

# HEADLINE DISCOVERIES

Mar/Apr 2012; Issue 2



**EARTH DAY**  
**APRIL 22, 2012**

**IT'S A GRAPE CAREER!**

**EYE SPY SUSPECTS  
WITH DNA**

**EARTH HAS A TWIN?**

**ONLINE IDENTITY  
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Price offers in this publication are good through December 31, 2012, unless otherwise stated.



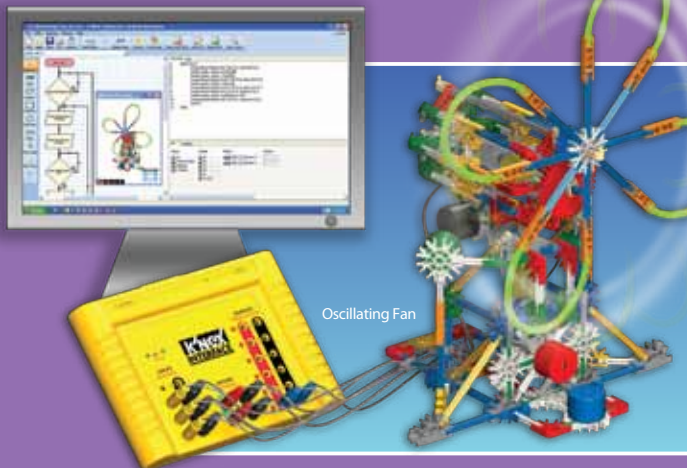
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**DNA Man cracks the human genetic code with his superhuman computing skills.**

— Illustration by Michael Andrulonis

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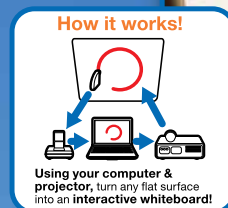
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# CAREER SPOTLIGHT: VITICULTURIST

By Gwen Myslinski



Many countries all over the world make remarkable wines — some that go for thousands of dollars. But what makes these wine enthusiasts pay exorbitant amounts of money for one bottle of wine? It generally boils down to the grapes; and who knows more about the grapes than the person who breeds and cultivates them? The viticulturist.

Viticulturists grow high-quality grapes to make the best wine possible. They determine the best time to harvest and prune, and

are vigilant in evaluating the vineyards for pests, disease, grapevine fertilization and mineral nutrition, irrigation and more. These “grape experts” are often working with vineyards, but can be found working for federal and state governments, college and universities, and the private sector.

## CAREERS

Students who are interested in pursuing a career in viticulture should take high school courses in the sciences, basic agriculture and communications, and enroll in college classes like grapevine biology, water management and soil nutrition. To enter the field, an individual can earn anything from a certificate, associate or bachelor’s degree; however, those who want to go into research will oftentimes need to earn a master’s degree and/or a doctorate.

According to SimplyHired.com, the average annual salary for a viticulturist is \$79,000, though it can vary greatly depending on the level of experience, education and geographic location. For example, a person in this field can earn an average salary of \$105,000 in San Francisco, while in Erie, Pa., the average salary drops to \$67,000 per year, according to the same website.

## JOB OUTLOOK

A study compiled by Cornell University reports employment opportunities are expected to increase between 9 and 17 percent between 2005 and 2014. Many of those jobs will be with private wineries in all 50 states, as well as with government and university research departments to improve vineyard management methods, harvesting techniques, environmental protection, water conservation, yield, quality and regulatory compliance.

Learn more about our career spotlights at [www.fisheredu.com/STEM](http://www.fisheredu.com/STEM).

## CLASSROOM DISCUSSION

- When starting a new vineyard, what are some considerations a viticulturist has to think about, and how does science and engineering play a role in the preparation? (proper trellis systems for sun exposure, air movement for avoiding mildew, etc.)
- Grapes play a significant role in the cost of a bottle of wine; how do they affect the cost?

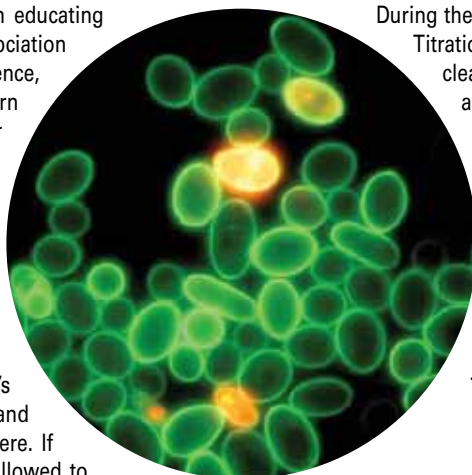
# STEM ADVANTAGE: USING INNOVATION TO MAKE WINE



By Robert Marshall, Educator, Carnegie Science Center

For one year now Fisher Science Education has been educating teachers who attend National Science Teacher Association (NSTA) conferences with a hands-on STEM (science, technology, engineering and math) workshop to learn about oenology: the science of wine making. After a brief wine-making course overview, workshop attendees visit several stations where they are immersed in specific scientific principles of the wine-making process. The aim is for these teachers to share their excitement with their students.

Biology and chemistry play major roles in oenology. Are the yeast cells operating in the optimal range? Why should wine makers be concerned with the solution’s chemical balance in a barrel? It is all about taste, and oenologists can tell you the questions do not stop there. If the wine is too sweet the yeast cells have not been allowed to ferment long enough. This is due to a direct correlation between the sugar concentration (brix) in the grapes and potential alcohol. On the flip side, if the wine is too sour the acidity level may be high (scientists say the pH is low), and therefore, may be detrimental to the survival of the microorganisms. And if the science of glycolysis and anaerobic respiration was not complicated enough, think about the scientific processes that take place even before the introduction of yeast. The climate and nutrients of the crop’s soil will change the initial quality of the grape juice before wine making even begins!



During these workshops there is something for everyone to touch. Titration, usually completed after seeing a pink indicator in a clear solution, is made possible for a red wine only by using an advanced datalogging system. For teachers unfamiliar with microbiology, they are given the opportunity, most for the first time, to use a digital microscope connected to a computer to look at commercial yeast cells. All of these tools are very exciting and worthy of the title STEM educational. It reminds us that putting innovating technologies in front of our students provides them with new and unique opportunities.

< Captured using a digital microscope, individual ovoid *Saccharomyces cerevisiae* yeast cells are seen here glowing from the presence of a vital stain. The orange specimens are no longer living, and are easily distinguished from the rest.

## CLASSROOM DISCUSSION

- How could you apply the science of physics to oenology? Hint: How might hydrophobic yeast cells affect the homogeneity of a mixture?
- What other scientific investigations could you use titration and digital microscopy for other than oenology?

# SNOWFLAKES – NOT JUST FROZEN RAIN

By Valinda Huckabay

You may already know that each snowflake is unique — there are never two created exactly alike. But did you know that snowflakes grow?

## HOW SNOWFLAKES ARE FORMED

Snowflakes are made of ice, but they are not just frozen water. Sometimes raindrops freeze as they fall, but this is called sleet, not snow, and it doesn't have any of the elaborate and symmetrical patterning found in snowflakes.

Snowflakes have fascinated scientists for centuries. Johannes Kepler, a 17th-century astronomer and mathematician, discovered that all snowflakes are unique variations on a six-sided crystal. Snow crystals form when water vapor within a cloud shrinks directly into ice. Intricate patterns emerge as the ice crystals grow. A snowflake typically begins as a single ice crystal, then becomes more complex by growing branches, combining with other ice crystals, and even gathering tiny frozen water droplets on its surface from within the cloud.

## COMMON SHAPES

In 1951, the International Commission on Snow and Ice produced a fairly simple and widely used classification system for solid precipitation (stuff that's not rain but falls from clouds), which defined the seven basic snow crystal types as plates, stellar crystals, columns, needles, spatial dendrites, capped columns and irregular forms — the most common snow crystals.

Caltech physicist Kenneth Libbrecht, however, prefers to use his classification system of 35 types of snow crystals. Libbrecht studies the physics of crystal growth; basically how temperature and electrical charges interact to produce snow crystals. He uses a high-quality, low-power photo-microscope that he designed himself to study snow crystals up close.

He is one of the world's top snowflake experts, and has written seven books on the subject.

Libbrecht received the esteemed Lennart Nilsson Award this year for his work with what he calls "nature's frozen art." The Nilsson Prize is awarded by the Karolinska Institute, and is considered the Nobel Prize of scientific photography.

## ARTIFICIAL SNOW?

So what about the snowflakes in artificial snow? Because artificial snow machines shoot out a mixture of water and compressed air, the water comes out as fine droplets, the air cools them and the droplets freeze. Artificial snow is, therefore, made up entirely of merely frozen water droplets, with none of the elaborate structure found in snowflakes.

So nothing beats the real deal ... as one of the most amazing and beautiful feats of nature, watching snowflakes fall is always fascinating entertainment!



## CLASSROOM DISCUSSION

- What was the most amazing snowflake you've ever seen?
- What do you think makes snowflakes stick together so you can make things like snowballs?

# CHASING WATER FOOTPRINTS

By Christina Phillis



The T-shirt you wear, the paper you write on and the food you eat could not have been made without water. T-shirts don't grow on trees, so why is water needed to make them? Think about the cotton needed to make the T-shirt. Did you know that it takes 713 gallons of water to grow the cotton that makes one T-shirt?

Scientists measure the amount of water being used to produce different goods around the world by dividing the Earth's surface by river basins. A river basin is the portion of land drained by a river and its many streams and creeks that flow downhill into one another. The next time you enjoy a Snickers you can thank the Volta River Basin. Located in West Africa, it is responsible for 10 percent of the water used to produce chocolate eaten in the United States.

## CONSERVATION EFFORTS

The fresh water used in agriculture and the production of goods is in high demand. Fresh water only makes up three percent of all the water on Earth. The other 97 percent of water is salt water found in oceans. While the amount of fresh water available stays the same, the population on Earth (more than seven billion people) keeps getting bigger. The need for fresh water continues to increase along with it.

There are different ways to reduce the world's water footprint, or the amount of water used. Farmers can reduce their water footprint by using drip irrigation, which works by delivering water directly to the roots of plants. This reduces the amount of water that evaporates or is absorbed into the air, meaning less water is lost or consumed.

Another way that people can conserve water locally is by buying goods that don't need as much water to produce. It takes 1,799 gallons of water to make one pound of beef. In contrast, one pound of chicken only needs 468 gallons.

Agriculture and industry not only contribute to the consumption of water, but also to its pollution. Fertilizer from farms in the Mississippi River Basin flows through different waterways until it gets to the Gulf of Mexico. Chemicals from this run-off fertilizer, such as nitrogen, result in the "dead zone," an area of low oxygen that is harmful to fish and aquatic life.

So the next time you wash your T-shirt, make sure it's with a full load. You never know what effect your water footprint can have.

## CLASSROOM DISCUSSION

- What factors contribute to your water footprint?
- What can you do to conserve the amount of water you consume?

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# SUNSCREEN — MORE LIKE SUN BODY ARMOR

By Ashley Peterson

With summer just around the corner, there will be plenty of opportunities to get out and soak up those rays. But while you are enjoying these longer days of fun in the sun, your skin may be left vulnerable to the damaging effects of the sun's harmful UV rays.

Due in large part to extensive exposure to the sun, it is estimated that one in five Americans will develop skin cancer in the course of their lifetime. Currently, skin cancer is the most common form of cancer in the United States with more than 3.5 million cases being diagnosed each year.

You have heard the warnings and know that sunscreen is your best bet when it comes to protecting your skin from the sun. But is it enough?

## A BRIGHT OUTLOOK ...

Thanks to a scientific breakthrough by an Australian team of researchers, it is possible that within the next five years, our coconut-scented sun protections will pack an even more powerful punch. Research is now shedding new light that sunscreens might someday prevent or even treat skin cancer by reversing dangerous skin mutations caused by overexposure to the sun.

Led by Professor Stephen Jane and Dr. Charbel Darido of Monash University's Department of Medicine at the Alfred Hospital, the researchers discovered a gene that helps protect the body from squamous cell cancer (SCC) of the skin, the second-most prevalent form of skin cancer in the U.S. Until now, the genetic basis for SCC has not been well-understood by scientists, leaving surgery as the only option for treatment.

The identified gene, *Grhl3*, acts as a "stop signal" for SCC and was virtually absent from every SCC tumor that was studied. The loss of this gene turns off

the signal to stop skin cells from growing. Without this signal, the cells keep increasing in number and eventually form a cancer. This important discovery provides researchers a clear direction for developing strategies for both prevention and treatment in the not-too-distant future.

Identifying this "stop signal" for the growth and spread of cancer is a breakthrough that will hopefully pave the way for speedy development of new prevention and treatment strategies.

In the meantime, don't skip the sunscreen and reapply often!



## CLASSROOM DISCUSSION

- Do you think cancer-preventing sunscreen will be available to the public within the next five years? What are some potential challenges that might hinder the development process?
- Can you think of any other genetic discoveries that have profoundly impacted medical/scientific research?

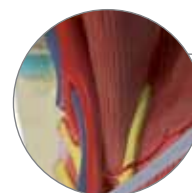
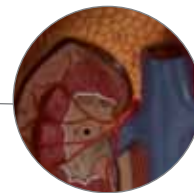
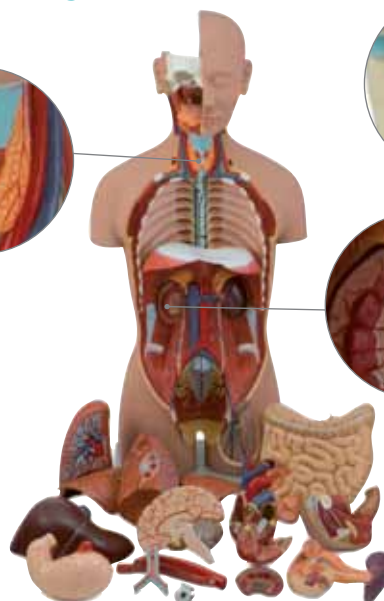
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# YOU CAN RUN, BUT YOU CAN'T HIDE THOSE BABY BLUES

By Sara Nedley



Little more than 25 years ago, the use of DNA to help identify humans was not well understood. But since its introduction into forensic casework in the mid-1980s, DNA has proven to be an increasingly important tool for forensic

scientists. Very few items of evidence hold the value of a DNA profile, which allows investigators to identify suspects by virtually eliminating the possibility that the DNA sample came from anyone else included in the world's population.

## NEW SCREEN DEMONSTRATES ACCURACY

In many instances, police are equipped with a DNA sample from a crime scene that cannot be matched in databases. As powerful as an entire DNA profile has proven to be, there is other information that can be ascertained from an individual's genetic sample. IrisPlex, a new genetic screen, uses DNA to determine whether a suspect has blue or brown eyes with up to 94 percent accuracy. The screen searches for single-letter differences in the genetic code known as SNPs (single nucleotide polymorphisms). The kit searches for six SNPs strongly linked to eye color, labeling them as blue, brown or undefined (undefined is likened to a color such as green or gray).

## RAPIDLY EXPANDING POTENTIAL

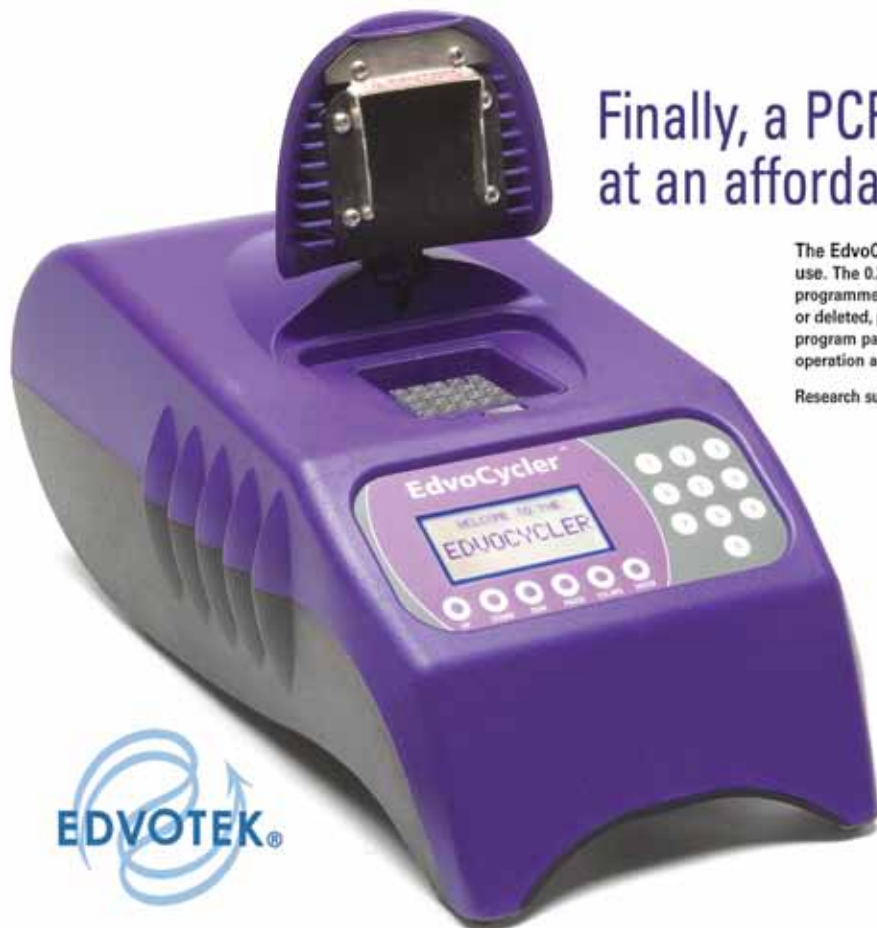
Current research is based on DNA from more than 6,000 Dutch Europeans from Rotterdam. The Dutch Ministry of Security and Justice is expected to approve the use of IrisPlex for forensic investigations, while the UK could use it immediately, making IrisPlex the first kit of its kind to be approved for forensic casework. Promising steps are also being made in predicting hair color, with one study showing 13 markers helped to predict red and black hair with about 90 percent accuracy, and blond and brown at about 80 percent.

Though IrisPlex is still not accurate enough to secure a court conviction, it can be used to provide law enforcement with helpful clues for narrowing suspect searches. Further work would be needed before the test could be used in other countries. When considering the advances forensic science has already made in the use of DNA, it seems as though future potential is only limited by what our minds can conjure.



## CLASSROOM DISCUSSION

- What other physical identifiers could help build a suspect profile?
- DNA profiles are created using STRs. What is the different between an STR and an SNP?



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# GETTING LIFEblood FROM A STONE

By Michele Cervi

Cut off from traditional sources of sustenance, the oldest forms of life on Earth are surviving on a diet of rocks and minerals.

Geomicrobiologists — one part Earth scientist and one part life scientist — have discovered thriving bacteria in underground rocks and trapped beneath glaciers. Cut off from sunlight, this microbial life cannot rely on photosynthesis to produce food. So, how are these single-celled organisms surviving?

## SURVIVAL OF THE EXTREMEST

A Welsh research team conducted experiments with ground-up rocks containing minerals, such as quartz and basalt, to which they introduced microbes. When the mixture was heated, it produced hydrogen as the temperature increased. The microbes then ate the hydrogen to survive.

While the Welsh experiment replicated the high-temperature, high-pressure underground environments present deep within the Earth, geomicrobiologists also have found microbial life that adapted to extreme cold. Blood Falls, Antarctica, earned its name from iron-rich water that seeps from an underground lake and turns a rusty red as it meets the oxygen in the outside air. The underground reservoir formed when a glacier moved over the salty lake, trapping the water and its contents beneath the glacier and shutting out the supply of oxygen. Research teams at Blood Falls have discovered that in the absence of oxygen, the microbes within the sub-glacial lake are surviving off the dissolved iron and sulfates in the water.

Researchers from Oregon State University have shown that microbes discovered in icy lava tubes subsist on iron contained within the olivine in the lava rock. Olivine also is found in volcanic rocks on Mars.



Benjamin Lundsten

Microbial life that thrives in such extreme conditions suggests that, in the search for life beyond Earth, we may need to expand our thinking on the elements required to sustain life. "If it can survive below this glacier, why not below the ice cap on Mars and on Europa?" asks Jill Mikucki, lead researcher at Blood Falls.

Could more microbes flourish in other inhospitable environments? A project called the Census of Deep Life, spearheaded by a microbiologist at Oregon State University, will attempt to quantify and classify microbes that live within the earth and at the deepest depths of the oceans.

## CLASSROOM DISCUSSION

- What are other types of microbes? How do they differ from one another?
- Do you think rocks and minerals on other planets might contain microbial life? Why?

# Innovating Science

by Aldon Corporation

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Urinalysis, one of the oldest medical diagnostic tests performed, is to this day still one of the most common. In this activity, students will use simulated urine to avoid the unpleasantness of using the real thing while still performing actual tests used on real urine samples. Students will examine the simulated urine for factors such as pH, color, clarity, as well as test for the presence or absence of proteins, glucose, and calcium. The students will then examine the samples microscopically to determine if crystals may be present.

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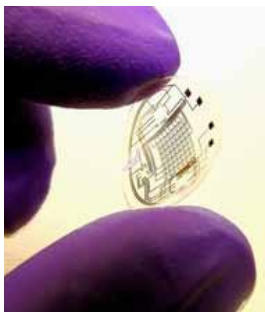


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## FEAST YOUR EYES ON THIS

By Ashley Peterson and Gwen Myslinski



For 100 million people around the world, retinal diseases have been the cause of partial or complete blindness, and most of these conditions are degenerative and passed down from one generation to another. While at the present time there is no cure for this type of gradual blindness, several researchers are working on solutions that will provide many individuals with improved vision and offer hope that their future generations won't have to experience this inevitable and debilitating journey from light to darkness.

### BIONIC ...

Last spring European regulators approved the first commercially available bionic eye. The Argus II is a video camera built into a pair of glasses that wirelessly transmits a signal to an implant located behind the patient's retina. It allows recipients to see a 60-pixel image, which means they can distinguish light from dark, localize large objects, recognize faces, read large print and independently interact with their surroundings. It's not high definition, but it's certainly a huge difference.

Though to make a significant impact, Richard Taylor, a University of Oregon physicist and vision researcher says, "Engineers and neuroscientists will have to come up with something much more sophisticated than an implanted camera."

### ... TO ARTIFICIAL

As with all technology, researchers are working on the latest and greatest: artificial retinas that don't require an external camera. "Instead, the photons will

strike light-sensitive arrays inside the eye itself," according to Carl Zimmer from *Discover Magazine*. One company even has experimental prototypes containing 5,000 light sensors.

Overall, this new technology is still in the infancy stage, and researchers are trying to answer several questions:

- According to Zimmer's article, one of them is, "Should the electrodes be positioned less like a grid and more like a set of psychedelic snowflakes with branches upon branches filling the retina in swirling patterns?"
- How many electrodes should the retina contain, and can the brain process the information?
- Is it possible to overcome the mismatch between regular electrodes and irregular neurons in the brain?

While scientists still have a lot of progress to make toward completely restoring lost vision, they certainly have helped some to "see the light" in recent years.

### CLASSROOM DISCUSSION

- How do the human eye and retina work to enable sight? How might a scientist replicate this process to help individuals who have lost their sight due to inherited disease?
- If you were a scientist working to improve vision loss, what advancements would you hope to make for the next generation affected by retinal disease?

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# WHAT'S IN A NAME?

By Gwen Myslinski



A name can mean everything. Parents can spend countless hours deciding what to call their unborn child; marketing departments will convene several times to decide how to brand a new product; and scientists who discover a new element must come up with one last discovery ... the name.

On December 1, 2011 the International Union of Pure and Applied Chemistry (IUPAC) unveiled the proposed names for elements 114 and 116: flerovium (atomic symbol Fl) and livermorium (atomic symbol Lv). The public then had a five-month review period to voice their opinions on the names and symbols before they were published in the IUPAC Journal, *Pure and Applied Chemistry*.

## EENY MEENY MINY MO

Choosing the name is a long and arduous process because the chemistry union has strict standards that each research team must follow. Kenneth Chang at *The New York Times* says, "For example, if the chemistry union rejects a name, that name cannot be proposed for any subsequent element discoveries."

In the end, flerovium was named after Georgiy Flerov, the founder of the Russian laboratory, Flerov Laboratory of Nuclear Reactions, which synthesized the superheavy element.

The discovery team of atomic number 116 chose to name livermorium after the city of Livermore, Calif., home to the Lawrence Livermore National Laboratory where the element was created.

## CLASSROOM DISCUSSION

- If your class discovered an element, what would you name it?
- If these elements can only be synthesized in a lab, and are around for such a short time before turning into other elements, why are they valuable?

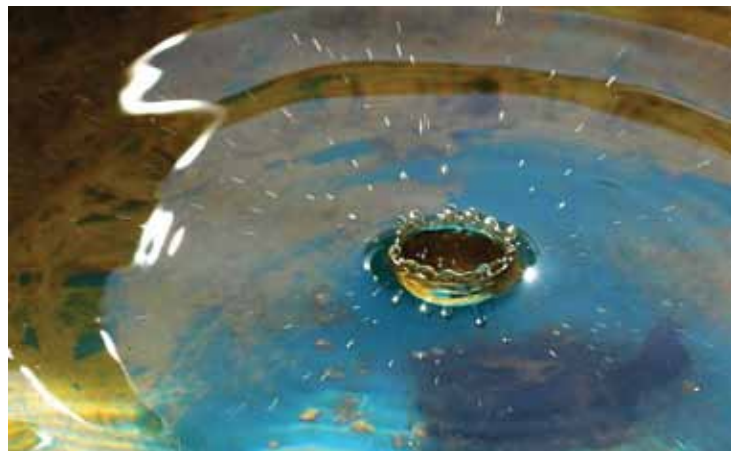
# HEAVY METAL BANNED

By Terri Sota

Researchers at Brown University have developed a new, two-step process that cleanly and efficiently removes heavy metals from water. In recently reported experiments, their cyclic electrowinning/precipitation (CEP) system removed up to 99 percent of copper, cadmium and nickel, resulting in concentrations at or below Environmental Protection Agency (EPA) standards.

The system improves upon an existing technique, electroextraction or electrowinning, which requires a threshold concentration of metal ions to be effective. Brown engineers overcame this limitation by adding either sulfuric acid or sodium hydroxide to change the water's pH, causing the separation of the H<sub>2</sub>O molecules from the metal precipitate. The "clean" water is removed and more contaminated water is added. The steps are repeated, first redissolving the precipitate, then reprecipitating all the metal, until enough exists for successful electrowinning. This second phase involves adding an electrical current to transform positively charged metal ions into an easily separated solid state. The new method is significant not only because it is scalable and commercially viable, but also because it fails to create toxic byproducts that endanger the environment.

Most contamination by heavy metals is the result of high-temperature combustion utilized by coal-fired power plants and solid-waste incinerators. Industrial manufacturing practices also release these pollutants, jeopardizing humans and ecosystems. Heavy metals can cause nervous system, liver and kidney damage, birth defects and even death. Although drinking water in the U.S. is carefully monitored to ensure compliance with EPA regulations, many urban estuaries are severely contaminated with heavy metals. And, in many parts of the world, food chain contamination caused by water pollutants is a real threat to human life and livelihoods.



The CEP system is a product of Brown University's Superfund Research Program (SRP) that takes a "state-based approach to environmental health research, technology development and contaminated land re-use with Rhode Island as our laboratory." The SRP is funded by the National Institute of Environmental Health Sciences, a branch of the National Institutes of Health (NIH).

## CLASSROOM DISCUSSION

- How does pH impact trace metals in water?
- What are the distinguishing properties of heavy metals versus like elements?



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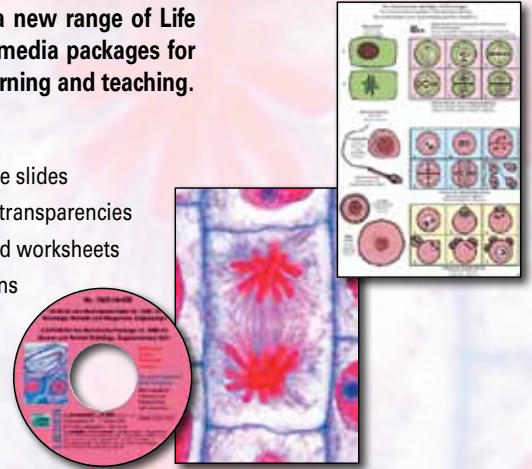


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# GREEN IS THE NEW BLACK

By Gwen Myslinski



Earth Day started as a grassroots movement on college campuses in 1970. The efforts and values first brought to light by that event 42 years ago has spawned the passing of groundbreaking environmental laws and the formation of countless groups who actively seek out new ways to continue the message. One notable group is Earth Day Network (EDN).

Earth Day Network, with partners in 192 countries, works hard to globalize the Earth Day movement. Last year, EDN introduced "A Billion Acts of Green<sup>®</sup>" — a campaign set forth to reduce the carbon emissions by more than one million pounds. Their goal is to register a billion acts of green by individuals or organizations before the U.N. Conference on Sustainable Development in Rio de Janeiro, Brazil, this June.

One program of particular interest to EDN this year is the greening of America's K-12 schools.

## GREEN SCHOOLS

According to Earth Day Network, "Green schools save money, conserve energy and water, and foster better-performing, healthier students."

Beginning at the school district level, decisions and plans are created addressing how each school will go about meeting building performance requirements as established by LEED and how they will adopt new operations and maintenance policies and practices to keep the program sustainable.

Each school progresses differently based on varying factors including the size and condition of each building, district size, budgets, the level of the LEED certification the district desires, etc., according to the Green Existing School

Project Management Guide.

Interesting facts related to green schools, according to the Earth Day Network:

- Green schools save an average of \$100,000 annually — enough to hire two new teachers, buy 250 new computers or purchase 5,000 new books
- Test scores and learning ability improves on average 3-5% — equating to an annual earnings increase of \$532 per student
- Green schools utilize 33% less energy and 32% less water than traditional schools

## THIS EARTH DAY, PLEDGE AN ACT OF GREEN

Looking for a more extreme way to go green in your community? How about working to turn your school into a green building? Eco-friendly schools are popping up all over the country because, according to The Center for Green Schools, "they create healthy environments conducive to learning while saving energy, resources and money."

Start small or go for it all, either way learn more about green schools at <http://centerforgreenschools.com> or <http://edu.earthday.org>.

Pledge your act of green at <http://act.earthday.org>.

## CLASSROOM DISCUSSION

- Do you think being environmentally aware/committed is important?
- Would turning this school into a green school make a difference in the students' performance overall?

# A DAY FOR SUPER DNA

By Gwen Myslinski

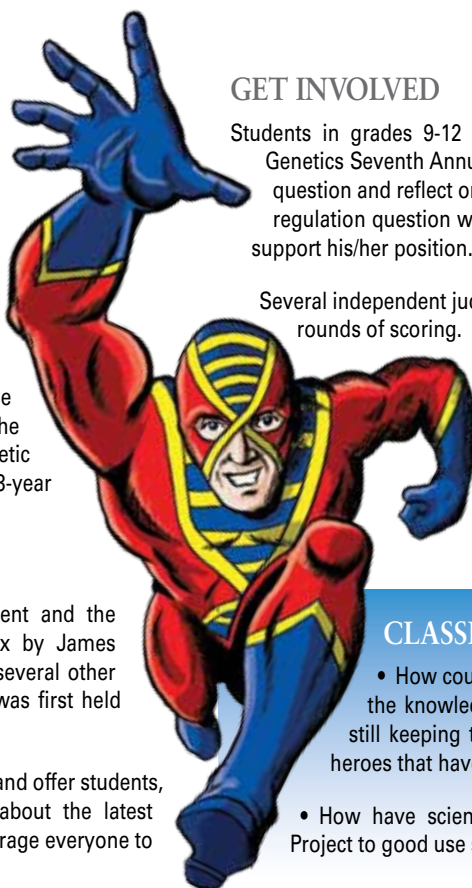
Spider-Man™, Captain America™ and The Incredible Hulk™ were all genetically altered and ended up with unique “super” abilities. Imagine how different the storylines could have been if they had been written today instead of more than 50 years ago, especially with the successful completion of the Human Genome Project, an endeavor of the National Human Genome Research Institute (NHGRI).

Before being elevated to a research institute in 1997, the NHGRI began as the National Center for Human Genome Research in 1989 to carry out the role of the National Institutes of Health in the International Human Genome Project. The project’s primary initiative was to map and understand the genetic makeup of human beings and to discover the genetic roots of diseases, and then develop treatments. It was a 13-year venture that concluded in 2003.

## DNA DAY

To commemorate this significant scientific accomplishment and the 50th anniversary of the discovery of DNA’s double helix by James Watson and Francis Crick in 1953, the NHGRI, along with several other genetic associations, instituted National DNA Day, which was first held April 25, 2003.

This year, the annual celebration will be held April 20, 2012 and offer students, teachers and the public an opportunity to learn more about the latest advances in the fields of genetics and genomics, and encourage everyone to explore how this field affects daily living.



## GET INVOLVED

Students in grades 9-12 can compete in the American Society of Human Genetics Seventh Annual DNA Day Essay Contest. Students can examine, question and reflect on important genetic concepts by answering the gene regulation question with logically argued content, along with citations, to support his/her position.

Several independent judges will read and evaluate the essays through three rounds of scoring.

To learn the specifics about the essay contest including the question, rules, guidelines, prizes and scoring rubric, visit <http://www.ashg.org/education/dnadaycontest.shtml>.

## CLASSROOM DISCUSSION

- How could the storylines have changed in the comics with the knowledge the Human Genome Project provided, while still keeping the story interesting? Are there any other super-heroes that have been genetically altered?
- How have scientists and researchers put the Human Genome Project to good use since it’s been completed?

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# SEEING IS BELIEVING

By Sara Nedley

For the last 60 years, the Standard Model has been used to understand the fundamental building blocks of matter, with one important piece to the puzzle missing. Although the Standard Model is employed as the “guide” for understanding particle physics, the theory is missing definitive proof of the piece that explains how particles get their mass. Physicists know that an elementary particle must somehow interact with other particles to give them mass, yet the particle has not been proven to exist. But physicists have recently moved closer to finding that very elusive last piece to the puzzle known as the Higgs boson.

## THE BUILDING BLOCKS OF LIFE

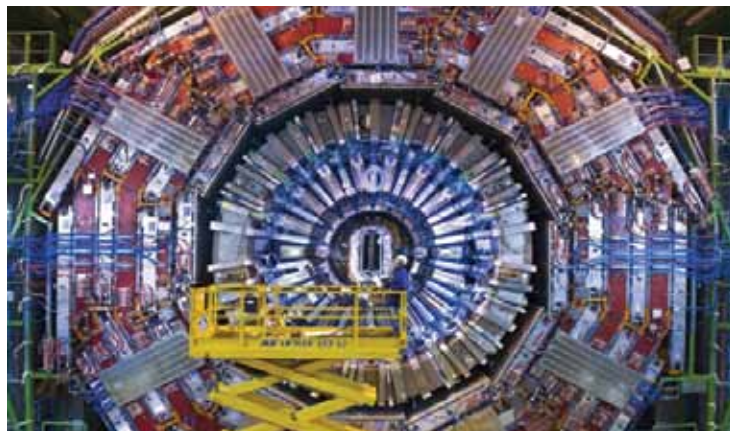
Sometimes referred to as the “God” particle, the Higgs boson is thought to give mass to all matter. Currently the mass of the Higgs boson remains unknown, and without that knowledge it is not understood how other particles acquire mass. Physicist Peter Higgs first used the Higgs boson to explain how particles obtain mass. He proposed that a “Higgs” energy field exists everywhere in the universe and as particles move within it, they interact with and attract Higgs bosons. The greater the amount of Higgs bosons that cluster around the particle, the greater the resultant particle mass.

## BIG DISCOVERIES, ONE PARTICLE AT A TIME

The Higgs boson is the proof needed to determine that there is a Higgs energy field. Scientists at the European Organisation for Nuclear Research (CERN) have been using the Large Hadron Collider (LHC) to create Higgs bosons through particle acceleration experiments. Two major experiments, known as ATLAS and CMS, observe the collision of protons that have been accelerated to nearly the speed of light. When particles collide, they can turn into energy and that energy can then create new types of matter. In December 2011, researchers

announced that both the ATLAS and CMS experiments have turned up signs of the Higgs boson’s existence.

Like all discoveries and revelations about the fundamentals of nature, the future implications of the discovery of the Higgs boson remain unclear. Finding the Higgs boson will not reveal everything about how the universe works, but it gets us one step closer to a more complete puzzle.



Maximilien Boivin (CERN)

## CLASSROOM DISCUSSION

- What other particles are included within the Standard Model?
- What are the masses of protons, neutrons and electrons? How do they compare to one another?

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# INVISIBILITY YOU CAN SEE

By Patricia Rogler



Harry Potter's invisibility cloak may soon become a reality. Scientists are getting closer and closer to making visible objects disappear. Until now, scientists have only been able to make objects invisible at the microscopic level, but two tests recently performed at MIT and the University of Birmingham have, for the first time, made objects invisible at the macroscopic level. The key to these tests is calcite crystals.

## CALCITE CRYSTALS VS. METAMATERIALS

In the first invisibility tests scientists performed, they used metamaterials — artificial materials engineered to have specific properties not found in nature. These metamaterials are expensive and limit scientists to infrared wavelengths

or longer, making them impractical for hiding objects greater than 1mm in size. However, with the use of calcite, a common and naturally occurring mineral, scientists have found a way to hide objects over the range of visible wavelengths. Calcite crystals are a naturally anisotropic material, meaning they can bend rays of light in two different directions. They reflect and refract light in such a way as to conceal objects on the other side of them. Using two calcite crystals glued together, known as a "carpet cloak," scientists have made a paper clip and a rolled up piece of paper invisible.

## PROS AND CONS

Unfortunately, right now the calcite crystals make objects invisible only in one light polarization, not in natural light. Also, although the object appears invisible on all sides, it is still not invisible from all angles. These issues obviously create some real-life application drawbacks. However, scientists are optimistic they can take these tests further — with the size of the crystal being the only real limitation. (So far the largest crystals were 23 feet in length.)

The use of crystals has overcome some major hurdles that the use of metamaterials presented — namely size, expense, bandwidth, loss and image distortion. Invisibility cloaks seemed like a creation of science fiction, but by using calcite crystals, scientists could finally be paving the way toward making them a reality. Who knows what further developments in cloaking devices we could see in the near future.

## CLASSROOM DISCUSSION

- What future applications are there for invisibility cloaks?
- Are there any drawbacks to creating invisibility cloaks?

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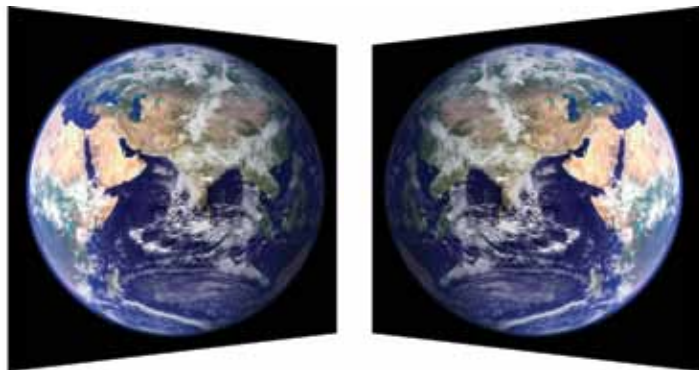
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# THE SEARCH FOR EARTH'S TWIN

By Joe Giacobello



Do alien beings exist in some distant corner of the galaxy? Astronomers believe that, if they do, they are probably living on a planet much like our own. In an effort to seek out and find such planets, NASA launched the Kepler spacecraft in March 2009.

## KEPLER MISSION

The purpose of the Kepler Mission was to discover Earth-like planets that orbit other stars. Its goal was to survey portions of the Milky Way galaxy in search of Earth-sized planets located in or near the habitable zone, and to determine how many of the billions of stars in the galaxy have such planets. Over the last few years, the mission has reported some interesting results. By December 2011, there were over 2,300 planet candidates, several of which were found in the habitable zones of surveyed stars. On December 5, NASA announced the discovery of Kepler-22b — the first planet officially confirmed to exist in the habitable zone.

## EARTH'S NEW TWIN

The new planet, located in a galaxy about 600 light years away, bears many similarities to Earth. Rotating around a star that is very similar to the sun, Kepler-22b is relatively close in size to Earth (about 2.4 times larger). With an orbit of 290 days, its year is almost the same length as the Earth's 365 days. A near "solar twin" to the Earth, it is surmised that the light hitting the planet's surface is likely the same color as that which illuminates our planet. Most importantly, it is situated at a distance from its sun where liquid water could very well exist. The average temperature of the planet's surface is estimated to be in the comfortable 70 degree range.

## THE MYSTERY REMAINS

Whether or not there is life on the new planet has yet to be determined. An organization called SETI (Search for Extraterrestrial Intelligence) in northern California is now focusing its 42-dish Allen Telescope Array at the planet, in hopes of finding some sign of communication. A preliminary search for radio signals from Kepler-22b is under way. Unfortunately, we won't be able to actually travel to our "twin planet" any time soon, as it is estimated that it would take our current space shuttle about 23 million years to get there.

### CLASSROOM DISCUSSION

- Do you believe that life exists on other planets in the universe? Why?
- How have modern books and movies portrayed the idea of extraterrestrial beings? Have they painted them in a positive or negative light? Give examples.

# THE PLACE OF THE GRAPE

By Terri Sota

Terroir [tare-wah'] is a French concept that by definition means "soil," but is more commonly used to express a sense of "place." With respect to wine, terroir encompasses everything that imparts personality to the final product; it is the sum effect of the local environment and, some would argue, the imprint of the winemaker. More specifically, terroir is the intersection of climate (including sun exposure), soil type, topography (drainage, altitude, slope) and a slew of intangibles (indigenous yeasts, worm population, etc.).



with the quality of the grape as the physical characteristics of the soil.

The winemakers of France, for the most part, are ardent terroirists. According to *Wine Spectator*, "The flavors of wine made from a particular grape variety will change depending on the terroir where it grows, and the expression of the terroir will change depending on which grape variety is growing in it." Burgundy is often cited as the ultimate illustration of terroir. French agricultural regulators rank terroirs in the region as grand cru, premier cru and village.

Despite the literal translation of terroir, Australian researchers were unable to link any chemical component of soil with wine character — with the exception of nitrogen and potassium. High levels of nitrogen can create overgrown and unbalanced wines. Potassium facilitates sugar transport into the fruit; it flows into cells in exchange for hydrogen ions from organic acids, thus buffering the pH.

Experts agree that the physical properties of the soil do play a significant role in terroir. Soil's structure influences internal drainage, and its topography influences external drainage; both are predominant forces determining wine quality and character. Intensive soil and water management can often correct nature-made problems in the vineyard.

While a perfect soil for grape growing may not exist, an ideal climate is more quantifiable, with desirable measures of sunlight, rainfall, temperature and wind equating to fruit in abundance. These contributing factors have as much to do

The whole notion of terroir inspires passionate debate. Some winemakers dispute that it, alone, accounts for the individuality of a wine. They argue that the skills of the winemaker are as pervasive in every sip as the environment. Still others contend that true terroir does not take hold in a vineyard until the vines reach a certain age, or the roots grow to a certain depth. Some experts dismiss the presence of "place" entirely. The controversy will likely continue as long as the vino pours.

### CLASSROOM DISCUSSION

- What are some of the geographical similarities shared by the wine-growing regions of California, Argentina and the Loire Valley?
- Why is terroir debate-worthy (hint: marketing)?



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Fisherbrand Lab Label Tape (Blue)	4 rolls/pk.	¾"W x 118"L	S98204	\$10.70
Fisherbrand Lab Label Tape (Green)	4 rolls/pk.	¾"W x 118"L	S98205	\$10.70

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# FACIAL RECOGNITION SOFTWARE QUICKLY ID'S FACEBOOK PHOTOS

By Nancy Thornton



Someone lingers at a store window admiring its display. Their image is captured by a store webcam and, within three seconds, matches that face with tagged and profile photos on Facebook®. In moments the unwitting subject has been identified.

enables scanning/matching facial and fingerprint images. To date, these scans are using existing law enforcement databases versus those that are publicly available via the Internet.

## RECOGNITION RESULTS

A 2011 study by a Carnegie Mellon University researcher demonstrated a 31 percent success rate of matching a webcam photo to one of 25,000 photographs taken from students' Facebook profiles. Participation was voluntary, so the webcam photo used to match was a well staged, clear, front-facing image. Nonetheless, a 31 percent match rate is impressive with, on average, less than three seconds required for the result.



## COMING SOON?

Use of 'public' images is not without controversy. Many likely embrace such a technology to identify insurgents attempting to invade a U.S. military safe zone. But are we comfortable with the idea that a local police officer might capture our photo and find it tagged to a Facebook image friends took when rocking out at New Year's Eve party?

At a software cost of \$3,000 each, it isn't likely that the MORIS iPhone application will be generally available anytime soon. And although Google®, and others, have similar technology available in their labs, the controversy surrounding its use will cause commercialization delays. In theory, such an application should require an 'opt in' feature when establishing profiles in services such as FaceBook and Google. In practice, this technology could easily streamline access to personal data. Just think . . . you capture a photo of someone you are meeting for a blind date and, within seconds, find that their relationship status on FaceBook is 'In a relationship.' Secret is out!

## TECHNOLOGY IN ACTION

Although the above test was conducted in a controlled environment, similar functionality has been developed and tested as an iPhone™ mobile application. Anyone within the iPhone viewfinder becomes a potential target – capture a photo, a second later, browse their Facebook page and scan their latest tweets.

Law enforcement agencies have vast repositories of images that include faces and fingerprints. Last fall marked the beginning of operation "Mobile Offender Recognition and Identification Systems" (MORIS) – a deployment to police stations across the country of a device that, when coupled with an iPhone,

## CLASSROOM DISCUSSION

- If this technology were available as an iPhone application, would you download it, and why?
- What are some of the positive and negative points of using this kind of technology?

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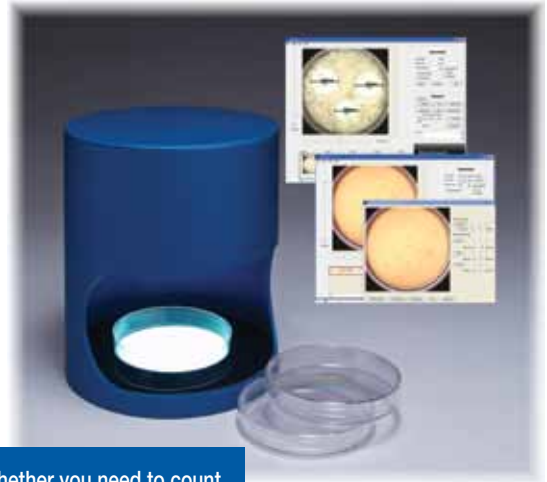
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## A BRIDGE SO FAR

By Terri Sota

Last June, four of the six longest bridges in the world opened — all of them in China. The 26.4 mile Qingdao Haiwan Bridge is now the lengthiest over-water span, extending more than three miles beyond Louisiana's Lake Pontchartrain Causeway (previous record-holder). The three other bridges are part of the Beijing-Shanghai High Speed Railway and China's ongoing mega-billion-dollar investment in infrastructure.

The Qingdao Haiwan connects the bustling port city of Quindau, in eastern Shandong Province, with the offshore island of Huangdau. With a growth rate of 16 percent per annum, Quindau is one of China's fastest-growing cities. It is home to the Chinese Navy and Tsingtau Beer, and was the site of the 2008 Beijing Olympic sailing events. The city is also a popular tourist destination, boasts beautiful beaches and attained "most livable city" status in 2009. Drivers of the 30,000 daily, toll-assessed cars can now save half an hour commuting from the island to the city.

Construction of the Qingdao Haiwan Bridge was extraordinarily quick. In just four years, 10,000 laborers — working in teams around the clock — erected 5,200 columns from 2.3 million cubic meters of concrete. Four hundred-fifty tons of steel, the equivalent of 65 Eiffel Towers, were utilized as work progressed from opposite ends toward the middle. Strong economic growth and a favorable production base enable China to reign as the world's largest consumer of steel.

Much of the employed bridge-building technology is patented. The engineering marvel is not only earthquake- and typhoon-proof, but also able to "withstand the impact of a 300,000-ton vessel" (The Guinness Book of World Records). At the opening ceremony, Quindau's Communist Party Secretary heralded the many (estimates vary widely) billion dollar bridge as "magnificent and very advanced ... and another stepping stone in the city's smooth and rapid development."



Currently, a 31-mile span linking Zhuhai (southern coast of Guangdong province) and Hong Kong is under way. The \$10 billion project is expected to open in 2016, and will also help connect, build prestige and relieve congestion in the world's most populated country.

### CLASSROOM DISCUSSION

- What are some of the many earth science considerations when building a bridge?
- How long can the lengthiest bridge be? What are the limitations/drawbacks to building super spans?

<http://freshome.com/2011/01/13/worlds-longest-sea-bridge-in-china-the-qingdao-haiwan-bridge-video/>



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# RAIN, RAIN, DON'T GO AWAY!

By Valinda Huckabay

Rain patterns seem like a straightforward process — water evaporates, is sucked into the atmosphere in large collections of water droplets called clouds, and then falls back to the earth as rain. But what we're putting into the air may now be affecting the planet's ability to produce effective rain clouds.

## WHY AIRBORNE POLLUTANTS MATTER

Based on what scientists from all over the world have been documenting for decades, the level of precipitation in some parts of the world has been consistently dropping. The normal process for creating rain-producing clouds has been hampered by the amount of man-made particulates being pumped into the atmosphere.

Particulates, called aerosols, are a mixture of solid particles and liquid droplets found in the air. Typically when particulates rise into the air, water vapor collects around them and they collide with each other, forming consistently larger droplets of water until they're heavy enough to fall out of a cloud as rain. With many of the man-made aerosols being released into the atmosphere (pollutants from sources such as power plants and gas-burning engines), the size of these particulates is too small to accumulate enough moisture to become heavy, so although the clouds form, they never produce rain.

## HOW THIS AFFECTS CLIMATE

A link has now been established between large amounts of aerosols in the atmosphere and extreme weather: The clouds that form in drier regions may hold their moisture for a longer time or not release it at all, which contributes to reduced rainfall and droughts. Clouds that form over moister areas may release water too rapidly, causing severe rainstorms and flooding.

A study by Daniel Rosenfeld of the Hebrew University of Jerusalem, which uses satellite images to track airborne pollution streams coming from major urban areas and other sources, supports this theory. These pollution streams manifest as "dry" clouds that don't produce rain because they contain abnormally small water droplets.



In addition, tall, dense clouds formed by aerosol pollutants can also reflect sunlight back to space, causing a global cooling effect that may actually cancel out the warming effect of greenhouse gases, says Owen Toon, an atmospheric scientist at the University of Colorado at Boulder.

There is much debate about whether these studies are conclusive for the parts of the world that are affected by the recent, severe weather bouts. Hopefully research, not time, will tell.

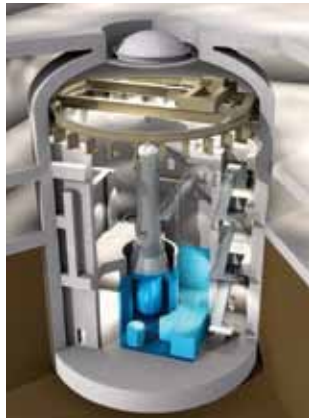
## CLASSROOM DISCUSSION

- How do you think this phenomenon will affect our planet's climate in the future?
- What do you think we can do to change this phenomenon?



# GO BIG AND GO FOR THE HILL

By Sarah McGann



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*Discover Magazine* recently joined forces with the National Science Foundation, the American Society of Mechanical Engineers and the Institute of Electrical and Electronics Engineers to hold a series of briefings on Capitol Hill. Four “bold ideas” were presented by eight leading energy scientists to politicians with the hope that these alternative energy solutions could be implemented in the near future.

## REENGINEER THE GRID

The Department of Energy has predicted that there will be 1.2 million plug-in hybrids and electric vehicles on the road by 2015, so in preparation, the

energy grid needs to be rearranged. Electricity generation from coal-fueled plants and transportation are responsible for 33 percent and 27 percent of America’s carbon emissions, respectively. Jeffery Stein, a University of Michigan mechanical engineer, states, “At first it may seem counterintuitive that making cars electric will help us limit greenhouse gases, but in fact we can reduce carbon emissions by adopting vehicle electrification.”

## MINI NUCLEAR REACTORS

Nuclear power is the cleanest source of energy on a large scale, but nuclear reactors are often costly and do pose safety risks. The solution: small modular reactors. Daniel Ingersoll, a nuclear engineer at Oak Ridge National Laboratory,

states, “Small modular reactors offer a better way to harness nuclear energy to produce power.” In addition, the smaller modules are safer and much more affordable than conventional nuclear plants.

## NATURAL GAS POPSICLES

Natural gas, the cleanest-burning fossil fuel, produces approximately half as much carbon per watt of power as coal and supplies 25 percent of America’s electricity. There are enough global frozen deposits where natural gas exists in the form of methane gas hydrates that, if tapped, could power the U.S. for 1,000 years at the current rates of consumption. Gas turbines use the natural gas to produce electricity, and thanks to a project funded by the Department of Energy, the efficiency of gas-fired power plants has been increased to 60 percent.

## POWER OF POND SCUM

Algae are the most efficient source of biofuel, with some algae species containing up to 60 percent oil – and genetic engineers believe they can increase this amount. The algae do not compete with farmland or food, which is the problem with other biofuels. “They are sustainable, highly productive, and easy to cultivate, and they capture carbon dioxide,” states University of Nebraska at Lincoln biochemist Donald Weeks.

## CLASSROOM DISCUSSION

- Which of these options do you think sounds the most feasible?
- Is there an alternative energy option that is missing from this? What argument can you make for it?

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# FROM PEAS TO GENOMICS AND BEYOND

By Merry Morris

Ever wonder why your father and your paternal uncles share some of the same facial features? Is there a “family nose” that you fear your children will inherit? Such comparisons are human nature. We often notice the similarity between related individuals, but until the science of genetics developed, the mechanisms behind these observations were unknown.

## A GENETICS TIMELINE

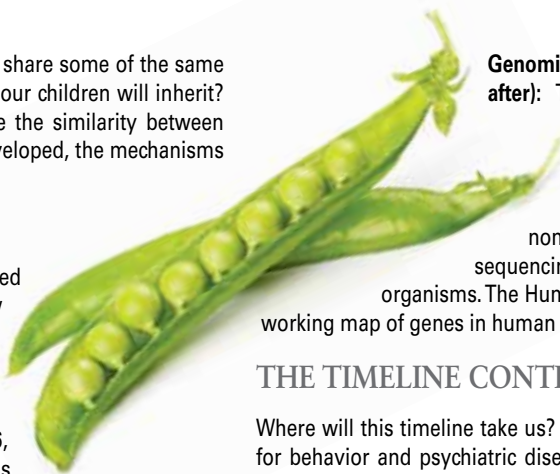
Science historians differ as to what might be considered the first step in the genetics timeline. Here are just a few major events in the birth and development of genetics.

**Gregor Mendel (1866-early 1900s):** He bred pea plants, and observed that the inheritance of certain traits followed statistical rules. His paper, published in 1866, reflected ideas like dominance and recessiveness. His “hidden” journal was later rediscovered by Hugo de Vries and other scientists looking at problems similar to those Mendel described.

**Chromosome Theory (1900-1913):** This advance put forth that chromosomes carry inheritance factors; the first chromosome linkage map was created in 1913.

**Genetic Recombination (1931):** “Cross-over,” the exchange of genetic material between chromosomes during meiosis — was found in corn by Harriet Creighton and Barbara McClintock. This exchange explained many genetic changes or “mutations”.

**DNA (1944–1970):** These years produced great advances with increased knowledge of DNA. In 1944, experiments by Oswald Avery implicated DNA (“transforming principle”) as the agent in bacterial transformation. The Watson-Crick double-stranded DNA model was determined in 1953.



**Genomics and Molecular Biology (1970s and thereafter):** The study of an entire genome through DNA sequencing and genetic mapping (genomics), as well as in-depth investigation of single genes (molecular biology) allowed genetics as we know it to flourish. The first genome sequenced, a bacteriophage, led the way to sequencing of thousands of viruses, bacteria and higher organisms. The Human Genome Project identified and produced a working map of genes in human DNA in 2003.

## THE TIMELINE CONTINUES

Where will this timeline take us? In exciting directions to be sure: genetic basis for behavior and psychiatric diseases, super-longevity, the expression of body shape by Hox genes, the importance of “junk DNA” ...

Hold on! It will be a wild ride!

## CLASSROOM DISCUSSION

- Do you think acquired characteristics can be inherited? For example, if rats are trained to navigate successfully through a maze, will their offspring be good at the same task?
- How do you think knowledge of a person's genome might affect treatment for medical conditions?

# GENE PEAS

By Terri Sota



Gregor Mendel became a father half a century after his death. His 1865 seminal paper, *Experiments in Plant Hybridization*, engendered little interest; it was not until the early decades of the 1900s that the scientific community suddenly embraced Mendel as the “Father of Genetics.” Long before the identification of genes, chromosomes and meiosis (reproductive cell division), Mendel theorized that specific characteristics were the product of “coding” from both parents and passed, sometimes unseen, to successive generations. Yet, despite his proven prescience, the true significance of his discoveries remained obscured until Darwinian theory was seen as a change in the Mendelian messaging mechanism, in populations over time.

Born in 1822, on a farm in Heinzendorf, Austria (now the Czech Republic), Mendel entered the Augustinian Abbey of St. Thomas in 1843. There he took an interest in experimental gardening, which led to a sabbatical of study at Vienna University. Gregor returned to teach physics and mathematics and, in 1856, began his work with pea plants in the Abbey's greenhouse.

## WHY PEAS?

Mendel recognized an either-or quality to their display: the flower color was either white or purple, the flower position was either axial or terminal, etc. And, because they were hermaphroditic, reproduction via self-pollination or cross-pollination could easily be manipulated. Their (relatively) rapid rate of reproduction enabled Mendel to observe up to two generations in one year.

Mendel's theories came to be known as the Law of Segregation and the Law of Independent Assortment. The former suggests that for every offspring trait, there is a pair of “alleles” responsible for the genotype (chromosomal mix) and the expression of the phenotype (observed, dominant allele). In the latter law, Mendel contends that allele pairs are passed (to gametes) independently of one another. Thus, the probability of the offspring being “purple” is independent of its stem length. Geneticists have since proven that incomplete dominance, codominance and linkage (same-chromosome alleles inherited together) are exceptions to this law.

Without the benefit of microscopic inquiry, Mendel relied on his meticulously recorded observations of 28,000 pea plants between 1856 and 1863. He deduced that although one generation of offspring fails to display a certain characteristic, the coding for the trait is still inherited, albeit as a recessive gene. Today, doctors can assess the probability of certain birth defects and diseases before conception, thanks to Mendel's investigations into the genetic can of peas.

## CLASSROOM DISCUSSION

- Illustrate the difference between phenotypes and genotypes using either Punnett squares or tree diagrams
- Calculate the probability of two or three generations of offspring displaying a recessive trait (after cross-pollinating parent plants that are homozygous for two colors of flowers)

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