

Student Handbook

Chemistry of Life Processes Predoctoral Training Program

This training program provides comprehensive training to bridge the gap between chemistry and biology in addressing important questions in human health and disease.

Table of Contents

Program Features	2
Program Timeline	3
Coursework	4
Integration with Graduate Programs	5
Preceptors	6
Application	7
Reappointment	8
Leadership	9

Explore Human Health & Disease

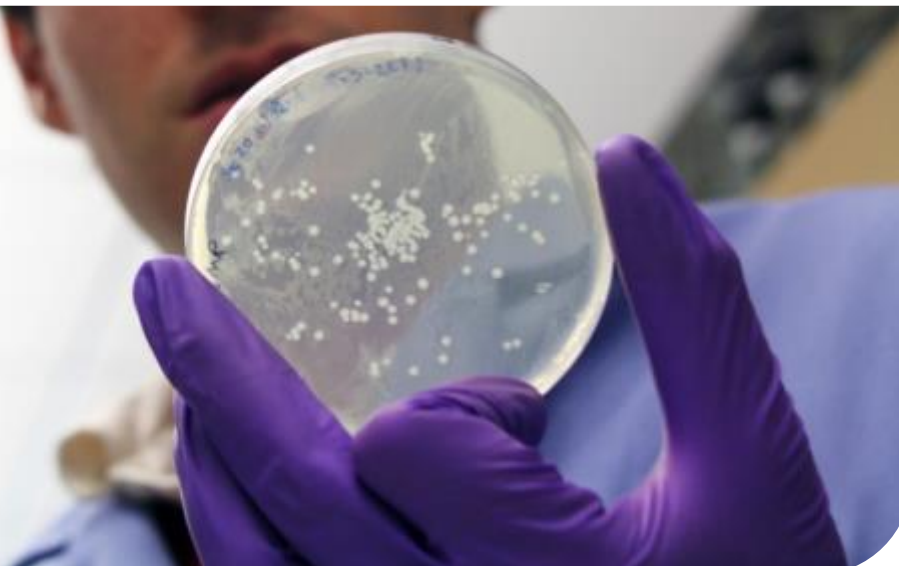
- Development of molecular therapeutics and diagnostics
- Study of molecular mechanisms and targets
- Molecular modeling
- Development of biomimetic molecules and materials

Northwestern



Chemistry of Life
Processes Institute

Trainees gain understanding and experience in transdisciplinary collaboration as an essential component in solving complex problems across the spectrum of health and disease.



Program Features

Dual Mentors

Each Trainee selects two mentors, one with a background in chemistry and the other in the life sciences. The primary mentor fulfills the role of a graduate thesis advisor while also ensuring the trainee is fully participating in program activities and completing requirements. The secondary mentor operates in collaboration with the primary mentor, providing insights and strategies for problem-solving the trainee's project from a different disciplinary perspective.

Immersive 10-week Experience

Trainees spend 10-weeks total in the research group of their secondary mentor after their graduate program's Qualifying Exams and before the end of their third year. This provides Trainees new analytical tools, model systems, and language for applying chemical approaches to research topics in the life sciences.

Seminar Series

These seminars feature topics that deepen Trainees' understanding of research at the interface of chemistry and biology. Up to ten required seminars are selected by program leadership to augment Trainees' graduate programs' seminars.

Additionally, the Trainees select and invite three external speakers annually from academia, and the pharmaceutical and biotech industries to be sponsored by the CLP training program. They meet with the speakers over lunch and dinner to engage in more in-depth discussions of research approaches and methodologies.

Monthly Research Forum

Trainees present twice each year at the CLP Research Forum to their peers and program preceptors. Primary and secondary mentors the presentations. Presentations not only enable Trainees to gain experience in public presentation of their work; they also provide a mechanism for gauging trainee progress and for identifying potential obstacles to the trainee's project.

First-in-class Laboratory Course

Chemistry 416: Advanced Analytical *Methods* covers topics high throughput testing, cheminformatics, chemical synthesis and purification, biologics production, in vitro testing, proteomics analysis, light microscopy and preclinical in vivo testing for efficacy and toxicity, plus in vitro and in vivo imaging techniques for targeting drug delivery, visualizing tumors, and documenting drug uptake and localization.

Entrepreneurship Training

Through quarterly meetings with entrepreneurs associated with Chemistry of Life Processes Institute Trainees' gain insight and training into how discoveries with implications for health and treatment of disease are moved into the public realm.

Breakfast with the Program Directors

Trainees have the opportunity to meet with the program directors over breakfast each quarter to discuss project progress and career development.

Graduate Program Timeline

Finish your program on time with your peers
Gain a competitive edge over your peers in funding your biomedical research

First Year:

- Work with Interim Advisor to identify training needs
- Complete at least (2) four-week home department rotations before choosing your thesis advisor
- Graduate program coursework
- Recommended completion of Chemistry 405: Chemistry of Life Processes
- Select primary and secondary mentors, develop your research proposal
- Apply to program by July 1st (applications reviewed July – August)

Second Year:

- Appointment to CLP Training Grant (September 1st start)
- Complete coursework
- Participate in program activities
- Present dissertation research at CLP Research Forums
- Meet with primary and secondary mentors at least quarterly
- Complete Chemistry 416: Advanced Analytical Methods
- 10-week Immersive Experience

Third Year:

- Complete CLP electives
- Continue dissertation research
- Present dissertation research at CLP Research Forums
- Attend a national research conference
- Continue meeting with mentors quarterly
- Participate in program activities

Following Years:

- Continue dissertation research
- Engage in career development training
- Engage in grantsmanship training
- Present research at national research meetings
- Present dissertation research at CLP Research Forums
- Continue regular meetings with mentors
- Participate in program activities

Eligibility

Eligibility for NIH training grant support will be determined by the following criteria:

- 1) Candidates must meet NRSA qualifications as US citizens or permanent residents.
- 2) Candidates must meet criteria of departmental programs plus provide tangible evidence of interest in transdisciplinary programs through undergrad coursework, undergrad research or internships.
- 3) Candidates must have taken undergraduate courses in general chemistry and organic chemistry. Additional course work in biology (organismal and cellular) and biochemistry is desirable, but not required.

Outstanding nominees who have not been appointed to the training grant due to lack of space or ineligibility for NRSA support will be considered for support through university fellowships.

Coursework

Given the broad range of degree requirements and variance in the schedules of the graduate programs that enroll CLP Trainees we have been careful to construct the program's training requirements in such a way as to enable you to stay in sync with your parent graduate program. The course requirements for the CLP training program have been designed with sufficient flexibility so as to enable you to use CLP-required courses to help fulfill the requirements of your degree granting programs.

- Chem 405: *Chemistry of Life Processes*
- Chem/IBiS 416: *Advanced Analytical Methods*
- (1) Elective from the CLP Training Program Electives
- RCR Training

Approved Electives

IGP 405	Cell Biology	Chem 401	Principles of Organic Chemistry
IGP 442	Microbiology	Chem 402	Principles of Inorganic Chemistry
IBIS 406	Cell Biology	Chem 403	Principles of Physical Chemistry
IGP 410	Molecular Biology & Genetics	Chem 406	Environmental Chemistry
IGP 426	Signal Transduction and Molecular Pharmacology	Chem 410	Physical Organic Chemistry
IGP 435	Receptors and Signaling Mechanisms	Chem 411	Organic Spectroscopy
IGP 475	Virology	Chem 413	Advanced Organic Chemistry
IBIS 402	Eukaryotic Molecular Biology	Chem 414	Chemical Biology
IBIS 405	Chemistry, Physics, and the Biology of Molecular Machines	Chem 415	Advanced Organic
IGP 440	Immunology	Chem 416	Medicinal Chemistry
IGP 450	Tumor Cell Biology	Chem 417	Photochemistry
IGP 466	Structural Basis of Signal Transduction	Chem 418	Organometallic Chemistry & Homogeneous Catalysis
IBIS 404	Principles and Methods of Animal Development	Chem 433	Structural Inorganic Chemistry
IGP 462	Eukaryotic Molecular Biology	Chem 434	Inorganic Chemistry
IGP 480	Molecular Mechanisms of Carcinogenesis	Chem 435	Advanced Inorganic Chemistry
IBIS 408	Fundamentals of Macromolecular Crystallography and NMR	Chem 442	Quantum Chemistry
IBIS 409	Biophysical Methods for Macromolecular Analysis	Chem 442	Quantum Chemistry
IBIS 417	Cell and Structural Biology of Alzheimer's Disease	Chem 443	Kinetics
IBIS 455	Stem Cells	Chem 444	Elementary Statistical Mechanics
IGP 465	Macromolecular Structure and Function	Chem 445	Advanced Instrumental Analysis
IBIS 401	Molecular Biophysics	Chem 448	Computational Chemistry
IGP 420	Molecular Basis of Drug Action	IGP 403	Advanced Immunology
IBIS 410	Quantitative Biology'	IGP 422	Introduction to Translational Research
IGP 430	Genetics	IGP 425	Advanced Topics in Drug Discovery
IBIS 403	Proteomics, Genomics, and Variation	IGP 433	Advanced Microbial Pathogenesis
IBIS 407	Genome Scale Science	IGP 456	Topics in Developmental Biology
IGP 403	Advanced Immunology	IGP 460	Cellular and Molecular Aspects of the Cytoskeleton

Integration with Graduate Programs

Biomedical Engineering Graduate Program

Home Department Rotations: Complete (2) four-week rotations in the research groups Biomedical Engineering faculty before selecting your thesis advisor. We recommend you rotate in the research groups of CLP training program preceptors.

Selection of Thesis Advisor and Program Mentors: Candidates for CLP traineeships are expected to choose a thesis advisor/ primary mentor from among the CLP Biomedical Engineering preceptors and a secondary mentor from among the CLP Chemistry or Chemical & Biological Engineering preceptors. The secondary mentor also sits on the graduate student's thesis committee.

Chemistry Graduate Program

Home Department Rotations: Complete (2) four-week rotations in the labs of Chemistry faculty before selecting your thesis advisor. We recommend you rotate in the research groups of CLP training program preceptors.

Selection of Thesis Advisor: Candidates for CLP traineeships are expected to choose a thesis advisor/ primary mentor from among the program's chemistry-affiliated preceptors and a secondary mentor from among the CLP life science preceptors. The secondary mentor also sits on the graduate student's thesis committee.

Chemical & Biological Graduate Program

Home Department Rotations: The ChBE first year rotations count towards the home department rotations. We recommend you rotate in research groups of CLP training program preceptors.

Selection of Thesis Advisor: Candidates for CLP traineeships are expected to choose a thesis advisor/ primary mentor from among the program's Chemical & Biological Engineering preceptors and a secondary mentor from among the CLP Life Sciences preceptors. The secondary mentor also sits on the graduate student's thesis committee.

Driskill Graduate Program in the Life Sciences

Home Department Rotations: The DGP first year rotations count towards the home department rotations. We recommend you rotate in research groups of CLP training program preceptors.

Selection of Thesis Advisor and Program Mentors: Candidates for CLP traineeships are expected to choose a thesis advisor/ primary mentor from among the program's life sciences-affiliated preceptors and a secondary mentor from among the CLP Chemistry or Chemical & Biological Engineering preceptors. The secondary mentor also sits on the graduate student's thesis committee.

Interdepartmental Biological Sciences Graduate Program

Home Department Rotations: The IBiS first year rotations count towards the home department rotations. We recommend you rotate in research groups of CLP training program preceptors.

Selection of Thesis Advisor: Candidates for CLP traineeships are expected to choose a thesis advisor/ primary mentor from among the program's life sciences-affiliated preceptors and a secondary mentor from among the CLP Chemistry or Chemical & Biological Engineering preceptors. The secondary mentor also sits on the graduate student's thesis committee.

CLP Training Program Preceptors

Cell & Molecular Biology	Chemistry	Molecular Biosciences
Huang, Sui ^D	Hoffman, Brian ^E	Bao, Xiaomin
	Meade, Thomas ^E	Carthew, Richard ^E
Biomedical Engineering	Mirkin, Chad ^{B,E}	He, Yuan
Ameer, Guillermo ^E	Nguyen, SonBinh	Horvath, Curt ^E
Backman, Vadim ^E	O'Halloran, Thomas ^E	Kelleher, Neil ^{C,E}
Scott, Evan ^E	Odom, Teri ^E	LaBonne, Carole ^E
Mrksich, Milan ^C	Schatz, George ^B	Lamb, Robert ^E
Szleifer, Igal ^{B,C}	Scheidt, Karl ^E	Marko, John ^E
Zhang, Hao	Silverman, Richard ^E	Mondragon, Alfonso ^E
	Thomson, Regan	Morimoto, Richard ^E
Chemical & Biological Engineering	Van Duyne, Richard	Pinkett, Heather ^E
Bagheri, Neda ^E		Radhakrishnan, Ishwar ^E
Jewett, Michael ^E	Materials Science & Engineering	Rosenzweig, Amy ^{C,E}
Leonard, Joshua ^E	Joester, Derk	Unger, Vinzenz ^E
Lucks, Julius ^E	Olvera de la Cruz, Monica ^{B,C}	Weiss, Eric ^E
Tyo, Keith ^E	Stupp, Samuel ^C	
Tullman Ercek, Danielle ^E		Obstetrics & Gynecology
	Neurobiology	Woodruff, Teresa ^E
	Allada, Ravi ^E	
	Klein, William ^E	Surgery-Organ Transplant
	Kozorovitskiy, Yevgenia ^E	Wertheim, Jason ^A
Additional Graduate Program Affiliations: ^A Biomedical Engineering; ^B Chemical & Biological Engineering; ^C Chemistry; ^D Driskill Graduate Training Program in Life Sciences; ^E Interdepartmental Biological Sciences		



The CLP Predoctoral Training Program has had unprecedented success in developing the grantsmanship skills of its trainees. In 2015-16 three of the six graduate students who completed the program applied for and won highly competitive predoctoral fellowships. Program members **Amanda Bayer** (left) and **Jennifer Ferrer** (right) were each awarded individual NIH/NIGMS predoctoral fellowships. In 2015 only 14.7% of fellowship applications were funded by NIGMS.

Bayer is a fifth-year Chemistry graduate student in Thomas O'Halloran's (Chemistry) lab in which she uses the tools and perspectives of inorganic chemistry to study the role of zinc in the fertilization process. She is jointly mentored by Teresa Woodruff (Obstetrics-Gynecology).

Ferrer is a fifth-year graduate student in the Interdisciplinary Biological Sciences program working on a new approach to drug delivery in the treatment of liver fibrosis. She is jointly mentored by Chad Mirkin (Chemistry) and Jason Wertheim (Transplant Surgery).

Previously, CLP trainee Stefan Kathman won a 2015 American Chemical Society predoctoral fellowship. He is advised by Alexander Statsyuk (Chemistry) and Amy Rosenzweig (Molecular Biosciences).

Application

The CLP Predoctoral Training Program traditionally supports up to 8 Trainees (6 funded by NIGMS, 2 funded by university fellowships) annually.

Candidates are asked to submit the following application materials by July 1st at 5:00pm:

- 1) Completed CLP Training Program online application form.
- 2) A one-page statement from the nominee describing career goals, commitment to and a detailed plan for completing the curricular requirements of the training program.
- 3) A one-page research project description including background and biomedical significance of the research, a list of project goals and specific plans to achieve these objectives. The biological and chemical approaches to problem solving must be emphasized.
- 4) CLP Training Program Candidate Home Department Rotation Form.
- 5) Copies of undergraduate and graduate transcripts. Official transcripts are not required.
- 6) A short CV, including honors, presentations, research experience, publications, etc.
- 7) Copies of GRE (or MCAT) scores that were submitted to the home department.
- 8) Two signed letters of recommendation on letterhead. One letter should be submitted by the candidate's primary CLP preceptor/mentor. The letter must include a statement from the mentor reaffirming their commitment to the training program and agreeing to allow their mentees to satisfy all training program requirements. The second letter should be obtained from the candidate's secondary CLP preceptor/mentor who is familiar with the applicant's academic accomplishments, research potential, and collaborative research project.

Further application instructions and forms can be found on the clp.northwestern.edu .

Reappointment Evaluation

Second-year NIGMS-funded trainees progress is evaluated prior to reappointment to the training grant. Trainees and Primary and Secondary Mentors are required to submit materials to the CLP Program Coordinator for record keeping and in support of the evaluation.

Trainees are asked to submit the following evaluation materials by July 1st:

- 1) Completed CLP Training Program Renewal Form.
- 2) Official Graduate School transcript showing completed coursework.
- 3) One-page summary of trainee's research accomplishments, techniques acquired and plans for the coming year.
- 4) Copies and citations of all published papers, manuscripts submitted, meeting abstracts for talks and poster presentations, and awards received.
- 5) Copy of Individual Development Plan updated from start of appointment.
- 6) Letter from trainee's primary mentor concerning progress in trainee's research and academic standing.
- 7) Letter from trainee's secondary mentor describing trainee's progress in applying transdisciplinary approaches to their research and the growth of the trainee's capabilities in applying orthogonal approaches to research problems.

The CLP Evaluation Committee will consider all of these materials and make the decision to reappoint based on the following criteria: first, that the trainee be in good standing with their graduate program; second, that the trainee has completed all CLP program requirements or have presented a feasible plan to do so; and third, that progress in research is clearly demonstrated.

Major changes in the trainee's research project must be reviewed by the Evaluation Committee for applicability within the parameters of the program. Failure to meet program criteria will result in loss of training grant support.

Training Completion

Trainees will be required to provide documentation of their completion of all program requirements for final review by program leadership at the end of their second year of support. Trainees will retain a close affiliation with the program after the termination of their formal appointment. They will continue to be a vital component of the training program and are encouraged to continue participation in all program activities; including the seminars, Research Forums, and social activities throughout their graduate career. Trainees' will continue to receive advice and support from their primary and secondary CLP mentors who will actively monitor the trainee's progress towards their degree. Additional oversight will be provided by the trainee's thesis committee, which includes the trainee's secondary mentor.

Program Leadership & Administration

Program Director: Richard B. Silverman, PhD

Patrick G. Ryan/Aon Professor of Chemistry
agman@chem.northwestern.edu
847-491-5653
Silverman Hall Rm. 4603
Assistant: Pamela Beck pamela-beck@northwestern.edu

Program Associate Director: Neil L. Kelleher, PhD

Walter and Mary E. Glass Professor of Molecular Biosciences
n-kelleher@northwestern.edu
847-467-4362
Silverman Hall Rm. 3609
Assistant: Haylee Thomas h-thomas@northwestern.edu

Program Manager: Sheila M. Judge, PhD

s-judge@northwestern.edu
847-491-5868
Silverman Hall Rm. 3635

Program Coordinator: Tiffany Leighton Ozmina

tiffany.ozmina@northwestern.edu
847-467-2303
Silverman Hall Rm. 3601

About Chemistry of Life Processes Institute

Established by Northwestern University in 2004, the Chemistry of Life Processes Institute (CLP) fosters the transdisciplinary collaborations among physical and life scientists and clinicians that are required to address the complexity of the “big questions” underlying human health and disease. The Institute has created an ecosystem that enables basic and translational research and training that transcends disciplinary boundaries built upon a custom designed physical environment in the Richard and Barbara Silverman Hall for Molecular Therapeutics and Diagnostics. A critical component of the CLP ecosystem is the capacity to move discoveries from the laboratory bench into the hands of society. The Institute provides researchers with the tools needed to translate their discoveries through its Entrepreneur-in-Residence program. This unique program bridges the academic and commercial environments.

The Institute’s 55 tenure-track faculty, while representing ten departments spanning the schools of arts and sciences, engineering, and medicine, are renowned for team-based, multi-disciplinary approaches to biomedical research. In addition, a 50 member PhD-level technical staff maintains and develops cutting edge instrumentation and services, provides training, and collaborates with researchers to advance their research programs.