Biochemistry and Biophysics

Much of today's scientific effort is directed towards an understanding of biological processes from the physical and chemical points of view. Nowhere is this trend more apparent than in modern medicine, which depends upon a molecular understanding of, and ability to manipulate the chemical processes within biological cells and organisms. Scientists with training in biology, chemistry and physics make medical advances by designing and synthesizing novel pharmaceutical chemicals (drugs) and by developing new diagnostic technologies, such as magnetic resonance imaging (MRI) and polymerase chain reaction (PCR). These advances have been made possible by a deep understanding of the underlying chemical and physical properties of molecules such as DNA and proteins. The Concentration in Biochemistry and Biophysics at Haverford College recognizes these current and enduring trends in interdisciplinary science by establishing in the curriculum a formal program of classroom and laboratory training at the interface between the biological and physical sciences.

After a thorough exposure to the principles of biology, chemistry, and physics, students participating in the concentration are encouraged to apply their knowledge to the solution of a research problem in the laboratory of a faculty mentor. The goal of the research program is to create unique opportunities for the student to develop as a scientist. For examples, a biology student combined lasers and biochemical techniques in a study of plant photosynthesis, one of our chemistry majors synthesized compounds that may help treat arthritis, and a physics major constructed a laser tweezer apparatus for the manipulation of cells. In summary, the diversity of the educational experience provided by the Concentration in Biochemistry and Biophysics prepares the student to meet the challenges of careers in a number of fields, including biotechnology, bioengineering, nanoscience, medicine, and research at the academic level.

Faculty

Six faculty members coordinate the curricular activities associated with the Concentration: **Robert Fairman** and **Jennifer Punt** (Biology), **Robert Scarrow, Casey Londergan** and **Karin Åkerfeldt** (Chemistry), and **Suzanne Amador Kane** (Physics). Many other faculty members in the three participating departments also contribute to the Concentration. In addition to teaching courses that emphasize interdisciplinary approaches to the understanding of biology, these faculty members also sustain externally funded research programs in molecular biology, biochemistry, or biophysics.

Curriculum

To be a member of the concentration a student must declare a major in one of the three sponsoring departments: Biology, Chemistry, or Physics. On the student's transcript, the concentration may be recorded as one in Biochemistry, Biophysics, or Biochemistry and Biophysics, depending on the individual program of study. The curriculum is built around a common foundation provided by introductory courses in biology (molecular, cell, and developmental), chemistry (general and organic), mathematics (calculus), and physics (mechanics, electricity and magnetism). Beyond this foundation, students take courses to satisfy their majors and specific courses in the other two disciplines, which serve to cement the interdisciplinary focus of the program. Examples of interdisciplinary courses are:

Chemistry 351, "Bioinorganic Chemistry": role of metals in enzyme mechanisms, biological energy conversion, and medicine;

Biology 303, "Structure and Function of Macromolecules": proteins and their interactions with substrates, nucleic acids, and membranes; and

Physics 320, "Introduction to Biophysics": single-molecule imaging and manipulation

techniques, and theoretical approaches to modeling protein and DNA structure.

The classroom experience is enhanced by a special laboratory program in the junior year. By combining advanced laboratory offerings in the chemistry, physics, and biology departments, students in the concentration are exposed to some of the most current topics in modern biochemistry, such as: the isolation and purification of proteins, enzymes, the cloning of DNA, the synthesis of molecules with possible therapeutic uses, and the use of lasers as probes for biological structure and function. In the senior year, the course of study culminates with a research project and a special seminar.

Student Research

The research experience at Haverford is designed to facilitate the development of experimental and interpretive skills and to help awaken talents and abilities that may lie dormant during formal class work.

Research may be conducted during the school year and also during the summer months. Students work under the supervision of a faculty member from any of the three participating departments, regardless of the major field of study. In the past, our undergraduates have achieved significant success in their research endeavors. Such efforts are often rewarded by co-authorship of articles in scientific journals or the opportunity to present results at scientific conferences.

Representative topics for student research projects involving biochemistry and biophysics are listed by faculty mentor:

Karin Åkerfeldt, Chemistry. EF-hand Proteins: A Synthetic Approach to Delineating Target and Calcium-binding Characteristics; Ion Channel-Forming Peptides; Design of Novel Porphyrin-based Biomaterials; Antagonists of Human Chorionic Gonadotropin.

Suzanne Amador Kane, Physics. Hybrid Quantum Dot/Biochemical Materials; Computational Studies of Artificial Evolution.

Frances Blase, Chemistry. The Chemical Synthesis and Analysis of Natural Products that Display Important Pharmacological Activity.

Robert Fairman, Biology. Developing Coiled Coil Peptide Model Systems for Biomaterials Design; Using Beta-Hairpin Peptide Model Systems to Study Beta-Sheet Aggregation of Polyglutamine Repeats.

Rachel Hoang, Biology. The Cell Biology and Evolution of Embryonic Shape.

Karl Johnson, Biology. Biologically-inspired Design: Principles and Applications from Cytoskeletal Polymers to Virus Particles.

Casey Londergan, Chemistry. Assessing Protein Conformation and Flexibility Using Vibrational Spectroscopy.

Robert Manning, Mathematics. Mathematical Modeling of Biomolecules.

Philip Meneely, Biology. Genetics and Genomics of *C. elegans*.

Iruka Okeke, Biology. *Escherichia coli*: Molecular Pathogenesis and Antimicrobial Resistance.

Judy Owen, Biology. Expression of Members of the Inhibitor of Apoptosis Family of Proteins in Activated Lymphocytes.

Jennifer Punt, Biology. The Molecular Basis for Decisions made by Developing T Lymphocytes.

Robert Scarrow, Chemistry. Modeling the Reactivity of Oxygen with Metalloproteins.

Walter Smith, Physics. Electronic Properties and Scanned Probe Imaging of Nanoscale Systems, Including Porphyrin Nanorods.

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