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FISHER SCIENCE EDUCATION

HEADLINE DISCOVERIES

MAKING SCIENCE MATTER™

LIE OF THE NEEDLE
PERFORMANCE-ENHANCING DRUGS IN SPORTS

Marion Jones, Olympic track medalist.
Floyd Landis, cycling champion.
Roger Clemens, 300-game-winning pitcher.

What do these three athletes share? All are entwined in the continuing story of performance-enhancing drug abuse in sports—a practice that threatens to destroy our ideas and attitudes about fair play in the games we participate in, watch and enjoy.

Performance-enhancing drugs (PEDs) are substances taken by athletes to gain a competitive advantage. This distinguishes them from so-called "recreational drugs" like marijuana or cocaine, which are used to "get high." Most PEDs are controlled substances that must be prescribed by a physician. Others are outright illegal. As a result, PEDs are banned by most organized sports authorities. PEDs defy the rules of fair competition, and the athlete who chooses to use them is, by definition, a cheater.

Steroids and HGH

The most common PEDs are steroids and Human Growth Hormone, or HGH. Both are taken to enhance the growth of muscle and lean body mass.

Steroids refer to a wide range of substances that produce effects similar to testosterone, the male sex hormone. Testosterone develops the masculine traits boys develop during puberty, including a deeper voice and body hair. They are prescribed by doctors to treat certain medical conditions, such as anemia. Steroids are taken orally or by injection.

HGH is administered by physicians into patients with growth hormone deficiency—an inability to sufficiently produce enough hormone naturally. It is taken by injection.

Looking for an Edge

Ideally, an athlete's formula for success is a combination of proper nutrition, rigorous conditioning, relentless practice, and positive attitude. Winning in athletics is hard work. From archery to volleyball, whatever the sport, wherever the venue—there are no shortcuts.

But for certain athletes, hard work isn't good enough. They give in to the temptation of PEDs—to bulk up physically, to recover faster from an injury, or maybe to look more "buff". Sometimes peer pressure is a factor—the desire to keep up with teammates or rivals who are doping. While these can seem to be compelling reasons for breaking the rules, disrupting your body's natural chemistry is a high-stakes gamble.

Gambling with Your Health

Using PEDs raises your chances to develop chronic conditions and debilitating diseases. Steroid use may result in high blood pressure, urinary problems, and higher risks for heart and liver diseases and cancer. Steroids can cause stunted growth in adolescents from premature skeletal maturation and accelerated puberty. Studies report that steroid use may also lead to psychiatric conditions such as heightened aggression, paranoia, and extreme irritability. Boys are at risk for baldness, development of breasts, and sexual problems later in life, including sterility. Girls may develop masculine traits like facial hair growth, a deepening voice, and menstrual cycle changes.

Sports Fight Back

In recent years the governing bodies of sport have battled back to "clean up" their games. Today testing and enforcement programs are the rule throughout sports. Random testing is the best way to catch cheaters, but implementing such a program can be problematic in the unionized sports, like Major League Baseball (MLB), where drug testing is negotiated as part of the collective bargaining agreement between players and team owners.

Drug abusers, aided by clever chemists, try to stay one step ahead of the testers. So-called masking drugs are used to prevent detection of PEDs during drug tests. An example is epitestosterone, a drug that has no effects other than to balance the testosterone/epistosterone ratio—a common measure in drug testing—to normal levels.

Challenges notwithstanding, testing is performed, and penalties for cheating are severe. In 2007, five MLB and seven National Football League players were suspended for using banned substances.

Falling from Grace

Getting caught can ruin an athlete's reputation and career. Faced with a perjury charge for lying to a grand jury, Marion Jones admitted to steroid use at the 2000 Olympic Games. Previously, Jones had adamantly denied using PEDs. The International Olympic Committee stripped Jones of the five medals she won at the Games and suspended her from competition; the discredited sprinter publicly apologized, then retired.

Floyd Landis, winner of the 2006 Tour de France, failed a urine test that cost him his title, his spot on his cycling team, and earned him a two-year suspension from competition.

The Mitchell Report

In December 2007, MLB released its investigation into performance-enhancing drug abuse in baseball. Known as the Mitchell Report, the 409-page document identified 88 present and former players as users.

The Mitchell Report prompted a government response. In January 2008, the U.S. House Committee on Government Oversight and Reform held hearings with key figures named in the report, including baseball executives, trainers, players, and former Senator George Mitchell, head of the investigation.

The biggest star invited to testify was pitcher Roger Clemens, identified in the Mitchell Report as a doper. The evidence accusing Clemens was the testimony of a former trainer who allegedly injected him with a steroid. Clemens steadfastly denied any steroid use. Clemens' election to the Baseball Hall of Fame, once a sure thing, is now in doubt. His fate rests with Hall of Fame voters baseball writers who see themselves as guardians of the game's reputation and may be reluctant to enshrine a presumed doper.

The Clemens case underscores the messy reality of steroids in baseball. The truth may never surface, the suspicions linger, and the aftermath of the Mitchell Report will haunt baseball for years.

This article should be a cautionary tale for the young athlete. Why risk your reputation? Or your health? Be smart and be safe. Even in a high-tech world, the old-fashioned approach works best. It's all about hard work. As we said before, there are no shortcuts.

—Dan Skantar

KEEPING SPORTS CLEAN: WADA IS WATCHING

NAME: World Anti-Doping Agency (WADA)
FOUNDED: 1999
HEADQUARTERS: Montreal, Canada
VISION: To promote, coordinate and monitor the fight against doping in sport.
KEY INITIATIVES:

- Code Adoption, Implementation & Compliance: facilitating sport and government acceptance of the World Anti-Doping Code (Code) and its principles to ensure a harmonized approach to anti-doping in all sports and all countries; monitoring implementation of and compliance with the Code
- Science & Medicine: promoting global research to identify and detect doping substances and methods; developing/maintaining the annual List of Prohibited Substances and Methods; accrediting anti-doping labs worldwide
- Anti-doping Coordination: developing and maintaining the Web-based Anti-doping Development Management System (ADAMS), to help stakeholders coordinate anti-doping activities and comply with the Code
- Anti-Doping Development: facilitating the coordination of Regional Anti-Doping Organizations by bringing together countries with no or limited anti-doping activities
- Education: leading and coordinating effective doping prevention strategies and education
- Out-of-competition Testing: ensure compliance with anti-doping rules via no-notice testing

PROFILE

DAME JOCELYN BELL BURNETT

Though it is changing rapidly, in the not-too-distant past women were unusual—even a novelty—in many scientific disciplines. Even though Jocelyn Bell turned out to be a "shining star" in the field of astronomy, her path was not easy and success was not a certainty.

Born Susan Jocelyn Bell in Belfast, Northern Ireland on July 15, 1943, the future scientist was introduced to astronomy through her father's books. Her own beginning in education was not auspicious: She failed the examination required for higher education in British schools. Fortunately her parents strongly supported education for women, and, as a second chance, Jocelyn was sent to a boarding school to continue her education. From there she advanced to earn a degree in physics at the University of Glasgow and later, a Ph.D. at Cambridge University.

As Bell toiled as a graduate student—the daily fare of a graduate student is not entirely an exciting proposition—she applied persistence and patience to her task. She spent many hours reviewing the output records generated by a 4.5 acre radio telescope. Earlier in her graduate school days, she had actually helped build the device, pounding stakes and stringing wire over the designated telescope area.

While poring over these records, she noticed an unusual phenomenon—an area of space from which light pulsed at a regular frequency. It was definitely not a quasar, which it had been the radio telescope's mission to track. After ruling out other possibilities, including LGMs (Little Green Men), a light-hearted term for hypothetical extraterrestrial beings, the scientists (Bell and her advisor Antony Hewish) determined that the 2.5cm bit of the 121.8m output chart represented something quite new to astronomers—it was the first demonstration of what we now call pulsars.

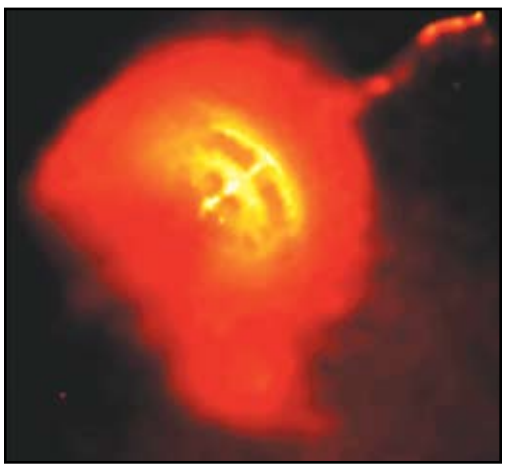
In 1968, when the discovery became widely known in a paper published in the journal *Nature*, the media of the time were captivated by the fact that one of the paper's coauthors was a woman. A bit of a frenzy took place, with reporters asking Bell questions like how tall she was and how many boyfriends she had. Fortunately the distractions abated and serious work was able to continue.

In 1974, when the first Nobel Prize in physics was awarded, Antony Hewish, Bell's graduate advisor, was named one of the recipients for the discovery of pulsars. Controversially, Bell was not among them. Nonetheless, her worked continued in a number of astrophysical areas, and in 1986, she was awarded the first Beatrice M. Tinsley Prize from the American Astrophysical Society recognizing her contributions of an exceptionally creative and innovative character. In 2003, she was named a Fellow of the Royal Society. Now retired, she continues to teach as a visiting professor at Oxford. In 2007, she was awarded the equivalent of a male knighthood, hence becoming Dame Jocelyn Bell Burnell.

In addition to her research accomplishments, we can thank Bell for her efforts to increase the number and status of women in astrophysics.

—Merry Morris

WHAT IS A PULSAR?



Even for astrophysicists, this has not been an easy question to answer. At the first discovery of a pulsar in 1967 by Jocelyn Bell and Anthony Hewish, only a few of its characteristics were known: The pulsar released small, regular pulses of radiation that eminated from outside the solar system and could be detected by large radio telescopes.

As other possibilities were ruled out—reflections from the moon or planets, transmissions from satellites, communications from Little Green Men—several other characteristics began to define this mysterious heavenly phenomenon.

1. The pulses were regular, ranging from 8 seconds down to just milliseconds.
2. The pulses traveled very quickly through space—4000 times faster than a jumbo jet.
3. The pulsars were composed of different frequencies. The higher frequencies traveled faster and reached the Earth more quickly that the lower ones. The difference between these arrival times (the pulse dispersion) could be used to determine how far away the pulsar was from Earth.
4. The pulsars were indeed very far away; all were outside our solar system, but most were still within our galaxy. The youngest ones were still in the Milky Way and seemed to be created in the explosion of a massive star.
5. The source of the pulses seemed to be very small (the size of a city) with a mass one-and-one-half times that of our sun. The density was such that one teaspoon of pulsar material would weigh a billion tons if brought back to Earth.

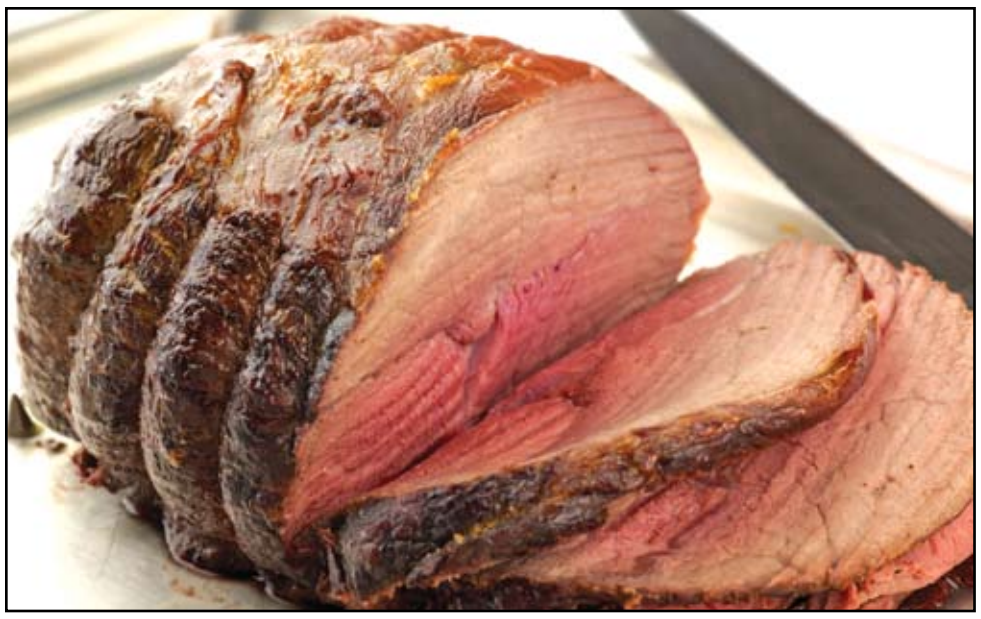
These observations led to the conclusion that pulsars were rapidly spinning neutron stars that emitted regular bursts of radio waves along their magnetic axes. (A neutron star had been earlier predicted to be a star that has collapsed under its own gravity.) As the neutron star rotates, its radiation sweeps across space, creating the pulses observed on Earth.

Many pulsars, especially those with only milliseconds between pulses, have been found in binary systems—orbiting with a normal star, planet, white dwarf (a collapsed star smaller than those producing black holes), and rarely, another pulsar. These latter rare occurrences have provided an opportunity to review Einstein's general theory of relativity, and researchers have found their observations are perfectly consistent with the theory.

As work continues, the data collected from pulsar observations are being used to investigate how stable the atomic clocks on Earth are. Researchers are also hoping to learn more about the masses and motions of planets, and to investigate "gravity waves," ripples in the fabric of space and time. Coming from extreme regions of spacetime, these observations can provide clues as to the nature of the very early universe.

—Merry Morris

RED MEAT ON TRIAL



Remember when chocolate was bad for us because of its sugar content? Ah, but we've since discovered that its antioxidants make chocolate almost healthy! Coffee has been linked to rheumatoid arthritis ... AND to lowering the risk of diabetes, Parkinson's disease, and colon cancer! Eggs were once declared to contain too much cholesterol; now, maybe not so much.

These days, it's red meat on trial. Based on available research—and the variety of conclusions—the jury could go either way:

"Red and Processed Meats Linked to Greater Risk for Bowel and Lung Cancer!"

"Red Meat Consumption Heightens Heart Disease Risk in Diabetics!"

"Study Shows Lean Red Meat Can Play a Role in Low-Fat Diet!"

The Defense

Red meat is high in zinc—essential for a healthy immune system—and low in sodium. It's also an excellent source of protein, iron, vitamin B6, and vitamin B12.

Red meat is not the heart-stopper it was once thought to be. In fact, researchers at the Johns Hopkins University Lipid Clinic concluded that, "If you follow a heart-healthy diet, it doesn't make a difference whether you eat red meat or white meat, as long as you choose lean cuts." Even the venerable American Heart Association doesn't suggest we give up red meat altogether...but rather partake of lean red meat in moderation.

The American Dietetic Association says that we can eat 6 oz. of lean red meat five or more days a week while still eating a diet that could decrease cholesterol levels. They also say that lean beef is just as effective as skinless chicken when it comes to lowering cholesterol.

The Prosecution

Red meat is high in saturated fat, which is associated with cardiovascular disease. When grilled, broiled or fried at high temperatures, carcinogens (heterocylic amines) form. (To be fair, they also form on poultry and fish cooked at high temperatures.) Research has linked red meat to increased incidents of breast, colon, prostate, lung and other cancers; Alzheimer's disease; diabetes; and rheumatoid arthritis.

Closing Arguments

In most studies, "red meat" (beef, pork, lamb and veal) and "processed meat" (sausage, ham, bacon and cold cuts) were lumped together. Some cuts of red meat are high in unsaturated fat, but processed meat is high in sodium nitrite, a preservative linked to cancer. So which is the real culprit? And, even allowing for causes such as smoking, could other life-style factors, obesity or even genetics have influenced cancer rates?

According to the World Health Organization (WHO), dietary factors account for about 30% of all cancers in Western countries and up to 20% in developing countries. WHO found that eating more than about 5.5 oz. of red meat and processed meat per day puts people in the most at-risk group. The American Institute for Cancer recommends limiting red meat consumption to 3 oz. a day or less.

The Jury

Is red meat guilty? Pity the poor jury! Given the variations in studies and results, it will be tough to get everyone to agree until such time as definitive conclusions are reached.

What's your opinion? Do you believe there's a place for red meat in a healthy diet, or do you play it safe and avoid those burgers and steaks? Perhaps you, like many people, take the controversy with a grain of salt? In moderation, of course.

—Alida Cataldo

ZINC, IRON, VITAMIN B6 AND VITAMIN B12 ARE ALL FOUND IN RED MEAT, BUT THERE ARE OTHER SOURCES, TOO.

ZINC

Animal sources—zinc is more readily absorbed from animal sources than plants—red meat, seafood, pork, poultry, fish

Plant sources—nuts, seeds, legumes and whole-grain cereals are all foods fortified with zinc

Iron

Animal sources—liver, kidneys, red meat, poultry, fish (especially oysters and clams), eggs

Plant sources—peas, beans, nuts, dried fruits, seeds, leafy green vegetables (especially spinach), wholemeal bread, enriched pastas and breads, and fortified cereals

Vitamin B6

Animal sources—fish, liver, pork, chicken, eggs

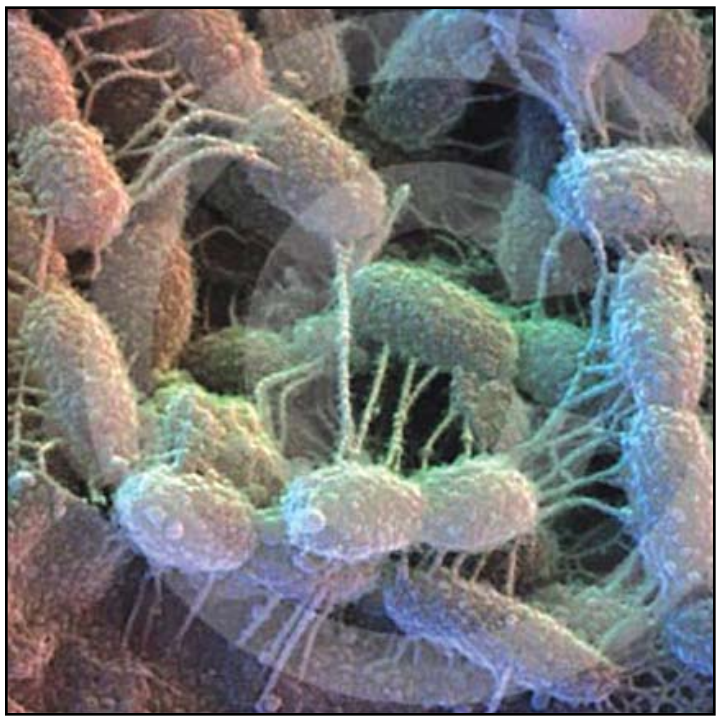
Plant sources—potatoes, wheat germ, bananas, dried beans, nuts, bananas, seeds (especially sunflower)

Vitamin B12

Animal sources—clams, oysters, fish, meat, eggs, milk and dairy products

Plant sources—fortified breakfast cereals, yeast extract, fortified soy milk.

GOOD GERMS, BAD BACTERIA



They're everywhere, in huge numbers, and all over you. You're host to more creepy-crawlies than there are people in the United States. More than 1000 species of microorganisms call you home.

Some are good, most are bad. Good germs protect our teeth, the soft tissues of our mouths, and the inner surfaces of our nose, sinuses, throat, stomach and intestines. Some protect us from disease-causing bacteria that could infect us. Others provide us with nutrients like vitamin K.

Bad bacteria give us life-threatening diseases and infections, and they have plenty of opportunities to accost us. In any building, doorknobs, elevator buttons, escalator handrails, and telephones are notoriously heavy with bacteria. In the office or classroom, pens and keyboards carry germs aplenty. In the grocery store, it's shopping cart handles and currency. And in the home, the worst offenders are faucets, toothbrushes, kitchen sponges and cloths, cutting boards, and pets.

Surprised the toilet isn't a culprit? According to a study funded by Clorox®, keyboards have 265 times more bacteria than a toilet seat. A 12-year-old student compared ice used in restaurant drinks with water from toilet bowls in the same restaurants. Her discovery: 70% of the time, the ice had more bacteria than the toilet water.

The best defense against all of these germs is personal hygiene...lots and lots of hand washing in particular.

We've Come a Long Way

Personal hygiene wasn't always high on anyone's list. King Henry IV required his knights to bathe at least once in their lifetime: during their ritual knighthood ceremony. Until the 1800s, surgeons operated in their street clothes, often without washing their hands. Rubber gloves were first worn during surgery in 1890, gauze masks in 1896.

Although the toothbrush was invented in China in 1498, tooth brushing didn't become routine in the U.S. until it was enforced on soldiers during World War II.

Dirty Hands Killed a President...and Many New Mothers

President James Garfield probably died not from the bullet fired by Charles Guiteau but from the manure-stained hands of the medical team who treated him. A severe infection killed him three months after he was shot.

During the 17th and 18th centuries, up to one-quarter of all women giving birth in European and American hospitals died of puerperal fever, an infection spread by unhygienic nurses and doctors.

Soap, Sweet Soap

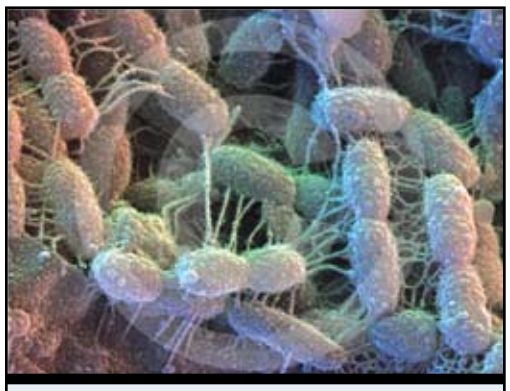
Soap gets its name from the fictional Mount Sapo, where fat and wood ash from animal sacrifices washed into the Tiber River and created a rudimentary cleaning agent used for washing clothes. Today, soaps are produced by mixing a variety of oils and fats with an aqueous solution of alkali.

More recently, manufacturers have added alcohol to create antibacterial soaps. Touted as a surefire and superior way to kill germs, research indicates that antibacterial soaps are no more effective than plain soap and water for killing germs.

Is Too Clean Too Much?

The recent emergence of the "Hygiene Hypothesis" postulates that decreased exposure to microorganisms by increased hygiene is affecting our ability to fight off some diseases and allergies. Our immune systems need to be exposed to bad germs in order to recognize and fight them, and we may be giving them less exposure to our detriment. However, it's still a hypothesis, and no one is yet suggesting we start eating dirt.

—Alida Cataldo



Cleanliness becomes more important when godliness is unlikely.

—P. J. O'Rourke

WHAT IS SOAP AND HOW DOES IT WORK?

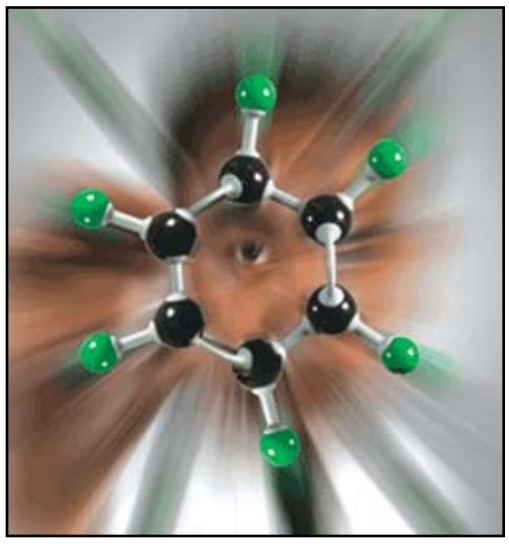
The cleansing product we know as soap is the result of a reaction between fats and alkali.

The fat could be tallow, grease, fish oils, and vegetable oils. Alkali could be lye (NaOH) or wood ash. (One popular home recipe uses olive oil and lye.)

When the fat (or oil) and alkali are mixed, they form glycerin and the sodium salt of the fatty acid. The combination of fat and alkali determines the hardness, lathering and transparency.

How does soap work? Soap forms a link between water and the dirt particle and lifts it from the dirty surface. One end of the molecule is hydrophilic ("water-loving") and the other is hydrophobic (attracted to materials that are not water soluble). The dirt is then washed away with the soap.

NANOPARTICLES—NO SMALL RISK



Nanotechnology—the manipulation of matter at nanometer-length scales to produce new materials, structures and devices.

Nanotechnology has been called a new Industrial Revolution, but it is one with far more pervasive effects than the original. As the number of consumer products claiming to use nanotechnology increases—according to some experts there are almost 600—questions are being raised as to the safety of nanotechnology-based production (molecular manufacturing) and the nanoparticles themselves.

Nanoparticles need not be tiny machines or structures, as is the popular view of nanotechnology. Even elements and compounds that have merely been reduced down to nanometer size—a nanometer is one billionth of a meter—are considered nanomaterials. Even in their simplicity, these nanoparticles can confer benefits to health and improvement to manufactured products.

Silver

Silver particles ground down to nano sizes exhibit antimicrobial properties and are being added to products where killing germs is an advantage—for example, babies' pacifiers or chopsticks. In food production, silver nanoparticles are being added in the fabrication of food-preparation equipment. (Even food ingredients themselves could be restructured as nano-sized particles to change the nature of the food. There is talk of a better tasting chocolate milkshake on the horizon.)

Titanium dioxide

Titanium dioxide is a compound used in many sunscreens, products in which the nanomaterials are applied directly to the skin. When produced in nano-dimensions, these products with titanium dioxide particles still block harmful UV light, but also allow visible light to pass through; these sunscreens are completely transparent on the skin, not pasty white like earlier ones.

Gold

Recently, gold nanoparticles imbedded in dyes have been shown to identify tumors under the skin of a living animal, creating a huge opportunity for earlier cancer detection at microscopic levels, using a much less invasive technique than traditional methods.

Jekyll and Hyde?

In the face of all the promise of nanomaterials, why is so much concern being voiced? Much of the uncertainty is because in nano-sizes, materials can have very different (even opposite) properties compared to their larger "cousins." For example, copper, which is normally a very soft metal, becomes quite hard when produced in nano sizes.

But why the change in properties? At very small sizes, the surface area of a nanoparticle becomes extremely large compared to its mass. Since atoms on the surface of a particle are more reactive that those within the mass, chemical and physical properties can be highly exaggerated. For a five-nanometer particle, half the atoms are on the surface, magnifying the chances for a highly reactive or toxic situation.

Adding to the problem, nanoparticles are so small that they are much more easily transported into the human body. Research suggests that these particles can evade the body's defenses and collect in the brain, cells, blood and nerves with unknown effects. When particles are engineered into unusual shapes, their behavior becomes even harder to predict.

Exposure increases the potential for harm, so where exposures could be great, as in molecular manufacturing, unknown health problems could arise in poorly protected workers. At the other end of the manufacturing process, environmental release of waste products could create damage that would be hard to recognize because we lack even basic knowledge on how to capture, measure and create standards for these new pollutants.

The Battle Begins

As a result of these uncertainties, one pressure group is demanding a moratorium on many nanotechnologies, while other scientists are trying to overcome concerns to take advantage of the new technology. Clearly not all nanoparticles should be considered inherently unsafe, but there must be a balance between research into the production of new nanomaterials and the investigation of environmental, health and safety risks.

This challenge bears no small risk. The future of nanotechnology will depend on its successful resolution.

—Merry Morris

A PRIMER ON NANOTECHNOLOGY

Nanotechnology refers to the technology of creating and using particles and structures on the scale of one billionth of a meter (roughly six carbon atoms in a row). Individual atoms can be precisely assembled into simple structures or used to cause specific chemical reactions. These nano-objects can also be more complex—devices built to specifications with intentional placement of atoms—not just randomly assembled.

Nanotechnology, which works on the element or compound level, contrasts with our "standard" technology where we use "large" amounts of materials—tons, for example—millions of atoms—to fabricate products.

Already through nanotechnology, propellers have been attached to molecular motors, and electricity has been conducted through nanowires. Researchers have built a DNA nanomachine that can control the construction of different DNA strands, the structure of which has been determined by "programming" the nanomachine with the desired DNA strand.

In the future, this technology may be able to use forces on the level of the van der Waals force or change the quantum state of particles, thus opening new areas for engineering research.

SCENTS AND SENSIBILITY: SNAKESKIN PERFUME HELPS SQUIRRELS PROTECT THEIR YOUNG

When you think of nature's lion-hearted warriors, does the squirrel readily come to mind? Probably not. Nevertheless, studies of rock squirrels and California ground squirrels reveal cunning survivors whose battles against the rattlesnake may redefine our view of predator-prey relationships. Continuing research by scientists at UC Davis has revealed that squirrels use a variety of tactics—some quite clever, others quite daring—to confound their foes.

Squirrels often harass rattlers, placing themselves at considerable risk to preempt and deter snake incursions into their living space. Says Chris Jenkins, a scientist with the Wildlife Conservation Society, in a December 21, 2007 interview with *National Geographic* magazine, "Sometimes it gets to a point where the squirrels will start kicking sand at the snakes, biting them, and pouncing on them." During staged laboratory confrontations between squirrels and rattlesnakes, UC Davis staff have witnessed astonishing feats of agility and resolve. Psychology Professor Richard G. Coss expressed his amazement related to one encounter described in an October 1999 issue of the *Science News*. In one instance, an adult female failed to flip out of the way of an attack and suffered a full rattler strike. "She just rubbed her face, and that was it," he said. "She just came right back for more."

Charmed by the audacity of the squirrels, researchers at UC Davis and cooperating institutions have examined a variety of both physical and social adaptations that support these rodent raiders in their war against snakes. Previously, researchers had observed squirrels heating up their tails by as much as nine degrees Fahrenheit, likely as a warning plume to fend off snakes which can "see" in the infrared range. In other studies, it was determined that ground squirrels can also distinguish snake size and body temperature—both factors in overall dangerousness—based on sound. Perhaps most importantly, the adult squirrels are known to have a protein in their blood that deactivates snake venom, making them immune to the effects of the rattlers' bite.

But only just recently has research uncovered a behavior which may be geared toward minimizing the need for confrontation in the first place. Barbara Clucas, a graduate student in animal behavior, has noted that squirrels will chew up pieces of shed snakeskin and lick their fur to apply the scent to it. These observations, recently published in the journal *Animal Behaviour*, were first made by Clucus while watching rock squirrels in Caballo Lake State Park in New Mexico in 2002, and were later confirmed when she witnessed the same behavior by ground squirrels in Lake Solano County Park in California in 2003.

By applying the pungent scent of the rattlesnake to their fur, squirrels presumably mask their own smell and may convince snakes that a competitor is already present in their burrow. Safety in the burrow is of paramount importance, as squirrel pups are not big enough to resist snake venom. As many as 40% of ground squirrel pups are eaten by snakes.

While other rodents have been observed demonstrating similar behavior, Barbara Clucus states in *National Geographic* that "this is the first case where (this idea) has been tested systematically and shown to have an antipredator function—protecting the squirrel from rattlesnake predation." Antipredator scent masking can be a controversial topic as it relates to animal behavior, as can be seen in the case of burrowing owls. Burrowing owls have been observed to collect and distribute animal feces around their shallow burrows. For a while it was believed that the feces served to mask the scent of the owls and their eggs, limiting predation by—yes, you guessed it—snakes. However, that theory was soon challenged by the idea that the scent was not intended to repel but rather attract—in this case, dung beetles, a favorite food source of the burrowing owl. Clucus's findings with squirrels are therefore quite significant, and will likely lead to further investigation of this type of adaptive behavior.

In the meantime, this discovery can only add to our appreciation of the squirrel and its resourcefulness. Acrobat, soldier, and spy—this furry friend has many faces.

—Edwin Schock

SOME SMELLY FACTS

- Gazelles are very fast on their feet, which helps them to outrun many of their predators, but their sense of smell alerts them early on when a predator is approaching.
- Pharaoh ants scouting for food alert others ants that an unrewarding branch is not worth the trip by placing a tiny scent marker “road sign” on it.
- Jaguars use their sense of smell to locate their prey in the dark—handy for a nocturnal predator.
- Finding each other in a dense bamboo forest is tough, but giant pandas use their keen sense of smell to locate others.
- Komodo dragons dine on rotting meat, which their sense of smell allows them to find at a distance of more than a mile.

NATURE VS. NURTURE: WHAT MAKES A WINNING RACEHORSE?

Horse breeding is a multi-billion dollar industry that is part science, part luck. Many thoroughbred breeding programs in search of prize-winning offspring now rely heavily on genetics to deliver exceptional traits such as running ability and endurance. However, a University of Edinburgh study suggests that training and environment may play a larger role.

How are thoroughbreds currently bred, and what technological advances and behavioral research might impact these long-standing traditions?

Unnatural Selection

The vast majority of the world's racehorses can trace their lineage to fewer than 30 ancestors, born in the 18th and 19th centuries. And all grey thoroughbreds can be traced back to one stallion, born in 1700. The crossing of English mares and Arabian and other stallions in the 18th century created a breed of horses with great stamina for long distance running; their progeny are found on racetracks today.

Experienced breeders have built their reputations by carefully selecting sires and dams to mate based on pedigrees and racing records. The belief that winners beget winners has resulted in exceptionally high stud fees for champion horses. But success on the racetrack can't be determined until the offspring are 3 to 10 years old. Only then can the relationship between genotype (genetic makeup) and phenotype (observable qualities) be truly assessed.

The Edinburgh study compared the stud fees, winnings, and earnings of over 4,000 racehorses since 1922, finding that only 10% of a horse's lifetime winnings could be attributed to their bloodline. In addition, the size of the stud fee was not reflective of the genetic quality of the stallion.

Gene Jockeys

The Horse Genome Project was started in 1995 to assign locations of thousands of genes to chromosomes within the equine body cell. Swedish researchers found that gene order is strikingly similar between humans and horses, meaning that much of the work done on the human genome can be applied to equine studies. A great deal of the research has focused on developing predictive tools for winning traits and to improve the overall health of the breed.

What if a simple DNA test could detect vulnerability to injury? Or, what if molecular genetics could identify potential Secretariats from a strand of hair? Scientists agree that a single genetic marker is unlikely to produce outstanding performance. Even if specific genes could eventually be tied to performance, inheritance of those genes cannot be guaranteed.

However, genetic studies do provide valuable data on inherited diseases and have already resulted in DNA tests for several lethal illnesses. But breeders are also becoming increasingly aware of behavioral factors, such as the time a foal spends with its mother, coupled with differences in nutrition and training.

Seeing Double

Cloning, a practice prohibited by the governing bodies for thoroughbred racing, has been used to produce both mules and horses. While commercial applications are stuck at the gate as governments and animal rights protestors sort out the ethical and legal ramifications, researchers are using cloning to learn more about embryonic development.

Advances in this still-limited field have also given scientists a unique opportunity to conduct side-by-side studies of heredity versus environment. Project Idaho, a privately financed venture, produced the first equine clones with the births of mules Idaho Gem and brother Idaho Star. Born in 2003, they have been raised and trained separately, providing valuable insight into the role played by factors such as diet and training.

Produced by parents that sired a champion mule racer, the two went nose-to-nose on the racetrack last year with Gem beating Star handily, supporting the claim that nurture may, indeed, have an edge over nature—at least for mule racing.

—Debbie Kopyta

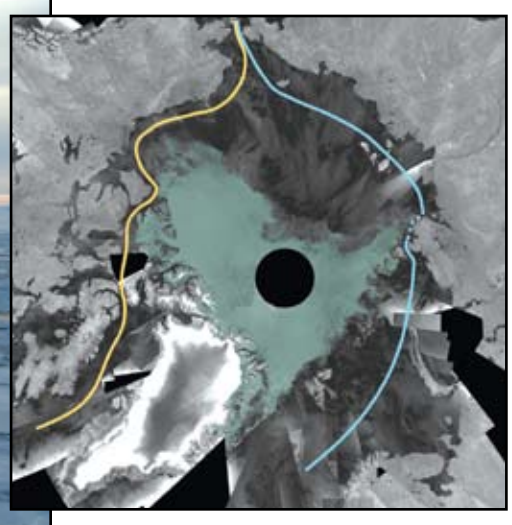
Horse History

One of the earliest ancestors of today's horse was the Hydracotherium which roamed the Earth around 50 million years ago. It stood only as tall as a fox and had toes rather than hoofs.

Fairly recently, 3000 B.C., people started taming horses for their ability to carry heavy loads. That saved the species from being just a source of food and leather.

ARCTIC WARMTH MAY LEAD TO A VERY COLD WAR

Sea Ice in the Antarctic—credit: Harvey Goodwin, Norwegian Polar Institute



2007 Envisat mosaic of Arctic Ocean—Credits: ESA

When you consider how much of the Earth is covered by oceans, deserts, towering mountain ranges, and other landscapes that challenge habitation, you realize that most of human civilization occupies a couple of rather small strips of temperate climate on a few increasingly crowded land masses. For that reason, it shouldn't come as a surprise that tensions would arise at the prospect that those areas of accessibility, navigability, and habitability—territories claimed over hundreds of years of political upheaval and military action—could be changing.

Cold Climates, Hot Topic

While global warming may be a controversial subject, rapid thawing in the Arctic Circle is an undeniable reality. According to images captured by the European Space Agency's Envisat satellite last summer, Arctic sea ice had shrunk to its smallest size in at least 30 years. On September 14, 2007, the agency reported that the ice loss was estimated at 1 million square kilometers compared to minimums in 2005 and 2006; that is a sobering number, given that annual ice loss during the previous decade had averaged only 100,000 square kilometers.

The effect of this ice loss could be staggering in terms of the world's energy reserves and its transportation network.

What Lies Beneath

Beneath the retreating ice sheath may lie a geological treasure chest of untold riches. A modern-day "gold rush" is already underway, sparked in part by the discovery of a 2.4-carat diamond at Garnet Lake in western Greenland last year. And even downgraded estimates of Arctic oil reserves released by energy consultants Wood Mackenzie in 2006 would suggest that the region has an untapped potential of 3 million barrels of oil equivalent per day.

Much sought after in past centuries, a new ice-free Northwest Passage would become an attractive alternative to the Panama or Suez canals for trade between many parts of Europe and Asia. Quoted in the November 2007 issue of *Discover Magazine*, Sheldon Drobot from the Colorado Center for Astrodynamics Research states, "We used to say that maybe by the middle of the century the Arctic would be seasonably navigable... At the current rate, we could see a seasonal shipping route in the next decade or two."

Polar Politics

Already, the geopolitical fallout of this change is beginning to be felt. In Greenland, a dependent territory of Denmark, separatist sentiment is being fueled by visions of future mineral wealth. Elsewhere, nations such as Russia, Canada, and the United States are racing furiously to map the once-inaccessible regions of the North to ensure that others do not infringe on their territory.

The relationship between the competing powers is anything but cordial. In August of 2007, explorers in a pair of Russian submersibles planted their nation's flag on the seabed at the North Pole. Days later, Canada commenced a very visible 10-day military exercise that it dubbed a "sovereignty operation." Said Canadian foreign minister Peter McKay, "This isn't the fifteenth century. You can't go around the world and just plant flags and say 'We're claiming this territory.'"

When we consider climate change, we need to remember that it has consequences beyond sunblock and storm damage. Hopefully, one of those consequences won't be an unfriendly meeting of East and West in a part of the world where those directional distinctions have the least meaning.

—Edwin Schock

What Lies Ahead

While the Earth's temperature has been measured as increasing by 0.6°C (1°F) every year, the Arctic is warming more quickly, almost twice as fast as the rest of the world. Over the next century, average annual temperatures are projected to rise by 3 to 7°C (5 to 13°F).

HD'S GREEN GAZETTE

A LOOK AT WHAT'S CONTRIBUTING TOWARD A GREENER PLANET EARTH!

Sustainability: NFL Scores with Green Practices

Glendale, AZ—The National Football League isn't just the worldwide icon for American-style football—it's also a leader in "green" business practices.

Now in its 15th year, the NFL's Environmental Program works with local organizations and governments to lessen the environmental impact of NFL events. According to Jack Groh, head of NFLEP, incorporating sustainable principles into an event "is good business, and a smart thing to do."

Before the 2008 Super Bowl, the NFL planted 30 acres of trees to offset greenhouse gas emissions caused by traffic and trash generated by the game and related events.

Other NFL environmental initiatives include recycling at NFL stadiums; donating leftover prepared foods to soup kitchens, shelters and churches; and sponsoring a program in which school children donate used books and sporting goods for redistribution to kids in underprivileged communities.

Construction: Greener Greensburg Rising

Greensburg, KS—A May 2007 twister virtually destroyed most of Greensburg. On Dec. 19, 2007, City Council members voted to rebuild tornado-ravaged city buildings using LEED Platinum Standards, the top level of certification given by U.S. Green Building Council. LEED, which stands for Leadership in Energy and Environmental Design, was chosen to "create a better quality

of life" for the citizens of Greensburg, according to City Administrator Steve Hewitt. LEED criteria cover six key areas of construction: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality and innovative design.

Nature: Elephant Crossing

Karnataka, India—More than 1000 Indian elephants can move freely between two forest reserves thanks to a strip of land donated by the International Fund for Animal Welfare. A 25-acre passage connecting the Edayagalli and Doddasampige refuges was purchased from local landowners. Facing loss of habitat to deforestation, farming and other human encroachment, marauding elephants have become a king-sized nuisance to local villagers. The connector is expected to curtail interaction between the pachyderms and the locals.

Recycling: Christmas Trees Truly Evergreen

"Live" Christmas trees can be reused in many ways, says the National Christmas Tree Association. The tree farmers' trade group estimates 93% of natural trees were recycled following the 2006 season. Most trees end up as compost or mulch. Others are used in coastal areas to help rebuild eroded dunes and beaches; submerged to provide cover for fish in lakes and marshes; or as nesting habitat for birds.

Transportation: Hybrid Cars Hit Record Sales

Energy-efficient, environmentally friendly hybrid vehicles rolled to a record in 2007 U.S. sales. According to Nov. 2007 data released by Autodata, hybrid sales tallied 33,233 units for the month—up 82% from Nov. 2006 and nearly four times as many as Nov. 2004. Hybrids accounted for 2.8% of the domestic light-duty vehicle market. The Toyota Prius topped all U.S. hybrid sales for the month with 16,737 units. With one month remaining, U.S. hybrid sales had exceeded 316,000 units, shattering the 2006 mark of 253,000 sales.

Green Bits

Global Warming has finally reached the mainstream. Consider: a Dec. 31, 2007 "Google" Internet search on the term returned 5.14 million results. In contrast, Google returned just 3.08 million hits for "George W. Bush" and 542,000 for "New England Patriots".... The Green Exchange, a new Wall Street trading house, trades carbon and renewable energy credits in lieu of stocks and securities. It's backed by major energy brokers, including the New York Mercantile Exchange, Morgan Stanley, and JPMorgan, among others... Thanks to a captive breeding program, the endangered black-footed ferret (Mustela nigripes) is making a comeback in its native Wyoming. A 2006 census reported 223 wild ferrets, up from just seven animals in 1981.

—Dan Skantar

YAHOO TO GO CARBON NEUTRAL

In April 2007, Yahoo announced plans to go carbon neutral. In addition to other activities already in place [conserving energy, using alternative commutes], it planned measures to offset those emissions it couldn't reduce.

Yahoo has now announced its decision to offset 250,000 metric tons of carbon [2006 figures] in a globe-spanning program involving hydropower in Brazil and wind farms in India.

Yahoo is purchasing carbon offsets from the Primavera hydropower project in the Brazilian state of Rondonia. The dam uses natural flow and elevation to generate electricity.

Around the globe in India, Yahoo will purchase offsets from forty-three 750-kilowatt wind turbines in western and southern India. According to a company official, "With our rapidly growing presence in India, we felt a sense of responsibility to encourage the development and use of cleaner energy here."

FOLLOW THE LEADER—COCKROACH STYLE

Imagine trying to convince a group of cockroaches to "come out, come out, wherever you are." Not likely to be successful with our usual forms of persuasion, eh?

It can be difficult to train animals to follow our instructions or change their behaviors--even our domestic pets like dogs and cats can have minds of their own and behave as they want to, not as we want them to. Clearly changing cockroach behavior requires a completely different approach.

Fortunately, it has been observed that groups of cockroaches do follow the leader, and scientists have now created a tiny robot that plays the Pied Piper with these creatures of the night.

In an experiment reported in the journal *Science*, scientists relate how they have created a robot cockroach, capable of joining—and being accepted by—cockroach groups. These "roach-bots" do not look like cockroaches: though they are cockroach-sized, they are rather clunky and lack the sleek cockroach good looks. More importantly, they can be made to smell like cockroaches--and smelling right is important in the highly sociable cockroach community.

To make the robots smell like the rest of the cockroaches, scientists coated the robot roachs' surfaces with pheromones (chemicals secreted by animals that influence the behavior and development of members of the same species) and other compounds found on the bodies of real cockroaches. With the right "perfume", these roach-bots became accepted into cockroach groups and were able to interact within the group. Because they had been previously programmed by their creators to behave in certain ways, the cockroach imposters began to change the way the true cockroaches behaved.

Many of us who have experienced cockroach sightings have turned on a light in a dark room to see these insects scurry into murky crevices and cracks for safety, away from the glare of the lamp. While the real cockroaches will seek out a dark shelter over a lighter one, the roach-bots were programmed to select lighter shelters. As the roach-bots "chose" the lighter shelters, more and more of their living counterparts joined them. Eventually, the imposters were able to redirect members of the group to the better-lighted, less safe hiding places. The result: the community becomes much easier to discover and eliminate.

Beyond helping scientists to better understand how animals behave and make decisions in groups, this type of insight may become useful in practical ways, according to researchers. The expression "following like sheep" has a basis in reality. An entire herd of sheep may jump off a cliff just because one sheep has done so, for example, when pursued by a predator. A properly programmed robo-sheep might be able to prevent this unfortunate and expensive occurrence.

—Merry Morris

ROBOTS ARE SHOWING UP IN THE STRANGEST PLACES...

The use of robots has limitless possibilities, bounded only by our imagination. Here's where robots have been showing up lately.

Mobility for disabled infants

Crawling around and exploring the environment is a critical exercise in an infant's development. For infants with muscular or orthopedic problems, this critical step in their development is delayed or impossible.

Thanks to research at the University of Delaware, robots are coming to the rescue. Scientists there have developed a mobile unit for these infants that is a combination of a robot and baby bumper car. Even six-month olds have been able to scoot around safely.

Though other powered mini-vehicles do exist, they have been used for older children with whom safety issues can be better controlled. They would not normally be available to toddlers until they are age four or five.

Use of the new contraption is aided by technology—infrared and sonar sensors—to avoid obstacles—useful where the buggy's driver isn't old enough to steer!

Camel-riding robots

Camel races in Qatar and elsewhere around the Persian Gulf have gotten a bad rap... one that is thoroughly deserved. You see, traditionally the camel jockeys have been young boys—even as young as four years old—who may have been bought from their parents or kidnapped. The camel ride is a dangerous one, and the young boy is secured to the saddle by Velcro®. Tragic accidents are not uncommon.

Now the role of the jockey is being filled by riders that no human rights group will have reason to worry about. The new riders are robots.

Camel races are traditional to these cultures and eradicating them would be difficult. Now with robo-riders, the tradition can be maintained without the human cost. Initially the robots were greeted with skepticism, but improving speed, weight and aerodynamics have convinced many sheiks that they are the way to go. Some camel racers even feel that after some tinkering, the robots can provide better results than the human jockeys!

EUROPEAN MATH STUDY MAY HOLD KEY TO MYSTERY TRAFFIC JAMS

One of the challenges of math instruction is to demonstrate the relevance of higher math to everyday life. Math, of course, pervades all of our decision-making, including how we choose to spend our money and the risks we're willing to take with our personal safety. But, ironically enough, it may be in solving one of the most mundane mysteries of life that mathematicians from Great Britain and Hungary will garner the most appreciation for complex math theory.

Virtually everyone has experienced the aggravation of a sudden traffic jam like the ones that seem to plague so many of our urban expressways. It is not uncommon to find yourself at a standstill for many minutes only to have traffic eventually thin out—without any sign of an accident—a few miles ahead. Until recently, such phenomena defied any comprehensive scientific explanation.

Traffic flow, you see, has always posed a unique problem as it regards mathematical modeling. While automotive traffic can be likened to blood pumping into and out of the heart of a city, the process defies analysis in terms of simple fluid dynamics. Our highways may feature bottlenecks and outlet valves that can raise or lessen traffic density, but each vehicle has a driver making his or her own individual decisions and is, therefore, quite unlike plasma flowing through a vein or a sand pebble tumbling through an hourglass.

Prior to the publication of a paper by Gabor Orosz (of the University of Exeter) and Gabor Stepan (of the University of Budapest) in The Proceedings of the Royal Society A in 2006, conventional wisdom had held that traffic jams were the result of overtaxed infrastructure–roadways unable to accommodate traffic volume many times their intended capacity. The study by Orosz and Stepan, titled "Subcritical Hopf Bifurcations in a Car-Following Model with Reaction-Time Delay," suggests that heavy traffic volume is not the sole cause of jams. Rather, heavy traffic volume merely creates the conditions under which human error can result in a jam.

Ideally, large numbers of vehicles (perhaps more than 15 per km) can follow each other at a constant speed on a given road in a steady state–a so-called "uniform flow equilibrium." As our own experiences would validate, heavy traffic can still be smooth-flowing traffic. But Orosz and Stepan would argue that it is our own reaction as drivers to interruptions in this flow that holds the key to traffic jam creation and perpetuation.

Faced with an unexpected event such as a truck changing lanes in front of them, drivers will apply their brakes and thereby create a rippling wave throughout the traffic stream behind them. If the first car slows below a certain critical speed for those conditions, each subsequent car must actually apply the brakes a little harder and slow down a little more than the car braking in front of it. Ultimately, traffic at some point (perhaps miles behind the event) must slow to a stop. Says Gabor Orosz, "It really matters how hard you brake—a slight braking from a driver who has identified a problem early will allow the traffic flow to remain smooth. Heavy braking, usually caused by a driver reacting late to a problem, can affect traffic for many miles."

In the conclusions to their paper, Orosz and Stepan offer the use of overhead gantries with electronic signs as a possible remedy to some traffic snarls. "In order to dissolve (a persistent stop-and-go traveling wave), an appropriate control can be applied using temporary speed limits given by overhead gantries that can lead the traffic back 'inside' the unstable traveling wave and then to reach the desired uniform flow." In the end, however, the responsibility to improve conditions rests with each of us as individuals to be alert and undistracted on our roadways.

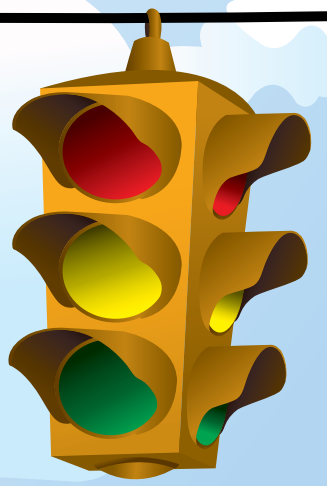
With apologies to Shakespeare, it would appear that the fault lies not in our cars but in ourselves.

—Edwin Schock

ADDING UP THE COSTS OF TRAFFIC CONGESTION

A 2007 study of urban transportation data shows that traffic congestion represents a massive drain on the U.S. economy.

- **For the study year (2005), traffic congestion resulted in a $78 billion drain in the form of 4.2 billion lost hours and 2.9 billion gallons of wasted fuel.**
- **According to the study, the amount of time urban commuters spend in traffic would equal 105 million weeks of vacation.**
- **The amount of fuel wasted would occupy 58 fully loaded supertankers.**
- **The toll on the average peak period traveler is an extra 38 wasted hours and 26 gallons of fuel, amounting to a cost of $710 per person.**



SCIENTISTS MAKE MIGHTY MICE

Muscle-bound, fearless, super-performing mice no longer exist only inside comics and children's books. They may not be able to leap tall buildings with a single bound, but running uphill for six hours, scarfing down 60 percent more daily calories with no negative health effects, and pleasantly playing with kitty cats big and small are all in a day's work for today's research mice. Several recent and ongoing studies have transformed these mice from "meek" to "mighty."

How "Mighty"?

Scientists at Case Western Reserve University were investigating the metabolic and physiological function of the PEPCK-C (phosphenonolpyruvate carboxykinase) enzyme on particular muscles and tissues. When they directed the expression of PEPCK-C exclusively to skeletal muscle, they found some surprising results.

PEPCK-C mice live and breed longer than regular mice; whereas most female mice stop reproducing after a year of age, PEPCK-C mice reproduced through age 2-1/2. The test mice ate 60 percent more than control-group mice, but remained fitter. They were seven times more active in their cages and could run 20 meters per minute on a treadmill for up to six hours, even at a 25 degree incline.

By testing blood lactate levels before and after exercise, researchers determined that the control mice switched between fatty acids and carbohydrates for fuel while the PEPCK-C mice used fatty acids only. Richard W. Hanson, a professor who wrote an article about the study for the Journal of Biological Chemistry, described PEPCK-C mice as metabolically similar to Lance Armstrong biking up the Pyrenees.

The Mighty Benefits

Scientists are using another set of super mice at the College of Georgia to investigate ways to increase bone density and prevent osteoporosis. Bones respond to stress by growing more bone, so researchers are trying to determine which stressors increase density the most.

The mice in the study lack myostatin, a gene that regulates muscle mass and ensures muscles don't overgrow during development. Carrying extra muscle stresses the bone, which leads to increased bone density. However, carrying extra fat stresses bones as well—so which is better? Because no gene stops their muscles from getting bigger and bigger, the test mice have up to 70 percent more muscle mass than normal and very little body fat. Researchers test whether muscle or fat does more to increase density by comparing the bones of the myostatin-lacking mice with control-group mice carrying extra fat.

Another differentiation the scientists are investigating is natural muscle and muscle gained through exercise. Does one increase bone density more than the other? The myostatin-inhibited mice are genetically muscular, but less inclined to exercise than regular mice. Scientists can again compare the bone density of the mighty mice to that of mice who "work out" to see which is more beneficial.

Brawn versus Bravery

While the mice above have the physical build to accomplish great feats, mighty mice also need to be fearless. At Rutgers University, mice lacking an active gene for the protein stathmin exhibited more courageous behavior than those with the gene; for example, venturing into the center of their box rather than slinking along exterior walls to avoid predators.

Test mice were also slower to learn fear responses in relation to pain. They were exposed to a loud noise prior to receiving an electric shock through the floor; when the sound was played the next day, the control group froze while the test group barely reacted. Scientists hope to use new-found knowledge from this research to treat people suffering from phobias and/or anxiety disorders.

In another study, Tokyo scientists created mice so fearless they were willing to play with cats. Part of the brain called the olfactory bulb processes information about smells; by disabling part of the bulb, scientists found that they could create mice that would not flee upon smelling predators. While most theories suggest fear is gained through experience, this new research indicates that some fears are lower-order functions hardwired into the brain at birth. Mammalian behavior then is determined by genetic instincts as well as learned behaviors.

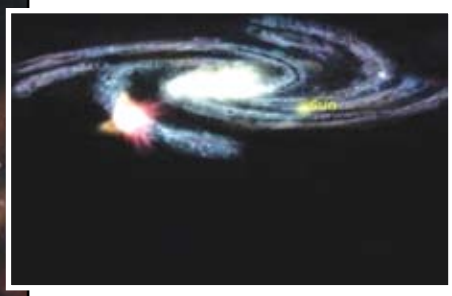
The point of all of these tests is to advance human medical research. In the meantime, it's fun to imagine the super feats enabled in these mighty mice by a bit of genetic tweaking.

—Aprile Smith

Why Mice?

Why are mice the study animal of choice? First, genetically they are extremely similar to humans. (Who knew?) They are convenient to work with—small and inexpensive to maintain. They have a short life cycle and high reproductive rate. In fact, under ideal conditions, a breeding pair of mice can produce 500 offspring in a five-month period!

THINGS THAT GO BUMP IN THE NIGHT SKY



Artist's conception of Smith's Cloud colliding with our own Milky Way Galaxy in approximately 40 million years. Projected impact location is on the left in this image. (Credit: Bill Saxton, NRAO/AUI/NSF)

When you think of space, you probably picture endless tracts of nothingness. You think of a void interrupted only occasionally by stars and planets. But when you look at many of the most current headlines in astronomy, it's clear that our universe is—at least on a certain scale—a fairly crowded neighborhood teeming with both minor fender benders and major cosmic collisions.

Our interests are usually fairly provincial; that is, we're primarily interested in objects that could impact Earth or other familiar bodies in our own solar system (i.e., the near miss of Mars by asteroid 2007 WD5 in January). However, that short-lived curiosity is fueled by immediate concerns for our own safety and fails to consider how common such interactions may be in shaping the cosmos around us. In the big picture, asteroid impacts like the one believed to have killed the dinosaurs are actually rather small compared to the planetary pinballing experienced by many newly formed worlds—including perhaps our own.

The Mystery of Object 2M1207B

Research released at a recent meeting of the American Astronomical Society suggests that scientists may have discovered proof of a planetary collision not unlike the ones supposed to have formed Earth's moon or turned Uranus's axis on its side. Eric Mamajek, of the Harvard-Smithsonian Center for Astrophysics, states that the object 2M1207B found orbiting the brown-dwarf star 2M1207A is likely the product of a collision between a Saturn-sized protoplanet and a Uranus-sized neighbor. Mamajek and colleague Michael Meyer, of the University of Arizona, propose this theory as an explanation for the planet's unusual features.

"It's either way too dim or way too hot," says Mamajek. At 2400 degrees Fahrenheit, Object 2M1207B is as much as 1100 degrees hotter than astronomers would expect for an object of its size, brightness and apparent age. Whereas other researchers postulated in 2006 that some of the planet's light was being obscured by a disk of floating dust, Mamajek and Meyer argue that the discrepancy fits the aftermath of a titanic collision. They also point out that this is hardly an uncommon occurrence.

"It's quite likely that major collisions happen in other young planetary systems," explained Mamajek in a January 9 press conference. "Hot, post-collision planets might be a whole new class of objects we will see with the Giant Magellan Telescope... Even if we're wrong, I wouldn't be surprised if someone finds a clear-cut case in the next 10 years."

Smith's Cloud on the Galactic Horizon

While planet-versus-planet collisions may seem extreme, they are still miniscule in comparison to collisions on a galactic scale. Additional research presented to the American Astronomical Society by Felix J. Lockman of the National Radio Astronomy Observatory (NRAO) would suggest that a huge hydrogen cloud—called Smith's Cloud—is even now brushing up against the outskirts of the Milky Way Galaxy. Discovered in 1963, the cloud measures 11,000 light-years wide and would appear 30 times wider than the full moon in the night sky if visible to the naked eye.

"When it hits, it could set off a tremendous burst of star formation. Many of those stars will be very massive, rushing through their lives quickly and exploding as supernovae... it'll look like a celestial New Year's celebration, with huge firecrackers going off in that region of the galaxy," Lockman said.

Before you go crawling under your bed, it's worth noting that all of this huge cosmic jostling tends to happen over a very long time in human terms. If Object 2M1207B did experience a planetary collision, we are likely viewing the aftermath tens of thousands of years later. And Smith's Cloud won't fully impact the Milky Way for roughly 40 million years—odds are good that you didn't have plans.

—Edwin Schock

COSMIC FIRSTS

Jupiter has the best storms—its most famous storm, the Great Red Spot, has been raging for centuries! Mars is home to the largest known volcano in the solar system—Olympus Mons is twice as high as Mt. Everest and as large as the state of Arizona. Neptune boasts of the fastest winds. These gusts attain 2000 kilometers per hour (1200 miles per hour). Sirius, the Dog Star, is the brightest in our solar system and one of the closest.

COSMIC WEIGHT LOSS

If you're looking to lose some weight this year, you might consider taking a little trip—into outer space! Sound a little "out there"? According to NASA scientists, a space flight might not be such a bad idea if you're looking to shed a few pounds. Most astronauts who weigh in after a Space Station mission generally find that they've lost about 5 percent of their original body weight. While this scenario might sound ideal to the average American, it is actually a concern to nutrition experts who are trying to ensure the health of astronauts during their long space missions.

Why does this weight loss occur while in space? Scott M. Smith, a nutrition scientist at NASA's Johnson Space Center in Houston, says that astronauts lose weight mainly because they don't eat enough. While in space, astronauts generally eat about 20 percent fewer calories than their recommended daily intake. While Smith is not quite sure why astronauts tend to eat less in space, he and other nutritionists have come up with a number of possibilities.

Loss of Appetite

Caroline Apovian, a nutrition consultant who focuses on astronauts' fitness and food, states "their appetite isn't as strong in space, and we don't really understand all of the reasons." Space motion sickness is a likely contributing factor. Nearly every astronaut experiences some form of space sickness in zero gravity, caused by the highly confusing information reaching their inner ears. Symptoms include headaches and nausea, two things that curb a person's desire to eat.

Bland Food

Another issue to consider is the bland menu that astronauts are subjected to. During the Mercury flights 40 years ago, freeze-dried powders and semiliquids packaged in aluminum tubes were standard. These unpalatable products have since been replaced with rehydratable foods such as chicken and rice, macaroni and cheese, and scrambled eggs. But they are still far from gourmet feasts. "They get tired of freeze-dried foods, and I don't blame them," states Apovian. Astronauts complain that it tastes like "camping food." Fresh food is always the preferred fare, but it requires refrigeration, which requires space. "Spacecraft usually don't include much refrigerator space, so it's difficult to include food that is more palatable," says Apovian. Refrigeration may become a key issue in future space flights. When a refrigerator was included on one of the shuttle missions, the astronauts did not lose as much weight as on other missions.

No Time to Eat

A final part of the problem could be the intense schedule and time limitations that are involved with a typical space mission. When asked why they eat less in space, some crew members said that they were "too busy." This tempts them to substitute snacks for meals. Senator E.J. "Jake" Garn, who flew on Discovery in 1989, said that during most of the flight, he had no interest in eating. "The view from space was so beautiful, eating was the last thing on my mind."

Importance of Good Nutrition

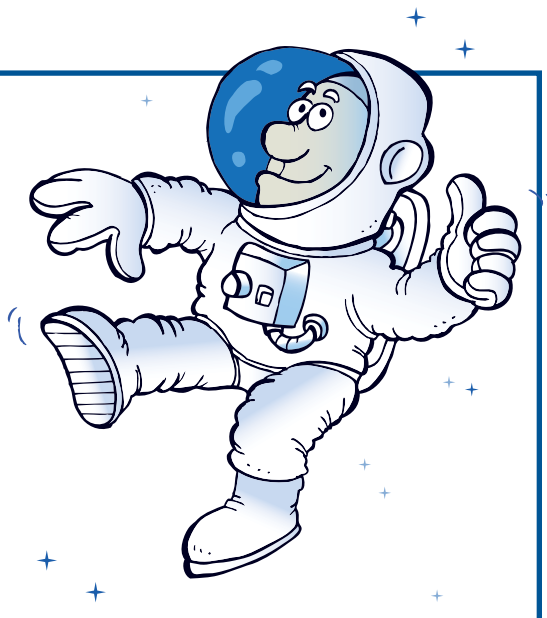
According to Apovian, it is imperative to provide a healthful and tasty diet for astronauts on prolonged missions. "If astronauts lose weight and muscle on long space flights, there may be risks...(these) risks are unacceptable if there is an impact that leads to many mission objectives lost, or even an aborted mission. This could mean serious injury to crew, or even death." Too much bone or muscle loss could be a problem, for example, if the astronaut becomes incapacitated and lacks the strength to get out of the capsule after landing. Bone fractures are another potential risk.

NASA researchers are planning further study of the nutrition-related changes that occur in space travelers. As the number of flights and the demands on space crews increase, nutrition research will play a crucial role in space exploration. Hopefully, with more study future astronauts will remain healthy, energetic and well-fed, even during the longest space missions.

—Joe Giacobello

HOW DO ASTRONAUTS WEIGH THEMSELVES IN SPACE?

They can't exactly step onto a scale, but there's another weigh (oops!)...way. A device with a spring-loaded metal arm applies a force to the body and measures how much it accelerates as a result. Based on Newton's second law of motion, the more massive the astronaut, the less the subject will accelerate.

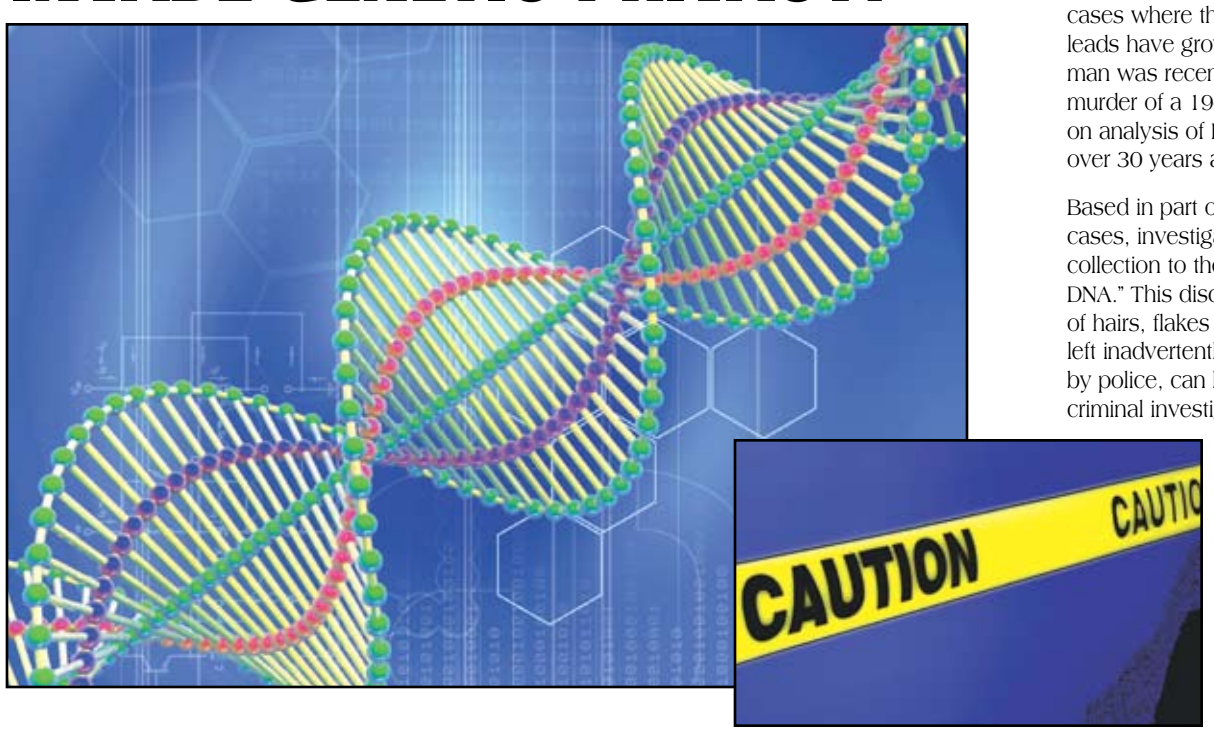


OTHER HAZARDS IN SPACE

Weight loss is not the only health problem for space travelers. Vitamin D is produced in our bodies by a reaction that requires ultraviolet light. In space, the astronauts are surrounded by ultraviolet radiation, but far too much. The Space Station shields them from the harmful levels, leaving its passengers with not enough UV radiation to supply their bodies with vitamin D. A deficit of this vitamin will affect the growth and maintenance of bones. To make matters worse, weightlessness seems to make the body absorb less of the vitamin D than is available, such as that from vitamin D supplements.

Iron presents a problem, as well. Astronauts have been found to build up very high levels of ferritin. The astronauts' diet is carefully watched, so researchers know the iron intake levels—and these are not out of line. So, perhaps the problem is not what's coming in, but rather what's not going out. In space, the volume of blood decreases, apparently because weightlessness makes it easier for the circulatory system to move blood and oxygen throughout the body. Under these conditions, less iron is needed for the production of red blood cells, and the body's iron rises even without additional intake.

ABANDONED DNA: DOES CRIME-SOLVING EVIDENCE INVADE GENETIC PRIVACY?



The advent of DNA (deoxyribonucleic acid) testing in the mid 1980s revolutionized criminal investigations and provided law enforcement with ironclad evidence to identify and convict criminals. Found in virtually all tissues and fluids of the human body, including bones, organs, skin, hair, saliva, semen and blood, DNA is now one of the most important pieces of evidence collected at crime scenes.

Technological advancements now allow DNA to be recovered and analyzed from many items including hats and masks, soda and beer cans, cigarette butts, electrical cords, sheets, inside latex gloves, and even saliva on postage stamps. Using this technology, biological evidence collected at crime scenes decades ago can now be analyzed to identify criminals. Countless criminals have been convicted based on the genetic fingerprints left behind at the scenes of their crimes.

New Life for Cold Cases

Armed with old DNA from unsolved crimes, investigators are now successfully using forensic databases of DNA stored from previous arrestees and convicts to match culprits in "cold cases"—cases where the perpetrator is unknown and all leads have grown cold. For example, a California man was recently convicted in the 1974 rape and murder of a 19-year-old pregnant woman based on analysis of DNA evidence left at the scene over 30 years ago.

Based in part on their success in solving cold cases, investigators have taken genetic evidence collection to the next level using "abandoned DNA." This discarded genetic evidence—strands of hairs, flakes of skin, or saliva on a coffee cup—left inadvertently or involuntarily but not coerced by police, can be used to confirm suspicions in criminal investigations.

In a 20-year-old cold case, Seattle police had long suspected John Athan in the rape and murder of a 13-year-old girl but had no way to confirm their suspicions. To obtain a DNA sample from Athan, cold case detectives sent a letter from a fictitious law firm inviting him to join a lawsuit. When Athan mailed his response, forensic testing of saliva left on the envelope matched DNA evidence at the crime scene, and he was arrested.

Investigators have also used partial DNA matches from family members to track down criminals. In the infamous Bind, Torture, Kill (BTK) serial murder case, detectives had genetic evidence from several crime scenes, but no match in any of their DNA databases. They suspected Dennis Radar as the killer but lacked a sample of his DNA to link him to the victims or place him at the murder scenes. After learning that Radar's daughter had been at the hospital for a pap smear, police obtained a court order for a DNA sample. DNA analysis revealed a familial match with genetic evidence at the crime scenes. Shortly after Radar was brought in for questioning, he confessed to the murders.

Discarded DNA Raises Privacy Issues

While abandoned DNA provides investigators with another venue for identifying suspects, does it go too far? When someone leaves their DNA in a public place, do they give up any expectation of privacy? Unlike traditional searches and seizures, collection of discarded DNA is not restricted by criminal law and can occur at any time in any place without consent. The Fourth Amendment restricts how police can search for evidence in and on your person, property and home, meaning that police need to establish probable cause before conducting a search. Law enforcement, for instance, can't search your home for hidden weapons or illegal drugs until they've obtained a search warrant. So should they be able to collect your genetic identity without a warrant?

DNA analysis has proven invaluable in assisting law enforcement in the investigation and prosecution of crimes but requires a complicated balancing act. How do we simultaneously protect individuals from criminals, the rights of individuals to be free from unreasonable searches and seizures, and the rights of crime victims and their families to receive justice?

—Mary Rose Thomas-Glaser

CHECKING FOR (DNA) FINGERPRINTS

DNA profiling or "fingerprinting" was discovered in 1984 by geneticist Alec Jennings of Britain's Leicester University. It didn't take long for the procedure to be used in crime-solving: Only three years later, Jennings used the technique to help solve the murders of two schoolgirls in Leicestershire.

WHEN IT COMES TO TOYS, MAKE BABY THE BOSS

We live in an amazing age in which constant technological advancement is the norm. Within a single lifetime, many people have witnessed the birth of television, the advent of space travel, and the proliferation of wireless telecommunications technology. With every leap, our entire culture has subsequently changed—including the culture of play. Porcelain dolls, die-cast trucks, and red rubber balls have given way to increasingly interactive electronic toys intended to direct our children's play. But recent scholarly articles on the nature of play would suggest that flashy, highly interactive toys aren't necessarily better when it comes to educating our kids.

Roberta Golinkoff, head of the Infant Language Project at the University of Delaware, explains in a November 26, 2007 *ScienceDaily* article that many of the claims made by toy manufacturers play on parents' fears that their children will fall behind in the global marketplace. Parents buy into the hype surrounding heavily interactive electronic toys and games that claim to boost brain development—hoping to give their kids a head start. Instead, says Golinkoff, "developmental psychologists know that it doesn't really work (that) way... Kids are not empty vessels to be filled. If they play with toys that allow them to be explorers, they are more likely to learn important lessons... Toys should be props."

Kathy Hirsh-Pasek, co-director of the Temple University Infant Lab and co-author (with Golinkoff) of the book "Einstein Never Used Flashcards", adds that many interactive toys talk and sing to children and ask them to press buttons and move levers; children are never really given an opportunity to figure things out for themselves. Says Hirsh-Pasek, "I look for a toy that doesn't command the child but lets the child command it."

So are there specific attributes that make for a superior toy?

Golinkoff and Hirsh-Pasek have a couple of suggestions: toys that can be assembled and reassembled in a variety of different ways (to spark imagination), and toys that encourage social interaction with other children (as this will help to develop necessary negotiation skills).

R. Keith Sawyer, associate professor at Washington University in St. Louis, would further argue that the level of realism invoked by the toy can affect the quality of resulting play. Quoted in a December 2007 **PhysOrg.com** article, Sawyer points out that toys low in realism permit more latitude and encourage more improvisation in play. For example, a child who receives an action figure based on a popular movie or television show will likely know how the character is expected to act and will restrict his play to conform to that model. However, age is a factor, as Sawyer does note that "younger children, those who are two or three years old, might need the extra realism in their toys because they aren't skilled enough yet to make up their own play scenarios."

How the toy is presented to the child cannot be discounted either. Says Sawyer, "Whatever toy you buy your child, don't just put her in a room with it and let her play with the toy by herself and think she's going to get anything out of it. The child will get the most benefit from parent/child interaction surrounding the toy or game."

Ultimately, what parents need to know is that the quality of the learning experience depends less on the money invested in the toy itself and more on the time invested in play. Not only do we build memories, but we help our children create memories that can blossom into skills. And that, in the end, is all the head start any child needs.

—Edwin Schock

TOY INDUSTRY FACTS

"Traditional" toys (excluding video games) represent a $22 billion industry in U.S. dollars, according to statistics presented by the Toy Industry Association.

2007 estimates would suggest that the video game industry garners as much as another $14 billion.

Since 2004, infant/preschool toys have led all traditional toy categories with annual sales of roughly $3 billion.

Youth electronics sales have seen a rapid climb over the last few years, with the category first topping $1 billion in annual sales during the period from July 2006 to June 2007.

Grandparents represent 15-25% of all toy spending, depending on the category being examined.

In 2006, the world toy market exceeded $67 billion according to the International Council of Toy Industries.

In the same year, North America was the largest part of that market (at 36% of the worldwide total), followed by Europe (29%), Asia (24%), Latin America and the Caribbean (7%), Africa (2%), and Oceania (2%).

DVD REVIEW

Orientation to Laboratory Safety
A Laboratory Safety Training Program
The MARCOM Group
Running time: 11 min.
Fisher Cat. No.: 18-555A

As pointed out in the very beginning of this DVD, laboratories are dangerous places—and human beings have a tendency to do the wrong things, like taking shortcuts and ignoring precautions. We know the result can be accidents of varying degrees of severity.

"Plan ahead!" is a message that comes through loud and clear in this fast-paced program. Whether the planning involves preparation of safety plans based on regulatory requirements, or simply checking glassware or making spill control materials available within easy reach before an experiment begins, the DVD makes the case for prevention in a clear and interesting way.

Topics covered in this DVD include:

- OSHA regulations
- Material Safety Data Sheets (MSDSs)
- Planning safe experiments
- Personal protective equipment
- Ventilation controls
- Chemical storage
- Accidents and emergencies

The package includes a guide to support the instructor in preparing and conducting the safety training, including a quiz to test how effectively this important message has been learned.

Orientation to Laboratory Safety is just one part of MARCOM's 12-part Elements of Safety Series. Other DVDs delve into more detailed topics including the OSHA Formaldehyde Standard and Safe Handling of Glassware. For the entire set, visit **www.fisheredu.com** and search for keyword "MARCOM".

BOOK REVIEW

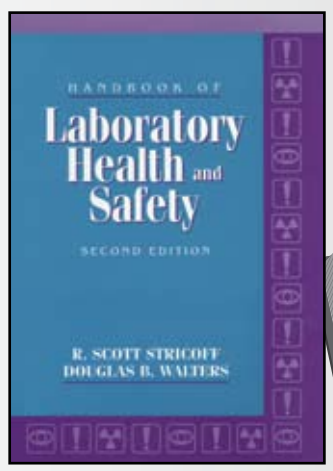
The Handbook of Laboratory Health and Safety
2nd Ed. 1995. John Wiley and Sons, Inc., 480 pp.
By: R. Scott Stricoff and Douglas B. Walters
Fisher Cat. No.: 17-805-12

This book is a reference that every school science department should have. The information in its pages provides any educator charged with school lab safety programs—as well as an instructor wanting to be knowledgeable and prepared for the unexpected in his/her own classes—with a well-organized, thorough presentation of safety planning, pertinent regulations, and prudent practices.

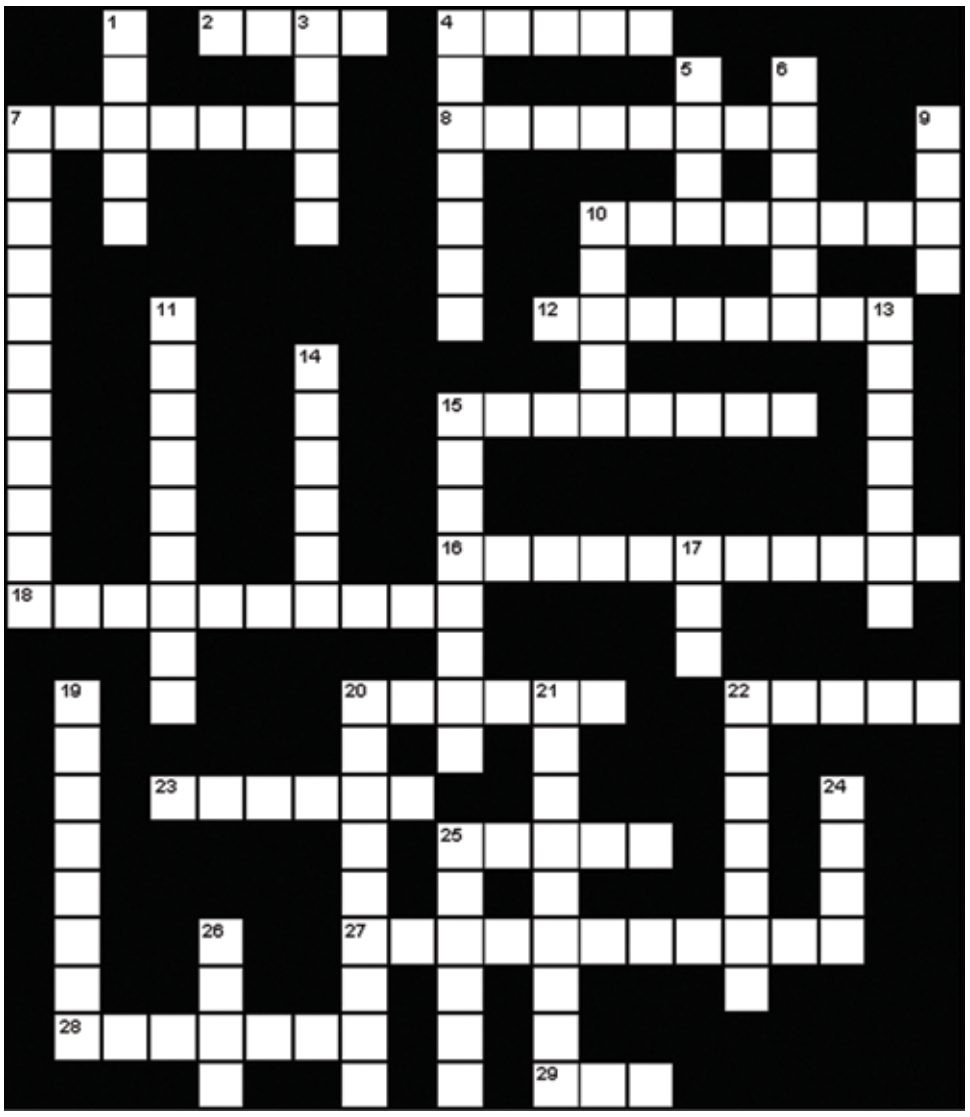
The book is divided into several sections:

- Managing Health and Safety Risks
- Laboratory Health and Safety Administrative Programs
- Hazard Evaluation and Identification
- Engineering Controls
- Protective Equipment and Work Practice Controls
- Emergency Response

Even though, with proper planning and attention to lab rules, lab emergencies should not occur, the chapter on Emergency Response is a must read. Included are detailed procedures to be followed in the event of a chemical release, requirements for means of egress, and necessary components of an alarm system.



CROSSWORD PUZZLE



Across

2. Sudden braking by cars creates a backward rippling _____ throughout the traffic stream (p. 13)
4. Researchers have used this to influence cockroach behavior (p. 12)
7. Red meat is an excellent source of this (p. 3)
8. One reason for weight loss in space: loss of _____ (p. 16)
10. A class of performance-enhancing drugs (p. 1)
12. This U.S. president died from infection caused by unclean hands (p. 4)
15. This discipline was used to investigate traffic jams: mathematical _____ (p. 13)
16. Red meat, when cooked at high temperatures, can contain these compounds (p. 3)
18. This oral hygiene device was invented in China in 1498 (p. 4)
20. In the 1960s, Jocelyn Bell discovered the first evidence of a _____ (p. 2)
22. A nanometer is one billionth of this (p. 5)
23. The endangered black-footed _____ is making a comeback in its native Wyoming (p. 9)
25. Washing these can prevent bacterial and viral infections (p. 4)
27. Olympic sprinter who admitted steroid use - two words (p. 1)
28. Bell and Hewish concluded that pulsars were rapidly spinning ____ stars (p. 2)
29. The advent of __ testing in the mid 1980s revolutionized criminal investigations (p. 17)

Down

1. In the distant future, a large hydrogen _____ will collide with the Milky Way Galaxy (p. 15)
3. California ground squirrels have an enzyme that helps them to resist snake _____ (p. 6)
4. Toys low in _____ permit more latitude and encourage more improvisation in play (p. 18)
5. Percent of body weight lost by an astronaut while in space (p. 16)
6. The Horse _____ Project was started in 1995 to assign locations of thousands of genes to chromosomes in equine body cells (p. 7)
7. A collision between the early Earth and another _____ may have created the Moon (p. 15)
9. In nano-sizes, a particle's surface area becomes very large compared to this (p. 5)
10. Squirrels chew discarded pieces of this animal's skin to apply the scent to their bodies (p. 6)
11. _____ is a gene that regulates muscle mass and ensures muscles don't overgrow during development (p. 14)
13. A recent "gold rush" was spawned in Greenland by the discovery of a _____ (p. 8)
14. Nanoparticles of this element can kill germs when added to certain products (p. 5)
15. Report detailing drug use among athletes (p. 1)
17. _____ planted 30 acres of trees to offset greenhouse emissions from the Super Bowl (p. 9)
19. One _____ of pulsar material would weigh a billion tons if brought back to Earth (p. 2)
20. A chemical produced by an animal that influences other members of the same species (p. 12)
21. Strands of hairs, flakes of skin, or saliva left on a coffee cup contain _____ DNA (p. 17)
22. A new ice-free Northwest Passage could result from the _____ of the Arctic ice cap (p. 8)
24. Flashy, highly interactive ____ aren't necessarily better for educating kids (p. 18)
25. Researchers have found that gene order is similar between humans and _____ (p. 7)
26. Genetically altered mice play with these, apparently without fear (p. 14)