
The Journal of the University of Notre Dame College of Science

Summer 2005, Volume 2, Number 1

Renaissance



Better Vision with Double Vision

New telescope technology promises astrophysicists an unprecedented view of the universe.

Mosquito Makeover

New research at Notre Dame may yield a transgenic approach to halting the spread of mosquito-borne viruses.

Hurley Hall



Nieuwland Science Hall

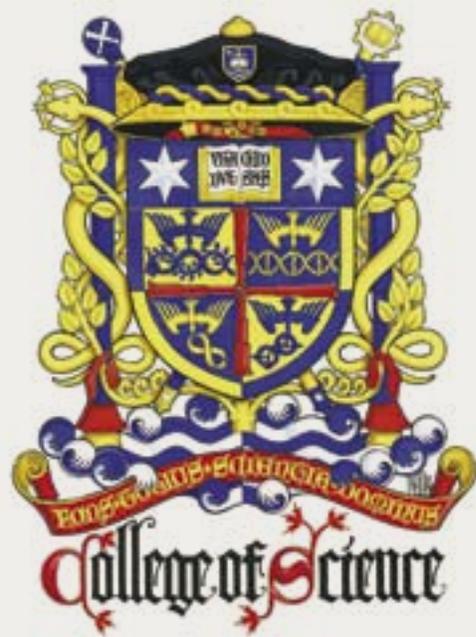


Galvin Life Science Center



Stepan Chemistry Hall

Front cover image: Sitting atop Arizona's Mount Graham (elevation 10,700 feet) the Large Binocular Telescope will offer Notre Dame astrophysicists unprecedented access to the world's most powerful optical telescope. Scientific operations are scheduled to begin late this year. The LBT's 165-foot enclosure is aluminum colored that will enable it to reflect the prevailing colors of the sky.



UNIVERSITY OF NOTRE DAME
College of Science



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SPOTLIGHT ON THE COLLEGE OF SCIENCE



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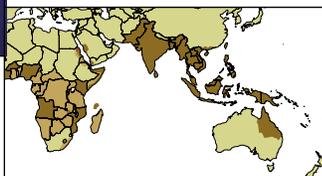
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LETTER FROM THE DEAN

Another academic year has finished with a new graduating class of bright, ambitious future leaders going out into the world. The graduates of the College of Science continue to distinguish themselves in their academic achievements, as well as in their service contributions. In this issue, you will be introduced to our award winners of the graduating class. Faculty members who have received teaching and research awards are also highlighted. As we all recognize, it is the combination of dedicated faculty and outstanding students that makes the Notre Dame education special. In this issue, we also highlight the undergraduate research experience of several of our students in the College of Science. It is our belief that undergraduate research provides one of the richest learning environments for students as they prepare for various careers. The College will continue to maximize the research opportunities for all of its undergraduates.

The 2005 commencement was an exciting and notable event with many distinguished honorary degree recipients from a broad spectrum of society and careers. It was a special commencement for science and medicine, with four recipients of honorary degrees and the Laetare Medal recipient all from the fields of science and medicine. The College continues to work hard at increasing the number of students majoring in science with positive results. Last fall's "science intents" numbered 485 or 25% of the entering class,

which was the largest number in ten years. This fall the number has jumped to 535. We look forward to this trend as we prepare to move into the new Jordan Hall of Science in the summer of 2006.

On the research front, several notable events have emerged. The cover photo of *Renaissance* highlights the dedication of the Large Binocular Telescope in Arizona last fall. Notre Dame is a partner in the consortium responsible for constructing the telescope. As the largest telescope in the world, it will provide Notre Dame astrophysicists with unique opportunities in research. Professor Malcolm (Mac) J. Fraser of our department of biological sciences very recently received a \$2.5 million Grand Challenge grant to combat dengue fever. The five-year research program is titled "Developing Novel Transgenic Strategies for Introducing Dengue virus Refractivity in Mosquito Cells and Tissues." Fraser's grant is one of only ten funded in the US and one of 43 worldwide.

Finally, I wish to report that the new Indiana University School of Medicine-South Bend facility is completed and will be ready for the new class of IU medical students. The Keck Transgene Center will occupy the second floor of the new building this summer. Dr. Rudy Navari, Associate Dean, in our College will be the director of the new facility.

We look forward to hearing from you with news to include in the alumni section of the next issue of *Renaissance*. If you can visit the campus in the next academic year, please stop by and also see the progress on the Jordan Science Hall slated for June, 2006 completion.

Best regards,

A handwritten signature in black ink that reads "Joseph P. Marino". The signature is written in a cursive, flowing style.

Joseph P. Marino
William K. Warren Foundation Dean
College of Science





The Jordan Hall of Science, scheduled for completion in summer 2006, is a 201,783-square-foot building that will contain 40 undergraduate laboratories for biology, chemistry and physics; two 250-seat lecture halls; a 150-seat multimedia lecture hall; two classrooms; 22 faculty offices; offices for preprofessional (pre-med) studies; and a greenhouse, herbarium and observatory.

UNIVERSITY OF NOTRE DAME COMMENCEMENT 2005

honorary degrees

DR. BENJAMIN CARSON

One of the world's leading brain surgeons, Dr. Benjamin Carson, director of the Division of Pediatric Neurosurgery at Johns Hopkins Hospital in Baltimore, Maryland, conducts brain surgery primarily on children and adolescents.

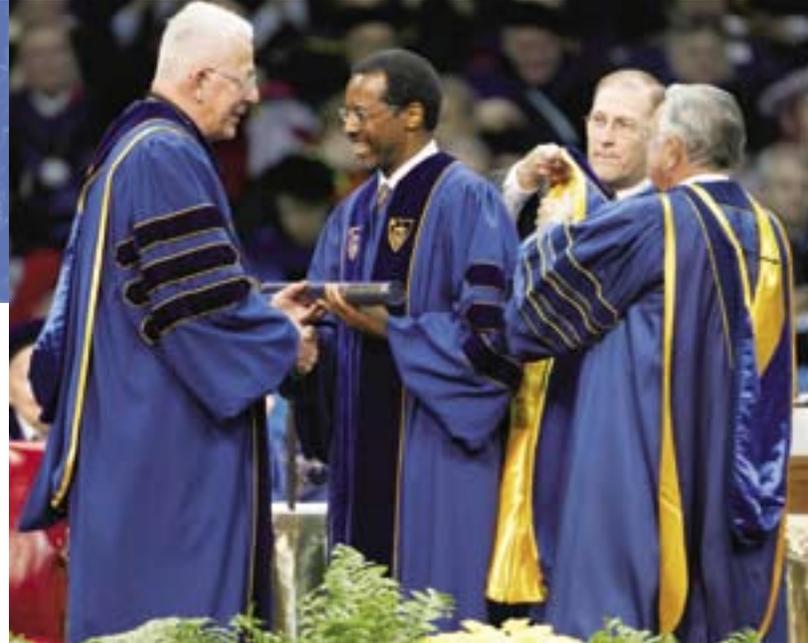
Among his most notable achievements was the separation in 1987 of Siamese twins joined at the back of the head, the first successful completion of such a procedure. The pioneering use of 3-D imagery of the infant boys' brains and skulls enabled Carson to practice "virtual surgery" before the actual operation, thus contributing to its success.

His practice includes traumatic brain injuries, brain and spinal cord tumors, achondroplasia, neurological and congenital disorders, craniosynostosis, epilepsy, and trigeminal neuralgia. His research interests include developing new methods to combat brain tumors; refinement of cranio-facial surgical techniques; and the use of 3-D imaging in preparing for and conducting surgery.

Carson has written over 90 neurosurgical publications and has been awarded 24 honorary degrees and dozens of national citations of merit.

In addition to helping children, Carson helps adults who suffer from trigeminal neuralgia, a nerve disorder that causes extreme facial pain. An under-diagnosed and difficult disorder to treat, he has achieved a 80-90 percent rate of success for the more than 100 adults he treats annually.

National and international audiences have followed his achievements



in separating conjoined twins and performing cerebral hemispherectomies to control debilitating seizures, often brought about by a disease called Rasmussen's Syndrome. Since the 1980s, Carson has refined and developed new approaches to these delicate surgeries, increasing their universal success rates.

He is a member of the board of directors of the Kellogg Company, Costco Wholesale Corporation, Yale Corporation (the governing body of Yale University), and America's Promise, founded by U.S. Secretary of Defense Colin Powell. Additionally, he is president and co-founder, with his wife, of the Carson Scholars Fund, a non-profit corporation that recognizes students in grades four through twelve for superior academic achievement. A widely-read author, he has written three top-selling books about his life, philosophies, and sources of inspiration.

DR. CAROL LALLY SHIELDS

Dr. Carol Lally Shields is a rarity among cancer specialists. She is one of six ocular oncologists in America and she has devoted her career to treating a condition known as retinoblastoma that overwhelmingly strikes children under the age of three.

Long ago, she established a precedent for distinguishing herself. In 1979, in her senior year at Notre Dame, she captained the women's varsity basketball team and later became the first female athlete at Notre Dame to win the Byron Kaneley Award for excellence in academics by a varsity athlete.

Shields and her husband, Dr. Jerry Shields, also an eye cancer specialist, have assumed leading roles in the field. Together, they direct the largest and busiest eye cancer center in the United States, the Ocular Oncology Service of Wills Eye Hospital at Philadelphia's Thomas Jefferson University.

Eye cancer in children is such a rarity that only 250 to 300 children are diagnosed with retinoblastoma each year in the United States. This condition initially manifests as whitening of the pupil (which the doctors call leukocoria).

"Usually, it is the mother or the grandmother who first notice the white pupil. In some instances, they might also detect a crossed eye, indicating that the vision is reduced," she said.

From that point on, events move fast. The parents call their pediatrician who typically ask for an opinion from an eye doctor. Sometimes within hours, Shields will get the call. "The child usually comes to our office the same week that the tumor was discovered. We receive children from all over the United States and even overseas," she said. "Because retinoblastoma is life-threatening, we want to see the children as fast as possible."



While once there was no treatment other than eye removal, progress in the field of ocular oncology has permitted salvage of the patient's life, and now even the eye can be saved. This means that doctors can save a child's eye and possibly even protect the vision if an early diagnosis is made and chemotherapy is employed. Shields has found it rewarding "to specialize in a field where one can make a huge difference in a person's life, especially for young children."

Shields credits her Notre Dame experience in the late 1970s as a guiding influence throughout her career. "I have always felt tremendous pride that I attended the University of Notre Dame. This has given me lifelong confidence in myself and allowed me to achieve my goals," she said. "In addition, Notre Dame provided a sense of spirituality that enabled me to accept personal sacrifices to help others." A mother of a family of seven children, she is well aware that she has had to make compromises in the service of others. "But I don't regret making these sacrifices," she said. "I am fortunate to have the training, desire, and opportunity to serve others as well as my family." Shields is aware of the enormous responsibilities that go along with being pre-eminent in a field with so few specialists. Being a member of the Notre Dame community "has instilled in me a sense of self confidence that my decisions are good ones."

Shields earned her medical degree from the University of Pittsburgh. She is the author or co-author of five textbooks, 700 articles in major journals, and 142 textbook chapters, and she has delivered more than 400 lectures. She has received numerous professional awards, including the prestigious Donders Medal, given by the Netherlands Ophthalmologic Society every five years to an ophthalmologist of world fame and outstanding merit. It is considered one of the most prestigious awards in the field of ophthalmology, and Shields is the first woman to be so honored.

UNIVERSITY OF NOTRE DAME COMMENCEMENT 2005

JOSEPH KELLER

Joseph Keller, professor emeritus at Stanford University, has had a singular influence on the development of applied mathematics and related areas of science and engineering.

As developer of the geometrical theory of diffraction, which describes the propagation of waves, Keller has had a profound effect on the fields of acoustics, elasticity, statistical physics, optics, fluid dynamics, biomathematics and quantum mechanics. His theory is widely used to analyze radar reflection from objects, to calculate elastic wave scattering from flaws in solids, and to study acoustic wave propagation in the ocean.

Keller also formulated the widely used "EBK method" for determining energy levels of atoms and molecules set by quantum mechanics. The technique is also used to solve characteristic values problems in other fields.

Keller, who taught and conducted research at New York University, is the author of nearly 400 scientific publications.

In 1973 he was elected to the National Academy of Sciences and has received numerous prestigious awards for his contributions to the field. Among them are the Wolf Prize, Wolf Foundation, Jerusalem, Israel (1997); the National Academy of Sciences Award in Applied Mathematics and Numerical Analysis (1995); the National Medal of Science (1988); the Timoshenko Medal, American Society of Mechanical Engineers (1984); von Neumann Lecturer, Society of Industrial and Applied Mechanics (1983); the Eringen Medal, Society of Engineering Sciences (1981); the von Karman Prize, Society of Industrial and Applied Mathematics (1979); and, Gibbs Lecturer, American Mathematical Society Scientific Discipline: Applied Mathematical Sciences (1977).



honorary degrees

DR. JOSEPH WALTHER

Dr. Joseph Walther's history of medical philanthropy in Indiana began in 1956 when he chartered as a tax-exempt charitable organization the Winona Memorial Foundation, named in memory of his mother.

An Indianapolis native, he founded Winona Memorial Clinic as his private practice in 1947 and then built the Winona Memorial Hospital, a 278-bed facility that opened in December 1966. After the loss of his wife, Mary Margaret, to colon cancer in 1983, Walther sold Winona Memorial Hospital.

From the proceeds of that sale he began the Walther Cancer Institute in 1985. His mission for the Institute has been to eliminate cancer as a cause of suffering and death. The institute employs leading biomedical and behavioral scientists at various Midwestern universities to vigorously extend the frontiers of cancer research.

The Walther Cancer Institute has gone beyond the traditional ideas that define a research organization. The institute has awarded research funds to Notre Dame beginning in 1998 to unlock the basic mechanisms that govern the formation of cancer.

"The institute and Notre Dame's relationship has initiated exciting research and results," Walther said. "It was a pleasure to participate in Notre Dame's commencement and an honor to be in such distinguished company."

The institute has also distributed research funding to Indiana University School of Medicine, Indiana University-Bloomington, Purdue University, University of Michigan, Michigan State University, The Ohio State University and Duke University.



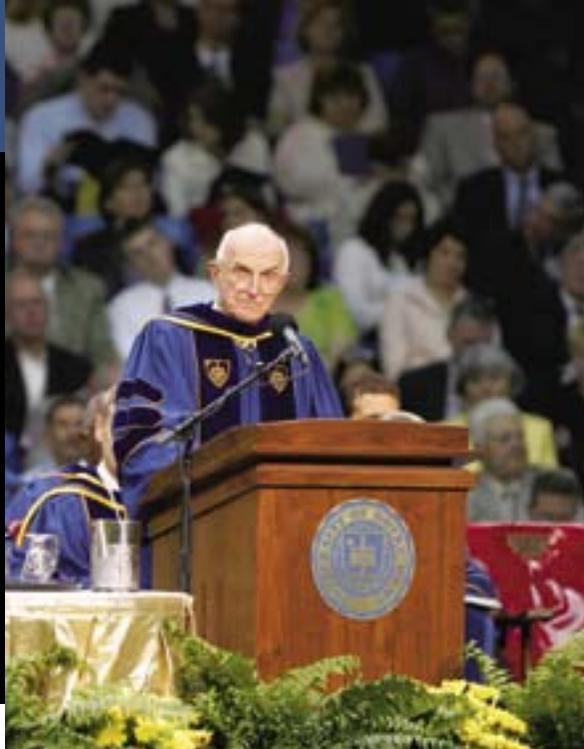
Walther earned his medical degree from Indiana University School of Medicine in 1936. Prior to World War II, he served as a physician for Pan-American Airways on Midway Island and then as a surgeon and physician on the island of Kauai, Hawaii. During World War II, he had a distinguished service record as a US Army Air Force surgeon in the Pacific. He won the Silver Star, Soldier's Medal, Bronze Star and Air Medal and logged over 30 combat missions. He remained active in the Air Force Reserves for 24 years, retiring as a colonel. Walther was one of the first gastroenterologists to use an endoscope in Indianapolis. The endoscope is used to diagnose diseases of the colon. In 2002, the *Indianapolis Business Journal* named him a Health Care Hero.

Walther stepped aside from his duties as president and chief executive officer of the institute in October 2002.

NOBEL LAUREATE RECEIVES LAETARE MEDAL

Dr. Joseph E. Murray, the 1990 Nobel Laureate who performed the first successful organ transplant 51 years ago, received the 2005 Laetare Medal, the highest honor given by the University. Established in 1883, the Laetare Medal is the oldest and most prestigious honor given to American Catholics.





Born April 1, 1919, in Milford, Mass., Murray received his medical degree from Harvard Medical School in 1943 after being graduated from the College of the Holy Cross in Worcester, Mass. In 1944, he began his surgical training at Brigham and Women's Hospital in Boston, and from 1944 to 1947 served as a surgeon at the US Army's Valley Forge General Hospital in Philadelphia. He became interested in the biology of tissue and organ transplantation at Valley Forge, where there was a major plastic surgical center to treat WWII battle casualties.

On Dec 23, 1954, Dr. Murray successfully transplanted a donated kidney from one brother to his genetically identical twin. Patrick F. McCartan, chairman of the Notre Dame Board of trustees, stated that since that pioneering transplant "human lives and hopes have been wonderfully invigorated by this triumph of medicine."

In his acceptance speech, Dr. Murray noted that he and fellow Nobel Laureate Charles Townes, both members of the Pontifical Academy of Sciences, have often discussed how science and religion can help find answers to the meaning of life. "We agree that serious intellectual evaluation of the nature of the universe and the pursuit of truth need open and careful examination. This search requires that every possible resource be explored: science, observation, intuition, logic, faith, and even revelation," Dr. Murray told those gathered for commencement exercises.

"Working in the field of transplantation was totally engrossing. When we developed and performed the first successful organ transplant in man...we never dreamed that the ramifications of this pursuit of knowledge today would lead to over 400,000 transplants that have been performed—kidneys, hearts, lungs, livers, intestines, and multiple other organs," he said in his address.

This achievement has had profound scientific and medical implications. It means that death had to be redefined as the cessation of the function of the brain rather than that of the heart and the lung.

But organ transplant was to have another important dividend—this being personal as well as societal. It created a new category of humanitarianism: the organ donor. "The altruism of human donors is one of humankind's noblest service to one another," Dr. Murray said. "As someone once said 'Service to society is the rent we pay for living on this planet.'"

UNIVERSITY OF NOTRE DAME COMMENCEMENT 2005

▼ Physics professor **Randal C. Ruchti** (left) receives the *Shilts/Leonard Teaching Award for 2005* from **Joseph P. Marino**, dean of the Notre Dame College of Science.



▲ **Meredith M. Doellman**, Outstanding Biological Scientist, and **Charles Kulpa**, chair of the Department of Biological Sciences.

▲ **Mary Kathryn (Molly) Savage**, American Institute of Chemists Award, and **Gregory V. Hartland**, chemist, Department of Chemistry and Biochemistry.



▲ **Alexander Hahn**, director of the Honors Program, College of Science, and **Matthew B. Bartley**, American Institute of Chemists Award.

COLLEGE OF SCIENCE AWARDS LUNCHEON

The College of Science held its annual awards luncheon in May for seniors who graduated with distinction. Fifty-one awards were handed out to seniors in the departments of Biological Sciences, Chemistry and Biochemistry, Mathematics, Physics, and Preprofessional Studies.

DEAN'S AWARD

Brian E. Kadera, Cedar City, Utah

DEPARTMENT OF BIOLOGICAL SCIENCES

Outstanding Biological Scientists
 Meredith M. Doellman, Cincinnati, Ohio
 Erin E. Kennedy, Niles, Michigan

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

American Institute of Chemists Award
 Matthew B. Bartley, Peoria, Illinois
 Mary Kathryn Savage, Shavertown, Pennsylvania

Merck Index Award
 Daniel E. Bugaris, Orland Park, Illinois
 Rachael T. Carpenter, Lancaster, Ohio

Outstanding Biochemist
 Gregory A. Ellis, Greenfield, Indiana

Outstanding Chemist
 Phillip M. Nagel, Charlotte, North Carolina

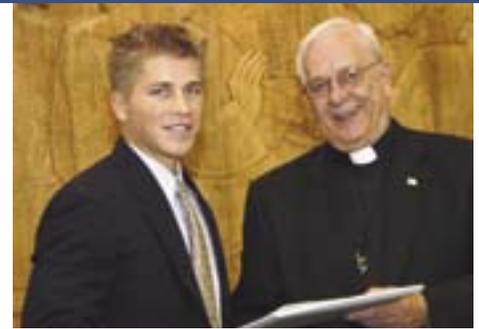
Dr. Norbert L. Wiech Award For Academics
 Katherine Traynor, Clarion, Pennsylvania
For Research
 Gregory A. Ellis, Greenfield, Indiana

William R. Wischerath Outstanding Chemistry Major Award
 Katherine Traynor, Clarion, Pennsylvania

Associate Dean Sr. Kathleen Cannon, O.P., and Katherine Traynor, the William R. Wischerath Outstanding Chemistry Major Award.



▲ Andrew J. Rupinski, the Haaser Scholarship in Mathematics, and William Dwyer, chairman of the Department of Mathematics.



▲ Michael J. Knesek, the Lawrence H. Baldinger Award, and Fr. Joseph L. Walter, C.S.C., chairman of the Department of Preprofessional Studies.

▶ Ani Aprahamian, chair of the Department of Physics, and Laurel E. Miannecki, Outstanding Senior Physics Major.



THE SHILTS/LEONARD TEACHING AWARD

Prof. Randal C. Ruchti, Department of Physics

HONORS PROGRAM GRADUATES

Anna M. Arias, Atlanta, Georgia; Stephen G. Arico, Annadale, Virginia; Matthew B. Bartley, Peoria, Illinois; Travis M. Bayer, Arlington, Texas; Jesse A. Beery, Elkhart, Indiana; Brodie M. Butland, Columbus, Ohio; Peter J. Chlebeck, St. Paul, Minnesota; W. Paige Hall, Austin, Texas; Keith S. Harwood, Pacific Palisades, California; Geoffrey L. Johnston, Westlake, Ohio; Kathryn G. Kinner, Lewiston, New York; Laurel E. Mianeckki, Ray, Michigan; Christine M. Mingione, Naperville, Illinois; Abby L. Nerlinger, Wilmington, Delaware; Eric R. Nitz, Mount Prospect, Illinois; Kevin P. O'Leary, Northridge, California; Anthony R. Strathman, Spring, Texas

DEPARTMENT OF MATHEMATICS

The Haaser Scholarship in Mathematics

Jessica J. Cisewski, Wayzata, Minnesota
Emily A. Gorman, Kansas City, Kansas
Andrew J. Rupinski, Homewood, Alabama

The Kolettis Award in Mathematics

Geoffrey L. Johnston, Westlake, Ohio

The Senior General Electric Prize for Honors Majors

Margaret I. M. Doig, Decatur, Georgia

The Senior General Electric Prize for Majors

Kevin M. Bott, Wilmington, Delaware

DEPARTMENT OF PHYSICS

Outstanding Senior Physics Major

Laurel E. Mianeckki, Ray, Michigan

Outstanding Undergraduate Research Award

Rebecca M. Marks, Clarkston, Michigan

DEPARTMENT OF PREPROFESSIONAL STUDIES

The Frank Azcarate Award

Jill S. Joehl, Carmel, Indiana

The Lawrence H. Baldinger Award

Elizabeth E. Bell, Baltimore, Maryland
Michael J. Knesek, Rochester Hills, Michigan

The Samuel J. Chmell, M.D. Award

Mary A. Blazewicz, Hollidaysburg, Pennsylvania

The Patrick J. Niland, M.D. Award

Brian E. Kadera, Cedar City, Utah

The Joseph L. Walter, C.S.C. Award

Madeleine M. Gagnon, Hudson, Michigan

Students Shine at Notre Dame Science Fair

Notre Dame hosts 2005 Northern Indiana Regional Science and Engineering Fair

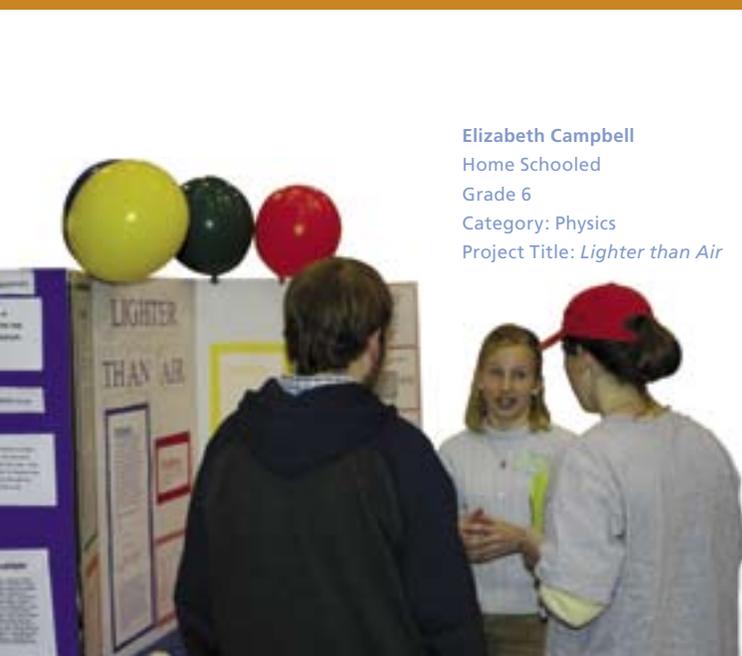
The 2005 Northern Indiana Regional Science and Engineering Fair—an affiliate of the Intel International Science and Engineering Fair program (ISEF)—was held at the Stepan Center on campus on Saturday, March 19. At the Regional Fair, 232 fourth through twelfth grade students from schools in St. Joseph, Elkhart, Marshall, and Fulton counties competed for nearly 140 special awards and prizes. Scientists, engineers, psychologists, and business people from Notre Dame, other local colleges and universities, and local industry judged the projects at the elementary (grades four through six), junior (grades seven and eight) and senior (grades nine through twelve) levels.

The top two senior projects won an all expenses paid trip to the Intel ISEF, this year held in Phoenix, Arizona, from May 8-14. In addition to the top two projects, two senior and four junior projects were selected to compete at the Hoosier State Science and Engineering Fair.

The Intel ISEF award winners were Jordan Hurwich, eleventh grade, from John Adams High School in South Bend, and Auna Badke, eleventh grade, from Marian High School in Mishawaka.

The senior Hoosier State Science and Engineering Fair winners were Mark Fraser, ninth grade, and Michael Chartier, eleventh grade, both from Marian High School in Mishawaka.

The junior Hoosier State Science and Engineering Fair winners were Bethany Werge, eighth grade, from LaSalle Intermediate Academy in South Bend; Patrick Flynn, eighth grade, from St. Anthony's School in South Bend; Evan Ivaldi, eighth grade, from John Young Middle School in Mishawaka; and Holly Vanderberg, eighth grade, from Clay Intermediate Center in South Bend.



Elizabeth Campbell
Home Schooled
Grade 6
Category: Physics
Project Title: *Lighter than Air*

Michael Chartier
Marian High School
Grade 11
Category: Biochemistry
Project Title: *The Study of a Macrolide, Peloruside A*





Brianna Deka

LaSalle Intermediate Academy

Grade 6

Category: Behavioral & Social Sciences

Project Title: *Does Color Affect Your Ability to Remember?*

Three elementary students received top honors from the Regional Fair with awards named for previous Northern Indiana Regional Fair Directors. The Emil Hofman Award was presented to an outstanding elementary project in the life sciences in recognition of Dr. Emil T. Hofman, University of Notre Dame chemistry professor and inspiration to many pre-med students. The Emil Hofman Award winner was J. Wesley Kerr, sixth grade, from Granger Christian School in Granger. The Mario Borelli Award was presented to two outstanding elementary projects in the physical sciences and engineering in honor of Dr. Mario Borelli, University of Notre Dame mathematics professor and strong supporter of the Regional Fair. The Mario Borelli Award winners were Allie Wood, fifth grade, from Granger Christian School and Erika Kiorgios, fourth grade, from Northpoint School in Granger.

At the Hoosier State Science and Engineering Fair, participants from the Northern Indiana Regional Fair received participatory medallions recognizing their stature as being the best in the state.

Some participants also received special awards. Auna Badke received the Stockholm Junior Water Prize, sponsored by the Water Environment Federation, for the Best Water Quality, Management or Protection Project in Grades nine through twelve.

Michael Chartier received a four-year partial scholarship to attend Franklin College, the Indiana State Yale Science and Engineering Award, and an award from the Indiana Pharmacists Association for the Best Pharmacy-Related project.

Mark Fraser received a second-place life science award at the senior level from the Hoosier Science and Engineering Fair.

Jordan Hurwich received Indiana state awards from the US Metric Association, the US Air Force and the National Society of Professional Engineers. In addition, he won first place in the physical division (for finalists) and first place of all finalists from the Hoosier Science and Engineering Fair. Jordan was also honored by the Toyota Motor Manufacturing Association of Indiana with the Toyota Type 2005 World Expo Award. This award will fund Jordan to attend the World Exposition in Japan.



J. Wesley Kerr

Granger Christian School

Grade 6

Category: Environmental Sciences

Project Title: *Water Quality*



Evan Ivaldi

John Young Middle School

Grade 8

Category: Engineering

Project Title: *Sticking to the Facts*

Notre Dame astrophysicists eagerly prepare to view extraordinary events through the lenses of a powerful new telescope.

Better Vision with Double VISION



Foreground: Submillimeter Telescope
Background on right: Large Binocular Telescope
Both telescopes sit atop Mt. Graham.

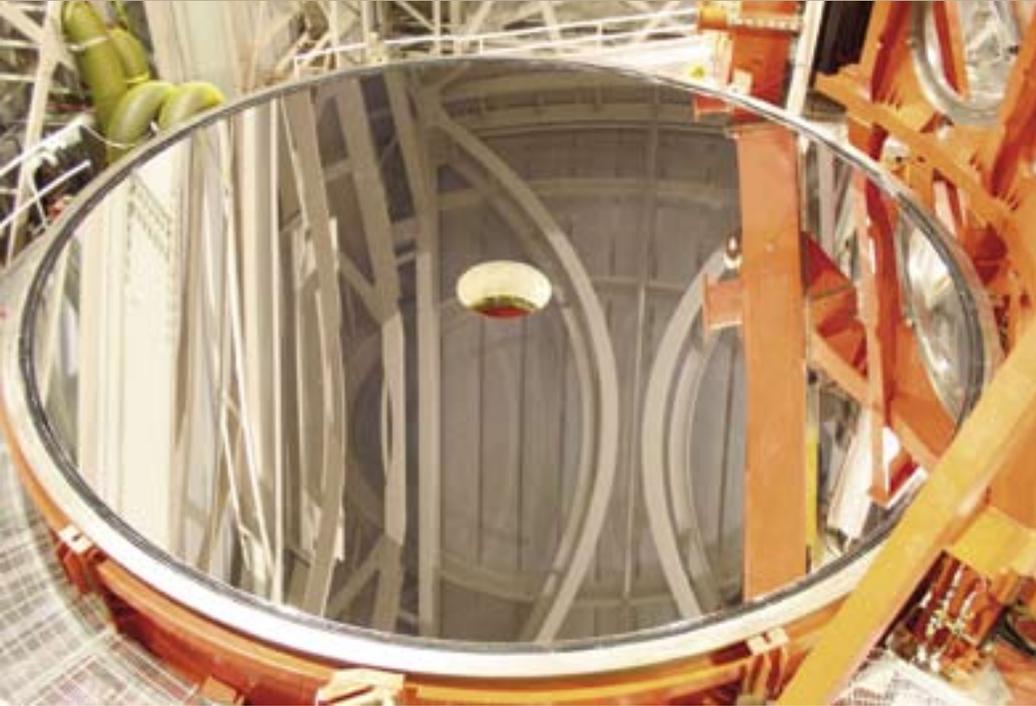


Photo by Bill Kindred

Magician David Copperfield has made the Statue of Liberty and an aircraft carrier “vanish,” but has never attempted what Notre Dame astronomer Terrence Rettig plans on doing a year or so from now—making a star disappear.

Another smoke and mirrors trick? Smoke no; mirrors, yes.

As soon as he gets the chance, Rettig will use the twin mirrors of the Large Binocular Telescope (LBT), located on the top of 10,000-foot Mt. Graham in Arizona, to pull off the “now you see it, now you don’t” feat using the latest in observational technology called nulling interferometry.

Unlike conventional telescopes, the Large Binocular Telescope is designed with two 8.4-meter (27.6-foot) “honeycomb” mirrors on a common mount. The mirrors are more rigid and lighter weight than conventional solid-glass mirrors and together will collect more light than any existing single telescope. With a maximum baseline of 22.8 meters, the instrument will be connected in an infrared interferometer that will utilize nulling techniques to enable the LBT to study emissions from faint dust clouds around stars. These dust clouds reflect light and give off heat, and so interfere with the search for planets.

Nulling interferometry has been used by radio astronomers for years, Rettig pointed out. It works on the principle that two waves that coincide with the same phase will amplify each other while two waves that have opposite phases will cancel each other out. Rettig will use the technique to make a star “vanish.” With the extremely bright star essentially “gone” from his field of view, Rettig hopes to search for the much fainter signature of planets and disks around stars that would normally be swamped by the star’s light. A star is typically millions of times brighter than a planet or the disk of gaseous and dusty planet-forming material that surrounds it.

Rettig is trying to understand how the disks of dust and gas whirling around stars settle first into a nucleus of matter and then continue drawing in more matter until a planet is born. “We do not have a clear understanding of how the huge disks of gas and dust that surround young stars can produce planets. There are many obstacles to overcome to form planetary objects such as the Earth and Jupiter. For example, the central star can clear the inner disk of gas and dust on a relatively short time scale of just a few million years. The removal of the planet-forming material effectively limits the time available for planet formation,” Rettig said.

Rettig has tentatively selected two candidate stars, TW Hydra, which is 100 light years away and HD 141569, a star that is 320 light years away in the constellation Libra and which is three times more massive than our sun and 22 times brighter. "TW Hydra is a young system that may be in the midst of its planet-formation epoch while HD 141569 has already cleared the disk of gas and dust out to about 17 Astronomical Units, so chances are, if it could have formed planets, the process has probably already ended. The ability to study the gas content and physical structure of a variety of disks will provide us new insights as to how planets form and evolve," Rettig said.

The LBT's interferometry abilities will provide high-resolution images of many faint objects over a wide field of view, including galaxies in the Hubble Deep Field, with ten times the Hubble resolution.

The LBT is not the first telescope to use the technique of nulling interferometry. Interferometry is already being used on the Very Large Telescope, operated by the European Southern Observatory in Paranal, Chile. In Hawaii, the Keck I and Keck II telescopes are the world's largest telescopes for optical and near-infrared astronomy. Sitting atop, Mauna Kea, a 13,600-foot-high dormant volcano in Hawaii, the twin telescopes are also being outfitted with interferometry.

Notre Dame is part of a consortium of 15 universities and institutions that have contributed varying amounts of money towards the \$100 million LBT, now in its final stages of construction. The first mirror was installed late last year, and the second mirror will be hauled up to the LBT site near Safford, Ariz. sometime this fall. Dedication ceremonies were held last October.

Notre Dame joined the project in the mid-1990s when it joined a consortium called the Research Corporation. Other Research Corporation members include Ohio State University, the University of Minnesota, and the University of Virginia.

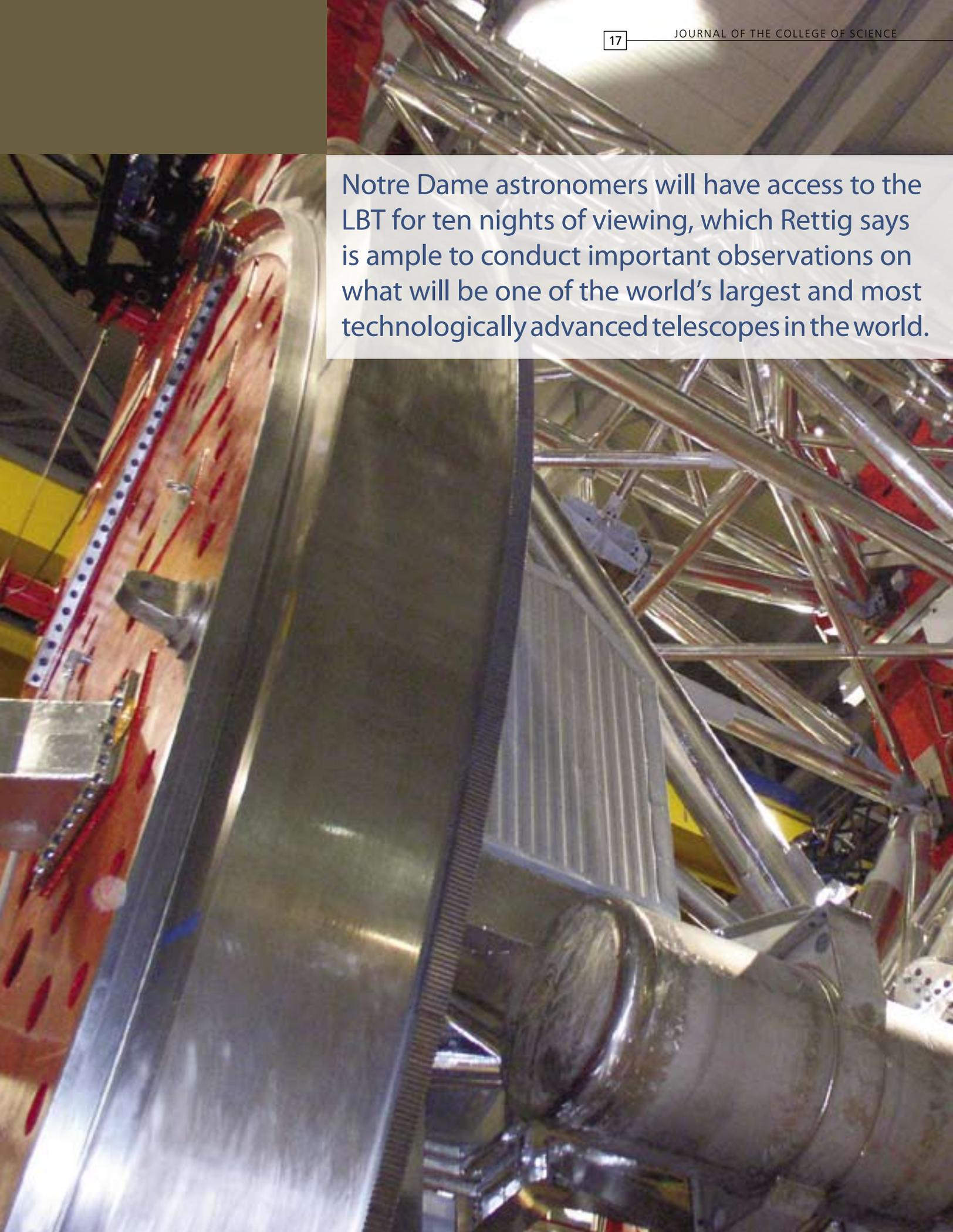
Notre Dame astronomers will have access to the LBT for ten nights of viewing, which Rettig says is ample to conduct important observations on what will be one of the world's largest and most technologically advanced telescopes in the world.

But Rettig may not be the first Notre Dame astrophysicist to use the LBT. That honor may fall to fellow astrophysicist Peter Garnavich, who has focused his career on studying supernova, those immense explosions of dying stars.

Already Garnavich has a project in mind using the single mirror and a wide-field imager that was put into place last year. "My proposal is to look at gamma ray bursts to see if a supernova pops out," he said. "We know that many gamma ray bursts are from supernova and we have been detecting gamma ray bursts in distant galaxies from 1 billion light years away to 10 billion light years away."



One of the two primary mirrors of the Large Binocular Telescope has been installed. When construction of the LBT is finished, the two 8-meter class telescopes on Mount Graham, Arizona, will be connected in an infrared interferometer. The resulting instrument will have a maximum baseline of 22.8 meters, that will provide high-resolution images of many faint objects over a wide field-of-view, including galaxies in the Hubble Deep Field with 10 times the Hubble resolution. Using a technique called nulling, scientists will be able to study the emissions of clouds of cosmic dust circling giant planets and will reveal planets hidden by starlight.



Notre Dame astronomers will have access to the LBT for ten nights of viewing, which Rettig says is ample to conduct important observations on what will be one of the world's largest and most technologically advanced telescopes in the world.

Garnavich and other scientists with the LBT member institutions will use the telescope this fall to search for gamma ray bursts as part of a “demonstration science” project. It is the moment they have long been waiting for.

Naturally, it would excite Garnavich even more should a supernova occur in the Milky Way galaxy. “It’s been 300 years since the last supernova, so we are long overdue,” he said. The last closest supernova occurred in 1987 in the Large Magellanic Cloud, and nothing would please Garnavich more than to see one, up close and personal.

In 1604 the astronomer Johannes Kepler observed the explosion of a star in our Milky Way. The most famous supernova of all occurred in 1054 and was visible to the naked eye even during the day.

“It may not happen in my lifetime, but then again it might happen tonight,” he said wistfully.

Although delays have plagued the LBT’s construction, astronomers with the member institutions have been patiently waiting for their opportunity. Now that time has arrived.

An Eye to the Sky

These are extraordinary times for astrophysicists.

The newest generation of technologically advanced telescopes, of which the Large Binocular Telescope is just one, will extend man’s vision to the deepest possible reaches of the universe, back to the time when the first stars and galaxies were born, starting just 300,000 years after the Big Bang.

These telescopes, both ground based and space-based, will give astrophysicists an unprecedented view of our galaxy and galaxies beyond and will help answer age-old questions such as: How big is the universe? How old is it? Are there other planets like Earth out there among the stars? Astronomers all over the world are marshalling their resources to answer two of the latest questions that continue to confound them: What is dark matter? What is dark energy?

With an eye toward finding the answers to these questions, much is expected of the LBT on Mount Graham near Safford, Arizona, when it starts taking data later this year. But the LBT is just one player in the next generation of highly advanced telescopes that are destined to rewrite astronomy textbooks.

While most telescopes are anchored on mountaintops, space is becoming a busier and busier place for a whole armada of telescopes that float high above the Earth’s atmosphere. In the next decade NASA will launch the Terrestrial Planet Finder Interferometer and the SIM PlanetQuest, both space-based interferometers designed to answer some of the most perplexing issues of our mystery-shrouded universe. These and other space-based telescopes are described in more detail below.

SIM PlanetQuest

SIM PlanetQuest (formerly called Space Interferometry Mission), scheduled for launch in 2011, will use optical interferometry to determine the positions and distances of stars several hundred times more accurately than any previous program. This accuracy will allow SIM to determine the distances to stars throughout the galaxy and to probe nearby stars for Earth-sized planets. SIM will open a window to a new world of discoveries.

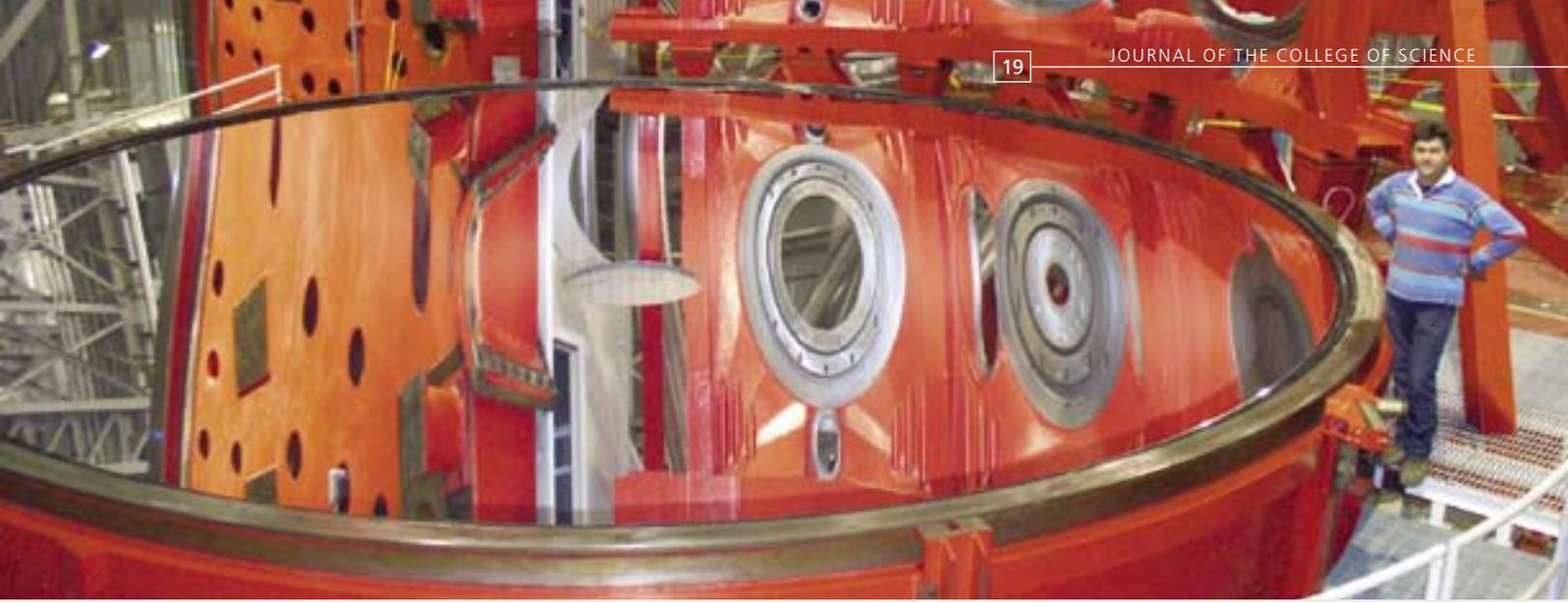
SIM is being developed by the Jet Propulsion Laboratory under contract with NASA and in close collaboration with two industry partners, Lockheed Martin Missiles and Space in Sunnyvale, California, and Northrop Grumman in Redondo Beach, California.

Terrestrial Planet Finder (TPF)

Terrestrial Planet Finder (TPF) scheduled for launch in 2014 is a suite of two complementary observatories that will study all aspects of planets outside our solar system: their formation and development in disks of dust and gas around newly forming stars; the presence and features of those planets orbiting the nearest stars; the numbers at various sizes and places; and, their suitability as habitats for sustaining life.

By combining the high sensitivity of space telescopes with revolutionary imaging technologies, the TPF observatories will measure the size, temperature, and placement of planets as small as the Earth in the habitable zones of distant solar systems. In addition, TPF’s spectroscopy will allow atmospheric chemists and biologists to use the relative amounts of gases like carbon dioxide, water vapor, ozone, and methane to find whether a planet someday could or even now does support life.





Spitzer Space Telescope

The Spitzer Space Telescope launched into space in 2004 has a cryogenically cooled telescope with lightweight optics that deliver light to advanced, large-format infrared detector arrays. The Spitzer has already detected light from planets in other solar systems and has discovered a possible asteroid belt around a nearby star.

The Spitzer Space Telescope is currently executing its first-ever High Impact Target of Opportunity (ToO) observation in order to catch a look at the aftermath of one of the most violent explosions in the universe—a gamma ray burst.

On May 24, 2005, the Swift satellite recorded the largest gamma-ray burst since its mission began. A major scientific goal of the Swift mission is to catch these mysterious bursts of gamma rays (extremely high-energy light) in the act of exploding, and quickly relay the location of the burst to other telescopes around the world, as well as up in space. Once alerted, other observatories scan the sky around the area of the gamma-ray burst, looking for any signs of an afterglow from the explosion. Once identified, more detailed observations of the counterpart to the gamma-ray burst begin.

Notre Dame physicists Peter Garnavich, the principle investigator of ToO, placed the call to alert Dr. Nancy Silbermann, Spitzer's Observer Support Team lead, to activate ToO to catch the gamma ray burst named GRB050525 before the afterglow of those monstrous explosions faded. "By calling the Spitzer control center I set a bunch of people scrambling. Within 60 hours, Spitzer took data on the burst," he said.

Spitzer is the fourth and final observatory under NASA's Great Observatories program, which also includes the Hubble Space Telescope, Chandra X-Ray Observatory, and Compton Gamma Ray Observatory.

James Webb Space Telescope

The next decade will see the launching of Hubble's successor, the James Webb Space Telescope. The Webb Space Telescope will contribute to NASA's search for new worlds by studying disks of dust and gas found around nearby stars, which are thought to eventually form "extrasolar" planetary systems.

It is also the first new mission under NASA's Origins program, which seeks to determine the shape of the Universe; explain galaxy evolution; determine how the Universe built up its present chemical/elemental composition; and, probe the nature and abundance of dark matter.

Kepler Space Telescope

Kepler, a NASA Discovery mission, is a space-borne telescope designed to look for Earth-like planets around stars beyond our solar system. Scheduled to launch in 2008, the Kepler Mission will enable humans to search our galaxy for Earth-size or even smaller planets and will help man answer one of the most enduring questions humans have asked throughout history: Are there others like us in the Universe?

The Future's so Bright



NATE JOHNSON

Nate Johnson is quick to confide that something clicked inside him while he was at home watching the hit TV show, *CSI* (for Crime Scene Investigation.)

It just seemed that for this high school senior at Parkview High School in Sterling, Virginia, the field of forensics was a perfect fit. "I will admit that it was *CSI* that caught my eye originally. But I also understand the show makes forensics look a lot more glamorous than it really is," Johnson said as he prepared to embark on a career in sleuthing using the genomic map as his field guide.

His undergraduate research at Notre Dame, first in studying variations within *Drosophila* (the fruit fly) and then later in identifying various types of macaques, turned out to be as perfect a match for his future plans as a positive DNA fingerprint. Johnson worked in the lab of Hope Hollocher, associate professor of biological sciences, in the basement of Galvin Life Science Center where he helped to

sequence the genes of different species of *Drosophila*. Later, he switched to the study of DNA samples of six different macaque populations to look for genetic markers that would provide insight into the primates' own evolutionary trek.

Johnson began preparing for his chosen profession by sequencing the genome of the fruit fly to analyze the yellow pigmentation gene that underlie the genetic differences among four different populations of *Drosophila* in Brazil and various other parts of South America. "This helped me understand evolution and how these various species branched off," he said.

In the Hollocher lab, Johnson was able to utilize a process known as gene amplification using technology, known as the polymerase chain reaction, or PCR. PCR provides genetic "fingerprints" that have helped with the identification of criminal suspects, crime victims, and even war casualties.

*I study nuclear science, I love my classes
I got a crazy teacher, he wears dark glasses
Things are going great, and they're only getting better*

*I'm doin' all right, getting good grades
The future's so bright I gotta wear shades*

"So a lot of these techniques I think were helpful in getting me into the forensics field," Johnson said. He is motivated not just by a fascination with forensics but also by a desire to be on the cutting edge of a rewarding field whose boundaries have been opened up in the past ten years with the amazing advances in genomics.

Having graduated in May from Notre Dame with a degree in biology, Johnson will continue his career thread at George Washington University, where he will pursue an advanced degree in forensic sciences. "I will stay at Notre Dame to continue this work before I start at George Washington," he said.

After having read the book *Dead Men do Tell Tales* by famous forensics scientist William R. Maples, Johnson is intrigued that one day he might be called to identify modern day ancestors to historical figures, as was Maples with the kin of the Romanovs.

If that doesn't pan out, Johnson holds out another possibility: FBI headquarters is not that far from his home in Virginia.

Some of you may remember that catchy 80s pop tune “The Future’s So Bright I Gotta Wear Shades” by Timbuk3. That is exactly how we feel in the College of Science about our undergraduates. They, along with our graduate students, represent the future of scientific exploration.

One of the greatest strengths of the college is its commitment to exposing undergraduate science majors to some type of research in the university laboratories as a means of stimulating their interests and broadening their intellectual growth while at Notre Dame.

For many of these students, the experience is both intellectually rewarding and fun. In turn, many professors report the appearance of fresh young faces and youthful spirits in a lab infuses the whole atmosphere with new energy.

Early this year, professors were asked to select a few students who most exemplified the objectives of the research experience. A flood of recommendations followed. Here are the stories of just a few of those students.

ERIN KENNEDY

Touted as “green chemicals,” ionic liquids (ILs) are a new class of non-volatile organic salts that could potentially replace some industrial organic solvents. But how “green” are these “green chemicals?”

“Ionic liquids are attractive alternatives to the volatile organic solvents currently used by industry,” said graduating senior Erin Kennedy. “But because ionic liquids are novel and not yet in widespread use, their potential effects on aquatic ecosystems are unknown.”



As a member of aquatic biology professor Gary Lamberti’s laboratory, Kennedy is studying the impact of ionic liquids on the behavior of snails and fish. The first order of business for any scientist working on new chemicals is to figure out what is known as the median lethal concentration (LC50), or the concentration at which 50 percent of the organisms exposed to the chemical die.

Kennedy, because she is investigating the effects of ILs on organism behaviors, works in the realm of much lower concentrations, typically 1% to 20% of the LC50.

“We are looking at concentrations that, while not directly lethal, could cause mortality by altering critical behaviors,” Kennedy said. At what IL concentration, for instance, is an organism’s ability to capture prey affected? Or at what concentration does IL exposure cause sluggish movement, which could reduce an organism’s ability to escape a predator?

Kennedy studied the effects of ILs with imidazolium-based cations and Br, BF₄, and PF₆ as anions on the freshwater pulmonate snail *Physa acuta*. She found that snail movement is indeed affected by ionic liquids. Her results suggest that there could be a threshold concentration affecting *Physa* for each IL. At low concentrations, the IL may suppress movement. IL concentrations above the threshold level trigger an escape response, causing snails to search for a patch of clean water or some other refuge from the toxicant.

“Our results suggest that behavioral effects should be considered in the overall evaluation of the toxicity and potential impact of ionic liquids on aquatic organisms and ecosystems,” she wrote.

Currently, Kennedy is studying the effects of ionic liquids on the group feeding behavior of *Pimephales promelas* (fathead minnows). Kennedy, a graduate of Niles High School in Niles, Indiana, will attend the Interdepartmental Biological Sciences (IBiS) Doctoral Program at Northwestern University next year.

MELINDA MORAN



One of the dominant science stories of 2005 turned out not to be about the cosmos or quarks but about a cultural theme: the reawakening to the reality that gender disparity continues in the sciences.

That "story" notwithstanding, mathematics professor Sam Evans had little doubt soon after meeting honors math senior Melinda Moran that she would be a woman who would go far in the sciences, so poised was she in her grasp of deep mathematics.

"Oftentimes I get students who come to me and say that they are confused about some of the material. With Melinda I soon learned that she understood everything," Evans said. When Moran submitted her senior thesis on April 15 on Algebraic Representation Theory, she had demonstrated that she was able to use difficult concepts in mathematics and apply them to the quantum state of the hydrogen atom's energy level.

"I was always fascinated by how mathematics can explain the physical sciences," she said. "So even though I majored in math at Notre Dame, I found myself wanting to go back to chemistry." Evans was impressed by Moran's ability to quickly make connections between what she learned in math classes to her Physical Chemistry course. "She learned a lot of new material on her own," Evans said.

Moran's learning curve was a steep one in her senior year. With her senior thesis in hand Evans said Moran was able to integrate what she learned in all of her math and science courses in order to tackle a difficult subject. "For her to perform at this level is indicative of her abilities in mathematics. It is quite rare for students who can see through the material and understand the underlying principles," he said.

After graduating in May, Moran will go on to graduate school at the University of Wisconsin, Madison, where she will begin her math PhD program with a possible focus in the physical sciences. Chemistry was one of her favorite subjects back in high school in her hometown of Fairfax, Va.

Others in the sciences may worry about the shortage of women in the sciences. But Melinda Moran has proved to be exceptional in many ways.

MEGAN WILSON

The evidence is clear that untreated depression can become life-threatening for an otherwise healthy person when the feeling of intense sadness and hopelessness spirals out of control. Consider the consequences of depression when the sufferer is diagnosed with cancer.

To understand how depression is apt to complicate cancer treatment, Notre Dame senior Megan Wilson teamed up with Dr. Rudolph Navari, director of Notre Dame's Cancer Research Institute, on a study of 293 patients in the early stages of breast cancer. Their objective was to determine the extent to which depression played a role in how patients followed their doctor's recommendations in connection with their chemotherapy or hormonal therapy treatment.

Breast cancer patients were prompted to answer questions on an emotional inventory to reveal any signs of depression. From those results, those who were asked to participate in the study were comparable in terms of age, sex, disease distribution, performance status, and level of depressive symptoms.

The double-blind experiment was conducted over the course of 20 weeks. Half in the study were given fluoxetine; the other half were given a placebo. The study revealed that patients treated with fluoxetine (Prozac) were far more likely to adhere to their doctor's advice compared to those who received a placebo.

"Few people realize that if depression is not treated, there is a significant outcome," said Wilson, a pre-med and economics major. Depression goes beyond being more than a quality-of-life issue. "I think it is more common than people think," Wilson said.

The value of the study is drawing attention to the consequence of depression on the patient's overall progress. Wilson, the captain of the Notre Dame cheerleading squad, presented the findings in a poster presentation at the American Psychosocial Oncology Society in Phoenix, Ariz. in January.

The 22-year-old from Greenfield, Ind., will now apply this experience in her pursuit of a degree in medical school.



VIJAY RAMANAN

Vijay Ramanan had barely reached high school when the field of bioinformatics and computational biology was born. He would in time excel at mathematics and biology at South Bend's Clay High School where he would eventually graduate as the school's 2002 valedictorian. When he came to Notre Dame he was ideally suited to use those math and science skills to make a substantial contribution to the laboratory of Biology Professor David Hyde.



"Bioinformatics is an exciting field. Science and technology are rapidly maturing, to the point where we can perform experiments on a small scale and get large amounts of data in a relatively short amount of time," Hyde said. "The resulting question is: How do you analyze that data to extract meaningful information?" Bioinformatics is an interdisciplinary program that integrates applied mathematics, computer science, and biology as a way to make sense of those mountains of data.

David Hyde's laboratory studies the mechanism by which adult stem cells in the zebrafish eye can regenerate functional neurons that die from either light damage or neurotoxin treatment. Dr. Thomas Vihtelic in Hyde's lab had performed a large-scale experiment where zebrafish were treated with intense light and RNA was isolated from retinas at six different time points during the retinal degeneration and subsequent regeneration process. This RNA was used in a microarray experiment to examine how the expression of 16,000 different zebrafish genes changed during neuronal death and regeneration in the retina.

As this data was being generated, Vijay came to the Hyde lab in the spring semester of his sophomore year. He began to apply several statistical analyses to this large data set. This was not a trivial assignment, as the 16,000 genes were each tested in triplicate at six different time points. After making good progress on examining the overall quality of the entire data set, Vijay was ready to begin identifying individual expression patterns and genes.

In the summer before his junior year, Ramanan received a summer research grant to go to State University of New York at Buffalo to study bioinformatics and apply what he learned to the ongoing study of retinal regeneration in zebrafish in Dr. Hyde's laboratory. "Our lab had started a microarray experiment, but we needed some computational methods to identify and categorize the specific genes involved in retinal regeneration. I took the microarray data to Buffalo and applied their newer programs to our data," he said. "The computational analysis has pointed to genes that we are now studying further in our lab."

"Vijay was extremely helpful in our microarray analysis," Hyde said. "He was instrumental in helping to identify which of the 16,000 genes are involved in retinal regeneration. His analyses also revealed groups of genes that may function in related events during the regeneration response. Many individuals have a strong background in either math or biology, but not both. Vijay has the ability to properly straddle that fence."

Vijay carried a 3.93 GPA and was graduated in May as a math and philosophy major. He intends to pursue an MD/PhD degree in graduate school. "I see math and philosophy as sharing a common thread: they are each very pure forms of intellectual exercise," he said. "Important philosophical questions have continually led into important scientific inquiries, and vice-versa, and I don't see that process ending anytime soon." Since progress in science often comes with ethical speed-bumps, Vijay said, "I think it helps a great deal to be able to understand both the science and the ethics of such matters."

SPECTROGRAPH TEAM

Part of being a physics student is conducting laboratory experiments in order to understand the concepts and principles being taught. But few get the opportunity to take their experiments to a deeper level by tearing down and reconstructing the very same instruments that are used in those experiments.

So it was for seven undergraduates who were charged with the job of refurbishing a 30-year-old spectrograph that had been sitting idle for nearly a decade in the deepest corner of Room 124 Nieuwland Science Hall.

Designed for the measurement of nuclear energy levels with very high precision, the spectrograph represented cutting edge physics when it was built in 1973. For nearly 20 years the spectrograph allowed Notre Dame physicists to detect nuclear particles on the focal plane of the spectrograph, originally using photographic plates and later using electronic detectors.

The extremely high resolution of the spectrograph was made possible because "only a very small portion of the reactions coming from the target are allowed to enter the spectrograph," said Research Professor Larry Lamm. "The probability of seeing any particular reaction was very small, but everything that was detected by the spectrograph was at very high resolution."

He continued, "The small acceptance of the spectrograph made it very difficult to use for the experiments in nuclear astrophysics that we began to conduct in the mid 1980s. As our interests moved from measuring nuclear energy levels to nuclear astrophysics, the spectrograph was used less and less."

However, the possibility of applying the powerful Accelerator Mass Spectrometry detection technique to a host of reactions of interest in nuclear astrophysics opened up new possibilities for the spectrograph. "After this long period of inactivity, the whole system needed to be checked, cleaned, and upgraded," said Philippe Collon, assistant professor of physics.

There was a job that had to be done and so Collon and his two graduate students, Dan Robertson and Chris Schmitt, turned to a group of undergraduates: Patricia Engel, Angelo Signoracci, Tristan Butterfield, George Hsu, Steve Kurtz, Gary Pritts, and Jason Wittenbach.

Engel and Butterfield, juniors from Hawaii and Seattle, Wa., respectively, said the job would allow them to gain a better appreciation for their experiments once the spectrograph was up and running. "Once you take it apart, and put it back together you get a better understanding of all the different components," Butterfield said. "It helps us understand what type of physics is going on inside."

Signoracci, a junior from Columbus, Ohio, said he found satisfaction in meeting the challenge of taking apart and cleaning the scattering chamber, installing new vacuum pumps and control gauges, and refurbishing the electrical panel.

Hsu, a junior from Taiwan, participated in the complete strip down of the spectrograph by refitting and re-aligning the beam lines and quadrupoles. Fascinated by how the spectrograph worked, Hsu was mindful of the delicate nature of the job. "You wouldn't want to mess it up. A mistake could cost a fortune."

Steve Kurtz, a sophomore from Chicago, Ill., helped design and build a new detector at Argonne National Laboratory over the summer and has been working on some of the peripheral systems prior to setting it up in the spectrograph.

Gary Pritts a sophomore from Columbus, Ohio, just joined the group and has been familiarizing himself with the lab by working on some of the beam line slit assemblies.

Perhaps the luckiest of all was Wittenbach, a freshman from Kearny, Neb. who found himself thrust into a major project in his very first semester at Notre Dame. Just three months out of high school, Wittenbach found the opportunity "mind-boggling."

"When I first got into it, it just blew me away," he said. "But when I started, I tried not to understand it all at once."



Back row (from left to right): Professor Philippe Collon, Dan Robertson, Angelo Signoracci, Steve Kurtz, Tristan Butterfield
Front row (from left to right): Chris Schmitt, Patricia Engel, George Hsu, Jason Wittenbach

A. Mosquito Makeover

Spreading insecticides to kill mosquitoes that carry viral disease has proven to be an expensive and flawed strategy. But, what about fortifying mosquitoes with carefully selected genes that protect them from ever being infected with a virus such as dengue fever in the first place?

Malcolm Fraser Jr., professor of biological sciences, has

developed one such strategy that accomplishes this objective while at the same time addressing the thorny issue of releasing transgenic mosquitoes into the wild. "The idea of reducing the prevalence of infected mosquitoes below a threshold for maintenance of the disease is not a new one. Insecticide spray programs can accomplish the same thing," Fraser said. "However, the ability of mosquitoes to rapidly evolve insecticide resistance is a significant factor in the failure of these strategies."

The object of Fraser's research is the *Aedes aegypti* mosquito, the number one vector of dengue, which in the second half of the 20th century joined malaria as an important mosquito-borne viral disease. Fraser has identified a way to protect mosquito cells from all strains of the dengue virus. He and members of his laboratory in the Galvin Life Science Center have devised a method to fit mosquitoes with a set of genes so that as soon as the mosquito draws blood contaminated with the virus, mosquito gut cells that are invaded by the dengue virus would begin dying.

"The mosquito is effectively protected from infection, and no new virus is transmitted," Fraser said. This transgenic approach aims to reduce the susceptible mosquitoes below a threshold for efficient transmission of the disease to humans. Just as importantly, the transgenic virus-resistant mosquitoes would survive and multiply with the native mosquitoes to become a significant part of the natural population.

While dengue fever is not as deadly as malaria, the Centers for Disease Control said the tens of millions of cases of dengue fever that occur annually make it "a major public health problem." Dengue has become especially problematic in Central and South America where it has spread and where new serotypes have emerged.





“While dengue fever is not as deadly as malaria, the Centers for Disease Control said the tens of millions of cases of dengue fever that occur annually make it ‘a major public health problem.’”

No dengue vaccine exists. So public health officials have had little choice but to suppress dengue transmission using the only means available to them—chemicals. However, they have known for a long time that the more they spread larvacides and insecticides, the faster *Aedes aegypti* would produce new generations that would develop resistance to these chemicals. Unfortunately, halting the virus at its source, through the insertion of genes, necessarily has proceeded in slow and cautious steps.

But lately decision-makers who fund such research have been increasingly open to bankrolling innovative genetic engineering techniques that offer a plausible and effective way of altering the genetic makeup of *Aedes aegypti* without compromising the safety of man or the environment. Fraser’s strategy to introduce a death-signaling gene sequence into the *Aedes aegypti* genome is considered an important step towards satisfying the concerns of scientists and the public at large about releasing transgenic mosquitoes into the environment.

“Over the last ten years or so my lab moved from doing basic molecular virology to developing transgenic approaches in insects. This shift in perspective followed our discovery of a self-mobilizing piece of DNA that we named ‘piggyBac,’ which can be used to carry genes into an insect chromosome,” Fraser said. His method of applied potential of mosquito transgenesis is the latest development of this concept.

The dengue fever virus belongs to the Flaviviruses group, which includes human pathogens such as West Nile fever, Yellow Fever, Japanese B and St. Louis encephalitis, and Hepatitis C viruses. These viruses use ribonucleic acid (RNA) as their genetic molecule (genome) instead of the deoxyribonucleic acid (DNA) that constitutes the chromosomes of animal cells.

Recently, virologists have been examining ways of expressing virus-suppressing RNA molecules in a cell, either interfering RNAs or catalytic RNAs, to provide a form of immunity against the virus. Fraser is especially interested in research with RNA-cleaving RNA molecules called ribozymes. “I was familiar with ribozymes as antiviral agents through assigned research papers of undergraduate students in my 400-level AIDS and Virology courses. This is a good example of how teaching at the undergraduate level and maintaining an active research program can work to the benefit of both endeavors. It helps keep the courses relevant for the students and keeps me current in the research,” he said.

Two classes of ribozymes caught his attention. The first were hammerhead ribozymes. These are small sequences of RNA that fold on themselves and cut other RNA molecules. Fraser saw that if these hammerhead ribozymes proliferated in cells in enough abundance they could prevent a virus from infecting the cell. “The biggest problem is making sure that enough can be produced in the cell to be protective,” he said. “Most RNA-suppression strategies have this problem, and in a transgenic mosquito it is difficult to ensure enough of the suppressing RNA is present to overcome the virus infection in all tissues.”

Fraser started thinking of ways to use ribozymes that don’t rely on having an abundance of the ribozyme to be effective. “In surveying the literature I was intrigued by an example of a ribozyme called a Group I intron, which is actually the first ribozyme identified and characterized by Nobel Laureate Thomas Cech,” he continued.

This ribozyme not only cuts a target RNA molecule, but can also splice any RNA sequence fused to it onto the target RNA molecule, creating a new RNA molecule that is translated into a new protein. In one of the



World Distribution of Dengue (2000)

- Areas infested with *Aedes aegypti*
- Areas with *Aedes aegypti* and dengue epidemic activity

"If his concept works the way he believes it will, then scientists will be one step closer to engineering a resistant mosquito."

demonstrations of this technology researchers studying muscular dystrophy were able to edit defective dystrophin gene messenger RNA by cutting off the incorrect sequences and splicing corrected RNA sequences to it. Some good messenger RNA for dystrophin is then made. And if there is enough, presumably one could rescue the muscular dystrophy trait. "In concept, it seems a reasonable approach, but application of that technology is another question. Still, it was a seminal article for me in that it introduced the concept of Group I introns and their capacity for creating new messenger RNAs," he explained.

Fraser also read another article that used this same Group I intron to attack the Hepatitis C virus genome to fuse an RNA transcript that expressed the Green Fluorescent Protein (GFP). If a toxin transcript is substituted for the GFP protein, then the fusion RNA transcript makes a toxin protein and the infected cells die.

"Considering Hepatitis C virus is a Flavivirus, in the same class as dengue fever, I easily put two and two together and decided 'Let's do it!'" he recalled.

"The concept is to fuse a gene to the dengue fever virus genome that otherwise would not be expressed *and* if that gene was toxic to the cell, then the infected cells would die, so no new virus would be produced," he said. This will happen before the virus multiplies in the mosquito, effectively reducing the possibility of selection and escape into nature of evolved resistant mutants. The mosquito would live because not all of its cells would be infected with the virus, and therefore would not be subject to this "death upon infection."

Fraser next wanted to discover what sequence would cause the cell to die if spliced to the dengue virus genome. "I thought about some toxin genes. But people don't like it when you talk about making transgenic insects with toxins," he said.

A Grand Challenge

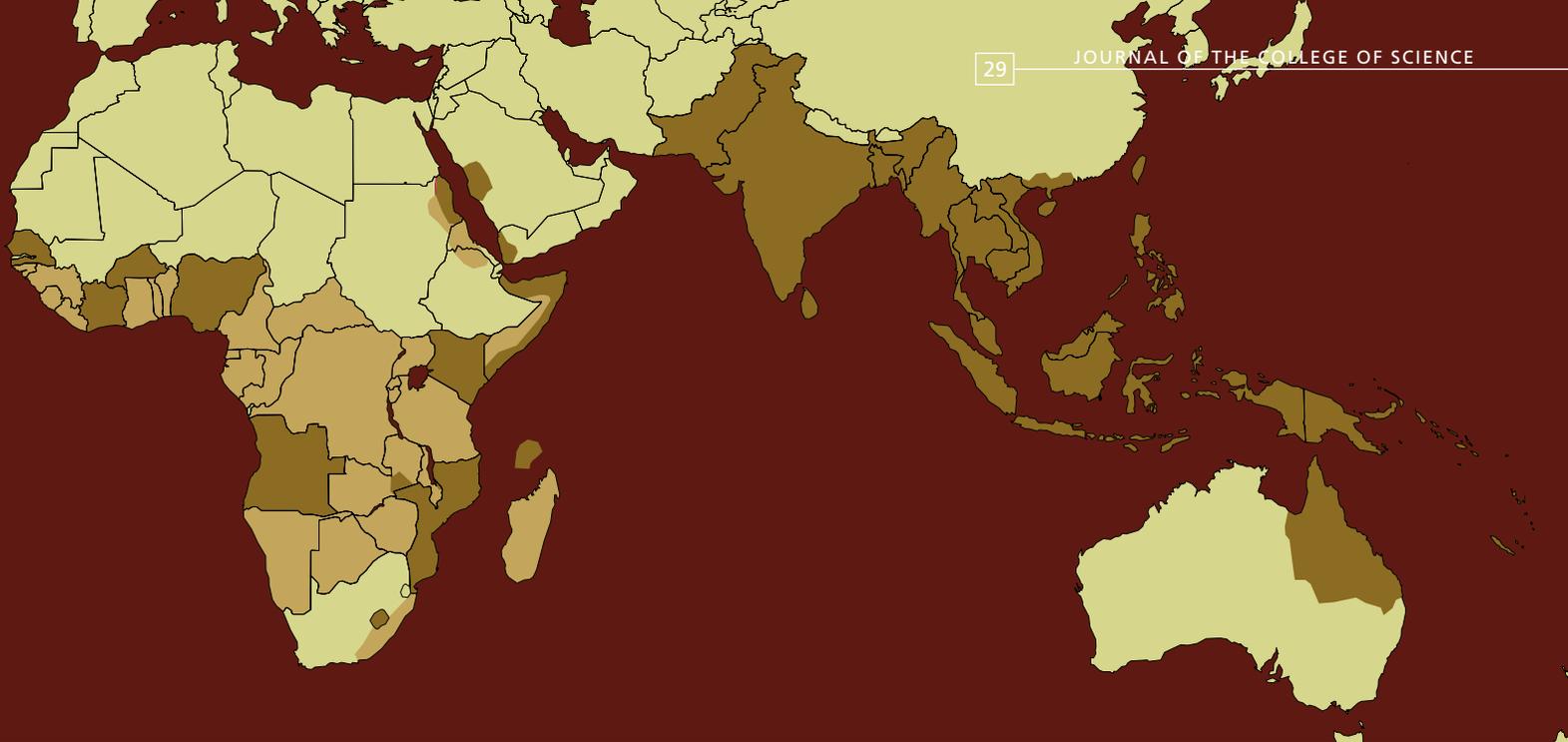
In late June, the University of Notre Dame received a \$2.5 million grant from the Grand Challenges in Global Health initiative, a major effort to achieve scientific breakthroughs against diseases in developing countries, for a program to develop a new approach to controlling dengue fever. Titled "Developing Novel Transgenic Strategies for Introducing Dengue Virus Refractivity in Mosquito Cells and Tissues," the five-year research program will be directed by Fraser. He'll conduct his research in Notre Dame's Center for Tropical Disease Research and Training, a world-renowned research program in the biology, ecology, genetics and molecular biology of tropical diseases and their vector insects.

Researchers at the Center for Tropical Disease Research and Training are concerned in particular with the impact of infectious diseases in less developed parts of the world, and their research interests range from biomedical sciences to issues of human rights. Among the diseases studied at the center are malaria, toxoplasmosis, tuberculosis, lymphatic filariasis, leishmaniasis, dengue, and West Nile encephalitis.

With regard to his research, Fraser said, "The application of this technology will ultimately involve localized release of genetically modified insects into the natural urban population of *Aedes aegypti* in a manner that will insure propagation of the engineered genetic molecular mechanism for eliminating dengue virus in endemic areas.

This would reduce the overall vectoral capacity of the mosquito population and, in turn, reduce the incidence of dengue among the associated human population."

The ultimate goal of the Grand Challenges in Global Health initiative is to create "deliverable technologies"—health tools that are not only effective, but also inexpensive to produce, easy to distribute, and simple to use in developing countries. This work is supported by a \$450 million commitment from the Bill & Melinda Gates Foundation, as well as two new funding commitments—\$27.1 million from the Wellcome Trust, and \$4.5 million from the Canadian Institutes of Health Research (CIHR).



His graduate student, James Keith, suggested the idea of using an apoptosis gene of some sort. Apoptosis is a normal cellular degradation process and there are a number of genes in this process that have been identified and characterized.

“So the concept evolved that if we could target the dengue virus genome in a conserved sequence region so that the Group I intron sees this sequence and splices an apoptosis-inducing gene to it, then it will create a functional transcript that produces cell death,” he said.

There just happens to be a highly conserved sequence among all dengue viruses in the major coat protein region of the virus. “If we target that sequence we can potentially protect mosquito cells from all strains of the dengue virus. We would try to have all the cells of the transgenic mosquito expressing the Group I intron/apoptosis gene. As soon as the mosquito takes a contaminated blood meal, the few mosquito gut cells infected with the dengue virus would begin dying from the activity of the Group I intron/apoptosis ribozyme on the invading dengue virus genome,” he said.

Fraser’s goal is not just to make the mosquito resistant to the dengue fever virus, but to find a way to actually couple a gene to that dengue resistance. Providing a gene that gives transgenics a controllable advantage over the native insect is one idea that seems attractive. “However, that gene must be genetically linked very tightly to the disease-resistance gene, otherwise we’ll lose the virus-resistance trait quickly,” Fraser said.

He envisions coupling the genes to use an Internal Ribosomal Entry Site (IRES), a sequence that several RNA viruses use to get ribosomes to translate their genomes into proteins. An IRES site physically links two genes on the same messenger RNA transcript, allowing both to be read from a single messenger RNA. If genes are linked in this way, they will stay linked, acting as a single genetic unit.

“And I think it is a great idea—if it works—but there are many, many steps that need to be developed and optimized. I am fairly confident I can make it through this proof of concept, fairly confident the Group I intron will work, that we will be able to get apoptosis induction upon infection with dengue, and that the infected cells will die without producing significant virus,” he said.

If his concept works the way he believes it will, then scientists will be one step closer to engineering a resistant mosquito. However, as with all environmental interventions, whether they be chemical, biological, genetic, or transgenic, the potential risks need to be weighed against the expected benefits. Many strategies for fighting vectored diseases have failed the test of real-world application.

According to Fraser, Notre Dame is poised to make transgenic approaches to controlling diseases of the third world a real possibility. In fact, he would like to see Notre Dame become a leader in this 21st century science, because, as he said, “I can predict that transgenic technologies of one sort or another will be incorporated into the overall strategy of preventing vectored virus diseases.”

He makes no prediction, however, about how long it will take to make transgenic strategies practical and acceptable. “The work we are doing now will eventually help us find the right path to success, and I am glad my lab can make a useful contribution to the overall effort,” he said.

STANDING OVATIONS

College of Science Faculty Honored with Kaneb Teaching Awards

Ten College of Science faculty members were among those honored in May with Kaneb Teaching Awards. The award, which recognizes excellence in the classroom, was established by a gift from trustee John A. Kaneb to honor teachers who have taught full time in undergraduate programs for at least five years.

Receiving the award were Margaret Dobrowolska-Furdyna, Kathie Newman, and Christopher Kolda, Physics; Paul Helquist, Chemistry & Biochemistry; David Hyde, Kristin Lewis, JoEllen Welsh, and Jeffrey Schorey, Biological Sciences; and Brian Smyth and Dennis Snow, Mathematics.



Margaret Dobrowolska-Furdyna

Margaret Dobrowolska-Furdyna had taught Physics 221-222, the introductory course for premed majors, in the past. But that was before the advent of the interactive style of teaching. So she had to revamp her style in the classroom.

"Although these are very bright kids, this course for some of them is one they have to take rather than the course they want to take," she explained. Consequently, she faced 84 students ranging from those who were fascinated by physics to those who were just going through the motions. The challenge was how to engage all of her students in the material, not just those who were already motivated and interested.

Dobrowolska-Furdyna found that the interactive method promoted by the Kaneb Center was an excellent way of engaging all her students in the classroom. Central to this method is the CPS (Classroom Performance System) "clicker" in which students use hand-held transmitters to answer questions. Then they are allowed to discuss the answers with each other. "Usually after this second round of discussion, 90 percent of the students will get the answer right," she said. "This is a more effective way of teaching."



Paul Helquist

Organic Chemistry 247-248 has a reputation as one of the most demanding courses in the College of Science. So why is it that the number of undergraduates taking the course has steadily increased to the point where 130 students were enrolled at the start of the 2004-05 school year?

One of the reasons is Professor Paul Helquist, who has been teaching this class nearly every year for the past 12 years since the course was first offered. This is Helquist's third Kaneb Award, and it underscores his reputation of excellence in the classroom.

"This course goes back to 1992 when the College of Science was invited by the Howard Hughes Medical Institute (HHMI) to submit a grant application to support a new medical sciences initiative program," he said. The HHMI funding combined with College of Science funds raised \$8 million to modernize the teaching labs and create new curriculum that was called the Howard Hughes program for a combination of chemistry, biochemistry, and biological sciences majors.

"This particular organic course is the flagship course in terms of getting this set of three majors through the program," he said. "It's a fun course and especially rewarding for me," Helquist said.

The fun continues for both Helquist and the next wave of undergraduates, for he will be teaching the class again next year.



David R. Hyde

BIOS 250, Classical and Molecular Genetics, is one of the first truly challenging classes for undergraduate biology and biochemistry majors. David Hyde understands that the course can be tough, so he has gone the extra mile to help students through the class.

"BIOS 250 is a difficult class," he said. "It's really directed toward the students developing problem solving skills and an entirely different thought process compared with their previous courses. This course challenges a lot of students because they were trained in learning facts and taking multiple choice exams," he said.

Instead, the exams involve a variety of problems in genetics "and they require the students to synthesize the entire solution," he said. To help the students learn the material so they can feel comfortable developing these new problem solving skills, Hyde holds two review sessions every week. He also meets with small groups of students at night and on weekends as they work on problem sets. These small group settings allow students to ask each other and Hyde questions and permit Hyde to critique the students' problem solving skills and suggest improvements.

This year, Hyde added an additional lecture to the course each week to provide another opportunity to obtain more in-depth understanding of material "rather than getting more material thrown at them," he said. Hyde even invites his students for dinner at his house just so they can socialize with their classmates. "It's a good opportunity for them to get to know each other," he said. Whether the students like Hyde's creole cooking or his extra help late at night, many will agree that this class would be much more difficult without Dr. Hyde.



Christopher F. Kolda

Physicist Christopher Kolda came to Notre Dame as a new professor in 2000 and, as one of his first teaching initiatives, set out to design a course for the students in the Arts & Letters Honors program, "Modern Physics: From Quarks to Quasars."

Designing a course in modern physics for students whose primary interests are English, political science, philosophy, and theology was a unique challenge. But it was also a rare opportunity to teach relativity and quantum mechanics to many of Notre Dame's strongest students.

"It's a course where we take a bunch of talented and smart Honors students and teach them modern physics in much the same way we teach it to our physics majors, just condensed," he said. But it should be pointed out that these are Arts and Letters students who also excelled in calculus in high school. So they don't shy away from physics, formulas and all.

"Actually it's been a lot of fun. The students are very enthusiastic. They are willing to learn and they are willing to work hard at it," he said. "Many could very well be physics majors themselves." Kolda sees "Quarks to Quasars" as a preparatory course for modern life. "It's hard to imagine someone who is going to be an effective leader in our society who does not have an understanding of what modern science is all about," he said.



Kristin M. Lewis

One of Kristin Lewis' first objectives upon taking her teaching position at Notre Dame in 1997 was to take the sophomore Introductory Lab Course to the next level. "A lot of students come with very sophisticated lab experience from high school. I was a high school biology teacher in Watertown, New York, so I knew what they could do. I knew I could push them a bit more," she said.

The course is designed to encompass primarily pre-professional and environmental science majors and Lewis had to be cognizant that not all respected schools have good lab courses. "So I didn't want to leave those without experience behind," she said.

Her other objective was to take a project-based approach to the class. Rather than performing demonstrations "of things the textbook already told them would happen," she has her students work on three or four projects each semester. "What I am trying to do is to give them a sense of what it's like to do research on a small scale and in a structured way," she said.



Kathie E. Newman

Kathie Newman was apprehensive in the fall of 2002. She had been associate dean in the College of Science for 11 years and was more accustomed to teaching graduate-level courses. She hadn't taught undergraduates for 15 years and yet here she was about to walk into a classroom of sophomore physics majors and immerse them in the abstract world of Lagrangian mechanics.

Newman regarded this new role as a heavy responsibility. For a long time, she toyed with ideas, concepts, and teaching innovations and then applied these teaching methods in the classroom. "I was astonished at how well things worked out," she said.

The students appreciated the effort she put into developing her lectures. She, in turn, made them aware how important they were to Notre Dame. "I always thought undergraduates are our lifeblood here. I let them know they were my first priority and they really responded well to that," she said.

"Teaching undergraduate majors was a new area for me. But I have had fun doing it," she said.



Jeffrey S. Schorey

Jeffery Schorey was surprised when he received a Kaneb Award for teaching. "I enjoy teaching. But this year was especially nice because the students were very interactive. They asked good questions and were enthusiastic about learning. So we had a good rapport," he said.

Schorey taught BIOS 435, which focuses on the cellular and molecular basis behind many human diseases. "It's, in essence, a pathology class," he said. The class was split between biology majors and preprofessional majors. "So they liked the material because it's very medically oriented," he said.

Schorey's first objective was to hammer home that an overwhelming number of common human diseases have an immunological and inflammatory component. "You can't understand many of the major human diseases unless you understand immunological and inflammatory processes," he said.



Jo Ellen J. Welsh

Flexible and fun. Jo Ellen Welsh makes it a point to include elements of both in her Cell Biology Laboratory class, which is taken primarily by sophomores and juniors and an occasional senior. "Most of the students really like this course because they have had the Cell Biology lecture class, and in this lab they actually get to play with cells—grow them, put them under a microscope and examine organelles stained with fluorescent dyes, induce and measure cell death, and more," she said.

Juggling two laboratory classes of 30 students each requires a lot of preparation and timing. "It can be really hectic because the cells have to be ready on the day of the lab," she said. Sometimes this requires generating over 100 million cells to distribute to the 16 research teams in the two classes.

"I try to make the course lively. In addition to lectures on basic research in cancer, students present case studies involving genetics and familial cancers. This allows them to really understand how one gene defect can impact on cancer in an individual or a whole family. In other exercises, students assess their own cancer risk based on their family history, or search for a clinical trial testing a new cancer drug," she said.

Welsh has been tweaking these classes ever since she arrived at Notre Dame in 1998.

"Flexible" is how she describes her teaching style. "For example, I know that some students perform better on multiple choice questions, whereas others do better with essays. So I try to make the tests a mixture of different types of questions, and allow the students a choice on which to answer," she said. "I think the students appreciate that."



Notre Dame Physicist Awarded Prestigious European Honor

Physicist Albert Laszlo Barabasi was awarded this year's Federation of European Biochemical Societies' Anniversary Prize of the Gesellschaft fuer Biochemie und Molekularbiologie.

Founded on January 1, 1964, the Federation of European Biochemical Societies (FEBS) is one of the largest organizations in European life sciences, with nearly 40,000 members distributed among 36 constituent societies and six associated member societies throughout Europe. FEBS seeks to promote, encourage and support biochemistry, molecular cell biology and molecular biophysics throughout Europe in a variety of different ways. They fund advanced courses, provide various types of fellowships, publish primary research through their publications, facilitate the exchange of information at their annual international scientific meeting, and award prizes and medals in recognition of scientific distinction.

The Anniversary prize of the Gesellschaft fur Biochemie und Molekularbiologie (Biochemistry and Molecular Biology) is awarded to scientists under the age of 40 for their outstanding achievement in Biochemistry and Molecular Biology. The prizes are provided by the pharmaceutical companies Boehringer Mannheim GmbH and Eppendorf Geratebau-Netheler & Hinz GmbH.

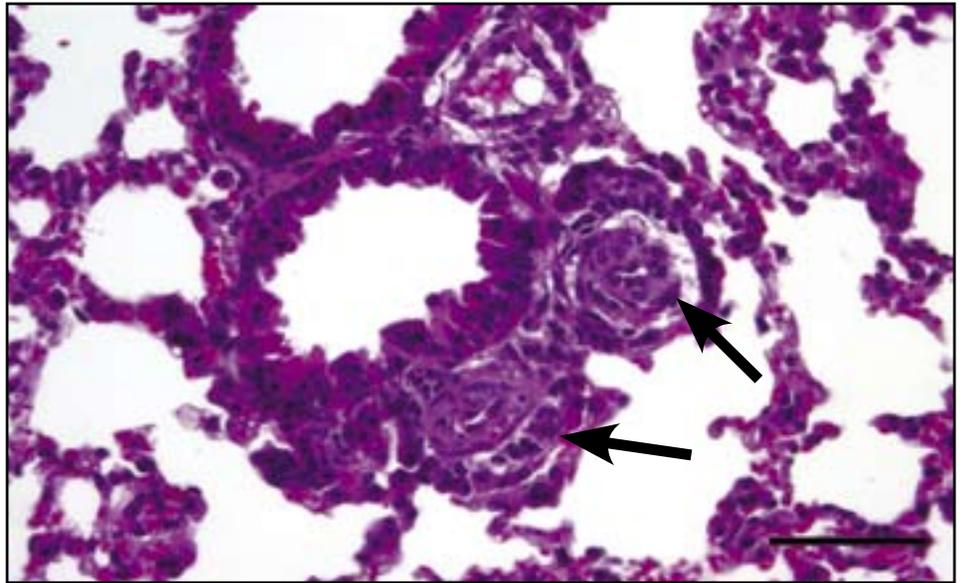
The award was presented at the FEBS Congress in Budapest on July 6.

Shaheen Award Recipient's Research Seeks to Halt Metastasis in Breast Cancer

Lorna Whyte arrived in the Department of Biological Sciences in the fall of 1999 as a graduate student from Dublin City University in Ireland. In Spring 2000, she joined the laboratory of Professor Martin Tenniswood, Coleman Professor of Life Sciences, and focused her research on the protein clusterin and the role clusterin plays in mammary gland development and the progression of human breast cancer.

For her work, she received the 2005 Eli J. and Helen Shaheen Graduate School Award, named in honor of a Notre Dame alumnus and his wife. The award recognizes the top graduate doctoral degree recipients.

Prior epidemiological research has shown that clusterin protein levels increase in a manner correlating with the progression of the disease, which allows for breast cancer tumors to become aggressive and metastasize. Whyte went to work to probe deeper into this apparent connection. She chose a nonaggressive form of human breast cancer cells, called MCF-7 cells, and proceeded to see how these cells reacted if their clusterin levels were raised.



"Although MCF-7 human breast cancer cells form in the mammary gland itself, they do not spread to the lymph nodes, lungs, or liver," she said. "So what I did was genetically engineer these cells to overexpress human clusterin at much higher levels," she said. "What I found was that these cells that overexpress clusterin actually grow faster and they are also more resistant to the drug tamoxifen."

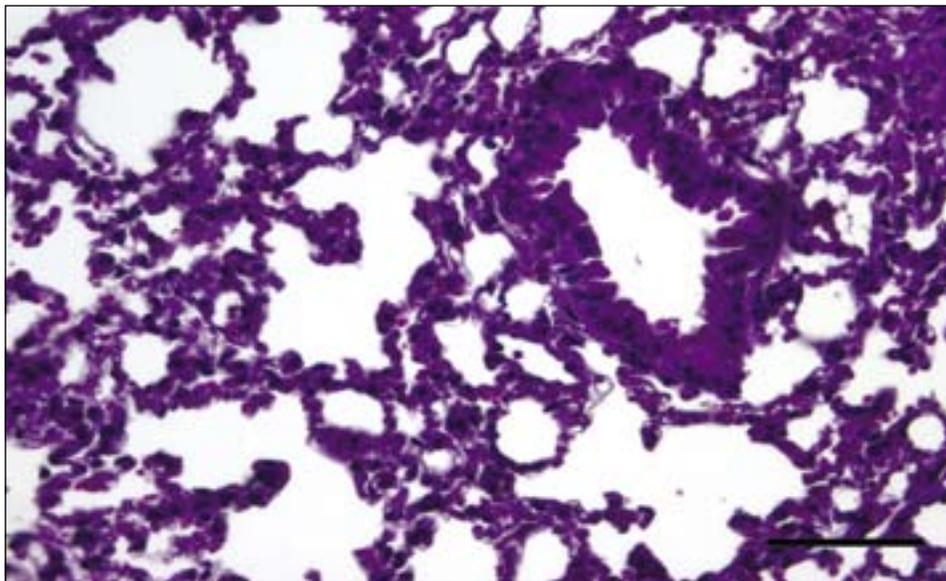
Tamoxifen is the number one drug that is used to treat patients with breast cancer. It appeared that clusterin was actually protecting the tumor cells and making them grow faster. "This is quite worrying because in women who have a localized disease that is confined just to the breast area, the five-year survival rate is 95 percent. But if the breast cancer grows at a faster rate, is resistant to drug treatment, and spreads outside of the breast, the five-year survival rate goes right down to about five percent," she said.



Overexpression of clusterin induces metastatic progression.

Lungs excised from mice bearing tumors derived from MCF-7 (Panel A), MCF-7 CLU (Panel B) cells were formalin-fixed, sectioned (5 μm), and stained with hematoxylin and eosin. (Micro-)metastases are visible in lungs (see arrows) of animals carrying MCF-7 CLU tumors but not in animals with MCF-7 tumors.

B



Whyte continued her investigation. In the laboratory, she developed an artificial matrix assay system to see if the tumor cells with the high level of clusterin would have the ability to be motile and therefore potentially invasive. "I placed the cells on top of a matrix, and I saw that the cells overexpressing clusterin were able to invade right through the matrix, travel through tiny pores at the base of the matrix and survive in a separate environment to which they were originally grown," she said. The nonaggressive tumor cells that had low clusterin levels remained in place.

Her next step was to see if these clusterin cells were also invasive in mice, and would have the ability to break through healthy tissue, get into the bloodstream, and metastasize to other tissues. She injected the overexpressing clusterin cells directly into the mammary fat pad of the mice. "We saw that starting at about five weeks, the cells overexpressing clusterin grew significantly faster. What's more the tumors seemed to stimulate blood vessel growth, called angiogenesis, which nourishes the tumors.

Further tests involving implanted pellets that slowly released tamoxifen into the blood system were conducted for another five weeks. "At the end of the study, tamoxifen had reduced the nonaggressive tumor cells in the mice, which was completely normal and expected. However, the tumors that had the cells overexpressing clusterin did not act in the same way. They were significantly larger than the nonaggressive cells," she said.

This proved that what she saw in the laboratory under artificial conditions worked out in a similar manner in the mice. In 26 out of 35 mice used in the study, the clusterin cells showed metastasis to the lymph nodes, the lungs, and the liver. The cells that did not overexpress clusterin did not spread outside of the mammary tissue.

"It was a very exciting result," she said. But the clusterin connection is just beginning. "If we can find out what genes are involved in actually making the cells become more aggressive and invade to other tissues of the body, then we can design drugs to target those genes and try to halt the spread of the disease," she said.

UNDERGRADUATE ACCOLADES

Patricia Engel Receives Goldwater Scholarship

Patricia Engel, a Notre Dame physics major and president of the Society of Physics Students, is a recipient of the 2005 Barry M. Goldwater Scholarship. The Barry M. Goldwater Scholarship and Excellence in Education Program was designed to foster and encourage outstanding students to pursue careers in the fields of mathematics, the natural sciences, and engineering. The Goldwater Scholarship is the premier undergraduate award of its type in these fields.

Engel, who will be a senior next semester, first became interested in physics while a high-school senior at Punahou School in Hawaii. At Notre Dame, she worked with Professor Phillippe Collon for two semesters in the Nuclear Structure Laboratory and was part of a team that refurbished a Browne-Buechner spectrograph and its associated beam line, neither of which had been used for over ten years. "I did everything from selecting and ordering safety railing to taking apart the beam line for realignment, to replacing o-rings and testing the scattering chamber for vacuum leaks," she said.



Engel participated in a Summer Research Experience for Undergraduates (REU) at Auburn University during which time she designed, built, and installed an apparatus that provides a temperature gradient within a dusty plasma, with the intent to simulate microgravity conditions. She plans to continue her studies in physics and eventually obtain her PhD.

Notre Dame Students Win NSF Graduate Research Fellowships

Margaret Doig and Stacy Hoehn were winners of the National Science Foundation Graduate Research Fellowships this year, and Melinda Moran and Andrew Rupinski won Honorable Mentions. In the United States, there were only 31 mathematics students winning NSF Graduate Research Fellowships this year.

Doig also won an NDSEG fellowship. She is a graduating senior in the Honors Mathematics program. Stacy Hoehn is a first-year graduate student. Moran and Rupinski are seniors in the Honors Mathematics program.

College of Science Grads— Tell Us About Yourself

Please let us know your notable achievements for future issues of Renaissance.

Please include publications, awards, honors, and appointments.

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