messages

... from the president

A great university is — first of all — an incubator of ideas. Purdue brings together some of the best minds of our time and gives them the freedom and resources to do their best work. The results not only advance the frontiers of discovery and help to drive economic development, but also present remarkable learning opportunities for our students. I believe the ideas being created and developed now are making this Purdue's greatest age of discovery. — *Martin C. Jischke, President*

... from the provost

The natural evolution of discovery at Purdue University has included building new facilities, increasing our overall infrastructure, hiring a wide range of new, very talented faculty, and engaging more and more of our students, both graduate and undergraduate in the discovery process. The pace of activity here at Purdue has increased substantially over the past three years, and that is intentional. We're proud of the role we're playing in helping rebuild the Indiana economy, and I'm especially proud of the initiatives we are undertaking in the life sciences. Great colleagues and outstanding students are impacting our abilities to conduct basic and applied research in very positive ways. They bring a creative and entrepreneurial spirit that will continue to drive Purdue forward in the coming years. — *Sally Mason, Provost*

... from the interim vice provost for research

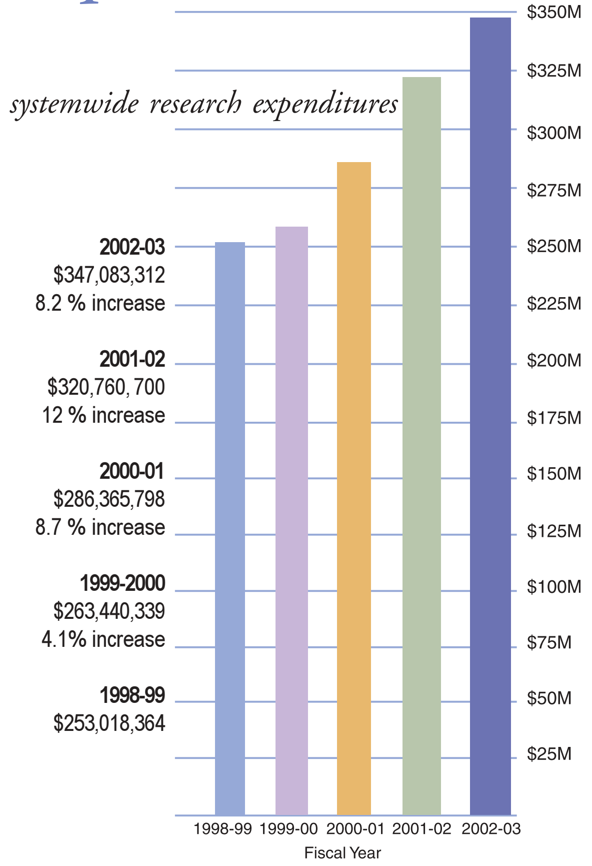
Discovery of the complete genome of the cell has opened the door to investigate more fully the many subcellular systems that coexist and, in many cases, cofunction together. The many protein systems encoded within the genome form the basis for the structure, metabolism, transport and numerous other functions of the cell. Purdue has a critical mass of faculty with expertise and the experimental tools to provide leaders in the discoveries of these interrelated cellular systems.

A pair of grants totalling nearly $18 million from the National Institutes of Health will support Purdue research teams in the Department of Biological Sciences and the Department of Medicinal Chemistry and Molecular Pharmacology in the pursuit of basic research on viruses which could lead to the development of antiviral agents. Awards such as these, along with sound investments in our research infrastructure, enable Purdue to move to the next level of preeminence in this important area of research.

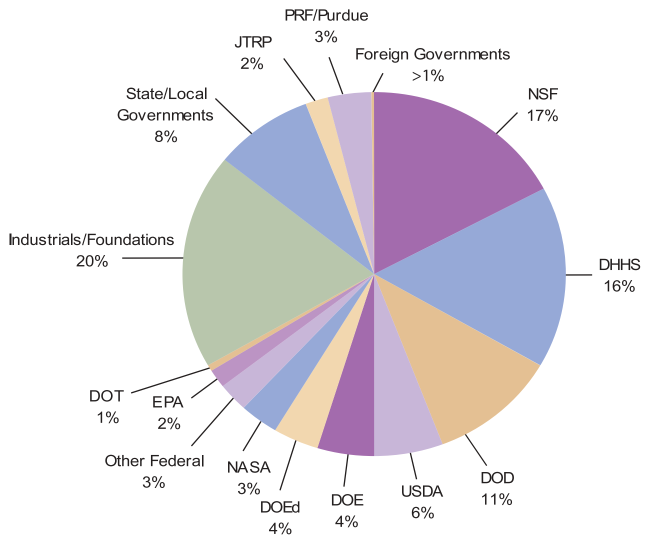
Gratitude and appreciation are extended to the many stakeholders working at the University and with the University to make this possible.
— *Charles O. Rutledge, Interim Vice Provost for Research and Executive Director of Discovery Park*

2002-03 research expenditures

systemwide research expenditures



sources of research funding by sponsor — systemwide



partnerships

Partnerships are an integral part of the strategic planning efforts at Purdue University. In February 2002, Purdue — along with the Central Indiana Corporate Partnership, the City of Indianapolis, Eli Lilly and Company, the Indiana Health Industry Forum, and Indiana University — joined together to form the Central Indiana Life Sciences Initiative. Now known as Bio Crossroads, the initiative works to attract and create jobs, companies and entrepreneurial opportunities in the life sciences industry by using world-class research capabilities to make Indiana a center of innovation in the business of improving health.

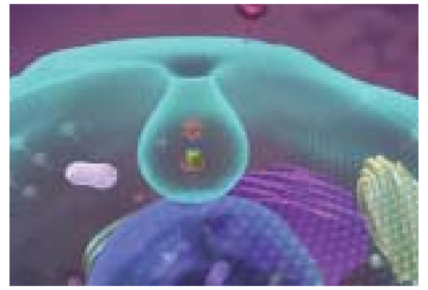
Indiana Future Fund 1 is a fund established through Bio Crossroads to create entrepreneurial opportunities. The fund is a $72 million capital pool that will invest in regional and national venture capital funds, encouraging direct investment in Indiana life sciences enterprises.

Inproteo — another partnership with Indiana University's Advanced Research & Technology Institute, Eli Lilly and the Purdue Research Foundation — is a new corporation that applies analytical chemistry to design, create, and optimize instrumentation and methodologies for the development of diagnostics and therapeutic agents.

Partnerships like these bring together the creativity of the academic and private sectors making way for new innovations that will improve the health and well-being of future generations.

Industry Research & Technology Programs
http://www.purdue.edu/research/vpr/partners
Bio Crossroads http://www.biocrossroads.com/

new technologies



Endocyte develops receptor-targeted therapy

Endocyte — a biotechnology company at the Purdue Research Park — has developed an effective targeting system that uses receptor-targeted therapeutics to destroy diseased cells while avoiding healthy cells. When a drug is linked to folate, researchers have found that the folate-drug conjugate binds to folate receptors present on the diseased cell's surface. The drug is then taken into the cell through endocytosis.

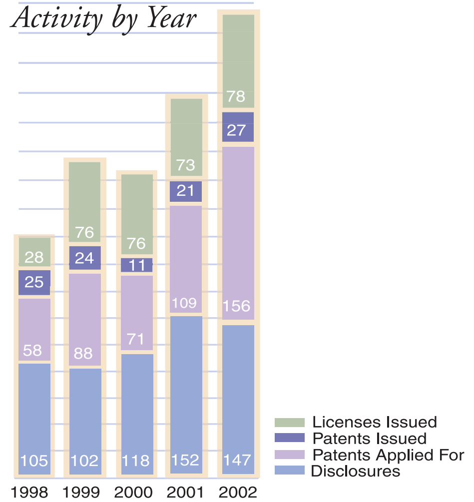
http://endocyte.com/

Research Park company develops diabetes sensor for continuous monitoring

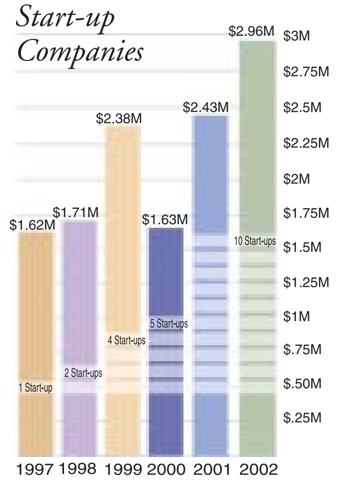
Vista Biosciences LLC, a start-up company located in the Purdue Research Park, has reached a milestone in the development of technology that can continuously monitor glucose levels without painful finger pricks and alert diabetics exactly when to inject insulin.

http://news.uns.purdue.edu/UNS/html3month/031028.Gore.Vista.html

Office of Technology Commercialization Activity by Year



Income and Start-up Companies



entrepreneurial competitions

"Roche is committed to strengthening life sciences here in Indiana, and working with a world-renowned university such as Purdue on a project like this enables us to advance the academic awareness and attention to the life sciences and bioresearch." Martin Madaus, president and CEO for Roche Diagnostics, North America

Matthew Campbell, chief operating officer of Iris AO, makes the winning presentation at Purdue's inaugural Life Sciences Business Plan Competition in April 2003. (Purdue University file photo/ John Underwood)

The Purdue University Life Science Business Plan Competition seeks commercially viable business plan entries for innovative products and services in the life sciences industry such as medical equipment and devices, pharmaceuticals and drugs, research services, and software.

Founding sponsor Roche Diagnostics contributed $100,000 to the competition. Sponsors for the 2004 contest include: Clifton Gunderson LLP, Aventor, Baker & Daniels, Indiana Health Industry Forum, and Bio Crossroads (formerly the Central Indiana Life Sciences Initiative). The second annual Life Sciences Business Plan Competition will be held April 20 - 21, 2004, on the Purdue campus.

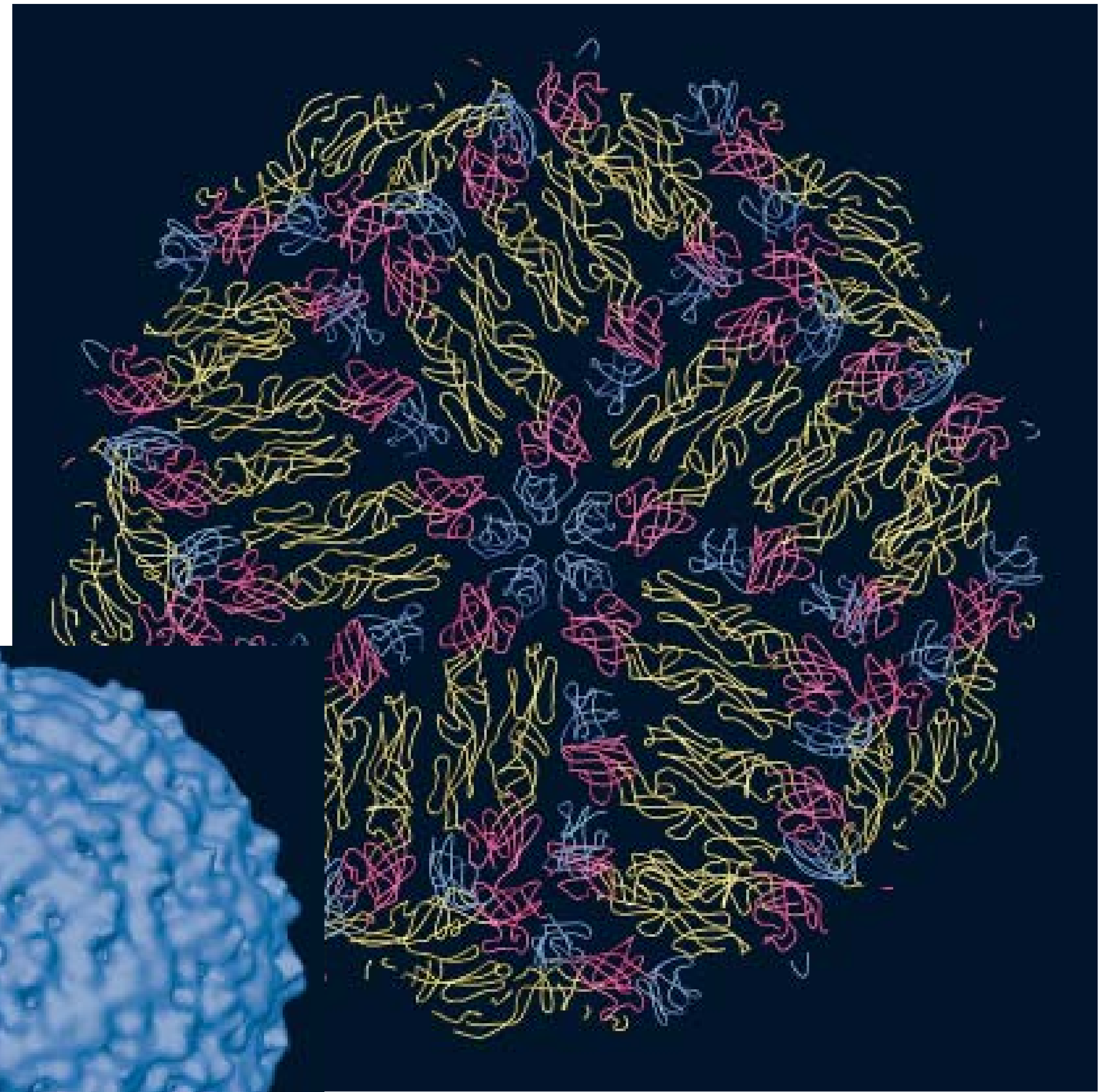
Contact Don Blewett, associate director of the Burton D. Morgan Center for Entrepreneurship, (765) 494-4485, blewett@mgmt.purdue.edu.
Web site: http://128.210.160.161/wps/portal/.cmd/

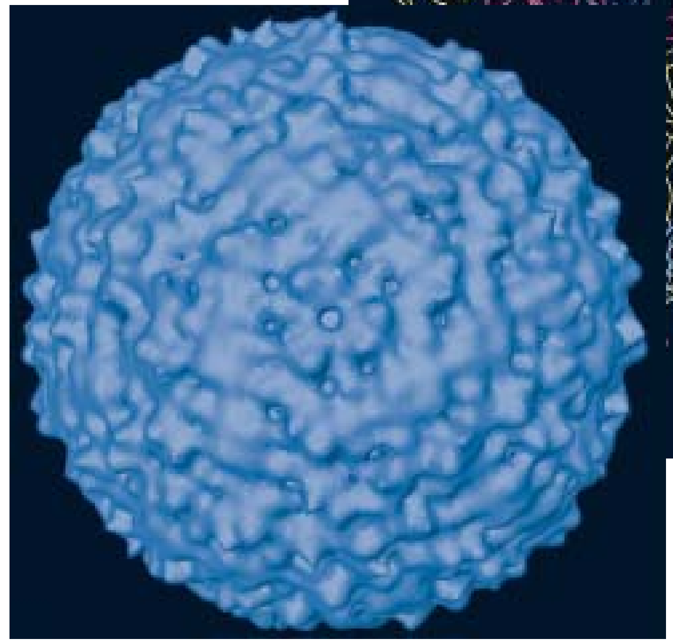
Credits: The Purdue University News Service, Agriculture Communications, and Engineering Communications Office contributed to this report. Please visit the urls listed in this report for more information on many of these research stories. This report also is available online at: http://www.purdue.edu/research/vpr/publications/

PURDUE
UNIVERSITY

2002-03 research activities
from the office of the vice provost for research

This year's annual report highlights some of the life science research activities at Purdue that contribute to the Indiana Bio Crossroads initiatives.





Pictured above is the orientation of the envelope protein molecules that comprise the surface of a West Nile virus particle. The major surface protein is composed of three domains, color-coded pink, yellow, and blue. The proteins self-assemble in a host cell, forming a well-organized geometric shape. Knowledge of the proteins' structure could help scientists in the effort to develop antiviral agents.

This inset image shows a surface-shaded image of the West Nile virus particle produced by Purdue University biologists using cryoelectron microscopy. The surface is composed of proteins that enable the virus to bind with and invade a host cell. The particle is approximately 50 nanometers in diameter, or about 1/1000th of the width of a human hair.
(Purdue Department of Biological Sciences images)

PURDUE
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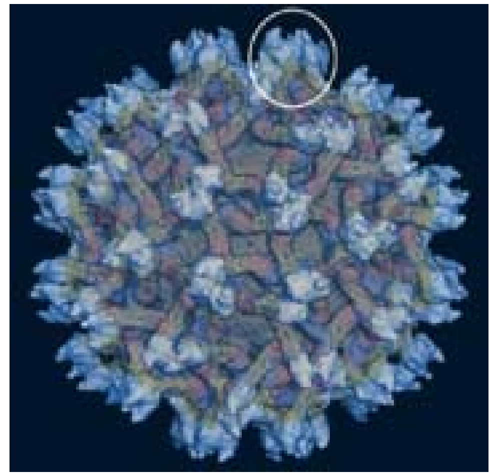
life science discoveries

Discoveries borne out of Purdue's life science initiative will likely touch every area of our lives.

Knowledge gained by uncovering the complexities of molecular structures and their interactions is leading to the development of targeted drug delivery systems, replacement tissues, biological detection instrumentation, the use of microorganisms to break down toxic waste in our environment, and computers that use DNA molecules for memory.

Previous advances in the instrumentation used to uncover the secrets of biological systems have made this current area of research a reality. With today's discoveries we will likely develop an entirely new variety of 'biological' tools that will help us solve the complex issues of this new century.

This report offers a brief glimpse at some of the past year's life science research activities at Purdue.



Dengue virus

Purdue biologists determine structure of the West Nile virus

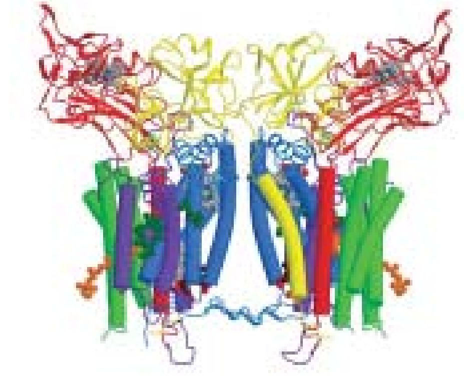
Using cryoelectron microscopy and advanced imaging techniques, the Purdue team has determined the orientation of the major surface proteins in a West Nile viral particle (see cover image). Because these proteins are instrumental in allowing the virus to bind to and invade a host cell, the research could be a step forward in combating the deadly mosquito-borne disease.

Previous work on other flaviviruses by scientists from the laboratories of Richard Kuhn, Michael Rossmann and Timothy Baker could assist with science's understanding of this particular viral family.

"What we already know from studying other flaviviruses could give us a leg up understanding West Nile's behavior," Kuhn said. "Dengue, (pictured above) for example, has a very similar structure to West Nile's, but its surface features are sufficiently different that comparisons could help shed light on how West Nile operates.

"By understanding how these proteins interact with one another, we can now start thinking about how to interfere with these interactions, which could be a key to stopping the infection's progress."

http://news.uns.purdue.edu/UNS/html4ever/031009.Kuhn.westnile.html



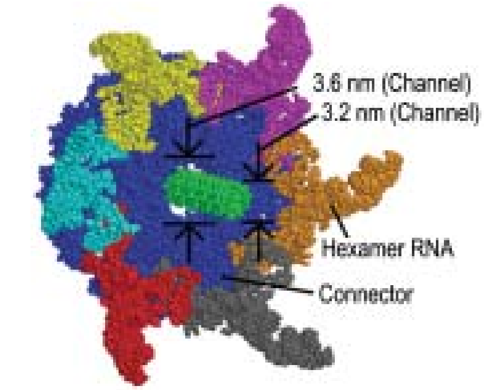
Purdue biologists solve mysteries of photosynthesis, metabolism

Purdue scientists have developed a complete molecular-scale picture of how plants convert sunlight to chemical energy, offering potential new insights into animal metabolism as well.

Using advanced imaging techniques, a team of Purdue biologists has determined the structure of cytochrome, a protein complex that governs photosynthesis in a blue-green bacterium. The research reveals a wealth of information, not only about a photochemical process crucial to all life on the planet, but also about how cells handle and distribute energy. According to team member William Cramer, Henry Koffler Distinguished Professor of Biological Sciences, the study is a great leap forward in our understanding of photosynthesis.

Cramer also said that the study is an important contribution to the young field of proteomics research because there are few data on the important family of membrane-embedded proteins in the total protein database.

http://news.uns.purdue.edu/hp/Cramer.photo.html



Life's storehouse of information, DNA, transformed into an engine fueled by ATP

Peixuan Guo, professor of veterinary pathobiology in Purdue's School of Veterinary Medicine, and his research team found a way to make ATP move RNA around. His team assembled several strands of RNA into a hexagonally-shaped "engine" with a strand of DNA functioning as the axle. When fed a supply of ATP fuel, the RNA strands kick against the axle in succession, much like pistons in a combustion engine. Such minuscule motors could find applications in nanotechnology.

The motors could also be used not only to spin the DNA strand, but also as potential gene delivery vehicles. Guo's team had already found that the motor could drive its axle into a virus' protein shell and has recently also learned that the ATP-binding RNA derived from the phi29 virus can deliver a ribozyme that destroys Hepatitis B.

"Delivering healthy genes or therapeutic molecules into damaged cells is the goal of gene therapy," Guo said. "With some modifications, we hope our research will enable us to deliver therapeutic molecules to cancerous or other virus-infected cells as well." The discovery made by Guo's team could advance nanotechnology and possibly solve fundamental mysteries about life itself.

http://news.uns.purdue.edu/UNS/html4ever/030204.Guo.ATP.html

multidisciplinary teams

Purdue scientists lead $5.9 million study to improve plant products

Everyday products from food to chairs could be improved through research led by a Purdue University scientist and funded by a new four-year, nearly $6 million National Science Foundation grant.

Nick Carpita, a Purdue plant biologist, will lead the investigation of the formation, development and growth of plant cell walls. The research team will include scientists from Purdue, the University of Florida, University of Connecticut, University of Wisconsin and the National Renewable Energy Laboratory, a Department of Energy contract facility based in Golden, Colorado.

"This project is to determine the function of all the genes involved in plant cell walls," said Carpita, professor of botany and plant pathology. "If we learn the way cells stick to each other, we may be able to control the softening of fruits and vegetables — increase the shelf life."

Knowledge of plant cell wall development and structure could lead to altering some of the polymers (which give wood its strength), such as lignin and carbohydrates, to make fodder more digestible for livestock, improve paper quality and improve corn stover for use as a biofuel, he said.

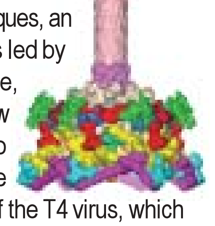
http://www.purdue.edu/UNS/html4ever/021101.Carpita.nsfplants.html

Tissue and Cellular Engineering, a signature area

One of Purdue Engineering's signature areas and a research thrust of the Bindley Bioscience Center, integrates engineering and the life sciences in order to develop replacement tissues such as knee cartilage and retinal tissue. Albena Ivanisevic, assistant professor of biomedical engineering, is fabricating mimemetic templates and scaffolds for retinal cell implantation that could help older people retain or even regain their eyesight.

Klod Kokini, professor of mechanical and biomedical engineering, says that a goal is to develop implantable materials that have cellular and tissue properties like the body itself. Interdisciplinary teams are necessary to design and investigate such materials and devices at the molecular and cellular level. Engineering replacement tissues requires researchers to understand how cells and biomolecules react to engineered tissues when implanted and to understand key tissue mechanical and chemical properties of the system.

https://engineering.purdue.edu/Engr/Signature/TCE/
http://news.uns.purdue.edu/hp/Ivanisevic.retina.html



Purdue researchers expose 'docking bay' for viral attack

Using advanced imaging techniques, an international team of biologists led by Michael Rossmann of Purdue, Vadim Mesyanzhinov in Moscow and Fumio Arisaka at the Tokyo Institute of Technology have analyzed the structure of part of the T4 virus, which commonly infects E. coli bacteria. The part the researchers analyzed, called the baseplate, is a complex structure made of 16 types of proteins that allows T4 to attach itself to the surface of E. coli in order to inject its own deadly genetic material. The research has produced the clearest picture ever obtained of the baseplate, which plays a critical role in the initial stages of viral infection.

"We now have a fairly complete picture of the baseplate, the part of the virus that latches onto its cellular victim," said Rossmann, Hanley Distinguished Professor of Biological Sciences in Purdue's School of Science. "Armed with this knowledge, we should obtain a better understanding of how this virus injects its genetic material into its host. It could be the key to stopping the process — or even harnessing it to benefit humanity."

http://news.uns.purdue.edu/hp/Rossmann.baseplate.html

Researchers close in on a natural solution to PCB contamination

An environmentally friendly solution to one of the world's most notorious chemical contamination problems may be a step closer to reality.

A research team from Purdue University and the University of British Columbia discovered the key stumbling blocks that prevent microorganisms from breaking down PCBs (polychlorinated biphenyls). The discovery could eventually show researchers how to teach microorganisms to break down PCBs into ecologically safe molecules, a process known as bioremediation.

By discovering that bacteria have difficulty digesting PCBs, Jeffrey T. Bolin, professor of biological sciences, and Lindsay Eltis, associate professor of microbiology and biochemistry at the University of British Columbia, predict that the next step is to discover which chemical step in the chain of digestion is causing this difficulty and then to breed microorganisms with the goal of improving their ability to breakdown PCBs.

"We have isolated one of the major hurdles to cleaning up PCBs naturally," said Bolin. "This gives us a clear picture of one route to degrading PCBs in the environment."

A micrograph image of Rhodococcus sp. RHA1, which are good PCB-degraders. (Photo/UBC Bioimaging Facility)
http://news.uns.purdue.edu/UNS/html4ever/021104.Bolin.bioremediatn.html

instrumentation

Purdue instrument to fashion custom-made proteomics chips

Purdue scientists are developing an instrument that can fabricate custom-made biochips for protein analysis, offering a potentially powerful new tool for drug development and basic medical research. The process, called ion soft-landing, is a comparatively gentle process producing highly pure protein samples that retain their ability to react with potential drugs.

"This technique, when fully developed, will allow us to take hundreds of proteins from a cell without damaging them," said R. Graham Cooks, Henry Bohn Hass Distinguished Professor of Analytical Chemistry in Purdue's School of Science. "We can then deposit these proteins in specific locations on a chip, where their functions can be analyzed quickly. We hope this chip-making instrument will streamline proteomics research."

http://news.uns.purdue.edu/hp/Cooks.chip.html

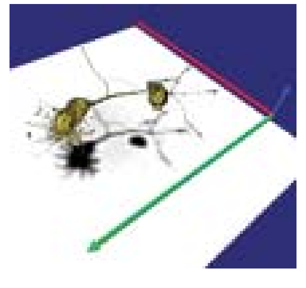
Researchers stretch DNA on chip, lay track for future computers

Albena Ivanisevic, assistant professor of biomedical engineering, and physics doctoral student Dorjderem Nyamjav have precisely placed stretched-out strands of DNA on a silicon chip so that their encoded information might be read more clearly, two steps critical to possibly using DNA for future electronic devices and computers.

An instrument called an atomic force microscope and a device called a cantilever were used to lay down lines of polymer in a process called dip-pen nanolithography. Each of the lines of polymer is about 100 nanometers wide, and each centimeter-square chip contains numerous templates. The positively charged polymer has the opposite charge as DNA, so when the genetic material is dropped onto the chip, it is attracted to the lines automatically. Then the researchers used a syringe to drag the DNA, uncoiling the strands along the template surface. This work could lead to the ability to stretch DNA molecules in specific locations on electronic chips, which is critical in harnessing the storage capacity of DNA for future computers.

http://news.uns.purdue.edu/UNS/html4ever/031007.Ivanisevic.DNA.html

Kinetic measurement of live cell function



When cells perform their normal functions, they operate within the confines of the environmental constraints of their specific systems. Each cell type has a specific function, and measurement of these functions is difficult. Replicating their environments *in vitro* is a challenging, but necessary, way to study how cells function. By using advanced technologies for cell analysis, such as laser-based flow cytometry and multidimensional imaging using confocal or multiphoton microscopy, it is possible to obtain detailed knowledge of how cells function in environments closely resembling their natural homes.

Image: A live neuron in 3-D space. Biochemical characteristics and structure can be studied simultaneously. (Collaboration between J. Paul Robinson and Richard Borgens) http://www.cyto.purdue.edu

breaking ground in research infrastructure

Purdue is committed to enhancing multidisciplinary relationships on campus and with other institutions. The establishment of centers and institutes provides a vital mechanism for nurturing these kinds of research interactions.

For a complete list of Purdue's centers and institutes, please visit the Web site at: http://www.purdue.edu/research/vpr/centers_institutes/index.html

Purdue center formed to create devices to speed drug discovery

A new state-funded research center at Purdue University will team up scientists and engineers for a project that could speed the discovery of drugs to treat numerous diseases, including cancer and cystic fibrosis. The Center for Membrane Protein Biotechnology will be funded initially with a $1.3 million, two-year grant from the Indiana 21st Century Research and Technology Fund, established by the state to promote high-tech research and to help commercialize university innovations. Funding for the first half of 2003 was approved in January 2003. Research in the center will concentrate on developing a new class of miniature devices that use cell membranes to screen new drugs — effectively recreating how cancer cells would react to the drugs. The goal is to produce "laboratories-on-a-chip," devices less than one half-inch square that contain up to one million test chambers, each capable of screening an individual drug, said Gil Lee, the project's leader and an associate professor of chemical engineering.

Visualization and computing through ITaP's Envision Center

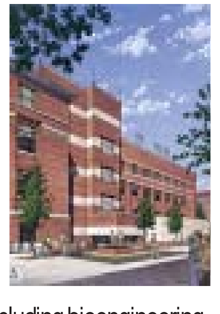
A vital component of the life sciences initiative is the robust computing environment provided by ITaP — Information Technology at Purdue. An innovative and nimble computing architecture makes it possible for Purdue researchers to gain new insights by visualizing the structures of viruses and proteins. ITaP enables these discoveries by providing high-performance computing resources that combine new computational instruments and high performance visualization techniques resulting in powerful tools for advancing science.

http://www.itap.purdue.edu/viscenter/

Bindley Bioscience Center

Important goals of the Discovery Park Bindley Bioscience Center are to provide an "engine" for harnessing multidisciplinary life science research innovations, to establish a conduit for engagement with outside constituents, to bring new life science technologies to bear on the economy and to provide a platform for the development of scientific leaders at Purdue.

Chemical Engineering Building Expansion



The available square footage of the Chemical Engineering Building increases by two-thirds, up to 67,000 square feet. The renovated building adds interactive teaching laboratories and classrooms and makes room for two new research cluster areas, including bioengineering.

Biomedical Engineering Building

State dignitaries participated in a ceremonial groundbreaking on Purdue's new $25 million Biomedical Engineering Building. The facility, the first at any public institution in Indiana, will enable Purdue to expand the current Department of Biomedical Engineering into a full-fledged school and create the state's first undergraduate program in biomedical engineering at a public university.

From left, Sen. Vi Simpson; Rep. Jeff Espich; Rep. William Cochran; Linda P.B. Katehi, Purdue's dean of engineering; Purdue President Martin C. Jischke; Peter Katona, president and CEO of the Whitaker Foundation; George Wodicka, head of Purdue's Department of Biomedical Engineering; Purdue doctoral student Rachel Price; Marilyn Schultz, state budget director; and Sen. Robert Meeks (Purdue News Service photo/Dave Umberger)