The Journal of the University of Notre Dame College of Science
Spring 2006, Volume 3, Number 1

Renaissance

Unprecedented Collaboration Among Notre Dame Researchers

I am pleased to present the Spring 2006 issue of *Renaissance*, which I feel is timely for two reasons. It is the last issue before the official dedication of the Jordan Hall of Science on September 14. As many of you know, Jordan Hall has been nearly two decades in the making, culminating with official ground-breaking ceremonies on a chilly, windswept day in the fall of 2003. The wait is nearly over. Once you step foot inside the Grand Concourse of this magnificent $70 million structure, you will soon feel—as I do now—that the intense planning and careful design by the architects and many faculty members of the Notre Dame College of Science has produced one of the finest university science learning centers in the nation. By mid-June, the building contractors will leave us a fully-built Jordan Hall. We will then transition into the next phase of equipping Jordan Hall. The 40 teaching laboratories for biology, chemistry, and physics will contain new, state-of-the-art equipment intended to provide a rich and stimulating learning experience for today's undergraduates. As this work progresses, other individuals will be unpacking furniture and moving office furnishings. In addition, a committee has been working since late last year to make sure that the display cases on all three levels of Jordan Hall are filled with fascinating examples of the accomplishments of Notre Dame scientists past and present. The entire coordinated effort required the work of hundreds of individuals who are dedicated to presenting to the Notre Dame community and the public at large a center of science learning that represents the highest goals of this university. In sum, Jordan Hall advances the College of Science into the 21st Century.

This issue of *Renaissance* also highlights a quiet revolution that has been evolving over the years at Notre Dame. By that I refer to interdisciplinary research efforts involving faculty members in the College of Science and their colleagues in other colleges on campus. As its name implies, interdisciplinary research involves a team-based approach by members of various scientific disciplines who hitherto have operated within their own academic spheres. The formation of the Interdisciplinary Center for the Study of Biocomplexity illustrates how biologists are working with physicists, mathematicians, and computer scientists to delve deeper into the complex machinery of the cell, for example. It is the broad objective of the center's research teams to advance man's understanding of the fundamental principles of human development at the molecular scale. This multifaceted approach creates opportunities for fresh thinking and novel solutions that likely would have escaped the attention of a single scientist working alone within his or her area of research. Another excellent example of this trend is the creation of a new classroom initiative called GLOBES (Global Linkages of Biology, the Environment and Society.) This exciting interdisciplinary program links scientists and social scientists at Notre Dame whose mission will be to examine the challenges posed by environmental degradation, the spread of infectious diseases and the long-range implications of invasive species to create lasting solutions using this unique approach.

This issue of *Renaissance* also highlights the beginning of a new era for our Preprofessional program starting with the appointment of Fr. James Foster, C.S.C., MD, as its new director, the expansion of the successful UNDERC program and the arrival of the 800 Nuclear Magnetic Resonance spectrometer that has already taken our research infrastructure to the next level. I hope you find this *Renaissance* as exciting to read as I have.

Joseph P. Marino

UNIVERSITY OF NOTRE DAME

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Dedication ceremonies for the new Jordan Hall of Science will begin at 3:30 p.m. Sept. 14 with a Mass at Sacred Heart Basilica. Following the Mass will be the blessing of the building, a reception and public tours.

Jordan Hall… *almost* Ready for Occupancy

Like many other bright high school graduates who imagine themselves as future scientists, Anna Drendall will begin her freshman year at Notre Dame this August with high expectations. As good fortune would have it, she will have a significant advantage over the sophomores who arrived as Notre Dame freshmen last year.

Even now, it's difficult to miss Anna's big advantage. And big it is. For rising on the easternmost edge of campus is a magnificent structure that has been taking shape over the past three years. When Anna walks into the gleaming new Jordan Hall of Science she will enter not just another imposing brick and mortar edifice but a bastion of education that will be fully equipped with the latest in teaching technology. Over the past year, a great deal of thought has been given toward making sure she and her classmates have every possible edge in their pursuit to obtain their bachelor of science degrees at Notre Dame.

Anna, and a thousand like her, could not have picked a better time to come to Notre Dame. The day they walk into Jordan, these young hopefuls will have incomparable opportunities virtually in every field of study they choose.

Right: With construction of the Jordan Hall of Science nearing completion, the focus will shift this summer to readying the interior for the first day of classes in August.

Left: Members of the faculty have been getting previews of the new Jordan Hall of Science, so they become familiar with the layout of the facility, including the teaching laboratories, lecture halls, multimedia room, and offices.

Top right: Image courtesy of NASA.

If astronomy piques their interest, they can head straight towards the Jordan observatory and peer into our solar system through a large research-quality telescope that will rival any other in the Midwest.

But on the galactic scale, the structures of the universe require a telescope of considerably stronger magnification. So how about real time, streamed images from the Hubble Space Telescope projected onto expansive screens in Jordan's twin auditoriums?

Students can leave the cosmos behind and shift their attention to the world of atoms. Some scientists claim that the biggest scientific discoveries that lie ahead in the 21st century are apt to be found on the molecular scale. For instance, why are so many diseases—Alzheimer's disease or cystic fibrosis among them—seemingly tied to mistakes when proteins fold?

The new and modern laboratories are located on every level of the Jordan Hall of Science. The spacious labs will be so much more conducive to helping the budding scientist understand the mechanisms of protein folding, or any other mystery of biology. In short, Jordan Hall is designed to nurture the curious mind.

The possibilities will be endless for the arriving freshmen who will never know a moment when their fledgling ambitions in the field of science might be restricted by space or technology.

They may not be aware that it took years of planning to take science education at Notre Dame to the highest level.

The Jordan Hall of Science has been over 17 years in the making, starting when a committee of science educators wrote a report describing the limitations of the laboratories, the lecture halls, and the equipment found in the aging Nieuwland Science Hall, and even in the newer Stepan Chemistry Building and the Galvin Life Sciences Building. Their report established the groundwork for a science building that would greatly exceed anything Notre Dame had ever seen.

Supported by a substantial gift from Notre Dame alumnus John W. "Jay" Jordan, the $70 million building went from an architectural blueprint to an actual concrete foundation in the Autumn of 2004.

Left: Visitors entering the Jordan Hall of Science for the first time are sure to be awed by the splendor of the grand concourse. Image courtesy of The S / L / A / M Collaborative, Inc.

Opposite Page: Jordan Hall will feature a high-tech multimedia visualization center. Image courtesy of Sky-Skan.

John W. "Jay" Jordan

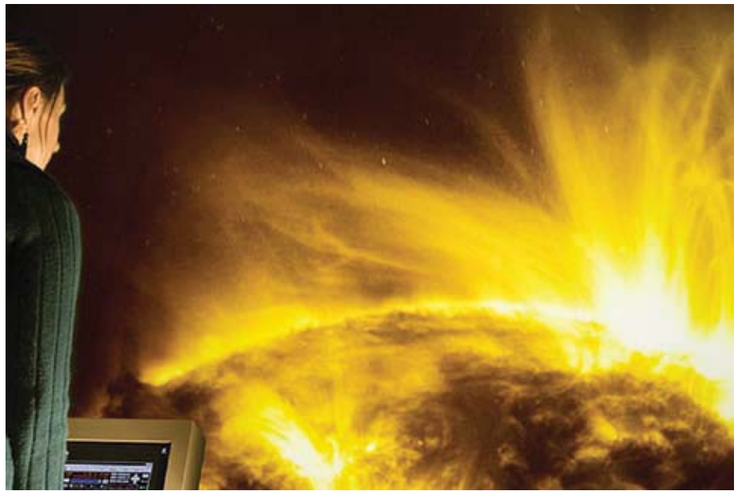
Concurrently, University scientists began taking inventory of what equipment could be transferred to Jordan, what should be disposed of, and what new equipment was needed.

A small committee consisting of Associate Dean of Science Mitchell Wayne, Associate Provost Dennis Jacobs, chemist Paul Helquist, physicist Michael Hildreth, and biologist Ronald Hellenthal was formed to conduct a bottom-up study that specified the needs of the new building.

Members of the committee toured the science facilities of several Midwestern universities. "We saw good examples and bad examples and tried to avoid mistakes some other universities have made," said Paul Helquist.

"We tackled the issue course by course, room by room, and lab by lab," Wayne said. "We considered other factors like present-day enrollment and projected future enrollments. It turned out we needed roughly $7 million in new equipment," Wayne said. "This does not include the base cost for all the multimedia visualization equipment that was already part of the cost of the building."

The South Bend community at large will see benefits as well, similar to the cultural opportunities offered with the opening of the DeBartolo Center for the Performing Arts.



One of the most memorable science-related public events in recent history occurred in the summer of 2003 when the Physics Department held "Mars Night." Thousands of students, faculty, staff and members of the Michiana community lined up inside and outside Nieuwland Hall just to look through the old telescope atop the building. People waited for hours on those balmy nights just to get a glimpse of the Red Planet.

The multi-media technology built into Jordan Hall of Science will be able to take the concept of "Mars Night" to an even more exciting level. "Now people will be able to look through the telescope while everyone else is seeing images broadcasted on the large screen of the planetarium. At the podium will be one of our astrophysicists describing what is so special about that particular evening," Wayne said. "The observatory and planetarium will greatly enhance the astronomy curriculum, no question about it."

The Jordan's official date of completion is May 18. Construction has proceeded smoothly and there is plenty of optimism that deadline will be met. Following that target date, there is a period of one month in which contractors will address anything that needs to be fixed. After June 18 the University has only two months to bring in the new equipment and furniture and be ready by the third week of August to begin classes in Jordan Hall.

It will be a daunting task right down to filling hundreds of feet of display cases with all things scientific.

Then there is the issue of the east wall. It's blank. It's white. And it's four stories high. Faculty members and the Jordan architects discussed numerous possibilities for that wall. Many people saw a surface onto which images could be projected. So the committee overseeing the construction of Jordan Hall agreed to in-stall projectors on each of the three floors and fill the wall with dynamic displays from each of the fields of science.

This attention to detail is just one example how those involved in the construction of the Jordan Hall of Science were dedicated to making the new building visually and aesthetically attractive for all Notre Dame students, faculty and visitors.

Consultants from the Snite Museum and the Art Department agreed to provide advice on how to best decorate and appoint the Jordan with the right touches to enhance its appeal.

One wing of Jordan Hall's second floor will serve as the home of the Preprofessional Program and the new Center for Advising in the Health Sciences. "The new center will have a nice reception area, a resource center for undergraduate research and a very beautiful common space just outside," Wayne said. The center is an expanded version of the earlier pre-med advising program.

Arched windows along Jordan Hall's central corridor are among the architectural details that provide a touch of grandeur to the new building.

Looking up in the central corridor of the almost-completed Jordan Hall.

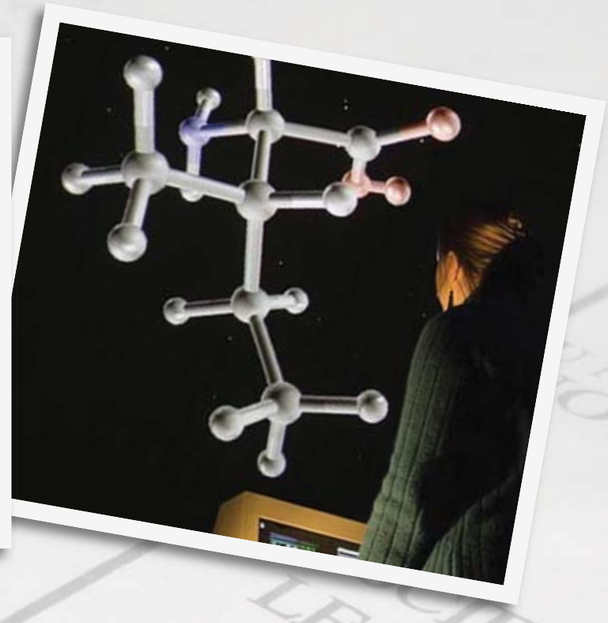
Jordan Hall of Science—First Floor

Legend

- Biology
- Circulation
- Chemistry
- Physics
- Shared
- Support

Image courtesy of The S/L/A/M Collaborative, Inc.

Multimedia



Above: Breathtaking images—from the cosmic scale to the molecular scale—will capture the magic of science in the multimedia visualization center. Photos courtesy of Sky-Skan.

"We wanted the Jordan to be a place where students will want to hang out, even after their classes. We hope they will want to sit down in a comfortable chair, read a book and talk to other students to follow up on their notes," he added.

A busy student is also a hungry student. So an effort was made to convince the University to change an earlier blueprint in order to include a small food service area equipped with vending machines and a counter with pre-made sandwiches. Café Galileo—or whatever it is named—will be located on the lower level of the Jordan.

Students going to classes in the Jordan for the first time will quickly see that the teaching faculty wanted to promote interaction and discussion between students. This objective is evident in the way the twin 250-seat lecture halls have been designed. They are unlike any other found on campus.

Theater seating that is typically found in most lecture halls has been replaced by an altogether different concept.

Each lecture hall consists of four layers, or platforms. And on each platform will be two rows of tables and chairs. The idea is to facilitate interactive teaching on each of these platforms. Students will be able to swivel around and talk to students across from them at the table. In effect, students will hold discussions as if they were at a dinner table.

The Jordan will be much more conducive to learning in other ways as well. Professors will lecture on a subject for a short period of time, followed by a question to the class. Students will have electronic clickers where they can give their answers. The result will be flashed onto a screen so the professor will get immediate feedback on whether the students understood the lecture.

Every lecturer will be able to flash images onto three screens with a state-of-the-art touch pad control system. Many instructors think this feature inevitably will change teaching styles to make lectures easier to understand.

"With the speeds we now have with the Internet it will be possible to connect to sites anywhere in the world. We can now bring in a guest lecturer, say a Nobel Prize winner who is a world expert in a particular field. This, I think, will be one of the Jordan's greatest teaching features," Wayne said. "A lot of dedicated people have been involved for the last year and a half to make the Jordan Hall of Science an ideal venue for learning."

Proof of their success will come on a graduation day in the not too distant future.

Preprofessional students Tom O'Grady and Johanna Villasenor acquire real-world experience as they listen to Stephen Ribaudo, MD at the Chapin Street Health Clinic in South Bend, Ind.

Preprofessional Program Undergoes Transition

The opening of the new Jordan Hall of Science is certain to touch everyone involved in the Notre Dame College of Science, but no more so than the students and advisors of the Department of Preprofessional Studies.

Undergraduates who are on a vocational track that will lead them to medical, dental, or other health professions schools following commencement have already experienced one of several significant changes planned for the department, namely the way the department facilitates student discernment toward the healing professions and provides assistance through the complex application process.

The newly-created Health Science Committee office, temporarily located in Room 227 Nieuwland Hall, will be relocated to the Jordan Hall of Science this summer, along with the triumvirate of advisors, Rev. James Foster, CSC, MD, the department's recently appointed director; Jennifer Ely Nemecek, assistant dean of the College of Arts and Letters; and Kathleen Kolberg, health sciences advisor and adjunct psychology professor. Together, the three will be advising 250 health profession applicants per year. Rev. Joseph Walter, CSC, who held the position as director since 1971, took an already successful program and brought it to a level few universities in the country can match. Notre Dame ranks 11th in the nation in the number of students matriculating at medical schools each year. Notre Dame's reputation for producing high-quality applicants is so widespread that the acceptance rate has annually hovered around 80 percent, compared with the national rate of near 50 percent.

Notre Dame ranks 11th in the nation in the number of students matriculating at medical schools each year.

With the construction of its new quarters in the Jordan Hall of Science nearly complete, the Department of Preprofessional Studies is on the verge of making yet another leap in excellence.

"Our new committee format is more typical of what you would find at a fairly large institution," noted Father Foster. "But not all schools provide what we are able to provide in terms of a centralized application process, especially given the number of applicants we have every year. Larger schools have so many students interested in pursuing the health professions that their offices have a difficult time getting to know each and every student on a personal basis."

As had been the case when Father Walter was head of the department, the advisors will continue to personally write a cover letter that they submit to allopathic and osteopathic medical schools and dental schools, along with that student's other letters of recommendation.

"Our cover letters help the professional schools get to know the students and the University of Notre Dame a little bit better," Father Foster said.

Instead of mailing individual packets of letters to all of the schools to which a student applies, the department will now be using an electronic computer-based system called *VirtualEval*, designed by advisors at Duke University. Letters of recommendation will be scanned into a pdf file, which is made available through a secure website. Packets of letters will continue to be mailed separately to the few schools not participating in the *VirtualEval* system.

Shortly after the Department of Preprofessional Studies moves into the new Jordan Hall, the next round of changes will occur.

In the past, undergraduates who were not science preprofessional majors may not have had personal contact with the preprofessional office until the application process began during the second semester of their junior year because of the departmental nature of advising at Notre Dame, and because the physical structure of the preprofessional office was not conducive to that level of preparation and planning for all pre-health students. Nor was its location in Nieuwland Science Hall especially convenient for all pre-health students, especially biology, arts and letters, and engineering majors.

The new office, because of its central location in Jordan Hall, will be available to respond to this need to help all Notre Dame students from early in their undergraduate years with their vocational discernment and professional preparation for the application process. It will also

Left to right: Stephen Ribaudo, MD, Johanna Villasenor, Tom O'Grady, Jacky Kehler, Chris Schuster '05 (Tom Dooley Internship Intern)

On April 24, Dean Joseph Marino announced that Rev. James K. Foster, CSC, would serve as director of the Center for Advising in the Health Sciences, and would become chair of the Preprofessional Program effective July 1, 2006.

Father Foster will also serve as an assistant dean for Health Sciences in the College of Science. He will oversee the advising activities in the center as it moves into the Jordan Hall of Science this summer.

"We are very pleased that Father Jim will take on these responsibilities and lead Notre Dame into a new era of excellence in preparing our students for careers in medicine, dentistry and the health sciences," Marino said. "His background in medicine and ethics, as well as advising, will serve him well in leading the University in broadening the scope of premed training nationally."

serve as a resource for students who are discerning any of the allied health professions, including physical therapy, pharmacy, optometry, podiatry, public health, and others.

"So the purpose of this new office in Jordan Hall is to have a place available to students starting during their freshman year, where they can go to get that advice early in their undergraduate careers. It will also provide assistance to students who are seeking research opportunities, clinical experiences, or service opportunities as they discern and prepare for professional school," Father Foster said.

A student finishing a chemistry class, for instance, may have time before the next class to peruse any number of journals or periodicals or inquire about medical schools. An advisor can begin a file on a student as early as the freshman year, even before he or she has declared a major.

Some of the other plans for the new office include:

- Serve as a resource with information about the many summer research opportunities and internships available across the country.
- Offer an easily accessible library of materials from the individual allopathic and osteopathic medical schools, dental schools, and allied health professions schools.
- Offer online access to information about the various health professional schools, as well as online access to several medical and dental journals.
- Offer a meeting space for student preprofessional clubs.
- Invite speakers to Notre Dame to address various issues regarding trends in the various health professions, preparation for the application process, interviewing strategies, financial planning, ethics in health care, and other issues.

Early Action Open House

Ninety high school seniors who have ambitions for careers in the sciences visited the College of Science at an open house on Feb. 9–10 to get first-hand experience of academic and campus life at Notre Dame.

The students—all of whom already received letters of acceptance from the University—were welcomed to campus by Dean Joseph Marino at a general session Thursday evening at the ballroom of the LaFortune Student Center. Dean Marino provided an overview of the science teaching and research at Notre Dame and provided the students with an update on the construction of the Jordan Hall of Science, which will be ready for the first day of class in August.

A dozen faculty members were on hand to answer their specific questions following the informal presentations.

The students came from throughout the country. They stayed overnight in a dorm room, ate at the dining halls, and toured science laboratories, classrooms, and facilities during their visit.

Many spoke favorably about their experience. "I thought (the open house) was extremely informative and gave me a clear idea of the goals of the science program at Notre Dame for the future," wrote back one student. Wrote another: "I enjoyed being able to meet all the faculty in the science department and being able to sit in on a freshman-level science class. I also enjoyed the lab tours that I was able to go on for they gave me a more hands-on experience."

UNDERC Goes *West*, & and *South*, too.

It is insufficient to talk of the University of Notre Dame Environmental Research Center (UNDERC) any more without answering the question, "Which one?"

There are three UNDERCs now, starting with the original site at Land O' Lakes, Wisconsin, now known as UNDERC-East. With the recent addition of UNDERC programs in the Rocky Mountains and in Puerto Rico, exciting new vistas are opening up for biology students.

This summer the first contingent of eight students will travel 2,000 miles to Montana—specifically to the 1.6 million acres of federal and tribal lands of the Confederated Salish and Kootenai Indian tribes as well as to the northern Milk River—to officially start UNDERC-West. The first two years of the program will be funded by the National Science Foundation through a program that involves Native American students in environmental biology.

"This area of western Montana has been called the Serengeti of North America—and rightly so—because of the great diversity of plant-eating animals there," said UNDERC Director Gary Belovsky, who has conducted his own research on the herbivores in this region for the past 28 years. "This intermountain valley is a grassland that is rich in bison, elk, pronghorn antelope, and deer. On top of that, there are streams, wetlands, and lakes the students can explore."

"In the mountains, students can experience an elevational gradient of forest habitats until the highest elevations only support alpine tundra. There are even glaciers in the region," Belovsky said.

This area of western Montana has been called the Serengeti of North America.

- Gary Belovsky, director, University of Notre Dame Environmental Research Center (UNDERC)

Located on the border of the United States and Canada, the Milk River is seven hours away by car from the intermountain area of the tribal reservation. This area of the Great Plains and badlands allows students an opportunity to investigate dinosaur fossil beds and Native American archeological sites providing a broad range of topics for students to study.

At the other end of the environmental and climactic spectrum is UNDERC-South, located in the tropical rain forest, coral reefs, and mangroves of Puerto Rico.

Next year will see the official beginning of UNDERC-South, which is affiliated with the University of Puerto Rico. UNDERC-South is essentially an exchange program between the two universities, Belovsky explained. Four Notre Dame undergraduates will make their first visit to the Caribbean island in the summer of 2007, and four University of Puerto Rico students will begin their environmental studies at UNDERC-East in the summer of 2006 under an endowment from Notre Dame alumnus and Board of Trustee member Joe Enrique Fernandez.

The creation of UNDERC-West and South opens up ecological and cultural opportunities students haven't had before.

Notre Dame students will have a choice of conducting tropical rain forest research at the El Verde Forest Research Station, or study coral reefs or mangrove ecology at the Mayaguez Marine Station. As is required for students going to UNDERC-West, students wanting to enroll in UNDERC-South must first spend a summer at UNDERC-East.

"The El Verde Forest Research Station is located in the 23,000-acre Caribbean National Forest in eastern Puerto Rico, and the Mayaguez Marine station is located on an 18-acre island in southwestern Puerto Rico," Belovsky said.

UNDERC became a haven for undergraduate and graduate research in the 1970 when famed biologist George B. Craig Jr. and then-director Robert Gordon set out to use this pristine tract of unspoiled Northern Forest as an outdoor teaching lab.

Undergraduate and graduate students have long relished the opportunity to become immersed in environmental research, whether in the field or in the classroom.

UNDERC-East, the venerable 7,600-acre site straddling both sides of the Upper Peninsula border, remains the jewel of the Department of Biological Sciences' ecology, evolution, and environment curriculum. UNDERC has been a special place ever since it was founded by famed biologist George B. Craig Jr. 30 years ago. Programs in this tract of pristine North American wilderness have helped launch the careers of hundreds of Notre Dame students.

"The huge success of UNDERC-East played a key role in the development first of UNDERC-West and now UNDERC-South," Belovsky said. "This summer we will again take 24 students to Land O' Lakes, and the plan is to increase the size of the class to 32. We have a new dormitory funded by the University and donations from Jerry Hank, an alumnus and Lifetime Trustee, that will be available this summer."

This past fall Notre Dame hosted its first meeting of scientists from Midwestern universities, many of whom got their first glimpse of the northern hardwood forest region that has been untouched by the encroachments of human civilization for nearly 100 years. "We gave them a DVD movie about UNDERC that was produced last year. They were so impressed by the film and with their experience at UNDERC-East that about a half dozen of them are now developing research projects that will use UNDERC."

Belovsky has been working for over four years with Executive Vice President John Affleck-Graves and Vice President of Research Jeff Kantor on a partnership agreement with the Confederated Salish and Kootenai Indian tribes of Montana to establish UNDERC-West.

But the idea to develop UNDERC-South came about fortuitously when Belovsky, who has conducted research in Puerto Rico, met with Fernandez and the chancellor of the University of Puerto Rico. "Naturally we discussed UNDERC-East. I gave them the DVD of UNDERC-East and by the next day they e-mailed me about developing UNDERC-South," Belovsky recalled.

The creation of UNDERC-West and UNDERC-South "opens up both ecological and cultural opportunities our students have not had before," Belovsky noted. "At UNDERC-West they will be closely involved with the Salish and Kootenai tribes. Those who go to UNDERC-South will get to experience the Puerto Rican culture."

Living quarters and laboratories at UNDERC-West have been arranged by the native American tribes. The University of Puerto Rico will make its own facilities available for Notre Dame students.

These recent developments have created unprecedented opportunities for undergraduate and graduate students with perhaps only an UNDERC-Amazon missing from the curriculum.

The growth and expansion of the UNDERC facilities has been phenomenal in the past 10 years. New laboratories and new residences have replaced UNDERC's original buildings.

"But something on the horizon may be developing there, too," Belovsky smiled.

For further information on the UNDERC programs and staff, visit the UNDERC website at http://www.nd.edu/~underc/.

An Ambitious New Classroom and Research Initiative

GLOBES

Global Linkages of Biology, the Environment, and Society

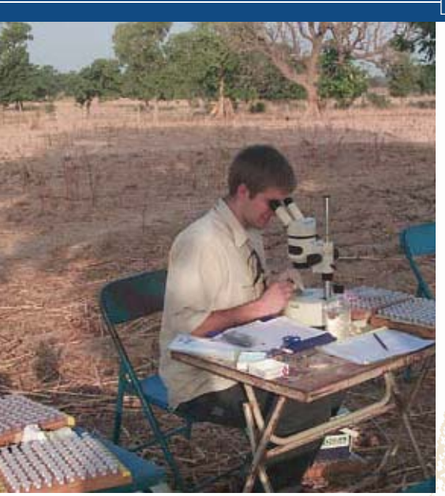
GLOBES Program Director Jeffrey Feder, Department of Biological Sciences

Something novel of global proportions is happening at Notre Dame. Starting in the fall of 2006, Notre Dame graduate and undergraduate students will be embarking on a new interdisciplinary program called GLOBES: Global Linkages of Biology, the Environment, and Society.

GLOBES is an ambitious new classroom and research initiative at Notre Dame. The program is being launched by a prestigious five-year, $3.2 million Integrative Graduate Education and Research Traineeship grant (IGERT) from the National Science Foundation to the colleges of science and arts and letters—the first of its kind received by the University.

The GLOBES program has two goals. "First, GLOBES will cut across traditional academic boundaries at the University, harnessing the collective skills of Notre Dame biologists and social scientists in a team-based approach to solve pressing problems in human and global health, including environmental degradation, the spread of infectious disease, and invasive species," says Program Director Jeffrey Feder from the Department of Biological Sciences. "Second, GLOBES will provide the next generation of Notre Dame graduate and undergraduate students with knowledge, technical tools, and experience to combat world challenges in socially responsible and ethically sound ways."

Team-based problem solving is a foundation of industry. Corporate executives know that good decisions about long-term planning never result from considering a single, isolated facet of a problem. Similarly, problem solvers in the life sciences face an analogous situation. Threats to human health and global well-being are often linked to a deteriorating environment of our own doing, and these detrimental effects are often inequitably borne by the poor. Progress in the fight against poverty, disease, and environmental degradation dictates that complementary groups of biologists, social scientists, ethicists, policy experts, legal scholars, and local citizens work together to design and implement



Left: GLOBES harnesses the resources and interdisciplinary expertise from across the University, including the Reynier Laboratory for Biocultural Studies

Right: GLOBES students study interrelated topics, including how changes to the ecosystem feed back to acerbate human and global health problems.

meaningful and lasting solutions to world problems.

"The GLOBES curriculum will provide the framework for Notre Dame's students to develop the requisite disciplinary expertise they need to contribute to their chosen professions, while simultaneously learning to work in multidisciplinary, faculty mentored teams focused on real-world problem solving. The insights generated about the problems at hand, coupled with the skills and attitudes developed to be effective team players and leaders, will benefit our students and the world well throughout their careers," says University of Notre Dame Provost Thomas G. Burish.

Key features of the GLOBES program include: (1) Field research projects organizing students and faculty into teams investigating the spread of infectious diseases and invasive species at sites in North America, China, West Africa, and Bali; (2) New interdisciplinary, team-taught courses and seminars for students focusing on such topics as "Humans and the Global Environment", "Science, Technology, and Values", "Human Culture, Genes, and the Environment", "Population and Disease Ecology", and "Biodiversity and the Law"; (3) Intensive training modules that give students practical, hands-on experience with techniques ranging from genomic to ethical to economic analyses; and (4) Training on campus and in Washington, D.C. to sharpen the teaching, communication, policy, and leadership skills of students.

Why is Notre Dame's GLOBES program so novel? Academic boundaries loom large at most universities and stifle interactions among relevant disciplines. The broader impact of this isolation in research, training, and infrastructure is that relatively simple and effective ways to reduce environmental damage and prevent disease may be overlooked or poorly implemented. The novel part of GLOBES is the interdisciplinary approach that stimulates innovation and the team-based problem solving ability of each discipline.

The GLOBES curriculum will begin this fall with the teaching of the first new course, "Humans and the Global Environment" by Jessica Hellmann, assistant professor of biological sciences, and Mark Schurr, chair of the Department of Anthropology. The course will challenge graduate and undergraduate students with the task of making the complex connection between human civilization and our planet's ecosystems. "Humanity has struggled against nature and benefited from its bounty since the dawn of humankind," Hellmann said. "The new class will explore the costs and benefits of modifying the environment as well as the scientific basis of global change. The fascinating thing is that people have always affected their environment, but we'll ask students to examine whether and how the pace and magnitude of that process has changed over time."

"The GLOBES program holds tremendous promise for environmental problem solving, continuing Notre Dame's tradition of uncommon leadership in the conduct of responsible science for the betterment of humanity," says Joseph Marino, dean of the College of Science. "GLOBES will help weave socially relevant science research and education into the fabric of the general Notre Dame community. I have made GLOBES a major priority of the College of Science's strategic plan for the future in the University's new fundraising campaign. My goal is to continue to nurture GLOBES development into a premier endowed program at the University and nation."

Top left: Laboratory and field-based studies of the spread of infectious diseases by insect vectors are focal points of GLOBES research, including mosquitoes and their transmission of malaria in West Africa.

Left: Macaque monkeys and their potential transmission of disease to humans are areas of study of GLOBES faculty Agustin Fuentes and Hope Hollocher.

Right: Center for Aquatic Conservation Director David Lodge examines small stream-dwelling animals that depend on clean, abundant flowing water. Photo courtesy of Angela Bobeldyk.

Below: Round Goby, one of several fish species from Eurasia that have invaded the Great Lakes. This species is now the most abundant fish along the shores of southern Lake Michigan, where it is the bane of anglers. It is now moving southward into the Mississippi River Basin.

Notre Dame's New Center for Aquatic Conservation:

Scientific Research Serving Society

Question: What does fresh water have in common with ocean fisheries, once-vast oil reserves, and North America's original forests?
Answer: The presumption of infinite abundance.

Thoughtless exploitation of water resources combined with bad management is seriously endangering our freshwater sources. This disregard is now threatening human welfare and the future of aquatic ecosystems that depend on unadulterated and plentiful water.

"Water is central to human life and to the existence of aquatic organisms. But you wouldn't know it by the way we have abused it," says biologist David Lodge.

Addressing the risks of diminishing water is the mission of Notre Dame's new Center for Aquatic Conservation (CAC). The CAC is dedicated to "the development and application of research to conserve earth's freshwater ecosystems, in balance with the water requirements for humans," said Lodge, director of the center.

The risks of increased water use by humans have become painfully obvious in recent years. Higher mortality from water-borne diseases, destruction of wetlands, chemical and biological pollution, and interstate and international conflict over limited water supplies are a few consequences of increased pressure on the earth's limited supply of freshwater.

The CAC builds on Notre Dame's strong commitment to excellence in the environmental sciences. Notre Dame is renowned for research on the ecology of lakes and rivers. In recent decades, University researchers have not only been leaders in ecological research, but have also informed the management and policy of global aquatic resources. The CAC will dovetail with Notre Dame's growing network of programs and research centers concerned with the environment, including the University of Notre Dame Environmental Research Center (UNDERC), the Center for Environmental Science and Technology (CEST), the new Energy Center, and the new GLOBES program.

Notre Dame Provost Tom Burish says, "The Center for Aquatic Conservation will provide an important link between Notre Dame's excellence in environmental research and society's need for scientific advice toward enhancing human welfare now while sustaining aquatic resources for future generations. The center will greatly enhance our interdisciplinary efforts in environmental scholarship at Notre Dame."

Lodge explains that one of the center's initial objectives will be to advance the science, management, and policy of invasive species, beginning especially in the Great Lakes Region. Invasive species are organisms that are out of place and cause serious trouble to human health, agriculture, forestry, natural ecosystems, or human infrastructure. Economic and societal costs from invasive species are so great that both the past and current US Presidents issued executive orders to address the growing problem. President Bush, in his 2004 Executive Order, identified invasive species as a top research and management priority for the Great Lakes Region in particular.

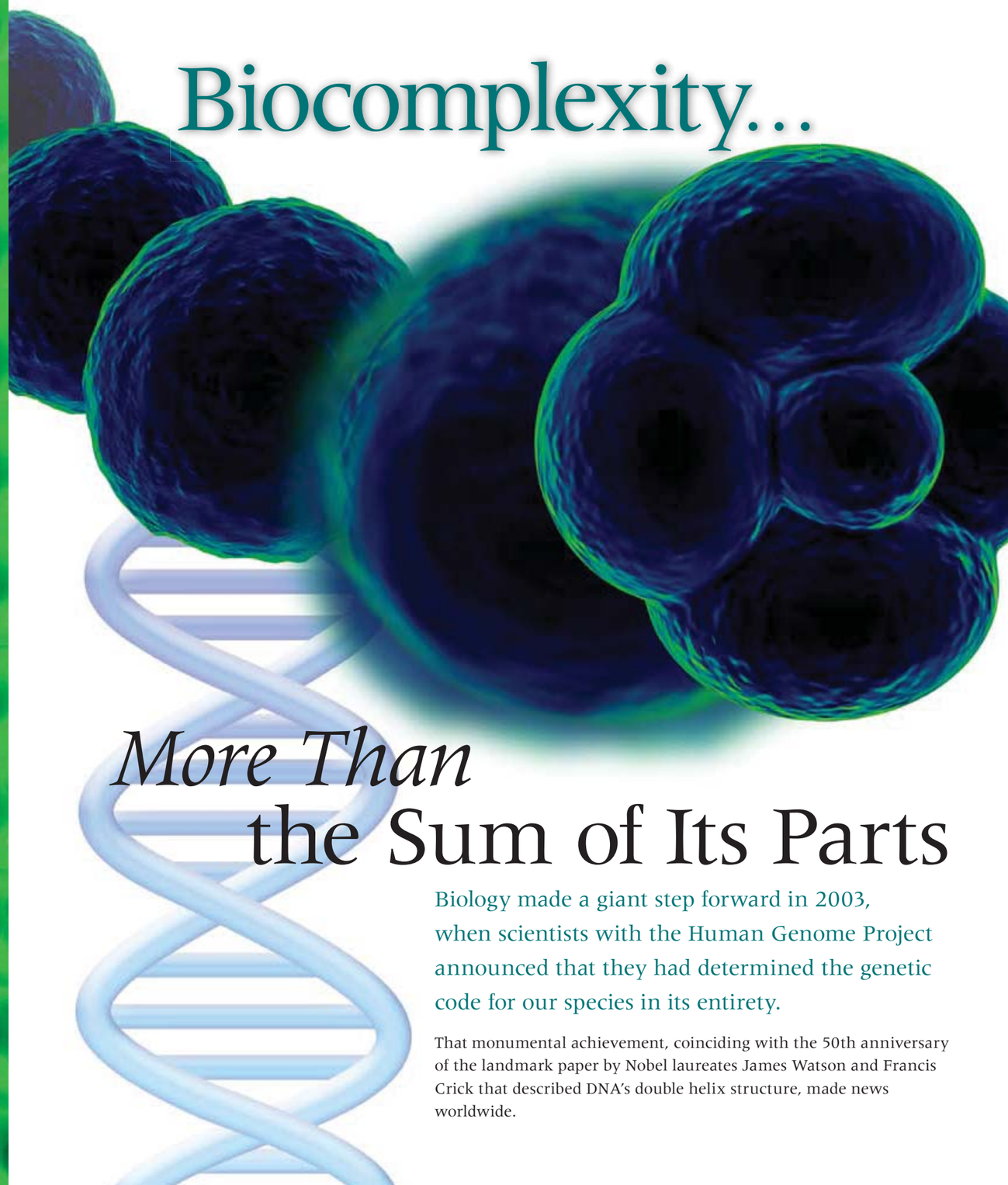
As part of the CAC's initiative on invasive species, the center is partnering with The Nature Conservancy, the largest and most scientifically-based conservation organization in the world. The Nature Conservancy owns and manages extensive lands and waters globally, and has had unparalleled success in working with industry and policy makers to protect the environment. According to John Andersen, director of the conservancy's Great Lakes Program, "the conservancy has found a wonderful scientific partner in Notre Dame. We look forward to developing this partnership to encompass the broad expertise in environmental science represented at Notre

Dame." John Randall, director of the Conservancy's Global Invasive Species Initiative, points out that "the synergism between Notre Dame's excellence in research and the conservancy's on-the-ground experience in managing harmful species will provide practical solutions to ecological problems."

Various Notre Dame scientists will lead the CAC's research efforts on other important environmental issues. These include the urgent need to reduce the run-off of fertilizers from Midwestern farms that has contributed to the huge "dead zone" in the Gulf of Mexico. How to manage the harvest of fish and other aquatic species so that populations are sustained for future generations is another central research challenge. In the context of urban development and forestry practices, Notre Dame biologists are testing how best to maintain or restore the underwater habitats essential for trout and the organisms on which they feed. Additional research will build on existing expertise in climate change effects on the evolution and occurrence of diseases and other species. A critical challenge is how to provide water supplies and manage natural habitats to reduce the spread of human diseases, including malaria and schistosomiasis. The location of these and other research programs ranges from the Great Lakes Region to the far-flung reaches of the globe, including Alaska, Indonesia, China, and Africa.

To Notre Dame undergraduate and graduate students, the center and its joint initiative with the Nature Conservancy will offer opportunities both to enhance research and work opportunities with NGOs and government agencies to guide the implementation of scientific discoveries beyond the classroom. "These new opportunities will help Notre Dame attract graduate students of high caliber, broad interests, and strong motivation toward solving the world's problems, and will help us prepare these students for leadership careers," says Jeff Kantor, Notre Dame vice president and dean of the Graduate School. Joseph P. Marino, dean of the College of Science, says that "the curriculum and research at Notre Dame will be enriched, and the center will contribute a vital component toward the larger goals of building interdisciplinary environmental expertise at Notre Dame." Notre Dame leaders, scientists, and students are gratified that the CAC will increase the opportunities for their research to serve society's needs.

Biocomplexity...



More Than the Sum of Its Parts

Biology made a giant step forward in 2003, when scientists with the Human Genome Project announced that they had determined the genetic code for our species in its entirety.

That monumental achievement, coinciding with the 50th anniversary of the landmark paper by Nobel laureates James Watson and Francis Crick that described DNA's double helix structure, made news worldwide.

In 2003 an event took place at Notre Dame that attracted little attention initially but that will affect the future of biological interdisciplinary research on campus for years to come. The creation of the Interdisciplinary Center for the Study of Biocomplexity (ICSB) began as a small collaboration of scientists to help to push biological research on campus beyond the genome.

"An organism is truly more than the sum of its parts. The purpose of the ICSB is to figure out how the "parts" encoded by the genome work together to make the "sum" that is a bacterium, a mouse, or a human being," said Mark Alber, a Notre Dame applied mathematician and the center's director.

A key part of the difficulty is that the human body is not assembled; it assembles itself. The complexity of this process is mind-boggling. To begin to understand the self-assembly of any organism, even a single cell, requires understanding how a staggering number and variety of components interact with each other. Acquiring such understanding requires new approaches to biological science. Similar problems present themselves at scales from the molecular to the ecological: in biology there is a recurring theme of myriad individual components interacting to create something—a pattern, a structure, a behavior, an environment—that is greater than the sum of those parts.

The creation of the Interdisciplinary Center for the Study of Biocomplexity (ICSB) began as a small collaboration of scientists to help to push biological research on campus beyond the genome.

"Twentieth century biology was 'reductionist'—the idea was that if you catalog all the parts of a organism, and figure out how they work individually, you will figure out how the organism works. This approach, culminating in the Human Genome Project, has been tremendously successful. However, it isn't sufficient. Just as having a parts list for your car will not tell you how to put it together, having the sequence of the human genome is just the beginning," explains Holly Goodson, assistant professor of biochemistry, who serves as associate director of the center.

To study such complex problems, biologists need new approaches capable of considering a large number of simultaneous interactions. Physicists, mathematicians, engineers, and computer scientists have tools and expertise to study such multidimensional problems, but lack the necessary understanding of the biological systems. "The goal of the Interdisciplinary Center for the Study of Biocomplexity is to bring these groups of scientists together with biologists in an effort to understand, predict, and eventually manipulate complex biological systems. Such efforts should have impact on fields ranging from human health to nanotechnology" said Alber.

"Having the center perform these functions of looking at biology in a deeper and deeper context will be essential to understanding how systems work," said Charles Kulpa, chair of the Department of Biological Sciences.

"Hot" issues that have biocomplexity at their core include epidemiology (spread of diseases such as "bird flu"), ecological degradation, and manipulation of metabolisms (animal, plant, microbial) for the purposes of biotechnology. Long-term goals of the study of biocomplexity sound like science fiction, but include limb and organ regeneration, self-assembly of nanomachines, and directed repair of damaged ecosystems.

Some faculty and students affiliated with the Center for the Study of Biocomplexity, from left to right:

Scott Christley
Gennady Margolin, Postdoctoral Associate
Richard Gejji
Dustin VonHandorf
Trevor Cickovski
Matt Rissler
Ivan Gregoretti
Olga Sozinova, Postdoctoral Associate
Mark Alber, Notre Dame Chair in Applied Mathematics
Jesús A. Izaguirre, Associate Professor of Computer Science and Engineering
Tanya Kazakova
Bei Hu, Professor of Mathematics
Nan Chen, Postdoctoral Associate
Fang Qi
Jianfeng Zhu
Yilin Wu

Current research of the ICSB is focused on the basic science that will build toward more long-term goals in the future. Ongoing center-associated projects include, amongst others, study of pattern formation in developing limbs, growth and behavior of bacterial colonies, bone mechanics (relevant to problems such as fractures and osteoporosis), and biological networks.

For example, Alber's group is working on developing computational models of myxobacteria, a soil-born bacteria that has the unusual ability to work together to form so-called fruiting bodies when nutrients become scarce. Alber and his coworkers study formation of these fruiting bodies because this simple process shares many similarities with development of more complex organisms like humans. Alber, together with Stanford University biochemist Dale Kaiser, has produced a computational model describing how theses bacteria interact to form streams, large aggregates,

traveling waves, and eventually fruiting bodies containing 100,000 spore cells.

"You can actually watch this happening," Alber said as he ran a movie showing a stream of myxobacteria moving train-like in a culture. By means of these "in silica experiments," Alber was able to show that this process conforms to certain rules that likely hold for other forms of pattern formation in biology, including processes like wound healing. These predictions are now being tested in living systems by his collaborating scientists at Stanford.

Associate Director Goodson is collaborating with Alber on a project funded by the National Institutes of Health. They are working on a computational model of how the microtubule network (basically, a system of train tracks on which intracellular cargo is moved and distributed) assembles itself. This work lays the foundation for understanding more complex systems like the "mitotic spindle," the self-assembled machine that pulls apart the chromosomes when a cell divides. Although the subject of this work is cell biology, the implications are broader: "As nanotechnology moves into biological systems, understanding processes such as self-assembly and pattern formation will be very important, especially when engineers begin building biologically inspired nanomachines," Goodson said.

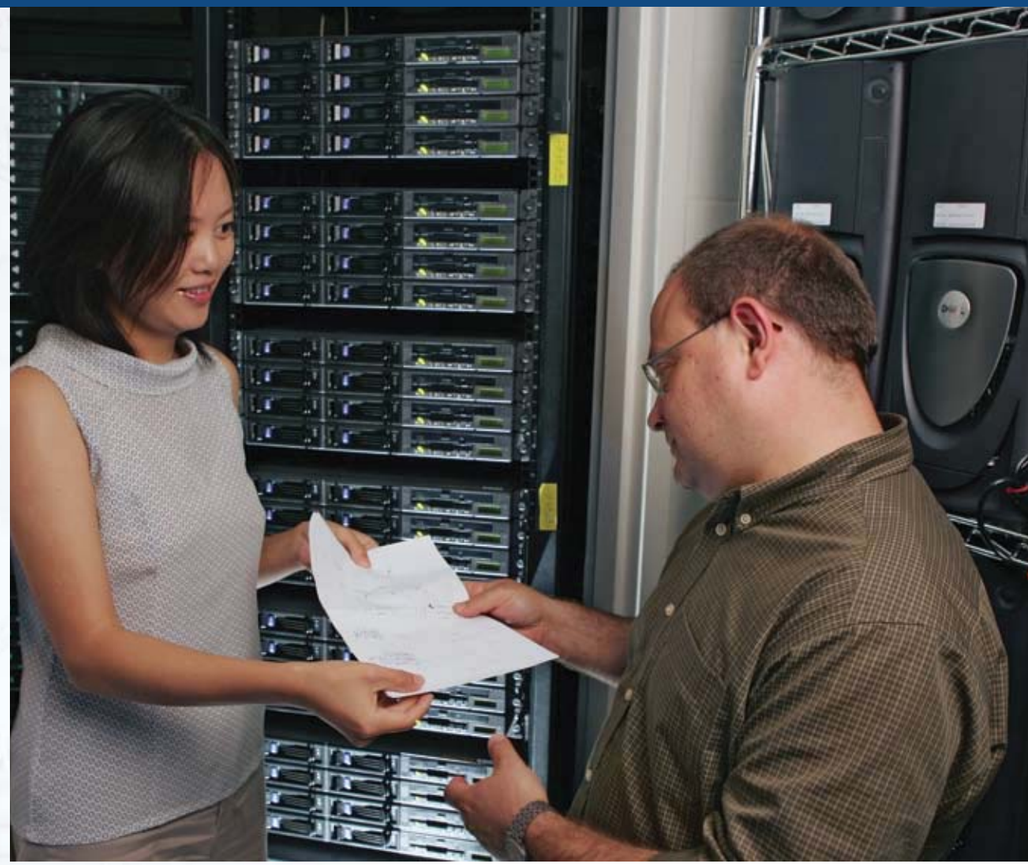
The ICSB has its origin in a long-term collaboration between Alber and Jesus Izuguire, associate professor of computer science, and their colleagues from Indiana University Bloomington, Emory University, Medical College of New York, and University of Missouri-Columbia to study chick limb development. These scientists saw the need for a catalyst to encourage collaboration between physics scientists, mathematicians, computational scientists, and biologists.

Coincidently, it was about this same time that Albert-László Barabási had turned his attention toward biological networks. Barabási, the Emil T. Hoffman Professor of Physics and member of the ISCB executive committee, had already achieved international fame for his description of the Internet as an ordered network. His network theory describes how the seemingly chaotic and random are in fact complex systems that have order and that follow simple rules and laws.

Having turned his attention to biological systems, Barabási set out to show that all the pieces of the human genome and the proteins it encodes can be described as a vast network of connections, or an architecture, that follows mathematical principles. Soon thereafter, Barabási joined the newly-formed ICSB. "Not surprisingly," Barabási points out, "the development of the center was just another example of the formation of a network."

The ICSB now includes over 50 scientists from eight departments in Notre Dame's schools of science and engineering. The Center's latest conference in October 2005 on Notre Dame campus drew 150 mathematicians, experimental and theoretical biologists, physicists, chemists, bioengineers, and computer scientists from United States, Canada, and Europe. It was held in collaboration with Los Alamos National Laboratory.

Development of complex living organisms, such as the formation of chicken embryonic tissues, left, can be simulated and described by sophisticated mathematical models using the latest computer technology.



Explaining and predicting the complex patterns and organization that arise in the development of living organisms is one of the goals of the Mathematical and Computational Biology Group at Notre Dame. Advances in computational capabilities such as BoB (Notre Dame's "Bunch-o-Boxes" Beowulf cluster) enable Notre Dame scientists to explain phenomena in the most intricate of detail.

The ICSB's educational goal is to help to train students who, regardless of their home department, are equally comfortable with the languages of developmental and cell biology, molecular biology, computer science, mathematics, and physics. The center meets these educational objectives by revising both the graduate and undergraduate curricula to include a broader range of existing departmental courses and by developing new explicitly interdisciplinary courses. The ICSB provides research opportunities in biocomplexity at both graduate and undergraduate levels and supports the short- and long-term visits of the Notre Dame students to other major institutions and programs, and the short- and long-term visits by members at other institutions to Notre Dame.

Alber and Goodson also point out that the ICSB will have a natural fit with the new GLOBES (Global Linkages of Biology, the Environment, and Society) initiative on campus (see page 17). Also an interdisciplinary program, GLOBES began last year with a mission to provide Notre Dame students with the training and technical tools they need to solve pressing environmental health-related world problems in a socially responsible and ethical way.

With the founding of the ICSB, Notre Dame established itself at the leading edge of a national movement to study complex biological systems. Harvard University recently started a new Department of Systems Biology, and similar centers are being founded at universities around the country.

NMR Technology Reaches New Summit

A new nuclear magnetic resonance spectrometer will allow Notre Dame scientists to perform high-resolution experiments in ways that were unthinkable just five years ago.

Carrying a huge wooden crate and the future of biological and biochemical research on campus, a loaded flatbed trailer pulled next to the Stepan Hall of Chemistry last July.

Inside the massive wooden crate laid a carefully protected 800 Nuclear Magnet Resonance (NMR) spectrometer that represented the most advanced analytical instrument in chemistry and biology today. Its arrival signaled a new chapter. A technique developed 50 years ago, NMR spectroscopy is based on the fact that nuclei of atoms have magnetic properties that can be utilized to yield chemical information. It has become the preeminent technique that allows chemists and biochemists to determine with great detail the structure of the chemicals they are synthesizing or isolating.

Jeff Peng, assistant professor of chemistry and biochemistry, and Jaroslav Zajicek, professional specialist in chemistry and biochemistry, supervised the unloading of the 800 NMR as if they were taking delivery of the latest model Corvette. In many respects, the 800 is as much of a high-performance machine as a 'Vette. "In order to be top-notch research university, you have to stay competitive with the big boys and have access to the sensitivity available at higher magnetic fields… that way you can attack larger, more biologically interesting molecules. The 800 will allow us to do just that," Peng said.

Many people are aware of a derivative of NMR technology called the MRI (Magnetic Resonance Image). With an MRI, medical radiologists are able to peer deep within the human body in a noninvasive way and obtain high-resolution images of soft tissue.

Jeff Peng, Assistant Professor of Chemistry and Biochemistry

A highly versatile technology, NMR spectroscopy is used throughout chemistry, physics, and biology to reveal molecular structure and dynamics at atomic resolution. NMR is especially useful because it is noninvasive. Samples are not destroyed during the process as in mass spectroscopy. Additionally, NMR relies on natural properties of atomic nuclei (their "spin") to report on the microenvironments of molecules. This contrasts with other methods, such as fluorescence spectroscopy, that require attachment of artificial probes. Finally, NMR methods are applicable in both the liquid and solid state. The latter capability is especially useful for samples that are insoluble and resist crystallization. Following an NMR analysis, the raw data are then combined with computational chemistry methods to translate spectral data into three-dimensional images of molecular structure and dynamics.

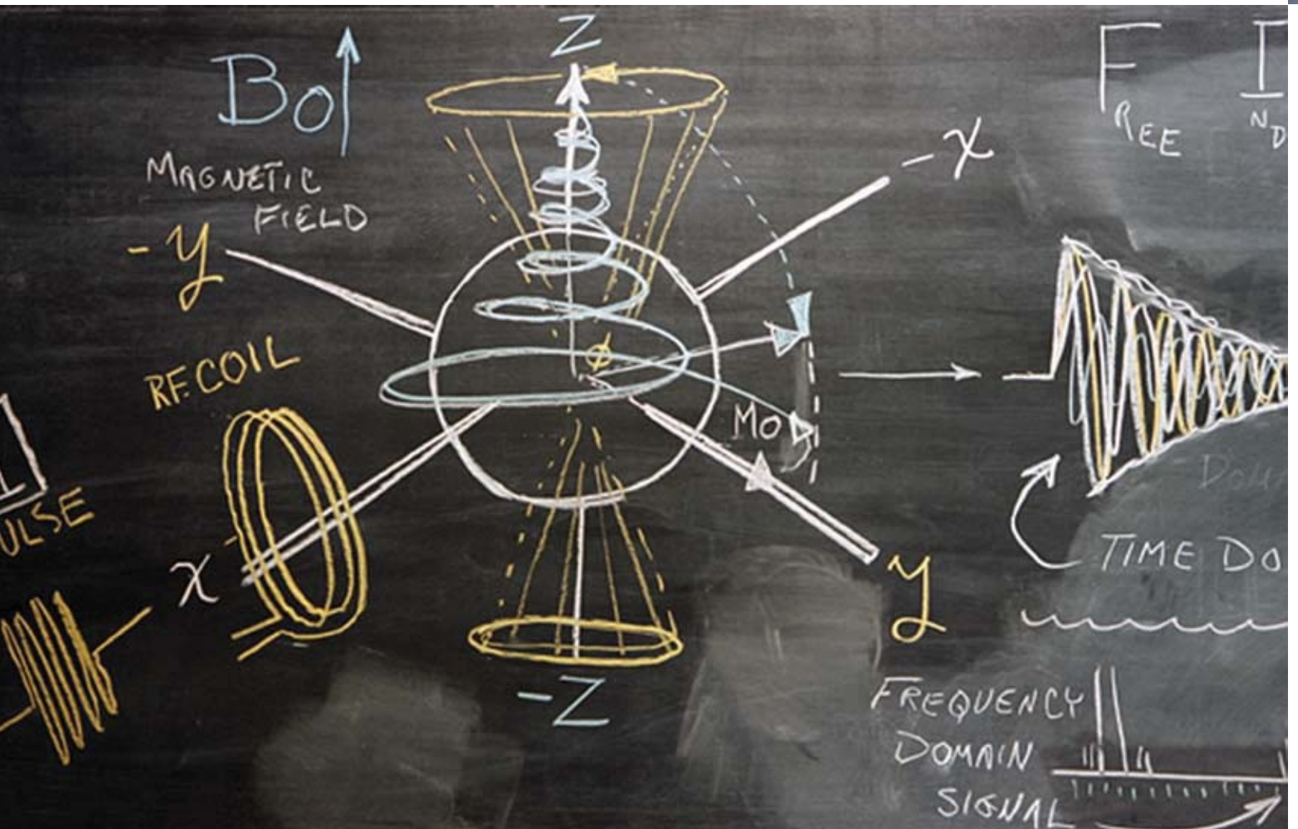
Nuclear magnetic resonance refers to the ability of atomic nuclei to reorient in a static magnetic field when exposed to another time-varying magnetic field that vibrates or oscillates at a particular "resonant" frequency in the radio band.

Most atomic nuclei possess a natural property called "spin." It is not rigorously correct to think of a nucleus as really spinning about some internal axis. Nevertheless, the effect of the "spin" is that the nucleus behaves as a magnetic "dipole moment"—a tiny bar magnet. This means that in an NMR magnet, the tiny nuclear bar magnets tend to align themselves preferentially in a particular orientation, while also undergoing spinning motions similar to the gyroscopic precessions of bicycle wheels or spinning tops under an external torque. Because of this, people refer to the tiny nuclear bar magnets as simply nuclear spins. When we do NMR experiments, we use radio-frequency pulses to cause the nuclear spins to "dance" in certain ways. In this sense, NMR experiments are really just specific choreographs for the nuclear spins. The experiments cause them to undergo particular "gymnastics" that reveal the desired molecular information.

Professor of chemistry and biochemistry Paul Helquist said the arrival of the 800—and the 700 MHz NMR before it—represent the culmination of an initiative by the College of Science in 1992 to move Notre Dame into the forefront of NMR research as related to the life sciences.

The decision to purchase both the 700 and the 800 also required construction of a new addition to the Stepan Hall of Chemistry to provide the necessary facilities. That came in 1996.

Helquist was elated with the arrival of the 800. "We by far have the finest overall combined facility in the state of Indiana and one of the very finest in the Midwest," Helquist said.



The new 800 NMR also required hiring somebody with the experience to realize its full potential. Before becoming a key player in Notre Dame's NMR operations in 2003, Peng had been the facilities manager for 10 years at Vertex Pharmaceuticals, Inc., where he had worked on the world's second 800. "I knew how that system worked, how to implement the latest multi-dimensional experiments, and develop new ones," Peng said. "But I had a stronger interest in developing and applying NMR for basic research in biological physics. So that's a key reason why I moved to academia," he said.

Notre Dame's 700 NMR was adequate to analyze smaller proteins up to the 60,000 Dalton range. "But therapeutically interesting protein molecules are typically larger. Also, there is increasing interest these days in studying large multi-protein complexes. So unless you have access to an 800 you are limited in your ability to do cutting edge research," Peng said. "Having an 800 on campus is a huge advantage for our chemists and biologists. With its higher field strength, the 800

What Exactly Does the 800 Do?

Many drug targets are proteins—essentially molecular machines that mediate the chemical processes that maintain life. Protein function depends on its 3-dimensional structure.

However, knowing the structure is only part of the battle. Proteins have moving parts—their structures change in time—they are dynamic. So a new challenge for researchers at Notre Dame is to understand how protein dynamics affect its function.

New instruments, like the 800 NMR, give Notre Dame investigators a window into those dynamics at the atomic level. The dynamic information from NMR will help reveal motions underlying the function of medically relevant proteins and thus generate new ideas for designing small molecule drugs that can target them. An example is ongoing work with the cancer-related protein enzyme called Pin1.

The function of Pin1 is to regulate other proteins that control cell division. The regulation consists of Pin1 binding to its target protein and accelerating (catalyzing) the change of specific peptide bonds within the target between the *cis* (U shape) and *trans* (zig-zag) forms. This acceleration leads to biochemical signals crucial for proper cell division.

In cancer cells, Pin1 is present in abnormally high levels. However, when Pin1 is blocked, cell division ceases. This has stimulated general interest in Pin1 as an anti-cancer target. Specifically, designing small molecules that can inhibit Pin1 may provide a new way for knocking out rapidly dividing cancer cells.

To pursue this idea, scientists need to understand how Pin1 recognizes its natural targets at the atomic level. This means identifying the structure and dynamics of Pin1. The structure of Pin1 has been resolved in other laboratories.

Notre Dame researchers are now moving on to the next stage to understand how the dynamics of Pin1 affect its function. They now use the new NMR spectrometers to study how the atomic-level motions of Pin1 in the presence and absence of small molecules mimic Pin1's natural protein targets. The NMR experiments allows us to (a) identify the Pin1 motions necessary for interacting with its targets; (b) estimate the size of those motions; and (c) estimate how fast those motions occur.

By analyzing Pin1's motions for a series of small molecules, they will learn how Pin1's dynamics enable it to work. Key questions they have are: (1) what motions are critical for Pin1's catalytic function? (2) why does Pin1 bind better to some proteins than others? (3) how flexible should one make the small molecules to achieve optimal inhibition of Pin1?

The NMR 800, shown here encased in its yellow scaffolding, dwarfs its predecessor on the right, the NMR 700.

Students using the new NMR 800 work on different aspects of this problem. Some focus on the motions of the protein, while others focus on motions of the small molecules that bind to Pin1. In addition to NMR spectroscopy, the students conduct protein expression, purification, enzyme assays, and molecular dynamics simulations. As such, the lab lies at the interface of physics and biology. Such interdisciplinary research is critical for making advances in 21st-century biomedical science.

Graduate student Gabi Pasat prepares to insert a sample into the 800 NMR.

will allow our scientists to examine molecular structure and dynamics to an extent not possible at lower fields," he said.

Future experiments will look at the dynamics of large molecular machines.

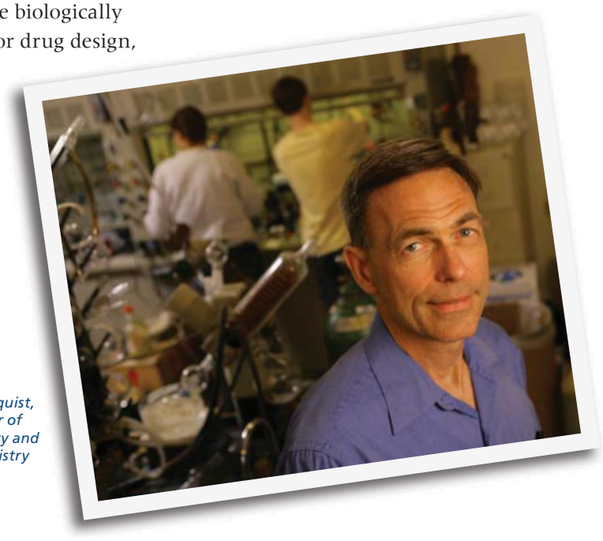
"Nuclear spin is like having a little spy on each atom. If we interrogate it the right way—if we do the right experiment—the spin will tell us what is happening at its local neighborhood inside the molecule," Peng said. "It can show us local changes right at that atom as a consequence of drug binding, or as consequence of some change in the protein, maybe from a mutation. It will illuminate the local structure around that atom, and how that structure fluctuates in time. Multi-dimensional NMR methods give us that information for the entire protein, and an understanding of how molecular structure and flexibility influence molecular function." In essence, current NMR methods on the 800 will enable Notre Dame scientists to construct a comprehensive picture of how a molecule, particularly a protein, behaves and how it carries out its function.

"If someone synthesizes a small molecule that has antibiotic activity, we can look at that molecule in the presence of the protein that it is supposed to bind to. Now we will be able to see what changes occur both in terms of structure and dynamics. A chemist will examine those changes at the atomic level, and he or she will be able to modify the molecule to make it better as an antibiotic."

> *The arrival of the 800 MHz NMR…will move Notre Dame into the forefront of NMR research in the life sciences.*
>
> *-Paul Helquist, Professor of Chemistry and Biochemistry*

Projects involving cell cycle division in relationship to cancer, for instance, will enable Notre Dame collaborators to take a giant leap ahead. Being able to look at larger biological molecules will enable them to address more biologically relevant systems. "For drug design, proteins are one-half of the equation. The other half of the equation are ligands that bind to them," Peng said. "A lot of NMR experiments use spin isotopes of low natural abundance, so you end up having to isotope-enrich the samples. This is done routinely for proteins using molecular biology methods. But for drug-like ligands, isotope enrichment is extremely expensive because they're usually synthesized. With the enhanced sensitivity of higher field and cryogenically cooled probes, it becomes less critical to label or isotopically enrich the ligands. You can get decent signal without enrichment."

The 800 NMR's high field and cryogenically cooled probes will allow Notre Dame scientists to perform high-resolution experiments in ways that were unthinkable just five years ago. "The facility will be a great boon for Notre Dame's research in chemistry, biochemistry, and biological physics," Peng said.



Paul Helquist, Professor of Chemistry and Biochemistry

Of Mice and Men

A white van backed up to the new Ernestine Raclin and O.C. Carmichael Jr. Hall, home of the W. M. Keck Center for Transgene Research, in late February carrying some very interesting mice—sentinel mice.

These rather plain looking white mice have lived extraordinary lives in that their well-fed bodies have never been host to any kind of bacteria, virus, or parasite that could do them harm.

With great care, a Notre Dame crew, employees of the Friemann Life Science Center, carried their sealed crates to the Transgene Center's spotless new animal facility while always making sure that these special mice would never breathe the ordinary air that people breathe.

These 20 sentinel animals took up residence in their disinfected quarters as the proverbial canaries in a mineshaft. If they took ill anytime in their four-week stay in March, then something would be terribly amiss in the basement and would need immediate repair. But if they continued to live their charmed and happy lives during that period, then Dr. Mark A. Suckow, DVM would have the assurance that he would be safe to bring on the next wave of mice, 12,000 in all, whose health was the real purpose behind the whole exercise.

The Keck's colonies of transgenic mice that are specially bred for research purposes have been housed in the Freimann Life Science Center in Galvin Hall since the inception of the center. But with the opening in the Autumn of 2005 of Raclin-Carmichael Hall at Notre Dame Avenue and Angela Boulevard, it was only a matter of time before the highly valuable Keck mice would be transferred to their new quarters.

The new Keck Transgene Center facilitates communication among the 40 people involved with the center.

"We had to be ultra-cautious with our research mice, and for a good reason," Suckow said after the sentinel mice had left the animal facility. "If the mice had become sick with mouse hepatitis or mouse parvovirus it would skew research results and invalidate all the work of our researchers."

Many of those mice were specifically bred with altered genes to be susceptible to diseases like cancer. So Suckow carefully mapped out this move for over a year. Starting on that grey day in February, all his careful orchestration paid off.

And the researchers themselves? Well, they had no problems moving from Stepan Chemistry Hall into the new facility even if they didn't get the same VIP treatment as the sentinel mice.

"The move went extremely well," said Vicky Ploplis, associate director of the Keck Center. "The movers came in and transferred everything that was marked to go and in about two weeks we were up and running. So we had very little down time."

The Keck Center is located on the second floor of Raclin-Carmichael Hall while the first floor of the 68,000-square-foot facility is home to the medical education programs of the Indiana University School of Medicine, that had been tucked away for 34 years in the cramped environs in the basement of Haggar Hall. Both Notre Dame and IU split the cost of the $19 million building.

There is a certain comfort about moving into a brand new building, but it's not just about cushy new chairs, observed Francis J. Castellino, Keck Transgene Center director and Kleiderer/Pezold Professor of Biochemistry. It's the comfort that comes with ease of interpersonal communication among the 40 people involved with the center.

A five-viewing port microscope serves as a teaching tool in histology.

"I would say the biggest advantage of the new Transgene Center for us is that we are now all together," he said. "We were spread out on various floors at Stepan. Now we can walk down a hall and bump into people who have the interests that focus around a central theme of research."

"We obviously gained in terms of decent lab space, but not as much as you might think," he continued. "But what we really gain is having habitable office space for everybody.

So it's good for morale. It's good for privacy. It's good for fostering interactions. And this just makes people feel a little better about coming in and doing things. We now have the ability to schedule meetings without hunting for a room and we have all of our equipment here rather than being scattered on several floors of Stepan Science Hall."

Castellino said the shift to the Raclin-Carmichael Hall means that he will have an easier time pursuing his primary area of research and that is the relationship between blood coagulation and inflammation, and ultimately many specific disease states.

"Whenever you have inflammation, you have the potential for blood to clot, and vice versa. There is a cross-talk with inflammation and blood clotting," he said launching into a description of his area of expertise. "Throughout medical literature you see that many diseases basically begin with an inflammation and this is a theme of today's popular press in medicine. So if you have chronic inflammation, you have a very good chance of diseases, such as cancer, emerging."

Specifically, one area of current interest in Castellino's group is to study the underlying gene interactions in sepsis, an infection that can spiral out of control with potential systemic inflammation, disseminated intravascular coagulation, organ failure, and death, especially in patients with compromised immune systems.

Sepsis kills over one million people a year in the United States and Castellino is convinced that the number of these tragic deaths can be greatly reduced with new therapies that get to the genetic root of the problem.

Ploplis, meanwhile, is investigating the genetic basis for colon cancer under the same NIH grant using Notre Dame's colony of genetically altered mice. These mice are predisposed to develop intestinal polyps and also carry deficiencies in genes that are involved in hemostasis, or the regulation of bleeding.

There is a relationship between a defective gene and the process by which benign polyps become cancerous and Ploplis feels that great strides have been made in identifying and understanding the complex systems by which a genetic abnormality cascades out of control and into cancer.

Another senior investigator, Notre Dame chemist Mary Prorok, studies structure-function relationships in neuroactive peptides and how certain peptides might have therapeutic potential in treating neurological diseases such as Parkinson's Disease and dementia, including Alzheimer's Disease.

She is particularly interested in naturally occurring peptides that interact with a receptor in the brain associated with neurodegeneration, "so it has very broad potential," she said. "We stumbled on that accidentally. So what it means we don't know. But we have made great strides in understanding how changes in these peptides affect their ability to interact with the receptor."

The first floor of Raclin-Carmichael Hall is where one can find Dr. Rudolph M. Navari, the new director of the IU School of Medicine-South Bend where about 35 IU medical students receive their first two years of medical school education.

"The new building is a great leap forward. It will allow us to interact with the Notre Dame researchers much more easily," said Navari, who also serves as director of Notre Dame's Walther Cancer Research Center.

"Our 250-seat auditorium is where national and international experts can address subjects of interest to university students, faculty, medical professionals, and the general public," he said.

"We have 17 students per class and we have the capacity to go up to 50 students, in anticipation of a doctor shortage soon," Navari said as he walked past a classroom full of students.

Raclin-Carmichael Hall itself is designed for expansion. Navari is looking forward to the day when another wing is added to the building's east corner to double the area for research.

"It was in the original design. But the building was downsized just to see where we were going," he said adding that Notre Dame and IU may be moving to add the new wing in just the next three to five years."

This capability will work to both the advantage of Notre Dame and Indiana University as more cancer investigators are brought on board.

The ART of an Attractive Website

www.science.nd.edu

an interview with Web Designer Cheryl Kelly

***Q** What is your objective in redesigning the College of Science site?*

My main objective is to make people aware of the great advances in research and education here in the College of Science. The type of research the college produces is so cutting edge. From cancer research to identifying new extrasolor planets to re-engineering the DNA of mosquitoes in order to decrease the spread of infectious disease, we will be involved in significant breakthroughs that will benefit humanity.

***Q** What is new on the website?*

The website is more vibrant, engaging, and interactive. The newsroom, resources, career discovery, and combined college calendar are completely new. Because the primary target audience is undergraduate students who are or will be majoring in science as well as prospective students, the website features dynamic, multimedia video interviews of current Notre Dame science students, faculty, and alumni that appeal to this digital generation. What better way of presenting our message to prospective science students than for them to hear the excitement in the voices of our leading researchers and successful students to envision where a University of Notre Dame science degree can take them.

***Q** How is the link structure set up?*

We will have four main college highlights—students, alumni, research, and an events calendar—that will appear on the front page and will change frequently. The "What's Happening" section will allow students and visitors to view a list of upcoming conferences, colloquia, and lectures that are open to the public. Subsections of the website will include department profiles, information about our facilities, research centers, and institutes; career discovery; press releases; an archive of the video interviews; and resources that are available for undergraduates, graduates, families, faculty, and staff.

***Q** How often will the website be updated?*

As often as humanly possible! The college's newly formed communications team keeps track of current research, press releases, department events, awards, and grants. Having consistent inter-departmental dialogue is critical, and I will rely heavily on this team of professionals to make sure that the content for the website is current and presented in a way that is fresh, interesting, and easy to understand. Our Web advisory committee members represent each department, provide direction on the look and feel of the site, and will routinely submit the latest information from their departments.

***Q** Will the College of Science department websites be upgraded? Will they be similar?*

Now that the new college site is launched, I plan to turn my attention to other department sites, then to our centers and individual laboratories, so there will be a consistent look and feel throughout the College of Science website. Each department has its own strength and personality. The key is to highlight that individualism and still visually connect them to the College of Science. My role is to design and manage the consistency and navigation for the departments while the departments manage the content for their areas, keeping the information timely, relevant, and interesting.

Standing Ovations

Ani Aprahamian Appointed to DOE/NSF Nuclear Science Advisory Committee

Physicist Ani Aprahamian was just appointed to be a member of the DOE/NSF Nuclear Science Advisory Committee for a term of two years through 2007. The committee provides advice and recommendations on scientific, technical, and programmatic issues relating to the nuclear physics program of the US Department of Energy and the National Science Foundation. Prof. Aprahamian is asked to provide her expertise in the field of nuclear science.

Ikaros Bigi

Ikaros Bigi was recently appointed Grace-Rupley II Professor of Physics. A member of the Notre Dame faculty since 1988, Prof. Bigi focuses his research primarily on the development of theoretical ideas that lead to novel experimental searches for new forces beyond the standard model of high energy physics. He was the corecipient of the American Physical Society's 2004 J.J. Sakurai Prize, which is awarded annually to recognize and encourage outstanding achievement in particle theory. He was cited for pioneering theoretical insights that pointed the way to the very fruitful experimental study of CP violation in B decays, and for continuing contributions to the field of CP and heavy flavor physics.

The Grape-Rupley II Chair in Physics honors Joseph Grace and Allen Rupley, both former chairmen of the board of W.R. Grace & Co.

Anna Goussiou

Physics professor Anna Goussiou received the prestigious 2005 National Science Foundation Award in Physics for a research program aimed at discovering the mechanism responsible for electroweak symmetry breaking and the origin of mass. This constitutes one of the most important open questions, and therefore highest priorities, in particle physics today. Prof. Goussiou is currently pursuing her research at the Tevatron proton-antiproton collider at Fermilab, and will continue at the proton-proton Large Hadron Collider (LHC) at CERN. The Faculty Early Career Development (CAREER) Program is a Foundation-wide activity that offers the National Science Foundation's most prestigious awards in support of the early career-development activities of those teacher-scholars who most effectively integrate research and education within the context of the mission of their organization. The award provides research support for five years.

Jessica Hellmann

Biologist Jessica Hellmann recently received a 2006 Career Enhancement Fellowship for Junior Faculty. This award is funded by the Andrew W. Mellow Foundation and is administered by the Woodrow Wilson National Fellowship Foundation. The award is granted to 20 individuals per year from applications across science, social science, and the humanities. The purpose of the fellowship is to assist "talented junior faculty to pursue scholarly research and writing during the fellowship year." The fellowship period is June 2006 through June 2007.

Founded in 1945, the Woodrow Wilson National Fellowship Foundation is an independent, nonprofit organization dedicated to the encouragement of excellence in education through the identification of critical needs and the development of effective national programs to address them. This combination of analysis and translation into action is the foundation's unique contribution.

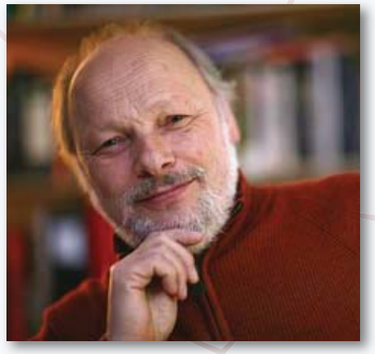
Air Force Institute of Technology honors Anthony Hyder

Anthony K. Hyder, associate vice president for graduate studies and research and professor of physics, has received the Air Force Institute of Technology (AFIT) Distinguished Alumnus title. A 1962 graduate of Notre Dame, Prof. Hyder earned his master's and doctoral degrees in physics from AFIT in 1964 and 1971, respectively. He taught at Auburn University and served as its associate vice president for research before joining the Notre Dame faculty in 1991 and assuming his current position in 1993. Prof. Hyder's research largely concerns the interaction of spacecraft with the space environment and his recent work has focused on the design of spacecraft systems.

The title is the highest honor the AFIT awards to its alumni, only 23 of whom have received it since it was first conferred in 1979. Previous recipients include Col. Frank Borman, the astronaut, and Gen. Jimmy Doolittle, the aviation pioneer and World War II hero.

Wiescher Appointed to Rare Isotope Science Assessment Committee

Michael Wiescher, Freimann Professor of Physics and director of the Joint Institute of Nuclear Astrophysics (JINA), has been appointed by the National Research Council of the National Academies to serve on the Rare Isotope Science Assessment Committee (RISAC). RISAC will assess the science agenda for the Rare Isotope Accelerator (RIA), which has been proposed as the highest funding priority for the US nuclear physics community. The objectives of RIA include measuring nuclear cross sections relevant to processes in stars and supernovas as well as studying nuclear structure effects in nuclei far from stability. Some of the cross sections may be useful in science-based stockpile stewardship.



GRADUATE STUDENT ACCOLADES

Kathryn Armstrong recognized for research in biocalorimetry

Kathryn Armstrong, a third-year graduate student in the laboratory of chemist Brian Baker, received a cash prize for oustanding research accomplishments in the field of biocalorimetry. Kathryn received her award at the 2005 Biocalorimetry Conference, held during July in Boston, Mass. Armstrong's research is on the physical mechanisms T cell receptors use to recognize their ligand. Most recently, her focus has been on using isothermal titration calorimetry to gain insight into the thermodynamic basis for recognition. Her award specifically recognized the technical complexity and detail of her experiments.

Katie Hull wins a Ludo Frevel crystallography scholarship

Katie Hull, a graduate student in the laboratory of chemist Kenneth W. Henderson, has been awarded a prestigious Ludo Frevel crystallography scholarship for 2006. This award supports the education and research program of promising graduate students in crystallography-related fields. The International Centre for Diffraction Data chooses the recipients of the award.

In Memorium

Hubert J.P. Schoemaker

One of Notre Dame's most distinguished alumni, Hubert J.P. Schoemaker, 55, died on Jan. 1 after an 11-year illness at his home in Paoli, Pa.

Schoemaker was a successful pioneer in biomedical research who founded Centocor, one of the nation's first biotechnology companies. He graduated from Notre Dame in 1972 as a chemistry major. Those who knew Schoemaker remember him as an exceptional athlete, an enthusiastic lover of music and the arts, a warm and engaging personality, and a man of deep religious faith. Born in the Netherlands, he was an all-European soccer player and later became a junior Davis Cup tennis player.

Schoemaker's achievements are remarkable. He founded Centocor in 1979 with a desire to use the new tools of medical research to help millions. And he succeeded. In 1994 Centocor produced *Reopro*, an anti-clotting drug that reduces heart attacks. Four years later, the company produced *Remicade*, a blockbuster drug that treats Crohn's disease and rheumatoid arthritis. It became one of the best-selling drugs ever produced by the biotechnology industry.

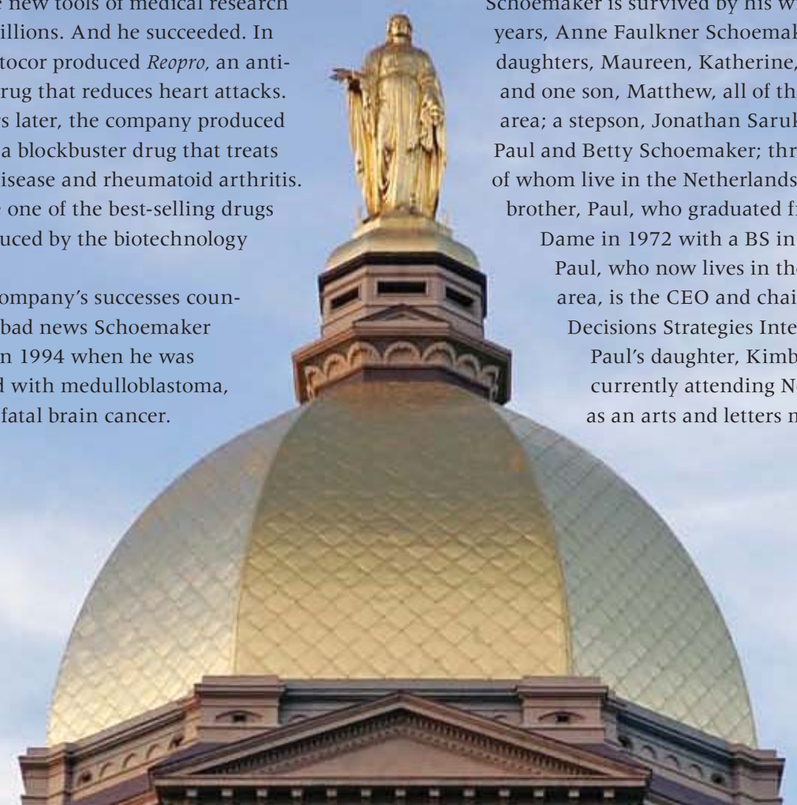
The company's successes countered the bad news Schoemaker received in 1994 when he was diagnosed with medulloblastoma, a usually fatal brain cancer. Doctors told him he had a year to live. But Schoemaker pressed on.

When he sold Centocor to Johnson & Johnson in 1999, Schoemaker could have chosen to spend the rest of his life with his disease as his central focus. Instead, he founded Neuronyx, a company that uses breakthrough science employing adult stem cells to help treat people with Alzheimer's Disease and Parkinson Disease.

Pennsylvania Bio, the trade group representing the state's biotechnology industry, awarded Schoemaker its first lifetime achievement award.

Schoemaker is survived by his wife of nine years, Anne Faulkner Schoemaker; three daughters, Maureen, Katherine, and Anne; and one son, Matthew, all of the Philadelphia area; a stepson, Jonathan Saruk; his parents, Paul and Betty Schoemaker; three sisters, all of whom live in the Netherlands; and one brother, Paul, who graduated from Notre Dame in 1972 with a BS in physics.

Paul, who now lives in the Philadelphia area, is the CEO and chairman of Decisions Strategies International. Paul's daughter, Kimberly, is currently attending Notre Dame as an arts and letters major.



UNIVERSITY OF NOTRE DAME
College of Science

NASA names Notre Dame official site
of Hubble photo unveiling

Photo courtesy of NASA

NASA has designated the University of Notre Dame as one of 50 official national sites to receive and display a photo print of the starbust galaxy Messier 82 (M82), taken by the Hubble Space Telescope and made in celebration of the 16th anniversary of its launch. The print will become part of a permanent science display in the Jordan Hall of Science.

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