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Otherworldly Sunsets Revealed in Planet Simulation

By Christina Phillis

A beautiful sunset is a glorious sight. From the Earth's surface, the pinks, blues, and yellows can swirl together like a celestial kaleidoscope. But not every sunset is the same — especially on different planets.

Geronimo Villanueva, a planetary scientist from NASA's Goddard Space Flight Center in Greenbelt, Maryland, created a sunset simulation to demonstrate what these colorful events might look like on other planets.

The sunset on Uranus, for example, is "a rich azure that fades into royal blue with hints of turquoise," according to the *Phys Org* article "NASA simulation shows kaleidoscope of sunsets on other worlds" by Lonnie Shekhtman.

Sunset Simulations

The Villanueva animations show the sun setting from the perspective of someone on the surface of Earth, Venus, Mars, Uranus, and Titan looking up at the sky through a super wide camera lens. A white dot represents the sun.

During sunset, a specific location on the planet rotates away from the light of the sun, causing photons to scatter in different directions based on their energy and the atmosphere. Both Earth and Mars can sometimes have hazy sunsets with a halo of light at the end, which is caused by light scattered by dust or fog. Mars sunsets go from brown to blue because its dust particles scatter the color blue.

To test these reproductions, Villanueva used known sky colors of Uranus and other worlds. When sunlight reaches Uranus, red colors are absorbed by the mixture of hydrogen, helium, and methane in its atmosphere and blue and green light scatters to create its unique sunset.

Future Exploration

This and other aspects of a computer modeling tool may one day be used for a mission to Uranus. Using light measurements to determine chemical content will help scientists better understand the planet's atmosphere.

Scientists can access these sky simulations with the Planetary Spectrum Generator, an online tool that recreates how light moves through the atmospheres of planets, exoplanets, moons, and comets and helps reveal their chemical makeups.

These detailed animations show that some space exploration can be just a click away with the right technology and a little imagination.

DISCUSSION QUESTIONS

Think of the things we currently know about space. Develop a list of additional types of space simulations that can be created to learn more about other planets.

Discuss why understanding the chemical makeup of the atmosphere of a planet would be helpful for future space exploration missions.

VOCABULARY

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Rodent Reactions to Fake Smells Offer Clues About Brain Function

By Ralph Birch

Scientists have discovered a way to implant an artificial odor into the brains of mice. Their work could provide clues about how our brains process information.

Details about the synthetic smell study will help answer fundamental questions about olfaction, according to computational biologist Saket Navlahka of Cold Spring Harbor Laboratory in New York.

The results of the study were first published earlier this year in *Science*. The findings give scientists a window into the processes used by the brain to shape signals from the outside world into perceptions and how those perceptions can guide behavior.

Making Fake Odors

To build the artificial smells, researchers used a process called optogenetics, a technique in which light prompts genetically engineered nerve cells to fire. Neuroscientist Dima Rinberg and his colleagues at New York University's Grossman School of Medicine used optogenetics to target nerve cells in the olfactory bulbs of mice.

Within the olfactory bulbs, clusters of nerve endings called glomeruli organize the signals related to the differentiation of smells that are picked up inside the nose.

Rinberg and his team activated nerve cells in six locations, each of which included between one and three glomeruli, in a specific order. This neural pattern was designed to serve as a simplified version of what a real odor might smell like to a mouse.

Rodent Reactions

The mice in the study learned to signal their recognition of the artificial smell's presence by licking one of two spouts. While the synthetic odor didn't actually exist, the researchers observed the mice behaving as if it did.

After "smelling" the synthetic odor, the mice reliably licked the correct spout. When researchers mixed up the signals using the same optogenetic approach, the mice reacted differently.

By making slight changes to the signals that generate the artificial odor, researchers could test which qualities of the cell sequence were important and which ones rendered the smell unrecognizable to the mice.

Smart Sniffing

The beginning of the sequence turned out to be the key. When researchers swapped the order of the first few spots, the mice had more trouble identifying the smell than they did when spots later in the sequence were changed. Delaying the sequence at the beginning also made more difference than delays at the end.

"If you modify the first few notes, you more easily ruin the song," Rinberg said.

Rinberg and his team want to further their research by following the synthetic smells to other parts of the brain, and then test where similar rules apply to real smells.

While the synthetic odor didn't actually exist, the researchers observed the mice behaving as if it did.

DISCUSSION QUESTIONS

Do you think scientists will be able to get similar results from the mice by using real smells rather than synthetic ones?

Could this research method be applied to learning more about how brain function relates to our other senses?

VOCABULARY

OLFACTION OPTOGENETICS

Bubbles May Offer a New Pollination Method

By Kylie Wolfe

Bees are professional pollinators. They buzz from flower to flower like it's their job, well, because it is. They play a critical role in crop production and are a vital part of our ecosystem.

But as you may have heard, populations are dwindling, so farmers are looking for new ways to replicate this important task. Some are even pollinating plants by hand.

In response, scientists from the Japan Advanced Institute of Science and Technology (JAIST) found a way to speed up this time-consuming and tedious process using pollen-containing bubbles. Their work was published in *iScience*.

Buzz-Worthy Workers

Many plants rely on bees and other insects for fertilization, transferring pollen from the anther, or male structure, to the stigma, or female structure. Doing so helps produce a variety of fruits, vegetables, and nuts.

While not all plants need insects for fertilization, many of the foods we enjoy require a little help from our friends in flight. Without their efforts, things like apples, avocados, coffee, and citrus fruits could be harder to come by.

A High-Tech Alternative

Eijiro Miyako, materials chemist at the JAIST, first attempted to replicate the pollination technique of bees with pollen-coated drones. Unfortunately, the drone propellers damaged the flowers.

To combat this, he and colleague Xi Yang, a JAIST environmental scientist, formulated a pollen-containing bubble solution. They found success with the chemical lauramidopropyl betaine, used in personal care products, combined with pollen-protecting ingredients, and a polymer to create a viable yet sturdy transport vessel.

Using this new method, the researchers released pollen-filled bubbles in the direction of three pear trees. Of the 50 pollinated blossoms on each tree, 95 percent of them formed fruit. This is comparable to the trees pollinated by hand. Not only did this approach require less effort, it required less pollen.

Pollinating by hand uses roughly 1,800 milligrams of pollen per flower. Each bubble used only 0.06 milligrams. Because both processes also rely on humans to do the pollen harvesting, these savings could be important.

Miyako is currently working to pollinate larger areas by releasing the bubbles via drone, as well as make the solution more biocompatible.

Navigating Nature

Though the results are promising, the idea isn't widely accepted as the answer to the pollination problem. Some fear the chemicals used to create the bubbles may interfere with the plants in the long term, while others are more concerned with the sustainability and overall effectiveness of the process. And some simply believe that protecting our natural pollinators should be the number one priority.

As scientists continue their quest to solve this looming issue, climate change, pesticides, and other factors threaten invaluable insects worldwide. The future of plant pollination could lie in bubble-blowing drones or it could be left to nature's professionals — if there are enough of them to do the work.

A pollen-containing bubble rests on a *Campanula* flower during lab tests.

Photo: Xi Yang, Eijiro Miyako

DISCUSSION QUESTIONS

What are the pros and cons of automating the pollination process?

What do you think is the best approach to ensure plant pollination in the future?

VOCABULARY

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Why Animals **Came Out to Play** During the Pandemic

By Kylie Wolfe

As many stayed within their own four walls to help prevent the spread of COVID-19, wild animals began exploring city streets. Coyotes were spotted in San Francisco, mountain lions in Boulder, and the list goes on.

Government guidelines and stay-at-home orders haven't necessarily caused an increase in animal populations, but they may have changed their behaviors. In reaction to quieter towns and less traffic, it's no surprise that a few species decided to see what the hubbub, or lack thereof, was all about.

Here are a few reasons you may have seen more wildlife than usual this spring:

Room to Roam

Animals are very careful and calculating creatures. They strategically avoid predators, including humans, as they search for food and shelter. This often means steering clear of populated areas during the day.

Black bears are a prime example, typically choosing to roam at night. But when the pandemic hit, more of them were spotted in broad daylight. The same is true for coyotes. They were no longer scared off by crowds but instead welcomed by empty public spaces.

Peace and Quiet

Believe it or not, animals are greatly influenced by human behavior and they adapt in response. Birds, for example, will sing at different times to avoid competing with traffic and other noisy activities.

Government guidelines and stay-at-home orders haven't necessarily caused an increase in animal populations, but they may have changed their behaviors.

Lately, there have been less noises for animals to accommodate. This lack of noise pollution may be a simple explanation for the increased presence of wildlife in residential areas. Less traffic means they're more willing to cross the street, test new territories, and chase new food sources.

Nature's Normalcies

While some animals decided to expand their explorations, others were taking care of timely business. In the Northern Hemisphere, March, April, and May are considered migration months for a variety of birds. And those that don't migrate will mate, attracting partners with song.

This explains why people may have heard more birds chirping, but what about snakes? Springtime is their time to come out of hibernation. They're looking to eat up, warm up, and partner up. While quarantine is a possible explanation for increased animal sightings, it's certainly not the only reason.

Undivided Attention

As people remained home, peering out windows or taking walks in the woods, it's likely they became more observant than usual. Spending time in nature, looking for distractions, and being at home instead of work or school created new opportunities to spot wildlife.

It's easy to imagine these animals stepping outside their comfort zone, changing their behaviors in response to ours, but maybe the explanation is simpler than that.

Coexisting Creatures

Species that live in close proximity to humans are likely to change their way of life and adapt when needed. They're considered behaviorally flexible, hunting and foraging when we're not around, whatever that may mean.

Animals that come out to play during the day are attracting attention, so, at the very least, maybe society will gain an appreciation for their presence. And now we know what animals do when they think we're not looking.

DISCUSSION QUESTIONS

Have you noticed more wildlife lately? If so, why might that be?

How do human behaviors influence animal behaviors?

What other reasons could explain an increased wildlife presence?

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Everyday Supply Chains

By Iva Fedorka

A **supply chain** is the system of companies, people, activities, information, and other resources that one uses to procure a product or service.

Common Supply Chains

A typical supply chain starts with the ecological, biological, and political regulation of natural resources. The next step is the extraction of raw materials and their delivery to a processing or manufacturing site. Components or products are then processed, constructed, or assembled. Used products or components may also enter the supply chain as recyclables. Finished products are packaged, moved to storage, and ultimately delivered to the consumer.

Types of Collaborations

In some cases, these exchanges occur between different companies that have little or no knowledge or interest in other parts of the supply chain, a situation that has been called "extended enterprise." Other types of collaboration are called "vertical" and "horizontal."

In vertical collaboration, two or more organizations from different levels or stages in the supply chain share responsibilities, resources, and information to support mutual customers. Horizontal collaboration is a relationship between two or more companies at the same level that cooperate to achieve a common objective.

Some companies and global brands integrate codes of conduct and guidelines into their supply chains, with specific standards and requirements for their suppliers. Others offer limited or no visibility into their supply chains, called mystification, and share little information about the origin of materials or processing and can hide irresponsible practices.

A Supply Chain Example

An everyday example of a supply chain would be your home vegetable and fruit garden.

- Verify that there are no gardening restrictions where you live (from the local government, homeowners' association, or other organization)
- Acquire or locate the site for your garden
- Find a lab to test a sample of your soil, then source and buy any supplements or treatments that will help to make it more arable
- Make a plan for what you'll grow and purchase seeds or seedlings from a seed catalog, a local farmer, or a retail store
- Locate a source and purchase the implements that you will need to weed, water, maintain, and harvest your garden
- As the fruit matures, collect, clean, and store them in the sourced containers; alternately, hire someone to help identify or hire transportation to move your harvested crops to friends, farmers' markets or other retail venues

Supply Chain Management

Supply chain management is an important aspect of modern business and includes tasks for finding or "sourcing" products. We have come to depend on retail outlets like grocery stores and other "big box" and online locations for nearly all of our purchasing needs. Imagine if we ourselves had to source all the products that we need or use — that would be really difficult! The supply chain also includes delivery of products to the customer.

Bachelor's and master's programs or certificates in supply chain management and logistics are now available at many colleges and universities.

DISCUSSION QUESTIONS

How did the COVID-19 pandemic disrupt supply chains?

Track the supply chain for an item of cotton clothing, from fiber to you.

VOCABULARY

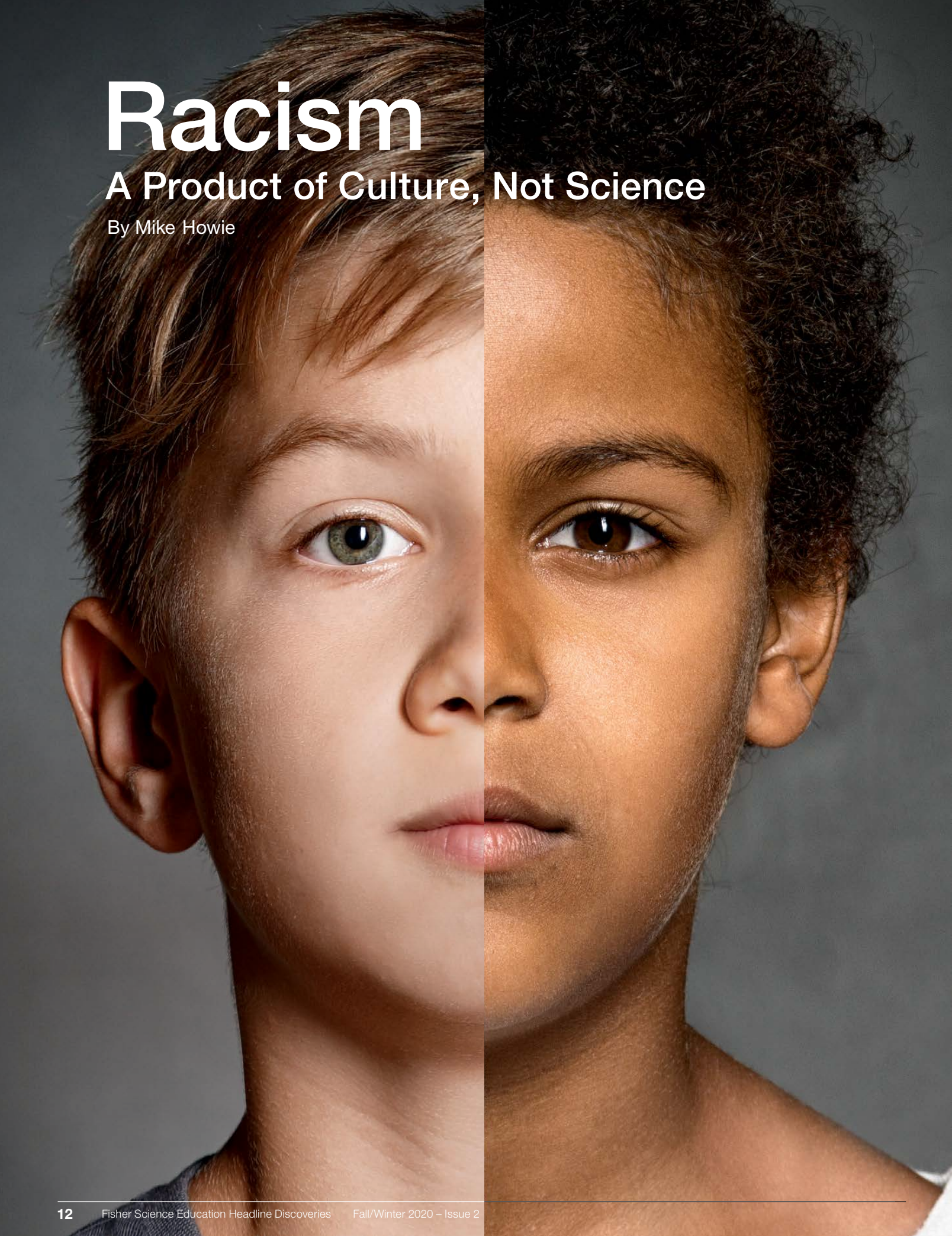
COLLABORATION HORIZONTAL

LOGISTICS VERTICAL

Racism

A Product of Culture, Not Science

By Mike Howie



Racism has been present throughout human history, causing pain and hardship for countless people. Lately, social justice movements like Black Lives Matter have surged in response to violence perpetrated against Black people and the mistreatment of all people of color. Protests calling for an end to such violence — and the institutionalized and systemic racism that enables it — have swept not only the United States but the world.

Science stands on the side of these protesters — biology and genetics show that all humans, regardless of skin tone, are just that: human.[1] It is especially important, then, to examine how some have manipulated science, regrettably, to try to legitimize racism.

One Human Race

Since the early days of science, people have attempted to scientifically justify racist beliefs. One such person was Carl Linnaeus, who invented the genus and species system of biological taxonomy we use today.

In his twelfth edition of *Systema Naturae*[2], published in 1767, Linnaeus labeled five "varieties" of human species: *Americanus*, *Europeanus*, *Asiaticus*, *Afer* or *Africanus*, and the mythological *Monstrosus*. He assigned defining traits to each of these, some based on physical appearance — in his words, "red," "white," "yellow," and "black" — and others based on his perception of culture and way of life. To *Europeanus*, the group he personally identified with, he assigned flattering traits: "gentle, acute, inventive; covered with close vestments; and governed by laws." To the other groups, with which he did not identify, he assigned decidedly less flattering traits. *Africanus*, Linnaeus asserted, were "crafty, sly, lazy, cunning, lustful, careless" and "governed by caprice." *Asiaticus* he described as "severe, haughty, greedy; covered with loose clothing; and ruled by opinions." And *Americanus* he described as "stubborn, zealous, free; painting himself with red lines."

None of these traits, positive or negative, has anything to do with the biology of human variation — they are not inherent in any of us. Linnaeus was neither the first nor the last to assert a "scientific" basis for such racist views, and hundreds of years of influence has unfortunately cemented ideas like these in the minds of many.

While skin color may be one of the easiest differences to spot among our fellow humans, it does not accurately reflect the genetics at play within us — far from it. Skin color evolved over generations, influenced by everything from the amount of sunlight where we live to the availability of food and the spread of disease.[1] In fact, shared skin color isn't necessarily a sign of genetic similarity.

Even direct descent does not guarantee genetic similarity. Because sperm and eggs carry only half of a person's DNA, some genetic information is lost every generation. After 11 generations, only half the DNA remains. That means we're genetically unrelated to our ancestors from as little as 300 years ago.[1] But if you look at the whole forest of human family trees, you'll see that we are all deeply intertwined — more genetically similar than we are different.

All human life can be traced back to Africa. Fossils indicate that modern human features began to show up on the continent about 300,000 years ago. Those early humans spread out over the African continent until a few thousand migrated about 60,000 years ago — these are the ancestors of all modern non-Africans. In the time since, humans have meandered all over the world, settling in different areas and evolving along the way. Those thousands of years of evolution created the brilliant human diversity we now know, but the greatest diversity arose between humans who stayed in Africa. Today, there's more genetic diversity in Africa than in the rest of the world combined.[3]

Race, as we think of it today, is not a scientific classification. It has no basis in the genetics or biology that guide human variation. Rather, it is a cultural classification that was created and can be altered by individuals' subjective perceptions of the world.[1]

The Effects of Racism

Racism can take many forms. It can be as overt as excluding or harassing people because of the color of their skin or as subtle as making assumptions about a person's interests. It can be unconscious, misleading us to assign unflattering traits to people of color without even thinking about it. Even when racist beliefs seem, on the surface, to be flattering — like assumptions about higher intelligence levels or enhanced athletic abilities — they are still ultimately harmful.

The effects of racism can take even more forms. In the United States, police target Black people more frequently and with greater force.[4] In Australia, a 2007 study conducted by the Australian Human Rights Commission suggested that people from Aboriginal and other ethnic groups avoided organized sports for fear of racial vilification.[5] In Europe, asylum seekers from the Middle East and Africa are regularly met with racism, turned away, or, in Britain, indefinitely detained.[6] Around the world, people have lashed out at those of Asiatic heritage in response to COVID-19.[7] Point to any spot on the globe, and there you will likely find racism.

Racism can also lead to a variety of health issues. In a 2019 *Perspectives on Psychological Science* article[8], researchers Antoinette M. Landor and Shardé McNeil Smith posited that racially motivated assaults may result in traumatic stress reactions, low self-esteem, hypertension, and other detrimental effects. Similarly, a 2016 study by psychological scientist Jordan Leitner published in *Psychological Science*[9] found that Black residents in communities with high levels of overt racism are more likely to die from heart disease and other circulatory diseases.

Add to these outcomes the institutionalized racism and bias widely found in hiring practices, housing, healthcare, education, restaurants, publishing, entertainment, and more and you see that racism negatively affects every aspect of life for people of color.

The truth is that we are all one people. Regardless of color or nationality or way of life, we are all one human race. And that is a scientific fact.

DISCUSSION QUESTIONS

What is the difference between conscious and unconscious bias?

The process of evolution promotes traits that are beneficial to survival. In what ways could different skin tones have been beneficial?

How can you combat racism in your school or daily life? What changes will you personally make?

Research Carl Linnaeus's taxonomy strategy. In what ways was it flawed regarding humans?

VOCABULARY

DNA GENETICS

INSTITUTIONALIZE RACISM

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Jenga Helps Build Understanding of Lithium-Ion Batteries

By Moira Bell

Jenga, a well-known game, is being used to teach students about a relatively new technology. It's not only a game that keeps you on the edge of your seat, it's also an effective tool for explaining the mechanisms of lithium-ion (Li-ion) batteries, according to a team from the University of Birmingham School of Chemistry.

> The layers of Jenga blocks demonstrate how the battery components interact with each other.

If you've never played Jenga, the rules are simple. You build a tower of wooden blocks and the players take turns removing one block at a time and placing it atop the tower without knocking it down. These actions are not dissimilar from charging a battery, says the team.

Battery Building Blocks

To understand the similarities, you must first know the structure of an Li-ion battery, which consists of layers of oxide and graphite electrodes separated by an electrolyte. At full charge, the lithium ions move via the electrolyte from the graphite to the oxide electrode. The electrode material is layered onto current collectors, which help to convert the electrons to power.

The layers of Jenga™ blocks demonstrate how the battery components interact with each other. By removing blocks and placing them on top of the tower, students can recreate the action of lithium ions moving from the oxide electrode to the graphite electrode, as when the battery is charging. Reversing these actions represents battery discharge.

Besides demonstrating complex chemistry and redox reactions, the game can also show the effects of the rate of charge for varying applications. As students move the Jenga blocks at faster rates, it will cause the structure to fall. Additionally, blocks become displaced as they are removed and reinserted, which helps explain changes to battery performance over time.

A Fully Charged Approach

The Jenga block sets have been tested by multiple visiting schools and at public events, and students and teachers both give it a "thumbs up."

Next, the team plans to make this learning activity more widely available for students and provide subject support for teachers. The team's paper in the *Journal of Chemical Education* includes instructions for producing your own sets.

Who said learning about chemistry can't be fun?

DISCUSSION QUESTIONS

Think of other games that would be helpful in explaining scientific concepts. Which ones would you pick and how would it work?

Why would it be useful to see a visual demonstration of how lithium-ion batteries work? Which part of the process would it help illustrate?

VOCABULARY

LITHIUM-ION BATTERY OXIDE
GRAPHITE ELECTRODE
ELECTROLYTE

Shaking Up the Classic Oobleck Trick

By Kevin Ritchart

An update to the classic **oobleck** science experiment could give runners a sinking feeling.

The mixture of cornstarch and water, known as oobleck, solidifies when subjected to a forceful impact. This means oobleck, which gets its name from a sticky green substance in the 1949 Dr. Seuss book *Bartholomew and the Oobleck*, has the ability to hold up the weight of a person when they run across it.

But a new technique published earlier this year in an issue of *Science Advances* could cause runners to sink rather than make their way across a container filled with oobleck.

Thick and Thin

Oobleck is a non-Newtonian fluid, meaning that its viscosity changes depending upon the forces exerted on it. Other non-Newtonian fluids include ketchup and frog saliva, both of which get thinner when force is applied. This is the opposite of what happens when force is applied to oobleck, which becomes a solid.

Laboratory experiments showed that a cylinder dropped onto the surface of oobleck sank more quickly when the container holding the mixture was rapidly rotated back and forth.

Under normal conditions, the impact of the cylinder hitting the surface would cause the particles of cornstarch to collide with each other and bind into a solid. But by oscillating the container, the particles are moving back and forth at such a rate where they are no longer in contact with each other.

Someone attempting to run across the oobleck while it's in motion would find their foot in the same situation as the cylinder in the lab experiments — sinking through the oobleck to the bottom of the container.

Real-World Applications

Researchers think this approach could be useful in other applications that employ non-Newtonian liquids or other things that possess similar properties. For example, this approach might be useful in industrial settings to keep cement from clogging as it runs through tubes.

But before they can expand the potential uses, researchers need to scale up the oobleck experiment and try to sink some runners.

DISCUSSION QUESTIONS

Aside from cement, can you think of any other substances or industrial processes that would benefit from the advancement of this research?

Besides the ones mentioned in the article, do you know of any other non-Newtonian fluids?

VOCABULARY

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Hummingbirds May Possess a **Sensory Superpower**

By Mae Pyer

What would it be like to see the world through a hummingbird's eyes? More colorful than you can even imagine.

Known for the way they rapidly flutter their wings and hover in mid-air, hummingbirds have another unique feature: next-level color vision. It helps them navigate, find food, impress mates, and evade predators.

To better understand what colors hummingbirds can detect, researchers recorded roughly 6,000 feeder visits over 19 experiments. Their results were published in the *Proceedings of the National Academy of Sciences*.

A Charm of Color

"Humans are color-blind compared to birds and many other animals," said Mary Caswell Stoddard in an article published by *ScienceDaily*. Stoddard is an assistant professor in the Princeton University Department of Ecology and Evolutionary Biology.

The colors we see are rooted in the retina, specifically in three color cones sensitive to red, green, and blue light. This is known as trichromacy and allows us to see the colors of the rainbow. Red, orange, yellow, green, blue, indigo, and violet are all within our visible range, but so is the color purple. Purple is known as a pure nonspectral color and stimulates red and blue color cones.

Hummingbirds are assumed to have a fourth color cone sensitive to ultraviolet light. This is known as tetrachromacy and allows them to see a wider range of colors, including nonspectral colors such as purple, ultraviolet+red, ultraviolet+green, ultraviolet+yellow, and ultraviolet+purple.

Avian Adventures

To determine if hummingbirds do, in fact, see nonspectral colors, Stoddard and her team set up several bird feeders near the Rocky Mountain Biological Laboratory in Colorado. They performed outdoor experiments over three consecutive summers to understand how hummingbirds use their color vision in real life. Observing them in their natural habitat was important to the study, establishing ecological validity.

Each feeder was equipped with LED tubes that could project two different color types, spectral or nonspectral, and a saucer with either sugar water or plain water. To prevent the hummingbirds from associating a particular location with a reward, researchers swapped the color tubes between trials. They also performed control experiments to help ensure they weren't using their sense of smell to find the reward.

Over time, the hummingbirds learned to choose the feeder where the sugary water was present, regardless of color type. Because of this, researchers were able to conclude that hummingbirds discern spectral from nonspectral colors, proven by their ability to choose between the two. For example, ultraviolet+green looks different than green to a hummingbird.

A Sensory Superpower

While scientists can only speculate about the way animals perceive color, they're able to conclude that hummingbirds see things we cannot. Even though visual perception is hard to study, it's thought that other animals may experience a similar superpower.

Stoddard and her team believe their results could apply to other birds, as well as fish, reptiles, and invertebrates. They realize they're only scratching the surface of understanding nature's visual capabilities and it seems there's still much to learn.

DISCUSSION QUESTIONS

What's the difference between spectral and nonspectral colors?

How does it benefit hummingbirds to have an extended range of visible colors?

VOCABULARY

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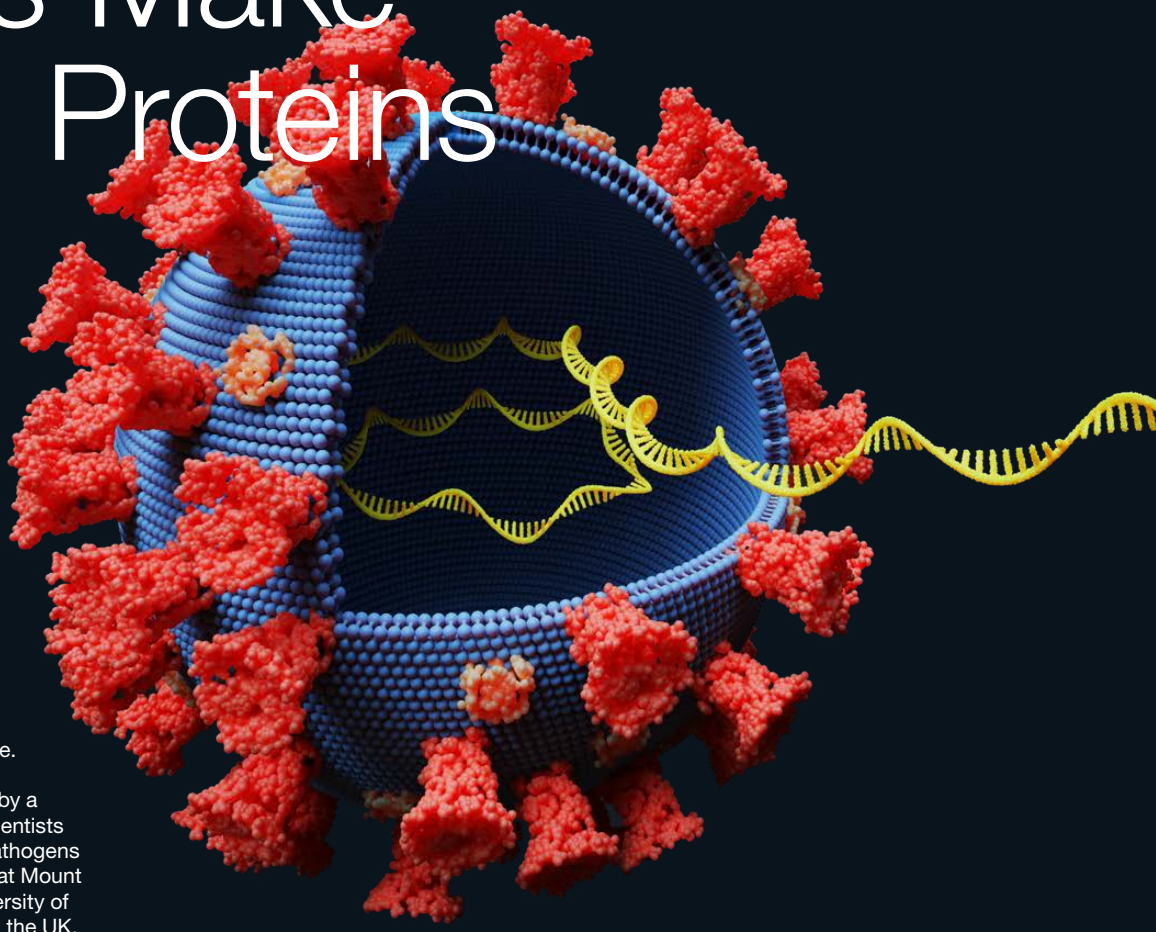
Gene Theft: Viruses Make Hybrid Proteins

By Dora Fatula



Researchers have found that some viruses commit theft by capturing genetic signals from their hosts and adding them to their own genetic code.

This finding was first reported in *Cell* by a cross-disciplinary collaboration of scientists at the Global Health and Emerging Pathogens Institute at Icahn School of Medicine at Mount Sinai in New York and the MRC-University of Glasgow Centre for Virus Research in the UK.

What Are sNSVs?

The teams of virologists examined a large group of segmented negative-strand RNA viruses (sNSVs) that are known to cause serious diseases in humans, domesticated animals, and plants, including influenza, Hanta, and Lassa viruses.

Viruses do not form their own proteins; they give instructions to the hosts' cell machinery to make proteins. In a process called "cap-snatching," the virus cuts the end from a piece of the cell's own messenger RNA (mRNA) and adds to it one of the viral genes to produce a hybrid message.

How Viruses Work

The hybrid mRNA lets the sNSVs send messages with extra, host-derived start codons, a process called "start snatching." By "stealing" genetic signals from their hosts, new proteins, the researchers call "UFO" (Upstream Frankenstein Open reading frame), are encoded from the combination of host and viral sequences. These hybrid gene products are visible to the immune system and may affect virulence.

"To understand how a pathogen antagonizes the host and establishes infection, we need to have a clear understanding of what proteins a pathogen encodes, how they function, and the manner in which they contribute to virulence," said Ivan Marazzi, PhD, Associate Professor of Microbiology at Icahn School of Medicine and corresponding author on the study.

The Roles of Unexpected Genes

"For decades we thought that by the time the body encounters the signal to start translating that message into protein (a 'start codon') it is reading a message provided to it solely by the virus. Our work shows that the host sequence is not silent," said Dr. Marazzi.

These UFO proteins may change the course of an infection and could also be useful for creating vaccines. Further studies are needed to understand these new proteins and the implications of their pervasive expression by RNA viruses that can cause epidemics and pandemics.

"This work implies that a huge number of viral species can make previously unsuspected genes," according to Ed Hutchinson, PhD, corresponding author and a research fellow at MRC-University of Glasgow Centre for Virus Research.

The next part of their work is to understand the distinct roles the unexpected genes play. "Now we know they exist, we can study them and use the knowledge to help disease eradication," said Dr. Marazzi. "A large global effort is required to stop viral epidemics and pandemics, and these new insights may lead to identifying novel ways to stop infection."

COMPREHENSION QUESTIONS

Are viruses alive?

How do viruses reproduce?

How do viruses cause illness?

VOCABULARY

PANDEMIC INFECTION

CODON

New Rubber Polymer Provides **Flexible Alternative** for Manufacturing

By Rita Waimer

Move over, bricks. Construction materials of the future could be made from recycled plastic.

Australian scientists have discovered a new type of rubber polymer that has potential for use in a variety of products. The scientists used sulfur and canola oil to create the new polymer, which takes the form of a powder.

This powdered rubber can be compressed, heated, and mixed with fillers to create new, more sustainable materials that could replace cement. It can also be used to make tubing, rubber coatings, bumpers, and possibly other products.

An Alternative to Cement

Cement has been used as a building material for thousands of years. Today, we use it to create everything from buildings to highways and bridges. But it's a finite resource, and producing cement releases carbon dioxide pollution and uses large amounts of fresh water.

Experts have estimated that producing concrete, which uses cement as a key ingredient, contributes more than eight percent of global greenhouse gas emissions. Furthermore, it accounts for an estimated 20 percent of global industrial water consumption.

The new material, however, is designed to be used and reused. To make the proposed building materials, the rubber polymer would be mixed with waste plant fibers, sand, or recycled PVC — which itself is difficult to recycle.

According to Nic Lundquist of Flinders University, lead author of the study, the rubber particles could first be used to purify water before being used to make a variety of rubber products. And after use, the rubber can be repeatedly ground up and recycled. In this way the new material is more recyclable, and therefore more sustainable, than traditional rubber. It also has other potential applications, making it ideal for use in a circular economy.

A New Manufacturing and Recycling Technique

This new method of recycling materials and manufacturing new ones is called reactive compression molding. It applies to rubber that can be compressed and stretched but doesn't melt.

In the first step of the process, the scientists used mechanical compression to bring the reactive interfaces of sulfur polymers into contact. They then heated the material to about 100° Celsius, or about 212° Fahrenheit, which causes chemical binding to occur. The sulfur used in the process plays a key role: it provides a unique chemical structure that allows multiple pieces of the rubber to bond together.

This new process and material could change the way we think about manufacturing a variety of products. Whether it's used to create construction materials for the jobsite or everyday products for use around the house, it provides new opportunities to make our world more sustainable.

DISCUSSION QUESTIONS

What other commonly used products or materials are hard to recycle?

Could this new material be used in other applications? Which ones?

VOCABULARY

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Fish Poop Study Aims to Control Starfish That Destroy Coral Reefs

By Sadie Laurie

Until recently, many biologists believed there were few coral reef inhabitants that could make a meal out of crown-of-thorns (COT) starfish (*Acanthaster planci*) because of their sharp spiny limbs and toxic venom. But new research on fish poop and gut contents has uncovered that it's already on the menu for at least 18 coral reef fish species.

Australian Institute of Marine Science Biologist Frederieke Kroon, PhD, led the study that was published in *Scientific Reports*. She collaborated on the work with researchers from the Australian Institute of Marine Science (AIMS), the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Land and Water, and the Great Barrier Reef Marine Park Authority.

"Our results strongly indicate that direct fish predation on crown-of-thorns may well be more common than is currently appreciated," Kroon said.

Destructive Dinner Habits

These findings are important because they could help biologists protect delicate coral reefs from destruction from COT feeding habits. Native to the Australian Great Barrier Reef, these gigantic starfish that can span 2.5 feet in diameter and wield 14 to 21 weaponlike arms can devour 20 to 32 feet of living coral a year, according to *The Washington Post* article "Scientists tackle starfish plagues on endangered Great Barrier Reef" by Allison Hirschlag.

A COT eats coral polyps by climbing onto a coral colony and ejecting its stomach out through its mouth, spreading it over the coral. Digestive stomach enzymes liquify and absorb the polyp tissue and leave only a calcified skeleton behind. Because of this devastating behavior, this species poses the second-biggest threat to reef life after tropical cyclones.

COT population surges that have occurred three times since 1962 have caused extensive damage to reefs that are already being impacted by climate change. But if natural predators of the starfish can help keep populations from growing, biologists can take steps to safeguard these species that serve as natural protection for the reef.

Starfish for Supper

Before the study, scientists knew of only one definite natural predator of COT — a mollusk called the Giant Triton (*Charonia tritonis*). The team's research confirmed that others include Spangled Emperor (*Lethrinus nebulosus*), Redthroat Emperor (*Lethrinus miniatus*), and Blackspotted Puffer (*Arothron nigropunctatus*). They also found nine other species that had not been previously known to feed on

This species poses the second-biggest threat to reef life after tropical cyclones.

COT, including Neon Damsel (*Pomacentrus coelistis*), Redspot Emperor (*Lethrinus lentjan*), and the Blackspot Snapper (*Lutjanus fulviflama*).

The group identified these species by applying a genetic marker unique for COT to samples of fish poop and gut contents to detect the presence of starfish DNA. They used the method on samples from 678 fish from 101 species gathered from reefs that experienced starfish outbreaks, according to an AIMS news release.

Harmonious Coexistence

Their results shed light on the natural environmental checks that are in place to keep the coral reef ecosystem balanced as long as they are not upset by external forces. Darren Cameron, co-author of the study and director of the COTS Control Program at the Great Barrier Reef Marine Park Authority, cautions that care should be taken to monitor fishing in these areas.

"A number of the fish species shown to feed on these starfish are caught by commercial and recreational fisheries," he noted, "highlighting the importance of marine park zoning and effective fisheries management in controlling crown-of-thorns starfish across the Great Barrier Reef."

DISCUSSION QUESTIONS

Name some other things that are harmful to coral reefs.

How can overfishing affect the environment?

VOCABULARY

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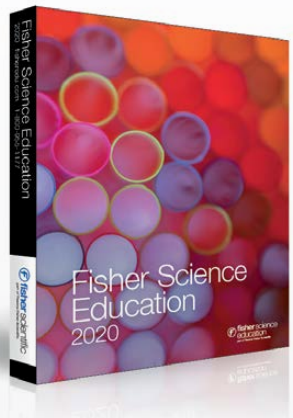

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