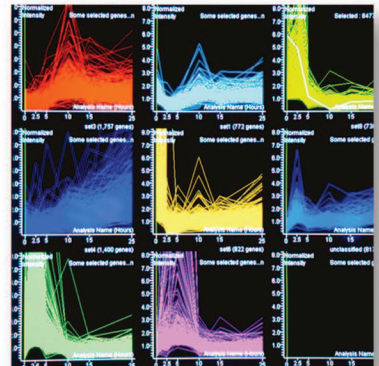
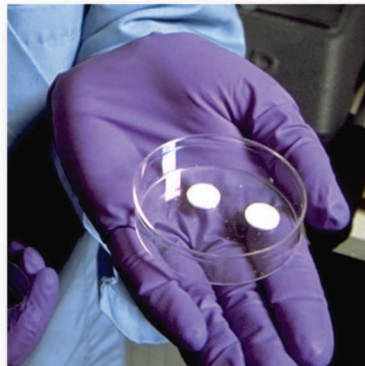
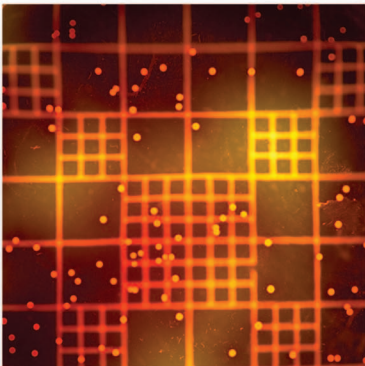
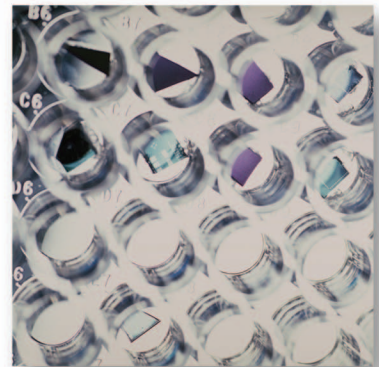
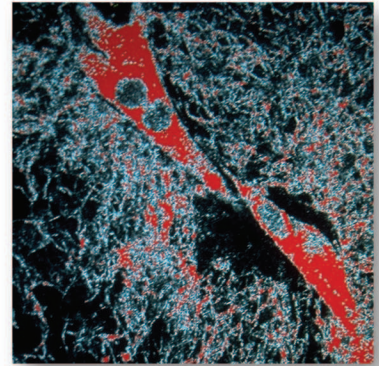
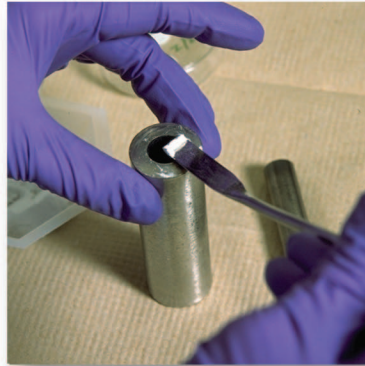
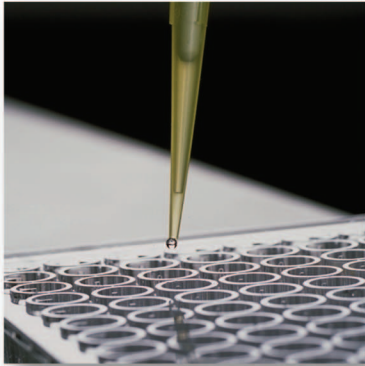


# PURDUE

UNIVERSITY

## *2003-04 Research Activities from the Office of the Vice Provost for Research*



Cover Photos by Vincent Walter

Shown are close-up images from the Cellular Biomechanics, Biochip, Tissue Engineering, and Nanophase Biomaterials Laboratories in the Weldon School of Biomedical Engineering. Research programs within the school range from fundamental studies of biological structures to applied medical device design and evaluation. Many of the projects are collaborative in nature, involving researchers from various Purdue schools and colleges, as well as the Indiana University Schools of Medicine and Dentistry. Additional information can be obtained by visiting: <https://engineering.purdue.edu/BME/>.



## President

The discovery of new knowledge is one of the fundamental responsibilities of a great university. Purdue brings together some of the finest intellects of our world and gives them the resources to advance the frontiers of their disciplines. At its best, research helps create a better world through the development of new products and processes, the discovery of treatments and preventatives for disease and the advance of our understanding of the full capacities of human beings. It also creates an exciting learning environment for our students, who are stimulated by learning from professors who are leaders in their fields. Purdue is committed to an expanding research enterprise of uncompromising excellence.

— Martin C. Jischke, President



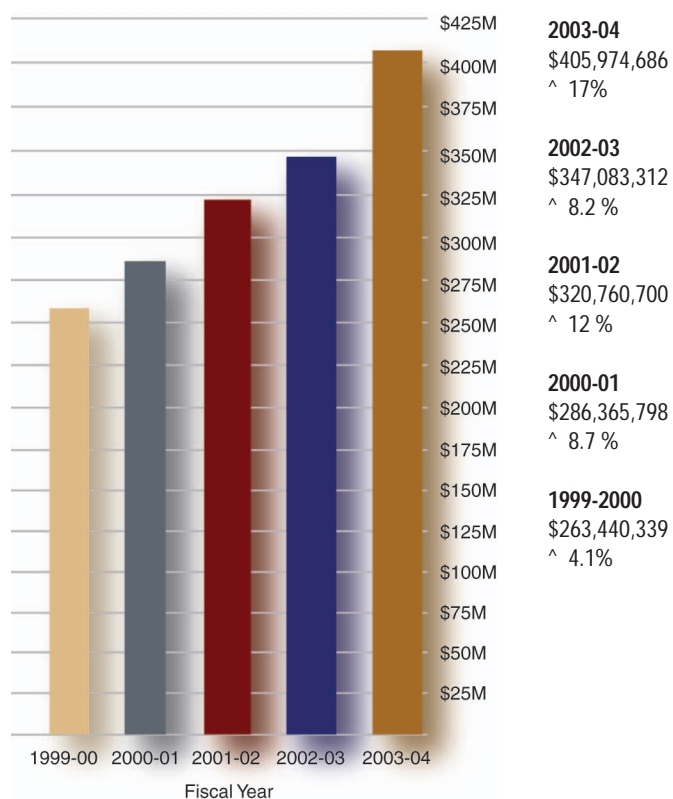
## Provost

As Indiana's land-grant university, Purdue embraces research as one of its primary missions. Our strategic plans have set goals of stepping up our research mission and this report shows that we are succeeding. We are rapidly moving forward with interdisciplinary research projects that bring together faculty from many different fields and even different institutions. Our Discovery Park is focused on the potentials of interdisciplinary research. In the coming year, two new Discovery Park centers for nanotechnology and biosciences will be coming on line, joining our already completed Burton D. Morgan Center for Entrepreneurship. There is much more to come. We are strongly focused on transferring our discoveries into the marketplace and the economy of Indiana where they can create jobs, revenue and a better future for our state. The Purdue faculty is doing an outstanding job of moving the research mission of this university toward its greatest potential. As our faculty and graduate programs grow in the years ahead, I believe we will create many more exciting opportunities. Purdue today is opening the doors to tomorrow.

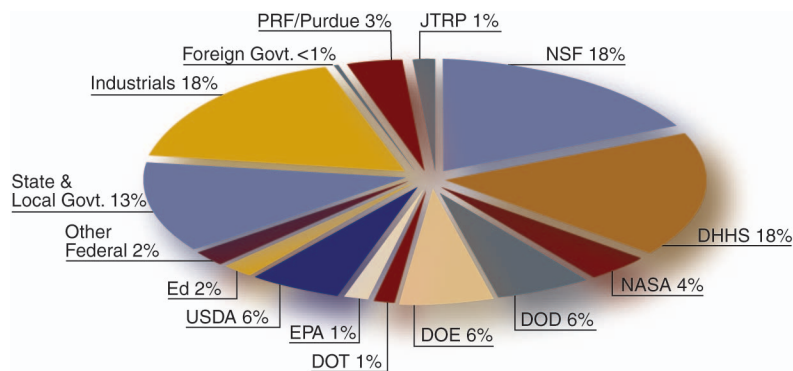
— Sally Mason, Provost

## 2003-04 Research Expenditures

### Systemwide Research Expenditures



## Sources of Research Funding by Sponsor





### *Interim Vice Provost for Research*

Purdue University is experiencing dynamic growth in research discovery. Our research infrastructure is transforming the ways that our research faculty and staff work together.

The expansion and renovation of traditional research programs and the building of Discovery Park — an entity created for interdisciplinary research efforts — along with an unprecedented effort to attract new faculty to join our research programs have infused the campus with a charged atmosphere for research activity.

Purdue's efforts in promoting multidisciplinary discovery is paying dividends as investigators connect and combine their expertise to find answers to concerns affecting the quality of life. The focus of this year's annual report is on health-related research activities at Purdue University.

As a tribute to our investigators, the Office of the Vice Provost for Research worked together with the Provost's office to create a new award — the Seed for Success Award — to acknowledge contributions made by researchers in capturing research awards of \$1 million. In addition to a bronze acorn award engraved with the researcher's name, a tree is planted in a grove on campus with a plaque recognizing his or her accomplishments. Several researchers featured in this report are recipients of the Seed for Success Award.

Those participating in our research programs are being recognized for their numerous achievements. The contributions made by Purdue investigators today will have lasting effects on generations to come. It is an honor to work in this capacity during such exciting era of discovery.

— Charles O. Rutledge, Interim Vice Provost for Research and Executive Director of Discovery Park

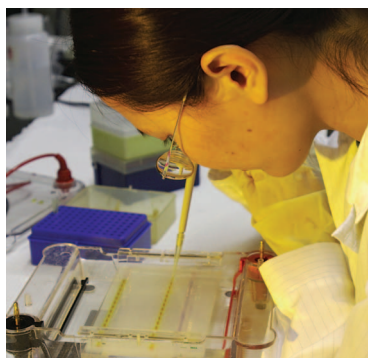


*Extraordinary  
discoveries affecting  
ordinary lives*

*Healthcare issues are  
part of our daily lives.*

*As Baby Boomers  
move toward their  
golden years, technology  
continues to advance in  
ways never before  
thought possible.*

*We invite you to  
explore some of the  
health-related research  
at Purdue University  
that could someday  
change our lives.*



Examining the affect of vitamin D on the expression of genes will help explain how vitamin D protects cells from cancer.

## Cancer

The **Purdue Cancer Center** provides a vital foundation for a league of experts from multiple disciplines involved in unraveling the intricacies of the cellular transformations associated with cancer. Progress is being made in uncovering the mysteries of cancer, and the center is uniquely positioned to integrate Purdue's traditional strengths in structural biology, chemistry and medicinal chemistry with discoveries in the molecular biology of cell transformation. Novel cancer targets have been discovered, and work is under way toward experimental therapeutics and diagnostics for the improved detection and treatment of cancer.

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*"Because of the centers, like the one at Purdue, we are on a fast track to making cancer a chronic disease that people will live with, not die from."*

Andrew von Eschenbach, director of the National Cancer Institute

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The Purdue Cancer Center has held the prestigious National Cancer Institute designation for more than 25 years and is one of only two NCI-designated cancer centers located at a non-medical university campus. The center is dedicated to the national goal of eliminating the suffering and death due to cancer.

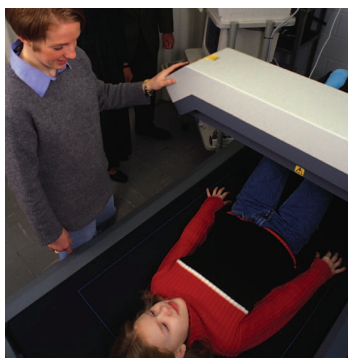
Purdue Cancer Center Director Richard Borch and cancer center colleagues received a Seed for Success Award acknowledging their success in acquiring cancer center support grants in excess of \$1 million.

Marietta Harrison, professor of medicinal chemistry and molecular pharmacology, received a Seed for Success Award for her work on the characterization of lymphocyte cell kinase (Lck) and associated proteins.

Lck is a signaling molecule and a member of the sarcoma family of protein tyrosine kinases. Lck regulates how the body's immune system recognizes and eliminates cancer cells. It is positioned at the beginning of a complex signaling pathway that ultimately mobilizes the body's T lymphocytes (T-cells) to destroy developing tumors. Understanding how Lck functions is important for designing strategies to mobilize the immune system during the early stages of cancer.

James C. Fleet, associate professor of foods and nutrition, conducts research on the molecular mechanism used by vitamin D to influence the function of epithelial cells from the intestine and prostate. While vitamin D is generally recognized for its ability to protect bone and prevent osteoporosis, experiments also show that low vitamin D status is associated with higher rates of epithelial cell cancers of the breast, prostate and colon. Insights into the molecular actions of vitamin D could lead to new therapies for the prevention of these epithelial cell cancers.

Additional information can be obtained by visiting: <http://www.agriculture.purdue.edu/agricultures/fall2004/bigC.htm#inside>



The dual energy X-ray absorptiometry machine, called DXA, helps investigators measure the effectiveness of a calcium intervention in sixth-grade girls. Identical machines on six other campuses in the U.S. allow Purdue to coordinate multisite research.

## Nutrition

The **Botanicals Research Center for Age-Related Diseases** funded by the National Institutes of Health and working in collaboration with the University of Alabama-Birmingham is one of six centers of its kind in the nation studying botanical dietary supplements. The center specifically studies botanicals claiming to prevent and treat age-related diseases, including cancer, cardiovascular disease, osteoporosis and dementia. For example, the center is evaluating alternatives such as soy and other plant phytoestrogens to prevent bone loss in postmenopausal women. Connie Weaver, head and distinguished professor of foods and nutrition and director of the Botanical Research Center for Age Related Diseases, received a Seed for Success Award along with several colleagues for their role in obtaining renewed support for the center.

Childhood obesity has become a leading public-health concern in recent years, and Purdue researchers are evaluating evidence that indicates that calcium/dairy consumption is associated in the moderation of body weight and body fat. Dorothy Teegarden, associate professor of foods and nutrition, pioneered a study that indicated higher calcium intakes might reduce overall levels of body fat and slow weight gain. Additional research on a larger scale is currently under way.



Youngsters participating in calcium studies.

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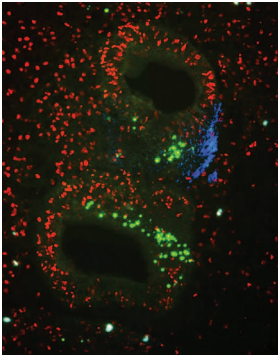
*Research Goal: "To promote optimal health through discovery and application of science-based knowledge of diet and behavior."*

Richard D. Mattes, professor of foods and nutrition

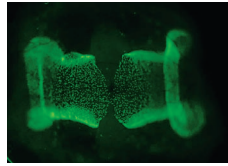
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Professor Richard Mattes, professor of foods and nutrition, observes that, "despite a long history of recommendations to moderate fat intake and a widespread recognition this action may be beneficial by the public, little reduction in fat consumption has been achieved." His research is focused on unlocking the hidden forces that seem to oppose this change. Human feeding and metabolic studies characterize the contributions of cognitive and sensory factors to fat intake and have recently demonstrated that the tasting of dietary fats actually alters their metabolism. The aim of this research is to better understand the independent and interactive influences of neural, genetic, metabolic, hormonal, cognitive, cultural and sensory factors on human ingestive behavior, nutrient utilization and energy balance in healthy and clinical populations.

Additional information can be obtained by visiting: <http://fn.cfs.purdue.edu/bot/>



Dividing (red) and dying (green) cells, and axons (blue) that project from the ear into the brain.



Antibody staining reveals sensory cells of the embryonic chicken ear.

## Speech, Language & Hearing

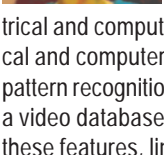
Donna Fekete, associate professor of biological sciences, studies the development of the inner ear. Her research reveals that the manipulation of specific signaling factors can affect the decision that the embryonic inner ear cells make to develop properly into hearing or balance cells in animals. Additionally, there is evidence that normal embryonic ear cells can make both the sensory hair cells of the inner ear and the neurons that connect



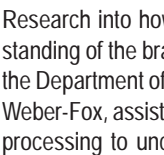
those cells to the brain. These findings may someday have a bearing on the hunt for therapeutic treatments of human deafness and balance disorders by offering an avenue to direct replacement cells to choose fates appropriate for hearing versus balance, depending upon the needs of the patient.



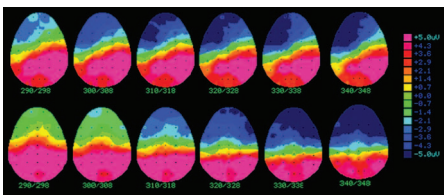
Ronnie Wilbur, professor of speech, language and hearing sciences and director of Purdue's linguistics program, collaborates with researchers in electrical and computer engineering to model the nonmanuals in American Sign Language (ASL). In addition to social interaction and conversational regulation, sign language facial expressions perform a variety of grammatical purposes. They interact with the manual signs and with each other. Avinash Kak, professor of electrical and computer engineering; and Aleix Martinez, professor of electrical and computer engineering from Ohio State, use computer vision and pattern recognition algorithms to automatically extract facial features from a video database of people signing. Based on computational analysis of these features, linguistic researchers in the Department of Speech, Language and Hearing Sciences will construct a model of facial behavior in ASL. These models will improve how ASL is taught and have practical applications in the development of automatic sign language translation, such as deaf-computer interaction or deaf-hearing communication.



Research into how the brain processes language is furthering our understanding of the brain's role in stuttering. Anne Smith, professor and head of the Department of Speech, Language and Hearing Sciences; and Christine Weber-Fox, assistant professor, are investigating the brain's role in language processing to uncover the reason a person stutters. New research from Purdue shows that even when people who stutter are not speaking, their brains process language differently.



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These images are a series of maps of areas of activation in the brain over time. By looking at these maps, researchers can see how neural activity in specific brain areas changes rapidly while the subject performs language tasks, such as reading sentences or hearing words.



Shown is an artist's conception of the T4 virus just after it has penetrated the cell membrane of the *E. coli* bacterium, which the virus infects.

## Viral Infection

Structural biologists, including Michael Rossmann, Henley Distinguished Professor of Biological Sciences, have obtained clearer pictures of how the T4 virus, long known to infect *E. coli* bacteria, alters its shape as it prepares to pierce its host's cell membrane. Years of research studying virus assembly and transmission have enabled the research group to create high-resolution snapshots of a virus attacking its host – culminating in a movie of the process.

The complicated infection process requires a virus' flower-like section, known as the baseplate, to shape-shift by dramatically changing the configuration of the numerous proteins that form it. The team has taken cryoelectron microscope images of the baseplate from different moments in the process and transformed them into a brief animated movie, helping scientists understand how infection occurs and possibly enabling them to apply this knowledge for the benefit of human patients in the future.

"A better understanding of the infection process is a step forward for fundamental science, but it also could allow scientists to alter the baseplate so that the virus could infect other types of cells," says Rossmann. "T4 might then be used to deliver beneficial genes to damaged or infected human tissue."

*"Structural biology offers the potential to unlock the secrets of viral attack, before which humanity continues to stand nearly helpless."*

Richard Kuhn, professor of biological sciences

Purdue investigators have obtained two large grants for multidisciplinary research from the National Institutes of Health and are working towards obtaining detailed knowledge of the structure and function of the alphavirus and flavivirus proteins. The long-term goal of this research is to understand the life cycles of these virus groups at the atomic level and to translate that information into novel antiviral approaches to control human infection.

Collaborations on the alphavirus and flavivirus have been going on for more than a decade. Grants in support of this research from the National Institutes of Health will permit researchers to analyze the protein building blocks of viruses more efficiently and enable large strides in viral research in a fraction of the time, according to Richard Kuhn, professor of biological sciences.

Several Seed for Success Awards have been granted to Purdue researchers for their research efforts in uncovering the role of certain proteins and their relationship to the spread of viral infections.

Additional information can be obtained by visiting: <http://news.uns.purdue.edu/UNS/html4ever/030909.Kuhn.grants.html> and <http://news.uns.purdue.edu/html4ever/2004/040820.Rossmann.baseplate.html>

## Discovery Park



### *Bindley Bioscience Center*

The **Bindley Bioscience Center**, scheduled to open this summer, blends life sciences and engineering research to cultivate and support innovative, multi-investigator, interdisciplinary research teams at Purdue University. The research and development efforts of the Bindley Bioscience Center also foster outside engagement activities that promote economic development initiatives in the life sciences sector of the state, region, nation and world.

#### Research Themes at the Center

- Chemical and Structural Biology
- Innovative Biological Instrumentation
- Tissue and Cellular Engineering Systems
- Nanomedicine

Additional information can be obtained by visiting: <http://www.purdue.edu/dp/bioscience>

### *Regenstrief Center*

**Regenstrief Center for Healthcare Engineering** is a new center that serves as a resource for improving healthcare delivery systems through the application of engineering, science and management principles. The center's primary focus is on a systems-analysis approach to improve the delivery of healthcare to consumers.

The Purdue Regenstrief Center also brings together faculty from the College of Liberal Arts such as sociology, health communication and kinesiology, and researchers in Purdue's Schools and Colleges of Pharmacy, Nursing, Health Sciences, Consumer Sciences, Technology, Agriculture and Veterinary Medicine to find ways to deliver healthcare more effectively and efficiently.

Additional information can be obtained by visiting: <http://www.purdue.edu/dp/rche>

## *Research Partnerships*

The Office of Industry Research and Technology Programs focuses on creating partnerships and developing models to help Purdue be recognized as a strong collaborator in research and technology transfer. New partnerships were negotiated with Purdue Research Park companies (gh LLC (assistive technology for the visually disabled); St. Vincent Hospital (re-engineering healthcare); and the state of Indiana, Crane NAWC, Indiana University and Purdue (Research Initiatives Cooperative R&D Agreement for Homeland Security efforts).

### *Indiana 21<sup>st</sup> Century Research and Technology Fund*

This fund was created by the Indiana Legislature to facilitate and accelerate the transfer of technology from Indiana's academic institutions to Indiana companies in order to stimulate economic development and job creation in the state.

Purdue is collaborating in 83 percent of the awards from Round V and 78 percent in Round VI.

Several of the new awards involve health-related research activities:

- Center of Excellence: Institute for Advanced Pharmaceutical Technology
- Gene Therapy for Joint Damage
- Controlled Environments Production System for Plants Genetically Modified to Create Pharmaceutical and Other Beneficial Proteins
- Indiana Protein Center
- Accelerator Mass Spectrometry Center for Biomedical Excellence
- Development of Vaccines in Microalgae
- A Center of Excellence in Medical Informatics
- Folate Chemo: Novel, Nontoxic Delivery of Chemotherapeutics

Purdue believes that strong, open partnerships are key to maximizing our research strengths and for achieving our engagement goals.

## *Health Communication Degree Program at Purdue*

Purdue's health communication program, established in 2002 and ranked ninth out of 29 programs at universities nationwide in the National Communication Association's Doctoral Reputational Study, looks at how interactions among patients, healthcare providers and the medical industry influence the quality of healthcare. Graduates in the area are now working in nonprofit organizations, the Centers for Disease Control and Prevention, health departments, research companies, worksite wellness programs and at other universities. Faculty in the health communication program are pursuing interdisciplinary research with areas such as Purdue's pharmacy, nursing and veterinary programs, and opportunities for collaboration are increasing as Purdue's health communication unit becomes involved in the new Regenstrief Center for Healthcare Engineering at Purdue. Howard Sypher, professor and department head, is one of Purdue's first two Regenstrief Center for Healthcare Engineering Faculty Fellows.

Additional information can be obtained by visiting: <http://www.sla.purdue.edu/academic/comm/index.htm>

## Office of Technology Commercialization

The Office of Technology Commercialization (OTC) has taken on the challenge of delivering on President Martin Jischke's vision of preeminence in technology transfer and is an important driver of economic development in the state of Indiana.

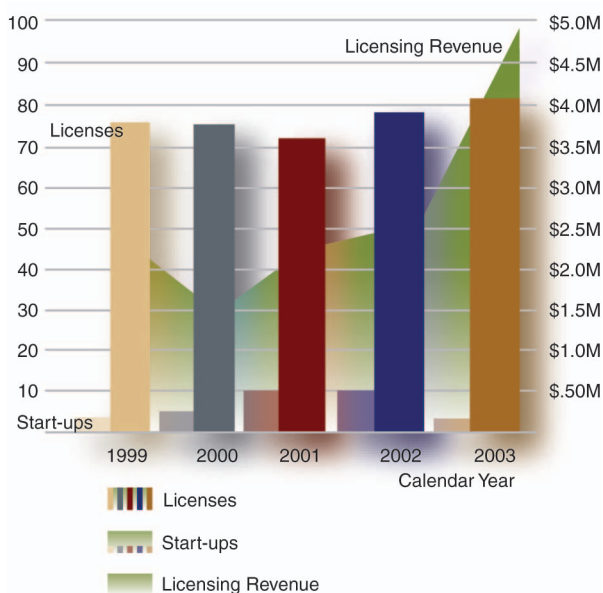
OTC met and exceeded all goals set for commercialization-related activities. The office set a new record handling 177 technology disclosures in 2003-04. Regular U.S. patent applications increased by 25 percent, and 37 percent more provisional U.S. applications were filed, while reducing Purdue Research Foundation (PRF) patent costs by 23 percent.

OTC also exceeded its revenue target for the fiscal year by 22 percent, generating approximately \$4.9 million in royalties. The major contributor of revenues to Purdue in technology commercialization was the Extra Cellular Matrix portfolio developed in the College of Engineering.

The Purdue Research Foundation's Trask Innovation Program invested almost \$500,000 in technology that could be enhanced for commercialization through further discovery. Eleven projects were funded and the goal is that this investment will facilitate the commercialization of new Purdue technologies.

OTC has increased the capacity to handle new disclosures and extend the effective management of Purdue's intellectual property. A significant focus over the next year will be to provide support for new technologies that need to incubate in start-up companies to reach the marketplace.

### OTC Calendar Year Summary



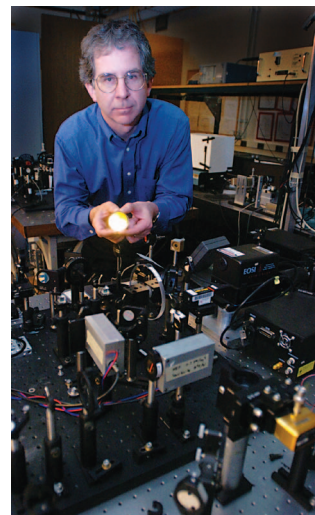
## Discovery to Commercialization

### BioCDs for Doctors

A team led by physicist David D. Nolte has pioneered a method of creating analog CDs that can function as inexpensive diagnostic tools for protein detection — a technology that could revolutionize medical testing by giving hospitals fast, easy ways to monitor patient health. Team members include Fred Regnier, distinguished professor of chemistry, and two physics graduate students.

The concept has been patented as bio-optical CDs or "BioCDs." The advantage to the bio-optical CD concept is the number of molecules the disks can screen, as well as the simplicity and low price. Instead of containing digital data, their surfaces would hold molecules that could detect levels of proteins in blood samples.

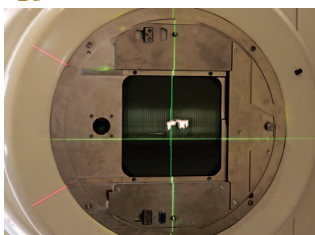
Additional information can be obtained by visiting: <http://news.uns.purdue.edu/UNS/html4ever/2004/040518.Nolte.CD.html>



### Improved Radiation Therapy

Researchers at Advanced Process Combinatorics Inc., Purdue and the Indiana University School of Medicine have designed and refined a new technique that allows physicians to quickly customize treatment plans that deliver more radiation to tumors without causing extensive damage to surrounding or healthy tissue. Support from Indiana's 21st Century Research and Technology Fund helped fund this research.

Additional information can be obtained by visiting: <http://news.uns.purdue.edu/UNS/html4ever/2004/040621.APC.radiation.html>



### Research Park company develops diabetes sensor for continuous monitoring

Vista Biosciences LLC, a start-up company located in the Purdue Research Park, reached a milestone in the development of technology that can continuously monitor glucose levels without painful finger pricks and alert diabetics exactly when to inject insulin.

Additional information can be obtained by visiting: <http://news.uns.purdue.edu/UNS/html3month/031028.Gore.Vista.html>

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*This annual report is not intended to be a comprehensive summary of health-related research activities at Purdue University.  
Purdue University News Service, Agriculture Communications, and Engineering Communications Office contributed to this report.  
Please visit the urls listed in the report for more information on many of these research stories.  
This report also is available online at: <http://www.purdue.edu/research/vpr/publications/>*

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