

BIOCHEMISTRY (PH.D.)

<https://colsa.unh.edu/molecular-cellular-biomedical-sciences/program/phd/biochemistry>

Description

The Ph.D. in Biochemistry combines a rigorous curriculum in biochemistry and related disciplines with interdisciplinary research opportunities at the frontiers of biochemistry, molecular biology, and cell biology. Graduates of the program are equipped for leadership positions in biotechnology and pharmaceutical companies, academic and government research laboratories, and successful careers in teaching and research at the college and university level.

Distinctive Features of the Program

- Advanced course offerings include signal transduction pathways, pharmacology, physical biochemistry, proteomics, endocrinology, structural biology, bioinformatics, and cancer biology
- Emphasis on interdisciplinary research training
- Well-equipped research laboratories and core facilities on the UNH campus
- Laboratory rotations upon entry to the program to become familiar with different research laboratories
- Weekly graduate student seminar presentations, as well as a departmental seminar series of invited speakers
- Opportunities to gain teaching experiences as a Graduate Teaching Assistant

Research Opportunities

- Cancer biology
- Protein structure, function, and regulation
- Signal transduction pathways
- Molecular and cellular neuroscience
- Genomics and bioinformatics
- Regenerative biology
- Molecular immunology
- Chemical biology

Financial Support

- Students admitted to the Ph.D. Program are typically supported by Research Assistantships or Teaching Assistantships
- Internal summer and academic year fellowships are available to students on a competitive basis.

Career Prospects

- Research directors in biotechnology and pharmaceutical industries
- Principle investigators of academic research labs and research institutes, state and federal government agencies
- Academic preparation for future teaching roles in a college or university environment

Admission Requirements

- Completion of foundational courses in biology, chemistry (including organic chemistry), physics, and mathematics

- Otherwise well-qualified applicants can correct academic deficiencies with enrollment in appropriate courses or independent study during the first year of graduate studies
- Applicants from non-English speaking countries must provide Test of English as a Foreign Language (TOEFL) scores
- Three letters of recommendation
- Personal statement, including research interests and identification of two or three potential Biochemistry faculty thesis advisors.

Requirements

Ph.D. Requirements

The Ph.D. in Biochemistry requires the completion of significant, original independent research and preparation of a dissertation for submission to the Graduate School. A minimum of two semesters of Doctoral Research (MCBS 999) is required. Graduate credits are earned for courses numbered 800-999. In most cases, it is expected that the Ph.D. degree will be completed within four to six years of admission to the graduate program. Demonstration of proficiency in biochemistry will be assessed in the first year by examination or coursework.

Guidance Committee: Initially, the Graduate Program Coordinator will assist the student in choosing courses. Following selection of the thesis advisor, the student and the advisor jointly agree on the members of the Guidance Committee, and communicate this recommendation to the Biochemistry Graduate Program Coordinator. The Doctoral Guidance Committee Nomination Form must be completed and submitted to the Graduate School by the end of the first year. The Guidance Committee consists of five faculty members: the advisor (as chairperson), two other members of the biochemistry graduate faculty, and up to two faculty members from other graduate programs. However, only three members of the Guidance Committee are required for the second-year exam. The Committee meets soon after selection of a thesis advisor to determine the student's curriculum. Courses required by the Guidance Committee must be taken for credit and completed with a passing grade (at least a B-minus-). Courses recommended by the committee may be audited or taken for credit, but in either case, the student is expected to be familiar with the subject matter of these courses. It is recommended that the Guidance Committee meet each semester thereafter to assess the student's academic and research progress.

Doctoral Dissertation Committee: The Doctoral Committee is composed of the faculty advisor (as chairperson), two other faculty members in the graduate program in biochemistry, and up to two faculty members from other graduate programs. In most cases, the Guidance Committee constitutes the Doctoral Committee. The Doctoral Committee evaluates the dissertation and administers the final examination. The Doctoral Committee meets annually to assess the progress toward completion of the Ph.D. requirements.

Qualifying Examination and PhD Candidacy:

After completion of required coursework in the program and fulfilling other degree requirements, students seek the approval of the advisory committee to proceed to the qualifying exam, which should occur within 3-6 months of approval. Typically, the qualifying exam takes place in the third year - between the 4th to 6th semester of the candidate student's academic program. The purposes of the qualifying exam are to i) assess the depth and breadth of knowledge in biochemistry, molecular, and cellular biology, and in the student's specific research domain; ii) evaluate the student's capability of critical thinking and to develop a rigorous

research proposal, and iii) assess the student's proficiency in scientific writing and communication, and to articulate and defend a research proposal.

The qualifying exam consists of both a written and an oral section, both of which center on a student's proposed dissertation topic. Alternatively, after consulting with the advisor and the advisory committee and receiving their approval, students may develop a research proposal on a topic that is derived from published research article(s). Students are expected to develop their research proposals under the oversight of their advisor and/or committee members, who should provide students guidance on topic selection and writing, with the aim of enhancing both scientific premise and written communications. It is recommended that the student and advisor meet at least three times to discuss and revise the proposal prior to submission to the committee. The student may submit the proposal to the committee only upon approval by their advisor. The advisor should ensure that the final version of the proposal is a product of original, creative thinking from the student.

The **written section** of the qualifying exam is a research proposal, typically following the format of NIH NRSA predoctoral F31 fellowship (sample F31 proposal are available for reference (see <https://www.niaid.nih.gov/grants-contracts/sample-applications>)). Alternatively, for research that is more related to NSF themes or other funding agencies, it may follow the format of graduate research fellowship of NSF or other funding agencies.

Specifically, the written section should include the following:

- **Specific Aims:** a one-page summary that outlines the gap-in-knowledge, the research's main objectives, the main hypotheses, and the potential impact the research could have. This should be structured to include 2-3 specific aims, each with a testable hypothesis.
- **Research Strategy:**
 - **Background, Significance and Premise:** a summary of the existing knowledge in the field, with an emphasis on the importance of the proposed research in advancing our understanding of biological processes while addressing broader socioeconomic needs. This should raise specific questions that will be addressed in the research and provide the scientific foundation and importance of the proposed work.
 - **Innovation:** A concise description of the uniqueness, specifically the technical and/or conceptual novelty of the proposed research.
 - **Approach:** A description of the methods and approaches that are employed, including identification of resources and expertise that the student will engage to tackle the research. This section should also highlight potential challenges and limitations and provide alternative approaches, in case the main hypothesis fails.
 - **Timeline:** A general timeline that outlines the anticipated milestones and deadlines for completing the research. This demonstrates the student's ability to plan and manage a research project effectively.

The research proposal is submitted to the advisory committee for evaluation at least three weeks before the oral exam. Committee members may approve or reject the written proposal. If a committee member rejects the submitted proposal, they must provide a response to the student, with copy to the advisor and other committee members. The responses should articulate specific shortcomings and actionable steps that the student may take to rectify. The advisor is responsible for convening the committee to collectively assess the quality of the

proposal. After the discussion, the committee will provide general comments and additional revision critiques specifying strengths and weaknesses of the proposal, as well as the necessary improvements that must be made by the student before submitting a revised version. Only after a majority of the members of the advisory committee has approved the written proposal, the student moves to the oral defense.

Students are encouraged, in consultation with their advisor, to submit their research proposals to NIH to compete for a NRSA F31 predoctoral fellowship.

The **oral section** is contingent upon the student having successfully completed the written section. The specific content of the oral exam is determined, in consultation with the advisory committee, primarily by the content of the written proposal. Students may give a brief update (~10 minutes) on their coursework and research progress at the beginning of the oral examination (~10 minutes). The presentation of the research proposal may last 30-40 minutes, followed by questions from the committee. Questions may arise from general knowledge in biochemistry, molecular, and cellular biology, or specifically associated with the proposed project. Students are expected to defend the significance, premise, rationale, methodologies, and experimental plans outlined in their proposals. They are expected to present a feasible project utilizing available resources at UNH, the advisor's laboratory, and collaborative supports. The oral exam typically lasts 90-120 minutes. Upon the completion of questions from the committee, the student will be asked to leave the defense room while the committee discusses the oral examination. The committee discussion should last no longer than 15 minutes, and consensus by the committee should be reached after a discussion. Afterwards, the student will be invited back into the room to hear the committee's verdict and their specific feedback on both the oral portion of their exam, and the qualifying exam in general.

The grading of the qualifying exam includes **Pass, Conditional Pass, or No Pass**. Upon passing the qualifying examination, the student advances to PhD candidacy, officially declaring the intended dissertation topic. For students receiving a Conditional Pass, specific weaknesses identified by the committee are addressed through additional revision or research. Students who receive a No Pass have demonstrated insufficient scientific premise, mastery of lab skills or critical thinking. In this case, they have the option to retake the qualifying exam within 6 months. Students who cannot pass the qualifying exam after 2nd trial are advised to pursue a master's degree.

Dissertation: The student is required to prepare a written doctoral dissertation for submission to the Doctoral Committee. The dissertation must represent significant and original research written in a clear, comprehensible style. A copy of the complete thesis must be made available to the committee at least two weeks before the date of the final examination. Publication of the dissertation by ProQuest is required.

Final Defense: An oral examination of the doctoral dissertation consists of two parts: an oral presentation of the research that is open to the public, and an oral defense of the dissertation conducted by the doctoral committee. Final approval of the doctoral dissertation will be determined by a majority vote of the doctoral committee.

Teaching Requirement: Teaching assignments in the laboratory, in lectures, or in an individual instruction format are an essential part of the graduate academic programs of the department and are designed to give graduate students practical teaching experience. Normally, one year of part-time teaching will be required of each doctoral student.

Student Learning Outcomes

Program Learning Outcomes

All MCBS graduates will be able to:

- Critically apply theories, methodologies, and knowledge to address fundamental questions in their primary area of study.
- Pursue research of significance in the discipline (or an interdisciplinary or creative project). Students plan and conduct this research (or implement their project) under the guidance of an advisor, while developing intellectual independence that typifies true scholarship.
- Demonstrate skills in oral and written communication sufficient to present and publish work in their field, and to prepare grant proposals.
- Follow the principles of ethics in their field, and in academia, as well as adhere to established principles of scientific rigor and reproducibility.
- Demonstrate, through service, the value of their discipline to the academy and community at large.
- Demonstrate a mastery of skills and knowledge at a level required for college and university undergraduate teaching in their discipline and assessment of student learning.
- Interact productively with individuals from diverse backgrounds in the roles of team members, leaders and mentors with integrity and professionalism.

Graduates of the Biochemistry Ph.D. degree program will be able to:

- Demonstrate extensive knowledge and understanding of fundamental biochemistry principles and their area of specialization in the field.
- Critically apply theories and methodologies to address fundamental questions in biochemistry through research activities.
- Design and conduct biochemical experiments in their area of specialization, analyze and interpret research data, and draw critical conclusions.
- Communicate biochemical concepts and experimental results effectively in writing and orally both in scientific technical language as well as at an appropriate level tailored for the general audience.