Information Sheet

Interdisciplinary Graduate Track in Structural and Computational Biophysics

Wake Forest University

Departments of Biochemistry, Biology, Chemistry, Computer Science, and Physics

This document provides a general overview of the requirements for students participating in the SCB Track,, including Admission Requirements, Academic Requirements, Allowed Courses, Participating Faculty, and Estimated Timetables for Degree Completion. For specific requirements, please see the Wake Forest University Graduate Bulletin.
For further information, please contact the Track Director, Jacquelyn S. Fetrow (fetrowjs@wfu.edu).

Track Overview. The Interdisciplinary Graduate Track in Structural and Computational Biophysics (SCB; www.SCBTrack.wfu.edu) is a collaboration among the departments of Biochemistry, Biology, Chemistry, Computer Science, and Physics at Wake Forest University and is designed to meet the need for scientists and educators with broad, interdisciplinary training in the quantitative biological, biochemical, and biomedical sciences. The general objective of the Track is to train and catalyze the development of highly qualified students who wish to pursue academic careers in teaching and research or in the biotechnology or pharmaceutical or affiliated industries. Students participating in the Track will pursue a Ph.D. degree in one of the natural (physics and chemistry) or biomedical sciences (biology or biochemistry), or an M.S. degree in Computer Science, and receive state-of-the-art interdisciplinary training in the emerging fields of structural and computational biology and biophysics. Students who successfully complete the Track and degree requirements will receive a certificate in Structural and Computational Biophysics, as well as the degree in the department in which they matriculate.

Student Admission Requirements. Students are considered for admission to the Interdisciplinary SCB Graduate Track during the second semester following their admission to the graduate program in their chosen department. (Students in doctoral programs may also be admitted at any time during their second year.) Admission to the Track is initiated by meeting with the SCB department representative. The student will then submit a letter of intent and a Wake Forest University graduate transcript to their department representative, who will submit it to the SCB Advisory Committee. The letter of intent should express the student's interest in the SCB program, a proposed plan of study, and how the SCB program meets the student's career and academic goals. Upon review of the application, admission may be recommended by the SCB Advisory Committee; final admission to the SCB Track is determined by the Graduate School.

Student Academic Requirements. Students admitted to the Interdisciplinary Graduate SCB Track must complete all graduate degree requirements in the individual department to which they apply. (The official degree requirements for the Ph.D. in Physics, Biology, Chemistry, or Biochemistry and Molecular Biology, or for the M.S. in Computer Science, are described in the WFU Graduate Bulletin.) In addition, the students in the SCB Track must complete the following requirements:

- *Cross-disciplinary Coursework and Training.* At least 15 hours of graduate course work (including a general, introductory SCB course and two hours of journal club credit) are required in the SCB Track. At least one course beyond the introductory SCB course and the SCB journal club must be at the 700 level. Students must take at least two graduate hours in each of the curriculum areas: Chemistry/Biochemistry, Computer Science/Math, and Biophysics. *The 15 hours may simultaneously satisfy elective requirements in each discipline*. (Courses which fulfill these requirements are listed subsequently in this document.)
- *Interdisciplinary Thesis Requirements.* All students in the SCB Track will be required to complete and defend a dissertation or MS thesis that involves original, interdisciplinary research in the area of structural and computational biology or biophysics, broadly defined. The student will select a Thesis Advisor from the SCB faculty who is also on the faculty in their home department. The student and thesis advisor will select a Research Committee consisting of members from at least three of the participating SCB departments, including the advisor. (This committee is intended to be congruent with existing Department Research Committees, with addition of interdisciplinary members. For doctoral candidates, this can be done within the first two years of admission to the graduate school, concurrent with the individual department requirements.)
- *Research Topics in Structural and Computational Biophysics.* Each student must take the one-credit course, SCB 710. (This course is offered each fall, as necessary.) Course topics will change, but the course is designed to teach skills involved in critical reading, writing, and analysis of the primary scientific literature.
- *Journal Club.* Each student will be required to successfully complete the Structural and Computational Biophysics Journal Club twice. After successful completion of this course, students are expected to attend and participate in the journal club until they graduate.
- *Ethics Training*. All students will be required to successfully complete a course in scientific ethics. This requirement may be fulfilled by participating in the one-week Ethics in Science program offered by the Graduate School or completion of one of several approved departmental electives which incorporate extensive discussion of scientific ethics.
- *SCB Seminars*. Each semester, several seminars from the participating departments are designated as SCB seminars. Students in the Track are required to attend these seminars and are encouraged to participate in lunches or dinners with the speakers.

Participating Departments and Affiliated Faculty in the SCB Track (as of December 2006) and their research interests

*Department representatives to the SCB Advisory Committee

Physics

Keith Bonin: Molecular motors; total internal reflection fluorescence microscopy

Jacquelyn Fetrow: Protein structure/function; redox signaling; modeling of signal transduction pathways; cheminformatics; structure-based drug discovery

Martin Guthold: Nanobiotechnology, atomic force microscopy, fluorescence microscopy, single molecule biophysics, fibrin fibers, blood clotting, aptamers

George Holzwarth: Motor proteins, fast transport of vesicles

*Daniel B. Kim-Shapiro: Spectroscopy, sickle cell hemoglobin, nitric oxide

Jed Macosko: Mechanics of protein machines and motors; atomic force microscopy (AFM), single molecule fluorescence microscopy and video-enhanced differential interference contrast light microscopy (VE-DIC)

Fred Salsbury: Molecular dynamics, protein dynamics and function, electrostatic and solvent models, structural modeling of proteins and protein-DNA complexes, electronic structure

Chemistry

*Rebecca Alexander: Mechanisms of protein synthesis; aminoacyl-tRNA synthetases

Uli Bierbach: Design of small-molecule agents for the cure and management of life-threatening diseases and for probing and modulating gene regulation

Bruce King: Synthetic organic chemistry; synthesis of new organic compounds as nitric oxide (NO) and nitroxyl (HNO) delivery agents and probes to identify modified proteins

Computer Science

Jacquelyn Fetrow: see Physics

*David John: Combinatorial algorithms; genetic algorithms; computational algebraic modeling; computational systems biology

Paul Pauca: Computational imaging systems, data mining, molecular dynamics simulation

Stan Thomas: Data mining, analysis, and storage; Bayesian network modeling; artificial neural networks; computational systems biology

William Turkett: Probabilistic reasoning, machine learning, bioinformatics, multiagent systems

Biochemistry

Larry Daniel: Cell signaling in cancer, lipid-derived messengers, redox networks; modeling of signal transduction pathways

Roy Hantgan: Integrin structure and function; biomolecular/ biophysical interaction analysis

Thomas Hollis: X-ray crystallography, DNA repair proteins, structural biology of Fanconi anemia

David Horita: NMR spectroscopy, structural biology, protein-lipid interactions, protein-nucleic interactions

Susan Hutson: Branched chain aminotransferases, leucine signaling pathways

Mark Lively: Protein biochemistry

W. Todd Lowther: Macromolecular X-ray crystallography, enzymatic reduction of cysteine sulfinic acid and methionine sulfoxide, thioesterase and glyoxylate/hydroxypyruvate reductase structure/function

Doug Lyles: Virus structure and assembly; biophysics and genetics of viral protein function; signaling pathways in virus-infected cells

Linda McPhail: Protein structure/function; lipid signaling pathways; mammalian NADPH oxidases; assembly of enzyme complexes

Charles Morrow: Synergy between drug efflux pumps and conjugating enzymes in cancer drug and carcinogen resistance; Regulation of genes associated with xenobiotic detoxification.

Derek Parsonage: Structure-function studies of the FAD-dependent streptococcal NADH peroxidase and NADH oxidase; site-directed mutagenesis

Fred Perrino: DNA replication, DNA repair, mutagenesis, carcinogenesis, cancer therapeutics, deoxyribonucleases, TREX genes, DNA polymerases, alkylation DNA damage, mechanistic and structural studies

*Leslie Poole: Enzymological and biophysical studies of antioxidant enzyme systems; flavoprotein structure and function; redox active cysteinyl centers; biological cysteine sulfenic acid formation

Larry Rudel: Plasma lipoprotein metabolism and regulation of apolipoprotein gene expression; cholesterol transport and trafficking

Suzy Torti: Proteins of iron metabolism: role in inflammation and cancer; transcriptional regulation; structure and function

Alan Townsend: Molecular pharmacology of anticancer drugs; mechanisms of resistance to cytotoxic and mutagenic agents; glutathione metabolizing enzymes; aldehyde dehydrogenases

Biology

*Jim Curran: protein synthesis, translation, ribosome, tRNA, frameshifting, programmed frameshift, translational regulation

Gloria Muday: Transport protein structure/function, plasma membrane protein targeting, phosphorylation dependent signaling pathways

Brian Tague: Plant molecular biology, epigenetics, transcription

Affiliated Faculty in Non-participating Departments (as of December 2006) and their research interests (currently, these departments are not formally participating in the SCB Track, but these faculty may be involved in SCB interdisciplinary theses or serve on dissertation committees)

Biomedical Engineering

Pete Santago: Pattern recognition, image analysis, signal processing, cheminformatics, QSAR prediction

Mathematics

Ed Allen: Combinatorial algorithms; computational algebraic modeling; computational systems biology

Jim Norris: statistics, biological network modeling

Courses currently approved for the Interdisciplinary Graduate Track in Structural and Computational Biophysics at Wake Forest University (Other courses may be allowed with prior approval by the SCB Track Advisory Committee)

SCB-specific courses.

SCB 701 (1 hour) Structural and computational biophysics journal club

SCB 710 (1 hour) Research topics in structural and computational biophysics (taught every fall)

Curriculum Area 1. Chemistry/Biochemistry

General prerequisites: Two semesters of undergraduate chemistry and one semester of undergraduate biochemistry or molecular biology; one semester of organic chemistry is considered ideal, but is not required for most courses. (If additional prerequisites are required, they are listed individually by course.)

CHM 670/BIO 670 (3 hours) Biochemistry: Macromolecules and Metabolism

CHM 671 (1 hour) Biochemistry Laboratory: Macromolecules and Metabolism

CHM 672 (3 hours) Biochemistry: Protein and Nucleic Acid Structure and Function

CHM 641 (3 or 4 hours) Fundamentals of Physical Chemistry (Prerequisites: MTH 112; co-requisite: PHY 113-114)

BAMB 705 (4 hours) Biochemistry I (taught every Fall)

BAMB 706 (4 hours) Biochemistry II (taught every Spring)

BAMB 707 (2 hours) Biochemical Techniques (taught every Aug. 5 - 24, approx)

BAMB 716 (2 hours) Macromolecular X-ray Crystallography (Prerequisite: one semester graduate level biochemistry)

BAMB 731 (3 hours) Molecular Biology (taught every Fall)

CHM 751 (3 hours) Biochemistry of Nucleic Acids

CHM 752 (3 hours) Protein Chemistry: Structures, Methods and Molecular Mechanisms

CHM 756 (1.5 hours) Biomolecular NMR (Prerequisite: POI)

CHM 757 (1.5 hours) Macromolecular Crystallography. (Prerequisite: CHM 356A/656 highly recommended)

Curriculum Area 2. Biophysics

General prerequisites: Two semesters of undergraduate physics. (If additional prerequisites are required, they are listed individually by course.)

PHY 607 (3 hours) Biophysics (Prerequisite: BIO 112 or 214 or POI)

PHY 625 (1 hour) Biophysical methods laboratory. (Co-requisite: PHY 607)

PHY 685 (3 hours) Bioinformatics (Prerequisite: Introductory courses in biology, chemistry, and molecular biology or biochemistry or permission of instructor; also listed as CSC 685, though requirements and prerequisites are different).

PHY 620 (3 hours) Physics of Biological Macromolecules. (Prerequisite: PHY 651 or CHM 641, or Biology 214 and PHY 113 and 114 or POI)

PHY 623 (1 hour) Computational Biophysics Laboratory. (Co-requisite: PHY 620 or POI)

Category 3. Computer Science/Math

General prerequisites: Two semesters of college-level calculus; in some cases, an introductory programming course. (If additional prerequisites are required, they are listed individually by course.)

CSC 685 (3 hours) Bioinformatics (Prerequisite: CSC112, introductory course in cell or molecular biology or POI)

CSC 631 (3 hours) Object-oriented software engineering (Prerequisite: CSC221, CSC231)

CSC 646 (3 hours) Parallel computation. (Prerequisite: CSC222, CSC241)

CSC 652 (3 hours) Numerical linear algebra. (Prerequisites: MTH 112, MTH 121)

CSC 655 (3 hours) Introduction to numerical methods.

CSC 753 (3 hours) Nonlinear optimization. (Prerequisites: MTH 113, CSC 655)

CSC 754 (3 hours) Numerical methods for partial differential equations. (Prerequisites: MTH 113, CSC 655)

CSC 621 (3 hours) Database management systems. (Prerequisite: CSC 221)

CSC 671 (3 hours) Artificial intelligence. (Prerequisite: CSC 222)

CSC 721 (3 hours) Theory of algorithms. (Prerequisite: CSC 222)

Approximate timetable for completion of SCB degree requirements with PhD in Biology, Biochemistry, Chemistry or Physics.

	Academic and Degree Requirements
Year 1, Spring	• Students matriculate into Track • Meet with Track Advisory Committee to articulate course deficiencies identified during admissions and plan course of study • Take courses as required by their disciplines and the Track • Do rotations, if required by department • Participate in journal club • Take courses as required by their disciplines and the Track • Select Thesis Advisor following departmental procedures • Together with Thesis Advisor, select the Research Committee and begin research • Report thesis advisor and committee members to the Track Director
Year 2, Fall	• Students meet with Advisory Committee at the beginning of the semester to monitor progress • Take courses as required by their disciplines and the Track • Participate in journal club • Meet with Research Committee at the end of the semester to introduce thesis topic and plan research objectives • Report thesis topic and objectives to the Track Director
Year 2, Spring	• Take courses as required by respective disciplines and the Track • Students in the Biochemistry and Molecular Biology degree program write and orally defend a research proposal for admission to Ph.D. candidacy before the beginning of the third year
Year 3, Fall and Spring	• Students meet with Advisory Committee to monitor progress at beginning of fall semester (may be done by written notification) • Fulfill any remaining course requirements • Meet with Research Committee at end of Fall semester to demonstrate continued progress on thesis topic and obtain feedback
Year 4, Fall and Spring	• Meet with Advisory Committee to monitor progress (beginning of Fall semester; may be done by written notification) • Meet with Research Committee to demonstrate continued progress on thesis topic and obtain feedback (end of Fall semester)
Year 5, Fall	• Meet with Advisory Committee to be certain that all Track and disciplinary requirements have been fulfilled (may be done by written notification) • Meet with Research Committee to demonstrate continued progress on thesis topic and obtain feedback • Begin writing dissertation
Year 5, Spring	• Students complete the dissertation and the final examination as described in the Bulletin of the Graduate School of Arts and Sciences

Timetable for completion of SCB degree requirements with MS in Computer Science.

	Academic and Degree Requirements
Year 1, Spring	• Students matriculate into Track • Meet with Track Advisory Committee to articulate any course deficiencies identified during admissions and to plan a course of study • Take courses as required by their disciplines and the Track • Participate in journal club
	• Take courses as required by their disciplines and the Track • Select Thesis Advisor following departmental procedures • Together with Thesis Advisor, select the Research Committee and begin research • Report thesis advisor, committee members, and thesis topic to the Track Director
Year 2, Fall	• Students meet with Advisory Committee at the beginning of the semester to monitor progress • Take courses as required by their disciplines and the Track • Participate in journal club • Meet with Research Committee at the end of the semester to plan research objectives
Year 2, Spring	• Take courses as required by the respective disciplines and the Track • Write and defend thesis, as required by department, Track, and Graduate School