World Science News in Review

[Biological Sciences]

First genetically modified primate bred

With the advent of genetically modified bacteria, mice, and plants, researchers in the United States are now able to produce the first genetically modified monkey. The genetically modified primate is named ANDi ("inserted DNA" backwards), who received extra DNA while it was still an unfertilized egg. Although the young primate carries a useless "marker" gene, researchers believe that it is possible to introduce specific human genes into the monkey. In all respects, the transgenic monkeys could contribute greatly to both the research and the treatment of conditions including diabetes and breast cancer.

In many aspects, the technique for producing the transgenic monkey is far from perfect. "We have shown proof of principle but the technique still needs to be optimized," says Gerald Schatten, who led the research at the Oregon Regional Primate Center, part of the Oregon Health Sciences University, Portland.

Also, researcher Dave Morgan of the University of Florida Tampa, who is using mouse models to develop a human vaccine against Alzheimer's disease, expressed that "Primate models technically would be very powerful, and clearly they would mimic the human condition far more closely, but I would have concerns over cost and the amount of time it would take to produce results."

Arabidopsis plant genome sequenced

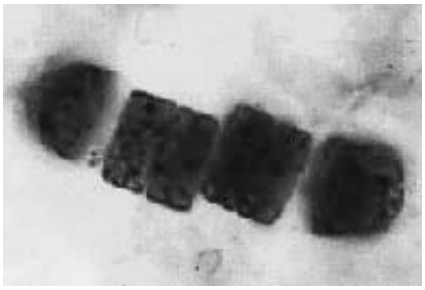
Modern study of genetics began a century ago with the rediscovery of Gregor Mendel's research in green pea plant genetics. The first year of this new century also starts with pioneering work in the field of plant genetics—the entire sequencing of the thale cress (*Arabidopsis thaliana*) genome. This mustard-like weed is the first plant to be completely sequenced.

Scientists will use the thale cress' genome as a reference when studying other plants in the future. The thale cress is a good model organism: It is cheap, grows and breeds easily, and has a short life cycle. In addition, it has one of the smallest genomes of any plant.

Research will continue to make strides in the field of plant genetics and will lean heavily on this landmark mapping. Scientists hope to one day understand how plant and animal kingdoms evolved from a hypothesized common ancestor. They will compare the thale cress' genome to that of animals to investigate how evolutionary mechanisms worked.

Condon-amino acid relationship random

According to the coevolution theory, the DNA comprising the genetic code of any organism contains a signature of its own development. This theory was revisited and disputed by Stephen Freeland and coworkers at Princeton University, who report in the *Proceedings of the National Academy of Sciences USA* that there is roughly a 50 percent chance that any record of the development of the genetic code has been scrambled beyond meaningful interpretation.



The genetic code essentially serves to translate one molecular language into another. Proteins, consisting of chains of linked amino acids, are derived from DNA, whose nucleotide sequence along the double helix specifies the sequence of amino acids.

Coevolution theory suggests that the genetic code was once simpler and that earlier organisms gradually became more complex, learning how to make new amino acids from already existing ones. The new amino acids would then usurp the codons that previously represented the amino acids from which the new ones were made. Therefore, according to the theory, we should be able to determine the sequence of steps by which the earliest genetic code expanded to encode more amino acids.

This theory fails, however, if the relationships existing between codons and amino acids are random. Freeman and his team argue that the coevolution theory effectively mismatched a number of precursor/product pairs, as they fail to make biochemical sense. Furthermore, the theory also neglects to take into account the shortcomings of the protein-making machinery that translates the code.

Thus, after considering and correcting these misconceptions, Freeman and his team were able to conclude that there is a 62 percent probability that the codon relationships existing between precursors and products arise by pure chance.

Mouse Alzheimer's vaccine promising

A vaccine against Alzheimer's disease has been shown to stop mice with the condition from losing their memory. It reduces the build-up of a protein called beta-amyloid peptide, a major indicator of Alzheimer's disease. Researchers have shown that Alzheimer's mice vaccinated with beta-amyloid peptide develop antibodies against the protein. These antibodies keep the brain free of plaques.

Researchers gave Alzheimer's mice learning and memory tests, in which the animals had to swim to a submerged platform. Short-term memory was tested by moving the platform daily. Spatial-reference memory was tested by leaving the platform in one place and testing the mice once a month.

Vaccinated mice developed fewer and smaller protein deposits and performed markedly better than unvaccinated mice in both memory tests.

"The really significant aspect of this work to me is not so much the result but the process they use," said Paul Chapman, who studies Alzheimer's at Cardiff University, UK. "Other treatment studies tend to create the pathology of Alzheimer's [the protein blobs] and then try to make them go away. Tests of behavior like this are critical."

Unfortunately, what works in mice does not always work in humans. The vaccine must still prove itself in a battery of further tests before human trials can begin.

Thalamic volume found important in schizophrenia

Imaging studies done by researchers in the United Kingdom at King's College in London found thalamic volume in schizophrenic patients differed about 5 percent from that of non-schizophrenics.

Schizophrenia affects roughly one in a thousand people. A poorly understood condition, with a wide range of symptoms, the disease poses complex questions involving cognition and emotion. The thalamus controls sensory and motor signals in the brain and is important to information processing. The recent discovery suggests that thalamic volume alone could be the culprit behind deficiencies in attention focusing, sensation prioritization, and stimuli filtration.

Future research on this topic will involve larger studies mirroring the King's College experiment. "The findings [of King's College researchers] are very exciting, and we will all look forward to replication in a larger sample of first-episode patients with schizophrenia," stated Laura Flashman of Dartmouth Medical School.

TAT useful in protein transport

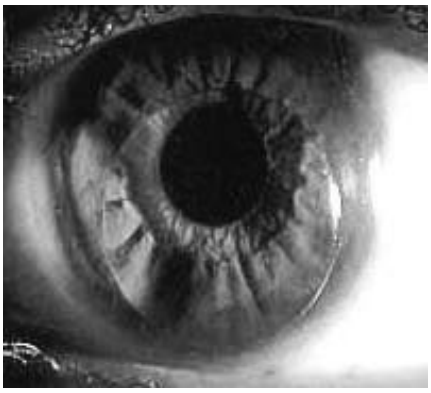
A nuclear transcription activator molecule (TAT) made from HIV type-1 has been used to smuggle protein drugs through cell walls.

Cells are designed to keep foreign invaders out of its walls. A membrane of fatty molecules acts as a gatekeeper for a cell. Drugs that are water soluble cannot penetrate a cell's fatty membrane. Drugs that are fat compatible are difficult to administer because fat does not dissolve in the bloodstream.

HIV attaches itself to the outside of a cell and passes protein molecules through the cell wall so that newly created cells will have the virus imbedded in them. TAT49-57 was discovered to be the instigator of the protein transfer. Researchers at Stanford University created chemically modified versions of TAT that smuggle proteins into cells over a hundred times better than TAT does.

Removing the filmy bacterial sludge

Anyone who wears contact lenses knows the horrible filmy coating that sometimes clings to the plastic lenses. What's more horrible is that the "biofilm" is a product of bacteria and is the kind of film that sometimes clings to artificial heart valves, your teeth, and even some contraceptive devices. Never fear: scientists may have found a way to remove it by looking at why bacteria cannot stick to some surfaces.



In the journal *Langmuir*, Anneta Razatos of the University of Texas, Austin, and colleagues revealed that coatings made of polyethylene glycol (PEG) can be used to actively repel bacteria by keeping them floating in a solution at a distance from the surface of a material.

"Proteins or polymers on the bacterial surface have to push the brush layers away to get close to the surface," said Jeffrey Hubbell, a biomaterials researcher at the University of Zurich and one of the research team. He told reporters from *Nature* that "for them it's like trying to crawl through a hedge."

Using glass plates and *Escherichia coli* bacteria, Hubbell tested antibacterial PEG substances in petri dishes incubated in tanks or in flowing liquid containing bacteria. The layer of PEG blocked attraction between the petri surface and the bacteria.

The "polymer brushes" Hubbel used to distribute PEG across the petri surfaces repelled sugary molecules on bacterial cell surfaces.

"It's as if as soon as they get a few inches into the hedge, they are pushed out again," Hubbell said.

Research Peter Suci, who studies bacteria at the Center for Biofilm Engineering at Montana State University, said that the discovery "is interesting and potentially valuable to probe how they work." But Suci is skeptical that PEG will be an effective agent against several different kinds of bacteria. Nevertheless, Hubbell's discovery could help deliver drugs by using protecting medical equipment and other materials.

Silk and soap show why flags flap

By suspending a silk thread in a fast-flowing stream of soapy water, Jun Zhang and colleagues at New York Univeristy and Rockefeller University were able to discover why a flag flaps in the breeze, one of the oldest and most experimentally inaccessible questions in fluid dynamics.

Using monochromatic light, researchers photographed interference patterns created by the differences in the thickness of the soapy film as it moved past the thread. Range of thread lengths and flow rates were also considered.

The results illustrate that at low flow speeds the thread remains extended in the direction of the flow. If the thread is longer, flow forms into the so-called "von Kármán vortex street," an alternating double row of vortices. This effect serves to explain the varying sound tones produced by a wire vibrating in the wind and the current patterns that form around a rock in a stream.

At higher flow rates, reports Zhang, the thread begins to flap in a highly stable, regular manner, just like a flag flapping in the wind. While the vortex is still present, it is heavily distorted by the flapping motion and is shown as "striking, sinuous trailing spirals" in the photographs.

These effects are repeated when two identical threads are placed a short distance from one another in the soapy film. As the distance between them is increased, the two threads lock into a stable motion in which the two flap exactly out of phase with one another. When the tips of the threads touch, flow is halted, leading to a build-up of pressure released as large droplets when the "walls" part. A third mutually stable state is also seen, in which both threads are fully extended and not flapping.

"From the experiment, it is quite clear that the flapping of a 'flag' is not because of the turbulence in the wind or the presence of the flagpole," states Zhang. "It is intrinsically embedded in the system, as a result of the inertia dynamics of the flag interacting with the surrounding fluid flow."

Previous models for a flapping flag, those devised by Lord Raleigh being the most famous, failed to take into account the tension, elasticity, and mass of the flapping material. Zhang and his team considered these effects in designing this series of experiments that mimic a flapping flag.

Zhang's models could serve as important tools in research concerning the dynamics of blood flow or the development of valveless pumping technology. Future research by Zhang and his team will test these results in three-dimensional space.

Heated floor can prevent drips

Those who have painted their dorm room ceilings will probably be familiar with the disgusting feeling of paint dripping down on to the back of their heads. Physicists at the University of Texas must have experienced such an episode—after all, they've spent years determining how to stop paint dripping from a ceiling.

The technique does not involve special paints, new brushes, or odd techniques. It is as simple—and odd—as heating the floor. A hot floor, it seems, augments surface tension of paint on a ceiling. But Michelangelo isn't celebrating in his grave: The temperatures needed to produce the effects would scare Satan. To prevent drips, your floor would need to be at about 10 trillion degrees centigrade.

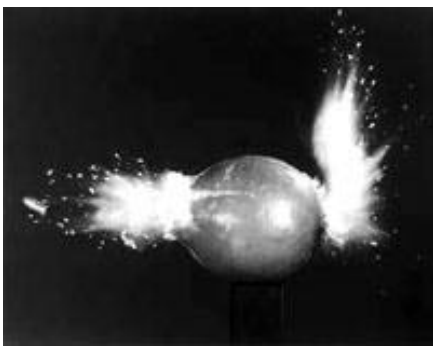
Despite the impracticality, the discovery of heat stopping paint drips is an interesting one. According to the Texas team, liquids clinging to the ceiling against the force of gravity will gather into thicker regions and drip. But even slight differences in the thickness of the liquid is augmented by liquid quickly flowing from the surrounding film to the thick spot, a phenomenon called "Rayleigh-Taylor instability."

John Burgess and colleagues reported that Rayleigh-Taylor instability can be overcome by heating the liquid film from below, because heat lowers the surface tension of liquid films. When a hot plate is placed just underneath the surface of a suspended liquid film, the high surface tension tugs liquid away from regions of low surface tension, so cool, thin parts of the liquid can pull thick parts flat. If the temperature of the hot plate is high enough, it can totally suppress drips.

Unfortunately, Burgess's research team used a hot plate just over a quarter of a millimeter below the liquid film. In a real room, the floor would have to be about 10 trillion degrees higher than the ceiling temperature.

Researchers develop faster photo finish

Recently, Ian Gould of Arizona State University and coworkers at Eastman Kodak in Rochester, New York, have developed a dye that could produce sharper images at faster shutter speeds. In the December 15, 2000, issue of *Nature*, Gould and his research team were said to have developed a dye made up of two molecules, which made film more sensitive to light. When the dye is



combined into the film's emulsion, the dye can generate two "hits" on the film for the price of a single photon of light.

The two molecules in the dye are linked by a chemical bond. When a photon is absorbed, an electron gets released from the bond, breaking the bond. Since Gould's team found a family of light-absorbing molecules that had a negative charge in the form of a carboxylate group, the dye becomes neutral when it loses an electron, and it can then break away from the carboxylate group.

This discovery will help revolutionize the current photo-development technique and the quality of the photos in general.

Asteroids found in Trojan force traps

It had always been thought that the asteroid belt between Mars and Jupiter might not be alone in harboring debris left over form the formation of the planets. In the December 12, 2000, issue of Nature, scientists showed that calculation hinted there could be indeed similar asteroid hoards associated with planets nearer the sun. In all respects, this raised the interests of many scientists because the hoards of asteroid are deemed a potential source of rare minerals, or bodies on a collision course with the Earth.

The asteroids associated with the giant planet Jupiter are known as "the Trojans." Through computer simulations and calculations, it was revealed that planets like Mars, Venus, and Earth can shepherd Trojans at their Lagrange points.

Scientists and researchers hope that the computer simulations and further research will lead them to locate the exact positions of these asteroids.

How to escape from a black hole

Stephen Hawking used mathematics to show that black holes can radiate light or particles. Researchers Maulik Parikh and Frank Wilczek of the Spinoza Institute and Princeton's Institute for Advanced Study, respectively, have a new derivation of Hawking radiation.

Previously, other scholars in the fields of math and science claimed that the math behind Hawking's explanation of Hawking radiation did not match the pictorial description of how the radiation works. Parikh and Wilczek's new derivation uses space-time geometry in a new type of coordinate system to depict quantum tunneling.

This new research draws attention from both Hawking's supporters and critics on the topic. However, since there have been no confirmed sightings of real black holes, the work in the foreseeable future will all be theoretical, and there will be no way to settle the arguments presented by the new research.

Earth scientists track down niobium

The Earth was formed when large rocky particles called "planetesimals" collided and coalesced in the early solar system. Therefore, most substances that make up the planet can be accounted for by standard theories of how the Earth formed. However, Earth scientists J. Wade and B.J. Wood of the University of Bristol have recently discovered that not all elements are where they are expected to be.

In the January 4, 2001, issue of Nature, the Earth scientists from the University of Bristol stated that one of the Earth elements, niobium, is not, as had been predicted, in the rocky mantle surrounding the Earth's molten core, but is instead hidden in the liquid iron at the center. Also, researchers from other universities had also discovered that elements such as vanadium, chromium, and manganese do not always appear where they should be.

Through the research of these scientists, we are able to gain a deeper understanding of the elements that make up the Earth.

[Technological Sciences]

Lasers sculpt, drive micromachines

Péter Galajda and Pál Ormos of the Biological Research Centre of the Hungarian Academy of Sciences in Szeged have used light to create power and hold tiny rotors invisible to the naked eye. Their work was recently published in Applied Physics Letters.

Typical microelectromechanical systems (MEMS) are a few millimeters across. Their microscopic components can flex to detect pressure or sound, or move mirrors to guide light beams, and are often carved from silicon wafers. MEMS may serve as sensors and switches for light-based information technology in the future.

However, in order to create even smaller rotors—only five thousanths of a millimeter wide—the researchers had to use a completely different manufacturing process. Galajda and Ormos projected the shape of the rotor into a liquid resin using a laser beam. The resin solidified only where the laser spot passed. Controlled by a computer, the laser creates complex shapes as precise as half a micron, its diameter. Unhardened resin is washed away to reveal the finished product.

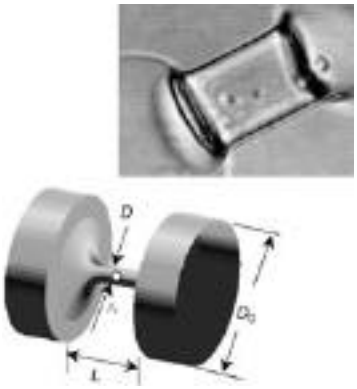
The researchers have also produced rotors similar to the twisted blades of an airplane propeller. These rotors are driven in a single direction, like a windmill. They can be suspended in a solvent on a glass slide using another laser beam. Very bright beams can serve as "optical tweezers" by immobilizing small objects in the light's electromagnetic field.

The light was successful in trapping the rotors, as expected, but it also made them spin. The light bouncing off the hardened resin pushes the spokes around, and the twist in the rotor guarantees that the rotation occurs in the same direction.

Galajda and Ormos have also created cogs using the same method. The cogs are fixed on a glass slide, teeth together. One cog, a twisted rotor, sets the others in motion. The researchers

suggest that a similar arrangement could be used to make a cell-size pump or switch.

Japanese scientists invent flexible polymer muscle



In the November 9, 2000, issue of Nature, Japanese researchers reported that they have invented a flexible polymer muscle. Through the use of lasers, the researchers were able to quickly and accurately flex the polymer muscle. In many aspects, the invention of the polymer muscle would make robots and machines more efficient in turning energy into work.

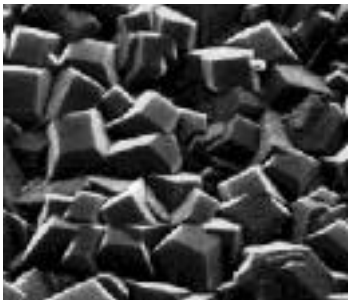
According to one of the researchers, Hiroaki Misawa, it is now possible to make polymer gels shrink and swell in a split second. Targeting laser light at the center of a cylinder made of a polymer called "N-isoproprylacrylamide" pinches together the tube's edges to form a dumbbell shape. However, the original cylinder shape returns when the laser is switched off.

Another researcher also pointed out that this discovery would have great impact on medicine. "Because gels that contain a large amount of water are very similar to tissues, in principle this method could be used to collapse tissue without heating effects," he says. "This may be useful for some cancer treatments, and it could be used as a new way of triggering controlled drug release from a gel."

Iridium smooths diamond chip problem

Microelectronic chips may be made of diamond instead of silicon in the near future. Matthias Schreck and his colleagues from the University of Augsburg in Germany have developed a method of making thin, high-quality crystalline diamond films that could potentially drive smaller, higher temperature devices.

Today's thin, synthetic diamond films are useless to electronics as they often contain misaligned crystals. These "grain boundaries" block the flow of current. However, German scientists have found a way to reduce the impact of grain boundaries. That is, they have restricted them to narrow bands that no longer isolate crystalline regions.



"Diamond chips" would be invaluable in electronic devices exposed to high temperatures and voltages. Semiconducting diamond works up to temperatures of 500°C — silicon devices fail at around 150 °C. And diamond can tolerate higher voltages before breaking down, so diamond devices could be made smaller than silicon ones working at the same voltage.

These advantages would make diamond films attractive were it not for the grain boundaries. If diamond films are grown on any surface other than diamond, grain boundaries appear. Schreck and colleagues have found that the metal iridium hardly suffers from this problem.

Films a few microns thick still contained a network of grain boundaries, but in the thicker films, these boundaries became isolated defects, like cracks in a flat, smooth single crystal. A current could find a path around such cracks, so these new diamond films might be good enough to use in electronic applications.

Braille expands computer memories

The information-storage capacity of magnetic hard drives in computers is slowly diminishing. Swiss scientists now suggest a touch technique to counteract this effect, a kind of microscopic Braille that would allow for computer memories to continue growing by reading their contents by touch.

The storage capacity of a magnetic hard drive is measured by the number of "bits" of information that fit into a square inch of disk space. Commercial drives now hold between 6 and 15 billion bits per square inch, each bit encoded in a small amount of magnetic atoms. This number is expected to reach its limits within the next four years.

For over a decade, Mark Lutwyche and colleagues at IBM's Zurich lab have been exploring another option in information-storage technology that promises to hold densities at least four times greater than the best magnetic systems. This approach involves a sharp needle, fixed to the end of a thin, hard cantilever arm, inscribing marks in the surface of a soft material. When the needle tip is placed a few atoms from the surface, a force of attraction bends the cantilever arm. This attractive force will increase with the number of bumps on the surface, thereby causing the cantilever arm to bend. Thus, this so-called atomic-force microscope (AFM) senses individual molecules by touch.

The AFM can also modify a surface by leaving behind a scratch a few molecules wide. Information can thus be stored in a series of scratches and patches, which can then be read using the AFM, encoding the data in a binary form.

The only problem with this technique involves the time it takes to scan an entire surface for marks. This can be remedied by reading lots of information in parallel, using many AFM tips at once. Lutwyche and colleagues created an array of 1,024 tips, each capable of reading and writing, that make indentations in the surface of a plastic film when heated.

The researchers were thus able to store about 20 times more information than is possible in current magnetic hard drives. Future research will involve ironing out software limitations.

Lasers from silicon may use light for information transfer

The holy grain of "optoelectronics"—using light as a means to transmit information—may be closer than scientists had originally believed. Italian physicists reported in late November in Nature that tiny solid-state lasers made of semiconducting materials can be used in electronic integrated circuits.

Circuits made of silicon cannot transmit light efficiently; in fact, even though lasers that read CDs can send light pulses down cables made from gallium arsenide, the material doesn't stick to silicon, and therefore cannot be fabricated on silicon chips.

The best alternative would be to design silicon that would itself emit light. As hard as this may seem, silicon may be able to transmit light if it were cut into very small pieces. If the material were made into wire, it would glow when electrically stimulated.

Lorenzo Pavesi of the University of Trento in Italy has been able to produce these laser-like emissions from silicon.

British physicist Leigh Canham told Nature reporters that Pavesi's report constitutes "a major milestone in our attempts to develop silicon-based optoelectronics."

Pavesi and colleague didn't simply make silicon into wires, but made nanometer-thick particles of pure silicon, showing that such "nanoparticles" could be made on a chip. Although other researchers have shown light emission from silicon nanoparticles, no one had yet produced laser light from them, conjuring a hoard of photons in an amplified light pulse.

The simulated laser action Pavesi produced demonstrates that specks of silicon might be effectively used for light-mediated information technology.