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Price offers in this publication are valid through December 31, 2015, unless otherwise stated.



## VACCINES SAVE LIVES

By Brianne McCurley



The most recent measles cases are tied to an outbreak originating in Disneyland and another theme park in Southern California. Victims are now reported in 14 states. The American Academy of Pediatrics is urging parents to vaccinate their children rather than delaying or refusing the shots. The Centers for Disease Control (CDC) says that 90 percent of people who come in contact with the disease and are not vaccinated will contract it. Children aren't administered the first dose of the Measles, Mumps and Rubella (MMR) vaccine until 12 months old and the second dose between ages four and five. Therefore, children under one year of age are at a high risk of being infected. The CDC has reported 102 cases in 2015, already and that number will likely increase.

The latest measles outbreak can be blamed on unvaccinated people traveling abroad, contracting the disease and returning to the U.S. Measles is still highly endemic in Africa and Asia. Anyone who is not protected against measles is at risk of getting infected when they travel abroad. The United States declared measles eliminated in the year 2000. This is a direct result of the vaccination.

### WHAT IS MEASLES?

Measles is a highly contagious viral infection of the respiratory system, immune system and skin. It is spread from person to person from coughing or sneezing. Symptoms include fever, cough, runny nose, red eyes, sore throat and Koplik's spots (white spots inside the mouth). Three to five days after symptoms emerge, a reddish-brown body rash will appear on the face and move downward until it covers the entire body. The rash typically lasts up to eight days. The virus can live up to two hours on a surface or in the air. An infected person can spread the virus from four days before to four days after the rash appears. There is no specific treatment for measles, but most people recover after a few days. Roughly 15 percent of infected people require hospitalization. Measles can lead to serious complications, including pneumonia, brain damage and deafness. One or two out of 1,000 children with measles will die, according to the CDC.



### VACCINATIONS

The measles vaccination became available in 1963. Before it was developed, the virus infected more than 500,000 Americans per year, causing 500 deaths and 48,000 hospitalizations. Vaccinations are given to people of all ages starting at birth. The CDC recommends the following immunizations according to age:

#### Birth through six years old

Disease	Vaccination
Chickenpox	Varicella
Flu	Flu
Haemophilus influenzae type b	Hib
Hepatitis A	HepA
Hepatitis B	HepB
Measles, Mumps, Rubella	MMR
Polio	IPV
Pneumococcal	PCV
Rotavirus	RV
Tetanus, Diphtheria, Pertussis	DTaP

#### Ages seven to 18 years old

Disease	Vaccination
Cervical Cancer	Human Papillomavirus
Flu	Flu
Bacterial Meningitis	Meningococcal Conjugate
Tetanus, Diphtheria, Pertussis	DTaP

After age 18, it is recommended that people get the flu shot every year and the DTaP vaccine every 10 years; otherwise, vaccinations are given depending on a person's health condition. For a complete immunization schedule, visit <http://www.cdc.gov/vaccines/schedules>.

The CDC recommends that children get vaccinated against measles in two doses distributed at 12 months of age and again at four to five years of age. The vaccine is considered safe and effective 97 percent of the time. The World Health Organization (WHO) reports that the measles vaccination resulted in a 75 percent drop in measles deaths between 2000 and 2013 worldwide.

The result of delaying or refusing vaccinations is the main cause of the rise of preventable diseases. *The Lancet*, a UK medical journal, sponsored a study in 1998 that claimed a link existed between the measles vaccination and bowel disease and autism. The report was later declared a fraud, but the damage was already done. It received worldwide media coverage and led many people to question the safety of the measles vaccine. This belief is still apparent in the U.S. culture today. The American Academy of Pediatrics advises parents to educate themselves and talk to their doctors about the importance of vaccinating their children per the recommended schedule. Vaccination rates remain in the 90<sup>th</sup> percentile; however, this is still five percent lower than recommended. People who choose not to vaccinate their children put others at risk of contracting diseases that are absolutely preventable, such as measles. Vaccinations have saved the lives of millions of children and will continue to do so.

### VOCABULARY

- Contagious
- Endemic

### EXTENSION QUESTIONS

- What are the risks of delaying or not vaccinating children?
- What are the benefits of vaccinating children?

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## POLAR BEARS SNIFF PAW PRINTS TO FIND LOVE

By Julianne Glaser

Polar bears live largely solitary lives camouflaged on the snowy arctic tundra, one of the coldest places on Earth. This barren environment lacks the trees and rocks that solitary bears in more temperate environments typically use to mark their territory with urine and body scents. So how do polar bears leave messages for other bears that may be many miles away?

### FINDING MATES THROUGH SCENTED FEET

Pioneering research has revealed that polar bears have adapted to their inhospitable habitat by excreting their scent through their paws and then tracking it in the snow as a means of communication. According to a recent collaborative study, polar bears imprint a unique scent in every step of their trek across the frozen terrain in order to establish dominance and, more importantly, to locate potential mates. This communication method takes advantage of the bear's excellent sense of smell, one that allows them to detect seals nearly a mile away!

To test this theory, researchers from the San Diego Zoo, Polar Bears International in Bozeman, Montana, and the Alaska Science Center collected paw scent samples from hundreds of wild polar bears during breeding season. They swabbed the scents onto cardboard boxes to create "scent boxes," and exposed 26 captive polar bears from 10 different North American zoos to these wild scents to analyze their reactions. Researchers measured the bears' interest in the scents by their approach to the box, sniffing and "flehmen response"—a special way of smelling in which an animal curls back its upper lip and gathers scent in its mouth.

Research results showed that captive polar bears were far more interested in paw scents from the opposite sex; males preferred the paw scent of fertile females over non-fertile females, and both male and female polar bears were more intrigued by

the scent boxes around spring breeding season than any other time of year. "Effective communication is essential for successful reproduction in solitary, wide-ranging animals," said Dr. Megan Owen, lead author of the study. This research verifies that polar bears use scented paw signals to locate mates during their solo voyages across the tundra.



### FORENSIC INVESTIGATION

Dissection of two polar bears that had died of natural causes revealed prominent sweat and oil glands in their paws, which are most likely responsible for their signature paw scents. Researchers note that this communication method depends upon the condition of the polar icecaps—once the ice melts and fragments, so do the scent trails, and the polar bears lose this essential means of communication.

### VOCABULARY

- Flehmen
- Arctic

### EXTENSION QUESTIONS

- Why do bears generally live solitary lives?
- What other ways can polar bears communicate once the snow and ice melt?
- How many species of bears exist and where do they live?

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## CHIMPS COMMUNICATE THROUGH RHYTHMIC TREE DRUMMING

By Julianne Glaser

Chimpanzees are known for their booming and melodic "pant hoot" vocalizations that echo throughout the rainforest. But few are aware of another equally important and fascinating means of chimpanzee communication—stylistic drumming on buttress roots of trees with their feet. The significance of this drumming has eluded scientists for decades. New research, however, has revealed that these symphonic displays serve not only as a show of physical prowess, but as a tool for long-distance communication.

### DRUM SOLOS ACCOMPANY PANT HOOTS

Groundbreaking field research conducted in Uganda by psychologist Katie Slocombe of the University of York in the United Kingdom and published in *American Journal of Physical Anthropology* suggests that buttress tree drumming contains unique rhythmic patterns to broadcast a chimp's location to distant troop mates. In fact, drumming sounds can travel through thick jungle for at least a kilometer. Moreover, Slocombe discovered that each chimp displays a distinct drumming style and cadence, with individual differences in the use of doublets, pauses and beats per bout that serve as musical identity to troopmates. When chimps are traveling across vast terrain, Slocombe hypothesized that "drumming patterns may act as individually distinctive long-distance signals that, together with pant hoot vocalizations, function to coordinate the movement and spacing of dispersed individuals within a community."

Additionally, researchers determined that drum frequency is related to age and gender of the chimp. For example, older, more experienced males used tree drumming more than other members, while social rank or the presence of female counterparts was not correlated to drumming frequency. The most significant factor related to drumming, however, was movement. Slocombe and colleagues found that chimps on the move paired hoots with buttress drumming about 75 percent of the time, compared to only 40 percent while resting and 10 percent while eating.

### ROOTS OF HUMAN MUSIC

Could these acoustic findings provide insight into how rhythm emerged in human lineage? The genetic and evolutionary similarities between humans and chimps are well established, and the earliest humans may have utilized drumming to coordinate movement over long distances, suggests Slocombe. However, Adam Clark Arcadi, an anthropologist at Cornell University, cautions that additional research is still required to clarify the significance of tree drumming amongst chimps and to determine the role of rhythmic drumming in human evolution.



### VOCABULARY

- Pant hoot
- Beats per bout
- Doublets
- Buttress roots

### EXTENSION QUESTIONS

- What are pant hoots? What other means do chimps use to communicate?
- What other animals use vocalizations and sounds to communicate?

# PORTABLE INSTANT BLOOD TEST PROVIDES FAST RESULTS

By Mona Simpson

Blood tests offer a way for doctors to determine how their patients' bodies are functioning. After a clinical worker collects the patient's blood sample, many procedures occur in order for doctors to get the blood test results for their patients. Currently, tests are performed on complicated, bulky lab equipment that is time consuming and labor intensive. Now, a company called Radisens Diagnostics claims that they have developed a blood-lab-in-a-box; a new way to perform blood tests for particular diseases.



## QUICKER TESTING AND FASTER RESULTS

Their simple tester is a handheld device that tests blood fast and easily. In only minutes, one blood drop can be tested for a range of diseases or conditions. The Gemini trial product, the official name for the blood-lab-in-a-box, took six years for the company to develop. It works in this way: the blood drop is placed inside special cartridges. These cartridges are pre-filled with beads that are coated with indicators for the particular condition being tested. The blood drop is spun with the beads. If disease molecules are present, they form long chains. A green light shows how much disease is present, if any. Doctors would use different cartridges for different diseases. Faster answers can allow patients to be treated faster and get healthier sooner.

Now blood testing can be faster and more convenient. This technology allows doctors to provide faster diagnoses and patients to be treated quickly and effectively, even in remote places. One of the investors in the company is the European Space Agency, presumably because they want the ability to test astronauts in space to learn the effects of zero gravity on the human body. Another benefit that instant testing provides is the ability for doctors to discuss an individual's test results immediately and in person, building trust and fostering communication, which may improve health outcomes.

## EXTENSION QUESTIONS

- Current lab testing of blood samples takes anywhere from days to weeks. What is the benefit of obtaining results faster?
- One remote location where these blood tests may be useful is outer space. Where are other remote places that could benefit from having access to lab results?

# COLOR BLIND PAINTER TESTS CORRECTION GLASSES

By Celeste Beley

Most people would assume that color blindness, or color vision deficiency, or CVD, would be an issue for anyone wanting to become a painter, but modern day artist Adam Fenton does have CVD and has built a successful career in landscape paintings and color studies.

Color blindness affects millions of people and their daily lives around the world. The most common form is deutanomaly, categorized as a red-green color blindness that affects roughly 8 percent of men in the world. For Fenton, this made it difficult for him to see shades of pink, red, orange and brown. He heard about a technology called Oxy-Iso that enhances the wearer's vision of certain colors that would normally be invisible for people with red-green color blindness.

## SEEING THROUGH ROSE-COLORED GLASSES

The glasses, developed by 2AI Labs, were created to help health-care professionals see bruises or veins beneath the skin. The concept is based on how oxygen levels in blood can change skin color and then transmit many different social signals: blushing indicates embarrassment, flushing signals anger, but these changes may also signal issues with a person's health; hence the advantage for healthcare professionals to use these glasses.

Fenton reached out to 2AI to test the glasses. He previously used the warm hues in his paintings by learning of their effect on people, basically, painting "blind." The Oxy-Iso lenses allowed him to see the differences between each of these hues, mostly by a glowing effect when seen through the glass. The cool colors, the blues and greens, did not look noticeably different. Fenton experimented with how the glasses affected his painting by doing a series of landscapes based on the same photograph. In Painting A, without the lenses, he realized that he used much fewer red, terracotta and



Photo courtesy of Adam Fenton, adamfentonartist.tumblr.com

sienna shades when painting, and that he mixed extra blues into the greens to make the hues even cooler and omitted adding warmer hues. In Painting B, with the Oxy-Iso lens, the fluorescent glow of the warm colors made it difficult to distinguish between red and orange, and also the cooler colors tended to look similar since they were not highlighted by the lens.

Fenton was happy to test the glasses, but sees his color blindness as an element of his own personal style, although they did allow him to pass the Ishihara test that commonly diagnoses color blindness.

"Color blindness is a condition that is diagnosable and recognized," Fenton says. "But I think every person or every artist has their own way of seeing and they can translate that into their work."

## VOCABULARY

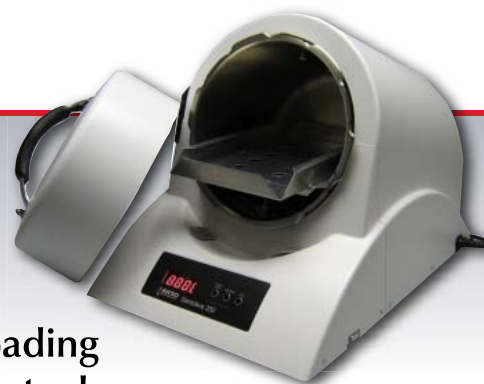
- Ishihara Test
- Color Vision Deficiency (CVD)
- Hues

## EXTENSION QUESTIONS

- In what other professions would color correcting glasses be useful?
- Are there any benefits to having some type of color blindness? Where and why?

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## ASTRONOMER & ASTROPHYSICIST

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When you look at Earth from the vast reaches of space, it looks like a blue marble. In the words of Carl Sagan, from his book, *Pale Blue Dot*, "That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives." Do you ever look up at the night sky and wonder what happens beyond the confines of this planet?

Astronomers and astrophysicists study the origins of the universe, galaxies and stars. They use modern technology to observe the billions of galaxies beyond the Milky Way, and use this data to find new stars. Theoretical astronomers use advanced mathematics to mold theories surrounding the laws of the universe. Some of these theories, such as Albert Einstein's Theory of General Relativity, end up impacting our lives in very real ways. Theoretical astronomers will usually find work in academia and will conduct research in their office; experimental astronomers and astrophysicists can find work in academia as well, but may also work for the government, such as at the National Aeronautics and Space Administration (NASA), or for private

research institutions. Some astronomers have to work non-traditional hours, because many will go to observatories at night to study the sky in more complete detail.

Students considering astronomy and astrophysics should begin by taking physics and calculus in high school. Many colleges and universities offer undergraduate degrees in physics, astrophysics and astronomy. To do independent research, a doctorate in one of these fields is also required.

Astronomers and astrophysicists can expect to see job growth in the future: it is expected that the demand for astronomers will grow by 11 percent from 2010 to 2020. Astronomers, on average, earn \$87,260 a year, according to the Bureau of Labor Statistics, though the pay varies widely.



## HUMAN EVOLUTION AND THE PRECISION GRIP

By Julianne Glaser

Picture an image of our earliest ancestors such as *Homo erectus*. What do you see? For many, we imagine a primitive, "ape-like" creature with brute strength but little finesse. Recent research, however, reveals ancient hominins that lived nearly 3 million years ago may have developed the fine motor movement for a precision grip, allowing them to wrap their thumbs and fingers tightly around objects. Precision grip is ability to touch the index fingertip with the tip of the thumb. Researchers are now speculating that this precision grip may have allowed our ancestors to create and use stone tools much earlier than previously believed.



### WHO WAS THE ORIGINAL TOOLMAKER?

Paleoanthropologists have discovered fossil records of the earliest stone tools in Gona, Ethiopia, that date back nearly 2.6 million years. The identity of the original toolmakers eluded researchers for years, because several hominin species dominated during this period, including *Homo*, our ancestral genus, and several species of close relatives, such as *Australopithecus*, including *A. afarensis*, the species of the famous Lucy skeleton. Identification has been further complicated by the fact that complete, intact fossils of delicate hand bones are nearly impossible to unearth.

In a groundbreaking study, paleoanthropologists Matthew Skinner and Tracy Kivell at the University of Kent and Max Planck Institute for Evolutionary Anthropology implemented an innovative CT scanning technique to extract a more intricate glimpse at the internal structure of hand bones. Skinner and Kivell examined the pattern of fossilized spongy bone tissue in the hand bones of hominins that lived two to three million years ago to determine signs of habitual, repetitive hand movements.

Scanning results indicated that the South American *A. africanus* species exhibited an asymmetrical pattern of trabecular bone tissue, which develops at the base of the thumb and knuckles as a result of precision gripping, similar to modern humans. This suggests that *A. africanus* developed the ability to handle stone tools more than half a million years before the earliest fossil record of stone tools had previously indicated. To validate a direct correlation between precision grip and tool use, paleoanthropologists are searching for stone tools in several early *Australopithecus* locations.

Paleoanthropologist C. Owen Lovejoy of Kent State University in Ohio cautions that "other activities that hominins engaged in frequently during development, such as digging tubers or climbing, might also explain the signs of stress."

Future studies are necessary to confirm *Australopithecus* tool use and the emergence of the precision grip in other related hominins.

### VOCABULARY

- Australopithecus
- Hominin
- CT scan
- Trabecular bone

### EXTENSION QUESTIONS

- What advantage does the precision grip provide?
- What are some possible reasons that *A. africanus* developed a precision grip before *A. afarensis*?

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## GENETICISTS ENTER FELINE TERRITORY

By Julianne Glaser

Attempts to unravel the mysteries of temperamental feline personalities and behaviors have challenged cat owners for centuries. The feline genetic paw print has been just as elusive for scientists. Over the past decade geneticists have favored genetic research with dogs over cats, given the similarities between human and canine diseases. But new, exciting research aims to decode the cat genome and identify genetic abnormalities responsible for feline diseases and unique breed traits.

### "99 LIVES" INITIATIVE LAUNCHES CAT GENOME SEQUENCING

In 2007, researchers began to sequence the genome of the first domestic feline subject, an Abyssinian named Cinnamon. In 2014, following data errors and setbacks, scientists published Cinnamon's full high-resolution genome and determined that house cats remain genetically similar to their wild counterparts despite thousands of years of domestication.

To build on this groundbreaking genetic research, renowned geneticist Leslie Lyons of the University of Missouri launched the "99 Lives" cat genome sequencing initiative. This unique research endeavor aims to demystify the cat genome, improve the quality of previous data, discover genetic mutations that cause inherited diseases and unique phenotypic traits, such as fur or eye color, and shed light on domestic feline evolution.

Lyons is eager to see genomic results benefit cats. "I would love to eradicate all genetic disease in cat breeds before we're done," she says.

Since the start of the project, Lyons and her colleagues have sequenced the complete genomes of 56 domesticated cats, an undertaking that has cost over \$400,000. The "99 Lives" initiative receives funding through a grant from the National Institute of Health and donations from feline breeders and private owners. In addition to studying rare feline diseases, Lyons has also analyzed feline dwarfism and genes related to fur color.

### POTENTIAL FOR HUMAN HEALTH

Lyons research has found that feline versions of diseases such as type 2 diabetes, asthma and retinal atrophy have close similarities to these diseases in humans. Cats can also become infected with an HIV-related virus and experience symptoms similar to AIDS patients. Thus, understanding of the cat genome has the potential to not only improve treatment of feline diseases and ailments but translate into improved prevention and intervention for numerous human diseases.

To learn more about the 99 Lives project, visit [www.felinegenetics.missouri.edu](http://www.felinegenetics.missouri.edu).



### VOCABULARY

- Phenotype
- Genome
- Sequence

### EXTENSION QUESTIONS

- Why are wild cats and domestic cats still so genetically similar?
- What other animals' genetic makeup might offer insight into human health and disease?



# TINY PARTICLES MAY HAVE A BIG IMPACT ON TREATING CANCER

By Mona Simpson

Cancer is a general name for a group of more than 100 diseases that start off as abnormal growth cells that could potentially spread throughout the body, growing new tumors in other organs. This process is called metastasis. Metastasizing cancer cells change the sugars on the surface of each cell, avoiding immune detection. They do this by overproducing enzymes that add sialic acids to sugar chains. These sialic acids allow the cancer cells to detach from one organ and move to another without alerting the immune system.

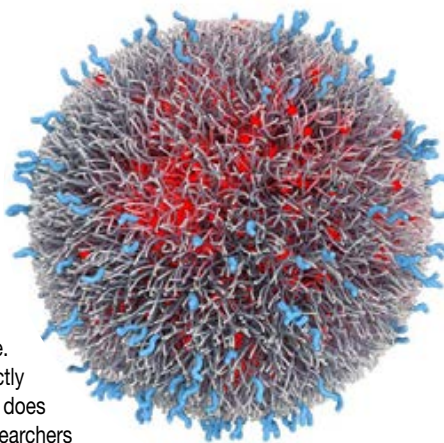
## TRIAL AND ERROR

Years ago, researchers developed a drug to stop this critical change in sugars. The drug they developed is a sialic acid inhibitor known as P-3Fax-Neu5Ac. Unfortunately, scientists found that the drug is also lethal to animals. When researchers injected mice directly with this drug, the mice developed fatal kidney damage. In order for a drug to save lives, the drug should only target cancer cells.

## NANOTHERAPY COULD BE THE ANSWER

Now researchers have developed a new method to deliver the drug directly to cancer cells. The scientists used nanoparticles, objects so small that 800 of them could fit in the width of a human hair. These tiny particles can deliver the drug directly to cancer cells without damaging healthy cells. Research led by Gosse Adema, a tumor immunologist, packed P-3Fax-Neu5Ac into nanosized, biodegradable vesicles made from PLGA, a compound approved by the United States Food and Drug Administration (FDA). The mice that received the drug via nanoparticles had 75 percent fewer tumors than the mice that did not receive the drug. This is a promising start, but more testing will be needed.

Researchers will need to do more work to make sure that P-3Fax-Neu5Ac will work in humans the way that it has worked in mice. This is because the creation of sugar chains on cells, called glycosylation, is different in people than it is in mice. So this research may not directly provide a cure for cancer, but it does suggest a promising path for researchers to follow toward a cure for cancer in humans.



### VOCABULARY

- Metastasis
- Glycosylation

### EXTENSION QUESTIONS

- What is metastasis?
- What has been identified as causing cancer deaths? Cancer deaths are caused by cancerous cells that metastasize: they move through the body and grow in other organs
- What was the problem researchers found with P-3Fax-Neu5Ac? How have they solved this problem so far?
- What is glycosylation?
- Do drugs that work in mice always work in humans? Why or why not?

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# WHY DOES A WET DOG SMELL SO BAD?

By Celeste Beley

Ask any dog owner their least favorite things about their pooch, and inevitably, the wet-dog smell will be added to the (likely short) list. Most dogs love water and love the car, but the smell that's left behind on your way home from the lake or beach is rather impossible to forget. So what is it about water that turns a dog's normal musty smell into an unbearable and unforgettable stench?

## THE SCIENCE BEHIND THE STINK

When you smell, microscopic molecules land on specialized cells— your olfactory sensory neurons. The cells translate the chemical signature of the molecules into an electrical signal that is sent to your brain. From there, the circuits help you label the smell: good, bad or just plain awful.

Canines are rife with microorganisms, and these are the source of most smells your dog leaves behind, mainly from bacteria and yeasts that live in the fur. When these microorganisms, normally unscented, are touched by water, the water breaks down the chemical bonds that hold the pieces together and release those musty molecules into the air. The water then evaporates and raises the humidity surrounding your dog, and since humid and/or warm air can hold more molecules (that compounds the effect on smell) the higher concentration of molecules means more of those make their way into your nose to assault those receptor neurons.



### VOCABULARY

- Microorganisms
- Microscopic
- Olfactory

### EXTENSION QUESTIONS

- Do you think the smell from any other wet animal (i.e. cats, ferrets) would be as bad? Why or why not?
- What steps can you take to reduce the number of microorganisms on a dog's fur?



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# STUDY FINDS HUMAN PATHOGENS IN GRAY SEALS

By Julianne Glaser

Zoonotic, or cross-species, diseases have plagued humans for centuries—from Ebola to malaria to bubonic plague. Scientists had believed that transmission of infectious diseases stopped at the water's edge, making spread of disease between land and sea animals impossible. A recent study to collect health data on Scotland's gray seals, however, revealed elevated levels of a human pathogen, shattering the previous understanding of pathogenic transmission

## TERRESTRIAL AND MARINE TRANSMISSION

Johanna Baily, a veterinary pathologist with the Moredun Research Institute in Penicuik in the United Kingdom, led an innovative study involving collection of microbiological samples from live and deceased gray seal pups on the Isle of May, an uninhabited island off the coast of Scotland. Baily and her team analyzed the samples to determine the presence of several pathogens and were surprised to find *Campylobacter* bacterium in almost half of the tested seals.

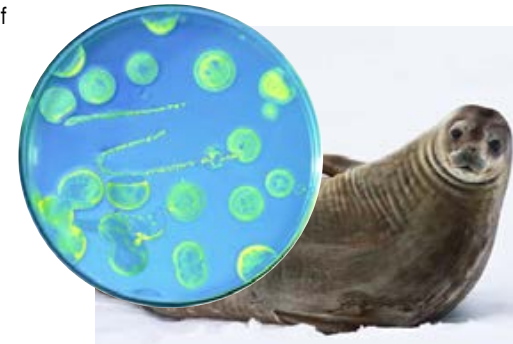
Primarily found in domestic livestock and wilds, *Campylobacter* can cause foodborne illness and inflammation of the intestines in humans. Dead seals with this bacterium also showed evidence of intestinal inflammation, suggesting that the pathogen could affect animal health as well as human health. According to Baily, "*Campylobacter* has been previously detected in seals at very, very low levels. The prevalence we found in these gray seal pups was absolutely shocking."

Researchers subsequently compared the pathogen genome sequence in seals to potential animal and human source populations. The team reported in *Molecular Ecology* that the pathogens infecting seals were most similar to those found in sick humans.

## WHAT'S THE SOURCE OF THE BACTERIA?

Microbial ecologist Erin Lipp from the University of Georgia cautions that further research is needed to determine if humans are in fact spreading the bacteria to seals. The pathogenic sequence isolated from seals was also highly similar to those found in poultry. Thus, both humans and seals could be contracting the pathogen from contact with contaminated chickens, or agricultural runoff.

Nonetheless, the presence of human pathogens in marine wildlife is cause for concern. "We've got a lot of gaps to fill in" to determine the potential for further terrestrial-marine transmission and how human pathogens might be affecting wildlife on a global scale, Baily said.



## VOCABULARY

- Runoff
- Pathogen
- Zoonotic

## EXTENSION QUESTIONS

- What other ways can agricultural runoff impact the environment?
- What other marine animals could possibly be affected by human pathogens?

# ENVIRONMENT AFFECTS YOUR IMMUNITY

By Joe Spivak



## "STOP, DON'T EAT THAT DIRT!"

How many times have you heard that growing up? Humans are born with an immune system that protects our bodies from bacteria, viruses and other environmental factors. But not everyone's immune system is the same, even in identical twins. Why does one twin get sick from the flu and the other does not?

exposed, your body remembers the specific pathogen and what antibodies it needs to destroy it. Vaccines work by exposing your body to an attenuated virus, producing antibodies and activating your immune system's 'memory.' The next time you are exposed to the pathogen...you won't get sick!

The immune system is complex and involves many different factors. Genetics and the environment determine our resistance to pathogens. It seems that scientists have found strong evidence that environment and exposure have the greatest impact on when and why you get sick.

In the future, we should probably tell our kids: "Stop. Don't. Eat that dirt!"



## DOING A DOUBLE TAKE

To understand the environmental and genetic influences that shape our immune system, scientists turned to the ever-reliable twin study. They recruited 210 identical and fraternal twins between eight and 82 years old and studied how they responded to pathogens. Identical twins possess almost exactly the same DNA and, therefore, should possess identical innate immune systems. So, scientists looked at 95 immune cells and 51 kinds of proteins and found enough variation to rule out genetics as the cause. Furthermore, scientist studied the twins' individual responses to identical pathogens, in this case: influenza. With identical genetic immune systems, their response should be...identical. It was not.

## NATURE VERSUS NURTURE

As it turns out, your environment and previous exposure to pathogens play a major role in the development of your immune system. As your body is exposed to antigens from those pathogens, it produces target-specific antibodies to destroy them. Once

## VOCABULARY

- Adaptive immunity
- Antigen
- Antibody
- Attenuated virus
- Innate immunity

## EXTENSION QUESTIONS

- Why do we give vaccines? Why was this year's influenza vaccine ineffective in some cases (est. 60 percent)?
- What can you do to strengthen your body's immune system?



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# X-RAYS REVEAL THE SECRETS OF ANCIENT SCROLLS

By Julianne Glaser

Nearly 2000 years ago, the ancient Roman cities of Pompeii and Herculaneum were destroyed and buried under volcanic ash by the eruption of Mount Vesuvius. Despite the devastating destruction, hundreds of papyrus scrolls stored in a Herculaneum library survived. The scrolls were unearthed in the 1750s, but due to their fragile condition, researchers had not been able to unwrap and read them...until now.

## X-RAYS ILLUMINATING HISTORY

The cataclysmic eruption of Mt. Vesuvius in 79 A.D. buried the surrounding Italian towns and villages under tons of debris and ash up to 20 feet deep. The scrolls, stored inside the lone surviving villa library thought to belong to a Roman statesman, were charred by hot gases estimated to be in excess of 600° F. The tightly rolled ancient scrolls could reach up to 45 feet in length and were rolled right to left to allow reading left to right as they were unrolled.

With use of X-ray phase contrast tomography, a powerful 3D technology best known for its medical applications, a team from the Institute for Microelectronics and Microsystems of the National Council of Research, led by Vito Mocella, has successfully exposed the writing on the brittle papyrus scrolls without unwrapping them. The technology was able to distinguish the difference in refraction between the black ink on the scrolls and the charred papyrus, enabling scientists to identify words on the scrolls. Previous attempts with conventional X-ray technology were unable to differentiate between the ancient black ink made from smoke residues and the charred papyrus.



"This study, without compromising the physical integrity of the roll, has not merely discovered traces of the ink inside it, but has also helped identify with a certain likelihood the style of handwriting used in the text, along with its author," noted Mocella. With the more powerful synchrotron X-ray machine, Mocella believes it will be possible to read entire scrolls.

Likewise, many scholars are excited about the prospect of unearthing previously hidden pieces of history. In the *New York Times*, Richard Janko, professor at the University of Michigan, optimistically added that "this technology, when perfected, does open the way to rediscovering a lot more ancient literature."

### VOCABULARY

- X-ray phase contrast tomography
- Papyrus
- Decipher

### EXTENSION QUESTIONS

- What are additional applications for X-ray technology?
- How did the ancient Romans make papyrus?



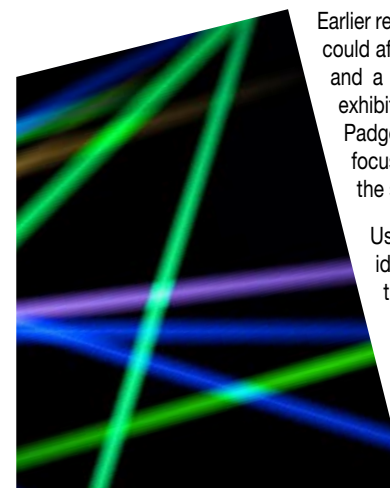
# HOW FAST IS THE SPEED OF LIGHT?

By Julianne Glaser

For more than 100 hundred years, the speed of light has been one of the accepted constants in physics—at 186,282 miles per hour in a vacuum—a rate that would allow one to circle the Earth 7.5 times in one second! But is the speed of light really constant?

## RACING PHOTONS

In 1905 Albert Einstein concluded in his special theory of relativity that the speed of light is constant ("c") for everyone, no matter how fast or in what direction the observer is moving. But recent research led by Miles Padgett, an optical physicist with the University of Glasgow, has shed new light on the special relativity theory. Padgett's experiments have provided evidence that the speed of light in a vacuum isn't so steady after all and should be treated as a limit rather than a constant rate.



Earlier research had indicated that the structure of light could affect its speed, because light is both a particle and a wave composed of photons (particles) that exhibit wave-like behavior. Based on this principle, Padgett's team devised a series of experiments to focus and manipulate light pulses in order to reduce the speed of light, even in vacuum conditions.

Using racing light photons, which were identical in every feature except structure, the researchers directed pairs of photons on two separate paths toward a detector. One photon travelled through a pair of devices that manipulated the structure of the light and then switched it back; the other photon was not manipulated and was sent directly

through a fiber.

If light structure did not matter, the two photons should have arrived at the same time. However, photons with manipulated structures consistently fell behind the other photons. Measurements revealed that the structured light lagged behind several micrometers per meter of distance traveled.

"It's very impressive work. I'm not surprised the effect exists, but it's surprising that the effect is so large and robust," said Robert Boyd, an optical physicist at the University of Rochester in New York.

However, Greg Gbur, an optical physicist at the University of North Carolina at Charlotte, claims, "The findings won't change the way physicists look at the aura emanating from a lamp or flashlight. But the speed corrections could be important for physicists studying extremely short light pulses."

### VOCABULARY

- Photon
- Physics
- Constancy

### EXTENSION QUESTIONS

- What other factors could impact the speed of light?
- What other theories inventions are attributed to Albert Einstein?
- What other physical scientific constants or "truths" have changed throughout history?



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## PLUTO BACK INTO FOCUS

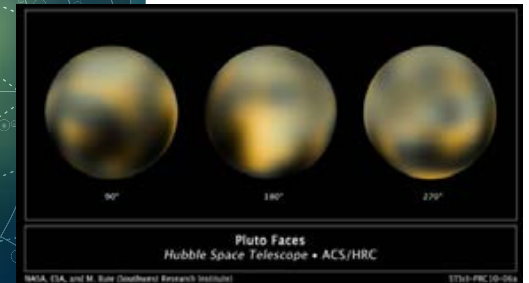
By Robert Marshall

Imagine being first to visit an ancient world known to exist for 85 years but never seen before! Dwarf planet Pluto, the largest object in the Kuiper belt, will soon be back in the science spotlight. Smaller than the Moon but more than 12,000 times farther away from Earth, Pluto is thought of by scientists as a tiny frozen time capsule. Made of the same materials as planets and comets, it may harbor secrets of our solar system's early development.

Astronomers have patiently taken photographs with the Hubble Space Telescope throughout its years of service, revealing that Pluto has five moons (Charon, Styx, Nix, Kerberos and Hydra) but very little detail about Pluto's surface. In fact, only computer images have been generated from low-resolution data, hinting at a landscape with color and contrast. Because of the vast ocean of space that separates our worlds, Pluto has yet to be studied like our closer neighbors via robotic spacecraft.



May when New Horizons' images will surpass the quality of Hubble's and when it eventually reaches closest approach on July 14th. Housing seven high-end analytical instruments, including cameras, spectrometers and a space-dust detector, New Horizons will orbit as a satellite just 6000 miles above the alien surface and send back data on a 4.5 light-hour one-way radio call. What hidings will Pluto reveal? Frozen lakes? Geyser eruptions? Maybe a ring?



Launched in January 2006, New Horizons is closer to completing its nine year and nearly three-billion mile journey. Just this past December, NASA engineers woke the spacecraft up from hibernation, a method used to conserve moving hardware so it can continue to operate years after it starts orbiting Pluto. Stay tuned for mid-

### EXTENSION QUESTIONS

- How will the impact of New Horizons' orbit of Pluto be similar to Mariner 4 orbiting Mars 50 years ago?
- Besides loss of power or hardware damage, what other concerns might NASA have regarding the health of the spacecraft? Hint: 5 moons!?

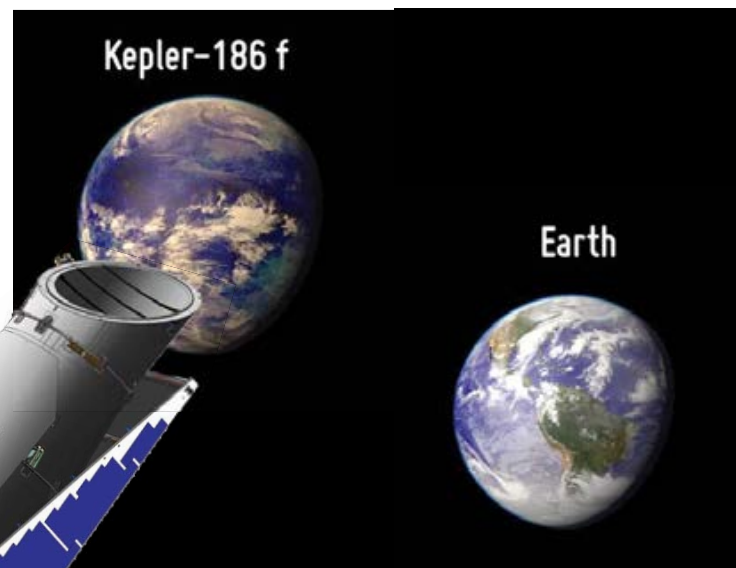
## FINDING EARTHS AMONG THE STARS

By Robert Marshall

On a clear night you step outside, look up and ponder the idea of intelligent beings up there—somewhere—looking back. Then it strikes you that the odds are probably unlikely. How many other Earth-like planets are out there in our Milky Way galaxy?

You might be surprised to learn that astronomers often rely on estimations, given the seemingly infinite number of objects in the Universe, the tremendously vast amounts of space that separate everything and how time plays a factor in what we Earthlings can witness in a lifetime. In order to answer the question of how many Earth-like planets orbit Sun-like stars in their habitable zone (the area of a solar system where liquid water could exist), scientists have to develop techniques to comb through a population of stars not too large to be overwhelming but not too small to provide false scalable data.

Using the space-based telescope Kepler, and other ground-based instruments to confirm results, NASA researchers recently announced that they have identified the 1000th exoplanets in a patch of sky slightly larger than your hand held out at arm's length containing roughly 100,000 stars. More exciting results suggest eight of the confirmed are Earth-size in habitable zones. While this seems like a small value considering the fact that Kepler is only identifying transients, an observation method in which planets eclipse their parent stars and which relies on the solar system's inclination: itself a less than one percent chance. Using these figures, astronomers have estimated that most Sun-like stars have planets even if not Earth-like. And at least one in six stars has an Earth-size planet. As our technology improves, scientists will fine-tune these numbers and eventually increase the likelihood of discovering life elsewhere.



### VOCABULARY


- Habitable zone
- Exoplanets
- Transients

### EXTENSION QUESTIONS

- Research what the parameters of the Drake Equation are and make a guess for every ratio. Multiplying them together will calculate odds of finding alien intelligence.
- Kepler is just one mission of many hunting for exoplanets. How many other confirmed planets have been found and what about number of candidates? What is the difference?

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# HI-TECH FABRIC PROVIDES WEARABLE HEATER

By Julianne Glaser

Since the dawn of mankind, keeping warm during the cold winters has been priority. Now, scientists have created an innovative fabric that traps body heat and may eventually provide a cost-effective means to keep you warm and toasty in cold temperatures without turning up the thermostat.

## THE FUTURE OF WARMTH

Researchers from Stanford University led by Yi Cui have transformed ordinary cotton fabric into a wearable “mini heater” that reflects the wearer’s heat, or infrared radiation, back to the body. The team created a mesh of easily bendable nanowire coated with

silver that’s placed on top of the fabric. As reported in *Nano Letters*, the fabric mesh can trap nearly 80 percent of the body’s heat while the nanowires’ porous structure allows moisture to pass freely, maintaining the fabric’s breathability and the wearer’s comfort.

Additionally, the silver nanowire structure creates a conductive network throughout the cloth that increases warmth when exposed to micro amounts of electricity, such as working at a computer. Silver has the highest electrical conductivity of all metals, so movement of electricity across the cloth from an electrical device effectively creates Joules heating. In fact, just 0.9 volts of electricity can warm the cloth to a 100 degrees Fahrenheit.

Moreover, according to Cui, the high-tech fabric is relatively inexpensive to produce—about one dollar’s worth of silver is all that’s needed to cover clothing for the entire body, except for head and hands.

Safety testing is ongoing to determine any potential human health effects with silver nanowire, and the fabric is likely years from commercial availability. With heating costs on the rise, this personal thermal management fabric might be the next major development in cost-effective and environmentally safe heating.

Meanwhile Cui and his team are looking to develop a similar silver-coated nanowire fabric to keep the body cool.



Nanowire coated with silver

### VOCABULARY

- Nano particles
- Infrared radiation
- Joules heating

### EXTENSION QUESTIONS

- What would be some possible safety concerns with this nanowire thermal clothing?
- What are other energy-efficient ways to cut heating costs?

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# MARVELOUS TRICKS OF THE TONGUE

By Julianne Glaser

All would agree that savoring a delicious meal is one of life’s great pleasures. But have you ever considered how we taste the intricate flavors of food and spices? Why some foods are sweet while others burn?

## THE VERSATILE TONGUE

We can detect five basic tastes—sweet, sour, bitter, salty and umami (savory)—through taste buds located primarily on the tongue, but also on the roof of the mouth and back of the throat. Did you know that our tongues are also sensitive to temperature, pressure and chemicals triggered by certain foods that can create unusual “gustatory” experiences? Research sheds light on how certain foods can effectively trick your tongue with unexpected sensations.

## THE UNUSUAL SENSATIONS OF “NON-TASTE” TASTE BUDS

Chemesthesis enables the tongue to sense temperature, pressure and chemicals through “non-taste” receptors that connect to nerve fibers in the brain. These chemoresponsive receptors are stimulated by unique compounds in certain spicy, “piquant” foods that cause a burning sensation or minty foods that cause a cooling sensation.

Sanshool, a compound found in Szechuan peppercorn, binds to chemoresponsive touch receptors on the tongue causing the mouth to gently tingle and become progressively numb. Similarly, capsaicin, a compound found in hot peppers, binds to receptors on the tongue that perceive pain as well as those that detect temperature to create the sensation of spicy heat. These same receptors are also activated by piperine found in black pepper and allyl isothiocyanate found in mustard and radishes. Ever notice how spicy food tastes spicier when you enjoy an alcoholic beverage? Ethanol actually lowers the temperature at which the capsaicin receptors are activated and increases pain perception.

Despite the burning and pain sensations, these compounds don’t actually harm the tongue. In fact, those who frequently eat spicy food actually desensitize their receptors and lessen their reactions to spicy foods. The capsaicin desensitization phenomenon has led to the development of capsaicin creams that alleviate arthritic pain as chemoresponsive receptors run throughout the skin not just the mouth.

At the opposite end of the sensation spectrum is the cooling sensation from foods containing peppermint or menthol. Like sanshool and capsaicin, peppermint and menthol transmit sensation to the brain via the trigeminal nerve, allowing you to quite literally feel your food.

Taste, aroma and chemesthesis combine to create unique and distinct food flavors and sensations that may well explain why some like it hot!



### VOCABULARY

- Gustatory
- Chemesthesis
- Umami
- Desensitization

### EXTENSION QUESTIONS

- What other foods or substances can create unusual sensations on the tongue?
- If someone has lost the ability to taste, could they still experience these sensations?
- What is your gustatory system, and why is it important?

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## SEWAGE SLUDGE COULD BE A GOLD MINE

By Samba Lampich

The sewage lines in your city could be lined with gold and other precious metals. Where do the metals come from?

Metals in sewage water come from many different places: natural weathering of soils and rocks as well as human activities that involve mining, processing and industrial plants. All of these sources flush down some amount of metal that makes its way into drains and water treatment plants. These metals can be corrosive and toxic, contaminating streams and other sources of water used for farming or fishing.

A new study conducted by scientists at Arizona State University, Tempe looked at the amount and value of these metals in sludge, a byproduct of sewage treatment.

In the study, the researchers used a mass spectrometer to identify 13 different metals in samples of sludge as they ionized through super-heating. They collected sludge from 94 different wastewater treatment plants in 32 different states. These elements included gold, silver, platinum and copper.

In a report published by *Environmental Science & Technology*, the researchers calculated that each metric ton of sludge could yield about \$280 worth of these 13 metals. By extrapolating this figure, they calculated that a city of a million people could generate up to \$13 million a year in these precious metals, of which \$2.6 million would come from gold and silver.

"While we expected that the metals were present at low concentration, the fact that the small amounts represent such a significant economic value was definitely surprising," says Pierre Herckes, associate professor at ASU and co-author of the study.

Extracting these metals might sound like a good idea, but it is not practically feasible. There is no current technology that could profitably extract the microscopic amounts of metals in sludge on a large scale.

However, a sewage plant in Japan has been able to harvest gold from burned sludge. They were able to get about 4.4 pounds of gold from every metric ton of ash from burned sludge.

While it may not yet be practical to extract metals from sludge, future capabilities to do so would help remove heavy metals that are detrimental to aquatic sources and not only help the environment but also earn a pretty penny.



### VOCABULARY

- Feasible
- Detrimental
- Spectrometer

### EXTENSION QUESTIONS

- What other resources could be extracted from sewage?
- How can heavy metals and minerals harm the environment?



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## CONSERVATIONISTS MAY BE KILLING MONARCH BUTTERFLIES WITH KINDNESS

By Patti Dobranski

Butterflies have fluttered across our skies for about 50 million years. Who doesn't smile when they see their brilliant wing patterns dance in the air among the colors of spring and summer? With beauty that inspired both poets and musicians, they have even graced the world with mystical symbolism.

From a scientific perspective, butterflies are indicators of a healthy environment and play a key role in our ecosystem.

So, it was no surprise that gardeners and conservationists came to the rescue of Monarch butterflies when their population began to decline about 20 years ago. Milkweed plants, the primary food source for Monarch caterpillars, can be toxic to livestock, so farmers often sprayed herbicides over large acreages to kill it. This created a loss of habitat for the milkweed, and consequently, the decline of Monarchs.

In an effort to prevent Monarchs from making the endangered species list, butterfly enthusiasts did what they thought was best: they grew milkweed plants. Turns out, this actually did nothing to help, because gardeners selected the wrong species of milkweed. Instead of solving the problem, they were creating a new one that may be just as harmful to the Monarch butterfly species.

### WHY ARE MONARCHS IMPORTANT TO OUR ECOSYSTEM?

The most common butterfly species in North America, Monarchs are migratory insects that travel to warmer climates like Mexico for the winter months. Their flight patterns carry them over many places where pollination is needed. As pollinators, they are happy to contribute on their journey. Without the Monarchs' help, some of the plant life in these areas may not survive.

Butterflies offer natural pest control. In turn, they are an important element of the food chain as prey for birds, bats and other insectivorous animals. So, bring on the milkweed! Well, the right kind.

### THE BITE OF THE HAND THAT FEEDS

Monarch lovers living in the southern United States truly thought they were helping the butterflies by planting an exotic species of milkweed that grows year round. However, they did not realize this particular type of milkweed would harbor a protozoan parasite called *Ophryocytis elektroscirra*, or OE, that normally would die off with the cycle of the seasonal, native milkweed. Unfortunately, caterpillars who ate the parasite-infected milkweed often suffered wing deformities when they grew to adulthood as well as shortened life spans. Essentially, the Monarch rescuers had traded one problem for another. But there was hope.

### HOW CAN WE REALLY HELP MONARCHS?

Scientists suggested purchasing native milkweed seeds to replenish the population. However, these seeds may be a little more difficult to find than the tropical variety. With the findings emerging that tropical milkweed can be detrimental to Monarch butterflies, the availability of the correct, native milkweed has begun to increase. Environmental researchers also suggest that cutting down the tropical milkweed plants a couple of times during the winter may help control OE parasite.

All of the current research and data have not been received and reviewed at this point. It should be known later this year if the beloved, partner-in-nature Monarch butterfly can avoid making the endangered species list.

### EXTENSION QUESTIONS

- What other insects are important to our ecosystem?
- What contributory insects are currently on the endangered species list?
- What can we do to get these eco-friendly insects off the endangered species list?

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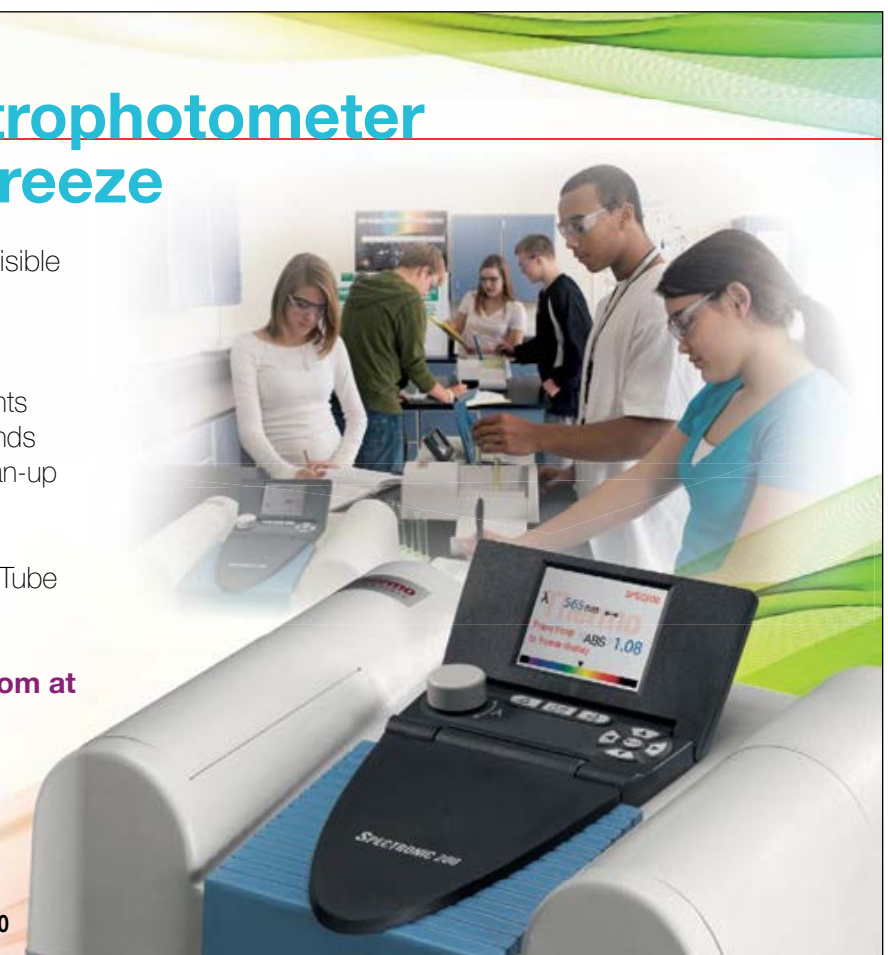
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# A MATTER OF TASTE...AND GLOBAL WARMING

By Merry Morris

Whether your favorite shrimp dish is Shrimp Scampi, Szechwan Shrimp or Shrimp and Grits, you could be sadly disappointed with these delicacies in the future...due to global warming.

## IT'S MORE THAN LIFE OR DEATH

The seafood industry in the United States is an economic engine that provides communities with jobs, populations with a low-fat, calorie-light protein and shrimp lovers with their favorite source of omega-3s. In a warming climate, we know that the sizes of fish and shellfish populations are at risk due to higher mortality. What has not been investigated thoroughly is that the very taste of these "fruits of the sea" is likely to be noticeably degraded. According to researchers from Sweden, the United Kingdom and Canada, a reduction in sensory quality, not just survival, is critical when considering impacts of global warming.

## OCEAN ACIDIFICATION

For many years, it has been to our benefit that the oceans have absorbed man-made carbon dioxide, blunting its impact on terrestrial systems. Over roughly 200 years, around 50 percent of the billions of tons of emissions have been absorbed and transformed into carbonic acid. Now the acidity of the oceans has begun to increase as carbonic acid concentrations have risen in surface waters. A reduction of 0.1 pH units represents an unsettling 25-percent increase in acidity.

## TASTE TEST

These researchers investigated changes in the taste of northern shrimp by raising the crustaceans in a more acidic environment than normal. Their two study treatments featured water at pH levels 7.5 and 8.0. As expected, more shrimp died in the lower pH water, but those that survived were not unscathed. Shrimp from both pH treatments were harvested, used by chefs as ingredients in shrimp dishes and subjectively judged by a panel of 30 "local connoisseurs."

When the culinary verdict was in, the judges were 3.4 times more likely to consider the pH 8-raised shrimp to be tastiest, while their more acidic, pH 7-raised counterparts were much more likely to be deemed the least desirable.

## IN THE OLD DAYS...

As ocean acidification continues, we may find that our seafood (and more) "just doesn't taste as good as it used to." Our maturing taste buds aside, now we know one reason why that might be.



## VOCABULARY

- Global warming
- Acidification
- Carbonic acid
- Crustaceans

## EXTENSION QUESTIONS

- In general, what is the effect of pH on living populations?
- pH units are logarithmic, so a change of 0.5 units is bigger than it first seems. Investigate ocean water pH from a variety of locations (temperate, tropical, arctic). What are the normal variations and what might suggest acidification?



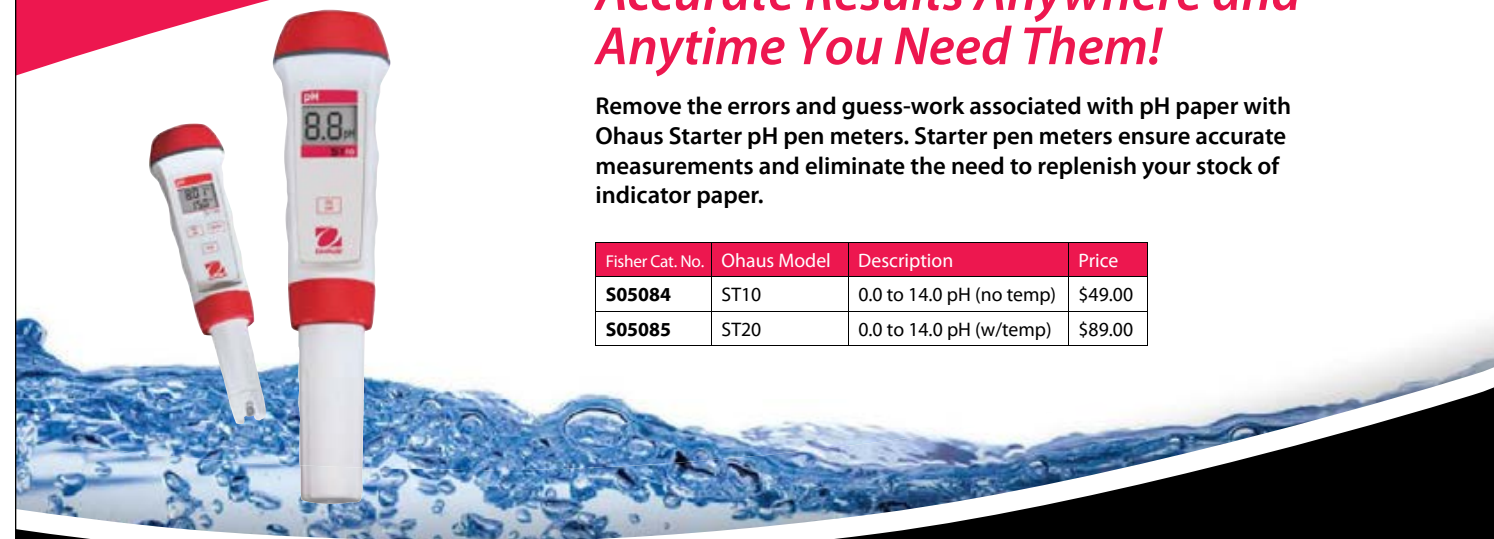
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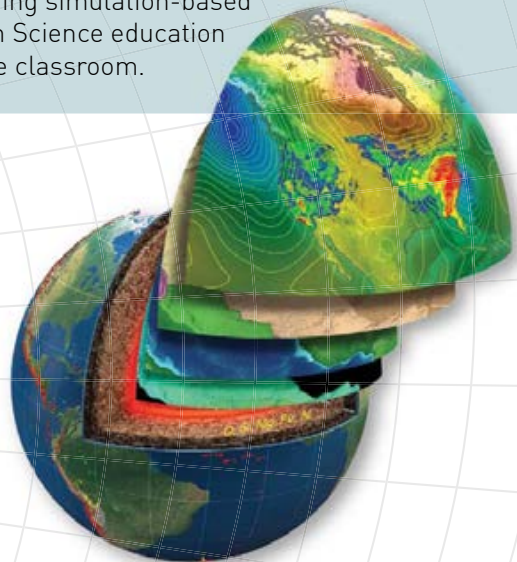


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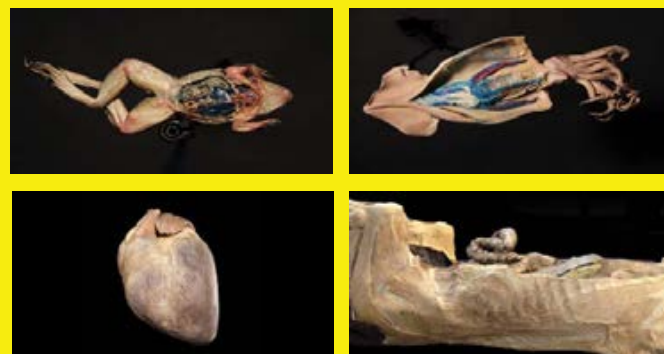
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2015

# EASTER ISLAND MYSTERY REVISTED

Researchers suggest climate change may have played a role in the demise of the native population

By Joe Spivak

Easter Island has long held mysteries about its giant, great, strange heads, how they got there and what happened to the people who made and moved them.

The story of Easter Island and the native Rapa Nui is a cautionary tale: man's expansion and abuse of the environment ultimately results in the collapse of civilization estimated to have been up to 15,000 people at its height. However, that population had dwindled to about 2,000 to 3,000 around the time a few Europeans arrived on Easter Sunday in 1722.

Some researchers have suggested that the Europeans brought with them diseases that the native islanders had no immunity against as well as other environmental factors.

## NEW EVIDENCE

However, contrary to the established narrative of imported diseases, exceeding carrying capacity, deforestation, resource exploitation, war, starvation and ultimately cannibalism, scientists now think that something very different occurred here, challenging previous assumptions.

When early colonists first visited Rapa Nui, they brought with them the Polynesian rat, either by accident as stowaways on ships or as a protein source for consumption. While rats may be deemed unpalatable by our tastes, they actually make sense as a food source: exponential growth/reproduction rate, hearty, resourceful and omnivorous. These characteristics make rats highly adaptable, but also have the potential to make them disastrous to local flora and fauna. Add in the absence of natural predators,

excluding people, and you have 'Asian Carpocalypse,' Polynesian rat style! Based on the reproduction rates of rats (doubling every six to seven weeks), in three years you could have a population of 17 million, more than enough to deforest the island. Further supporting this explanation is the fact that destruction of ecosystems by rats and other invasive species has been well documented in other locations.

The story of Easter Island is definitely a cautionary tale. However, it seems now like more of a warning to not jump to hasty conclusions and assign blame to the wrong species.

Most people would agree that humans should be good stewards of the Earth and do our part to protect our resources, but to think that we would drive ourselves into extinction so wantonly seems short-sighted at best. Invasive species are arguably the pinnacle of Darwinism. A new species moves into an area and out-competes the local organisms to establish a population in a new environment. This has been occurring since the dawn of life on this planet. However, the artificial introduction of these species by humans can and has radically altered established ecosystems in the past.

## VOCABULARY

- Symbiotic relationship
- Exponential growth curve
- Flora and fauna
- Ecosystem
- Omnivorous
- Invasive species
- Darwinism

## EXTENSION QUESTIONS

- What other examples of invasive species can you think of?
- What are some of the ways that scientists have proposed to combat/control invasive species?





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# 3D PRINTING TO EXPAND IN THE CONSUMER MARKET

By Lisa Jancarik

The International Consumer Electronics Show (International CES) occurs annually in Las Vegas and showcases the latest prototypes consumers can look for in coming years. The 2015 show that concluded in January expanded the amount of space allotted to 3D printers from 7200 square feet to nearly double that amount of exhibit space. This year's 57 vendors needed that kind of elbow room. For the first time, some vendors exhibited 3D-printed food and clothing, and many more companies displayed models targeted at hobbyists and people who would put 3D printers to personal use.

Show planners had reason to expect exhibits of these devices to draw visitors: sales of 3D printers were estimated to reach \$76 million in revenue in 2014, a 43 percent increase over 2013 sales, according to the more recent *U.S. Consumer Electronics Sales and Forecast* report published by the Consumer Electronics Association (CEA).

## SMALLER AND CHEAPER

According to Karen Chupka, senior vice president of International CES and corporate business strategy, CEA, “With huge advancements in digital technology, 3D printers are moving toward more compact units that are more suitable for consumers and capable of printing a variety of consumer goods, from toys and electronics to clothing, shoes and even food.”

This year, 3D Systems designed its CES booth around the theme “the home of now.” The company's CEO, Avi Reichental, declared 2015 the year that 3D printing becomes mainstream.

Fashion featured heavily into the vendor's display, with printed jewelry, bags and shoes. Reichental sported his own custom 3D-printed watch band. The company also exhibited leisure equipment, including customized skateboards and printed ping pong paddles and balls. Some of this gear was printed using the 3D Systems' Ekocycle, a 3D printer developed in partnership with Coca-Cola, which uses PET plastic made from recycled soda bottles. This booth also featured some 3D-printed food, described below.

## CAPTURING YOUR STYLE IN 3D

Airwolf 3D earned plenty of attention at the show with the exhibit of a 3D-printed outfit. The latest printer offered by this company can work with 25 types of materials. Airwolf lists each of the materials used for the dress, shoes, necklace, headband, phone case and bag. Although plastic resins already familiar to industry insiders make up much of the construction, nylon and metals like copper fill and stainless steel fill make the complete printed fashion look possible.

Once a consumer's 3D-printed look is complete, Artec's Shapify can now capture it in a 3D-printed figure. The Shapify booth is like a photo booth that creates a plastic figure from a person's image instead of a strip of photos. When a person steps into the center of the round booth, he or she is scanned by four scanners that rotate around him or her. This part of the process takes 12 seconds. Then, the printable model is created from a plastic powder in about 15 minutes. If a customer prefers to use a different 3D printer, the scanned data can be transferred to another device. Shapify is calling these full-color, six-inch models “Shapies.” The vendor hopes to introduce these booths to public spaces where crowds naturally gather, like department stores and even airports.

## 3D SNACKTIME

This year, CES visitors to the XYZPrinting booth could sample cookies printed on the company's new Food Printer. The unit's dimensions are about the size of an espresso machine, and it features a touch screen. It also offers a USB port for users to upload their own cookie designs if none of the printer's preset choices suit them. XYZPrinting worked with a food specialist to develop its recipe for dough that the device's nozzles can print into uncooked shapes. The resulting cookies or decorations for cakes need to be baked before they can be eaten.



3D Systems' ChefJet's CocoJet

Food printing technology has another major player, 3D Systems' ChefJet's CocoJet, developed in partnership with familiar household brand, The Hershey Company. 3D Systems has some clout on the professional food circuit because it also partners with the Culinary Institute of America, which introduces prestigious chefs to food printing. ChefJet offers professional users the means to create interlocking candies, cake supports and sculptures made from sugar.

## 3D PRINTING AND CONSUMERS

3D printing has worked with design software to produce resin models of products for years. These have had exquisite detail and even moving parts. These designs would have to be manufactured from appropriate materials when the design process was complete. Small businesses could outsource this aspect of design, but consumers had almost no access to this capability. 3D printing companies are now aggressively pursuing the the consumer market.

Among the more consumer-minded units displayed this year is the Polar 3D printer. Its most striking feature is that instead of having a moving nozzle for its filaments, the nozzle stays in a fixed location and the build platform moves underneath it. This design allows a very small machine to create objects up to six inches high, quite large for its size. Size and price (around \$800) for this device make it a more reasonable desktop device for the home office.

Other 3D printers are already on the market for several hundred dollars and are even available through consumer outlets like Amazon. With smaller and less expensive models now or soon to be available in 2015, hobbyists have some access to 3D printing previously only reasonable for larger organizations.

To see some of the 3D printers in action, visit the 2015 CES website.



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# A VIRTUAL WALK AROUND MARS WITH HOLOLENS

By Merry Morris

There's no question that working on Mars is a hard gig. Just getting to work calls for a 180-day, one-way commute with no stops for Starbucks™. That is unless you will be investigating the red planet with the new Microsoft™ wearable technology, HoloLens, an augmented-reality headset and platform. Simply put, the HoloLens can project three-dimensional images into the air.

Microsoft and NASA's Jet Propulsion Laboratory have been jointly developing software that will allow researchers to move around Mars as if they were really there. Imagine being able to kick through the red Martian dust without leaving your office!

This sounds amazing and requires a bit of explanation.

## HOLOLENS TECHNOLOGY

There are three technologies working together that would make our virtual ramble on the red planet possible:

- Microsoft Holographic — an “augmented reality” platform that supports 3D imaging
- HoloLens — a wireless holographic computer headset for viewing and interacting with 3D images
- HoloStudio — an application that helps users create their own holograms



The attention-grabber, the wearable HoloLens, will have a transparent lens complete with advanced sensors, unencumbered by cords, wires, tethers or phones. The headset wearer will see a “smart” version of augmented reality set within a rectangular field hovering roughly six inches from his face. In that field, virtual images appear that remain in place so the user can approach, walk around or peer over them. A finger gesture can initiate interactions with the virtual objects, as can verbal commands.

## ONSIGHT, BUT NOT ON SITE

A new technology called OnSight, the result of the collaboration between NASA and Microsoft, will enable scientists to explore the planet surface virtually. As part of that effort, composite images of the Mars surface were used to create a 3D mesh that allowed the user to walk around the study area. OnSight superimposes visual information and real rover data onto the HoloLens's rectangular field, where holographic computing generates a realistic environment for exploration, discussion, planning or other tasks that may arise as the rover continues its mission.

## VIRTUAL OPPORTUNITIES FOR GAMING, ENGINEERING DESIGN AND MORE

The future of the HoloLens technology is not limited to the NASA application. HoloLens can scan your surroundings so you can “live” your games, e.g., Minecraft, right in your own living room. HoloStudio gives the user an assortment of virtual shapes that can be assembled into an untold number of virtual objects—think toys, for example. Those virtual toys can then be used in 3D printing. Complex engineering designs can float before you as you tinker with their details.

## VOCABULARY

- Virtual
- Holography

## EXTENSION QUESTIONS

- Review the examples of the HoloLens in action from the company's website.
- How would you use the technology to teach earth science, for example, in your classroom?

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Students who are interested in becoming geoscientists should begin taking math and physics in high school. In college, students should major in geosciences, geology or earth sciences. Other degrees, such as physics or chemistry, will allow a student to pursue higher education in a geosciences career, if they also

took some work in the geosciences. Many geoscientists choose to pursue a doctorate, so that they can conduct their own research.

Geoscience is a rock-solid career choice. The United States economy is predicted to increase its demand for geoscientists by 21 percent from 2010 to 2020, according to the Bureau of Labor Statistics. The average geoscientist earns \$82,500 per year while working for architecture firms, engineering firms, oil and gas companies and others.



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