GRADUATE STUDIES IN BIOCHEMISTRY

CASE WESTERN RESERVE UNIVERSITY

CLEVELAND, OHIO
FROM THE CHAIRMAN

Recent advances in genetics and genomics mark the beginning of a new era in biochemistry and structural biology. For the first time the complete genetic toolkits of diverse organisms are becoming available, literally at the “click of a mouse”, on the world-wide web. These growing databases pose fundamental questions about how genes and gene products are regulated. Traditional fields in biochemistry, such as metabolism, enzymology, and protein design, are being reborn as new opportunities emerge for interdisciplinary investigation, both basic and clinical.

The Department of Biochemistry is positioned at the interface between the worlds of genes and their encoded products, RNA, and proteins. Our training program integrates the chemistry of proteins and nucleic acids within broad themes of molecular and cell biology. Our faculty are exploring diverse applications in endocrinology, metabolism, immunology, infectious disease, and neuroscience. Teaching and research in the Department thus aim to prepare students to participate in the frontier of research today and to meet the scientific challenges of tomorrow.

THE DEPARTMENT

The Biochemistry Department is located in the School of Medicine. The department has over 60 pre- and post-doctoral trainees, representing diverse backgrounds and interests.

The Department offers comprehensive and flexible training in a wide range of research areas. The research of Department faculty is enhanced by collaborations with researchers from CWRU and from other institutions. The research laboratories are small, which strengthens the interaction between students, post-docs and advisors. The annual department retreat and other social activities create a cohesive and collegial atmosphere.

THE BIOCHEMISTRY PROGRAM

The Biochemistry Program is one of the curricula in the Biomedical Sciences Training Program (BSTP). The BSTP is comprised of 14 graduate programs within the School of Medicine and provides students with interdisciplinary training.

Approximately half the faculty in the Biochemistry Program are members of the Biochemistry Department. The remainder are affiliated either with other departments or the Lerner Research Institute of the Cleveland Clinic Foundation (CCF).

Ph.D. candidates apply to the Biochemistry Program either directly through the Biochemistry Department or through the BSTP. Candidates interested in an M.S. degree apply directly to the department.

ALUMNI

Graduates of the Biochemistry Program are represented on the faculty of notable universities and in biotechnology and pharmaceutical companies worldwide. Recent graduates are readily recruited as postdoctoral fellows in major research laboratories and institutions.

Notable alumni include Paul Berg, winner of the Nobel Prize in Chemistry in 1980 for his fundamental studies of the biochemistry of nucleic acids, Jay Short, CEO of Diversa Corporation, a biotechnology company, and Geoffrey Duyk, CSO of Exelixis Pharmaceuticals.

The Harland G. Wood building is home to the Biochemistry Department. The building is named in honor of the late Chairman in recognition of his historic contributions to enzymology. (Courtesy of the CWRU Publications Office)

http://www.cwru.edu/med/biochemistry/
THE PH.D. PROGRAM

Degree requirements include course work, research rotations, participation in formal and informal seminars, a qualifying exam, and publishable research and dissertation.

Selecting an Advisor
During the first year, students become acquainted with the research opportunities through participation in a laboratory rotation program.

Students admitted through the BSTP must complete a minimum of three different research rotations during the first year and may rotate in laboratories of faculty members from any of the training programs in the BSTP. The rotations are six weeks long and are arranged by the student with the research advisor. BSTP students interested in biochemistry can individualize their program by rotating with Biochemistry Program faculty. A research advisor is selected in December of the first year. BSTP students who select Biochemistry advisors become members of the Biochemistry Program and must satisfy its degree requirements.

Students admitted directly to the Biochemistry Program participate in three one-month long rotations in laboratories of faculty members in the Biochemistry Program. A research advisor is selected upon completion of rotations in December, in consultation with the Graduate Education Committee. Students who select a faculty member conducting metabolic research become eligible for admission to the Metabolism Training Program, an interdisciplinary program funded by the NIH.

Dissertation Research
Dissertation research is the most important part of the Ph.D. Program. Original research is carried out in close consultation with the dissertation advisor. Students also benefit from advice and discussions with other faculty, students, and postdoctoral fellows. The purpose of the dissertation is to give the student a deep understanding of one area of biochemistry, as well as training in research methods and scientific writing.

Qualifying Exam
Successful completion of the qualifying exam advances the student to Ph.D. candidacy. The qualifying exam is administered during the third year and consists of two parts: a written proposal and an oral defense. The proposal is formatted as an NIH grant application, on a topic unrelated to the thesis research.

Teaching
Starting in the second year, students contribute to the teaching of either laboratory or lecture courses. Laboratory course assignments last for several weeks while lecture assignments are for one to two hours per week for the entire semester.

THE M.S. PROGRAM

The Biochemistry Department offers two Master’s of Science degrees. A three-year program emphasizing research leads to a Master’s of Science in Biochemical Research, while a two-year program emphasizing course work leads to a Master’s of Science in Biochemistry.

Students with the Biochemical Research degree are well-suited for positions in academic, government, hospital, and industrial laboratories. Students with the Biochemistry degree obtain positions in fields not directly involved with research, such as teaching and various administrative positions in the pharmaceutical industry.

Master’s students may transfer into the Ph.D. program but they must have performed well in course work and submitted or published a research article or obtained significant research data.

http://www.cwru.edu/med/biochemistry/
APPLYING

Ph.D. Program
Applications should be submitted in late autumn or early winter for anticipated enrollment in July. Preference is given to applications received before February 1, but applications are accepted at any time. Students accepted into the Biochemistry Program generally have academic preparation in chemistry or biology. Students without biological training may apply but must possess strong grades and GRE scores and have completed undergraduate courses in mathematics, physics, and chemistry.

M.S. Program
Students are admitted in either the fall or spring. Deadlines for completed applications are June 15 for fall semester and November 1 for spring semester. The Master’s program is independent of the Ph.D. program, and students are evaluated by different committees.

Application Requirements
Students should submit a completed application form, three letters of recommendation, official undergraduate transcript(s), official GRE scores (Verbal, Quantitative and Analytical) and, when applicable, official TOEFL scores.

FINANCIAL SUPPORT
All full-time students in the Ph.D. and M.S. in Biochemical Research Programs have tuition waived and academic fees and health insurance paid. A competitive stipend to cover living expenses is also awarded. The stipend for the 2002-2003 academic year is $20,000.

CONTACTS

Ph.D. Applications
• Biomedical Sciences Training Program
  Ms. Debbie Noureddine
  School of Medicine, WG46
  Case Western Reserve University
  10900 Euclid Avenue
  Cleveland, OH 44106-4934
  bstp@po.cwru.edu
  http://www.cwru.edu/med/BSTP

• Biochemistry Program - Direct Admission
  Department of Biochemistry
  School of Medicine
  Case Western Reserve University
  10900 Euclid Avenue
  Cleveland, OH 44106-4935
  (216) 368-3334
  admissions@biochemistry.cwru.edu

M.S. Applications
Department of Biochemistry
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Cultured human cells stained for the transferrin receptor. (Courtesy of Martin Snider)
**MAJOR AREAS OF STUDY**

**Proteins and Enzymes**
Proteins are components of all living tissue and their function is critical for life processes. Understanding the chemical mechanisms of enzymatic catalysis is essential for determining the role of individual proteins in human disease. Our faculty study numerous proteins and enzymes ranging from growth factors to oncogenes.

**Structural Biology**
The function of a protein is determined by its three dimensional structure and interactions. Our faculty apply many modern techniques to determine macromolecular structure, including X-ray crystallography, multidimensional heteronuclear NMR, fluorescence, and Raman & CD spectroscopy. Macromolecules under investigation include the serotonin receptor, transcarboxylase, ribosomes, DNA-protein complexes, and neurochemical enzymes.

**Regulation of Gene Expression**
The elucidation of mechanisms regulating gene expression is a major goal of modern biology. Our faculty study the control of transcription by hormones and other regulatory molecules, the interaction between proteins and DNA, the function of oncogenes, viral replication, the basal transcriptional machinery, and the processing and translation of RNA.

**Metabolic Regulation and Gene Therapy**
Our faculty investigate the control of metabolism in animals, such as dietary and hormonal regulation of gene expression. Transgenic murine technology allows the study of the impact of gene ablation on metabolic processes. New approaches to gene therapy for human genetic diseases are also being developed.

**RESEARCH FACILITIES**

Research in the Biochemistry Program is conducted in laboratories equipped with state-of-the-art instrumentation and computers for protein chemistry, molecular biology, and structural biology. These include:
- Ultracentrifuges
- Gamma and beta liquid scintillation counters
- Ultraviolet and fluorescence spectrophotometers
- Mass spectrometer
- Raman spectrometers and microscope
- Chemiluminescent/Fluorescent Imager
- Phosphorimeter
- Stopped-flow spectrophotometers
- Quasielastic laser light scattering

Several core facilities also offer access to services and equipment as follows:
- X-ray crystallography; diffractometer/synchrotron
- Modern NMR Facilities (Multi-nuclear 600 MHz)
- 5-liter Microbial growth facility
- Animal facility
- Transgenic animal facility

**Cleveland Center for Structural Biology (CCSB)**
This center, established jointly by members of CWRU (including the Biochemistry Program), the Cleveland Clinic Foundation, and Cleveland State University, contains modern NMR and X-ray instrumentation.

Genetically engineered mice with a deletion in the PPARγ-binding element in the promoter of the endogenous P-enolpyruvate carboxykinase gene are smaller than litter mates. (Courtesy of Richard Hanson)
Alok Agrawal  
Structure-function relationships of human C-reactive protein; Molecular mechanism of the roles of NFkB transcription factors in eukaryotic gene expression

Vernon Anderson  
Enzyme reaction mechanisms; Protein-protein interactions; Protein oxidation; Mass spectrometry

Paul Carey  
Protein-ligand interactions and Raman spectroscopy

Cheng-Ming Chiang  
Mechanisms of transcriptional regulation in mammalian cells and their associated viruses

Pieter deHaseth  
Mechanism of RNA polymerase-DNA interactions; Mechanism and control of initiation of RNA synthesis

Thomas Gerken (Pediatrics)  
Protein structure and dynamics; NMR techniques

Richard Hanson  
Hormonal control of gene expression

Qing-xin Hua  
Protein structure and dynamics probed by multidimensional NMR spectroscopy and other biophysical methods

Eckhard Jankowsky  
Molecular mechanisms of RNA helicases and single-molecule spectroscopy

Hung-Ying Kao  
Signaling pathways controlled by transcription corepressors and histone deacetylases

Joyce Jentoff  
Protein structure and function; Protein-nucleic acid interactions

Ganesh Kumar  
Structure and function of enzymes of acetyl-CoA pathway; Neuropeptides and O2 sensing mechanisms

Biaoru Li  
Function of HNF-1α in diabetes; Regulation of tissue-specific gene expression

David McPheeters  
Pre-mRNA splicing in yeast

William Merrick  
Mechanism and regulation of eukaryotic protein biosynthesis

Narendra Narayana  
Structure of transcription factors involved in diabetes mellitus and related protein-DNA complexes using X-ray crystallography

Nelson Phillips  
Biochemical mechanisms of tissue-specific transcription factors

Bryan Roth (Psychiatry)  
G protein-coupled receptors; Structure-activity relationships

David Samols  
Regulation of the acute phase response to inflammation; Function and regulation of the acute phase reactant, C-reactive protein

Menachem Shoham  
X-ray crystallographic studies of the enzymatic cytotoxin colicin E3 and of G-coupled protein receptors

Martin Snider  
Intracellular movement of cell-surface receptors during endocytosis

Edward Stavnezer  
Role of the ski oncogene in cell differentiation and transformation

Michael Weiss  
Structural mechanisms of human diseases; Transcriptional deregulation and protein misfolding with applications to diabetes and disorders of sexual development

Shwu-Yuan Wu  
Transcriptional regulation in human papilloma viruses and the mechanisms of nuclear hormone receptor function

The α-carbon structure of the helical receptor binding domain of Colicin E3 (yellow) super-imposed on the electron-density map (white). (Courtesy of Menachem Shoham)

http://www.cwru.edu/med/biochemistry/
AFFILIATED FACULTY

THE CLEVELAND CLINIC FOUNDATION

Amiya Banerjee  
- Molecular Biology  
Replication and pathogenicity of negative strand RNA viruses

M.L. (Nikki) Harter  
- Molecular Biology  
The adenovirus E1A protein: providing insight into pathways that control cell proliferation and differentiation

Vincent Hascall  
- Biomedical Engineering  
Glycosaminoglycan chemistry

Donal Luse  
- Molecular Biology  
Eukaryotic gene transcription and RNA polymerase

Ganes Sen  
- Molecular Biology  
Mammalian gene expression of angiotensin-converting enzyme and interferon; Mechanism of interferon action

Robert Silverman  
- Cancer Biology  
Molecular mechanisms of the antitumor and antiviral activities of interferons

SECONDARY APPOINTEES - CWRU AND AFFILIATED HOSPITALS

Nathan Berger  
- Medicine, Oncology
Sosamma Berger  
- Medicine, Oncology
Henri Brunengraber  
- Nutrition
Pamela Davis  
- Pediatrics
Dorr Dearborn  
- Pediatrics
Richard Eckert  
- Physiology & Biophysics
Helen Evans  
- Radiology, Oncology

Douglas Kerr  
- Pediatrics
David Lundgren  
- Metro Health Medical Center
Vincent Monnier  
- Pathology
Nancy Oleinick  
- Radiology
David Sedwick  
- Medicine
Martina Veigl  
- Medicine
Barbara Wible  
- Metro Health Medical Center

http://www.cwru.edu/med/biochemistry/
“The high quality of the specialized courses and the exceptional opportunities given to students to present their work and participate in small group forums actively attended by faculty at CWRU was a great advantage. I continue to benefit from the active mentorship of my graduate advisor, more than 10 years later.”

Terri Goss Kinzy, Ph.D.
Assistant Professor
Department of Molecular Genetics and Microbiology
UMDNJ Robert Wood Johnson Medical School
Piscataway NJ

“One of my first impressions upon arriving in the Dept. of Biochemistry at CWRU was the air of intellectual excitement and curiosity fostered by the professors.”

Thomas E. Dever, Ph.D.
Research Chemist
Laboratory of Eukaryotic Gene Regulation
National Institutes of Health

“Graduate studies in the Department of Biochemistry at CWRU were formative experiences in my scientific career. The department has a long and outstanding tradition of world-class scientific achievement and of commitment to excellence. I was provided with a tremendous opportunity, and I reflect back on memories that I cherish.”

Austin L. Gurney, Ph.D.
Acting Director, Molecular Biology
Genentech