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Supplier Index:

A3B.....	13
ALDON.....	20
CELESTRON.....	16
CONTROL.....	26
CORNING.....	18
DIVERSIFIED WOODCRAFTS.....	27
DYNALON PRODUCTS.....	17
E-COM SEATING.....	25
EDVOTEK.....	12
EISCO.....	8
GSC.....	6
JUSTRITE.....	20
KEN-A-VISION.....	24
KEMTEC.....	11
KIMBLE.....	23
KNEX.....	26
LABOMED.....	22
LAMOTTE.....	18
LEARNING RESOURCES.....	4
NEULOG.....	24
NEW PATH.....	14
OAKTON.....	22
OHAUS.....	2, 21
RANACO.....	17
REV SCI.....	6
SP SCIENCEWARE.....	4
SPER.....	15
STARRY NIGHT.....	16
SWIFT.....	8
THERMO SCIENTIFIC.....	7, 24, 25
TROEMNER.....	14
UNITED.....	15

Inside This Issue:

ASTRONOMY AND EARTH SCIENCE.....	16, 22-23
BIOTECHNOLOGY.....	6-7
CHEMISTRY.....	10-11
ELEMENTARY.....	5, 27
ENVIRONMENTAL.....	20-21
LIFE SCIENCE.....	9, 12-13
PHYSICAL SCIENCE.....	14-15
STEM.....	3, 19, 25, 27
TECHNOLOGY.....	26

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COOKING WITH NGSS

By Robert Marshall

Despite only 13 states and the District of Columbia having formally adopted the new Next Generation Science Standards (NGSS), many school districts in non-acting states are not waiting on their governments. We are hearing more and more reports from teachers in Florida, Pennsylvania and Wyoming that their schools have adopted NGSS in some format despite few (and sometimes abandoned) legislation discussion.

Considering all of this, at Fisher Science Education, we thought it would be a good exercise to task ourselves with an assignment more and more science teachers across America are being asked to complete: rewrite an existing lab activity following the NGSS formula. How did we do it and what can we share? Read on to find out and then follow the web link to reference and use our developed lab in your classroom!



FOUNDATION TO FRAMEWORK

It was not too long ago our professional development team implemented a middle school chemistry workshop utilizing ordinary classroom lab equipment and the smallest form of United States currency: the penny. The first portion of the experiment is to clean an old copper Lincoln by creating an everyday cleaning solution using Sodium Chloride (table salt) and Acetic Acid (vinegar). The second portion is to electroplate Zinc onto the copper followed by adding heat to then create a brass metal alloy. Science concepts covered include exothermic versus endothermic reactions, pH, matter, energy and chemical change.



In order to marry this with NGSS we first have to take a step back and consider the new standard's framework. There are three specific areas, or dimensions:

1. Science and Engineering Practices teach both knowledge and skill sets that aid in scientific literacy. These two fields of study, science and engineering, have similar problem solving processes that can be tackled the same way and are often taught together. Expanded beyond the scientific method, these practices can be interpreted as a kind of cooking recipe – starting with use of inquiry and ending with your students being able to communicate ideas. There are eight practices in total and these laid the groundwork for the flow of our lab write-up. As you read it, you will notice we were able to incorporate several, such as analyze and interpret data.
2. Disciplinary Core Ideas are the main ingredients to our science meal. This is where we get our content which covers engineering, technology, physical, life, earth & space and application of science. There are 44 ideas in total, but after visiting <http://www.nextgenscience.org/search-standards>, highlighting the middle school grade level, highlighting chemical reactions under physical science and then clicking search we narrowed it to two core ideas: structure/properties of matter and chemical reactions. Together both make up MS-PS1-1 through MS-PS1-6 performance expectations.

Grades

K-2
K
1
2
3-5
3
4
5
Middle School (6-8)

Disciplinary Core Idea

Physical Sciences
-PS1A: Structure and Properties of Matter
-PS1B: Chemical Reactions
-PS1C: Nuclear Processes
-PS2A: Forces and Motion
-PS2B: Types of Interactions
-PS3A: Definitions of Energy
-PS3B: Conservation of Energy and Energy Transfer
-PS3C: Relationship Between Energy and Forces

Search Reset

MS.Structure and Properties of Matter
MS.Chemical Reactions

Displaying 1 - 2 of 2

Knowing our experiment contains chemical reactions (or at least appears to) we reviewed MS-PS1-2 further and it is present in our lab rewrite.

MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

3. Cross Cutting Concepts are 'bridges' that link across multiple core ideas. In our cooking analogy these can be thought of as spices which enhance flavor. In this dimension we might be able to link multiple core ideas. For instance, you could teach scale, proportion and quantity during introduction to cells just the same when covering the scope of the universe. There are seven concepts in total which typically link together multiple lab activities over the period of several weeks. Since we are only redrafting one lab here, we have suggested possible extensions given those listed via NGSS: patterns and energy/matter.

FROM RECIPE TO THE LAB

As you are brainstorming how to reformat your own labs to NGSS consider you are not alone. We understand your commitment to science education and know your time is valuable. Our expert educators on staff would like to offer real assistance. How can we partner with you and your school to help rewrite your science labs? Call your Fisher Science Education representative today!

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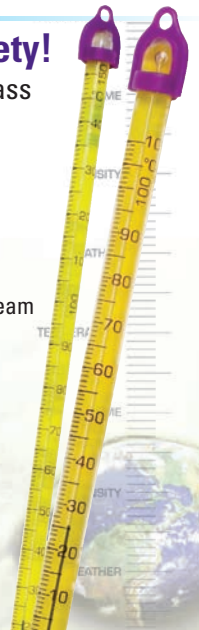
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THE NAME GAME: BRONTOSAURUS VS. APATOSAURUS

By Julianne Glaser

Dinosaurs first appeared during the Triassic Period of the Mesozoic Era over 245 to 208 million years ago and dominated the planet for 135 million years. Among the largest were the herbivorous sauropods known for their long necks and tails and immense size. For generations of children, the most famous of these giants was the Brontosaurus, or “thunder lizard.”

The Brontosaurus genus was named in 1879 by famed paleontologist Othniel Charles Marsh. During the “Bone Wars” and subsequent twentieth century debate, the name was discredited when research suggested that the Brontosaurus was actually part of a larger genus of dinosaur, the Apatosaurus. A recent in-depth study of the dinosaur family tree, however, has revealed key information that has resurrected the Brontosaurus genus.

THE DIPLODOCIDAE FAMILY

The Diplodocidae were plant eaters that roamed North America and Europe between 145 to 160 million years ago and included the gigantic Apatosaurus, Diplodocus and Barosaurus based on their similar characteristics.

A new study, however, has revealed that Brontosaurus and Apatosaurus fossils have significant skeletal differences and are, in fact, two separate dinosaur genus.

Emanuel Tschopp, paleontologist at the University of Lisbon and lead author of the study, analyzed 81 dinosaur skeletons and 477 skeletal features from 18 museums in the United States and Europe.

“I didn’t start out trying to resurrect Brontosaurus,” Tschopp states. Yet, his comprehensive findings have impressed the scientific community. Philip Mannion, a paleobiologist at Imperial College London, says, “Emanuel’s data set is now the largest published so far” for plant-eating dinosaurs.

As published in Science Magazine, Tschopp and colleagues found that the Brontosaurus differed from the three other recognized species of Apatosaurus in at least a dozen key skeletal characteristics. As a result, Brontosaurus nomenclature has been reinstated into the scientific community.

NOMENCLATURE DEBATE CONTINUES

Not all paleontologists are welcoming the name change. John Whitlock, a paleontologist at Mount Aloysius College, expressed hesitation about the recent change: “It’s going to force us to ask questions about what we really mean by genus and species in a paleontological context...”



Mannion, however, has embraced the resurrection of an iconic name, “Brontosaurus has a prominent place in the public imagination; it can only be a good thing that it is back with us.”

EXTENSION QUESTIONS

- What were the “bone wars”? Who was involved and what was at issue?
- What are some of the theories regarding extinction of dinosaurs?
- What are the three periods in the Mesozoic Era? During each of these periods, what was the Earth like and which dinosaurs lived?

VOCABULARY

- Nomenclature
- Herbivore
- Mesozoic Era
- Taxonomy
- Paleontologist



SIMPLE ANIMALS WITH SUPER POWERS ARE LARGER THAN LIFE

By Patti Dobranski

Considering the popularity of all of the Marvel Comics movies, it’s pretty easy to see that everyone enjoys super powers.

All of the high leaping over buildings, shooting of poison gases, transforming from one shape or form to another, incredible feats of strength and immortality do make captivating stories. They allow our imaginations to soar.

Humans may be limited to super powers on the big screen, but there are some simple and sometimes unseen creatures, whose super powers are not imaginary at all. Let’s meet some.

SUPER STRENGTH

When you compare the jumping distance of fleas to their 1/50 of an inch size, they are tiny Supermen. The top jumper is the bird flea, which leaps 220 times its size. For a human, that would mean a jump over an 820-foot tall building.

The Incredible Hulk has nothing on the punch of the four-inch-long mantis shrimp. This Australian crustacean can hit as fast as a bullet.

FLAME ON

A dragon millipede is 1.2 inches, but eye-catching with its hot pink exoskeleton. Get too close and you’ll get a hydrogen cyanide cloud blasted in your direction.

The two-inch pistol shrimp is aptly named. This animal has two claws — one small and the other almost half its body size. The larger creates cavitation bubbles almost as hot as the sun that emit tiny sonic booms of up to 218 decibels!

CHANGE IS GOOD

The idea for Wolverine may have come from the hairy frog, a little amphibian with claws that burst through its skin when threatened. It breaks its own toe bones and pushes a sharp tip through the skin.

Many animals can change colors to blend into their surroundings, but the mimic octopus is a true magician. This sea resident can pose as a dozen different species! Try that costume changing, super heroes!

FOREVER AND A DAY

Cats may have nine lives, but the Turritopsis Nutricula jellyfish appears to live forever. When it gets old or sick, it starts its life cycle all over again.

Tardigrades are bear-like organisms only 6/100 of an inch, but their super powers are off the charts. Their abilities include withstanding temperatures ranging from -328°F to 302°F and not eating or drinking for 100 years. They may even be able to survive zero gravity space.

UP, UP AND AWAY

The final animal super hero is the smallest bird on Earth: the hummingbird. It can fly 385 times its own body length



per second. They are the only birds that can hover in mid-air and fly backwards.

Who needs imaginary human super-heroes? There are tiny, powerful and real creatures we already share our world with!

EXTENSION QUESTIONS

- Do you know of any other animals with super powers?
- If you could have one of these animal super powers, which one would you pick and why?
- Why do you think some animals have these super powers?

VOCABULARY

- Hydrogen cyanide
- Cavitation bubbles
- Exoskeleton

OPTIMIZED HEALING THANKS TO VIRTUAL WOUNDS

By Merry Morris



Originally used in video games, computer modeling is increasingly being used to investigate and predict complicated real-life events. Agent-based modeling (ABM) simulates the ways many individual agents, e.g., virtual soldiers, will interact based on the rules set by the programmers. Myriad scenarios can be set, tested and altered to see how the outcome changes.

Complex events occur within the human body, such as when the body fights off an infection or repairs cell damage. This inflammatory process is critical for survival — without it the body cannot repair itself. Researchers like Gary An, surgeon and researcher at the University of Chicago in Illinois, and Shayn Peirce,

researcher at the University of Virginia in Charlottesville, are using ABM to create “virtual wounds” with immune cells as programmable “agents.” Their models are robust enough to closely simulate the body’s actual inflammation response.

INFLAMMATION RESPONSE – FRIEND AND FOE

When a wound is created by falling, cutting, scraping or other damage, the body’s protective and healing functions kick into high gear.

- More blood flows to the injured area as blood vessels dilate
- Fluid and blood proteins flood into spaces around the damaged cells as capillaries become more permeable
- Fighting forces, the white blood cells called neutrophils, move into the area and release enzymes that attack invading microorganisms
- Debris-cleaning macrophages arrive to clean up the battlefield, allowing the neutrophils to go off duty

Sometimes, however, the “field instructions” get fouled up — no one tells the neutrophils to go home — and they continue fighting, attacking the wrong targets in a cellular level “friendly fire.” Sepsis is the result, as the battle spreads immune chemicals throughout the entire

body in life-threatening, out-of-control inflammation. This is not a minor problem: severe sepsis is a leading cause of death in the United States with its incidence estimated to be 300 cases per 100,000 population.

NOT JUST FOR GAMES ANYMORE

Now, with ABM becoming a potent study tool, researchers can use its simulation power to better understand the intricate interactions of inflammation and sepsis. With ABM, possible remedies can be tested in the virtual sepsis patient where a failure is not tragic, and work toward finding the most effective treatment.

EXTENSION QUESTIONS

- What conditions might a modeler vary when testing an inflammation response model?

ACTIVITIES

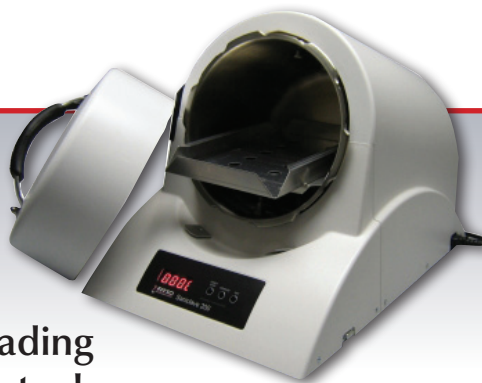
- Investigate how ABM is used in making amazing battle scenes in movies. Check out *Lord of the Rings*.
- Research the signs of inflammation. What does the acronym “PRISH” refer to?

VOCABULARY

- Computer models
- Virtual reality
- Agent-based modeling (ABM)
- Inflammation
- Neutrophil
- Macrophage

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NON-INVASIVE TESTS FOR CANCER – LIQUID BIOPSIES

By Merry Morris



Imagine a simple blood test that could detect cancer so early that it's quite curable. What a reassurance to a cancer surgery patient whose test confirms no residual cancer throughout his body!

LIQUID BIOPSIES – PROMISE AND CHALLENGES

Cancer detection from a standard blood draw is becoming a reality. Because cancer cells shed their DNA into the bloodstream, traces of the cancer as well as actual cancer cells are there for the finding. What makes detection so extraordinarily difficult, especially in cancer's earliest stages, is the presence of a lot more normal DNA.

But super-early detections are now within medicine's grasp thanks to advances in rapid DNA sequencing. Earlier attempts at pinpointing cancer DNA were plagued by technical limitations like high background noise and error rates. With improved techniques, the results from decoding millions of the patient's short DNA fragments can be compared against the map of the human genome

to highlight particular arrangements of DNA that indicate a specific cancer.

Dennis Lo of the Chinese University of Hong Kong, a long-time researcher in this area, is currently conducting large-scale tests to pinpoint liver and nasopharyngeal cancers, both relatively common cancers in China. A number of researchers are now competing to create a "pan-cancer" test that would detect several common cancers.

GUIDING CANCER THERAPY

When a cancer patient is prescribed specialized drugs to fight a particular tumor, doctors assume that the right drug is being administered. What if that tumor mutates during treatment? Will the existing drug be effective then? Not necessarily, asserts Helmy Eltoukhy, CEO of California-based diagnostics startup Guardant Health. "Seventy five percent [of patients] are on treatments that are not working for them," he says. However, repeating these rapid-sequencing-based tests during the course of an individual's therapy can alert that a genetic change has occurred and a different chemotherapy drug is needed. That saves the patient from therapies that are doing no good, while the cancer progresses to untreatable levels.

EARLY DETECTION, EARLY ATTENTION

The recent increase in cancer survival rates has been largely the result of early detection and treatment. For the fortunate patient whose cancer will be found early on with the help of a "liquid biopsy," the benefits are startling. Consider one statistic: More than 90 percent of women diagnosed with the earliest stage ovarian cancer survive their disease for at least five years compared to around five percent for women diagnosed with the most advanced stage of disease.

EXTENSION QUESTIONS

- Research cancer survival rates. How do the current survival rates compare to those of 20-, 30-, or 40-years ago?

ACTIVITIES

- Investigate the basics of rapid DNA sequencing. Draw a rough flow chart of the steps
- Compare leading cancer rates in various countries. Check China's leading cancers

VOCABULARY

- Cancer
- DNA
- Background noise
- Biopsy
- DNA sequencing

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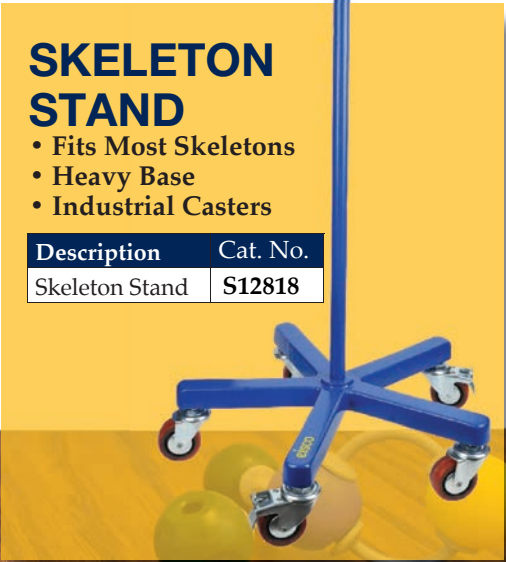


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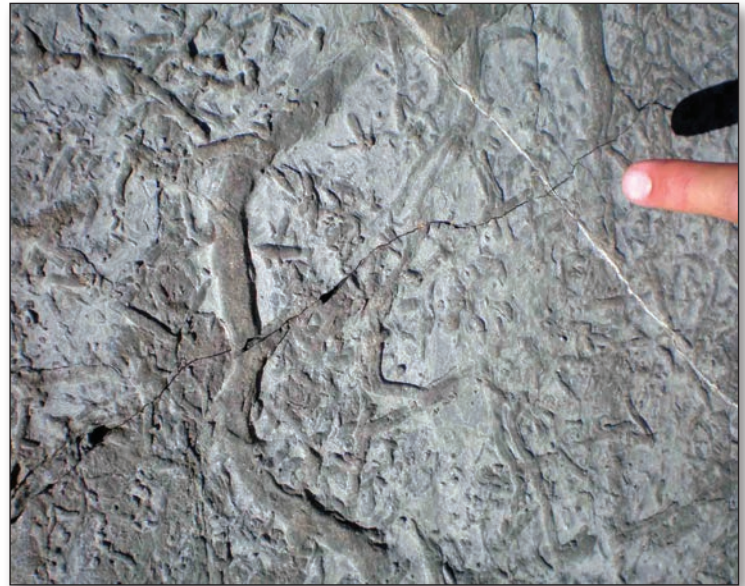
BURROWING ANIMALS MAY HAVE STABILIZED EARTH'S OXYGEN

By Joe Spivak

The presence of oxygen in the Earth's atmosphere is a critical component to life as we know it. But how did our atmosphere come into existence? What events created the oxygen rich air that we breathe? Scientists think that the answer lies in the lowliest of creatures; creatures that we don't even notice unless we pull back the muck and 'dig deep'.

Scientists theorize that around 540 million years ago, the first burrowing animals evolved in the muck on the ocean floor. As these animals weaved their way through the sediment at the bottom of the ocean, they were exposed to the oxygenated water in a process called 'bioturbation'. As a result, the bacteria in the sediment 'fixed' the phosphorous present in the water, creating a net negative feedback loop which ultimately decreased the oceans' store of oxygen. At first glance, this may seem counterintuitive...don't animals need oxygen to survive? Well, yes, but in reality animals require surprisingly little oxygen to grow. More importantly, it is the oxygen and atmospheric stability brought about by the 'bioturbation' that has been proven to be critical to evolution.

With the amount of oxygen available in the ocean and in the atmosphere stabilized, complex organisms were able to develop in and from this new environment. Therefore, the net atmospheric stability created by the first burrowing creatures helped to drive the evolutionary process and form life as we know it.



EXTENSION QUESTIONS

- What other oceanic and atmospheric factors contributed to evolution?
- What other examples of negative feedback loops can you think of? Positive feedback loops? (Hint: think blood)

VOCABULARY

- Bioturbation
- Oxygen Cycle
- Phosphorous Cycle
- Negative Feedback Loop
- Positive Feedback Loop
- Sequestration



FAT GRIZZLY BEARS STAYING HEALTHY AND DIABETES-FREE

By Melissa Koontz

There's no denying that grizzly bears are huge animals and gain even more weight when getting ready to hibernate (they can gain 100 pounds before hibernation). If humans don't take care of themselves, it can lead to weight gain or other serious issues such as diabetes. Grizzly bears can stuff their stomachs and then sleep like there's no tomorrow knowing that they don't have to worry about their diet or diabetes. New research, published in the August 2014 issue of Cell Metabolism, sheds some light into this seemingly unfair phenomenon.

DISCOVERIES LEAD TO DIABETES PREVENTION FOR HUMANS

When humans gain weight, fat, liver and muscle tissues become less sensitive to insulin. The pancreas must then produce more and more insulin to control blood sugar until it eventually shuts down causing diabetes.

Unlike humans, bears remained healthy year-after-year even after such extreme weight gains preparing for hibernation.

Dr. Kevin Corbit, a senior scientist at California-based drug company, Amgen, working with the researchers at the Washington State University Bear Center in Pullman,

looked at the blood metabolism of the grizzlies. They analyzed many key molecules in liver, fat and muscle cells of the bears before, during and after hibernation – in October, January and May.

Corbit and the researchers found a key protein called PTEN, which controls insulin sensitivity and fights weight gain. When the bears hibernated, their bodies shut down this protein. If they didn't have this protein, the bears wouldn't be able to store as much sugar in their bodies.

If the same pathway could be shutting off PTEN in humans, diabetes could be treated. A study showed that when one gene for PTEN was missing in a person, they were less likely to develop metabolic or cardiovascular disease even as they gain weight. The results imitated the bear-like qualities. Other diseases like cancer can be developed because the PTEN levels are reduced, but if scientists can shut them down in fat cells, like the grizzlies, these side effects might be reduced.

MORE HARM THAN GOOD?

Although this is all very exciting news for us humans, in order to support the bears finding and connecting it to helping human diabetes, more evidence is needed.

Shutting down PTEN in humans might be able to help with diabetes, but it might cause other issues like arthritis or even weight gain. We just need to be sure that this would help more than hurt and target the correct patients.

"Moving forward, this more sophisticated understanding of the relationship between diabetes and obesity should enable researchers not only to develop therapies targeting these mechanisms, but also to identify the appropriate patients to whom these therapies should be targeted," said Corbit.



EXTENSION QUESTIONS

- Which protein controls insulin sensitivity and fights weight gain?
- On average, how much does a grizzly bear weigh?

VOCABULARY

- Protein
- Diabetes
- Insulin

WHAT WOULD MENDELEEV SAY — SYNTHETIC ELEMENTS

By Merry Morris

Dmitri Mendeleev was an excellent teacher and searched for ways to make chemistry easier for his students. He began arranging the chemical elements in groups with similar characteristics which developed into today's periodic chart of the elements.

Mendeleev's original chart included 63 elements; today we know 118. Though puzzled by the gaps in his first table, Mendeleev was confident the table was right and the missing elements to fit in the gaps would show up ... sometime. These mysterious elements WERE discovered, and in Mendeleev's lifetime. Since then, more distinct elements were found that fit right into place in the periodic table.

Mendeleev could not have imagined what the periodic table looks like today. Scientists are now able to create "synthetic elements" that never existed in nature. Mendeleev would want to know "how do you make these crazy elements" and "how many different unnatural elements can you make?"

Those are the same questions that scientists are still considering today.

HOW TO MAKE AN UNNATURAL ELEMENT?

The typical element is comprised of a nucleus of protons and neutrons, surrounded by orbiting electrons. The protons determine the atomic number and have a positive charge. Neutrons have a mass similar to the proton, but no charge. What if scientists could slip more protons or neutrons into a regular atom, creating a brand new element?

More protons and neutrons get into a nucleus by brute force. To create this force requires a particle accelerator or collider, a machine that boosts charged particles to very high speed and channels them into beams using electromagnetic fields and magnets. Then scientists smash together the nuclei, occasionally creating a new nucleus with additional protons or neutrons. The first success was technetium: its unique properties have made it important for medical imaging.

HOW FAR CAN THEY GO?

Scientists have discovered 92 natural elements and 26 synthetic ones with very interesting properties. Many of these synthetic elements, e.g., element 117, are unstable and exist for less than the blink of an eye.

Though short-lived, these creations reveal important details on the way atoms work.

Whether all synthesized elements will be so unstable they cease to exist remains to be seen. There may be a sweet spot of stability — a specific combination of neutrons and protons where nuclear forces keep them together. Finding that spot depends on bigger and better accelerators.



EXTENSION QUESTIONS

- Where are the largest particle accelerators and colliders located? What are they capable of doing?

ACTIVITIES

- Investigate some of the early synthetic elements and outline how they have been used.
- Create a timeline of unnatural elements, starting with technetium, created in 1937.

VOCABULARY

- Proton/neutron/electron
- Technetium
- Particle accelerator



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SUN PROTECTION MAKES VACATION SENSE

By Merry Morris

Those warming rays of the sun have a well-deserved Dr. Jekyll and Mr. Hyde reputation. While they generate vitamin D and make us feel great, they also cause skin damage with UV radiation. UV-A radiation prematurely ages skin and contributes to skin cancer. UV-B radiation creates the tans we love and burns we hate.

Our skin's natural protection, melanin — associated with the amount of pigment in the skin — is not enough. So how can you enjoy the outdoors safely?

CHEMISTRY TO THE RESCUE

Certain chemicals applied to the skin can either filter out some UV rays, or completely block sun damage by reflecting UV away from the skin.

Sunscreens combine organic and inorganic chemicals that absorb UV radiation and release it as heat, allowing longer exposure before burning begins. How much longer is indicated by the Sun Protection Factor (SPF): a SPF of 5 allows you to remain in the sun five times as long as you could without it.

Note that SPF refers only to UV-B, not to UV-A. To ensure protection against UV-A, buy sunscreens that include specific agents against UV-A radiation.

Sunblocks reflect the sun away from the skin by

providing a barrier of inorganic particles, e.g., zinc oxide or titanium oxide. Sunblocks can be components of sunscreens as well as being used alone.

RISKY EXPOSURES

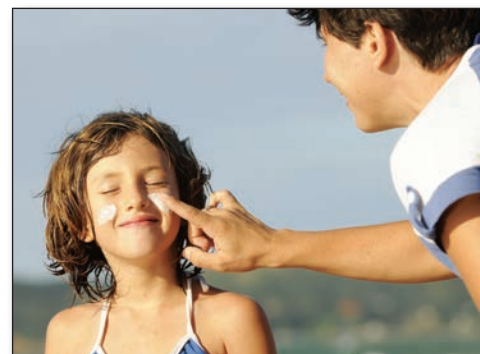
Many of the activities we most enjoy outdoors pose high risks of sun damage.

- Beach activities — sun plus a 25-percent added exposure from the reflective sand
- Water activities — water is highly reflective, and in shallow water, a sandy ocean bottom can add to the radiation intensity
- Snow activities — snow is a very reflective surface, creating a double burn from the sun and its reflection

Certain locations are more dangerous too.

- High altitudes where UV radiation is more intense than at sea level
- Low latitudes in tropical regions where rays do not have far to travel
- Ozone holes where the Earth lacks its protective filtering layer such as Australia, the skin cancer capital of the world.

To get the most from your sunscreens and sunblocks, remember to apply early, often and carefully.



EXTENSION QUESTIONS

- How does the amount of pigment in our skin protect us from sun damage? Why are some individuals photosensitive?
- In what ways does our skin protect us?

ACTIVITIES

- Research the layer of stratospheric ozone as found in the Southern Hemisphere, especially the "seasonal ozone hole."

VOCABULARY

- Ultraviolet Radiation
- Sunscreen
- Sunblock
- Ozone
- Altitude
- Latitude

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WHY ARE DUTCH PEOPLE SO TALL?

By Celeste Beley

The Netherlands is officially the tallest country on planet Earth. For the most part, scientists believed this was due to wealth, a rich diet and quality health care. But a new study suggests that the overall height of Dutch people may actually be human evolution in action.

Scientists have identified 180 genes that influence your height. Individually, all account for a very small effect, but combined, may explain up to 80% of the variation in height of a population. Environmental factors may also play a role. For example, children of Japanese immigrants to Hawaii are much taller than their parents. Scientists attribute this to a diet that is rich in milk and meat.

The Dutch have grown so quickly in a short period of time that most of the growth is attributed to their changing environment. They are one of the world's largest producers and consumers of cheese and milk. Scientists also wonder if natural selection may have played a role: height is associated with better health, attractiveness, better education and higher income—potentially leading to more reproductive success.

Gert Stulp, behavioral biologist at the London School of Hygiene & Tropical Medicine led the study. Including people over the age of 45 born in the Netherlands to Dutch-born parents, the sampling of 42,616 people showed that taller men, on average, had more children. Since tall men are more likely to pass on genes that

made them tall, the study suggests that the Dutch population is evolving to become taller.

Similar studies in the U.S. do not show a similar pattern. Stulp's research of people born in Wisconsin in the late 1930's show average height men had more children and that shorter women had children of average height. These factors suggest that natural selection in the U.S. is opposite of environmental factors like diet, although this likely explains why the average height of Americans have leveled off.

The surge in height of the Dutch population is likely only temporary, similar to Americans growth in height during the 18th century. Natural selection tends to favor one trend for a few generations, and then stabilize or decrease in subsequent generations.

EXTENSION QUESTIONS

- How can a diet rich in milk and meat affect a country's overall height and health?
- Are there other factors that may affect a population's overall change in height? How would they affect the changes?

VOCABULARY

- Natural selection
- Evolution
- Environmental Factors
- Generation



MRI SCAN REVEALS WHY KNUCKLES CRACK

By Samba Lampich

The room is quiet and the only sound is that of pencils scratching answers on papers as everyone focuses on the exam. Then the silence is broken by the unmistakable sound of someone cracking their knuckles.

Scientists now know why knuckles make that distinct popping sound when cracked.

A 1947 study of X-rays of knuckles cracking seemed to suggest that sound occurred when the bones at the joint rapidly separated forming an air bubble or cavity, a process known as cavitation. But in 1970 another group of researchers suggested the cracking noise was emitted when the cavity collapsed. The bubble-bursting theory was widely accepted but remained uncertain until recently.

THE PULL MY FINGER STUDY

A team of Canadian researchers set out to conduct a test to get a final and definite answer. Gregory Kawchuk, a bioengineer and rehabilitation-medicine specialist at the University of Alberta in Canada and his team used magnetic resonance imaging, or MRI to study the very fast process of cracking knuckles. The results were published in the April 2015 edition of journal PLOS One.

They enlisted team member Jerome Fryer who had the special skill they needed. "We call him the Wayne

Gretzky of knuckle cracking," explains Kawchuk. "He can do it in all 10 fingers."

Fryer laid face-down and put his hand inside the MRI machine and they made a movie of his knuckles as they pulled a cable attached to each of his fingers.

CRACKING THE SECRET

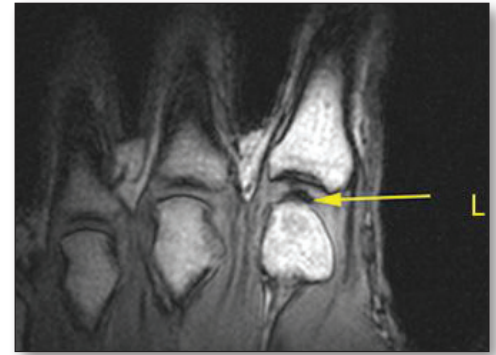
As the finger is pulled, tension is created in the knuckle joint where fluid rapidly accumulates. A cavity or bubble opens and as it does the knuckle makes a pop sound.

The MRI showed that the bubble remained in the joint, for up to 20 minutes. The results were clear. The cracking sound comes when a bubble forms between the knuckle joint, not when it bursts.

The researchers also say that habitual knuckle cracking has not been shown to increase damage to joints causing arthritis.

They hope that understanding the mechanics underlying joints can lead to a better development of therapeutic treatment for patients with degenerative joint diseases.

Finally, the researchers acknowledge that their experiment did not explain why the sound of cracking knuckles could be heard across a room.



EXTENSION QUESTIONS

- What are some benefits of popping or manipulating joints?
- When would joint cracking be harmful?

ACTIVITIES

- See how long it will take until you can crack the same knuckle. Why does it take a while?
- Watch a video of a Cracking Knuckle MRI <https://www.youtube.com/watch?v=BHEcQluSzmM>
Courtesy: RehabMedicineUofA

VOCABULARY

- Bioengineer
- Rehabilitation
- Cavitation

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THE SCIENCE OF FIREWORKS

By Christa Cuccia

What are The Fourth of July, baseball games and New Years Eve all known for? FIREWORKS of course! The bright and sparkling lights from fireworks are so unique and beautiful and a great firework show can be unforgettable. But what are fireworks? How do they create those magical displays in the sky? Fireworks may seem astonishing, but the science behind them is easy to understand.

BACK TO BASICS

Let's start with the basics. Understanding pyrotechnic devices such as sparklers and firecrackers are a great foundation. The sparkler creates the bright light and the firecracker demonstrates the explosion. Both of these qualities are found in most fireworks.

Firecrackers have been around for a long time, dating back hundreds of years. A firework contains either Black Powder (gunpowder) or Flash Powder. These powders are put in a tight tube with a fuse to light the powder. Black powder contains things like charcoal, sulfur and potassium nitrate. If a firecracker needs to have a brighter explosion then it may contain aluminum instead of or in addition to the charcoal.

Sparklers on the other hand, are surprisingly much different from firecrackers. A sparkler burns for a long period of time and produces bright lights. Sparklers

can also be called "snowball sparklers" because of the ball of sparks that form around the tip of the stick. A sparkler is made of several different components that include a binder, fuel, an oxidizer and iron or steel powder. Charcoal and sulfur make up the fuel and the binder is usually sugar or a starch. These chemicals are then mixed with water to form slurry that can be coated with wire or poured in a tube. Voila! You have a sparkler.

ADDING METAL FOR AN EXTRA SHINE

Aluminum, iron, steel, zinc and magnesium dust are all commonly added to fireworks in order to create brighter and more brilliant sparks. Metal flakes heat up until they are incandescent and shine brightly. Extra chemicals are added to create the vibrant and unique fun colors.



EXTENSION QUESTIONS

- What other chemicals do you think are added to fireworks?
- What are some of the different sounds produced by fireworks? How are they produced?
- Did you know science played such a big role in the production of fireworks?

VOCABULARY

- Pyrotechnic Devices
- Incandescent
- Oxidizer

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PHYSICIST INVENTS CHAMELEON-LIKE ICE CREAM

By Melissa Koontz

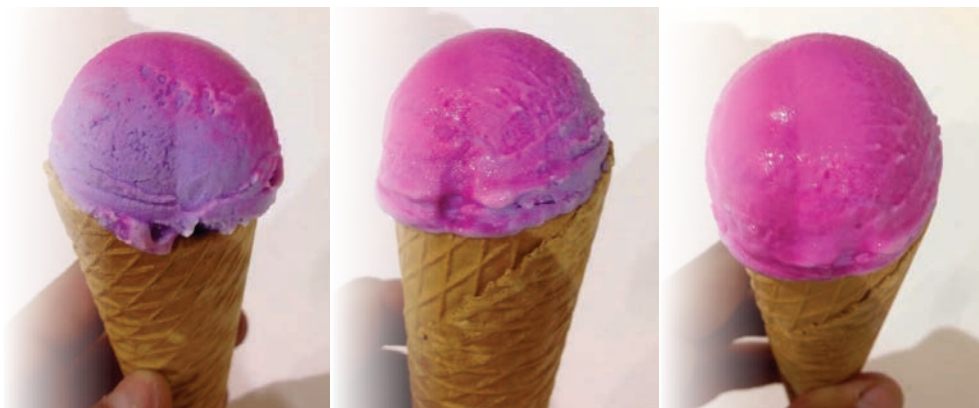
That time of the year is finally here again ... pool parties, picnics, amusement parks and just all-around fun-in-the-sun. And along with all of the good people and times, always comes food! From that delicious burger on the grill to that potato salad to everything in between and all of the delicious desserts, we can never get enough.

And if things couldn't get any better, there is now an ice cream that changes colors as you lick!

A DIFFERENT COLOR WITH EVERY LICK

Xamaleón, a "tutti frutti" delight, changes from blue to pink and then purple when it touches the tongue and is exposed to temperature changes. Manuel Linares, a former physicist with a passion for frozen desserts, only took one week to develop this chameleon goodness with two other members. He said it's simply chemistry and "any food can change color depending on temperature and oxidation".

This ice cream is made with natural ingredients such as strawberries, bananas, vanilla and almonds. He does have a few secret ingredients that he calls a "love elixir" on the ice cream that helps the reaction after



it's scooped. Linares doesn't want to reveal too much, but we might get a little bit more of an insight when he secures a patent for his creation, which is pending.

Linares now has an ice cream shop called IceXperience open in Blanes, his hometown in Spain, and is already whipping up ideas for more interesting flavors. He

wants to create an ice cream that reacts to UV lights in nightclubs as well as one that'll be made with Peruvian and African medicinal plants with an aphrodisiac effect called Xamán. Any taste testers willing?

"As a physicist, I know that there are various possibilities that might work and I was delighted when I managed to crack it and create an ice cream that changes color," Linares said.

COMPREHENSION QUESTIONS

- What is tutti frutti?
- What flavors are in Xamaleón?
- Where is Blanes located?
- What is physicist Linares thinking of creating next?

VOCABULARY

- Chameleon
- Chemistry
- UV lights
- Oxidation

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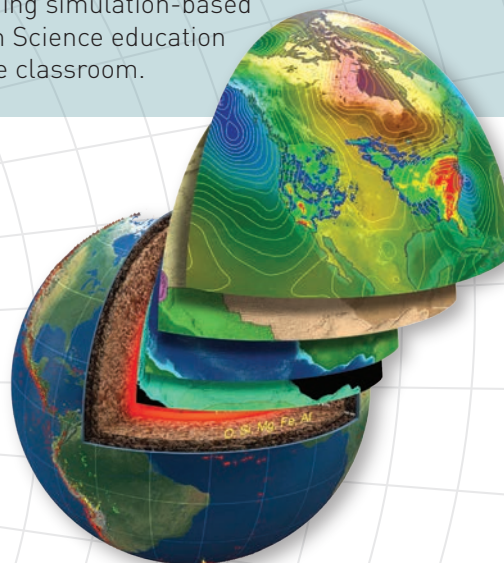
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**3D PRINTING HELPS TO REVEAL
THE SECRETS OF A SUPERSTAR**

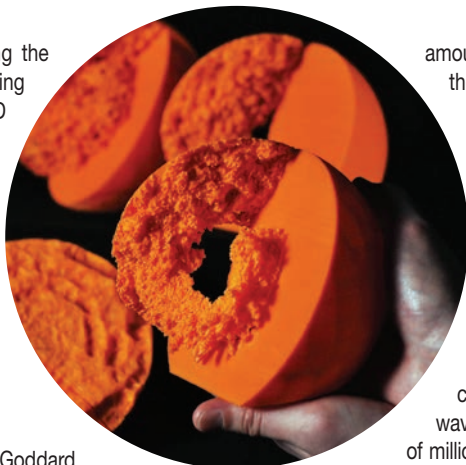
By Julianne Glaser

3D printers are revolutionizing the fields of medicine, manufacturing and even astrology. 3D simulations are providing insight into the depths of our solar system, including Eta Carinae, one of the most explosive galaxies in our solar system.

**THE DOOMED
SUPERSTAR ETA
CARINAE**

Michael Corcoran of NASA's Goddard Space Flight Center refers to Eta Carinae as "an erratic stellar monster." Though Eta Carinae is 7,500 light years away, it's one of the brightest and largest stars in the night time sky — and estimated 10 billion miles across. First catalogued in 1677, it has faded and brightened repeatedly due to its volatile nature.

Eta Carinae is actually comprised of two highly unstable stars surrounded by gas shells. The larger star is 100 times the size of the sun, and the smaller star is 30 times the size of the sun. As these stars orbit, an immense



amount of material, equivalent to the mass of Jupiter, is released.

According to Corcoran, the stars remain separate during most of their five-and-half year orbit. But once per orbit the stars closely pass each other, and their competing supersonic solar winds — up to 420 kilometers per second — create a bow, or curved shockwave. This energy wave heats the gas shells to tens of millions of degrees, so hot that the gas emits x-rays. Corcoran frames it as "these stars are literally blowing themselves apart."

**UNDERSTANDING GALAXIES
THROUGH 3D SIMULATION**

Recently NASA scientists studying the intricacies of Eta Carinae captured the approach of these two stars with the Swift satellite. The team created complex computer simulations to predict movement of gas as the stars orbited, but the simulations were difficult to view on a computer screen.

Scientists turned to 3D printing to view all the stellar features of Eta Carinae. NASA researchers discovered finger-like protrusions from the bow shock believed to arise from instabilities in the heated gas. They hope that advanced 3D printed simulations will provide in-depth understanding of Eta Carinae and other galaxies, and provide a glimmer into the vast darkness of outer space.

EXTENSION QUESTIONS

- If you had a 3D printer, what would you create and why?
- How long has the Hubble been in space? What information has it provided?
- What are the differences between stars and planets?

ACTIVITY

- Watch a NASA Video - Missions Take an Unparalleled Look into Superstar Eta Carinae https://www.youtube.com/watch?feature=player_embedded&v=0rJQi6oaZf0

VOCABULARY

- Light year
- Supernova/hypernova
- Bow shockwave
- Satellite

WHAT DOES YOUR “SELFIE” REALLY SAY ABOUT YOU?

By Celeste Beley



The Millennials are often called the “Selfie-generation.” They pride themselves on using those selfies to create their personal online brand — defining who they are, what they like and what they stand for. But even if you aren’t a Millennial, it’s likely that you use Facebook, Twitter, LinkedIn or Instagram and you’ve probably taken at least a few selfies. While some credit the selfie as pure narcissism, others consider them a form of self-expression and a way to control how others perceive us online. But what do those selfies really say about you? How do others perceive you based on your social media photos?

A new study is showing that people’s first impressions vary widely depending on how a person’s face is presented. Alexander Todorov and Jenny Porter from Columbia University led the study where subjects were presented with headshots of different

people. The lighting and background was identical in all photos, but they each had slight variations in facial expressions. Subjects were then asked to rate the photos on attractiveness, intelligence, competence, creativity, trustworthiness, cunning, extraversion or meanness.

The results showed that perceptions were formed based on the facial expression in the image — not the actual face of that person. Subjects rated images of the same person with different facial expressions as differently as they did completely unique faces. So while those learned in the art of photo manipulation are nodding in agreement, Todorov and Porter agree, there’s no way to demonstrate a person’s full, true character in one single photo. We are human beings who can change expressions and body-language by the second and no one image can represent that.

“The face is not a still image frozen in time but rather a constantly shifting stream of expressions that convey different mental states,” they noted.

So while generations become more and more “selfie-obsessed”, the true lesson is that your character is not defined by any single image and meeting someone in person is still the best way to know who they are and what they stand for.

EXTENSION QUESTIONS

- What are the benefits of taking selfies? What are the drawbacks? Discuss the differences.
- What types of facial expressions do you think demonstrate the qualities used in the study: attractiveness, intelligence, etc.?

VOCABULARY

- Selfie
- Narcissism
- Self-Expression

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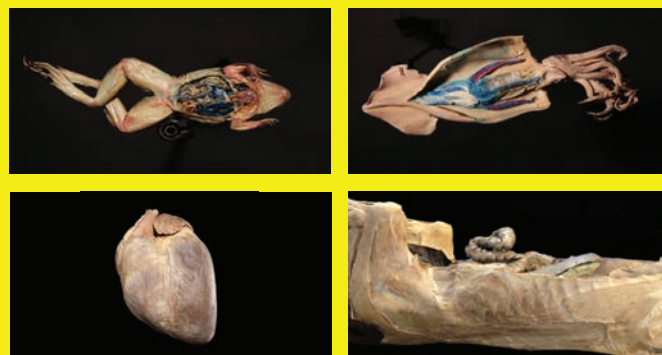
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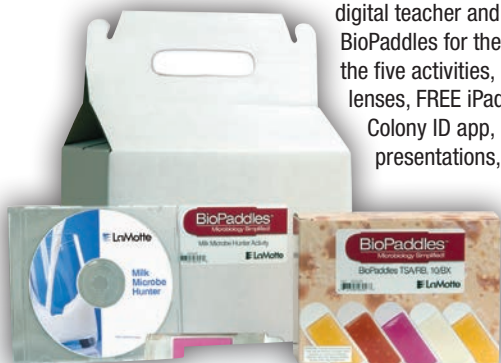
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SISTERS e S.T.E.A.M. PROGRAM

By: Venneasha Davis, Woodland Hills Academy

Dear Mirror,

Straight or Curly? Why won't this frizzy hair go away? I want to wear lipstick but what color is right for me? I put on deodorant every morning, but I'm still a sweaty mess by noon. No one understands my dilemmas and my reputation is everything.

Sincerely,

The Middle School Girl



As we reflect on being 13 or 14 years of age, it was hard to conceptualize what was happening in the real world around you. People may have called us self-centered and self-absorbed as adolescents, but was that really the case? As much as you tried to get through Mr. Rawson's science class, nothing fully made sense because you were focused primarily on you. In those hallmark years, it is important to understand the trials of being an adolescent and using that as a positive addition to the learning environment.

Sisters e S.T.E.A.M. is an afterschool program focused on empowering 7th and 8th grade girls in STEAM education. Children are born as naturally inquisitive; inquiring about the world's intriguing phenomena around them. Then boom! After the 4th grade something goes wrong. Science now resembles the reading and writing class and labs are completed "if we have time." This combined with a student's natural focus on their image, their peers, and where they fit in the world completely brings that natural inquisitiveness to a halt. Research has shown by the time the middle school girl reaches the 9th grade, they have completely checked out of science.

Sisters e S.T.E.A.M. is an inquiry-based hands on science program for young women that exposes them to STEAM content that promotes personal and academic learning. Designed primarily for African American females and females situated in poverty, Sisters e S.T.E.A.M. provides a culturally-relevant science curriculum that transforms the way that girls understand and approach the STEAM careers.

Primarily delivered as an after-school program in Woodland Hills and through pop-up programs throughout Allegheny County, Sisters e S.T.E.A.M. utilizes real world applications to connect girls to science content that is aligned to the PA Core and the Next Generation Science Standards. Sisters e S.T.E.A.M. began as an innovative idea through Teachers Leading Change and has grown into an independent science program in its second year of operation.

Sisters e S.T.E.A.M. transforms the way that young women look at the STEAM careers, generally introducing young women to a successful experience with science for the first time. This program is designed for young women who typically do not have the opportunity to engage in science enrichment programs. Currently, Sisters e S.T.E.A.M. is delivered through six core units. Example units are: Hair & Cosmetic Chemistry,

Newton's Laws of Motion through Dance, Ecological Biodiversity, Thoughts & Bots (Robotics), and Lights! Camera! Action! (the science of photography).

In Sisters e S.T.E.A.M., we try to match the natural interests of young females with science that is engaging and interactive. Two of the most popular lessons are focused on hair/cosmetic chemistry and learning force and motion through dance. In the hair chemistry and cosmetic chemistry lessons, students are able to study matter and its interactions as well as learn the differentiation that occurs between physical and chemical changes. Using the scientific process, this unit begins with exploring the question: "What is healthy hair, what does it look like, feel like?" The students then test many of the common hair products and they explore the impacts of byproducts, pH levels, acids, and bases. Throughout this unit, the students are also making soap, lipstick, and even designing and testing their very own deodorants.

Things also get funky up a bit as Sisters e S.T.E.A.M. moves and grooves across the lab floor. When teaching the principles of force and motion and the effect of multiple forces on movement, speed, or direction of an object, what better way than to use dance? Through Move and Groove, together we collaborate with Foxtrot Dance Studio of Swissvale as we study Newton's law of motion and gravity and how the body is able to leap, jump, push, and pull. Together we use our bodies to create simple machines and dance routines.

Sisters e S.T.E.A.M. strives to immerse young women into the STEAM fields but another important component is that we provide a peer mentoring component with the chief goal of reducing girl on girl disruptions throughout the day. The peer mentoring or "e S.T.E.A.M. (esteem)" part of Sisters e S.T.E.A.M. is delivered through targeted lessons, peer support, & team competitions. In this two-pronged approach to supporting young women, we look at the issues that are of utmost concern to them and use program variables to provide opportunities to learn and grow as a team and as an individual. In addition, this program moves them towards college and/or career readiness. Our e S.T.E.A.M. curriculum addresses the realities of STEAM careers for the young women and provides them with the requisite skills and experiences.

Editor's Note: Venneasha Davis is a 5th/6th grade science teacher at Woodland Hills Academy in Pittsburgh, PA. We learned about the innovative program she started and asked her to write about it for *Headline Discoveries*. If you have ideas for articles or want to tell us about innovative programs and lessons in your schools, please email celeste.beley@thermofisher.com.

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JUSTRITE

RETURN OF AN EXTINCT CONGO MONKEY!

By Julianne Glaser

First observed in the forests of the Republic of the Congo in 1887, the rare Old World Bouvier's red colobus monkeys (*Piliocolobus bouvieri*) were distinguished by their reddish fur, large eyes, white chin and whiskers and long tail. Originally considered a sub-species of Pennant's Colobus monkeys native to Central Africa, they were reclassified as a distinct species in 2007.

In the 1970s, scientists failed to find a single Bouvier's red in Central Africa and declared the species extinct. Amazingly, in February 2015 primatologists working in the Democratic Republic of the Congo photographed a Bouvier's red colobus mother and infant.

PHOTOGRAPHIC EVIDENCE REVERSES EXTINCTION STATUS

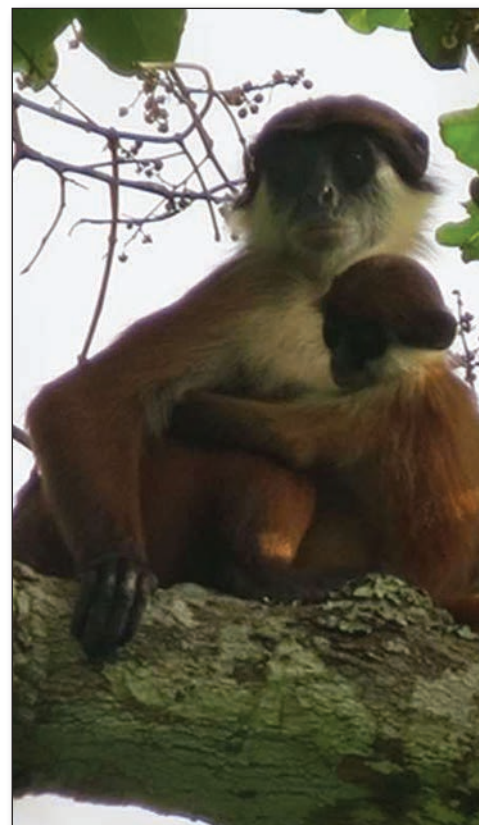
Primatologists Lieven Devreese and Gael Elie Gnondo Gobolo set out on a mission into the Ntokou- Pikounda National Park to prove the existence of the “Old World” Bouvier's red colobus monkey.

As reported in UPI Science News, the researchers were aided by local guides who provided knowledge of the colobus monkeys. With their help, Devreese and Gnondo Gobolo located not just one, but a whole troop of Bouvier's monkeys living in the swamp forests near the Ntokou-Pikounda National Park. Though previous sightings had been reported, “Our photos are the

world's first and confirm that the species is not extinct,” says Devreese.

The Bouvier's red colobus monkeys lack a fear of humans and continue to be vulnerable to hunting in their natural habitat. James Deutsch, vice president of conservation strategy at Wildlife Conservation Society remains hopeful: “confirmation that Bouvier's red colobus still thrive in this area reminds us that there remain substantially intact wild places on Earth, and this should re-energize all of us to save them...”

Devreese and Gnondo Gobolo's discovery of a substantial population will provide an opportunity for researchers to study this elusive species in its natural habitat.



EXTENSION QUESTIONS

- Research the Congo Rainforest. Describe its size, location, climate, and animal and plant life
- What does “colobus” mean and how does this name describe the Bouvier's Red Colobus monkeys?
- What other animals thought to be extinct have been rediscovered?
- What are the differences between Old World and New World monkeys?

VOCABULARY

- Primate
- Extinction
- Rainforest
- Old World



ANCIENT WEATHER PATTERNS TEACH SCIENTISTS ABOUT DROUGHT

By Julianne Glaser



California is now entering its fourth year of drought. The U.S. Drought Monitor reports more than two-thirds of California is in “extreme” drought, with more than 40 percent of the state in “exceptional” drought, the most extreme category. Worse yet, the area received only five percent of normal snow pack precipitation from the Sierra Nevada Mountains this winter, which provides most of the area’s water.

According to the Institute of the Environment at the University of Arizona, California’s drought is the worst since weather records began in the late 1800s. Researchers contend that though this drought is unprecedented in modern times, analysis of ancient data indicates droughts that lasted for decades in past centuries.

NATURE’S RAIN GAUGES REVEAL WEATHER HISTORY IN THE WEST

A dendrochronological study by Daniel Griffin and Kevin Anchukaitis published in *Geophysical Research Letters* confirms recorded weather data and indicates that the recent drought is the worst in 1200 years. Researchers compared width of tree rings to determine wet years (wide rings) versus dry years (narrow rings) to create a timeline before climatological data was available.

“We were genuinely surprised at the result,” said Griffin. “Time and again, the most common result in tree-ring studies is that drought episodes in the past were more extreme than those of more recent eras. This time, however, the result was different.”

WHAT’S CAUSING THE DRY WEATHER?

Through climate models and weather archives, scientists determined that the prime cause of this drought is increased sea surface temperature in a portion of the Pacific Ocean. Unusually warm sea surface temperature changed atmospheric circulation and blocked winter storms from reaching the west coast. The result: dryer conditions in the southwestern part of North America.

A study sponsored by the National Oceanic and Atmospheric Administration and led by Professor Richard Seager of Columbia University, found that natural weather patterns and not man-made global warming are responsible for the current California drought.

“It’s important to note that California’s drought, while extreme, is not an uncommon occurrence for the state. In fact, multi-year droughts appear regularly in the state’s climate record, and it’s a safe bet that a similar event will happen again,” noted Seager.

Some outside climate scientists criticized the conclusions claiming the report did not take into account how record warmth worsened the drought.

EXTENSION QUESTIONS

- Why are blue oak trees used by scientists to study climate data?
- What other data can scientists learn from tree rings?
- What are America’s “dust bowl years”? When did they occur, what were the causes and impacts?

VOCABULARY

- Dendrochronology
- Drought
- Weather patterns



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SMARTPHONES MAY SOON SERVE AS EARLY EARTHQUAKE WARNING

By Julianne Glaser

Smartphones have revolutionized the way we work, play, communicate and carry out our day to day lives. Recently, researchers discovered a surprising and potentially life-saving application for this technology: early earthquake detection. This unconventional pocket detector could provide precious seconds for people to take shelter or for utilities to implement emergency shutdown procedures.

HARNESSING THE POWER OF NUMBERS

Most of the world's population live in areas susceptible to earthquake damage. While automated earthquake early warning (EEW) systems to transmit warnings of tremors are available, high costs limit their use to a few areas such as Japan and Mexico. In the United States, the U.S. Geological Survey (USGS) has been working on development of ShakeAlert as an EEW on the West coast.

Scientists at the USGS are also researching the potential of crowdsourced observations from smartphones to detect, analyze and customize earthquake warnings.

"Crowdsourced alerting means that the community will benefit by data generated from the community," stated Sarah Minson, USGS geophysicist and lead author of

the study. The GPS sensors in smartphones, though less accurate than scientific equipment, are able to detect ground movement caused by fault motion in a large earthquake.

USGS researchers tested crowdsourced smartphone capability using a computer-simulated magnitude-7 earthquake on the Hayward fault in California. In the simulation, a quake was detected if five or more phones registered simultaneous movements of at least five centimeters, but issued alerts only when 100 phones recorded an event to prevent false alarms. The smartphone GPS system detected the simulated earthquake within five seconds, before the strongest tremors occurred in the epicenter and ten seconds before tremors hit nearby regions.

For a real-life comparison, USGS scientists used actual data from the devastating 2011 Tohoku-oki magnitude-9 earthquake in Japan. The team utilized 462 GPS stations across Japan to approximate data from smartphones and aligned detection to reduce false alarm to one in two million. Researchers found the system would have provided a ten second warning before the earthquake hit Tokyo and several minutes before the subsequent tsunami.

Smartphones could be a cost-effective, life-saving option for areas without detection systems.



CROWDSOURCED QUAKE DETECTION HOLDS PROMISE

Jesse Lawrence, a computational earthquake seismologist of Stanford University, acknowledges there are limitations to the smartphone system such as GPS battery drain. Nonetheless, he is optimistic about future applications of this technology: "it's great research, and this is the first step."

EXTENSION QUESTIONS

- In geology, what is a fault? Where are the largest faults in the world?
- How does GPS work?
- What causes earthquakes? What are the early warning signs?
- What is the Richter scale and how does it work?

VOCABULARY

- Seismologist
- Global Positioning System
- Tsunami



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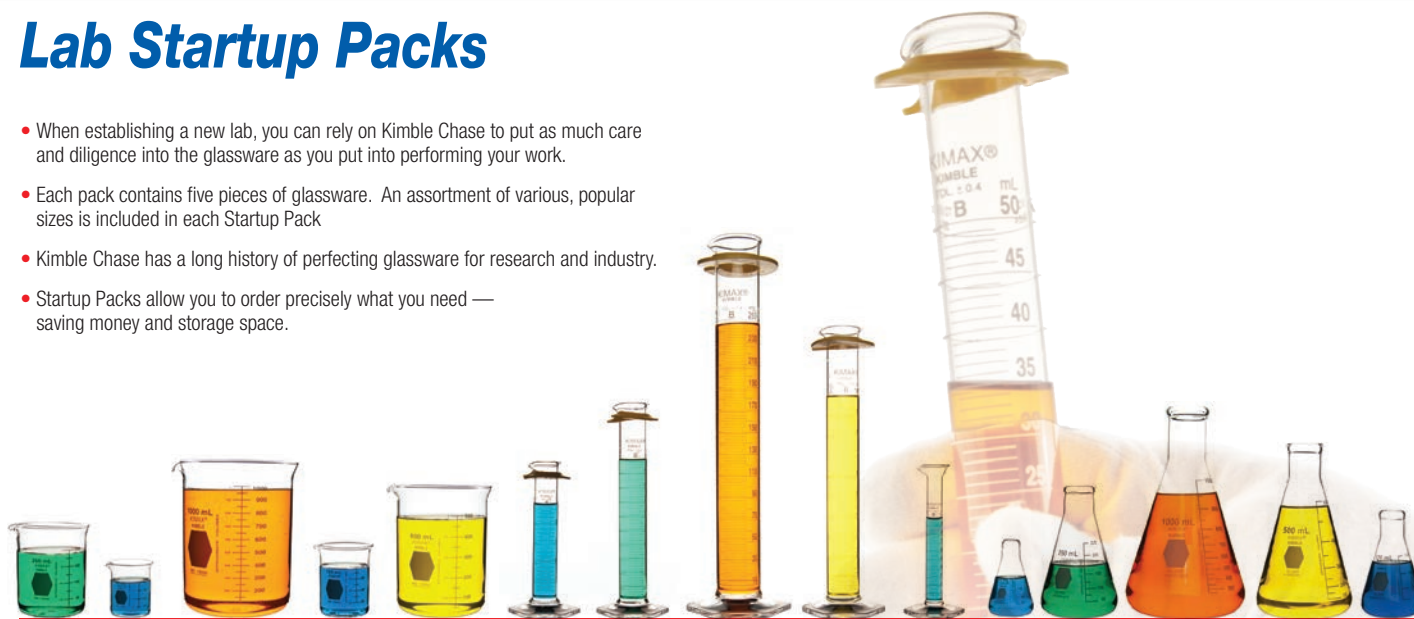
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IS CLIMATE CHANGE SPAWNING INFECTIOUS DISEASES?

By Merry Morris

Buruli ulcer is not an affliction you would like anyone to contract. Caused by *Mycobacterium ulcerans*, it produces a toxin which necrotizes tissue and hampers immune response. Up to 6000 cases are reported annually to the World Health Organization from 15 countries. Though 80 percent of cases can be cured by antibiotics if caught early, late reporting is typical, leading to a high proportion of permanent disability.

In its early, pre-ulcerative stage, painless nodules, plaques, or edema appear as the disease attacks skin and bone. In the next stage, open ulcers appear. As the ulcers “heal,” the body tries to combat the disease with an unsuccessful immune response. The result is scarring, calcification, contractures and loss of function. In advanced cases, amputation may be the only option.

HARD TO CONTROL

Controlling this disease is difficult. In areas where buruli ulcer is prevalent, different animals species and possibly aquatic insects spread the disease, but the natural reservoir and mode of transmission are not definitively known. However, there is a key association between the disease and stagnant and slowly flowing water. Knowing this, officials can target such areas for treatment programs.

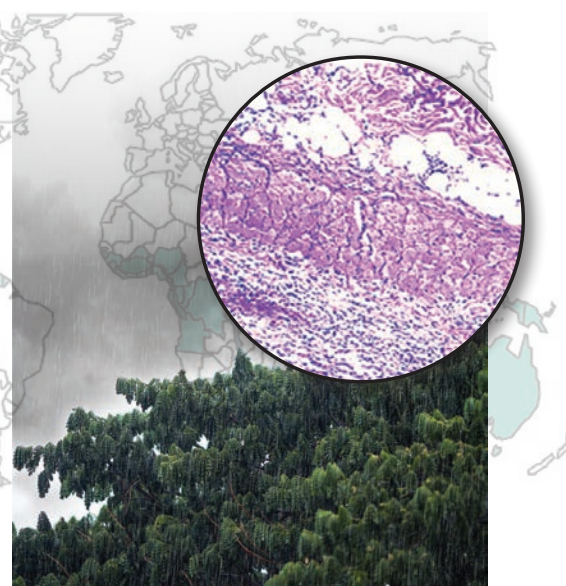
But not so fast...in some areas of the world, the disease is on the move and one of the theorized factors in new outbreaks is global climate change.

CLIMATE CHANGE AND DISEASE

Global warming is associated with changes in rainfall, including heavier precipitation events. For water-borne illnesses, this may provide microorganisms access to previously disease-free locales where they can react to their environment, favorably or not. As an area’s ecology changes, wetter conditions with more ponds and water interconnections, usher in unpredicted outbreaks.

Recent investigations established correlations between emerging outbreaks of buruli ulcer and changes in complex rainfall patterns. The study, published in *Emerging Microbes and Infections* and led by Aaron Morris of Bournemouth University, showed that in French Guiana, buruli ulcer occurrence did show correlations with the changing ecosystem, especially extreme rainfall events associated with the El Nino Southern Oscillation acting off the coast of South America.

As changing climate modifies natural habitats, potential hosts may be exposed to new types of microbes and spread tropical diseases into temperate climates.



EXTENSION QUESTIONS

- What are the causes and effects of El Nino?

ACTIVITIES

- Investigate the generalized cycle of parasite – host infection
- Contrast the environmental conditions in stagnant water pools and swiftly flowing streams.

VOCABULARY

- Climate change/global warming
- Habitats
- Parasites
- El Nino

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Robots are becoming ubiquitous in everyday life. Robots build cars, help us checkout at the grocery store, and complete millions of tasks which human beings used to do. Those who design robots must understand computer science, electrical systems, mechanical systems, and some aspects of human psychology. If you think that you can make better and more efficient robots, then perhaps pursuing a career in robotics engineering is your path.

In high school, a student who wants to pursue robotics should take mathematics and physics. In college, very few universities offer majors in robotics engineering, though some do. If robotics is something a student wants to pursue, finding a college or university with a major in robotics engineering is a great first step. Otherwise, a major in mechanical engineering, electrical engineering, or computer science will be a step in the right direction. After college, consider finding a Masters program in Robotics Engineering and Sciences.

Robotics engineers often work for private industry, though some do work in the government. According to the Occupational Information Network, O*Net, there are 44,800 robotics engineering positions that are expected to open between the years 2010-2020. A robotics engineer can expect to earn an average salary of \$92,030.

Source: <http://www.onetonline.org>

STEM TEACHER



Every great student requires a great teacher. The fields about which we have written, and the fields about which we will continue to write, all encourage students to begin taking STEM courses in high school. These STEM courses need good teachers to teach them. If learning about science, technology, engineering, and mathematics is what you want to do in college, and then you want to pass that knowledge on to future generations, consider becoming a STEM teacher.

To become a STEM teacher, first major in something you love in college: perhaps physics, mathematics, computer science. Engineers, such as chemical, civil, mechanical

engineers also often have the background to teach high school STEM courses. After college, many states require a teaching certificate, or a Master of Education, to

become a teacher. These postgraduate degrees will help you to become a better teacher as you instruct future generations.

Students interested in becoming a teacher can look forward to an average annual salary of \$53,230. However that number does improve for teachers with a master's degree. It is also important to remember that many teachers, just like their students, receive a two month summer vacation. There is some growth expected from 2010 to 2020: a growth of 7 percent, or an increase of 72,000 jobs.

Source: <http://www.bls.gov>

STEM CAREERS

SMART WINDOW CHANGES COLORS AND CREATES ELECTRICITY

By Samba Lampich

It's unsettling when a strong rain storm brings down power lines and leave entire neighborhoods without electricity. But, what if you could simply plug a cell phone into the window and let it charge as the storm rages on outside?

This alternative source of electricity is an idea Dr. Zhong Lin Wang and his colleagues from the Georgia Institute of Technology have been working on. They recently published their research in the March issue of ACS Nano.

CONVERTING AMBIENT MECHANICAL ENERGY INTO ELECTRICITY

The idea is relatively simple: glass, such as that in windows and cars, is often subjected to pouring rain, gusting wind and glaring sun; so why not harvest the energy from these to generate electricity?

To do this the researchers needed to create a device that would take advantage of triboelectric effect – a contact electrification that occurs when two materials come into contact with one another. They invented a triboelectric nanogenerator (TENG) which can effectively convert ambient mechanical energy into electricity.

The resulting self-powered smart window is composed of a raindrop-TENG, wind-powered-TENG and an electrochromic device (ECD). The window is also coated with a negatively charged silicone material known as polydimethylsiloxane.

When the two layers of TENGs are activated by rain and wind the resulting electric charge powers an electrochemical reaction in the ECD that tints the window a translucent blue.

According to the research, the windows were able to produce up to 130 milliwatts per square meter of glass which the researchers point out, is enough to charge smart phone in sleep mode.

THE RAINDROP-TENG

This outermost layer of nanogenerators takes advantage of the positive charge a raindrop gets as it falls from the clouds and rubs against the air on its way down. When this positively charged raindrop hits the negatively charged glass, an electric current is produced.

THE WIND-POWERED-TENG

The second layer of nanogenerators is made up of two



sheets of charged, transparent plastic separated by nanoscopic spring coils. As wind makes contact with the smart window, the springs are compressed and cause the two charged sheets to approach each other, creating an electric current.

NEXT STEPS

The researchers are now looking at ways to store the power that is generated by the smart glass for use when there is no rain or wind. They also suggest that the smart glass could be used with wireless networks because they generate their own power and don't require an external power source.


EXTENSION QUESTIONS

- What are some practical applications for self-powering windows?
- What other glass products change color and why?

VOCABULARY

- Nanogenerators
- Nanoscopic
- Milliwatts
- Electrochromic

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2015 PA STATE STEM DESIGN CHALLENGE



The 2nd Annual Pennsylvania State STEM Design Challenge finals were held on May 6th at Harrisburg University of Science and Technology. Sponsored by Thermo Fisher Scientific, Harrisburg University and the Allegheny Intermediate Unit (AIU3), the STEM Design Challenge was started five years ago to promote STEM Education in the Pittsburgh area. Last year, the design challenge was launched state-wide where more than 2000 students participated in regional competitions before the winners headed to the state finals. This year's challenge was even larger and included 22 competitions hosted by the Intermediate Units with more than 3000 students competing!

This year's challenge was to create a structure from K'NEX® that would move a ping pong ball a distance of four feet. Structures had to use at least one motor and be built in a two-hour period. The teams of four also

had to present blueprints, a narrative, and prepare a two minute presentation to the judges. Students were judged on their design, narrative, blueprint, teamwork, creativity, and presentation. The student's creativity shone in this challenge; Judges saw designs like a set of Ferris wheels, a pinball game, bridges, recycling centers and many more innovative structures.

For photos from the day, please be sure to visit our Facebook page.

As the market for STEM careers grows, events like the Design Challenge are vital to encouraging young minds to think outside the box. Jill Jones, general manager of Fisher Science Education said "It is our hope that these children will one day be our employees or our customers, making the discoveries that change the world. Everything is circular, and it all connects through this program."



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- Honorable Mention – Trinity East Elementary School – IU 1

Grades 6-8

- 1st place – East Vincent Elementary School – IU 24
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