MIT Science News In Review

[Architecture/EECS]

MIT and General Motors Investigate the Ultimate City Car of the Future

"The Soft Car with electric wheel motors, exoskeleton frame and programmable outer skin," one of many designs from a collaboration among members of the MIT Smart Cities project, General Motors and architect Frank O. Gehry.
Image / Mitchell Joachim, MIT Ph.D. candidate, architecture.

Architect Frank Gehry and General Motors have teamed up with the MIT Media Lab to design a prototype for the next generation of city cars. Their vision is to create a savvy and safe vehicle that is more considerate of its surroundings and enhances city life. Preliminary sketches and models of this revolutionary project can be seen at the "Smart City Cars in the 21st Century" exhibit at the Wolk Gallery.

The modern car has contributed to unprecedented levels of pollution, consumption of fossil fuels, road injuries, and inefficient land use. The Smart Cities group at MIT hopes to change this by utilizing vehicles as a resource for navigating the city. As William J. Mitchell, head of the Media Arts and Sciences program, says, "Our hope is to invent a car that can function as though it has a good London cab driver built in." The city cars of the future will have enough customization, intelligence, and safety features to boggle any mind. Some features that are being researched include networking the vehicles to prevent traffic jams and car accidents, exoskeleton frames, innovative power sources, and wheels that simplify parallel parking.

GM hopes to build the final design of the Media Lab's smart car in 2006. Currently GM design experts Wayne K. Cherry and Frank Saucedo are working closely with MIT to assist with engineering and design. —M. Anahtar

Source: http://web.mit.edu/newsoffice/2004/smartcars.html

[Biology]

Unlocking the Mystery of Gene Regulators

In the September 2004 issue of *Nature*, researchers at MIT and the Whitehead Institute for Biomedical Research published their findings regarding the identification of gene regulators within yeast cells. Gene regulators, also known as transcription factors, control the expression of all genes by turning them "on" or "off." In the past, these molecules have been extremely difficult to locate. The Whitehead team, led by MIT Professor of Biology Richard Young, identified the regulators by subjecting yeast cells to a series of extreme environmental conditions; these conditions induced the various gene regulators to respond to the stimuli and thus reveal their locations. The next step after mapping the yeast genome's 203 regulators is to locate the roughly 2,000 regulators in human cells. The identification of human gene regulators could help physicians and researchers better understand everything from the epigenetic complications of cloning to diseases such as diabetes and cancer, which are caused by mutated gene regulators. —G. Denman

Source: http://web.mit.edu/newsoffice/2004/genomecontrol.html

A Twist in Cancer Metastasis?

In the June issue of *Cell*, researchers at MIT and the Whitehead Institute for Biomedical Research published their findings on a protein whose malfunctioning may be responsible for cancer metastasis. The question of how cancer cells are able to migrate throughout the body and invade surrounding tissues has always been confusing. However, the MIT research team, led by Professor of Biology Robert Weinberg, has shed light on the process by identifying a gene regulator called Twist in mice with breast carcinoma. During early embryonic development, Twist is activated to help cells travel to different tissues as the embryo forms. Weinberg's team discovered that the long-dormant protein is often reactivated by tumor cells, and later spreads cancer around the body. High levels of Twist have been found in human patients with invasive lobular carcinoma, a form of breast cancer. Researchers' new understanding of the role of Twist in cancer metastasis presents a variety of potential applications in helping physicians identify tumors that will metastasize and in developing a Twist inhibitor to limit a tumor's ability to spread. —G. Denman

Source: http://web.mit.edu/newsoffice/2004/metastasis.html

Understanding the Dual Nature of Ginseng

Prompted by Shiladitya Sengupta's research in complex sugars, a team of MIT colleagues can finally explain the dual nature of the popular herbal medicine ginseng. Conflicting studies have shown that ginseng can both help and block the growth of blood vessels. Scientists are interested in understanding the opposing effects of ginseng because increased blood vessel growth aids in wound healing while the reverse effect can inhibit the growth of cancer and tumors, since tumors are nourished by blood vessels.

Complex sugars in the molecular constituents of ginseng turn out to be accountable for these differences in the behavior of the alternative drug. In fact, different varieties of ginseng have been found to have different chemical make-ups, which include two main ingredients, one of which promotes the growth of blood vessels while the other inhibits it.

Ginseng (*Panax quinquefolia*).
Photo / Lyntha Scott Eiler, Library of Congress

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``We found that this composition really matters for the ultimate outcome,'' Sengupta says. These results, however, suggest new possibilities in treatments such as healing wounds and promoting the growth of blood vessels through isolating and utilizing these compounds in ginseng." —E. Liu

Source: http://web.mit.edu/newsoffice/2004/ginseng.html

Reversed Cancer Cell Development Shown by Cloned Mice

Professor Rudolf Jaenisch's team from the Whitehead Institute, in collaboration with Lynda Chin from the Dana-Farber Cancer Institute, has successfully cloned mice from an advanced melanoma cell. This achievement suggests that the epigenetic components of cancer—how regulatory molecules in a cell affect gene expression without altering the DNA itself—are reversible.

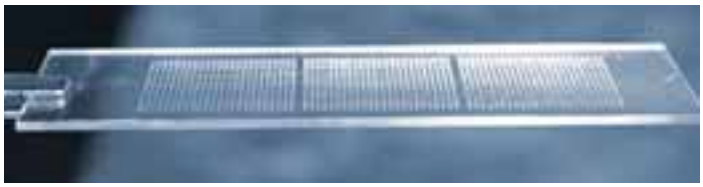
Postdoctoral researchers Konrad Hochedlinger and Robert Blelloch of the Jaenisch lab tested the reversal of epigenetic influences by injecting the nucleus from a melanoma cell into a de-nucleated mouse egg cell, which developed into a blastocyst. They then harvested embryonic stem cells from the blastocyst and incorporated them into a group of healthy mouse blastocysts. Many of these blastocysts developed into normal adult mice, as reported in the August issue of the journal *Genes and Development*. These findings have shed light on the relationship between epigenetic and genetic elements in cancer development, and may prove instrumental in medical treatments. —S. Chou

Source: http://web.mit.edu/newsoffice/2004/clones.html

[Chemistry]

MIT Team Makes Headway in Human Embryonic Stem Cell Technology

A team of MIT researchers has developed a possible method to create specific cell types from human embryonic stem cells (hES). The ability to harness the potential of hES cells, which can change into a variety of different forms, has a vast impact on biotechnology, particularly in the creation of replacement organs and numerous types of tissues. However, hES cells are difficult to manipulate, as many factors can impact their behavior.



More than 1,700 spots of biomaterial (500 different materials in triplicate) cover the surface of this glass slide; each can then be "seeded" with living cells. The MIT technology offers a quick, easy way to test how a given material affects cell behavior.
Photo / Dan Anderson, MIT

The MIT team, which focuses on the material on which the cells grow outside the body, developed a process to quickly and simultaneously test hundreds to thousands of different mediums. The researchers created robotic technology to make minuscule slides, or microarrays, measuring 25 millimeters by 75 millimeters and comprised of over 1700 spots of biomaterial. These microarrays are exposed to ultraviolet light, seeded with cells, and incubated in solution. This process allows

several microarrays to be tested under a variety of different conditions. The microarrays also cut costs, as they work with fewer cells, growth factors, and other materials. Scientists used this process to test materials that could potentially be useful in the production of epithelial cells. Further experimentation could contribute immensely to our ability to control hES cell behavior. –S. Xie

MIT research associate Dan Anderson holds a slide patterned with some 1,700 spots of biomaterial upon which he grows human embryonic stem cells. The machine behind him is the robot key to patterning and analyzing the slide.
Photo / Donna Coveney

Source: http://web.mit.edu/newsoffice/2004/celltest.html

Needle Relief

Professor Robert Langer, along with his colleagues Joseph Kost, Professor Daniel Blankschtein, and Dr. Samir Mitragotri, have developed a battery-powered painkilling device called SonoPrep. Approved on August 17 by the FDA, it could offer relief to patients who must endure repeated needle sticks.

The SonoPrep device consists of a battery-operated power and control unit, a handpiece containing the ultrasonic horn and the disposable coupling medium cartridge, and a return electrode.
Image / Sontra Medical Corp.

SonoPrep uses an ultrasonic method that temporarily perturbs the skin cells' lipid bilayers to open cavities for fluid extraction, making the skin more permeable for about 15 seconds. Moreover, this process accelerates the effect of the anesthetizing lidocaine cream, shortening the one hour wait to just five minutes.

This simple and painless method could become a standard medical procedure, with potential uses in angiography, balloon angioplasty, and venous catheter insertion. According to Langer, "approval of this device opens the door to many new uses such as glucose-sensing or insulin delivery for diabetics." Sold by Sontra Medical Corp, a company founded by the research team and directed by Langer, SonoPrep is anticipated to go on the market in September at $2000 each.

–S. Chou

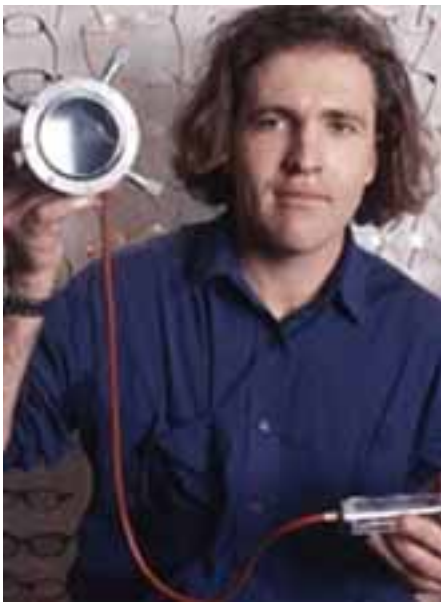
Source: http://web.mit.edu/newsoffice/2004/sonoprep.html

[Mechanical Engineering/ Materials Science]

Lemelson-MIT Prize for Low-cost Eyewear

On February 19th, 2004, doctoral candidate Saul Griffith was awarded the $30,000 Lemelson-MIT prize for his creativity in invention and commitment to improving the welfare of the global community. Griffith designed a low-cost, high efficiency process for vision-testing and for the production of eyeglass lenses, allowing people in developing nations greater access to prescription eyeglasses.

Lens manufacturing typically uses expensive materials, has high inventory and handling costs, and results in great waste. Griffith's process, however, known as programmable molding, cuts costs and increases the speed and efficiency of lens production. He created a portable device that uses car window tinting film as the membrane and baby oil to apply the correct pressure to turn the film into the mold surface. From two molds, Griffith's method can cast a large range of lenses, each taking only five to 10 minutes to produce.



Saul Griffith, 2004 winner of the $30,000 Lemelson-MIT Student Prize, holds part of his lens molding device that can produce any prescription lens quickly and inexpensively. Griffith describes the device as a "desktop printer for eyeglasses" and envisions its use in developing countries where billions of people cannot access nor afford prescription lenses.
Photo / Mark Ostrow

The other problem with prescription eyeglass lenses is tailoring them to the particular needs of each individual. Griffith approached this issue by using a device, resembling large goggles: built-in electrical sensors adjust the lens of the device to match that of the patient's eye, and the correct prescription is determined. Compared to traditional systems, Griffith's invention is of lower cost and higher accuracy.

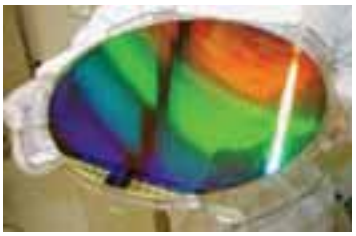
Griffith and colleague Neil Houghton have started a company called Low Cost Eyglasses to bring these products to market. –S. Xie

Source: http://web.mit.edu/newsoffice/2004/lemelson-student.html

[Nanotechnology]

A New Mark for Nanorulers

MIT researchers have designed the world's most precise nanoruler, creating parallel lines only 400 billionths of a meter apart. Mark L. Schattenburg, the director of MIT's Space Nanotechnology Laboratory in the Center for Space Research, and his team had been working towards this goal for the past five years. The nanoruler, the size of a commercial wafer, will have a huge impact on space physics and computer chip manufacturing. It will be used to pattern extremely fine gratings by moving a desired surface across a stage with a laser to



MIT's Nanoruler was used to create parallel lines and spaces only 400 billionths of a meter apart (the diameter of a human hair is about 250 times larger) across this silicon wafer. The wafer is 12 inches in diameter.
Photo / Ralf Heilmann

make interference fringes on the surface, which then become lines and spaces in a process known as interference lithography. This nanoruler technique is advantageous over conventional methods because it is both faster and more accurate. Ultimately, this technique will result in finer gratings on computer chips and better diffraction gratings for high-resolution space telescopes. Schattenburg's team has been sponsored by both the National Aeronautics and Space Administration (NASA) and the Defense Advanced Research Projects Agency (DARPA). Nanoruler technology is currently patent-pending. —H. Wang

Source: http://web.mit.edu/newsoffice/2004/nanoruler.html

[Neuroscience]

Mice Rewiring Experiments Show Adult Brain Plasticity

By understanding the extent to which our brains can be "rewired," Mriganka Sur, head of the MIT Department of Brain and Cognitive Science and Sherman Fairchild Professor of Neuroscience, and Susumu Tonegawa, director of the Center for Learning and Memory and Professor of Biology, hope to allow deaf and blind individuals to regain their ability to perceive stimuli.

MIT post-doc Jessica R. Newton points at a representation of a section of a mouse's brain that had been "rewired" to receive visual cues in the hearing region. Looking on are neuroscience professor Mriganka Sur (center), head of the Department of Brain and Cognititve Sciences, and Susumu Tonegawa, director of the Picower Center for Learning and Memory at MIT.
Photo / Donna Coveney

Researchers in the laboratories of Sur and Tonegawa "rewired" mice to change their responses to a flashing light followed by a weak shock to one foot. In normal mice, response to a fear-inducing signal is faster when it is heard rather than seen. However, Sur and Tonegawa rewired mice to reroute the visual cue through the auditory part of their brains. It took these mice far fewer repetitions of a visual cue followed by a shock to fear a subsequent visual cue alone.

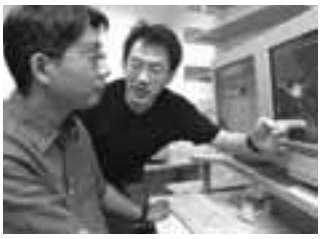
This process of rewiring is accomplished by destroying normal inputs to the auditory thalamus, which is upstream of most auditory structures. According to Jessica R. Newton, a brain and cognitive sciences graduate student working in Sur's laboratory, "Over the subsequent weeks of development, some of the visual inputs that haven't yet formed their connections to the visual thalamus then grow into the auditory thalamus. This then provides visual information to all the downstream auditory structures including the ones responsible for fear conditioning."

This study is the first of its kind to investigate whether or not rewired sensory projections can influence behavior. Newton explains that "it suggests that cross-modal inputs in deaf and blind individuals can influence and enhance learned behavior even for learning that occurs in adulthood." The results also give hope for accelerated learning and functional recovery after central nervous system damage.

—M. Anahtar

Source: http://web.mit.edu/newsoffice/2004/plasticity.html

Unlocking the Brainpower



Neuroscience professor Morgan Sheng points to an image of glutamate receptors as he and MIT postdoctoral fellow Sang Hyoung Lee discuss their work on how brain cells build and eliminate synapses.
Photo / Donna Coveney

Neuroscience researchers at MIT have moved one step closer to understanding the mechanisms of learning and memory, which may eventually allow us to boost our brainpower. The research, led by Professor Morgan Sheng, showed that a glutamate receptor subunit called GluR2 directs postsynaptic glutamate receptors (AMPA receptors) from the surface to the inside of the brain cell, thereby weakening synapses, the connections between brain cells.

The number of receptors on a synapse can dictate the strength of the surrounding neural connections. Glutamate, a common neurotransmitter, acts as a messenger that sends information across synapses. The AMPA receptors are glutamate receptors that migrate from inside the cell, where they lie to the cell surface where they can strengthen synapses. In the July 22 issue of *Neuron*, Sheng discusses how the recycling and redistribution of AMPA receptors is governed by GluR2. While little is understood about how AMPA receptors are removed from synapses, it has been determined that their removal is tied to the elimination of poorly used synapses. Unlocking the mechanisms of receptor formation and elimination on the synaptic level is an important step to understanding the basis of learning and memory, as well as for ultimately improving brain function. —H. Wang

Source: http://web.mit.edu/newsoffice/2004/sheng.html

[Sociology]

Register Your Community For I-Neighbors!

MIT Assistant Professor of Sociology Keith Hampton has initiated I-Neighbors, a free online service to promote community ties and participation. The website, accessible to every neighborhood in the United States and Canada, provides community groups with services that include a local directory, a shared photo album, a messaging program, a carpool system, and an email list.

According to Hampton, "Much research has focused on the ability of the Internet to connect people over long distances, but we wanted to focus specifically on how the Internet is used locally. We are hopeful that I-Neighbors will lead to neighborhoods that are safer, better informed, have a stronger sense of community and are better equipped to deal with local problems."

Four Boston area neighborhoods (two suburban neighborhoods, one of which was the control; an apartment building; and a gated condominium community) were given the I-Neighbor services. Hampton's research group studied the residents of these neighborhoods over two years. They observed increased local interaction and involvement, newly formed social ties, and a more heightened sense of community as a result of I-Neighbors. Of the three experimental neighborhoods, the suburban neighborhood was found to have benefited the most, while the apartment building, which had many younger residents, used the service the least. —E. Liu

This free service can be found at http://www.i-neighbors.org.

Source: http://web.mit.edu/newsoffice/2004/ineighbors.html