

CATAPULTA

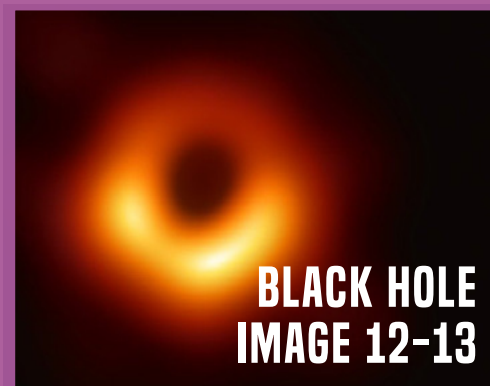
SPRING 2019

NATURE'S
WONDERS

HEALTH
NEW
DISCOVERIES



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EDITORS' NOTE

BEING THE SENIORS AFFLICTED WITH CHRONIC SENIORITIS THAT WE ARE, WE SINCERELY HOPE THIS IS PUBLISHED IN THE SPRING AND NOT AFTER WE'VE STARTED COLLEGE. SHOUT OUT TO THE CATAPULTA OFFICERS, WE REALLY HOPE THEY KNOW WHAT THEY'RE DOING, BECAUSE WE CERTAINLY DON'T.

ANYWAY, MUCH HAS HAPPENED IN THE STEM WORLD SINCE THE WINTER, AND APPROPRIATELY, THIS IS NOT ONLY OUR LAST ISSUE OF THE YEAR BUT OUR LONGEST ONE AS WELL. THANK YOU TO EVERYONE WHO READS AND CONTRIBUTES TO CATAPULTA, AND WE HOPE THAT YOU CONTINUE TO DO SO FOR MANY YEARS TO COME! UWU

- ASHLEY CHOU & JERRY HAN
EDITORS IN CHIEF

THANK YOU TO OUR PATREON SUPPORTERS!

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CBD HEALTH BENEFITS

FACT OR FRAUD?

Cannabidiol, commonly abbreviated as CBD, is a natural compound found in the flower of the cannabis plant. There are two major species of the plant that are cultivated: hemp and marijuana. While CBD is closely related to tetrahydrocannabinol (THC), it is non-addictive and does not have the same psychoactive effect. The most significant difference between hemp and marijuana is the amount of THC, with marijuana plants having a significantly greater amount of THC than hemp. As of recent, the market has exploded with CBD-containing products ranging from makeup to food. Analysts predict that the CBD market in the United States will skyrocket from 512 million dollars in 2018 to almost twenty billion dollars by 2022. Many people looking for a natural alternative to pharmaceutical drugs with severe side effects turn to cannabis. CBD is often sold as a natural remedy for a wide assortment of health issues from acne to Alzheimer's to even cancer.

Contrary to popular belief, however, there is not enough scientific evidence to back up any of those health claims except

for one: treating childhood epilepsy. In June 2018, the US Food and Drug Administration (FDA) approved the CBD medication Epidiolex to treat two rare and extremely severe forms of childhood epilepsy, Lennox-Gastaut Syndrome and Dravet Syndrome, which generally do not respond to anti-seizure medication. Neurologist Elizabeth Thiele of the Massachusetts General Hospital in Boston found in a fourteen week clinical trial that patients taking the drug saw a median drop of about 44 percent in monthly seizure frequency.

UNTIL THE GOVERNMENT TAKES FURTHER ACTION, CBD'S EFFECTIVENESS, SAFETY, AND LEGAL STATUS REMAIN AMBIGUOUS

Interestingly, CBD does not latch onto the same chemical receptor as THC. Instead scientists think that it attaches to two different targets: Transient Receptor Potential Vanilloid 1 (TRPV1), which is known to play a role in pain sensation, and G Protein-Coupled Receptor 55 (GPR55), which may change the activity level of nerve cells in the brain, possibly leading to the reduced seizures in Thiele's trial. Data from 92 out of 171 of Thiele's patients, however, indicated that the benefits of CBD began to dwindle after seven months on Epidiolex.

The critical question is whether CBD is safe



School of Medicine found that around one in five CBD products contained the pot chemical THC. Although experiments have had mixed results, THC has been associated with permanent functional impairment of cognitive abilities, worsening of seizures, and increased anxiety.

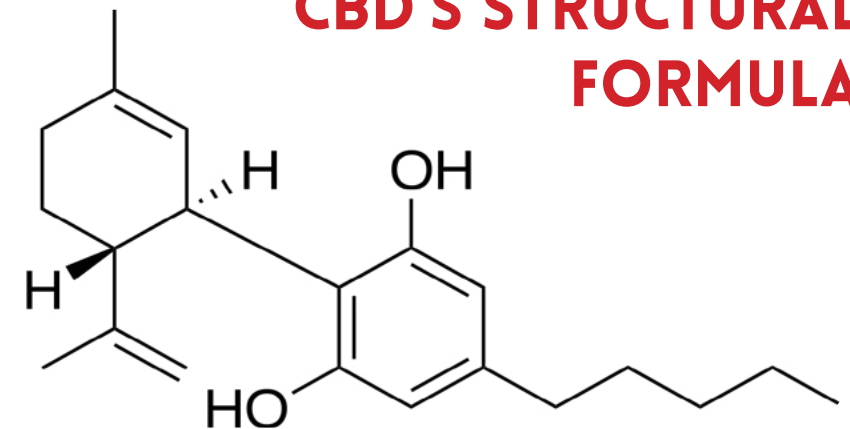
An unregulated CBD product could potentially contain something even worse. From 2017 to 2018, 52 people got sick in Utah with symptoms such as hallucinations and seizures after taking a product labeled "Yolo CBD Oil" that held a synthetic cannabinoid which poisoned them. Although the product contained no CBD, lack of regulation allows it to be sold as a CBD product.

In most parts of the US, CBD is easily obtainable. All fifty states have legalized CBD with different levels of regulation, but the federal government's stance on CBD remains unclear. Technically, CBD is regarded to be in the same class as marijuana, but the law is not usually imposed upon it. The government's position will come down to whether CBD is derived from hemp or marijuana to determine its legality.

Until the government takes further action, CBD's effectiveness, safety, and legal status remain ambiguous.

or not. Because the precise legal status of CBD is in flux, the FDA does not currently regulate the safety or purity of dietary CBD supplements. This means that no one can know for certain what those supplements contain. States are beginning to put regulations in place, but they do not have the financial capability of the federal government. A 2017 study led by Marcel Bonn-Miller of the University of Pennsylvania

CBD'S STRUCTURAL FORMULA





TUMBLING TERRORS

Frogs are known for their incredible jumping ability—the farthest recorded frog jump was over thirty feet! On the other hand, toads can only hop short distances, which means they cannot escape danger as easily as frogs can. To combat this, toads have developed some impressive defense mechanisms. In order to deter predators, they can secrete a foul-tasting toxin, puff themselves up to appear more intimidating, or play dead.

Perhaps the most amazing adaptation can be found in the *Oreophrynella nigra*, better known as the pebble toad. Native to Venezuela, these toads do not grow very large: adults generally peak at one inch in length. Since they live in rough mountainous terrain, hiding is not always an option. At the first sign of danger, pebble toads will tuck in their limbs as close to their

body as possible. Gravity takes care of the rest, and the toads can tumble away down the mountain at impressive speeds.

Interestingly enough, an animal in an entirely different environment has also adapted the same streamlining strategy. To get away from predators, the wheel spider draws in its legs. Since it lives in the desert, however, its speed comes not only from gravity, but also from desert gusts. They regularly reach speeds of one meter per second. The wheel spider is also one of the species of spiders that do not build webs. They instead dig burrows in the sand, moving up to eighty thousand times their body weight in the process. Thankfully, these tumbling terrors only grow up to twenty millimeters, or about 0.8 inches. Moreover, these spiders are native to South Africa, so arachnophobes can rest easy.

Parents often tell you to refrain from eating paint, but the discovery of blue paint in a medieval woman's teeth has actually changed the way females from the Middle Ages are viewed.

Anita Radini, an archaeologist at the University of York, discovered these brilliant particles while dissolving dental plaque in a weak acid. Dental plaque is a film that coats your teeth and is made up of the natural bacteria in your mouth mixed with food byproducts, which later hardens into tartar if it is not removed. Dr. Radini's work primarily focuses on studying fossilized plaque and the traces of food that are found within it in order to determine the diet of that time period. Occasionally, she finds things like fibers from textiles or pollen, which help scientists figure out what the daily lives

of these individuals would have been like.

In the case of B78, a German nun whose skeleton dates back to around 997 to 1162 A.D., Dr. Radini found particles unlike any she had seen before. After consulting with physicists from the University of York, they concluded that the particles were ultramarine, a blue substance derived from lapis lazuli. This particular pigment was once worth its weight in gold, as it could only be sourced from a specific part of Afghanistan. It was often used to produce books and manuscripts.



Researchers believe that the pigment most likely ended up on her teeth from the process of shaping a paintbrush with her mouth. The fact that there were layers of pigment found throughout her plaque implies that she had painted quite a lot of books. This discovery was deemed as important because it proved that some women were considered skilled enough to use such a valuable material. Ordinarily, only monks were entrusted with ultramarine, so the possibility of skilled female artists begs the question of whether women were able to pursue other high-level positions in jobs.

MEDIEVAL BLUETOOTH?

MAGICAL MUTUALISM

Symbiosis is a term referring to the interaction between two different organisms, and mutualism is the type of symbiosis in which both organisms benefit. Familiar examples include clownfish and sea anemones, humans and digestive bacteria, and species of cleaner shrimp and most aquatic animals. The Earth, however, boasts some rather unbelievable instances of mutualism that frequently go unnoticed. Some of these unexpected pairings may leave you shaking your head in disbelief.

URCHIN CRAB AND SEA URCHIN

As the name suggests, the urchin crab has a two-way relationship with sea urchins. Even with their tough shells and dangerous claws, crabs are still unable to guard against all predators. Urchin crabs have been observed picking up sea urchins and carrying them above their heads for defense. In return, the normally stationary sea urchins get a free ride to new feeding grounds.



COYOTE AND BADGER

At first glance, the coyote and badger seem like an incredibly unlikely pairing. But consider this: coyotes hunt on grassland simply by chasing down their prey as fast as possible. Potential meals like prairie dogs can get away by simply diving into their burrows. Badgers wait underground for prey that's fleeing from coyotes. Although both animals enjoy generally solitary lives, this hunting combination is just too good to pass up.



COLOMBIAN LESSERBLACK TARANTULA AND DOTTED HUMMING FROG

In most situations, a tarantula would not hesitate to devour any frog unwise enough to come within its reach. Nevertheless, this tarantula actually tolerates dotted humming frogs to the point of sharing a home. Tarantulas have even been observed picking frogs up, then releasing them unharmed. The frog defends the nest and any spider eggs from flying pests with its impressive tongue. In return, the frog gets a nice cozy home and protection from the tarantula.



ANTS AND APHIDS

Aphids, or ant cows, are treated by ants exactly as their name suggests. Ants protect the aphids and their eggs, and even relocate them if needed. This is because aphids produce honeydew, a sugary liquid, when they feed, which under normal conditions, simply falls to the ground. Ants, however, love this honeydew and collect it from the aphids, similar to how humans allow cows to graze in return for milk.



A MATCH



MADE IN THE LAB

In February 2019, a group of scientists led by Steven Benner created four new nitrogenous base pairs, which revolutionize our understanding of DNA across a wide variety of fields. This was more than one hundred years after Albrecht Kossel discovered the four natural DNA nitrogenous bases: adenine, thymine, guanine, and cytosine.

Made up of a sugar-phosphate backbone and nitrogenous bases, DNA serves as the principal genetic code for life. Not only is it used as a template for cell division and differentiation, it is also used for the synthesis of important proteins that help sustain our bodies. One hundred years after its discovery, scientists have used this genetic code to assess risks for certain diseases, including certain forms of cancer,

and to develop synthetic molecules used to alleviate those illnesses.

For years, scientists have questioned whether the four bases that make up the DNA language were the only existing bases that are capable of encoding the building blocks of life. Many have sought to create synthetic base pairs, in-

HACHIMOJI DNA FROM THE JAPANESE FOR “EIGHT LETTER”

cluding an effort in 1989, which was also led by Benner. These efforts have largely failed because the synthesis of new base pairs would lead to a modification of the bonding patterns between the pairs, which are oftentimes unstable.

The new base pairs, popularly known as hachimoji DNA

from the Japanese for “eight letter” (the total number of base pairs known after the discovery), are the first to have fulfilled all the parameters of DNA: a double helix structure, nucleotide stability, and the ability to transcribe. The scientists demonstrated this by performing X-ray crystallography in order to show that the nucleotides maintained a double helix structure. Highly-stable hydrogen bonding, found in both natural and hachimoji DNA, achieved the stability

requirement. Finally, the ability to transcribe was demonstrated when the team modified T7 polymerase, which is a major component in DNA replication, to adapt to the synthetic alphabet, which is made up of complementary base pairs P and Z as well as B and S. The newly modified T7 polymerase

transcribed hachimoji DNA into hachimoji RNA, which reacted to produce a green fluorophore.

The discovery of these new synthetic nucleotides gives rise to wide-reaching implications. In the field of biology and cancer research, Benner and his team have found that the synthetic pairs P and Z are more effective at binding to cancer cells than any of the four standard bases. This indicates that the base pairs could be incorporated into developing new and more sensitive diagnostic tools for cancer as well as in immunotherapy, where molecules can be used to target and destroy cancer cells.

Outside of biology, however, the hachimoji DNA is a major breakthrough in the effort to store digital data into genetic material. The expanded DNA al-

phabet gives rise to higher storage capacity and more complex storing capabilities as scientists try to convert binary information into genetic code. DNA is an ideal candidate for this type of data storage, as it is able to last centuries

ARGUABLY MOST INTERESTING OF ALL, HOWEVER, IS HACHIMOJI DNA'S IMPLICATION ON THE GENETICS OF EXTRATERRESTRIAL LIFE

and will likely never become obsolete, unlike other digital devices.

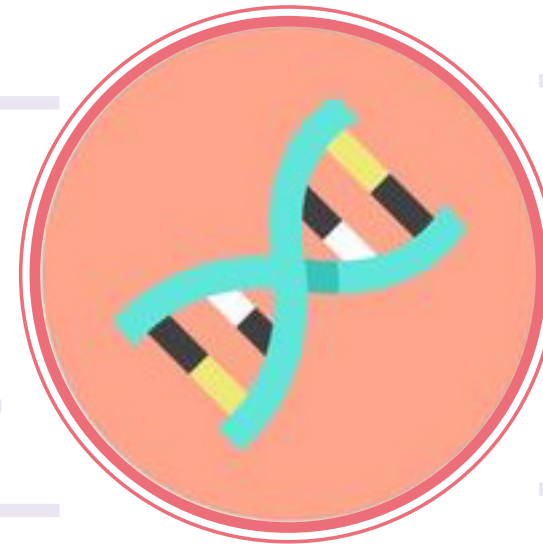
Arguably most interesting of all, however, is hachimoji DNA's implication on the genetics of extraterrestrial life. The discovery of these base pairs support the idea that our natural base pairs may

not be the only chemicals of life's code in the entire universe. Rather, these chemicals were readily available at the advent of life on Earth and could sustain the storage and transfer of genetic material. Therefore, alien life could have followed an entirely different path of genetics and used a different set of nucleotides than those on Earth, such as hachimoji.

Adapting the DNA for clinical use is a challenge as it currently cannot sustain itself outside of the laboratory.

This hinders its applications in healthcare, particularly its possible role in detecting and treating cancer. Despite this, the expansion of the DNA alphabet from four bases to eight has the potential to further our understanding of the methods for creating more synthetic base pairs and making huge changes to a number of fields.

NEW DNA BASES



ON APRIL 10TH, HEADLINES BROKE WHEN AN INTERNATIONAL TEAM OF RESEARCHERS RELEASED THE PRODUCT OF A YEAR-LONG PROJECT: THE FIRST IMAGE OF A BLACK HOLE EVER TAKEN.

BLACK HOLE IMAGING

Black holes often feature in sci-fi novels and television, so they might come to mind when you think of space or physics. But why are they so important, and how is it just now that one is being seen for the first time? What are the images of black holes displayed in movies and science exhibits?

The telescope is highly sensitive to radio waves, which can be detected across the extreme distance of 55 million light-years from the black hole to Earth due to their long wavelengths.



To explain, one should first understand what black holes are. In 1916, Einstein published his theory of general relativity, which states that gravity shows how space-time is shaped. When an object with mass exists, it creates curvature or a distortion in the otherwise level continuum of space-time, causing matter and energy, including light, to fall towards it. This phenomenon is seen in how our feet stick to the ground and our atmosphere does not disperse into space. In this theory, Einstein predicted the existence of objects with density so great that they distort the continuum to infinite curvature, so that nothing escapes their gravity, including light.

Up until now, Einstein's claim about the existence of black holes has been accepted by the global scientific community, even without a visual sighting of one. However, their presence has been observed at the center of galaxies, as their gravity keeps stars and solar systems in orbit. The technology which enabled the imaging of this black hole is called the Event Horizon Telescope (EHT). The event horizon is the larger boundary region of the black hole since no mass or light can escape once it

is within the event horizon. The EHT is comprised of eight radio telescopes based on various points on the Earth's surface, working in conjunction to function as one Earth sized, virtual telescope.

The black hole itself cannot actually be seen by current technology. Black holes are relatively tiny astronomical objects, with their masses compressed into proportionally miniscule spaces. The image taken displays the object's shadow, which is around 2.5 times larger than the event horizon of the hole. Around the shadow spins a ring of highly energized gas and dust, the remnants of the supernova, or explosive death of a massive star, which created the black hole. This particular body resides in the center of Messier 87, a galaxy in the Virgo galaxy cluster.

The observations taken from the EHT match the theoretical descriptions of black holes remarkably well. Researchers are optimistic about future breakthroughs regarding black holes and informing current theoretical understanding with observed evidence.

On April 15 6:20 p.m. local time, a fire ignited on the oak spire of the Notre Dame Cathedral in Paris. It burned till the next morning, eventually causing both the cathedral's spire and roof to collapse. In many ways, Notre Dame was the perfect storm for such a devastating fire. In an interview with Business Insider, Christopher Marrion, the founder of Marrion Fire and Risk Consulting, discussed the factors of the fire.

A fire is a form of combustion, or the reaction of a fuel and oxygen. Some initial action, such as a spark, begins the reaction. Combustion is usually exothermic which means that the reaction gives off energy. As a result, fires are able to sustain themselves if there is available fuel and oxygen.

Prior to the fire, the 12th century cathedral had been undergoing renovation. Marrion notes, construction is a common culprit of fires because new sources of risk such as equipment and metal materials are introduced to the area during it. Marrion also considered the possibility of a fire separation being removed during the construction process. Fire separations are any barriers specifically placed within a structure to prevent the spread of fire.

The Notre Dame fire was further worsened by the high Gothic ceilings, which provided plenty of air to fuel the fire. In addition, the roof was built mostly of wood unlike the stone frame below, and artwork and other combustible items provided even more material for the fire to consume.

The 141 year old St. Patrick's Cathedral in New York City also faces the threat of fire; in fact, an attempted arsonist was arrested at the cathedral on April 17. The cathedral, however, does have protective measures, which were recently added in a \$177 million renovation. Misting systems were installed inside the building, and the roof was coated with a fire retardant.

A fire retardant is any chemical that slows down combustion, usually by cooling the material via an endothermic reaction. Unlike exothermic reactions, endothermic reactions absorb energy, and in this case, the energy is in the form of heat. Other retardants prevent potential fuel from burning by forming a protective layer.

Misting systems also cool down the fire. Since the fire is much warmer than the liquid water, heat is transferred to the water until both are at the same temperature. This transfer causes the fire to cool while the water evaporates and becomes very hot steam.

Despite being able to save much of the structure, the fire in Notre Dame is a great loss. The structure has seen over eight centuries of French history, weathering wars and rebellions alike. Nonetheless, rebuilding the church is an opportunity to install new fire safety systems and ensure that what makes Notre Dame so notable does not also cause it to fall. With many already making contributions, French President Emmanuel Macron has vowed to rebuild the rest of the structure "because that is what the French expect".

BURNING DAME

Chemists in China have invented a new type of wallpaper, which is both fireproof and able to prompt a fire alarm. Ying-Jie Zhu and a team of researchers from the Chinese Academy of Sciences developed the wallpaper from a fireproof nanostructured material. Conventional wallpaper is made with a material called cellulose, which ignites easily. The smart wallpaper is a network of nanowires and is made up of the mineral hydroxyapatite, which is highly flexible and fire resistant, thus making it perfect for fireproof wallpaper. After forming the wires, the team successfully tested their prototype by placing it next to a flame for a whole day. The nanowires that make up the wallpaper are about the thickness of a piece of printer paper. The actual paper, however, had not yet been created. Scientists poured a liquid containing the nanowires into a paper-making machine, which resulted in a smooth and flexible white wallpaper that can be altered into an assortment of colors, designs, and patterns.

On the back of this paper, there is a temperature-sensitive sensor that is made from graphene oxide, a natural electrical insulator. When the temperature heats up to 129 degrees Celsius or above, this material becomes an electrical conductor. This means that if there is a fire, which is typically around five hundred degrees Celsius, an electrical current will form and trigger a fire alarm. This sensor was incorporated onto the wallpaper by mixing graphene oxide and water, creating an ink to print onto the paper.

Although the wallpaper may seem practical, it is currently too expensive for consumers. The team is looking to work with different companies in the hopes of making the wallpaper more affordable in the future.

FIREPROOF WALLPAPER

NEW HOPE FOR BUBBLE BOYS

IMAGINE LIVING A LIFE WITHOUT FRIENDS, A LIFE OF CONSTANT CAUTION RIDDLED WITH COUNTLESS CHECKUPS AND ENDLESS PRESCRIPTIONS. EVERYDAY YOU FEAR THAT SOME STRANGER'S SNEEZE OR SOME CHILD'S COUGH COULD BE THE END OF YOU. SUCH IS THE LIFE OF A BUBBLE BOY

—the colloquial name for a person with X-Linked Severe Combined Immunodeficiency (SCID-X1). SCID-X1 is an extremely rare genetic disorder that affects approximately one in every 58,000 people; it stems from a mutation in IL2RG, a gene crucial in the translation of a protein called a common gamma chain, which plays a role in many cellular receptors involved in the immune system function. As a result, those with SCID-X1 have defects in their lymphocytes, which cause these cells to either function incorrectly or not at all. Lymphocytes are white blood cells, like B-cells and T-cells, which are responsible for detecting, remembering, and destroying foreign threats. For example, if you get the flu, a helper T-cell might bind to the virus and release signals to recruit B-cells and killer T-cells. The B-cells will generate antibodies for the pathogen, and the killer T-cells will destroy it. The next time the same virus appears, the antibodies generated by the memory B-cells will be used to kill it. This process is the basis of the human body's immune system; without it, even the most common colds and infection could put us in our deathbeds.

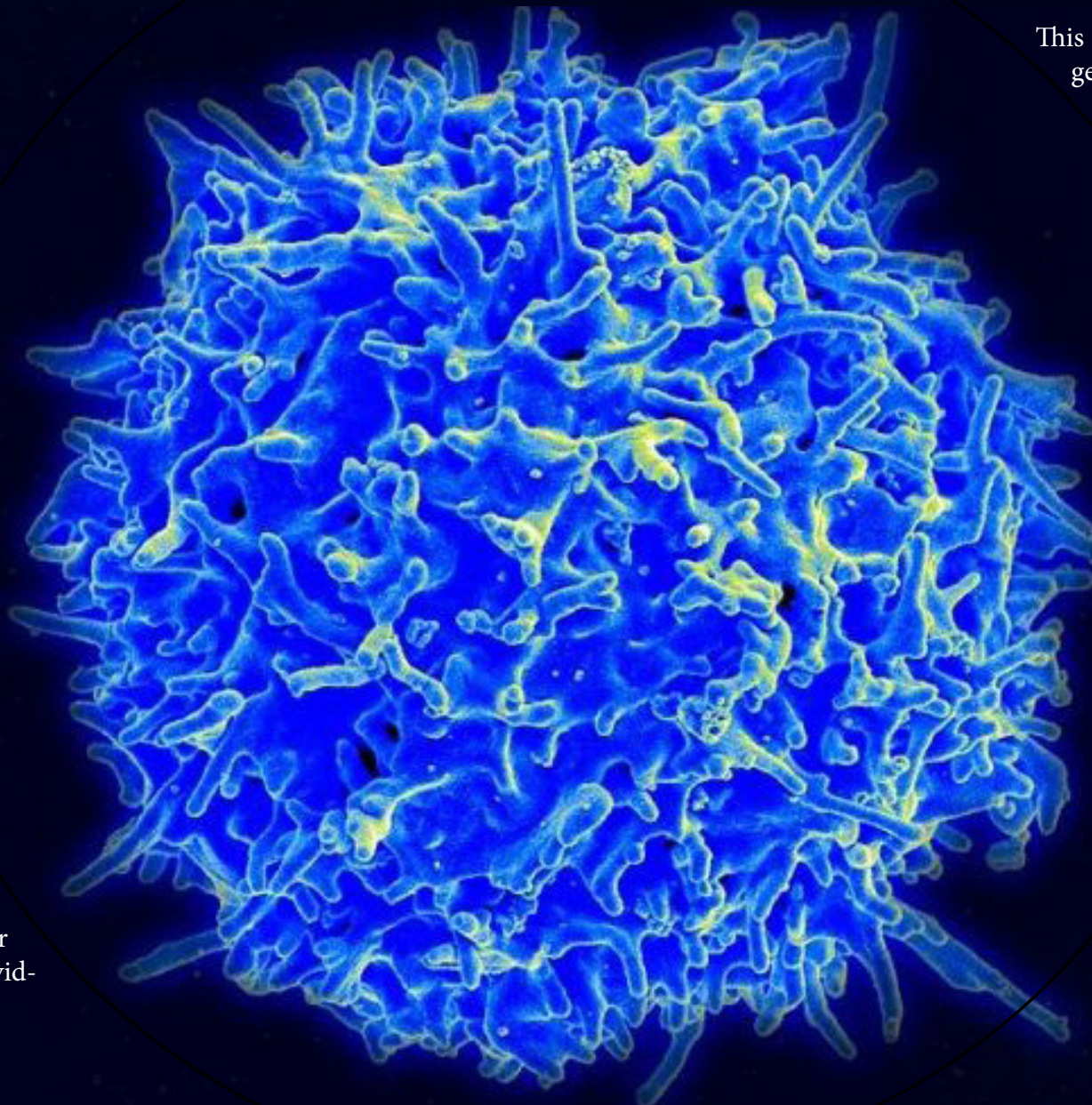
Unfortunately, for bubble boys, this line of defense does not exist—they are at the mercy of all the bacteria and viruses that enter their bodies. Millions of years of evolution and selection have provid-

ed us with a strong natural defense against microscopic invaders, and if it does not function, there is trouble. Those with the mutation can only engage in limited contact with others, have shortened life spans, deal with chronic diarrhea and skin rashes, and cannot even receive vaccinations. Thus, their short existence often becomes a miserable one. The treatment for SCID-X1 has traditionally been bone-marrow transplants. Bone marrow is the site of growth and maturation for many lymphocytes, and scientists hope that by transplanting healthy stem cells, the recipient will be able to generate their own B-cells and T-cells, creating their own immune system to protect themselves. Unfortunately, the procedure is tricky and the cells must be taken from a closely-related, healthy family member, such as a sibling.

This option, although generally regarded as the best one that these patients have, is only available

able for approximately twenty percent of those affected. That leaves the remaining eighty percent in a rather hopeless situation—or at least, it did. Recent research has pointed to the promise of gene therapy, a new branch of medicine in which doctors seek to address the root cause of the issue: your DNA. Typically, a retrovirus or some other vector is used to replace the mutated gene. In this case IL2RG is replaced with a healthy copy of the gene. With a healthy copy, the patient would be able to create their own functional B-cells and T-cells. According to a study published in *The New England Journal of Medicine*, seven children with SCID-X1 have returned home after successfully receiving gene therapy treatment, and another is expected to follow. They have all developed immune systems that should allow them to battle most childhood diseases on their own. Gene therapy, however, is not only for bubble boys. The beauty of gene therapy lies in its many possible applications. Many scientists foresee a future in which this technique could be used to treat a myriad of genetic disorders and even cancers. Mutations in the genome are the cause of countless diseases, and there are innumerable possibilities of editing these mutations—by editing your genome, you are literally changing your blueprint.

WITH THESE RECENT DISCOVERIES, THERE IS NOW A LOT MORE HOPE FOR THOSE PREVIOUSLY DEEMED HOPELESS.



A REPEATED MIRACLE



A CURE FOR HIV?



**SCIENTISTS
HAVE FINALLY
MADE
PROGRESS
AFTER CURING
A PATIENT FOR
THE SECOND
TIME IN THE
HISTORY
OF THE HIV
EPIDEMIC**

When discussing cures for diseases, the definition of a cured patient seems to be the easiest part. Either the disease still remains, or it is completely destroyed. Current methods to treat the human immunodeficiency virus (HIV) include taking medications to repress the effects of the virus. Many patients, including former basketball player Earvin “Magic” Johnson, live with HIV simply by taking medication despite not being cured. Although a complete cure has not yet been discovered, scientists have finally made progress in finding a cure for the disease after completely curing a patient for the second time in the history of the HIV epidemic.

The first time the treatment succeeded, scientists were uncertain about the treatment’s efficacy. During treatment, the patient went into critical condition. Later on, the patient recovered and was cured of HIV. Scientists were not sure whether this was because of the new treatment or because of the near-death experience. A second case of success, however, showed that the treatment worked.

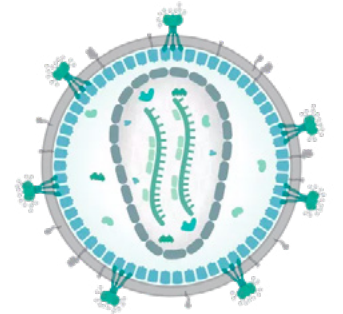
The second patient, who wishes to remain anonymous, has been dubbed “the London patient.” In addition to HIV, he was also treated for and cured of Hodgkin’s lymphoma, a type of cancer. He initially underwent chemotherapy, but when that did not work, he had bone marrow transplants. Although most treatments for HIV involve different kinds of antiretroviral drugs to slow the progress of the infection,

these transplants also help treat HIV as well.

HIV is a virus that attaches to and destroys white blood cells, which protect us from disease. When the white blood cell count gets too low, even regular infections, such as the flu, can become deadly dangerous. A specific genetic mutation called CCR5-delta 32 alters the receptors of these white blood cells and makes it impossible for HIV to attach and infect the cells. This mutation, however, is only present in about one percent of the population.

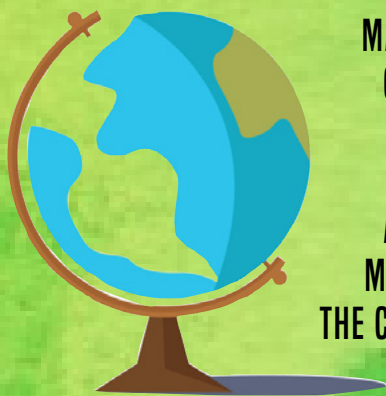
The donor for the London patient’s bone marrow transplants was a carrier of this CCR5 mutation. White blood cells produced by the donated bone marrow were entirely resistant to the strain of HIV. After two surgeries, the outcome was very similar to that of the first patient. Tests showed no signs of HIV in the bloodstream and that his white blood cell count was rising.

Although this treatment has proven to work, it has taken more than twelve years of testing in between the two cases, and only these two patients have had success. Despite this, the treating patients with CCR5-delta 32 transplants is not completely effective. Different strains of HIV use other methods to attack white blood cells, making even those with the CCR5-delta 32 mutation vulnerable to HIV. A second successful case is a promising step for the future, but there is still much more work to be done.



**A SECOND
SUCCESSFUL
CASE IS A
PROMISING
STEP FOR THE
FUTURE, BUT
THERE IS STILL
MUCH MORE
WORK TO BE
DONE.**

INNOVATION IN



MANY PEOPLE AND ORGANIZATIONS CAN AGREE THAT CLIMATE CHANGE IS ONE OF THE BIGGEST CHALLENGES THAT WE FACE IN THIS ERA. SCIENTISTS AND INNOVATORS ARE SOLVING THIS BIG PROBLEM THROUGH TAKING ADVANTAGE OF 21ST-CENTURY TECHNOLOGICAL INNOVATIONS. OFTEN, THEIR “UNICORNS-AND-RAINBOWS” PRODUCTS NEED TO BE PROBED AS WELL AS REVIEWED TO MAKE SURE THEY ARE REASONABLE AND SUSTAINABLE. LET’S TAKE A LOOK AT THE CURRENT PROTOTYPES AND PRODUCTS THAT ARE OUT THERE TODAY.

Trees are a very important part of our world; they take in carbon dioxide, provide oxygen, and even provide beautiful foliage. BioCarbon drones are devices that fly over hillsides and mountains, spraying tree seeds into areas struck by deforestation with just enough pressure for the seed to enter the ground snugly. Although planting seeds by hand is always helpful, BioCarbon drones can plant significantly more seeds in a shorter span of time. The company states that they will be able to plant one billion trees per year.



Many scientists and innovators are taking this climate change initiative in a different direction: renewable energy sources. A team of researchers is pushing to create a wind turbine farm in the ocean. These wind turbines are set to be placed in the ocean because the wind over the ocean is seventy percent stronger than wind over land. The wind farm is planned to be the size of Greenland and could potentially power eighteen terawatts, which is the amount of electricity all of humanity currently uses.



As expected, building a wind farm the size of Greenland, which is 836,300 square miles, is no easy task. It will be extremely costly for many reasons: purchasing enough materials for this product as well as paying workers for construction, troubleshooting the turbines, and connecting them to the world’s electricity grid. Furthermore, these windmills will affect the habitat of the creatures living in the ocean. It is not ideal for these sea creatures to have to move out of a place the size of Greenland. Wind turbines would also affect flying creatures, such as birds. In North America alone, “wind turbines kill an estimated 140,000 to 328,000 birds each year”. This makes wind energy the most threatening form of green energy. Many birds migrate across the ocean during the winter, and they could be swiped by these wind turbines. This can result in birds changing their migration pattern, which would cause further problems. These wind turbines could also completely alter the ocean climate by

CLIMATE CHANGE

cooling it by about thirteen degrees Celsius. Although there are many problems that come with this wind farm, it nevertheless could still serve as an example of smart, useful wind energy.

More than eighty percent of the earth’s marine life is affected by climate change, including coral reefs. These colorful, vivid reefs are quickly becoming dull, plain skeletons mainly due to the wa-

ter in the ocean warming up and acidifying because of greenhouse gases. Pumping cold water into areas of the ocean inhabited by coral reefs would cut down on the quickly rising temperature of the sea and decrease the amount of bleaching. Though this product might seem like a good solution, there are many side effects to it. For example, it could increase the amount of ocean acidification, which harms sea life.

David Suggett from the University of Technology Sydney says that the pumping of this cold water would be more detrimental to the coral reefs.

Rather than attempting to combat problems caused by global warming, some solutions attempt to combat the cause of global warming itself—the build up of greenhouse gases such as methane. Researchers from a company called Newlight Technologies are working to turn methane into plastic. Their AirCarbon plastic material is made of forty percent oxygen from the atmosphere and sixty percent hydrogen and carbon. The carbon is sourced from methane produced by agricultural operations. The AirCarbon would later be used to create plastic items, such as phone cases and chairs.

After careful reconsideration and evaluation, one can see that these products and ideas are useful but have some drawbacks. Although these scientists and inventors have good intentions in creating these products, there can be many disadvantages that pop up along the way. Climate change is a pressing problem, and despite all the problems that get in the way, these scientists are working hard to fix it. Their technological innovations could very well be able to make the world a better, smarter place to live in.



WHAT MAKES MUSIC SO FUN TO LISTEN TO,

THE SOUND

To answer that, we need to explore the basics. The music and noises we hear everyday are composed of vibrations travelling through the air, known as sound waves. These invisible waves vary in length and speed to create different frequencies of sound. The longer the wavelength, the lower the pitch, and the shorter the wavelength, the higher the pitch. The amplitude, or height, of the wave determines how loud it is.

When sound waves collide, they interact to create interference patterns, affecting the pleasantness of the sound. There are two kinds of interference patterns: constructive and destructive. Constructive interference occurs when two sound waves line up at the peaks (maximums) and troughs (minimums). This kind of interference creates a grander and more melodious sound.

On the other hand, destructive interference

occurs when peaks of one sound wave line up with troughs of another, thus leading to either silence or dissonance. Another way to create uncomfortable sounds is through nonlinear noise, or inaudible disturbances, which can be created by high-pitched screams or even an animal's distress calls.

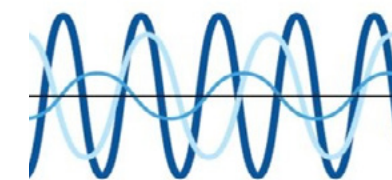
When sound waves interfere with themselves in woodwind instruments, standing waves are formed. The longest wave that can fit in the tube without interfering with itself is called the fundamental frequency, and the others waves are called the overtones. The fundamental frequency is heard the loudest and, therefore, is identified as the pitch of the tone. Overtones combine to create sounds of the same pitch. Musical instruments make their unique sounds due to overtones. For example, a violin's wave is jagged and creates a much different sound than a piano, which produces a smoother wave.

BUT SO HARD TO CREATE?

OF MUSIC

The ability to not only recognize the different musical intervals, but also utilize them in songwriting is an essential skill for composers and artists. Interference patterns of waves create many combinations, but only twelve are considered musical. An easy way to recognize them is to associate songs with each interval. For example, the "Jaws" theme is associated with the minor second, which creates a dissonant, suspenseful sound. A slight change into a major second creates a harmonious, happy song like "Happy Birthday."

Composers and artists utilize constructive and destructive interference as well as overtones when writing a new piece or song in order to control the mood of their audience. Although you cannot see them, sound waves, shaped by many factors, create not only the melodies and harmonies, but also the dissonance we hear all around us.



ALTHOUGH SCIENCE CAN HELP CLARIFY ONE'S UNDERSTANDING OF MUSIC, LISTENERS, UNAWARE OF THE SCIENCE, CAN STILL DETERMINE WHAT SOUNDS GOOD. THAT IS WHAT MAKES MUSIC SO COMPLEX, YET SO SIMPLE.

FIND THE ARTICLES' TITLES IN THE WORD SEARCH BELOW (NO SPACES). THEN, TAKE THE REMAINING LETTERS FROM LEFT TO RIGHT TO FIND A SECRET LIST OF WORDS. REMOVE ANY PROPER NOUNS TO GET THE FINAL QUESTION.

CBD NEWHOPEFORBUBBLEBOYS ADVANCESINHIV MEDIEVALBLUETOOTH	MAGICALMUTUALISM BLACKHOLEIMAGING BURNINGDAME FIREPROOFWALLPAPER	NEWDNABASEPAIRS TUMBINGTERRORS SOUNDOFMUSIC CLIMATECHANGE
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PUZZLE

Send your answer to catapultsciencebls@gmail.com for a chance to win a \$10 giftcard!