also hard to study the respiration of an insect without recognizing the significance of its ability to fly. The one thing that really ties this field together is its biological relevance. Although this field is very math-based, its most important part is not finding values for every little variable for every little part of an organism. What's important is figuring out what variables are relevant for which animals and why, and how a larger or smaller value of some variable for some organism makes evolutionary sense. The most interesting thing about this field is the amount of creativity and flexibility needed. Every experiment is different. The way one person measured the stiffness of the skin of some animal might not work for another animal because the skin is too slippery, too stretchy, or too thin. And sometimes what is measured in one organism isn't even a relevant feature in another, so quite a bit of insight is needed to make effective comparisons.

Each year, the Society for Integrative and Comparative Biology hosts a meeting heavily attended by scientists who study biomechanics. This year there were talks presented on such phenomenal topics as: the first account of bipedal locomotion in octopuses, adhesion mechanisms of the gecko, the fluid dynamics of insect flight, broad-leaf aquaplaning during floods, electro-sensory detection by the paddlefish, and even the responses of lizards and amphibians to weightlessness. The field is bounded only by the availability in the natural world of creative responses to physical constraints. Fortunately, this is one area where there does not exist an epsilon small enough to constrain the possibilities for intriguing exploration.

James is a fourth year math major who would like to study the algebra of central pattern generators, plant biomechanics, or the small-scale architecture of insects in graduate school.

Kevin is a third year physics major who is interested in animal flight stability and vortex generation, and is looking to study biological fluid mechanics in graduate school.

Symposium

An Investigation of the Unifying Effects of the CAURS on Undergraduate Researchers and the Scientific Community.

by Ritbune Prakobkit, photography by Benjamin Trofatter

The inaugural Chicago-Area Undergraduate Research Symposium, or CAURS, was held earlier this quarter at Northwestern University's Kellogg School of Management in downtown Chicago. Students and faculty members from four Chicagoland universities came together to share their research and learn from the research and experience of others. The students were from the University of Chicago, Northwestern University, Loyola University of Chicago, and the University of Illinois at Chicago.

> *"Different disciplines crossed paths to promote an exchange of roles where the student becomes a teacher to the teacher."*

This event was an opportunity for undergraduate researchers from many different disciplines to present their findings in a formal setting, either through a poster session or a lecture-type oral presentation. The students' work and presentations were judged by professors from the participating universities, and prizes were awarded at the end of the evening for the best research projects. Although this was essentially a collegiate science fair, the event was devoid of any competitive sentiment. Students were more eager to embrace the learning experience that comes with the opportunity to act as experts on their particular research. As such, each presentation or speech was followed by a question-answer segment that allowed the direct sharing of further insights as well as constructive criticism. All the participants—students and professors alike—gained knowledge that is only available through such collaborative efforts.

The day-long symposium, which took place on Saturday, April 23, began with encouraging remarks from the president of Northwestern University, Henry S. Bienen, who earned his master's degree and Ph.D. at the University of Chicago. He spoke about his appointment to the Argonne National Laboratory's Board of Governors, as well as his Carnegie Corporation Academic Leadership Award. These accomplishments were evoked in President Bienen's opening remarks to show the importance of collaboration in the sciences and to advocate a necessary commitment to undergraduate research. He cited his position with the Argonne National Laboratory as an example of the benefits of a growing cooperation in the sciences, specifically between Chicagoland universities in the University of Chicago-operated Argonne research facilities. Dr. Bienen also spoke of his $500,000 Carnegie Award, a part of which he designated for Northwestern University research funds and the School of Education, to exemplify his dedication to fostering inquisitive minds via research opportunities. He said of his intentions, "I remember as an undergraduate how important it was for me to do good research". The symposium was integral to the fortification of the research process and demonstrated his and his colleagues' commitment to undergraduate research. President Bienen was pleased to commence the day's activities, stating that the first annual symposium "will be the beginning of an enterprise that will grow in scope".

Representatives of corporations reliant on scientific research also attended the symposium to conduct a career forum for the students. The students—many of whom were approaching college graduation—benefited from the knowledge and guidance of the four speakers: Thy Nguyen, assistant director of Northwestern's career services, Kelly Dietz of Philips Electronics, Linnette Demers of the Evanston-based consulting firm Sg2, and Northwestern Professor Hilary Godwin (Chicago SB '89). Highlights of the forum included Dietz' explanation of the Philips Leadership Competencies, a guideline establishing the six key points that Philips looks for in a strong resume. Also noteworthy was Demers' contribution, which exemplified an alternative career path for researchers that strays from the traditional academia or industrial researching paths. Her account was from a personal perspective: after Demers obtained a Ph.D. in chemistry from Northwestern University, she found herself thinking, "I could be a professor or an industrial researcher. Well...what else?" Demers described her unique

From Left: Professor Hilary Godwin, Linnette Demers, Kelly Dietz, and Thy Nguyen (at podium)

Professor Harinder Singh at the podium, lecturing on his research of gene regulatory networks and the control of hematopoietic system cell fates.

career pathway and the road that led to her current position as a consultant for Sg2, which is a career that still requires her doctoral knowl-edge. Her clients are primarily hospitals—treated from a business standpoint. Demers' presentation informed students of possible interdisciplinary research-based work, such as her work with Sg2 that incorporates technology, business, and medicine. The path to Demers' career contrasted with the next panelist's career path, Professor Godwin, who followed the traditional post-doctoral path of academic research and teaching. Godwin emphasized the value of undergraduate research experience for graduate school candidates, suggesting that research experience was more significant than an applicant's GPA or GRE scores. In a combined effort, the panelists effectively exemplified some of the research-based career options that catered to the symposium student participants' research interests and offered credible advice for pursuing those options.

In the afternoon, attendees were treated to a lecture by University of Chicago Professor Harinder Singh on his research of gene regulatory networks and the control of hematopoietic system cell fates. Dr. Singh, who is also a professor at the Howard Hughes Medical Institute, presented his findings in an exemplary fashion, not only seeking to educate audience members with his results and conclusions, but also to demonstrate the methodology behind a useful and informative research project and presentation. His research was explained in the logical, systematic manner characteristic of an effective presentation. The problems that motivate Singh's research were addressed first, followed by an explanation of the thoughts and ideas underlying his work. He presented his findings in clear diagrams and models to delineate the circuitry of regulatory proteins in mice to ascertain the pattern of lineage in immune system cells differentiated from a single HSC stem cell. Also, Dr. Singh incorporated other labs' work or literature as well as his own graduate student's work to show the necessary exchange of ideas in good research. He said, "Science these days is a great collaborative effort", essentially encapsulating the CAURS doctrine.

Dr. Singh continued to demonstrate the strength of his research by making his findings of lineage patterns applicable to other developmental pathways, "With different players, of course," he noted. This makes his research valuable, a key feature of any good research project. Furthermore, Dr. Singh opened his research to many possible future directions, including studying the relationship between the specialization of nuclei in terms of the regulation of gene location and the influence of gene location on recombination for genes in the immune cell specialization pathway. Professor Singh's lecture was a paragon for significant research presentations that gave students and professors a clear representation of effective and informative science scholarship.

> *"[After obtaining] a Ph.D. in chemistry from Northwestern University, she found herself thinking, 'I could be a professor or an industrial researcher. Well...what else?'"*

UIC undergraduates Shayan Sartipi (right) and Syeda Hafsa Shahid coordinated the entire judging process for all 72 poster presentations.

Throughout the day, most of the undergraduates presented their research posters on easels that aligned the Kellogg's hallways and classrooms. The more courageous researchers agreed to present their work in 15 minute lectures in a small lecture hall. University of Chicago student Stephen L. Brusatte was chosen to present his research in the oral presentation category—a category for which he was very well suited (see Brusatte's findings in the **Works in Progress** section). Brusatte gave a very vibrant and mature presentation that culminated in a Q&A session during which he was fielding professors' difficult questions like an expert. He even included humor in his lecture with his acknowledgment of the possibility that his specimen shows an example of intraspecific variation between Carcharodontosaurus, analogous to the variation in humans from, "say, Shaquille O'Neal, who's like, 7'1", 320 pounds, to me, who's like, 5'8", [looking at wrist] and 60 pounds".

Maliha Darugar, a University of Chicago student, presented a poster of her study of the "Association of the Serotonin Transporter Promoter Polymorphisms with Impulsive Behavior". This behavioral genetics experiment was limited by convenience sampling of a small number of undergraduates, which Darugar hopes to fix with further studies after her graduation from the College. UIC senior Olga Escanilla shared a similar outlook on continuation of her studies after graduation. Her research sought to develop a prototype of a ventricular volume sensor for the brain in hydrocephalic patients, but the studies were quite preliminary. Escanilla hopes, "Within a year, I will have something more comprehensive".

Escanilla also described her motivation for attending CAURS: "It's really interesting to find out what everyone else is doing." For example, at an earlier conference for student researchers at UIC, Escanilla found another student with similar research interests and thought to herself, "Hey—this is what else is going on with hydrocephalus".

> *"Overall, the term 'symposium' was quite fitting for the occasion, for it describes a situation dominated by the exchange of ideas."*

Northwestern University freshman student Sarah Oshea came to the symposium but was not presenting a research project. She, like Escanilla, was interested in learning about others' projects, and decided to attend in order to prepare for her lab position in the summer. "I want to get a feel for different research methods and techniques," she said, "and see where I'll take my research when I'm a junior or a senior".

Erna Davidova, a 1st-year student in the College, offered her reasoning for attending and presenting her research on N4 phage mini-vRNA polymerase: "It's an opportunity to learn. And it's not so much that my project's so great—it's just that I can share what I've found out with the rest of the people".

Davidova was simply being modest, for her project, like many others at the symposium, were of very high quality. "We're really impressed with the quality of research presented at the undergraduate level," said Dr. SonBinh T. Nguyen, professor of chemistry at Northwestern. Dr. Godwin also added, "You know—if those were graduate students, some of the research projects would be good Ph.D. theses!" She was especially astonished with UIC's Nan Sethakorn's project entitled "Microphthalmia-associated Transcription Factor Modulates Melanoma Cell Growth and Differentiation". Sethakom's novel research findings drove Dr. Godwin's enthusiasm: "That was huge!"

University of Chicago 3rd-year David Valley presents his poster to Professors Alessandr Goltikes (left) and Asim Gangopadhyaya (right) of Loyola University.

University of Chicago Chemistry Professor Ka Yee C. Lee is honored by symposium creator Chandler Robinson for her hard work to foster undergraduate research at the University of Chicago.

After participants were rewarded with a quaint banquet dinner, Dr. Steven Rosen, MD, delivered the keynote address to a tiring audience: "At this moment, if I gave a science lecture, I'd lose you all in moments". Aware of the circumstances, Dr. Rosen, who is a professor in Northwestern's Feinberg School of Medicine, decided to keep the speech light-hearted and anecdotal. He was propositioned to discuss how he arrived at his current position in life, and he began, "I'm 53 and I'm an Aquarius". When seri-

Article author Ritbune Prakobkit and Northwestern first-year Sarah Oshea discuss scientific matters during the poster presentation session.

ous, Dr. Rosen gave a sensitive, inspirational speech that included mention of his youthful desire to be a sportswriter, success stories of his children, and his dictum of choice: "Be ambitious".

He ended the address with a slideshow of his favorite motivational quotations, including Theodore Roosevelt's quote: "Far and away the best prize that life offers is the chance to work hard at work worth doing".

The mention of a prize was an appropriate segue into the awards ceremony. University of Chicago student Erin Ables won 1st place in the poster presentations category for her research entitled, "Foundations for Human Kin Recognition: The Relationship between Odor Cues and Degree of Relatedness in Humans". Dr. Ka Yee Lee won a faculty award for her outstanding contribution in support of undergraduate research. Despite the prizes, as stated earlier the day lacked a sense of competition, and participants in the CAURS were more satisfied to carry with them the knowledge and experience from the event.

> *"'I was really surprised by the range [of projects], for example, from hardcore chemistry, on the one hand, to ecology on the other.'"* -Harinder Singh

One of the strengths of the CAURS is that it brought together students and faculty with knowledge from different backgrounds in an environment that encouraged curiosity and creativity. Professor Singh said, "I was really surprised by the range [of projects], for example, from hardcore chemistry, on the one hand, to ecology on the other". Different disciplines crossed paths to promote an exchange of roles where the student becomes a teacher to the teacher. After judging Northwestern's Jin Suntivich's materials science and engineering project, "Improving Separation of Single-Walled Carbon Nanotubes by Diameter in Density Gradient", Professor Bryan Pickett of Loyola exclaimed, "This is very nice. And well explained to a biologist, too!"

Another benefit of the CAURS was that it gave students a chance to connect personally with other students and learn of their peers' future endeavors. Summer plans were a common topic amongst dinner table conversations, as were interests outside of science and outlets for fun around each school's respective location.

The only negative comment about the symposium was from Dexter Syracuse, a first-year in the College: "I wish they would wait until the end of the day to give us those mugs—I had to hold that glass all day!" The souvenir mug, in the shape of a flask found in chemistry labs, was a delight for most participants.

Overall, the term 'symposium' was quite fitting for the occasion, for it describes a situation dominated by an exchange of ideas. 'Symposium' comes from the Greek *sympinein*, which means "to drink together". Nothing illustrates 'symposium' better than a gathering of drinking scholars. And yes, wine was served at dinner...

Nanomedicine: An Overview

Sarah Kamhawi

Today, the most fundamental branches of science, such as biology, chemistry, physics, and so on, are no longer independent disciplines; all sciences have become interconnected to form beautifully woven tapestries. Each of the fields is an individual fiber, and the plethora of interactions that are between them creates an exquisite overlapping cascade. One example of such an interdisciplinary tapestry arose from the cooperation of engineering and molecular biology, giving us a hybrid we call nanotechnology. Nanotechnology has made a tromendous impact on all aspects of science. One of the most important integrations of nanotechnology has occured in medicine. In this review, I will explore how nanotechnology has influenced medicine.

Nanotechnology is leading to a new class of multifunctional devices and systems for biological and chemical analysis with better sensitivity and specificity and a higher rate of recognition (1). The brilliance of nanotechnology and all of its entities has been incorporated into many areas of science. Specifically, the new realm of "nanomedicine" has emerged from the influence of the unique tools that nanotechnology on the domain of medical science. Nanomedicine: Nanotechnology, Biology and Medicine, the new scientific journal dedicated to this innovative field, defines nanomedicine as "the process of diagnosing, treating, and preventing disease and traumatic injury, relieving pain, and preserving and improving human health, using molecular tools and molecular knowledge of the human body. In short, nanomedicine is the application of nanotechnology to medicine" (2).

What is nanotechnology?

As previously mentioned, nanotechnology is an interdisciplinary technology resultant from the combination of engineering and biological sciences. The technology is named for its key entity and the dimensions with which it deals, the nanometer: 10^{-9} m. Nanotechnology research has given rise to novel tools such as quantum dots (QDs), nanorods, nanoprisims, carbon nanotubes, noncarbon nanotubes, nanocapacitors, nanopores, nanochannels, and nanomechanics (1). A recent work by Paolo Fortina *et al*. is an excellent summary of what all of these technologies are and the roles they play in bionanotechnology as a whole. The main concern of this article is how the various aspects of nanotechnology have been incorporated into the realm of medicine. Therefore, I will look at how nanotechnology has improved the accuracy and efficiency of certain medical studies and opened new means for diagnosis and treatment.

Nanotechnology and its implementation in medical research.

Nanotechnology has affected numerous aspects of medicine, and trends indicate that it will become even more influential in the coming years. Nanotechnology has been applied to everything from controlling membrane permeabilities and gene expressions to synthesizing artificial organs. In this section, I will provide some examples of such advancements, but keep in mind that the true extent of nanotechnology's infiltration into the medical realm is immeasurable, for every day come new advancements and discoveries.

Nanotechnology has played a large role in the advancement of immunoisolation techniques. Immunoisolation membranes can be surface micromachined in bulk to generate uniform and well-controlled pore sizes as small as 20nm (2). The size of the nanopores is essentially what makes them useful, for they are large enough to allow molecules like oxygen, glucose, and insulin to pass, while preventing the passage of larger immune system molecules such as immunoglobulins and graft-borne virus particles (2). This advancement could allow for the implantation of replacement pig islet cells under the skin of diabetes patients in order to temporarily restore the glucose control feedback loop without using immunosuppressants that could potentially leave the patient susceptible to infection (2). Therefore, nanopores are leading the way towards less aggressive means of immunosuppression.

Magnetic nanoparticles are another great instrument of nanomedicine. Studies conducted by Hilger *et al*. using in vivo experiments in laboratory animals indicate that using heat emitted by magnetic nanoparticles successfully eliminates small tumors in the lungs (4). Such studies are very promising concerning the development of less invasive means of cancer treatment. However, very large amounts of research and work still need to be conducted in order to fully apply these technologies to diagnostics and therapy. Magnetic nanopores can also provide higher stability for large molecules such as enzymes. The binding of enzymes onto nanoparticles seems to enhance their tolerance to pH, temperature, and substrate concentration while also reducing the energy barrier for the enzyme's activity. One study conducted by Kouassi *et al*., showed that this effect holds for cholesterol oxidase (CHO) when it is bound to Fe_3O_4 magnetic nanoparticles (5), which bodes well for improving the stability and efficiency of enzymes in general.

> *"... the true extent of nanotechnology's infiltration into the medical realm is immeasurable, for every day come new advancements and discoveries."*

Nanotechnology has also provided the medical field with accelerated, more precise methods for studying DNA, such as rapid self-assembly of DNA, which can replace costly and slow methods of sequencing. Zheng *et al*. developed a rapid means of DNA self-assembly within a microfluidic system by electrically extracting the DNA from an environment containing an uncharged denaturant (6). They controlled when and to what extent hybridization occurred, and also they were able to perform sizing, heteroduplex analysis and single-stranded conformation analysis within minutes (6). Such developments may aid in improving mutation detection in DNA. Many other researchers are also perfecting this form of DNA sequencing by using nanopores (2). Furthermore, DNA has been successfully controlled by radiofrequency (RF) antennas and gold nanoparticles which are attached to oligonu-