your committee will work with you to finalize a suitable topic from among the three you propose and you will complete the proposal independently, though you are encouraged to consult appropriate faculty and peer expertise for methodological guidance.

For the oral component of your comprehensive examination, you will schedule a meeting with your Supervisory Committee at which you will give a presentation of your proposal and defend against the committee's questions. We ask that you circulate the proposal to the members of your committee two weeks before the meeting. The oral exam will probe the depth and breadth of your biochemistry knowledge, and the sophistication of your scientific thought process. All members of your committee must be present for the oral examination. It

is acceptable for members to participate remotely if necessary. Please be sure to fill out the appropriate Graduate School forms (<https://grad.ncsu.edu/faculty-and-staff/forms/graduate-school-forms/>).

Passing the Comprehensive Examination results in your being recommended for Ph.D. candidacy. The Graduate School has a rule that all doctoral students must attain candidacy for the degree within four years of starting their program or after they have completed 48 hours of coursework, whichever is later. Hence, we strongly recommend completing this process within the fifth semester of your program.

Seminars: The development of oral communication skills is an essential component of professional development. Doctoral students give regular presentations in laboratory meetings, journal clubs, and other informal settings. The required credit hours in seminar courses (BCH 801) are expected to give you experience in formal presentations. All Ph.D. students are required to give a formal, research-based, publicized seminar related to their dissertation research.

In addition to giving seminars, it is equally important for students to educate themselves by attending seminars. External speakers are regularly invited to present within several seminar series and annual symposia that we urge our students to attend. In particular, you should attend the weekly Biochemistry Departmental Seminar (BCH801) or other comparable departmental series, at which eminent speakers of international renown present their research at the invitation of our own faculty.

Teaching: Learning to communicate effectively in a teaching capacity is also critical to your future career as a scientist. To facilitate this aspect of your development, you will typically be required to assist with teaching biochemistry courses for at least one semester. This responsibility may be fulfilled in some cases by providing teaching assistance in a lab course, or in others by assisting course instructors with grading, problem solving, and fielding student questions.

Dissertation requirements

1. The Graduate School requires all coursework to be completed with a grade point average of 3.0. The Department further requires that you achieve a grade of B- or better in all graduate core coursework.
2. Original research publications are the currency of your degree. The Department requires all doctoral students to have a minimum of one first author manuscript under review in a peer reviewed journal.
3. All doctoral students complete a written thesis dissertation according to the requirements of the Graduate School.
4. The dissertation must be approved by your Supervisory Committee, presented in a public oral seminar, and defended in a final oral examination before your Supervisory Committee.

Timeline for Ph.D.

Average time to completion of a Ph.D. is a little over 5 years. How does that typically break down in milestones for students?

First year: complete core courses in Biochemistry; first year of seminar

- First semester: rotations and selection of a lab
- Second semester: selection and first meeting of supervisory committee; select coursework for second year of study.

Second year: continue/complete all coursework; continue meeting research and seminar requirements

- Second semester: second meeting of supervisory committee; select format / topic for written and oral comprehensive exams.

Third year: continue meeting research and seminar requirements; first semester of teaching

- First semester: complete written and oral comprehensive exams
- Second semester: third meeting of supervisory committee

Fourth year: continue meeting research and seminar requirements; potential second semester of teaching

- Second semester: fourth meeting of supervisory committee; discussion of time to graduation

Fifth year: complete research; write thesis; final defense of thesis work; final examination by supervisory committee; Ph.D. conferred

Sample Doctoral Schedule:

Year 1, fall semester			Year 1, spring semester		
Course		Cr	Course		Cr
BCH701	Macromolecular Structure and Metabolism	3	BCH703	Transcription, Translation, and Genome Dynamics	3
BCH590	Special Topics in Biochemistry: Experimental Design and Application	3		Specialty course *	3
BCH870	Research credit (rotations)	2	BCH870	Research credit	2
BCH801	Departmental seminar	1	BCH801	Departmental seminar	1
BCH810	Research seminar/journal club	1	BCH810	Research seminar/journal club	1
	Credits toward 18	6		Credits toward 18	6
Year 2, fall semester			Year 2, spring semester		
BCH705	Signal transduction and cellular regulation	3			
	Specialty course *	3			
BCH899	Dissertation research (credits variable)	2	BCH899	Dissertation research (credits variable)	
BCH801	Departmental seminar	1	BCH801	Departmental seminar	1
BCH810	Research seminar/journal club	1	BCH810	Research seminar/journal club	1
	Credits toward 18	6			
Year 3, fall semester			Year 3, spring semester		
BCH899	Dissertation research (credits variable)		BCH899	Dissertation research (credits variable)	
BCH801	Departmental seminar	1	BCH801	Departmental seminar	1
BCH810	Research seminar/journal club	1	BCH810	Research seminar/journal club	1
	Oral comprehensive exam				
Year 4, fall semester			Year 4, spring semester		
BCH899	Dissertation research (credits variable)		BCH899	Dissertation research (credits variable)	
BCH801	Departmental seminar	1	BCH801	Departmental seminar	1
BCH810	Research seminar/journal club	1	BCH810	Research seminar/journal club	1
	* Options for fall specialty courses			** Options for spring specialty courses	
CH727 MB714	Biological Mass Spectrometry Microbial Metabolic Regulation <i>Other course approved by supervisory committee</i>		BCH710 GN735 GN702 MB758 GN758 PP707 PB/BCH /GN761 MB751 CH795 <i>Other course approved by supervisory committee</i>	Biological Scanning Electron Microscopy Advanced sequencing applications Developmental genetics. Microbial Genetics & Genomics Plant Microbe Interactions Advanced Molecular Biology of the Cell Immunology Introduction to Chemical Biology	2

Comments on Molecular and Structural Biochemistry Program

- Shaded boxes indicate core Program elements.
- PhD students need 18 credits of formal coursework. Minimum of 72 total credits.
- Following completion of 72 credits, students need only register for three credits per semester to be considered full time and eligible for the graduate student support package.
- Credit totals from courses that are eligible to count toward the 18 credits are given in red font.
- BCH 801 and BCH 810 are required for all PhD students in both Fall and Spring semester for four years, for a total of up to 8 credits each. To earn credit, students will consistently attend both the weekly Graduate Seminar / Journal Club (currently 12:00 Friday) AND the Biochemistry Departmental Seminar (currently 4pm Thursday).

Academic Performance

Graduate students are expected to meet the minimum academic requirements of both the Graduate School and the Department of Molecular and Structural Biochemistry.

1. Graduate School Requirements.

Graduate students are expected to maintain an overall GPA of 3.0 or higher. Students will receive a notice of academic warning if their GPA falls below 3.0 and they have accumulated less than nine credit hours towards his/her graduate program. If a student has attempted between nine and eighteen credit hours and earned a GPA of less than 3.0, the student is placed upon academic probation. A student's graduate program is terminated if he/she has 18 or more credit hours and has a GPA of less than 3.0. Students receiving an academic warning or academic probation may not hold an assistantship.

2. Molecular and Structural Biochemistry Department Requirements.

Graduate students are expected to maintain an overall minimum GPA of 3.0. A minimum acceptable grade of B- is required in each of the biochemistry core courses. If a student receives a letter grade of less than B- in a core course, he/she must retake that course and earn a B- or better. Two grades of less than B- in the biochemistry core courses, including two unacceptable grades in the same core course, will result in termination of the student from the Department's graduate program. If a student's GPA falls below the minimum 3.0, he/she will have not more than 2 semesters to raise the GPA back to the minimum 3.0 by taking graduate courses in or outside the department at the 500 level or above (excluding BCH 553 and BCH 555).

BGSA

Graduate students in the Department formed the Biochemistry Graduate Student Association. The purpose of this organization is to represent our graduate students in communications among members of the Biochemistry community, and also to promote unity, camaraderie, and active participation in departmental affairs. Membership is open to all Biochemistry graduate students.

Research equipment

Core facilities

Molecular Education, Technology, and Research Innovation Center (METRIC)

Directors: David Muddiman, Chemistry, and Joe Barycki, Biochemistry

Biophysical instrumentation: Dr. Peter Thompson, 51 Polk Hall

Microscopy (CMIF): Dr. Eva Johannes, 4115 Gardner Hall

Flow cytometry & Cell Sorting Facility: Javid P Mohammed, CVM Main Building, Room# B303

Genome Sciences Laboratory: Dr. Andy Baltzegar, 2518 Thomas Hall

Departmental Equipment

The Biochemistry Department has numerous pieces of shared equipment available for use by any member of the Department. Many common items are available, including autoclaves, dishwashers, walk-in warm and cold rooms, scintillation counters, low-speed ultracentrifuges, floor shakers for large scale culture, spectrophotometers, conventional thermocyclers, etc. A partial list of shared equipment can be found at:

<https://cals.ncsu.edu/molecular-and-structural-biochemistry/shared-departmental-equipment/>

Please be aware that this list is a “work-in-progress” and additional instrumentation is likely available. Please receive proper training on an instrument prior to use, use the log book associated with the instrument, leave the instrument ready for use by the next researcher, and indicated any issues with the instrument to the appropriate contact person.