Emily Mick
Third-year undergraduate, Chemistry
Hyun-Soon "Joy" Chong
Assistant Professor of Chemistry

MAKING FLUORESCENT IRON-DEPLETING AGENTS FOR CANCER THERAPY AND IMAGING

Professor Chong's lab specializes in interdisciplinary research to realize safe, effective, and targeted therapeutic and imaging drugs for cancer and neurodegenerative diseases. Her team is developing drugs for diseases that can be employed for various targeted therapeutic and diagnostic techniques such as antibody-targeted radiation therapy (RIT), iron-depletion therapy (IDT), and magnetic resonance (MR) and positron emission tomography (PET) imaging.

The goal is to generate cancer drugs linked with smart tracing peptide or antibody targeting antigen such as prostate-specific membrane antigen (PSMA) and human epidermal growth factor receptor 2 (HER2) to deliver the cytotoxic (cell-killing) agents and/or imaging probes directly to the cancer cells without causing toxicity to normal cells.

The lab has developed several promising cancer therapeutic and diagnostic agents with successful preclinical profiles that compare favorably with existing cancer drugs. Its RIT study published in the *Journal of Medicinal Chemistry* was highlighted in publications including *Cancer Weekly*, *Clinical Oncology Week*, and *Biotech Business Week*. Research results have led to a U.S. provisional patent application. Professor Chong has received two National Institutes of Health (NIH) awards totaling about $1 million.

A native of Lake Forest, IL, Emily spent the summer developing a novel iron chelator as an antitumor agent in Professor Chong's lab. The body needs iron to function, but too much free iron is harmful and associated with diseases including cancer and Alzheimer's disease. Taking iron from the body using an iron chelator – little molecules that selectively bind to iron – has been shown to slow or stop the growth of tumor cells. Eventually, Emily's ligand will be evaluated using the HeLa (cervical cancer) and HT29 (colon cancer) cell lines.

Emily transferred to IIT from Lake Forest College in part because she wanted a "more intense" lab experience, and she got it this summer. "All day long I asked questions," she said. With plans to go to pharmacy graduate school, Emily said of her experience, "It was perfect. It definitely applied to what I want to do next."

Emily assists Professor Chong with her NIH-funded cancer research.

College of
Science and Letters
ILLINOIS INSTITUTE OF TECHNOLOGY

2008 CSL Undergraduate Summer Research Stipends

This report presents the research of CSL undergraduates and their faculty mentors during Summer 2008.

Angela Pak
Fourth-year undergraduate,
Molecular Biochemistry and Biophysics
Nick Menhart
Associate Professor of Biology

DETERMINING THE ROLE AND CLINICAL RELEVANCE OF EXON SKIPPED MOTIFS OF THE DYSTROPHIN ROD

For two years – funded by the National Institutes of Health, National Institute of Arthritis and Musculoskeletal and Skin Diseases – Menhart and his team have been mapping the rod region of dystrophin, the protein whose defect underlies Duchenne muscular dystrophy, a fatal disease that strikes 1 in 3,500 boys. Their work is critical to gene therapy for DMD.

Dystrophin is very large, in part why this disease is so common. It is coded for in its gene in a modular fashion in 79 distinct pieces called exons. A defect in just one or a small number of exons disrupts all protein production. Like a train derailment on a subway line, if one piece of track is broken, it can bring the whole system to a halt as trains stack up.

Researchers are trying a strategy called exon-skipping to restart protein production, "detouring" around individual patients' exon defects. But detouring can cause problems. Skipping can affect the nature of the dystrophin made and whether it will be effective.

"That's where we come in," says Menhart "We're trying to determine the properties of the protein so that we can plan effective detours." It is critical to know as much as possible about dystrophin and how edited dystrophin works.

"I've known since I was a little kid that I wanted to help people who are sick," says Angela, a student from Guam who plans to study medicine after IIT. This summer, using recombinant DNA technology, she prepared test versions of various alternative repairs involving exon skips and determined which repaired dystrophins most closely mimic the intact natural dystrophin. The goal was to pinpoint the most productive dystrophin repair sites, including repairs being studied for actual patients.

Angela said, "Studying something that is still a mystery to the scientific world – that can possibly make a positive impact in our society – is so exciting."

Angela's work may improve gene therapy for Duchenne muscular dystrophy.

Scott Justus
Fourth-year undergraduate, Biochemistry
Joseph Orgel
Assistant Professor of Biology,
Associate Director BioCAT

BIOPHYSICAL STUDIES OF CONNECTIVE TISSUE STRUCTURE AT MOLECULAR RESOLUTION

Recipient of a prestigious NSF CAREER Award in 2007, Professor Orgel studies the organization of the extracellular matrix (ECM) and the molecular structure of collagen. His work provides clues to new ways to stop or slow cancer metastasis, rheumatoid arthritis, and other diseases.

The ECM is the non-cellular element of connective tissue, mostly proteins and carbohydrates deposited outside of cells. Collagen, the principal component of the ECM, is a complex protein found throughout the body, from skin and blood vessels to teeth and bone.

To study its structure, Orgel's lab specializes in x-ray diffraction. Diffraction techniques make it possible to determine molecular structure by "bouncing" x-rays, neutrons, or electrons off atoms in an experimental sample, and reading their intensity at the angles at which they are detected after passing through the sample to ascertain their arrangement.

Orgel has taken a leading role in determining the molecular structure of whole collagen molecules within intact animal tissues. Using the Advanced Photon Source (APS) at Argonne, he did x-ray diffraction studies on rat tail tendons to study collagen microfibrils and fibrils (collagen bundles). He identified how the molecules work together to bind and regulate the action of enzymes called "collageneses," which enable tumor metastasis or rheumatoid arthritis.

New Lenox, IL, native Scott plans to earn a PhD in biochemistry or structural biology and has become proficient in various structure-determining techniques like circular dichroism. He has worked in Orgel's lab for a year and now sometimes trains other students. This summer, he made, purified and crystallized collagen fragments for APS studies. Others described the low-resolution structure of intact tissues, identifying where ECM components attach to collagen, and Scott examined them in more detail. He expects to help publish a paper on the work. He said, "Dr. Orgel is one of the world's leading experts in fiber diffraction and collagen structure. It is exciting to learn from him."

Scott works with Orgel (left), an expert in fiber diffraction and collagen structure.

The College of Science and Letters at the Illinois Institute of Technology believes strongly in research experience for undergraduates. Research allows students to explore their interests, solve problems, advance knowledge, and prepare for the next step – whether graduate school, medical school, or the workplace.

Research opportunities for CSL undergraduates:

- Available as early as second semester of freshman year
- Guided by world-class faculty who have received national and international recognition in their respective fields

Yaofu Zhou
First-year undergraduate, Physics
Dan Kaplan
Professor of Physics

MEASURE ANTIMATTER GRAVITATIONAL FORCE

According to the theory of general relativity, antimatter should have the same gravitational acceleration as matter. But no one has proved this experimentally. Professor Kaplan is leading an initiative to explore using Fermilab's antiprotons – the world's most intense source – for new matter and antimatter research, including research in antimatter gravitational acceleration.

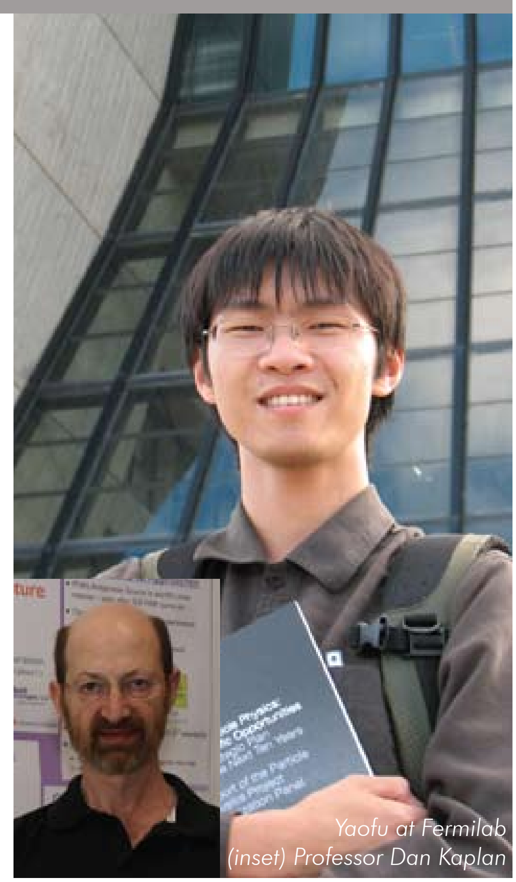
"Antiprotons don't occur in nature," said Kaplan. "You have to make them. Fermilab is the world's leading antiproton factory" – it produces four trillion per day. By adding a decelerator and detectors, researchers might be able to use these antiprotons in exciting new ways. What is the gravitational force on antimatter? Do antiatoms emit light in the same way as atoms? Do evanescent particles containing "charm" quarks "know" whether they're matter or antimatter? Ultimately, scientists could learn more about matter, the universe and how it began.

Kaplan has led IIT's efforts on the HyperCP experiment at Fermilab, helped to form the Illinois Consortium for Accelerator research, is leading U.S. collaborators in the Muon Ionization Cooling Experiment, and is working on the international Double Chooz reactor-neutrino experiment. He chose Yaofu, a student from China who would like to be a theoretical physicist, to help with the antimatter research because of Yaofu's excellent work as a freshman and desire to be a theoretical physicist.

> **"Fermilab is the world's leading proton factory."**

Working at Fermilab five days a week, Yaofu developed tools for measuring the gravitational acceleration of hydrogen (to prototype the experiment with matter first) in a Mach-Zehnder interferometer. He will continue the work during the school year.

"I could see very clearly [how] physics looks in the world – how to build a collaboration, how to get funding," said Yaofu of his experience. "It also was a good opportunity to be with some very smart, great scientists."



Yaofu at Fermilab
(inset) Professor Dan Kaplan

Christos Mitillos
Fourth-year undergraduate,
Applied Mathematics and Computer Science

Hemanshu Kaul
Assistant Professor of Applied Mathematics

OPEN PROBLEMS IN GRAPH THEORY

A 2007-2008 Project NExT Fellow, a professional development program for new or recent PhDs run by the Mathematical Association of America, Professor Kaul focuses on graph theory, combinatorics, discrete optimization, operations research, probabilistic models and methods in discrete mathematics. This summer, he worked with Chris on unsolved problems in graph theory.

"Graph theory is a way of describing binary relationships," said Kaul. A simple problem: to book classrooms for a semester, what is the least number of rooms needed without having a conflict? "Graph theory is the study of those relationships," he added. "It can be applied to problems involving thousands to millions of relationships that occur in both social and physical sciences."

All summer, Chris worked on problems involving "fall chromatic number of graphs," a combination of graph coloring and dominating sets. "Graph coloring" is a partition of graph vertices into color classes. The partition is a "proper coloring" if no two related vertices are in the same color class. A "dominating set" is the fewest number of vertices from which all vertices in a graph can be reached within a step. "For example, consider the locations for a communications network or emergency services like fire stations. You'd want to reach all of the vertices as quickly as possible," said Kaul. In fall chromatic number of graph problems, Chris sought insight into how both could be used.

Chris will publish his work, a step toward his goal of earning a PhD in discrete mathematics and becoming a professor. A double major, Chris has placed in both ACM programming and MAA mathematics competitions and was a mathematics Olympiad in his native Cyprus. Like many students preparing for graduate school, he welcomed the opportunity to do original research.

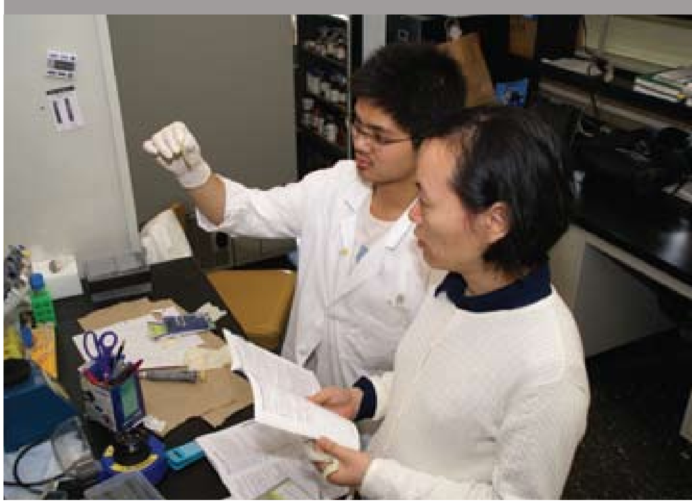
"A PhD is not about coursework or homework," noted Kaul. "It's, 'Here's a question we don't have an answer for' – and you try to find that answer. It's more creative."

Chris will publish his original research.

CSL Undergraduate Summer Research Stipends provide students with $5,000 for 10 weeks of focused research under faculty guidance.

"A university like IIT is a place for the creation, sharing and application of knowledge. Here, students have the opportunity to learn from people who not only **have** knowledge but who also know how to **create** knowledge. Education in the environment of knowledge creation is extremely powerful."

— Dr. R. Russell Betts, Dean, College of Science and Letters



Sam studied connexin 43 and its role in preventing cancer.

Kok Ann "Sam" Gan
Fourth-year undergraduate, Biology

Chunbo Zhang
Assistant Professor of Biology

GAP JUNCTION REGULATION AND CANCER PREVENTION

Professor Zhang focuses on the development of the olfactory system and the structural and molecular mechanisms of olfactory sensation. As an offshoot, she and her team look at the connection between gap junction expression and cancer in order to explore possible cancer prevention.

There is low incidence of cancer in the olfactory system compared with other systems, such as the liver, Zhang explained. "We wonder why," she said. "We are interested in whether and how the gap junction is involved."

"Gap junctions" are microscopic channels that allow molecules and ions, including cell-signaling molecules, to pass between cells. "We know gap junctions are important in cancer prevention," said Zhang. "Now, we think they may have different roles in different stages of cancer. When the person is healthy, they may prevent cancer; in the early stages of a tumor, they may help to suppress the tumor; but when cancer is spreading, they may make it worse."

Each gap junction is made up of a pair of connexons, which in turn are made up of connexins.

Since August 2007, Sam has been involved in research on connexin 43 and its role in preventing cancer through understanding the mechanism of gene regulation and signaling. This summer, Sam worked on the connexin transcript promoter region, which controls expression, testing to see how it is altered under different conditions. He was making various gene constructs to do this – an often-tricky process, "like cut and paste," Zhang said. "Sometimes, it doesn't work."

> **"When I do something, I love to know why."**

Sam is a near straight-A student from Malaysia with a special interest in genetics. He sought out research at IIT because, he said, "When I do something, I love to know why," and because research opportunities are not common in Malaysia. There, he said, "We're not trained to ask questions. We're trained to listen. This summer was very different."

Yacin Nadji
Third-year undergraduate, Computer Science

Douglas Cork
Professor of Biology

TOOLS FOR VISUALIZING AND ANALYZING MOLECULAR DATA

Today, computers are essential in molecular biology. But most biologists don't know a lot about computer science. Yacin bridges that gap in Professor Cork's lab. A research assistant in the Information Retrieval Laboratory since his freshman year, he also helps Cork's team use computers to understand how some bacteria cause disease.

Cork researches such things as antibiotic resistance at the genetic level in animal proteins, and why and how a cell turns on the protein that causes the toxicity of Salmonella or other bacteria – working with organizations like USA Poultry and pharmaceutical company Alpharma.

He developed the W-curve algorithm to visualize and analyze long genomic sequences and infer the phylogenetic (evolutionary) history of a species. "Instead of a string, the W-curve describes DNA as a three-dimensional curve, making it easier to see patterns," he explained. It also allows for fuzzy matching and can speed locating genes within chromosomes.

This summer, Yacin helped to develop a tool for the sequencing and clustering of prokaryotic DNA in phylogenic trees. Basic comparative genomic analysis involves alignment and analysis of linear strings of DNA (A, C, G, T). Many tools like BLAST already exist to search for similar strings of DNA. But they can't be used to visualize and analyze genomic patterns. "I generally ran visualizations based on the data the lab team found using more traditional techniques," said Yacin. "For example, the lab group did a BLAST search of a specific protein, and gave me the results from the search. I got the visualizations for them to compare to the BLAST search that they initially did."

Yacin liked that he "could do the work almost anywhere, like the park," but he went to the lab regularly to talk to the biologists. An avid participant in computer science groups and competitions, Yacin now also loves research and plans to get a PhD and teach.

Yacin brings computer power to biology.

Research is critically important to advances in health, energy, security, information technology, and countless other areas. When you invest in student research, you give students the joy of inquiry and discovery, and enable them to learn how to ask and answer the questions that improve peoples' lives.

If you would like to support a stipend, please send your gift to:

College of Science and Letters
Illinois Institute of Technology
10 W. 32nd Street, E1 Room 125
Chicago, IL 60616
Or call 312-567-3132

College of Science and Letters
ILLINOIS INSTITUTE OF TECHNOLOGY

Susan Mallgrave
Third-year undergraduate,
Professional & Technical Communication

Kathryn Riley
Professor of English and Chair,
Humanities Department

Matthew Bauer
Assistant Professor of Linguistics

MACHINE-MEDIATED COMMUNICATION AND THE SOCIAL AND COGNITIVE DIMENSIONS THAT AFFECT IT

What happens when humans communicate with and through machines? Successful communication depends not just on hardware and software but on social and cognitive dimensions such as accent, visual cues, and the speaker's attitude toward interacting with a machine. This summer, Susan did a literature review and wrote an annotated bibliography on social and cognitive dimensions of machine-mediated communication, co-supervised by Professors Riley and Bauer.

Reading widely in linguistic theory and other fields, she analyzed nearly 100 articles in peer-reviewed journals and compiled an annotated bibliography of 60 of them. Her work will provide a foundation for further research related to the topic.

Susan focused on three areas: intercultural communication and comprehensibility problems of native and non-native speakers; cognition and the presence or absence of multiple modalities accompanying the speech signal (e.g., not seeing the order-taker at a drive-thru, or receiving conflicting communication cues); and human-technology interaction, including customer anxieties about machine-mediated communication. She was particularly interested in the effect of language attitudes about regional, social, and ethnic aspects of spoken English on speech perception.

"I enjoyed it because I find any issue about communication intensely interesting," said Susan, a straight-A student who last year won the Edwin H. Lewis Prize for Fiction and the Molly Cohen Poetry Prize in the 42nd Annual Writing Contest. Results of the research have practical applications in a variety of interactions involving humans and spoken dialogue systems (computer-generated "language"). Examples include voice-recognition software currently being tested for use in Chicago Transit Authority kiosks to serve patrons who are unable to see screen displays; speaker systems used to communicate with customers at drive-thru windows; and voices used in children's toys.

Susan researched linguistic theory and other fields.

"The project addresses research questions that have both an intrinsic interest within linguistic and psycholinguistic theory, as well as applications to practical problems within professional and business environments," said Professor Riley.

Photographer: Mindy Sherman, IIT Communications & Marketing