Transforming Science—Transforming Life
Established in 2004, the Chemistry of Life Processes Institute (CLP) pushes the boundaries of science and technology to bring life-saving drugs and diagnostics to people faster. CLP is home to major discoveries like Pregabalin, the chemical that became the blockbuster drug Lyrica®—now used by over 9 million people as one of the most effective treatments available for fibromyalgia, seizures, epilepsy and neuropathic pain.

More than 65 world-renowned chemists, life scientists, engineers and clinicians from across Northwestern and the Feinberg School of Medicine (FSM) converge at CLP to address the most urgent clinical needs of our time.

Where new cures begin
One of the nation’s foremost biomedical research institutes, CLP fosters team science across Northwestern’s medical and basic science researchers to drive major breakthroughs in human health. Our efforts have fueled the development of innovative new approaches to treat and detect:

- Age and metabolic disease
- Cancer
- Cardiovascular disease
- Neurodegenerative diseases
- Organ disease and transplantation
- Urology and visceral pain

CLP supports high-risk, high-reward research to grow the pipeline of promising translational research. With the generous support of its highly engaged Executive Advisory Board, $1 million in innovation awards has returned $23 million in new external funding for collaborative faculty projects.

Sparking Collaborations to Drive Discovery
Turbo-charging discovery of new therapeutics and diagnostics requires close ties between scientists and clinicians. To strengthen these bonds at Northwestern, CLP has formed a Scientific Advisory Committee, comprised of medical researchers and CLP leadership to identify clinically relevant priority areas for pilot funding in the next five years. These CLP-Feinberg Medical School (FSM) Convergence Initiatives will combine CLP’s physical science strengths and resources with clinical expertise to exponentially increase the impact of Northwestern research on health and disease.

CLP will institute a Visiting Scholars Program as well as a Convergence Postdoctoral Fellows Program to expand the impact of the Institute’s interdisciplinary research programs and foster new partnerships with researchers across the world.

Mapping the Human Proteome
Proteins are the workhorses of the cell; responsible for signaling, structure, energetics, and other activities. Northwestern Proteomics is the leading lab in the world for studying proteins using an approach that identifies multiple forms of proteins and their critical role in human health and disease. Under the leadership of Neil L. Kelleher, a world-renowned proteomics expert, the Institute is spearheading a $1.3 B national initiative to map the all proteins in the human body: The Human Proteoform Project. This initiative will spur major innovations in human health and economic gains for the US and industry.

Neil L. Kelleher, PhD, Walter & Mary E Glass Professor of Molecular Biosciences, Professor of Chemistry, and Professor of Medicine, is the director of CLP and Northwestern Proteomics.
Preparing Tomorrow's Scientific Leaders

The next generation of researchers must be able to think and communicate in a common language that spans many scientific disciplines. CLP's highly regarded NIH Predoctoral Training Program and three laboratory-based undergraduate research programs prepare students to work at the interface of medicine, biology, chemistry, computation, engineering and physics. Trainees work with dual faculty mentors and take specialized courses to master the tools and methods of different disciplines. Seminars, research forums and workshops sharpen students' science communications skills. Career coaching by industry members, faculty and guest lecturers opens a world of possibilities.

CLP trainees and students are in high demand upon graduation. Of the 60 undergraduates who have participated in CLP programs, 83% have pursued PhDs at top graduate schools, enrolled in Medical Scientist Training programs, or attended medical school. Of the 23 graduate students who completed training program, 80% were recruited by world leading pharmaceutical companies, including AbbVie, Eli Lilly, Genentech and Merck, biotech startups and prominent universities.

Increasing Equity and Diversity in Research

To increase opportunities for equity and diversity in interdisciplinary biomedical research, CLP will launch the Interdisciplinary Summer Undergraduate Research Experience (CLP I-SURE), a summer research program for Chicago-area students attending Northeastern Illinois University, a majority minority school. The program will provide students with the opportunity for research training and mentorship in CLP laboratories. In addition to research skills and confidence, students will gain insights and soft skills needed to prepare for postgraduate education and employment.

Accelerating drug discovery and translation

CLP provides administrative expertise and entrepreneurial resources to nurture promising breakthroughs in human health. Since the Institute's founding, CLP faculty have spun off 38 new biotech companies that have attracted $2.5 billion in investment.

Prowess in the development of molecular therapeutics, diagnostics and technologies for biomedical discovery distinguishes CLP from other biomedical institutes. CLP’s in-house experts collaborate with researchers across Northwestern applying sophisticated methods and instruments to unlock scientific discoveries.

Our six award-winning core facilities provide a deep bench of tools and state-of-the-art instruments for preclinical development and testing that include:

- Bio-elemental mapping
- Imaging and theranostics
- Intact protein analysis
- High-throughput screening to identify potentially therapeutic compounds
- Sharpening the chemical properties of potential therapeutics and diagnostics to increase their effectiveness
- Toxicity and efficacy testing

The Institute is headquartered in the 147,000 sq ft Richard and Barbara Silverman Hall for Molecular Therapeutics and Diagnostics, which was designed for CLP as hub for interdisciplinary collaboration.

More than 500 Northwestern researchers have benefitted from CLP’s facilities for drug discovery and translation.

To support the Chemistry of Life Processes Institute, please contact:

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Accelerating Drug Discovery Through Team Science

New cures begin with people—individuals living with disease and the clinicians and scientists working to make them better. For nearly two decades, the Chemistry of Life Processes Institute (CLP) has pushed the boundaries of science and technology to bring life-saving drugs and diagnostics to people faster. With 65 faculty distributed over 19 departments representing chemistry, life sciences, engineering, and medicine, CLP draws world-class talent from across both Northwestern campuses to advance human health.

CONVERGING STRENGTHS TO SECURE LARGE-SCALE FUNDING

To accelerate development of new therapeutics and diagnostics, CLP has convened a Scientific Advisory Committee, comprised of medical researchers and CLP leadership to identify clinically relevant areas for pilot funding over the next five years. These CLP-Feinberg School of Medicine (FSM) Convergence Initiatives will combine basic science strengths and resources with clinical expertise to exponentially increase the impact of Northwestern research on health and disease.

To bolster collaboration between CLP researchers and medical researchers CLP will host a series of internal Convergence Workshops. These workshops will foster development of “dream teams” to target therapeutic and diagnostic development in areas of highest clinical need.

Convergence initiatives will become the focus of Institute resources and support for a period of two to three years, with the goal that they become self-sustaining through new large-scale federal and foundation funding.

Potential target areas for CLP-FSM convergence research include:

- Aging and Metabolic Diseases
- Cancer Epigenetics
- Cardiovascular Disease
- Neurodegenerative Disease
- Nephrology
- RNA Therapeutics
- Transplant Biology & Liver Cirrhosis
- Urology/Visceral Pain

BUILDING GLOBAL PARTNERSHIPS

Tackling the biggest challenges in human health and disease requires strong ties between Northwestern chemists, life scientists, engineers and clinicians, as well as partnerships with other world-leading institutions. To raise global awareness of CLP research and technology development and spark new global initiatives, CLP will organize an annual Symposium where CLP faculty and invited speakers will present new approaches and methods for drug and diagnostics discovery.

CLP will also launch a Visiting Scholars Program to enable biomedical researchers to spend time in CLP labs to learn advanced methods and stimulate new joint research projects.

These strategies will initially rely upon institutional funding for support, with the goal of eventually obtaining corporate sponsorship for each of these activities.
TRAINING TOMORROW’S BIOMEDICAL INNOVATORS

One of the hallmarks of CLP is its innovative approach to training students at the interface of chemistry and biology. To grow the impact of the Institute’s interdisciplinary research programs, the Institute is seeking support for a highly competitive Convergence Fellows Program. The two-year postdoctoral fellowship will be awarded to a cohort of outstanding postdoctoral associates who will learn new approaches to complex diseases from dual mentors (a basic researcher and a clinician).

Fellows will gain experience translating their innovations from the lab bench into society and acquire skills highly valued by the most prestigious academic institutions, pharmaceutical and biomedical companies, and research centers in the world.

SUPPORTING BLUE-SKY RESEARCH

To grow the innovation ecosystem at Northwestern, CLP supports high-risk, high-reward collaborative research through its annual Cornwell Innovation Awards. With the generous support of its highly engaged Executive Advisory Board, $1 million in innovation awards has returned $23 million in new external funding for collaborative faculty projects.

SECURING LARGE-SCALE FUNDING FOR LONG TERM IMPACT

CLP-FSM Convergence Initiatives will catalyze novel ideas for understanding disease that will attract sustainable, large-scale funding from both federal agencies and foundations.

CLP faculty are renowned for their expertise in development of new technologies and methods to make, model and measure biologically important molecules that play a critical role in health and disease. This expertise, coupled with CLP staff expertise in developing team science research programs and grant applications, has resulted in major federally-funded interdisciplinary biomedical research awards for Northwestern. These include federal funding of a ten-year $23 million Physical Sciences-Oncology Center (PSOC), a joint venture with Northwestern’s Lurie Cancer Center. The PSOC has produced groundbreaking insights into epigenetic mechanisms for regulating gene expression, developed new methods for imaging cellular changes, and discovered new approaches to cancer diagnosis.

The CLP-FSM Convergence Initiatives will expand the boundaries of biomedical innovation through the application of unique Northwestern technologies and approaches. These innovations will speed the delivery of more effective treatments and diagnostics to people living with disease.

To support CLP-FSM Convergence Initiatives please contact:

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Unlocking the Human Proteome

THE NEXT BIOLOGICAL FRONTIER

Northwestern Proteomics, a Center of Excellence within the Chemistry of Life Processes (CLP), is laying the groundwork for the Human Proteoform Project (HPfP), an ambitious, $1.3 billion initiative to map every protein in the human body. The HPfP will lead to earlier detection of disease, better diagnostics, and faster development of new drugs to treat people living with cancer, heart disease, neurodegenerative disorders, and many other conditions.

DRIVING INNOVATION AND THE ECONOMY

The HPfP is a natural next step to the Human Genome Project (HGP) and will mirror its impact on healthcare and life sciences, return on investment, and the economy. The ten-year initiative will place the US at the forefront of the next great biological frontier and open new avenues for research and discovery. It will spur major advances in human health and create jobs in the life sciences industry, including biotech, pharma, agriculture, forestry, and veterinary science.

From big pharma to biomedical startups, investment in proteomics science is expected to generate explosive growth in biomedical innovation and economic gains for the US and industry.

THE SCIENCE

Proteins, the worker bees of our cells, play a central role in maintaining and regulating human health. When things go wrong, scientists are increasingly looking to proteoforms, the exact molecular forms of proteins, for answers. When proteins confront a challenging environment, disease and illness can result. Identifying how each proteoform precisely functions within the human body enables scientists to pinpoint the true culprits behind disease and develop better targets to eliminate them.

Northwestern Proteomics is the leading lab in the world for studying proteins using a ‘top-down’ approach that analyzes intact proteoforms to fully understand their critical role in human health and disease.

Under the leadership of CLP director Neil L. Kelleher, PhD, a world-renowned proteomics expert, public and private support for the HPfP has grown. As president of the Consortium for Top-Down Proteomics, Kelleher has authored breakthrough studies and coordinated efforts to secure federal funding for the HPfP over the next decade.

CLP Director
Neil L. Kelleher, PhD
Walter & Mary E Glass Professor of Molecular Biosciences, Professor of Chemistry, and Professor of Medicine, and director of Northwestern Proteomics
THE HUMAN PROTEOFORM ATLAS

Proteins in their myriad forms are the fundamental working elements of our cells and tissues. Although a single cell contains hundreds of thousands of different proteoforms, existing analytical methods detect fewer than 10,000.

Northwestern Proteomics isremedying this knowledge gap through the development of the Human Proteoform Atlas, a database that provides an open-source, central location for scientists to browse proteoforms and contribute datasets. The platform combines both new and existing technology and high throughput methods to create a comprehensive record of every proteoform found in cells, fluids, and organs in the human body. As the Atlas expands, scientists will understand the diversity of protein signatures in health and disease, which will enable earlier and more precise identification of all human disease.

Critical insights derived from the Atlas will also accelerate the development of more targeted and effective therapies and are required to achieve personalized medicine.

PROOF-OF-CONCEPT

A recent collaboration between Kelleher and Josh Levitsky, MD, a hepatologist in the Feinberg School of Medicine, resulted in the development of the Blood Proteoform Atlas. This proof-of-concept recently published in the top journal, Science, identified proteins associated with liver transplant rejection providing physicians with early-stage markers needed to fine-tune immunosuppression to prevent rejection.

REGIONAL POWERHOUSE, NATIONAL INITIATIVE

Within the next three years, CLP will lead a regional effort to develop proof-of-concept studies in cancer, cardiovascular disease, immunology and neurodegenerative disease that demonstrate the tremendous potential of the HPfP.

This regional effort will include the build-out of Chicago-area collaborative workspaces with administrative oversight by CLP. The labs will support research collaborations already underway between Northwestern Proteomics and more than 100 Northwestern labs on the Chicago and Evanston campuses, as well as 40 university investigators from across the Midwest.

TECHNOLOGY

Scientists have made significant progress in proteoform discovery, however, to achieve the ambitious objectives of the HPfP to transform human health within the next decade, a concerted effort to accelerate development of instruments and methods is needed. Advances in current technologies for complete proteoform analysis, as well as the development of highly automated, scalable, and cost-effective proteomics platforms of the future will hasten life-saving discoveries for this generation and for generations to come.

To support Northwestern Proteomics, please contact:

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Training tomorrow’s biomedical innovators

The next generation of biomedical researchers must be able to think and communicate in a common language that spans many scientific disciplines.

Chemistry of Life Processes Institute’s (CLP) highly regarded NIH Predoctoral Training Program and three laboratory-based undergraduate research programs prepare students to work at the interface of medicine, biology, chemistry, computation, engineering and physics. Trainees work with dual faculty mentors and take specialized courses to master the tools and methods of different disciplines.

Seminars, research forums and workshops sharpen students’ science communications skills. Career coaching by industry members, faculty and guest lecturers opens a world of possibilities.

CLP trainees and students are in high demand upon graduation. Eighty-three percent of the 60 undergraduates who participated in CLP programs have pursued PhDs at top graduate schools, enrolled in Medical Scientist Training programs, or attended medical school. 14 of the 19 graduate students who completed CLP’s predoctoral training program were recruited by world leading pharmaceutical companies, including AbbVie, Eli Lilly, Genentech and Merck, biotech startups and prominent universities, the remainder went on to pursue law and medical degrees.

INCREASING DIVERSITY, EQUITY AND INCLUSION

Although one of the hallmarks of CLP’s educational programs is the diversity of highly qualified students recruited into our program each year, major disparities persist in diversity, equity and inclusion across STEM education. As the table below illustrates, African American and Latino students represent just a small fraction of the overall student population in science and engineering doctoral programs.

<table>
<thead>
<tr>
<th>Students in doctoral studies</th>
<th>Black or African American</th>
<th>Latino</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>2.4%</td>
<td>5%</td>
</tr>
<tr>
<td>Women</td>
<td>4.6%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Source: 2018 National Science Foundation

Numerous studies have shown that democratizing undergraduate research experiences across different socioeconomic groups may improve persistence, retention, and diversity of students pursuing postgraduate education. It is especially beneficial to expose students who attend local institutions—many of whom are first generation—to laboratory training in the setting of a major research university.
CLP’s Interdisciplinary Summer Undergraduate Research Experience Program

To create a stronger path to STEM careers for students from Chicago-area working class families, CLP has created the Interdisciplinary Summer Undergraduate Research Experience (CLP I-SURE) program.

Together with Northeastern Illinois University, located in northwest Chicago, CLP will provide diverse undergraduates with the opportunity for interdisciplinary research training and mentorship in its faculty laboratories. Northeastern is a federally designated Hispanic-Serving Institution and has been ranked No. 1 among all Midwest colleges and universities as the most diverse by the Wall Street Journal/Times Higher Education College Ranking.

The goal of the I-SURE program is to contribute to increasing the persistence of chemistry and biology undergrads in pursuing postgraduate education (medical, dental, and graduate school) and STEM-intensive careers. A secondary outcome will be to create a conduit for diverse talent to Northwestern graduate programs and the CLP Predoctoral Training Program.

CLP’s new I-SURE program will build on more than a decade of experience in managing summer research experiences for Northwestern undergrads. The program will provide funding for a summer stipend, lab expenses, and an opportunity for students to present at the annual Chicago Area Undergraduate Research Symposium. It will leverage existing relationships with the NEIU Student Center for Science Engagement to identify potential candidates and to ensure that students are fully prepared to engage in laboratory research and benefit from their experience.

To be eligible for the program, students must have a cumulative GPA of 3.0 or higher; completed at least three semesters of undergraduate education, including at least one chemistry or biology course; have at least one semester of undergraduate education remaining after completing the summer research experience; and have a strong interest in pursuing a postgraduate degree.

To support CLP’s I-SURE program, please contact:

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CLP CONVERGENCE FELLOWS PROGRAM

Training Tomorrow’s Biomedical Science Leaders

Chemistry of Life Processes Institute (CLP) is seeking an industry partner to support a highly competitive postdoctoral training program designed to prepare the next generation of biomedical researchers to use the tools and concepts from multiple scientific disciplines to drive new approaches to complex problems in human disease. The two-year CLP Convergence Fellows Program will select a cohort of six exceptionally promising young scientists and provide the highest level of preparation for independent careers in academia, industry, and research centers.

One of the most distinct aspects of the program is that fellows will learn new approaches to complex diseases from dual mentors, a basic researcher and a clinician, and gain experience translating their innovations from the lab bench-to society. Fellows will pursue an ambitious research program and gain mentoring experience in the labs of their advisors to prepare them to manage their own labs. They will receive guidance in writing a research grant application to a federal funding agency in support of their independent research program. The Institute's rich interdisciplinary ecosystem will develop their ability to tear down disciplinary silos and work in multidisciplinary teams. Participation in CLP seminars, workshops, and symposia will expose fellows to the latest technology developments in proteomics, biophotonics, epigenetics, synthetic biology, nanotechnology, molecular modeling, metallomics, drug discovery and development.

CLP faculty will nominate candidates from top national and international PhD programs, in chemistry, biology, engineering, medicine and related interdisciplinary programs. The Institute will focus particularly on recruitment of candidates from populations underrepresented in STEM. Calls for application will be disseminated twice annually. Candidates will be selected based on their record of accomplishment, interest in learning new skills, perseverance in overcoming obstacles, and enthusiasm for pursuing a research-intensive career. Rolling selections will be made by CLP Faculty Executive Committee. Finalists will be interviewed by CLP leadership prior to selection.

Record of Training Success

One of CLP’s hallmarks is its innovative approach to education and training. The CLP Convergence Fellows Program joins a cadre of highly-regarded education and training programs sponsored by the Institute. Our NIH Predoctoral Training Program and three laboratory-based undergraduate research programs prepare Northwestern students to work at the interface of medicine, biology, chemistry, computation, engineering, and physics. CLP trainees and students are in high demand upon graduation. Eighty-three percent of the 60 undergraduates who participated in CLP programs have pursued PhDs at top graduate schools, enrolled in Medical Scientist Training programs, or attended medical school. 14 of the 19 graduate students who completed CLP's predoctoral training program were recruited by world leading pharmaceutical companies, including AbbVie, Eli Lilly, Genentech and Merck, biotech startups and prominent universities, with the balance pursuing law and medical degrees.

Program Metrics

Program success will be measured by the number of publications, grants, honors, and awards earned by program fellows during their tenure and their career trajectory after completing the program. These metrics will be gathered through annual surveys of fellows and mentors and an annual report to CLP leadership.

To support CLP’s Convergence Fellows Program, please contact:

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PROGRAM FEATURES

- Dual mentors from FSM and CLP.
- Fellows required to work on a collaborative research project and learn methods in both labs.
- IDP training required with 6-month updates.
- Participation and presentation at national meetings and conferences.
- Entrepreneurship training and networking.
- Guidance in writing R01 application.
- Rigor and reproducibility training.
- Participation and presentation at CLP Graduate Research Forum.
- Participation in CLP seminars, workshops, and symposia.