Complex Biosystems PhD Program Graduate Handbook

Program Overview

The PhD Program in Complex Biosystems is directed toward students interested in applying quantitative statistical and computational approaches to data acquisition and analysis in multiple life sciences fields. This is a research-intensive program in which students address `big' questions and grand challenges in the life and data sciences.
Students are admitted to the program through one of two mechanisms. Some students are admitted without an identified doctoral advisor. These students receive stipend and tuition support (i.e., a graduate assistantship) from the CBIO program. If you are admitted with program financial support, you will participate in a full year of research rotations (three total) on diverse topics, with one semester of laboratory teaching experience. Some students are admitted with an identified doctoral advisor. These students receive a graduate assistantship from their advisor. If you are admitted with advisor financial support, rotations and teaching experience are omitted.
In the first year of study, you will consider "big questions" in the life sciences and learn current technical and analytical approaches to address them. In addition to scientific communication skills and ethical research conduct, you will acquire a foundation in population, cellular and molecular life sciences; statistics; bioinformatics; and computational analysis. Following the first year, you will choose a mentoring team and complete one of the following training specializations:

Systems Analysis
Pathobiology and Biomedical Science
Microbial Interactions
Integrative Plant Biology
Computational Organismal Biology, Ecology, and Evolution (COBEE)

Orientation

The program leadership will assist you in your initial course selections and research rotation choices. You will have a guidance meeting with the Directors at the beginning of each Fall semester to learn about the program, receive program updates, and choose courses for the first year. If you are doing research rotations, a list of available rotation mentors will allow you to find out about their research and contact faculty whose research interests you. 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 with the guidance of a faculty advisor YOU select. Students typically choose an advisor (or advising team) based on a shared research interest and/or a good rapport with that faculty member. Many students entering the graduate program will have limited experience upon which to base this important career decision. The program is set up to allow you, if applicable, to rotate for one 16-week session during one semester of the first year (the 16-week session will be done concurrently with your first-year teaching assignment) and two 8-week sessions during the remaining semester of the first year. You will choose your first rotation after interviewing faculty whose research attracted you during the orientation period and then make your second and third choices later in the semester when you have had an opportunity to acclimate. Prior to the end of your first year of study, you are required to secure an advisor(s) with a graduate research assistantship that will support your continuing studies.

Supervisory committee

In your second year of study, you will confer with your faculty advisor(s) to form a Supervisory Committee. The approval form for the Supervisory Committee can be found on the website of the Office of Graduate Studies. 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 and must consist additionally of at least two other Complex Biosystems faculty and at least one faculty member outside the advisor's department (for a minimum of four committee members). In the second half of each year of study (starting with Year 2), you will schedule a meeting with your Supervisory Committee. At the meeting, you will present a 20- to 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 program leadership as to 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.

Courses

All Complex Biosystems PhD students **are required** to take the following courses: Biosystems Research I (CBIO841; 3 credit hours); Biosystems Research II (CBIO842; 3 credit hours); Statistics 801 or equivalent (4 credit hours); Professional Development (CBIO844; 1 credit hour); Seminar (CBIO843; 1 credit hour for a total of at least 10 credit hours); and Introduction to Biotechnology (1 credit hour). An outline of the typical first year of study is provided below.

<table>
<tr><th>Semester 1</th><th colspan="2">Semester 2</th></tr>
<tr><th>Rotation 1</th><th>Rotation 2</th><th>Rotation 3</th></tr>
<tr><td>LIFE 120 teaching assistant*</td><td colspan="2"></td></tr>
<tr><td colspan="3">Complex Biosystems Graduate Seminar (1 cr, at least 5 years)
Program faculty research presentations with student evaluation of research publications and a seminar evaluation; student research presentations are integrated into the seminar rotation.</td></tr>
<tr><td>Professional Development (1 cr)
Scientific communication: seminars, posters, journal publications and grant proposals
Ethics in research and publication

Elective course (3-4 cr)</td><td colspan="2">Statistics 801 (4 cr):
Statistical methods in research (or appropriate alternative course if student can document equivalent knowledge of statistics)

Center for Biotechnology Instrumentation Core Course (1cr)</td></tr>
<tr><td colspan="3">Alternatively,</td></tr>
<tr><td>Professional Development (1 cr)

Statistics 801 (4 cr):
Statistical methods in research</td><td colspan="2">Elective course (3 cr)

Center for Biotechnology Instrumentation Core Course (1cr)</td></tr>
</table>

CBIO841: Big Questions (3 credits)	**CBIO842: Integrating quantitative discovery into basic and applied research (3 credits)**
One module for each specialization featuring a coordinated, systems-level examination of a key research question in each specialization using primary literature:	Series of modules featuring in-depth examinations of key challenges in computational and quantitative biology

*Some of the cohort of first-year students will serve as teaching assistants for LIFE 120 lab. The first research rotation is conducted for the full 16 weeks of the fall semester; rotations 2 and 3 in the spring semester (each for 8 weeks).

All students in the Ph.D. program are required to register for the graduate seminar *every* semester for at least the first five years of their program, receiving *one credit per semester* for a total of 10 credits over five years. See below for additional information regarding seminars.

Other course requirements are arranged in consultation with the program leadership and/or the Supervisory Committee using the guidelines provided for the chosen program specialization. The student and advisor then submit a Program of Studies that details the student's course work requirements to the Graduate College before one half of the courses are complete (before the completion of 45 credits of study). Forms can be found on the Graduate Studies website.

Successful completion of the Ph.D. degree requires 90 credit hours, of which at least 35 credits are coursework and the remainder thesis research. No more than 55 of the 90 credit hours may be dissertation research, and 45 credit hours must be in life science, data science, or related specialized offerings (including dissertation research).

Seminars

The development of oral communication skills is an essential component of professional development. Students give regular presentations in laboratory meetings, journal clubs, and other informal settings. The required credit hours in the Complex Biosystems seminar course are expected to give you experience in formal presentations, as well as exposure to the research of your colleagues. 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 seminar series and annual symposia both on and off campus that we urge our students to attend.

Qualifying Exam

Students in approximately their fifth semester must pass a Qualifying Examination. You will be asked to write a research proposal in the style of an external grant application on the topic of your proposed dissertation research. Additional requirements for the exam may be determined by the Supervisory Committee. You will schedule a meeting with your Supervisory Committee, to be held at least two weeks after you have provided the Committee with your research proposal, in which you will give a presentation of your proposal and defend against the Committee's questions. The exam will probe the depth and breadth of your expertise and technical knowledge, and the sophistication of your scientific thought process.

Passing the Qualifying Examination results in your being recommended for Ph.D. candidacy. You must be admitted to candidacy at least 7 months prior to your final oral dissertation defense. Also, the Graduate College has a rule that if a student does not graduate within three years of passing the Qualifying Examination, the Supervisory Committee must give another such exam.

External proposal submission

Each student in the program is strongly encouraged to identify an external fellowship opportunity and work with the program directors and their advisor to develop and submit the proposal. In the case of National Science Foundation fellowships, the proposal will be submitted in the first or second year. For other agencies, the specific agency requirements will be followed. The proposal will be submitted with support from your research advisor as sponsor and advice or critical review as needed from the supervisory committee. If you do not yet have an advisor, a program director may serve as your sponsor.

Dissertation, final oral examination, and public seminar

All students will complete a written dissertation describing their original graduate research. Students will present a public seminar summarizing their research and will defend the research in a final oral examination before the supervisory committee.

Teaching

Learning to communicate effectively in a teaching capacity is critical to your future career as a scientist. To facilitate this aspect of your development, if you receive financial support, you may be required to assist with one semester of teaching within the first year. This is usually for either LIFE 120 Lab or LIFE 121 Lab as needed.

Timeline for Ph.D.

Students are strongly encouraged to refer to the Office of Graduate Studies website https://graduate.unl.edu/) for information about milestones to degree completion.
The average time to completion of a Ph.D. in Complex Biosystems is 5 years of full time study. How does that break down in milestones for students?

First year: complete core courses in Biosystems Research; first year of seminar

- First semester: [rotations], coursework, [teaching], [NSF proposal submission]
- Second semester: [rotation], selection of mentor(s), select coursework for second year of study.

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

- First semester: first meeting of Supervisory Committee; submit Supervisory Committee approval and Program of Studies forms to OGS
- Second semester: second meeting of Supervisory Committee; select format / topic for qualifying exams.

Third year: qualifying exam; continue meeting research and seminar requirements.

- First semester: complete qualifying exam

- Second semester: third meeting of supervisory committee

Fourth year: start thesis writing; continue meeting research and seminar requirements.

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

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

Upon completion of coursework, candidate may consider requesting Full Time Certification from OGS

Example Programs for Ph.D. As stated above, the average time for completion of a Ph.D. is 5 years. Each student must choose a specialization program which provides guidance on course selection (including required coursework) and relevant dissertation topics. Below we present example programs of study for each specialization. These are only examples and should be modified for each student in consultation with the program leadership and Supervisory Committee.

Pathobiology and Biomedical Sciences

Year	Fall	Spring
1	CBIO 841 Big Questions CBIO 844 Professional Development CBIO 843 Seminar STAT 801 Stat Methods in Research BIOS 898 Independent Research in Bio Sci	CBIO 842 Integrating Quantitative CBIO 843 Seminar BIOC 934 Genome Dynamics LIFE 891-002 Biotech Core Res Fac BIOC 898 Research in Biochemistry
2	CBIO 843 Seminar BIOC 831 Structures and Metabolism STAT 802 Experimental Design BIOC 898 Research in Biochemistry	CBIO 843 Seminar BIOC 837 Research Tech in Biochem BIOS 812 Human Genetics BIOC 999 Doctoral Dissertation
3	CBIO 843 Seminar BIOS 818 Advanced Genetics BIOS 966 Advanced Viral Path BIOC 999 Doctoral Dissertation	CBIO 843 Seminar BIOC 999 Doctoral Dissertation
4	CBIO 843 Seminar BIOC 999 Doctoral Dissertation	CBIO 843 Seminar BIOC 999 Doctoral Dissertation
5	CBIO 843 Seminar BIOC 999 Doctoral Dissertation	CBIO 843 Seminar BIOC 999 Doctoral Dissertation

Microbial Interactions

Year	Fall	Spring
1	CBIO 841 Big Questions CBIO 842 Professional Development CBIO 843 Seminar STAT 801B Stat Methods in Research BIOS 898 Independent Research in Bio Sci	CBIO 842 Integrating Quantitative CBIO 843 Seminar FDST 842 Omnivore's Microbiome LIFE 891-002 Biotech Core Res Fac FDST 896 Independent Study
2	CBIO 843 Seminar BIOS 820 Molecular Genetics	CBIO 843 Seminar BIOS 840 Microbial Physiology

	BIOS 826 Systems Biology STAT 850 Comp Tools FDST 896 Independent Study	PLPT 896 Special Topics Plant Path BIOS 843 Immunology FDST 999 Dissertation Research
3	CBIO 843 Seminar STAT 841 High Throughput Bio Data FDST 999 Dissertation Research	CBIO 843 Seminar FDST 999 Dissertation Research
4	CBIO 843 Seminar FDST 999 Dissertation Research	CBIO 843 Seminar FDST 999 Dissertation Research
5	CBIO 843 Seminar FDST 999 Dissertation Research	CBIO 843 Seminar FDST 999 Dissertation Research

Systems Analysis

Year	Fall	Spring
1	CBIO 841 Big Questions CBIO 842 Professional Development CBIO 843 Seminar STAT 802 Stat Applications BIOS 898 Independent Research in Bio Sci	CBIO 842 Integrating Quantitative CBIO 843 Seminar CSCE 155T CS1: Informatics LIFE 891-002 Biotech Core Res Fac CSCE 996 Research Problem
2	CBIO 843 Seminar AGRO 896 Bioinfo App in Ag ASCI 896 Genomics and Sys Bio BIOS 827 Practical Bioinfo Lab	CBIO 843 Seminar CSCE 878 Machine Learning BIOS 825 Plant Biotech CSCE 971 Advanced Bioinfo
3	CBIO 843 Seminar CSCE 990 Mol and Nano Comm BIOS 829 Phylo Biol CSCE 999 Doctoral Dissertation	CBIO 843 Seminar MATH 938 Math Modeling CSCE 999 Doctoral Dissertation
4	CBIO 843 Seminar CSCE 999 Doctoral Dissertation	CBIO 843 Seminar CSCE 999 Doctoral Dissertation
5	CBIO 843 Seminar CSCE 999 Doctoral Dissertation	CBIO 843 Seminar CSCE 999 Doctoral Dissertation

COBEE

Year	Fall	Spring
1	CBIO 841 Big Questions CBIO 842 Professional Development CBIO 843 Seminar STAT 801B Stat Methods in Research BIOS 898 Independent Research in Bio Sci	CBIO 842 Quantitative Approaches CBIO 843 Seminar BIOS 803 Principles of Evolution LIFE 891-002 Biotech Core Res Fac NRES 896 Independent Study
2	CBIO 843 Seminar STAT 803 Ecological Stats BIOS 863 Animal Behavior BIOS 856 Math Mod in Biol BIOS 898 Independent Research in Bio Sci	CBIO 843 Seminar NRES 862 Conservation Biology BIOS 958 Genetic Ecology BIOS 999 Doctoral Dissertation
3	CBIO 843 Seminar NRES 859 Stream and River Ecology BIOS 999 Doctoral Dissertation	CBIO 843 Seminar BIOS 999 Doctoral Dissertation

4	CBIO 843 Seminar BIOS 999 Doctoral Dissertation	CBIO 843 Seminar BIOS 999 Doctoral Dissertation
5	CBIO 843 Seminar BIOS 999 Doctoral Dissertation	CBIO 843 Seminar BIOS 999 Doctoral Dissertation

Integrated Plant Sciences

Year	Fall	Spring
1	CBIO 841 Big Questions CBIO 842 Professional Development CBIO 843 Seminar STAT 801B Stat Methods in Research AGRO 896 Independent Study	CBIO 842 Quantitative Approaches CBIO 843 Seminar AGRO 896 Bioinfo Apps in Ag LIFE 891-002 Biotech Core Res Fac AGRO 896 Independent Study
2	CBIO 843 Seminar BIOS 879 Plant Growth and Dev AGRO 931 Pop Gen AGRO 896 Independent Study	CBIO 843 Seminar AGRO 810 Plant Mol Bio PLPT 867 Plant Associated Microbes AGRO 999 Doctoral Dissertation
3	CBIO 843 Seminar AGRO 919 Plant Genetics AGRO 999 Doctoral Dissertation	CBIO 843 Seminar AGRO 999 Doctoral Dissertation
4	CBIO 843 Seminar AGRO 999 Doctoral Dissertation	CBIO 843 Seminar AGRO 999 Doctoral Dissertation
5	CBIO 843 Seminar AGRO 999 Doctoral Dissertation	CBIO 843 Seminar AGRO 999 Doctoral Dissertation

Assistantships and Financial Support

At the University of Nebraska-Lincoln, Graduate Research Assistantships (GRAs) and Graduate Teaching Assistantships (GTAs) may be available to qualified students. Student researchers may also be funded as GTAs for a portion of their PhD work. Students who receive program funding during their first year are *required* to serve as GTAs for at least one course. Prior to the end of their first year of study, students are *required* to find an advisor with stipend funding for the student at the current program stipend rate.

International students that have not completed a previous degree in the United States are *required* to *satisfactorily complete* the Institute for International Teaching Assistantships workshop prior to assuming the role, responsibilities, and benefits of a graduate teaching assistant. More information is available here: https://graduate.unl.edu/institute-international-teaching-assistants/
It is recommended that international PhD students complete the IITA training as soon as possible upon arrival to facilitate later appointments such as GTAs and completion of their PhD program of

study.

Decisions on graduate research assistantships are made on a case-by-case basis by individual faculty members. Graduate research assistants are typically expected to produce a thesis or dissertation, and also typically at least one peer-reviewed journal article during a MS and three peer-reviewed journal articles during a PhD program. Production and presentation of papers and/or posters for national and international conferences and symposia are also commonly expected during a research-based graduate program.

Other fellowship and scholarship opportunities

Other UNL or externally funded scholarships or fellowships may be available to qualified students. Current information about UNL and externally funded fellowships is available at:
https://graduate.unl.edu/funding/fellowships/
Students holding fellowships receive advising similarly to those holding assistantships.

Academic Leave of Absence

An Academic Leave of Absence may be granted to students for illness or injury, to provide care or assistance for family and dependents, to meet military service obligations, or for other personal reasons. Current information about UNL academic leave for graduate students is available at:
https://graduate.unl.edu/academics/academic-leave/

Vacation Policy for Students on Assistantships

All vacations and leaves must be planned in advance and approval obtained from your graduate advisor. There are many times when a student's presence is absolutely necessary for the proper conduct of research. Conflicts can be avoided by careful and advanced planning. School breaks such as Christmas, Thanksgiving, and Spring Break are work periods, except for days declared as official University holidays. When going on vacation or leaving, a telephone number and/or address should always be left with your graduate advisor.