Indiana Science and Engineering News

sponsored by the Science Education Foundation of Indiana

AUTUMN 2004

# Rose-Hulman's Homework Hotline Helps with Tough Math and Science Homework

### Students say tutoring improves understanding and confidence

There's nothing more frustrating than getting stuck on a difficult math or science homework problem. Teachers are great at explaining concepts and assisting in the classroom, but they can't always be available in the evening.

Fortunately, Indiana students in grades 6 through 12 can get free math and science homework help from Rose-Hulman Institute of Technology's Homework Hotline. A toll-free telephone tutoring service, the Homework Hotline helps Indiana middle and high school students better understand math and science concepts and improve their problem-solving skills.

The Homework Hotline is open September through May for students who want math or science homework help. Students may call toll free at 1-877-ASK-ROSE from 7 p.m. to 10 p.m. (Eastern Standard Time), Sunday through Thursday.

Homework Hotline tutors are Rose-Hulman college students specially chosen and trained to work with middle and high school students of all academic levels. Tutors have access to math and science textbooks used by Indiana students, computers and the Internet. The Homework Hotline tutors help students work through their homework problems and guide students in learning more about a subject. Tutors do not do the work for the students or give them the answers. Instead, tutors help students arrive at the correct solutions. Last year, tutors answered more than 29,500 calls. About 75 percent of the calls were from students asking for help with math homework.

"The Homework Hotline is great and really helps me. It was the way I survived algebra last year and the way I am surviving geometry this year," said one student caller in a survey conducted by the Homework Hotline.

"The tutor was patient, kind and sounded like she had helped students many times before. I got the information and help I needed to complete my entire homework assignment," said another student.

Students who call the Homework Hotline will be asked to give their first name only and the name of their school. They should have the following items handy before calling:

- Homework assignment
- Textbook (if available)
- Paper
- Pen or pencil
- Calculator (if needed)

Students may also access the Homework Hotline web site at *www.AskRose.org*. The site offers free educational resources and helpful educational links. Students can post math and science questions on the Web site, and a tutor will respond during the Hotline's next hours of operation.

So the next time math or science homework is a problem, don't worry! Help is just a phone call or mouse click away at toll-free 1-877-ASK-ROSE or *www.AskRose.org*.

*The Homework Hotline is sponsored by Rose-Hulman Institute of Technology, Lilly Endowment, Inc. and 3M Corporation.*

### IAS Annual Fall Meeting

The Fall Meeting of the Indiana Academy of Science will be held at Hanover College October 28 and 29. The local arrangement committee, headed by Jeff Hughes and Daryl Karns, has been hard at work preparing for the event.

This year's meeting promises to be outstanding. In addition to the usual oral and poster presentations, the Biodiversity and Natural Areas Committee of the Academy is hosting workshops on reptiles, tree rings and bees. The principal speaker is Dr. Gene Kritzky from the Biology Department of the College of Mt. St. Joseph in Cincinnati.

The meeting is being held in conjunction with the annual meeting of the Ohio Valley Entomological Association (OVEA). The dual meeting will provide excellent opportunities for both academic and social interactions among members of both organizations. In addition, members of the Science Writers of Indiana and members of the Indiana Environmental law group will meet with the Academy.

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## Over $190,000 in Scholarships & Prizes Won at The Intel International Science and Engineering Fair

At the end of a long school year, most students are thinking about how they will spend their time over summer break. For a few Indiana high school students, however, summer 2004 started with a special reward for a job well done – over $190,000 in college scholarships and prizes.

These students participated in the Intel International Science and Education Fair (Intel ISEF), the world's largest pre-college science fair. The 2004 Intel ISEF was held in Portland, Oregon, May 9-15, and included more than 1,400 students from 41 countries competing for over $3 million in prizes.

The Indiana team was made up of "Best of Fair" winners from regional fairs in the state, including 12 male and 14 female students in grades 9 through 12. Details about the students and their projects can be found at *www.sefi.org/portland/Awards_Won_by_Indiana_Students_2004_ISEF.pdf.*

The Indiana Science Education Foundation (SEFI) sponsored the students in their journey to Oregon. SEFI is a non-profit organization dedicated to encouraging students to choose careers in math and science and to practice these careers in Indiana. SEFI focuses on issues affecting math and science education in Indiana and administers the state's regional science and engineering fairs.

SEFI is also responsible for bringing the Intel ISEF to Indianapolis in 2006, attracting over 5,000 visitors—including key scientific and business leaders in the life sciences—to Indiana's capitol city.

"We're very proud of these Indiana students, who have shown that they are among the next generation's best and brightest," said SEFI Executive Director William Gilmore. "Indiana's success tomorrow in the knowledge economy will depend on the talent we develop in our schools today. All 26 Indiana students who participated in the Intel ISEF 2004 have demonstrated that Indiana is fertile ground for creativity and innovation—today and tomorrow."

Sponsored by Intel since 1997, the International Science and Engineering Fair is the world's largest pre-college science competition showcasing the most promising young scientists and inventors. Students competing in Portland emerged from a worldwide field of several million science fair participants during the past academic year. They then went on to compete with over 65,000 students at more than 500 regional Intel ISEF-affiliated science fairs around the world to win the right to attend at the Intel ISEF. Intel ISEF 2004 was presented by Applied Materials during its first exhibition in Portland, Ore. Visit *www.intelisef2004.org* for more information.

## IUPUI News

### IUPUI to Offer Associate, Bachelor's Degrees in Biotechnology

The level of training required for the biotechnology workforce has escalated as the life sciences industry has become larger and more sophisticated. Regionally, employers face an urgent need for trained life sciences employees to fill available jobs.

To meet the current and future need for highly skilled workers in biotechnological manufacturing, the School of Science at IUPUI is now offering, for the first time, an associate as well as a bachelor's degree in biotechnology.

Working with Dow AgroSciences LLC, Eli Lilly and Co., and Roche Diagnostics Corp., all of Indianapolis, and Baxter Pharmaceutical Solutions of Bloomington, IUPUI academic administrators and faculty developed a common core curriculum coupled with clusters of applied courses that allow specialization to accommodate several areas of industrial placement.

"IUPUI is committed to supporting Central Indiana's Life Science Initiative. Biotechnology is a critical element in the life sciences. So we rapidly developed these programs to support the future of Indiana's economy and to provide new career opportunities for IUPUI students," said IUPUI Chancellor Charles R. Bantz.

The four companies estimate they alone will generate 60 to70 new openings each year. They are also collaborating with the Indiana Department of Workforce Development to make the program available as a retraining option for the existing workforce.

IVY Tech recently announced an associate degree in biotechnology as well. Although the two programs have different credit requirements for completion, students who earn the community college degree will be able to transfer all their program credits toward a bachelor's degree at IUPUI.

### New Life Science Degree Opportunities at IUPUI

The School of Science at IUPUI began offering the Forensic and Investigative Science degree program to students this fall. First of its kind in Indiana, the program will not only prepare students for the criminal justice system, but also train students for careers in forensic science, public health, environmental science, pharmaceutical sciences and other life sciences jobs.

Students earning the forensics degree at IUPUI will complete a core program of required courses, along with advanced courses leading toward specialization in one of six areas: biology, chemistry, computing, psychology, criminal justice or environmental science and health investigation.

This science-packed program will educate students in the natural, physical and social sciences, teaching them how to use an interdisciplinary approach to a life sciences career.

A nationally recognized expert on crime-science investigation and evidence collection, Jay A. Siegel, will head IUPUI's new program which began August 1. For more than 20 years, Jay directed the oldest continuously functioning forensic science program in the U.S. at Michigan State University.

# National CSI Expert/Michigan State Director to Head New IUPUI Program

A nationally recognized expert on crime-science investigation and evidence collection will head IUPUI's new forensic science degree program.

Jay A. Siegel, former criminal justice professor and director of the forensic science program at Michigan State, has become the director of the Bachelor of Science in Forensic and Investigative Science degree program at IUPUI.

Forensic science is the application of scientific methods and practices to legal or judicial matters, such as criminal court cases, civil matters or environmental disputes. The Forensic and Investigative Science degree program at IUPUI, offered through the Purdue School of Science on the campus, will be the first of its kind in Indiana. The program enrolled its first students this fall.

"With the establishment of the new degree program and the appointment of Jay A. Siegel as director, IUPUI is advancing Central Indiana's life sciences initiative. We are partners with the Indiana and Indianapolis communities to enhance economic development through forensic science activities," IUPUI Chancellor Charles R. Bantz said.

Siegel, who holds a doctorate degree from George Washington University, has more than 20 years of experience in setting up and running forensics programs, Crowell said. He has also served as an expert consultant on legal cases, including the William Kennedy Smith rape trial.

"Having Siegel as director guarantees the success of this program," said IUPUI biology Professor Dring Crowell, who chaired the committee that spearheaded efforts to create the IUPUI forensics program. "He is going to take this thing to the moon."

Since 1980, Siegel directed the Michigan State program, the oldest continuously functioning forensic science program in the U.S. and probably the nation's largest. Graduates of the Michigan program are currently working with the FBI, DEA and ATF.

Siegel also played a key role in the creation of forensic programs at Metropolitan State College in Denver; Xavier University, Cincinnati; and three Australian universities: University of Technology, Finders University and the University of Western Australia.

"Everywhere he goes, the programs become extremely successful. Not only does he bring a tremendous amount of experience, but he also brings a tremendous track record of success in setting up these programs," Crowell said.

Siegel is editor-in-chief of the three-volume *Encyclopedia of Forensic Sciences.* Published in 2002, the encyclopedia was the first resource to provide comprehensive coverage of the core theories, methods, techniques, and applications employed by crime science and laboratory forensic scientists.

The new IUPUI director is also author of the forthcoming *Fundamentals of Forensic Science*. The book addresses the scientific processes behind the elements of forensic science, such as biology, chemistry and physical sciences.

Students earning the forensics degree at IUPUI will complete a core program of required courses, along with advanced courses leading toward specialization in one of six areas: biology, chemistry, computing, psychology, criminal justice, or environmental science and health investigation. All seniors will complete an internship in an actual crime lab.

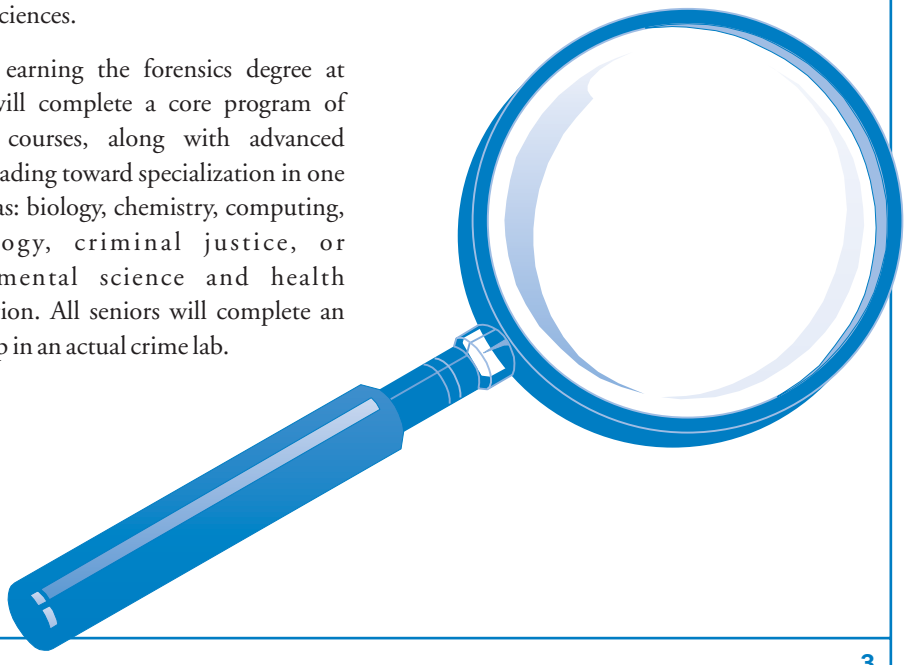
"This program will educate students in the natural, physical and social sciences and show them how to apply these sciences to the forensic sciences and to the criminal justice system in the U.S.," Siegel said. "We hope to prepare students for careers in forensic science and allied careers such as public health, environmental science, pharmaceutical sciences and others."

The program is expected to begin with 35 students and to grow to about 100 students within four to five years.

Job prospects for graduates of the new degree program are good, officials say. The Bureau of Labor Statistics has projected a 13 percent increase in employed forensic technicians from 2000 to 2010.

The Indiana Department of Workforce Development predicted more than 1,000 openings in the field between 1998 and 2008.

For more information contact: Diane Brown, 317-274-7711, *habrown@iupui.edu.* Interested students can contact an SoS advisor: 317-274-0626 or *jlthomp@iupui.edu*.



# CANCER: What is it?

Our bodies are made of billions of cells of hundreds of types. Some are formed early and remain unchanged throughout life. There is a nerve cell from your brain to your lower back that connects with another to your big toe. Adults don't make many new nerve cells, and cancers of such cells are uncommon. Liver cells are relatively long-lived, but if the liver is damaged, for example by hepatitis, the remaining liver cells "turn on" and grow new liver cells, but just enough to replace the injured cells. They don't grow two or three new livers. Cancers of such cells are more common. Some cells, like our blood, skin, and the linings of our gut, die quickly and are constantly replaced. Cancers of these cells are the most common.

A Boeing 747 airplane is much simpler but is also made of many different parts, each in just the right place and connected perfectly. Its instructions would fill a library, and an army of skilled specialists build and maintain it. If a part malfunctions it is replaced, but if one light is burned out they don't put back ten to replace it. That would be a tumor (from the Latin *swelling*). If the wing lights spread all over the wing and then took over the lavatories, they would have "metastasized" and it would be a cancer (from the crab-like invasion of normal structures).

Where is the blueprint of our body that keeps repairing it for a century? Why don't we have two noses or one eye? (A few people do have 12 fingers.) Instead of a library of blueprints we have just 35,000 instructions, our genes, and we got only one copy from each parent. These instructions are written with an alphabet of just four letters, the four nucleic acids (ACGT) that make up the DNA of all life on Earth.

We began when one of billions of sperm won the race to fertilize one of the third of a million eggs in our mother. If this tiny single cell, invisible to the naked eye, divided just 30 times, we would have 165 pounds of fertilized eggs–caviar. Instead, the instructions direct cells to bud off as limbs, to become eyes and kidneys, each at the right moment, in the right place, with the right shape.

Cancers begin when something changes these finely tuned instructions. Cells, even the ones that last 100 years, have "go" and "stop" signals that control when they will divide and form new cells and to stop such growth after just the right amount of repair. We are learning to stimulate even nerve cells to replace damaged nerves in adults, and "neuroimmunophyllins" may be able to re-grow the nerve cells in the "black stripe" in the brain whose death causes Parkinsonism.

Cancers start when cells get too many "go" signals and not enough "stop" signals. Then any cell can begin to grow, divide, and make a small nest of cells. When this clump gets to be about 1/5 inch in diameter it needs new blood vessels to nourish it. With better blood supply it can continue to grow and cause local problems as it pushes normal cells to one side. If the lump is in your stomach or colon, it can grow very large before it causes mechanical problems, and it is usually detected because cancers and their new blood vessels tend to be fragile and bleed. If the tumor is in your brain, it doesn't have to be very big before it can cause paralysis, seizures and other major problems.

In addition to local swelling, some tumors begin to shed cells into the blood or lymphatic systems. Although millions of such cancer cells may have left home, only a few find a fertile place to nest and begin to grow as metastases. This is very important because one tumor in almost any location can be slashed or burned out, but once it spreads we have to poison it, and we are not very good at poisoning only the cancer cells.

A new system under development detects a single cancer cell in 1/4 ounce of blood. In women with breast cancer, such a blood test detects a hidden cancer and predicts response to treatment. When drugs shrink the cancer, the cells in the blood decrease in number. If the cancer becomes resistant to the drugs, the first sign is an increase in these cells in blood. This may lead to a new way both to find and to monitor treatment of many cancers.

We know that the genes of a cancer cell are different from normal because when it divides, each of the new cells continues to be the same kind of cancer. We used to recognize cancer because under the microscope the cells looked different from the normal cells surrounding them. Today we can either look for genes that indicate a cancer or, even more important, a tendency to form cancer. When a cancer is cut out, the surgeon removes some normal tissue around it and the pathologist examines that margin to be sure there are no cells that look like cancer. It is becoming possible to test the genes in the surrounding cells to tell if they will become cancer in the future, requiring a wider excision to be safe.

Tests for genes are complex and timely, but many genes change the surface of the cell. We see textbook pictures of cells that look round and smooth, but cells actually look like a jungle of asparagus, broccoli and celery all mixed together. These projections from the cell surface are often antennae that detect the "go" signals that drive the cancer cells to divide. Sometimes one type of cancer has surface shrubbery that differs from normal, and we can make antibodies that bind only to such new foliage and thereby detect that cancer cell's garden. If that antibody is made fluorescent, we can see it on the surface of the cell. If we make a short strip of DNA fluorescent, it may bind to and signal presence of an altered cancer gene.

Some cancers make proteins that circulate in blood. A few cancers make normal hormones so there is an excess of adrenalin (causing rapid heartbeat, high blood pressure and sweating) or insulin (causing low blood sugar). Just as a pilot carries maps of every airfield in the world, each cell has the instructions for making all cells, including those that make hormones. So when a lung cell becomes cancerous it can lose its distinctive features and start making a hormone that normally comes from a gland in some other part of the body. This loss of the special features of the cell (dedifferentiation) is another characteristic of cancer.

Unfortunately, we haven't found enough such signal proteins in blood. We know that prostate-specific antigen (PSA) or the membrane-specific antigen (PMSA) are signals of most prostate cancers and also mirror the cancer's response to treatment. Other signals are being found for other cancers.

*Learn about the CAUSES of Cancer in the next issue, and PREVENTION and TREATMENT of Cancer in the following issue. (by: W. Leigh Thompson, PhD, MD)*

# Findings Could Aid Efforts to Harness Nature for Making Drugs

Chemical engineers at Purdue University have shown how to make yeast cells double the activity and boost productivity of a type of enzyme plants need to create important chemicals such as anticancer compounds. The work is related to efforts aimed at developing techniques to use plants and microorganisms as natural factories for producing pharmaceuticals. Such techniques would be safer and more environmentally friendly than conventional methods for making drugs, which often require hazardous chemicals and steel "reactors" operated at high pressures and temperatures. The enzymes from plants and other organisms typically function in water near room temperature under ordinary pressure.

The Purdue researchers demonstrated that altering the nutrients and carefully controlling fermentation time caused yeast cultures to produce an enzyme called ferulate 5-hydroxylase that has twice its normal rate of activity, which increases the enzyme's productivity.

"Activity relates to the amount of product that can be synthesized in a given time," said John Morgan, an assistant professor of chemical engineering at Purdue. "So we could make more than twice the amount of product per hour."

Findings are detailed in a paper appearing in the Jan. 20 issue of the journal *Biotechnology and Bioengineering*, published by John Wiley & Sons Inc. The paper was written by Morgan and Purdue doctoral student Hanxiao Jiang.

The enzyme is a member of a family of enzymes called cytochrome P450, which plants need to produce numerous chemical compounds. Plants ordinarily produce small quantities of "flavonoids," which are beneficial chemicals known as antioxidants. So researchers are developing ways to boost production of the chemicals by transferring vital enzymes from plants to microorganisms. Because P450 enzymes are "biocatalysts" that enable an organism to produce the beneficial drugs, researchers are trying to develop techniques that cause plants to make greater quantities of the enzymes and enzymes that are more productive.

The method pursued by the Purdue researchers was to focus on a gene responsible for producing ferulate 5-hydroxylase. Altering the composition of nutrients fed to the yeast cultures and controlling the fermentation time caused the gene to be "expressed," producing 45 percent more of the enzyme while doubling the enzyme's activity.

Increasing the quantity and activity of various cytochrome P450 enzymes might enable scientists to use plants and microorganisms like E. coli and baker's yeast to one day commercially produce pharmaceuticals. More progress is needed, however, before it will be practical to use plants and plant enzymes in microorganisms as natural pharmaceutical factories, Morgan said.

"I wouldn't consider this a major breakthrough, but it does represent significant progress in improving the expression of the enzyme," he said. "I think there is certainly room for greater expression of these P450 enzymes."

The same technique could be used to increase the production of other P450 enzymes, Morgan said. "The plant kingdom contains a large and relatively untapped diversity of P450s that are needed to create thousands of valuable natural products," he said.

In ongoing work, the Purdue researchers also are trying to develop methods for coaxing the enzymes to make drugs not normally produced by plants. "We are feeding them what's known as substrate analogs, or compounds that are structurally similar to the compound that this enzyme will normally recognize and react with but are somewhat structurally different," Morgan said. "Therefore, if the enzyme recognizes this compound, it will produce a novel product, or a product that's never been synthesized before.

"From a scientific standpoint, we want to understand better precisely how organisms make certain compounds, and from an engineering standpoint we want to devise a strategy for manipulating the organism so that it makes the chemicals we want it to make."

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**About SEFI**

The Science Education Foundation of Indiana began in 1965 to help organize science and engineering fairs throughout the state. SEFI sponsors travel of Indiana science fair winners to the Intel International Science and Engineering Fair, held each year in the late spring. In 2006, the Intel International Science and Engineering Fair will be held in Indianapolis which will be a unique opportunity to showcase Indiana. SEFI is broadening its franchise to include all aspects of science and engineering education and will play a leadership role with the many other professional groups in Indiana who work to advance education. These include the Indiana Department of Education, Hoosier Association of Science Teachers, Inc. (HASTI), Indiana Health Industry Forum, the Indiana Academy of Sciences, the Girl Scouts and Boy Scouts and others.

More about SEFI can be found at ***www.SEFI.org***.

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## Dr. Elaine Wolfe: Indiana's Outstanding Biology Teacher

The National Association of Biology Teachers, in conjunction with Prentice Hall, Leica Microsystems Inc., and Ken-A-Vision, has selected Dr. Elaine Wolfe to receive the 2004 Outstanding Biology Teacher Award. This honor, given annually since 1961, identifies a teacher from each of the United States, its possessions, Puerto Rico, the District of Columbia and Canada who has made valuable contributions to the profession and to his/her students. Criteria for the award include teaching ability, experience, inventiveness, initiative, inherent teaching strengths and cooperativeness in the school and community.

Dr. Wolfe is a biology/life science teacher at Guion Creek Middle School in Pike Township, Indianapolis. She graduated B.S. with honors from Purdue University School of Science and obtained her Ed.D. from Indiana University. Elaine has been actively involved in teaching for over 40 years. Before joining her current school in 1982, she held positions in Canoga Park, California; Fort Worth, Texas; and King of Prussia, Pennsylvania. Elaine has earned both a principal's and superintendent's license and, until this year, was the Science Department Chair at Guion Creek Middle School.

Dr. Wolfe's philosophy of teaching permeates all of her lessons—learning is fun, all students can learn, and learning is life long. She believes learning is promoted by stimulating students in a variety of ways. Her lessons have included creating an undersea mural from floor to ceiling in the school's seventh grade atrium, conducting experiments concerning the interdisciplinary topic of Egyptian mummies, and experiments with oil-consuming microbes to study how bioremediation is being used to clean up oil spills in the ocean.

Elaine is busy outside of the classroom, too. She has traveled to every continent except Antarctica and incorporates photos and materials from these trips into her teaching. Dr. Wolfe is also a professional artist and encourages multiple-intelligence learning in her classroom.

As a tribute to her excellence as an educator, Dr. Wolfe has earned a number of awards including Purdue University Science Department Distinguished Alumni Award for K-12 Science Teaching, the Subaru Middle School Midwest Regional Excellence in Science Teaching Award, and MSD of Pike Township Teacher of the Year Award.

The National Association of Biology Teachers and the Indiana Outstanding Biology Teacher Award Committee are extremely proud of Dr. Wolfe. "Such accomplishments and awards make not only the recipient's school district but the entire State of Indiana proud of the members of our education community," said Dr. Robert Yost OBTA Director and Senior Lecturer in the Department of Biology at IUPUI.