THE SYNAPSE

INTERCOLLEGIATE SCIENCE MAGAZINE

ISSUE 24 | JUNE 2020

The Synapse

INTERCOLLEGIATE SCIENCE MAGAZINE

Writers

Monica Dix
Victoria Fisher
Nicole Franowicz
Norah Han
Anna Harrison
Sophie Lyon
Oluwadamilare Ogunjimi
Ethan Pochna
Neil Ruthen
Mariam Saied
Jinhan Wu

Artists

Athina Apazidis
Della Copes-Finke
Norah Han
EJ LaFave
Evelyn Lazen
Veronica Mahoney
Zoe Miller
Oluwadamilare Ogunjimi
Averly Sheltraw
Yue Yu

Layout Editors

Rebecca Fenselau
Victoria Fisher
Genevieve Kirk
Rochelle van der Merwe
Evelyn Morrison
Yue Yu

Content Editors

Rebecca Fenselau
Victoria Fisher
Nicole Francowicz
Emma Keppler**
Eunice Kim
Emma Larson
Rajitha Narreddy
Caroline Pierotti
Elizabeth Rigby
Victor Salcido
Jon (Yanni) Sarrimanolis

Copy Editors

Nicole Franowicz
Riley Gillibrand
Mikaela de Lemos
Sarah Passannante
Caroline Pierotti
Elizabeth Rigby
Allison Schmitt

Photographer

Chris Schmucki

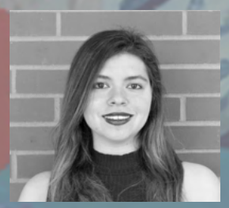
Cover Art

Veronica Mahoney

** A special thanks to Emma Keppler for her help in making final edits on all articles.

Managing Staff

ENC Victoria Fisher (OC) & Rebecca Fenselau (OC)
Managing Editor Kileigh Ford (DU)
Chief Layout Editor Yue Yu (OC)
Art Coordinators
Athina Apazidis (OC) & Delaney McRitchie (DU)
Outreach Coordinator
Zoë Martin Del Campo (OC)
Treasurers
Rebecca Fenselau (OC) & Casey Pearce (DU)
Liaisons Emma Larson (OC)
Intercollegiate Coordinator Evelyn Morrison (OC)
Web Manager Miranda Marnik-Said (OC)
Graphics Designer Steven Mentzer (OC)



Editor-in-Chief

Tori Fisher (OC '21)

Tori Fisher is very excited to present the 24th issue of *The Synapse*. She is very proud of the hardwork and dedication from every one of our contributors - especially those who may have stepped out of their comfort zone by taking on another role. This issue brings us insights into the incredible quantum computer that is taking the technological world by storm and the lives of those with the debilitating Sjögren's Syndrome. She hopes you enjoy the final issue of this academic year and continue supporting *The Synapse* through your readership and contributions!

synapse@oberlin.edu
@thesynapsemagazine
@thesynapsemagazine
synapsemagazine.org

Featured Contributer

Yue Yu (OC '20)

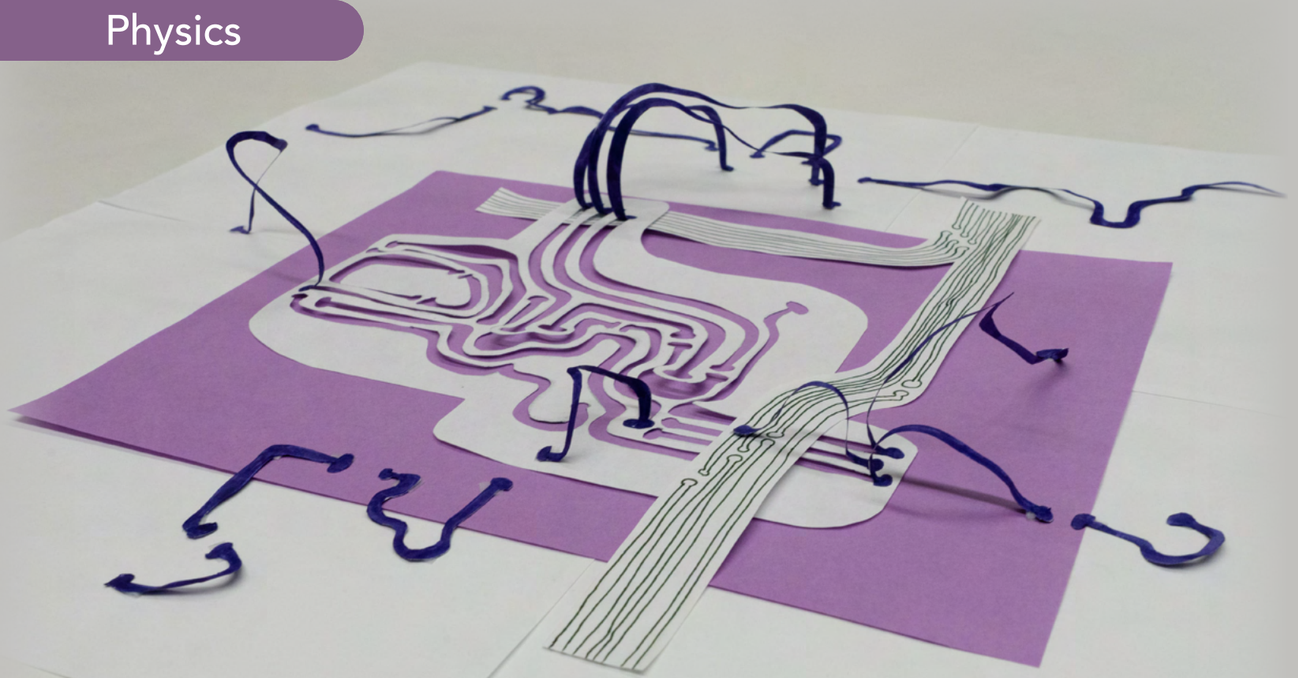
Yue is a fourth-year biology major and chemistry minor at Oberlin College who came from Shanghai, China. She became involved in *The Synapse* as Chief Layout Editor and artist in Fall 2018. She sees the unparalleled role of science journalism in connecting the scientice professionals with the non-scientific community, and enjoyed every moment she worked with the team. You can find her art and layout for the article "The Age of the Virus" on pages 5-6 of this issue. In her free time, Yue enjoys both outdoor activities and indulged in video games during quarantine. She also finished her honors research this April, and will pursue further education in dental school in Philadelphia, Pennsylvania after graduation.

Featured Contributer

Genevieve Kirk (OC '22)

Genevieve is a second-year studio art and intended art history major from Columbia, MO. She has been working with *The Synapse* since Fall Semester of 2019 as a layout editor and will be joining the board next year as Chief Layout Editor and Interim Graphic designer. You can see her incredible work throughout the last several issues including the layout on page 12 of this one. Her artistry is also showcased in "Myths and Facts About the Coronavirus" on pages 7-8. Genevieve loves *The Synapse* for the strong bond it encourages between artists and science writers. Genevieve is also a huge Star Trek fan and enjoys rewatching the shows - especially during this quarantine, as they are a source of freedom for her. While Genevieve is not certain of her post-undergraduate plans, she hopes to study jewelry making and design in Florence.

Contents



Cute Bits

Enormous Power Within Tiny Particles

Written by Norah Han
Illustrated by Evelyn Lazen

Quantum physics, the overcast weather on the leaden sky of classical physics, is no longer in the stage of mere theoretical exploration. Quantum computers are one of its most exhilarating new applications. In classical computer science, the last milestone was the popularization of the universal Turing machine. Its design was inspired by Alan Turing's invention of the Bombe that broke the German Enigma machine codes during World War II. Now, the world is awaiting for its next "Turing Machine'' — quantum computers. However, it is still unclear to what extent this enigmatic technique could change the world.

Since the invention of computers in the 1930s, their performance has been drastically improved as the semiconductor industry has undergone several breakthroughs. However, classical computers have reached the ceiling of modern physics — their components' size approaches atomic scale. On such a minute scale, our basic understanding of physics (such as Newton's laws) no longer works and those laws cannot explain the phenomena. The next step for scientists is to utilize the properties of the quanta to explore the area of quantum computers.

In classical computers, a bit, the smallest information unit, is either 0 or 1. Amazingly, the information unit for quantum computers, qubits, can exist in multiple states simultaneously. While seemingly counterintuitive, the theory of quantum superposition can assuage some of this confusion. Superposition, in brief, means that a system can have multiple configurations, either particles or fields. The system's more macroscopic state is the combination of all the different possibilities. Therefore, a component in a quantum computer can be in the state of on and off at the same time. Obviously, this does not follow our daily life's intuition. But in quantum physics, this is the principle that bolsters our world on the atomic scale.

Then how does the property of quantum superposition contribute to possible breakthroughs in quantum computing? The classical bits have sixteen possible combinations, but only one can be chosen at a time. However, qubits can exist in sixteen states simultaneously, a state known as quantum parallelism. Now we know that each component of a quantum computer can be in the state of superimposed "on" and "off." But why does this property make the quantum computer a supercomputer? Suppose you are stuck in a maze. The way to find your way out, analogous to the classical computation method, is to make a choice whenever you are at a fork. However, if you want to be a player who utilizes the logic of quantum computers, then suppose you are transformed into the form of water — your existence simultaneously penetrates every fork. Your new mentality shows the state and capacity of a quantum computer — simultaneously on and off.

Compared with classical computing methods, two aspects make quantum computers unique: software and hardware. With classical computers, we need better algorithms to maximize their computing power. Similarly, in quantum computing, we need quantum algorithms to maximize the quantum computer's computing speed. This area of quantum computing research is still in its primary phase. On the other hand, the actual components of the quantum computer carry considerable weight in its development as well. David P. Di Vincenzo, a theoretical physicist, proposes seven requirements for the implementation of quantum computers. The requirements and explanations are rather detailed-oriented, but the big picture he offers is that the current quantum computers are largely limited by the development of their physical components. Inventive physicists have come up with possible ways to design a blueprint for quantum computers. The most prominent ways are linear optics, ion traps, and Josephson junction.

To better grasp the idea of the immense computing power of quantum computers, consider the information that Google published in 2019. It claims that it has made the first quantum computer, Sycamore. Sycamore can operate a series of complicated computations — which would take the fastest normal computer ten thousand years to complete — within two hundred seconds. That would be the equivalent of starting the calculations at the time when the mammoths went extinct in North America and finishing today.

John Preskill, a prominent figure in the field from CalTech, proposed the concept of quantum supremacy. This term is used to describe the quantum computer's supreme ability to operate. If quantum computers can solve the problem left behind by the classical computers, regardless of the actual implication of the task, then quantum supremacy is fulfilled. The quantum computer's rapid growth rate is defined by Neven's Law, unlike the classical computer's development, which follows Moore's Law. Both of these laws refer to the increase in the number of transistors, which are responsible for the computing speed, included on a computer chip. Moore's Law states that the newest computer chips will have double the number of transistors as those developed two years prior. However, as the size of the transistor is becoming smaller and smaller, this law is slowly losing its credibility, since even more transistors can fit on these small chips. Harmut Neven, the director of the Quantum Artificial Intelligence Lab at Google, thinks that the quantum computer's capacity will be growing at a doubly exponential rate which is expressed by the following equation where x = number of years that have passed:

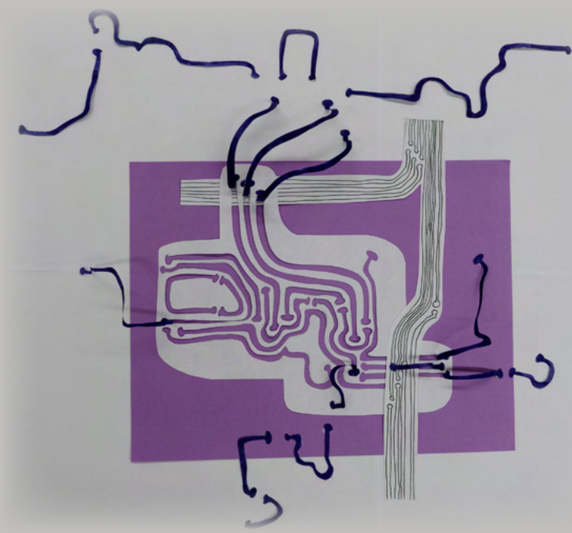
$$2^{2^x}$$

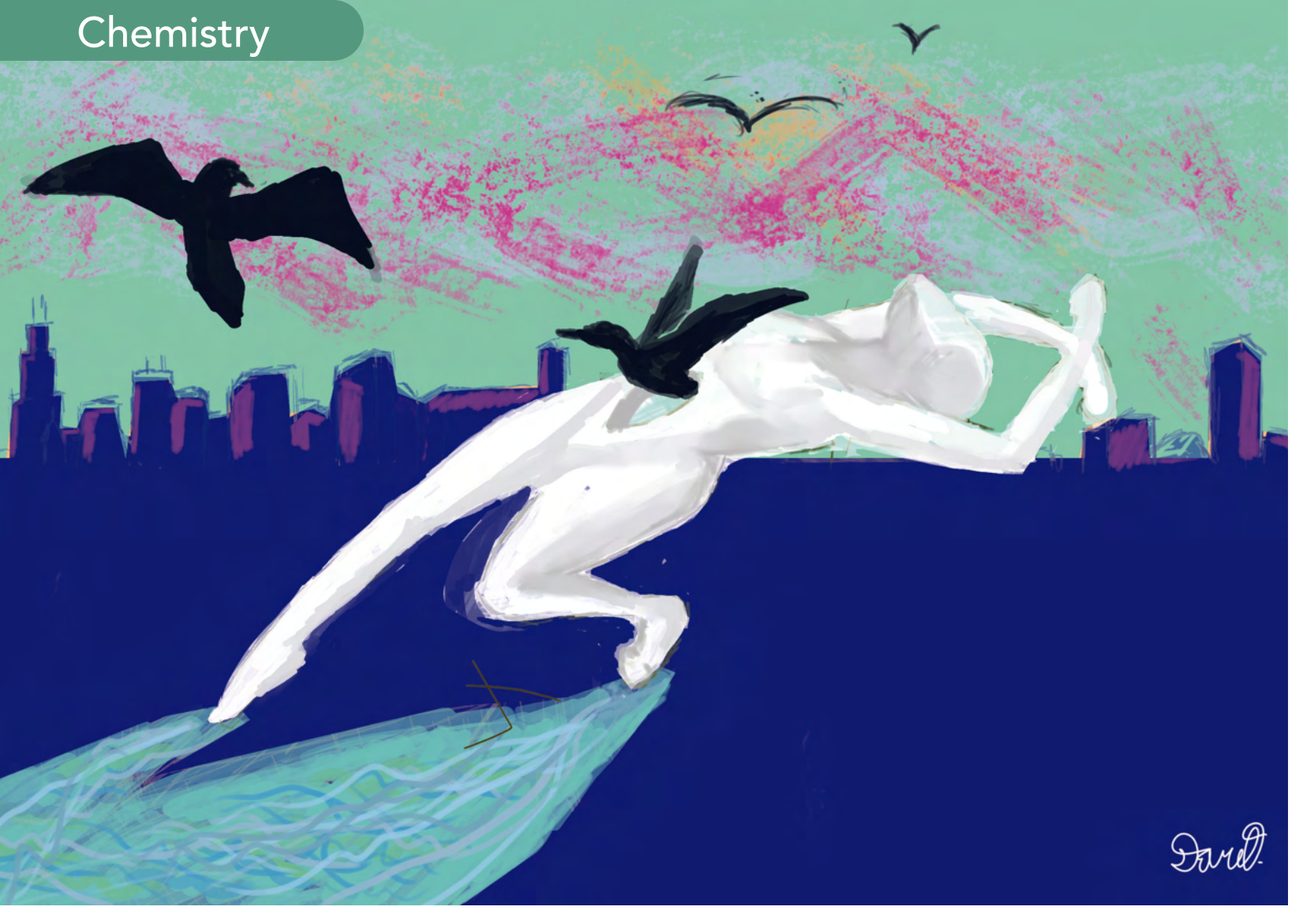
While these increases in computational speed are impressive, what can a quantum computer actually offer us in everyday life? Weather forecasting can be one of its applications. Nowadays, we cannot entirely rely on the weather forecasting news, since the current computers we have are not entirely capable of simulating complicated weather changes. Quantum computers, on the other hand, are able to compute global weather changes instantly, therefore providing fast and accurate weather forecasts to the public.

Quantum computers can also be used for encryption, or rather de-encryption. As mentioned previously, quantum computers can process data information at a much faster speed (2 hundred seconds) than a normal computer (10 thousand years). As a result, quantum computers could process and decode encrypted materials very quickly. This poses a problem for the market of virtual currency, such as Bitcoins. Since this market was established upon the principle of cryptography and the ability to keep coins safe by encrypting them, the whole system could be entirely dismantled by quantum computers. By using a quantum computer, you could instantly retrieve the passwords of coins, which is referred to as quantum attacks, and dissipate the online currency.

> The brilliant idea of quantum computing shows us that puzzling physics concepts can have captivating applications.

The brilliant idea of quantum computing shows us that puzzling physics concepts can have captivating applications. Whether or not quantum computing is going to be carried out in the form of classical computers is still unknown. No matter if these quantum computers remain with large companies or become the new norm of everyday technology, they have the ability to make our world faster, more efficient, and more accurate. However, like quantum theory, their development remains as a Schrödinger-styled superposition. • • •





Energetic Roots

The Thermodynamics of ase

Written by Oluwadamilare Ogunjimi
Illustrated by Oluwadamilare Ogunjimi

Many of us who have taken Chemistry courses are familiar with the three laws that are the foundations of Thermodynamics, the transferal and transformation of energy. Energy is constant, neither created nor destroyed, only transferred and transformed. As energy is transformed, the state of total energy becomes increasingly disordered. This disorder is known as entropy.

Science's definition of energy mirrors the concept of "ase" (ae shé) from the Yoruba people of West Africa. Like many concepts in Yoruba tradition and culture, ase is simple but possesses an impossible depth. This powerful and practical term has received many translations. "Power," "authority," and "so be it" are amongst the most popular. The simplest translation of ase, however, is "energy." Power is quite literally the rate of energy transfer. Authority is simply a manifestation of power, a state of being able to utilize energy. "So be it" is a somewhat inaccurate translation that parallels the Abrahamic "amen," also often translated as "so be it" in the Christian traditions. Broken down, ase can be taken as "A se:" "We do (it)."

The difference between the "so be it" and "we do (it)" is more profound than it may initially seem. Christianity, the most prolific advocate of amen, is a religion based on recognizing and respecting an external authority. Yoruba tradition, on the other hand, is based on the recognition of both external and internal authority and recognizing their unity. Thus, when a Christian says 'amen,' they are pleading for God to use His authority in their favor. When a Yoruba says 'ase', they are investing their own God-given authority and energy. 'Ase' in this context indicates a much more personal and active investment than a standard 'amen.' It indicates a willingness to do whatever is required of you to bring about what you have agreed on. As such, saying 'ase' is the signing of a spiritual contract, and it is used with far more caution than 'amen'.

The spiritual investment of 'Ase' must be utilized wisely due to the Yoruba manifestation of the First Law of Thermodynamics. The First Law says that energy cannot be created or destroyed and, therefore, the total energy is constant. For the Yoruba, this first law is found in Olodumare, the Almighty God of the Yoruba worldview. Olodumare, known by a wide variety of names and titles such as Olorun and Oluwa, is often compared to the Christian God. However, while Olodumare fulfills many similar roles as the original and final authority, he has this authority because he is the source of ase. Thus, Olodumare serves as the embodiment of total ase, or energy. As the embodiment of everything, Olodumare's authority originates from his agency over himself; nothing can happen to or within his body without his consent, much like how the Devil cannot attack Job without God's permission in the Biblical Book of Job.

This manifestation of thermodynamics also appears in the traditional Yoruba view of positive and negative experiences. While a negative experience can be interpreted as some form of divine punishment, it is, at its core, viewed in a manner akin to an exothermic (heat-releasing and destructive) reaction, breaking things down and transforming knowledge into wisdom. Positive experiences are akin to an endothermic (heat-absorbing and constructive) reaction, building something up at the expense of energy (i.e. physical and/or spiritual resources). Much like in thermodynamics, endothermic "reactions" must be paired with and fueled by the exothermic, resulting in the Yoruba concept of ebo, sacrifice and offering. The offering of ebo serves as a method of refilling internal and external energetic reserves, essentially an act of spiritual eating or filling a car with gas.

> ase has received many translations. "Power," "authority," and "so be it" are amongst the most popular. The simplest translation of ase, however, is "energy."

Much like when gas is burned to fuel a car, ase changes forms when it is utilized. The Second Law of Thermodynamics states that as temperature increases, the distribution of energy becomes more disordered, an increase in entropy. Like the gas' energy that transforms into an explosive force when it meets a spark, ase scatters when it is utilized. Once used, ase is available for other work. This renewed potential is referred to in Yoruba tradition as a "multiplication." Multiplication is not the creation of new ase, but a redistribution as ase is bestowed and nurtured, much like plant reproduction. As time moves on, one tree becomes a forest and the root system becomes increasingly complex and chaotic. Thus, entropy increases as the manifestations of ase expands and diversifies.

An excellent example of the entropic nature of ase from Yoruba tradition is the counting of "201 or 401" orisa, or Yoruba deities/deified ancestors. Here the "1" is the most important symbol, as it indicates that there is always one more orisa. In other words, the courts of Heaven grow more chaotic as they grow more crowded.

Much like when gas is burned, the utilization of ase is accompanied by heat. Physical and spiritual heat for many traditional African spiritualists tend to go together. Work releases heat as a by-product, both in the spiritual and the physical. Spirits orientated towards action are perceived as hotter. Spirits can vary in temperature from moment-to-moment and incarnation-to-incarnation.

An example of the relative nature of spiritual heat is the duality of Ogun: Ogun, the fire, who uses the blades he forges to carve new paths and facilitate the forward movement of civilization down these path; and Ogun, the hunter, who must patiently wait for his prey to be vulnerable. Like physical heat, spiritual heat requires a standard to compare to and provide contrast.

The Third Law of Thermodynamics gives a hypothetical standard to which all measures of entropy are compared: a perfect crystalline substance at absolute zero has zero entropy. The Yoruba equivalent of this perfect crystalline substance would be the most prominent head of the Yoruba pantheon: Obatala, the King of the White Cloth. Many versions of Obatala that exist around the globe are said to have never been human, a rarity within Yoruba tradition as the human experience is often considered the fastest (and most challenging) route for completing one's spiritual journey. Because of the human experience's efficiency, many orisa have undergone countless human incarnations.

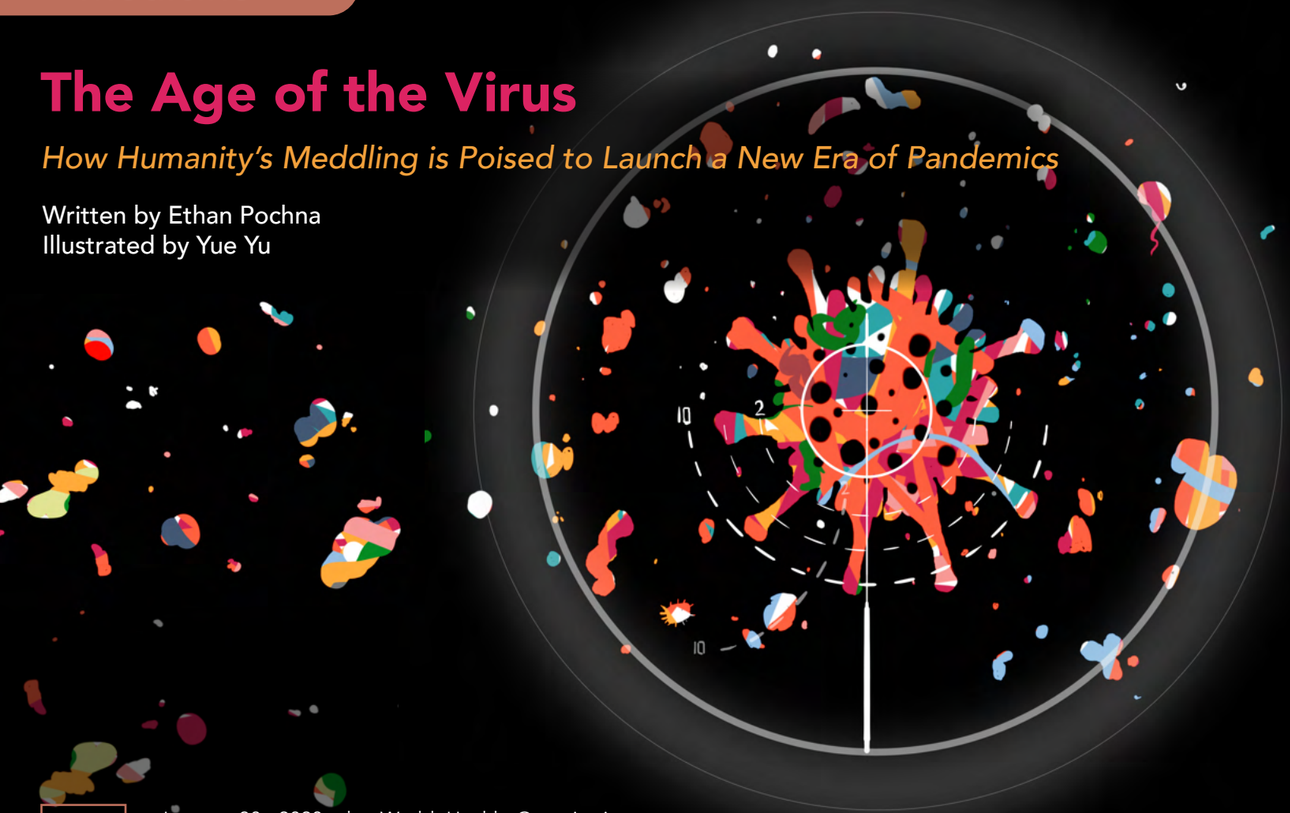
Obatala's alleged lack of human experience would make them purely spiritual, or hypothetical, also denoting his role as the personification of the Spiritual Realm. Obatala's role as a standard originates from both his imagery as the Great Carver and the pinnacle of iwa pele, or balanced character. As the Great Carver, Obatala molds all life in the womb and serves as the standard for all that he carves (i.e. all that holds ase). Iwa pele, or balanced character, can be summarized as the ideal of walking your own path without disrupting anyone else's and wasting as little ase as possible. This principle serves as the backbone of many Yoruba customs, particularly between elders and youths, and facilitates the ease with which ase diffuses. The ease of this diffusion results in the quality of itutu, or coolness. Thus, as the perfection of iwa pele, Obatala exists in the coolest state: absolute zero.

Throughout all its states, energy follows the same rules. These rules have been summarized, not only by modern science, but also by the spiritual traditions of the Yoruba and indigenous peoples all around the world. Across human history and the myriad of cultural backgrounds and experiences, humans have made many of the same observations. Among these observations is that energy cannot be created nor destroyed, only transferred and transformed. The transfer and transformation of energy creates chaos, thus heat and work walk hand-in-hand. Even if it does not physically exist, there exists an object or being in a perfectly ordered state, free of chaos. Just like energy, knowledge cannot be created or destroyed, only transformed and transferred. • • •

The Age of the Virus

How Humanity's Meddling is Poised to Launch a New Era of Pandemics

Written by Ethan Pochna
Illustrated by Yue Yu



On January 30, 2020, the World Health Organization (WHO) declared a "Public Health Emergency of International Concern" regarding the emergence of a novel coronavirus — only the sixth such declaration in WHO's history. At that point, the virus was called 2019 Novel Coronavirus (2019-nCoV), had infected fewer than 8,000 people, and the epidemic was largely confined to central China. By late February, however, the virus had infected nearly 80,000 people across 37 countries, and by mid-March, U.S. colleges and universities were suspending classes. The virus's corresponding disease, the Coronavirus disease (COVID-19), was on the verge of pandemic status. The virus also gained a permanent classification: SARS-CoV-2, short for "Second Severe Acute Respiratory Syndrome Coronavirus."

The name "SARS-CoV-2" evokes its infamous predecessor, the original SARS, which infected over 8,000 people over the course of two years. In 2002, a novel coronavirus known as SARS (Severe Acute Respiratory Syndrome) emerged in China, giving rise to a series of devastating outbreaks that left at least 774 people dead. The 2002-novel-coronavirus, which shares eerie similarities with the current virus that is circulating, eventually became rebranded as SARS-CoV (the first). SARS-CoV's global rampage redefined how we approach viruses in a globalized age, a paradigm shift that catalyzed the creation of today's global health infrastructure. Yet in hindsight, the SARS pandemic is just a point in a broader trend. The last 20 years could easily be described as a story of virus-caused destruction on the back of ever-increasing human activity. SARS-CoV-2 both validates this story and signals a new level of severity in the trend.

SARS-CoV-2 provides the best window into the relationship between increasing anthropogenic domination and a new era of viral emergence, as it is possible the most devastating iteration of this virus yet shares a strong link to the first SARS-CoV. Indeed, it is the science and history of coronaviruses at large, as well as parallels across the viral world, which signal that humanity has brought the age of the virus upon itself.

The connection between human activity and coronaviruses starts with the fact that viruses are biologic automata, not organisms. A single virus particle is a collection of genetic material and protein that attaches to a host cell and, after several phases of complex molecular interactions, hijacks the cell's reproductive mechanisms to produce more of itself. However, each virus reacts with a specific sort of cellular receptor, so specific viruses tend to be endemic to a certain population or species of host animal. Even as viruses evolve for "cross-species transmission," different species handle infections differently.

These idiosyncrasies can be devastating for humans when an animal virus adapts to harm us, as our immune systems have no precedent for a response. The subsequent diseases are called "viral zoonoses" and, fortunately, have several barriers for emergence. First, the virus must utilize its evolutionary mechanisms, which include random mutation and "recombination" with genes of other viral strains, with extreme efficiency. To maintain this efficiency, the virus requires a "reservoir population" of hosts that can handle specific evolutionary paths. Sometimes, the reservoir serves as the vector, or the point of animal-to-human transmission; often, though, intermediary species are required to adapt for human reception. When groups of humans interact with these vectors, the resulting animal-to-human transmission event is called a "spillover," and if the virus evolves within humans to spread human-to-human, it becomes a zoonosis.

The first sign of evidence that human meddling is involved in the stories of SARS-CoV-1&2 is that coronaviruses are zoonotic. These viruses were thought to exclusively infect animals until a strain coronaviruses emerged in humans in 1960.

The coronaviruses' strains are split into three distinct groups, and the 20th century's human coronaviruses, as well as coronaviruses found among cats and dogs, were all part of the mild Group I. While these early coronaviruses shared their predecessors' penchant for cells lining the throat, lungs, and intestines, they were more closely associated with the common cold than global pandemics.

The next subset of coronaviruses, Group II, are found in cows, rats, and wild animal populations. Group II viruses are much more problematic as they can mutate much more rapidly than other coronaviruses. Consequently, when distinct Group II populations are brought together, the resulting recombination evolves the viruses at an absurd rate and they are able to easily overcome typical barriers to cross-species transmission.

A group of Chinese horseshoe bats in a Yunnan cave, infected with a SARS-like Group II coronavirus (SL-CoV), served as the original reservoir population for SARS-CoV. For reasons not fully understood, bats tend to resist disease from the viruses they carry, providing an outlet for rapid viral evolution. Unfortunately, bat hunters, incited by a booming wildlife trade, brought the Yunnan cave's reservoir population to Guangdong's markets around the turn of the century. Due to the proximity of dozens of disparate animal species and low hygiene standards at that market, the Yunnan SL-CoV evolved quickly, adapting to fit a general mammalian template along the way. Eventually, it found its way to palm civets, which are the stars of Guangdong's wildlife trade. This would prove the penultimate step as the palm civet strain mutated rapidly, soon turning into SARS-CoV.

The inevitable spillover's subsequent SARS outbreak was made official on November 16, 2002. SARS proved severe, with an initial 10 percent fatality rate, and this severity should have mitigated the spread. Patients exhibited symptoms quickly and dramatically, so they tended to seek immediate care and were quickly diagnosed and isolated, making contact history more traceable and containment easier. Four factors, however, turned Guangdong's SARS outbreak into an epidemic. First, the Chinese government denied the epidemic's existence, resisting global coordination and WHO involvement toward containment until the disease had already spread around the world. Second, SARS is nosocomial, meaning it originates in and hits hospitals the hardest. This further strained China's healthcare infrastructure, already weakened by the government's inaction. Third, human SARS-CoV found its way back to palm civets, where it spread across the civets' geographic range and evolved for ever-greater virulence. As a result, random SARS outbreaks emerged throughout a large region of area. Finally, little understood and unprecedented super-spreader events replaced the traditional "20/80" rule, where 20 percent of patients cause 80 percent of cases, with a "5/90" rule, making outbreaks unpredictable and difficult to contain.

By June 2003, SARS had reached 8,000 patients in 26 countries and caused 800 fatalities. Due to the lack of a cure, the terror of superspreading events, and the disease's exponential spread, fear of SARS permeated the international community. With that fear came extreme quarantines, a slaughtering of palm civets, travel bans, school closures, international cooperation, and public paranoia. Gradually, the epidemic waned. The international economy also took a major hit, but by July, SARS was on the verge of disappearing. That's when the rebuilding began. Although sporadic interactions with palm civets caused a handful of cases over the next year, by 2005, SARS had been eradicated.

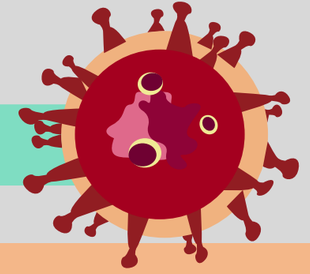
Today, however, we have SARS-CoV-2 to contend with. While we don't know anything for sure, bats are the probable reservoir, Pangolins replace civets as the vector, and the epicenter is again a wet market, this time in Wuhan. The global reaction was faster, more severe, and more informed than in 2002. Nevertheless, COVID-19 has persisted. COVID-19's two-percent fatality rate may seem low compared to the catastrophe of SARS, but its virulence and pathogenicity far outstrips that of its predecessor. Human activity brought SARS out of the woodwork and nearly paid a catastrophic price 18 years ago; it seems that nature has come back for more.

Humanity first learned what a global pandemic looked like in 1918, when the globalization that accompanied the Industrial Revolution and World War I brought a bird's flu to 500 million humans. Unfortunately, as humanity cements its influence on the natural world, we are more vulnerable to viruses crossing over now than ever. As we encroach farther and farther into the territory of wild animals, we expose ourselves to potential reservoir populations more regularly. Strains of viruses in humans tend to evolve at a slower rate than those in other animals. This fast mutation rate can be attributed to the rise of industrial farming and urban overcrowding, which provide the perfect stage for host-jumping virus evolution.

Of course, this trend is hardly new. Viruses have spread across South America along new agricultural routes via rats whose growth became uncontrollable after DDT wiped out large populations of cats in the 1960's. HIV started with primates, spread across Africa via truckers, and devastated New York City, the epicenter of world trade in the 1990s. The Nipah virus emerged in 1999 on pig farms invading bat territory. The list goes on. However, the forces behind this trend in viral emergence are only consolidating.

Zoonotic viruses are poised to become one of humanity's major hurdles in the 21st century. This threat cannot be combatted without improvements to global health conditions or the cessation of humanity's march against nature, there is little to prevent the unmitigated rise of a new viral era. Recent developments have only exacerbated the factors that encourage zoonotic evolution and facilitate their spread beyond a reasonable scope; the SARS-related coronaviruses are only two extremes. 2009's H1N1 swine flu strain was a combination of strains from global pig populations intermingling in Mexico. The Middle East Respiratory Syndrome went from bats to camels to humans, who spread around the world following the Syrian Civil War. 2014's Zika crisis came from a mosquito that spread with international travel in the 1980s. And as we now see with COVID-19, the current conditions for viral evolution and the state of global movement have made it impossible to contain these outbreaks. It is unknown and difficult to predict what the rest of the century has in store for us, but as viruses become more dangerous and containment becomes more difficult, there's little room for optimism. • • •

Myths and Facts About Coronavirus



In this time of uncertainty, it can be easy to become misinformed. In wanting to resume normal life, certain statements are often easier to believe and spread than the truth. The staff of the *Synapse* is here to inform you of some misleading statements that could be harmful to you and your loved ones, and to keep you informed on proper safety procedures.

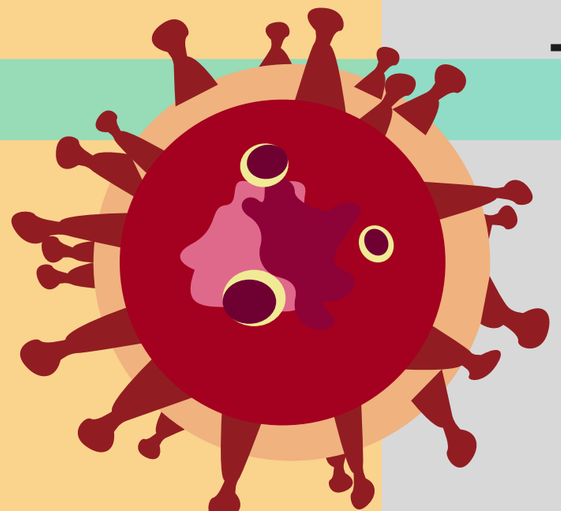
Myths

The virus will weaken when warmer April weather takes over. 1.	The virus will just disappear. 2.	Testing is accessible for everyone in the United States. 3.	A vaccine for the virus will be created and available soon. 4.	The antimalarial drug chloroquine has been approved for use against the coronavirus and is affective. 5.

Facts

Although respiratory viruses like coronavirus can be seasonal, the World Health Organization has confirmed that the new coronavirus can be transmitted in hot and humid areas as well as all others. Thus, we do not yet know if the virus's spread will weaken in April. 1.	New cases of coronavirus continue to rise, as the peak of the virus in the United States has yet to be reached. There is no evidence that COVID-19 will disappear out of nowhere like a miracle. 2.	Testing in the United States is extremely limited. Vice President Mike Pence acknowledged this and stated, "we don't have enough tests today to meet what we anticipate will be the demand going forward." 3.	White House experts have stated that a vaccine to coronavirus could take up to a year to 18 months to develop. Even after the development of a vaccine, it will take longer to produce and mass distribute. 4.	Director Fauci stated that, "today, there are no proven safe and effective therapies for the coronavirus." While chloroquine can be prescribed by a doctor for treating COVID-19, it has not yet been tested in a clinical setting or approved by the FDA for treating COVID-19. 5.

Sourced from The Atlantic



Tips to Stay Safe

Disinfect your groceries

Stay 6 feet away from others

And, as always, wash your hands!

Sjögren's Syndrome

More Than Meets the Eye

Written by Anna Harrison
Illustrated by Norah Han

Primary Sjögren's syndrome (SS) is a common autoimmune disease that afflicts over one million people in the United States. Autoimmune diseases involve the body's immune system attacking some of its own cells instead of potentially dangerous foreign bodies like bacteria and viruses. Different types of autoimmune diseases are classified based on the cell type that is attacked. In Sjögren's syndrome, the immune system targets moisture-producing gland cells, often in the eyes and mouth. Damage to the gland cells that produce and secrete saliva and tears leads to the distinctive SS symptoms of painful dry eyes and mouth. However, in many patients, Sjögren's affects other cell types as well. Symptoms such as peripheral neuropathy, lung problems, skin rashes or dry skin, joint pain, and fatigue are common, occurring alongside the dry eyes and/or mouth. Clinical presentations are variable, and there is also a significant overlap of SS symptoms with other common autoimmune conditions. On top of this, SS lacks robust, objective, diagnostic methods, making it easy for clinicians to overlook. This article discusses the challenges that surround diagnosing and treating Sjögren's syndrome.

Diagnosing Sjögren's: From Blood Tests to Biopsy

Many patients with Sjögren's have one of two specific abnormal autoantibodies or self-harming antibodies that can be detected in blood: anti-SSA and anti-SSB, also known as "anti-Ro" and "anti-La," respectively. If one or both autoantibodies are present, it is highly likely that a patient has Sjögren's or a closely related autoimmune condition. However, these tests have high false-negative rates, where only about half of patients with Sjögren's neuropathy will have these autoantibodies in their blood, even after repeated testing. Other inflammatory markers, including rheumatoid factor and antinuclear antibodies, can be detected from the blood tests of people with Sjögren's syndrome. However, these indicators are non-specific as they are found in a number of inflammatory conditions and are thus insufficient to diagnose Sjögren's syndrome. As a result, physicians often use the combination of clinical symptoms and autoantibodies to diagnose. Risk factors, such as age, sex, and family history are also considered. Sjögren's syndrome patients tend to be female, 40 to 60 years of age, and have another autoimmune disorder approximately half of the time. A family history of autoimmune issues is a risk factor as well.

Patients who have these risk factors but test negative for antinuclear antibodies, anti-SSA/B, and rheumatoid factor, and/or do not have dry eyes or mouth may require further testing. Two other tests are recommended. The "Schirmer tear test" is performed to assess eye dryness. It involves an eye doctor placing a small strip of paper in the lower margin of the eye to measure tear production. Very low tear production is evidence of Sjögren's.

The other recommended diagnostic test is a biopsy of tiny salivary glands located on the inside of the lower lip. These minor salivary glands feel like small lumps if you rub your tongue along the inner surface of your lip. Typically, an oral surgeon will inject local anesthetic in the inner bottom lip, make two small incisions, and remove 3-6 salivary glands for pathological studies The characteristic Sjögren's syndrome lip biopsy finding includes a foci of immune cells gathered around salivary gland tissue and ducts. The amount of these clumps present in the biopsy is quantified and used to make the diagnosis.

Precautions should be taken when considering lip biopsy testing. False-negative results can be obtained if patients are taking or have recently taken immunosuppressive medication, including corticosteroids or if they smoke cigarettes. Additionally, if patients have had Sjögren's syndrome long enough for salivary glands to entirely degenerate, false-negative results can occur. False positives can occur in older people, trauma victims, and hepatitis C, lymphoma, or sarcoidosis patients.

Treatment of Sjögren's: Many Options

A diagnosis of Sjögren's can be of great relief to patients like MaryEllen, who have suffered for years and faced skepticism from doctors, peers, and insurance companies. Once they are diagnosed, patients should discuss treatment options with their doctors. More specifically, patients should consult rheumatologists, ophthalmologists, dentists, and neurologists. Some treatments are tailored to relieve specific symptoms, such as eye drops and artificial saliva, while others are intended to dampen inflammation throughout the body. In any case, quality of life can be improved after receiving a Sjögren's diagnosis. Nonetheless, research on SS is still minimal, and has yet to lead to a cure. • • •

A Patient's Perspective: A Long Road and an Important Diagnosis

MaryEllen Talbot describes her path to a Sjögren's diagnosis:

I had vision problems since I was five years old. As an adult, I started seeing an ophthalmologist. My eyes were so dry it felt like I had sand in them. My contacts would crack into pieces in my eyes after brief wear. I had zero tear production and a dry mouth. My ophthalmologist noticed that there were issues with my corneas, and referred me to a corneal specialist.

My eye pain was never ending, regardless of what medications we tried. It felt like I had shards of glass in both eyes, and especially when I shifted my eyes from side to side. I constantly wore sunglasses, even indoors, because the lights and glare gave me severe headaches. The corneal specialist suspected Sjögren's and referred me to another specialist, a top corneal immunologist.

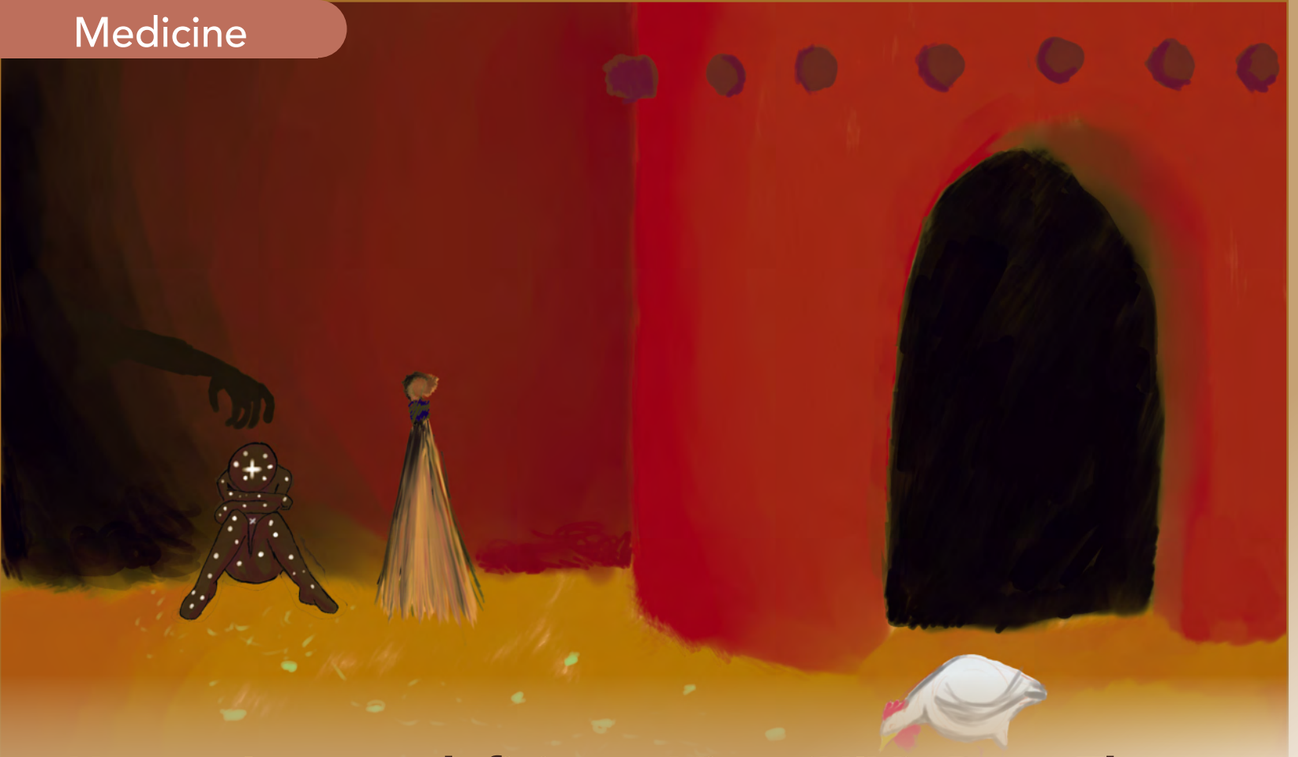
The next year, I formed a medical dream team at Massachusetts General Hospital. My first lip biopsy was inconclusive. Still searching for an answer to my pain, I had a second lip biopsy four years later. The surgeon took more salivary glands and definitively diagnosed Sjögren's.

The diagnosis was very important to me. As a patient, it was essential for medication trial eligibility, to get insurance coverage, and to help my other doctors understand my symptoms. Even after I had a clinical diagnosis of Sjögren's, some doctors continued to question it. This was very challenging to me, and highlights the necessity of educating everyone about this disease and how it is diagnosed.

One of the most important things I have learned in my life comes from my 22-year-old son, who suffers from life-threatening medical problems: Happiness is all about your perspective and how you see yourself. He has taught me to fight for today, have a positive attitude about my medical problems, and be my own best advocate!

My eye problems are severe and go beyond the symptoms of Sjögren's. I also have severe corneal neuropathy, corneal lesions, vision loss, and have had a prosthetic eye lens for two years. My medical team has me on an intense regimen of eye medications and intravenous immunoglobulin (IVIG) to try to prevent further vision loss.

Due to the care I received after my Sjögren's diagnosis, I am still able to drive, work as a trauma therapist, and, most importantly, care for my son! Our message is all about perspective, positive attitude, and fighting hard... life is good! I am so grateful for my medical team that continues to research ways to improve my quality of life.



Human Immunodeficiency Virus (HIV): Does The West Matter More?

Viral Evolution and the Consequences of Western Supremacy in HIV Research and Treatment

Written by Mariam Saied
Illustrated by Oluwadamilare Ogunjimi

Over the last 40 years, we have made remarkable progress in reversing the human immunodeficiency virus (HIV) epidemic. However, despite the drop in worldwide cases, we should be wary that this effect may be short-lived. Viruses are constantly evolving to become more aggressive and drug-resistant, and there is evidence that a new wave of HIV is likely approaching. This surge is already beginning to affect the Global South, including regions in Latin America, Africa, Asia, and Oceania. HIV, due to its high mutation rate, has the remarkable potential to transform itself into a new virus every time it infects a new cell.

HIV is a subgroup of retroviruses, which are ribonucleic acid (RNA) viruses characterized by how they replicate in a host. HIV, and other retroviruses, enter the human cell, where the viral RNA sequence is converted to deoxyribonucleic acid (DNA) by reverse transcriptase, a virally encoded enzyme. The resulting viral DNA is then imported into the nucleus of the cell and integrated into cellular DNA. The infected cell then creates more of the virus and causes the cell to burst, releasing more of the virus into the blood. The increase of HIV in the blood continues the multiplication process and worsens the infection. HIV targets a specific type of immune system cell known as Helper CD4 cells or T-cells. When the virus has destroyed a certain number of CD4 cells and the CD4 count drops below 200, a person will develop Acquired Immunodeficiency Syndrome (AIDS). This damage to the immune system makes it progressively harder for the body to fight off infections and other diseases.

We have fought against HIV by developing medicines that block its replication, either by blocking HIV's access to immune cells or by stopping the virus from self-replicating. These medicines, known as antiretrovirals (ARVs), are a group of drugs that work in different ways to combat HIV. For example, some ARVs work by blocking receptors and thus prevent HIV from attaching to the host cell. Additionally, these drugs can work preventatively in people who do not have the virus. Pre-exposure prophylaxis (PrEP) is an HIV prevention strategy where those who are HIV-negative take ARVs to reduce their risk of becoming infected. What makes ARVs revolutionary is for people who are HIV-positive, ARVs can dramatically reduce HIV transmission. As long as ARVs are taken as prescribed, HIV can become undetectable and also untransmittable. This tactic is known as "Treatment as Prevention" and has the potential to end the epidemic.

However, the story is not that simple. There are actually two different species of HIV that infect humans. The most common, HIV-1, is responsible for the worldwide AIDS epidemic. The HIV-1 virus is further divided into groups M, N, O, and P. Viruses categorized under Group M are of most concern as they are the most common and caused the worldwide epidemic. Group M can consist of nine subtypes, A through J, and at least 58 circulation recombinant forms. Some subtypes are known to be more virulent or more resistant to certain medications.

To truly show how extensive HIV-1's genetic diversity is, Edsel Salvana, an infectious disease specialist and molecular epidemiologist based in the Philippines, elucidates a genetic comparison between the different subtypes. The genetic difference between humans from different continents is about 0.1%. Alternatively, if we look at the differences between humans and rhesus macaque (a monkey species), that number jumps to 7%. In contrast, the genetic variation of HIV is 25-35% between subtypes and 15-20% within subtypes. The difference between the mother virus and its subsequent daughter viruses in a person infected with HIV can be as high as 5%. As Salvana puts it: "this is the equivalent of a gorilla giving birth to a chimpanzee, then to an orangutan, then to a baboon."

With new HIV subtypes discovered regularly, the story takes a dark turn. The majority of HIV/AIDS research uses only subtype-B strains. While this strain is dominant in Europe, North and South America, Japan, Australia, the Middle East, and North Africa, it only accounts for 12% of cases worldwide. Given the homogeneity of research, we cannot adequately treat the other subtypes, nor are we able to address increases in genetic diversity, which causes the virus to be more aggressive and resistant to drugs.

> The difference between the mother virus and its daughter viruses can be as high as 5%. As Dr. Salvana puts it: "this is the equivalent of a gorilla giving birth to a chimpanzee."

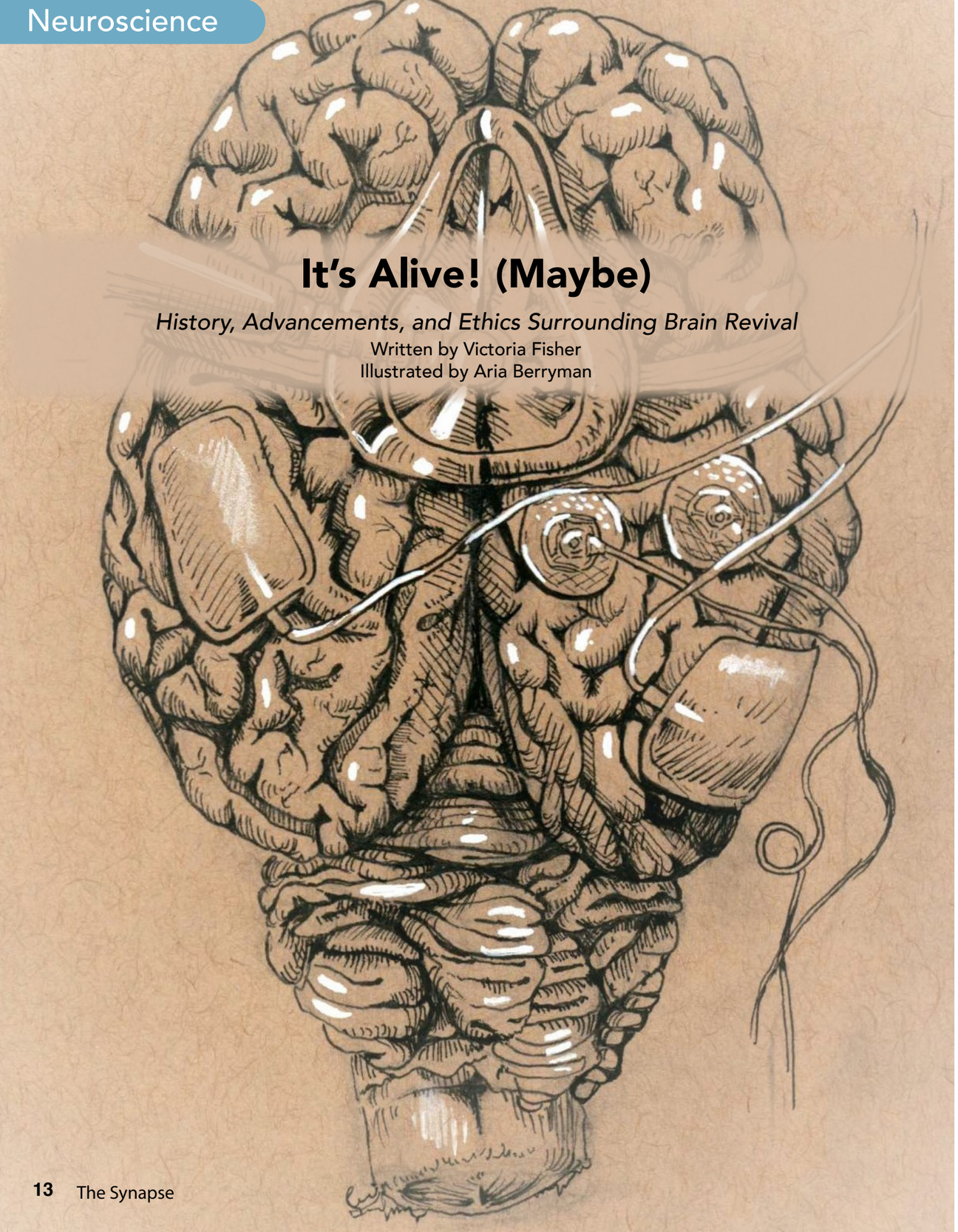
Since subtype-B is primarily researched, the vast majority of our treatments are subtype-B specific. However, these treatments are used to treat those who have and those at risk for non-B subtypes. This failing in research falls into a trend within medicine where illnesses that affect Western countries are disproportionately researched, limiting the robustness of any treatment developed. These inequalities in research and medicine can disproportionately affect the most vulnerable populations, particularly communities of color.

The effects of these inequalities are strongly evident in HIV treatment. Subtype C is the dominant subtype in North-, West-, East-, and Southern Africa, which collectively contribute approximately 26 million of the 37.9 million cases worldwide, according to the United Nations 2019 AIDS report. Thus, AIDS research is not targeting the strains affecting the vast majority of people. Further, using treatments from subtype-B research may lead to the other strains mutating at a faster rate. Researchers from the University of Leuven in Belgium have identified a new subtype of HIV called CRF19, a recombinant comprising three different subtypes, A, D, and G, all of which are found in Eastern Africa. For this subtype, 72% of patients identified were rapid progressors, meaning that they progressed to AIDS in only 1.4 years compared to the 9.8 years that non-CRF19 patients experienced.

A significant obstacle in developing an effective HIV vaccine or cure is its rapid viral evolution, making HIV "a moving target." The rapid rate of development is mainly attributable to the error-prone nature of reverse transcriptase, which lacks proofreading activities. In addition, one or more viruses may undergo recombination to produce a completely new virus. Recombination is the rearrangement of genetic material, but in viruses, it occurs when one or more viral strains "co-infect" the same host cell and interact to create viral progeny that has some genes from some parents and some genes from others. Due to the extensive variation between strains within one person, a single ARV is not sufficient alone. Therefore, drug cocktails are taken together to hopefully combat several forms. Using a large cocktail may effectively target a broader range of the virus; therefore, decreasing its ability to spread. Unfortunately, this can lead to multiple-drug-resistant strains exacerbated by inappropriately using subtype-B medications in individuals with other subtypes of HIV1-M. Thus, these cocktails cause only the inherently resistant viruses within the host's body to survive. These viruses will then proliferate, making a new, highly resistant strain that can be passed on.

> Unfortunately, [drug-cocktails] can lead to multiple-drug-resistant strains exacerbated by inappropriately using subtype-B medications in individuals with other subtypes of HIV1-M.

It is time that we stop thinking about HIV as a single virus and instead view it as a collection of rapidly evolving viruses, each with the potential to be highly unique. We need to invest in newer and more powerful tools to identify and combat new strains. We need to address the inequality within this system so that we can treat the majority of patients and prevent the emergence of a deadlier HIV strain. We need urgent research on the behavior and proper treatment of non-B subtypes. And we must understand that the HIV epidemic is not over yet. • • •



It's Alive! (Maybe)

History, Advancements, and Ethics Surrounding Brain Revival

Written by Victoria Fisher
Illustrated by Aria Berryman

Mary Shelley's novel Frankenstein astonished readers in the 1800s. The concept of disembodying and reviving corpses was sacrilegious and grotesque to some and a feat of scientific pursuit and progress to others. This controversial book has inspired cinema and science alike for the last 200 years, however, the resurrection of dead tissue has remained a topic of science fiction until recently. In April of 2019, a team of researchers led by Zvonimir Vrselja and Stefano Daniele at Yale University were able to partially revive (a topic we will explore later) 32 pig brains, six hours post-mortem. Similar to Shelley's book, this discovery led to a multitude of responses, ranging from excitement over progress to questions of ethics. But where did this fascination with reviving the dead begin?

Investigations into the reanimation of dead tissue can be traced back for millennia, but the true spark (no pun intended) began with Luigi Galvani, a late-18th-century scientist. Galvani noticed that when he tapped a disembodied frog leg with a metal scalpel, the leg reflexively twitched. In order to explain the phenomenon, Galvani and his nephew Giovanni Aldini were inspired to investigate the role of electricity in animal life. Aldini held public demonstrations during which he applied electricity to recently deceased bodies such as sheep, dogs, and even the executed convict George Foster. These fantastical displays led to the incorporation of electricity, termed Galvanism, into the scientific community as medicinal "cure-alls." While Galvani was correct in that electric impulses dictate our every move, his and his contemporaries' advancements left us far from a resurrection.

In fact, when the Yale researchers revived the pig brains, electricity was not introduced in any capacity. They used a system called BEx, which works by perfusing a solution containing artificial blood, called hemopure, as well as other additives such as metabolic compounds, cytoprotective (cell-protecting) agents, and antibiotics into the brain. The profusion was at a rate comparable to that of a pulse, imitating the real-life introduction of nutrients from the bloodstream to the brain. It is important to note that the brain had to be continually connected to the source of blood in order to maintain the revived-like state. Unlike the fictional monster of Frankenstein or the supposedly animated corpses from Aldini, the brains could not remain free-standing. Nonetheless, cells in the brain displayed partial revival, as determined by a myriad of tests that we will explore/discuss next.

First, the Yale researchers assessed the brains for tissue maintenance and integrity. Unsurprisingly, when we die our brains and its tissue begin to degrade and lose functionality. Thus, in order to be deemed as a successful revival, the pig brains with BEx must be able to slow the degradation process. The researchers determined tissue integrity by measuring the size of different parts of the pig brains, such as the corpus callosum and the ventricles. They found that these areas in pig brains receiving the BEx solution were more comparable in size to living brains relative to degraded tissue in the controls. Further, the researchers also measured the grey matter (cell bodies/dendrites) to white matter (nerve fibers) ratio. In brains that received the BEx injection, this ratio was again more comparable to living pig brains than to dead brains. Thus, the BEx solution was able to maintain the structure of the pig brains.

Researchers also tested the responsiveness of the brain cells to disruptions. These include testing the inflammatory response, synaptic firing, and metabolism. The researchers introduced lipopolysaccharide or LPS (an immunogenic substance) into the glial cells, which are responsible for immune responses in the brain. The injection led to an inflammatory response, indicating that the glial cells were functional. The researchers also wanted to assess if neurons had the machinery to fire, which is how neurons communicate and allow us to think, move, and process our environment. When perturbed, the hippocampus in the revived brains demonstrated typical synaptic firing. This is not to say that the neurons were able to communicate or work cohesively, but that the individual neurons were capable of firing. Finally, the cells also displayed typical consumption of nutrients such as glucose and oxygen compared to controls. Thus, through these tests, the researchers were able to demonstrate that pig brains exposed to BEx maintained the structure and capacity to respond to and process chemicals as a living brain would.

From the ivory tower of academia and science, these advancements are incredible and exciting. However, from a more grounded perspective, this research introduces questions concerning the ethics and impact these revival solutions may have. Dead animal bodies are not protected by many restrictions, in part because dead brains do not experience pain or discomfort. As stated by Zvonimir Vrselja, one of the lead authors of the study, the synaptic firing observed in the brains was neither sufficiently organized nor cohesive to indicate any level of perception. However, the firing of neurons reflects that regaining consciousness is theoretically possible. While researchers at Yale took several measures to make sure this would not happen, ambitious researchers may attempt to regain consciousness in a dead brain without proper regulations. Thus, as Nita Farahany, an ethics expert from Duke Law School, discussed with the National Public Radio, action needs to be taken to make sure we protect not only the living creatures but those with the potential to be revived.

> The resurrection of dead tissue has remained a topic of science fiction until recently, when researchers partially revived 32 pig brains.

We are still very far from having a "living" Frankenstein's monster in the world. Despite significant steps toward understanding the degradation of dead matter, the Yale researchers still doubt the efficacy of their own tools. However, even with moderate progress additional ethical concerns arise. While the partial-revival of the pig brains may allow us to better study diseases and their effects on functionality post-mortem, it also brings about a new world of potential for harm and abuse of the dead. So we must ask ourselves: what is the next step? And how can we avoid hurting those most vulnerable amongst us? • • •

The History of Geology

Oberlin College Rock Garden Unearths Ohio's Geologic History

Written by: Monica Dix
Illustrated by: EJ LaFave

About 10 thousand years ago, Ohio began a natural rock collection with samples that hitched a ride on mile-thick glaciers that traveled through Canada and carved out the Great Lakes Region. Some of the most prominent erratics, or large rocks transported by glaciers, are regularly spray painted in Oberlin's Tappan Square. The Tappan Square erratics, dug up from the banks of Plum Creek, are familiar reminders that the flat Ohio landscapes we take for granted are only a recent renovation in the history of Earth.

For nearly a century, the Oberlin College Geology Department has been curating a collection of their largest pieces in the department's rock garden. Often unnoticed, the garden now sits on the north side of Carnegie Building, under the arbor of trees and thick English Ivy. Despite its modest appearance, the Oberlin College Geology Department Rock Garden has a long history that showcases Ohio's place in Earth's history.

The collection started to accumulate in the early 1900s, when the Geology Department was in its first iteration as a house on Oberlin College's north campus. Professor Emeritus Bruce Simonson, a current faculty member at Oberlin, has a suspicion that the rocks originated in the collection of George Frederick Wright. Wright was an alum and minister in New England who started marveling at glacial deposits even before the development of glacial theory. His interest grew to be academic, and he was later hired back at Oberlin as the Professor in the Harmony of Science and Revelation, a position which combined Geology, Archaeology, and Theology. He rapidly became one of the leaders of glacial field work, spending his summers mapping the most recent glacial edge, called a terminal moraine, from Long Island, NY to the Mississippi River. He curated the "Erratic Collection," which has been suspected to be the first garden's original rocks, sent to Wright by people from all over the US to identify. These rocks carry on in Oberlin's collection as a reminder of Wright, one of the founders of the Geological Society of America and a preeminent North American geologist who put the Oberlin Geology department on the map.

Dr. Jim Powell, a previous acting president and Geology Department Professor in '62, witnessed the move of the Geology Department, Psychology Department, and the Rock Garden to Severance Hall. In today's architecture, the area is now where the benches sit in the L-shaped area behind the building. In 1989, the Carnegie Building was finally renovated for the Geology Department to make another move, but the rocks were placed in storage. It was only in 2003 when Professor Karla Parsons Hubbard proposed to the grounds committee to move rocks to the current arrangement, where they have remained for the past two decades. After all the shuffles and new contributions, what is in the current collection?

The first major category of samples in the collection are the world's first conglomerates, the oldest coming from a Candian Greenstone belt at the end of the Archean Era. One of many conglomerates, or rocks made up of many smaller rocks or minerals sedimented together, it is about 2.6-2.8 billion years old and either from an on-land fan-shaped deposit or deep-sea environment in Earth's early ocean. The mineral pieces it is made of are only igneous, or directly originating from earth's interior, since there were no large continental river systems to break down these initial rocks into smaller mineral components. Just 100 million years after this rock's creation, the continental masses we are familiar with today developed. Today, these Greenstone belts lie north of Oberlin in Canada and are where the gold mines of Ontario are located.

The most famous and striking conglomerates in the collection are Puddingstone, named after the bright red pieces of silica-rich Jasper. The Puddingstone conglomerates are found only in the north shore of Lake Huron and are often compared in appearance to raisins in English pudding. Bright red Jasper rock breaks off of ancient banded iron formations, which record the introduction of oxygen into Earth's atmosphere from blue-green algae. Since these can only be found on the Northern coast of Lake Ontario, this made Puddingstone's presence in Ohio a key piece of evidence for glaciation. Our Puddingstone rocks are 2.4 billion years old, mostly from the margins of early oceans with the first quartz weathered on the edge of the first continents in the Canadian Shield region. This rock was so special to Wright, that a large Puddingstone erratic makes up his gravestone in Oberlin's Edgewood Cemetery.

The second major category of rocks in the garden are igneous erratics and gneisses. Unlike Puddingstone conglomerates, it is hard to determine the specific origins of metamorphosed gneisses, which are physically and thermally altered igneous rocks. As rocks that were part of the original continent, they have been stretched and squashed until their chemical composition and structure began to alter. Many of the gneisses in the collection are suspected to come from the Grenville Orogeny, which was a mountain forming event that occurred only a billion years ago. Other gneisses are smaller igneous erratics derived from Canada in various forms, including igneous and metamorphic.

One prominent erratic is a sample filled with mafic xenoliths, which are pieces of rock that intruded into and were not part of the original sample. The xenoliths have weathered away more slowly than the original rock's surface, creating geometric gouges. It is apparent that there was one intrusive rock, and then potentially another intrusion of different origin, then a large fracture that split the original grey material apart and granite filled in the cracks. The weathering difference is so aggressive that Professor Simonson suspects that it has gone through several more glacial cycles than the other smoother erratics.

The third major category of rocks in the collection are those who are glacially carved, which are most recognizable by large-scale scratches, scrapes and grooves big enough to sit in. Easily identifiable from its man-made label, a sample from Kelley's Island in Sandusky features spectacular glacial grooves that were cut by the strong rivers blasting underneath the glaciers and fossils of corals that were present in the environment where the rock was first formed. You can see preserved horn coral, colonial coral, and other fossils, which serve as reminders of the vast inland sea that once covered the land. Larger corals from this rock will occasionally have comet trails, which are grooves that stretch behind corals as the glacier raises up to accommodate the hard, silicified coral.

The largest slab in the collection shows two distinct ice-carved features, superimposed over one another in two directions. Chattermarks are distinct U-shaped scratches that scrape the bedrock in short pressure-release cycles where they are pressed against the rock until they fracture, jump and repeat the cycle again. There are a couple of these punctuated tracks, in addition to long scratches where glacial rocks were dragged against the bedrock more steadily. While its original origin is unknown, the sample is made up of the local Berea sandstone, whose structure shows these features more easily.

The fourth and final rock category in the garden is the collection of ripples. Also the only part of the collection that is unrelated to Ohio's rich glacial history, the garden's collection of fossilized ripples is all sourced from local Berea sandstone. These features were created by both waves and currents, and some samples have two-way ladderback ripples which make them look like tortoise shells. Ladderback ripples are unique combinations of waves and current resulting in an array of perpendicular lines. This formation can also be seen in the sandstone slabs behind Cox Administration Building in bullseye shapes. The most recent addition to the ripple collection was sourced from the Amherst quarry on a field trip by Professor Dennis Hubbard and shows a cross-cut on the side of the rock with ripples, dunes, and soft sediment deformation.

These ripples were created back when the Appalachian Mountains were building to Ohio's east, and the state was a shallow, sandy shoreline. Overall, this was an epicontinental sea environment with very high global sea level that flooded continents and contributed to coral reef environments. The Berea sandstone dips down deep into the ground from our area towards the Appalachian Mountains, and as close to Oberlin as Akron, OH. You can even pump oil out of it or find tap water in Cleveland which naturally contains gas because the Berea is so oil rich.

These four categories of rocks in the Oberlin Rock Garden capture the many forces that have shaped the history of Ohio, from glaciers to a vast inland sea. These rocks celebrate a near-100 year history of being used in classes, labs, and as tools to reflect on material that has been eroded, squeezed, carried and reshaped entirely in the past 4.5 billion years. With the help of some football players, a crane, and persuasive blueprints to facilities, the rocks now rest in the shade of Carnegie Building, a perfect place to rest and reflect. • • •

This article is in memory of Dr. William Skinner who was a Geology Professor and Petrologist at Oberlin for many decades.

Too Juul for School

Serious Dangers Wrapped in Fun Flavors

Written by Nicole Franowicz
Illustrated by Athina Apizidis

The days of smoking tobacco seemed long gone, with widespread anti-smoking campaigns instilling our generation with the perception that cigarettes were gross and unhealthy. This shift, however, was short lived. In 2003, e-cigarette companies presented us with a new, sleek, tasty alternative to tobacco that appeared less harmful and still provided the same nicotine rush that many people seek.

The e-cigarette's cool friend, the JUUL, has been extremely popular among middle school and high school students over the last three years. The use of e-cigarettes increased by 78 percent and 48 percent from 2017 to 2018 for high school and middle school students respectively. Products like the JUUL were widely discussed in social and news media at the time because they were a new and promising method to help heavy smokers. Their dangers were not known until cases of lung collapse in young teens began showing up in the news.

Over time, accumulated research has uncovered just how dangerous these e-cigarettes are. A study published in Nature's December 2019 issue tested different JUUL pod flavors and found that these nicotine pods "induce inflammation, epithelial barrier dysfunction, and DNA damage in lung epithelial cells and monocytes," among other things. This new research specifically reveals the dangers within the varying synthetic flavorings that so many JUUL smokers love.

The goal of this study was to test the effects of these different synthetic flavorings in JUUL pods, including Creme Brulee, Fruit Medley, Virginia Tobacco, Cool Mint, Cool Cucumber, Mango, and Classic Menthol, have on lung tissue when exposed in different concentrations, mimicking the amount of puffs someone would take in at one time. The study produced many findings, such as how JUULs "induce irritation of the lung and inflammatory responses" and that "these flavoring chemicals can induce significant reactive oxygen species (ROS) release, oxidative stress, inflammation, and barrier dysfunction." Such findings had not been found previously because, here, researchers were targeting the effects of synthetic flavoring of certain e-cigarettes. This new information can fuel research by organizations looking to test other synthetic aspects of e-cigarettes.

> The use of e-cigarettes increased by 78 percent and 48 percent from 2017 to 2018 for high school and middle school students respectively.

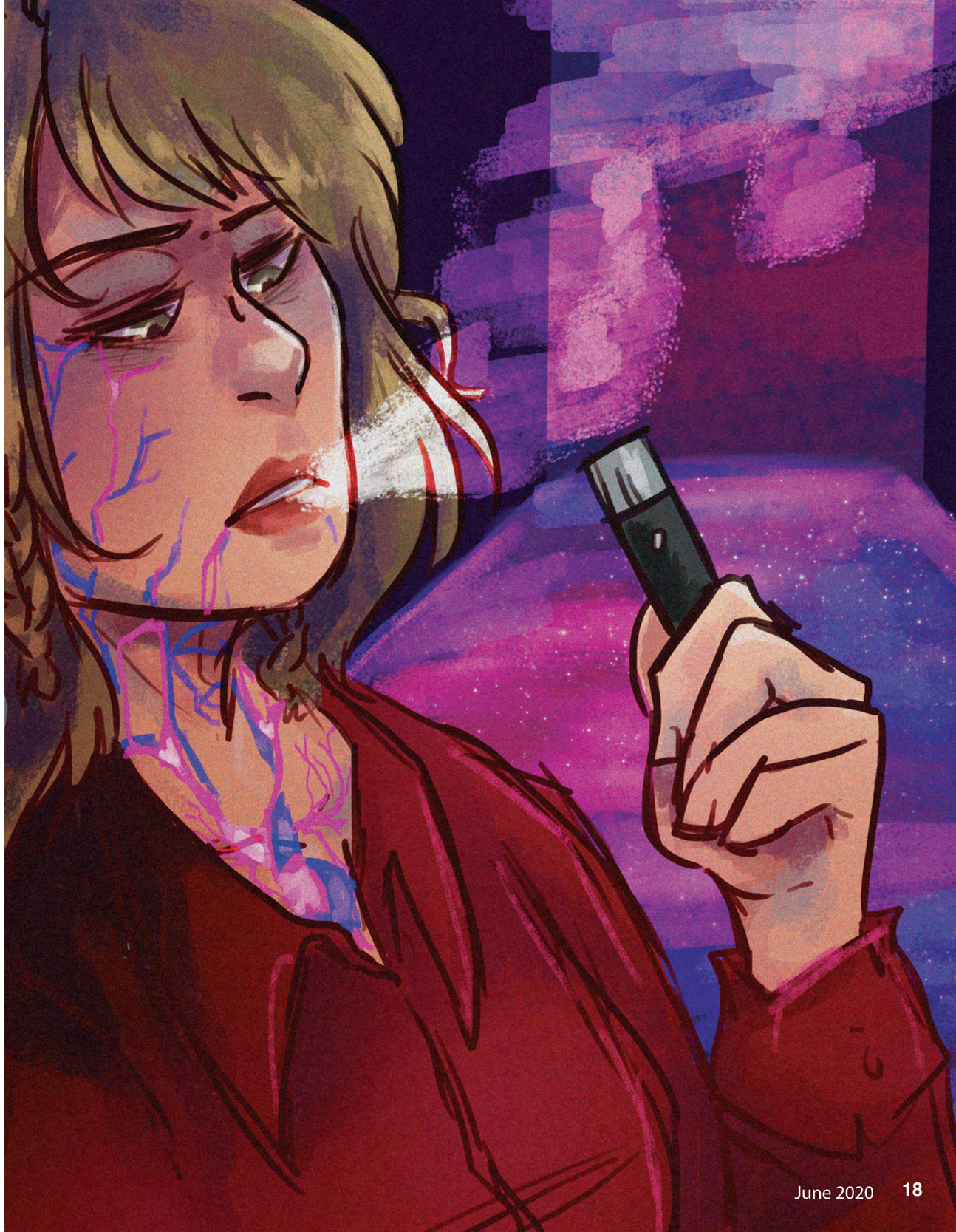
However, the effect of these popular pods flavors was not a major concern for the company or its consumers, who assumed the pods were relatively safe. As stated on JUUL's website: "We recognize that alternative tobacco products continue to be the subject of conversation. We welcome dialogue, debate and data, and will register and publish results from vapor-related research we conduct." While this portrays the company as caring about its users' health, there has been no significant research conducted by the company on the health effects of their product.

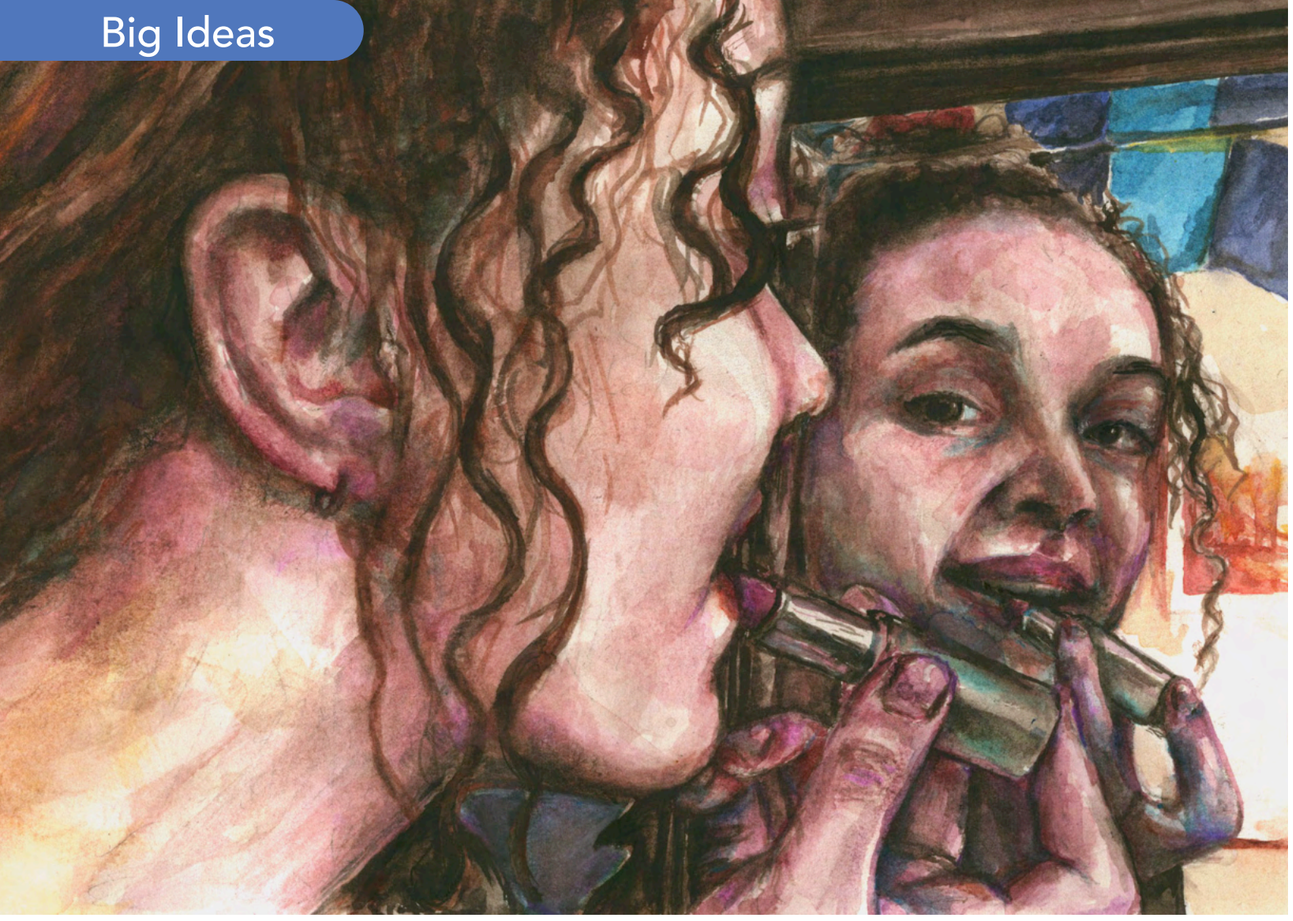
Since the Fall of 2019, all flavors except for Virginia Tobacco, Menthol, and Classic Tobacco have stopped being sold by the JUUL company as a part of their Youth Prevention initiative. Many accused them of intentionally marketing toward the younger generation and encouraging underage nicotine consumption. In response to the criticism, the company decided to stop manufacturing their top-selling flavors. By removing the most popular flavors, JUUL hoped that many of the teenagers drawn to the product because of its fun flavors would stop vaping.

Looking at outside research, it is clear that all JUUL products, regardless of pod flavor, have dangerous effects on the lungs and entire body. Doctors have compared the lung damage caused by e-cigarettes to that of chemical burns or toxic chemical exposure. "More than 800 cases of lung illness in 46 states have been linked to vaping, and 16 people have died" according to the New York Times. An article published in Nature also noted that e-cigarettes also pose significant dangers to cardiovascular health including inducing: "atherosclerosis, hypertension, thrombogenesis, and myocardial infarction."

The JUUL website highlights the fact that their product is healthier than traditional cigarettes and that their goal is to help existing smokers quit. Even though the JUUL company claims they are mainly looking to help cigarette smokers switch to something less harmful that provides a similar effect, they have released little company-produced studies on the effects of their product. Regardless of intent, middle and high schoolers are using these products. They start vaping because it is popular among their friends and makes them feel a head rush under the guise that JUUL is a safer and possibly even a completely safe alternative. As a result, they are introducing lung-related illnesses to themselves.

While it is true that e-cigarettes do not contain all the harmful ingredients that traditional cigarettes do, there is not enough accumulated research on the effects of their ingredients to deem them a safe choice. With nearly 1 in 3 high school students using e-cigarettes, this misnomer of their "safety" has the potential to eventually be fatal for thousands of teenagers developing nicotine additions. It is clear that the media is trying to steer young people away from e-cigarettes; however, there needs to be an increase in research concerning the dangers of e-cigarettes and easier ways to learn about the dangers of vaping. Society was slowly phasing out nicotine with each generation, but unfortunately, JUUL has fueled a massive resurgence of consumption and addiction.





Lips Don't Lie

Lipstick Effect, Self-esteem, and Social Implications

Written by Jinhan Wu
Illustrated by Della Copes-Finke

What object has existed since 5 thousand BC in ancient Mesopotamia and remained popular in today's society? The surprising answer is lipstick. Tremendous changes have happened in human society over thousands of years, but lipstick remains an essential part of our daily life. Lipstick's resiliency within our culture implies that lipstick aligns with something fundamental to human nature. Recent studies show that self-esteem might be the answer.

Derived from one's past experiences - self-esteem is motivated by the basic social motive of self-enhancement as described by social psychologist Susan Fiske. People like to feel good about themselves, so they seek to maintain high self-esteem and self-improvement. Feelings of high self-esteem often follow success in an important task, positive feedback from others, the feeling of being unique, and things that increase positive perceptions of oneself. People with high self-esteem tend to perform better, work harder, and collaborate more willingly. Positive feedback from daily achievements enables people to boost their confidence and maintain self-esteem at an appropriate level - which reflects the common loop of self-esteem under most circumstances. However, during difficult times, even people born with high self-esteem can feel terrible about themselves and in need of a booster. That is where lipstick got involved.

Economists first revealed the relationship between lipstick and self-esteem through data on lipstick sales during economic depressions. We usually assume that demand for non-necessities during an economic depression will drop because people lack the resources and therefore the desire for them. However, lipstick sales increase during times of economic hardship, which is termed the "lipstick effect." Psychologists assert that young, unmarried women bought and used more products like lipstick during economic recessions to increase their attractiveness. The research of Dr. Geoff Beattie at the University of Manchester shows that red lipstick draws five extra seconds of attention, typically from the opposite sex. An investigation in France also revealed that female waitresses received more tips from male customers when wearing red lipstick. Another relevant study indicates that wearing makeup will intervene in others' facial perception and make people look younger. Since red lips and smooth skin are often indicators of better health and younger age, strengthening those characteristics through makeup can vastly increase physical attractiveness.

The ability of lipstick and other makeup products to increase physical attractiveness is deeply intertwined with self-esteem and the reinforcing effects of past experiences. In the research previously described, makeup led to positive experiences such as receiving more attention and increasing amounts tipped. All of these beneficial effects bolstered participant's perceptions of themselves, causing them to maintain their high level of self-esteem.

Direct evidence on the relationship between makeup and self-esteem came from research at Edith Cowan University, which found that women today primarily wear lipstick because it made them feel more confident. Wearing makeup is revealed to be beneficial to academic performance by raising people's self-esteem. Unlike directly giving you positive feedback under other circumstances, increased physical attractiveness during a test may increase your overall confidence by making you feel good about yourself, which has been shown to increase test scores in general.

The interesting consumer behaviors in the beauty market during recessions inspired some economists to regard lipstick as a new indicator of the economy. Makeup, correlated with self-esteem, can take on many additional roles and meanings. Furthermore,

The interesting consumer behaviors in the beauty market during recessions inspired some economists to regard lipstick as a new indicator of the economy.

what is unique about the make-up-self-esteem model is that while "makeup" (or the presence of it) is explicit, "self-esteem" is hard to measure. The lipstick effect in the economy has shown the power of this model on interpreting self-esteem levels and makeup's impact on it. However, we can also utilize the model reversely, letting makeup reveal changes in self-esteem. Makeup has many natural advantages in such analyses.

Experiences shape self-esteem. Therefore, as a daily routine for some people, makeup is quite close to the origin of their self-esteem, which makes it an excellent indicator of this abstract concept. Take social hierarchy in the mid-18th century as an example. The aristocracy at that time applied flamboyantly styled blushes on a daily basis to distinguish themselves from people in the middle and lower classes. Wearing makeup to represent social status may have increased their feeling of superiority, a critical property of high self-esteem. Studies with lobster demonstrate that self-esteem and social hierarchy are both related to levels of serotonin. Higher self-esteem usually means a higher status in the social hierarchy. The mid-18th century aristocracy likely hoped to raise their self-esteem by utilizing makeup as a status symbol of their wealth and power.

But the greater potential of the make-up-self-esteem model lies under longitudinal comparisons. After all, makeup has existed in human societies over millennia and recorded complexity in human society over all these years. Recording history with vivid colors, makeup enables us to compare the self-esteem of societies from different periods.

Let's continue with the example of social status, specifically focusing on women. In ancient Egypt, acceptance of makeup was so widespread, women would wear it daily. In fact, women at the time had more autonomy compared to other contemporary and later civilizations. They were able to own and inherit land, own business, and instigate legal proceedings against men, all of which indicates high social status. If wearing makeup made them look more successful and confident, ancient female Egyptians could have experienced a relatively high level of self-esteem, matching with their social status.

However, compared to Egyptians, women living in medieval times were strictly restricted on makeup, because early

Recording history with vivid colors, makeup enables us to compare the self-esteem of societies from different periods.

Christian writers closely related makeup with deception. Makeup became something done in secret. The social status of women around this era was also fairly low. It is likely that without the freedom of pursuing physical attractiveness and lacking many rights, women in medieval times generally had lower self-esteem than Egyptian women.

Public perception of makeup transformed in the late 19th century with the beginning of the silent movie industry and female emancipation, allowing it to become a popular way for females to express themselves. With the rise in female social status derived from feminist movements, women enjoyed increased freedom of wearing makeup and personal expression. For example, in the 1970s, some women wore black lipstick to express nonconformity. Though red lipstick is often associated with high estrogen levels, which stands for being sexually attractive, wearing black lipstick was not for physical attractiveness. Instead, this choice should be regarded as a way of expressin g women's unique value, a significant portion of self-esteem. Again, makeup leads us to mark female social status and match it with self-esteem level.

Make-up has had a profound effect on our society. By just browsing social media or looking through advertisements, one can see the ability of make-up to mark trends in society. Make-up use also provides a window into the past. Just think about how many subtle changes in female self-esteem across time we can detect by using the make-up-self-esteem model. It is incredible how this small tube of wax can reveal worldly trends. • • •

Artificial Intelligence: The Engine That Can

The Transition from Artificial Intelligence to Artificial Creativity

Written by Neil Ruthen
Illustrated by Athina Apazidis

In a 1990s interview, Alicyn Warren, a renowned Professor of Music at the University of Virginia, declared: "Musicians will always be in demand. As accurate as computers are, they can't come close to the creative ability of people." Warren's statement reflects the prevailing sentiment on the limitations of computers at the turn of the century, a sentiment that still exists today. Not long after the interview, another Professor of Music, David Cope, introduced the world to Emily Howell — a computer program designed to compose music. Behind the idea for Emily's software was the notion that artists draw inspiration from other artists and, furthermore, that their works are only a few levels of abstraction away from existing ones. If human creativity stems from the unintentional mimicry of previous works, might a computer be able to replicate that process through machine learning?

To answer this question, Cope constructed Emily from an earlier program, Experiments in Musical Intelligence (EMI), that was trained on the musical styles of famous composers. Like this program, Emily initially produced only rudimentary pastiches of the likes of Mozart and Bach. In response, Cope improved her supervised learning algorithms so that she could learn continuously from criticism. Two decades later, musical experts could no longer differentiate between the works of Cope, Mozart, and Emily. They confused Cope's works with Emily's, Mozart's works with Cope's, and most impressively, Emily's work with Mozart's. Like only a handful of systems before, Emily has passed the Turing Test, meaning her work is indistinguishable from that of a human. Cope's creation is non-living proof that the question is no longer whether computers can match human creativity but whether they can surpass it.

Definitions of creativity are difficult to extend to artificial intelligence (A.I.). Creativity is often considered to be a biological process and, subconsciously, an innately human trait. But Dr. Daniel T. Gruner and Dr. Mihaly Csikszentmihalyi — researchers of creativity and artificial intelligence at Harvard University — suggest that we expose the limitations of A.I. by juxtaposing two theories of creativity: individualist and sociocultural. The individualist theory states that "creativity is a new mental combination that is expressed in the world." This definition requires that creativity includes the expression of original ideas or a new application of learned information. Writing out a synopsis of Twelfth Night would not be considered an expression of creativity under this definition, however, using Shakespearian sonnets to structure a new poem would. This individualist definition of creativity pertains to what is dubbed "little-c" creativity, that is, creativity on a person-to-person basis. The second sociocultural theory of creativity focuses on "Big-C" creativity: ideas or works that expand the horizons of human capability. In this sociocultural approach, creative work is defined as being different from the individual's past work, work that is accepted by a field of experts, and is outside of the domain of current knowledge. Thus, implementing Shakespearian sonnets into one's poetry would not meet the requirements for Big-C creativity, one would have to invent their own style of poetry to qualify.

Furthermore, the individualist and sociocultural definitions leave little room for artificial intelligence to sneak into the realms of creativity. All A.I. systems rely on training datasets, normally provided in the form of visual, auditory, and alphanumeric data types. Such systems are often only as good as their training datasets and so most implementations of A.I. fall short of little-c and Big-C creativity: these systems fill out our search queries, pick out abnormalities from medical images, or even recommend what songs we should listen to next. Several A.I. systems do satisfy conditions for creativity, however. Like Emily Howell, these systems 1) produce original work, 2) learn in ways that are distinct from humans before them, and 3) are able to apply what they have learned in new settings. IBM Watson's cognitive platform, the same platform that won a game of Jeopardy! against two former champions, produced the world's first A.I.-generated trailer for the horror movie Morgan. After sifting through hundreds of existing horror film trailers, Watson was able to select short clips from Morgan based on the auditory and visual signatures associated with emotionally salient moments, the key elements of a good trailer. Another example from the world of art, Google's Deep Dream Generator has been warping base images in its own psychedelic style and adapting the styles of human artists to new settings. In 2016, Deep Dream's digital paintings sold for high prices at a San Francisco art show, receiving critical acclaim.

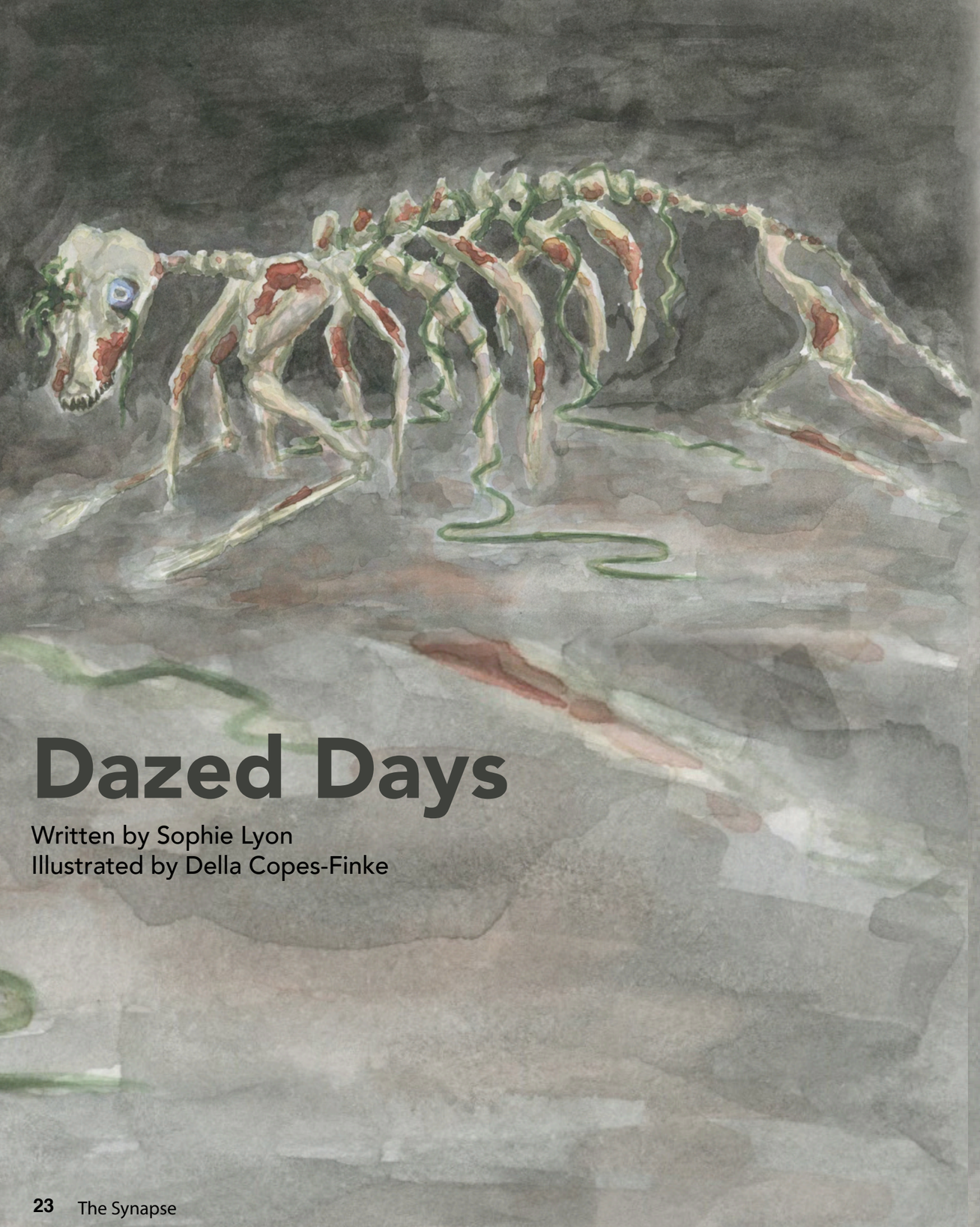
> The question is no longer whether computers can match human creativity but whether they can surpass it.

If you are troubled by artificial intelligence rapidly encroaching on creativity, you are not alone. Presidential candidates, scientists, and tech CEOs have all raised concerns about the potential for A.I. to automate white-collar positions even as blue-collar jobs are outsourced to robots. Democratic candidate Andrew Yang based his campaign on a proposal for universal income to offset the mass layoffs due to the rise of automation. His book, The War on Normal People, suggests that one-third of working Americans could lose their jobs to computational or robotic workers within the next twelve years. The advent of computational creativity presents the final straw in the shift to an A.I. driven future: A.I. could replace humans in the workforce entirely.

The concern for advances in A.I. creativity should not stop with our worries of becoming obsolete. In the wrong hands, creative A.I. could accelerate the spread of disinformation. Researchers at Open A.I. Laboratory have developed a model known as GPT-2 that is tasked with predicting the next word following an incomplete passage of text. When running recursively, GPT-2 can auto-complete passages of text in a coherent fashion and even generate convincing arguments to prompts provided by researchers. The power behind this model lies in the 8 million pages of internet resources that GPT-2 has been trained with. The A.I. system can be compared to an extremely observant but uncomprehending student: it gives the expected answers without understanding the material. Though the most recent version of GPT-2 outputs high-quality responses infrequently, future versions may patch the system's flaws. Open A.I. worries that GPT-2 could be used as bots to spread or generate fake news — as GPT-2 is adept at creating original headlines — and has withheld the release of the program to prevent GPT-2 from being used maliciously.

> The A.I. system can be compared to an extremely observant but uncomprehending student: it gives the expected answers without understanding the material.

With the real possibility of artificial intelligence competing with humans in music, art, literature, and industry, where does that leave us? Legally, more powerful A.I. systems may not be worth the risk. Questions about who is liable for accidents involving autonomous vehicles has slowed down the commercial launch of self-driving cars. Concerns about who should be sued in the case of a misdiagnosis by machine learning algorithms ensure that medical practitioners supervise their computational coworkers. As A.I. systems cannot accept responsibility for their actions, they will require human guardianship in the coming years. As of now, A.I. creates from what already exists. Though A.I. creates original work, it is work that resides within arm's length of current advances. In this sense, computers have not yet reached Big-C creativity. Computer programs are currently incapable of producing ideas that revolutionize entire fields or transcend artistic trends, and must depend on these trends to express their creativity. For now, artificial intelligence needs humans to show them the endless possibilities. • • •



Dazed Days

Written by Sophie Lyon
Illustrated by Della Copes-Finke

CONTENT WARNING: The following story contains depictions of disease, gore, and death

Anyone who knew Doctor Sato on a first-name basis, and very few did, just called her Daze. She hadn't heard the name Daisy since she left the New Miami Stronghold years ago, and even then few called her by that name. Her parents had seen daisies in their youth, long before Daze was born. A few had lived within Daze's lifetime, but had all died before she could see one. The fragile flowers couldn't weather the effects of global warming and stood no chance against the new, more aggressive plant life, which had taken root in the dusty soil, murky water, and crumbling concrete buildings.

Daze hit the capped test tube against the heel of her hand with a little more aggression than was needed. She held it up to the light, glaring at the little green specks, which didn't look like they would dissolve any time soon. Her research had hit another dead end. She put the tube back on the rack and made a note to look at them again in a few days, maybe a few weeks. It was less of a dead end, and more another false start. The dozens of samples she had collected had yielded plenty of interesting information. Unfortunately for Daze, "interesting" did not mean a viable starting point for a cure.

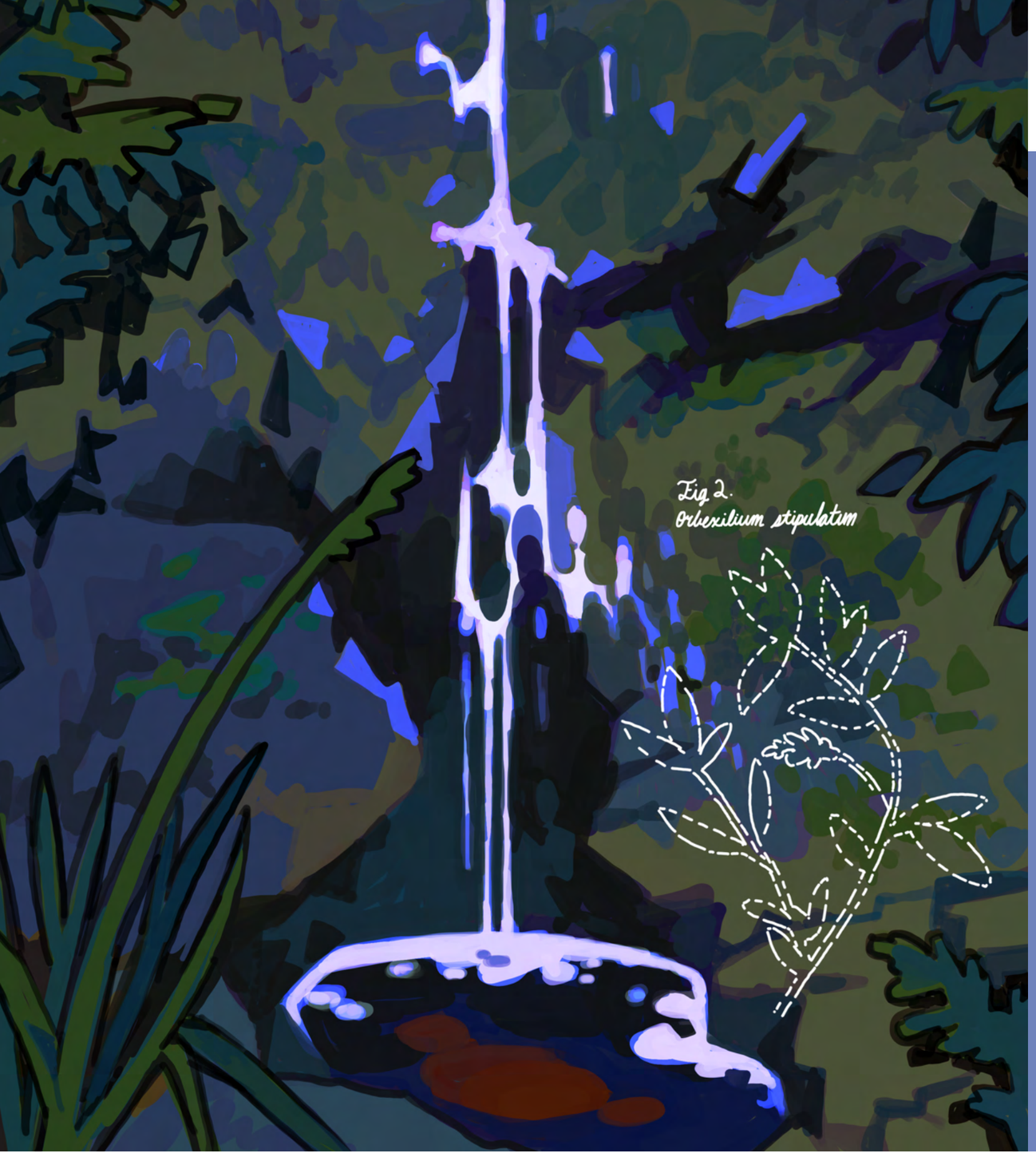
Daze sighed, shrugging off her lab coat. Back at the New Miami Stronghold, it was never her job to gather samples. Intriguing mosses and fungi were brought straight to her well-stocked lab, already prepped for testing. Results, or at least progress, seemed to come easier back then. The better technology and fuller staff could be thanked for that. Back then, the results were less dire. It was a lot easier to be patient when finding the cure for someone else.

After rolling up her left sleeve as high as it would go, Daze pulled a separate notebook off her shelf and examined her arm. There was not much daily progress to be noted. Limited sensation remained in her hand and further up her arm. She tried to look at it as a specimen, focusing on the thriving moss instead of her own dying flesh that it grew on. When Daze looked at her arm without a scientist's eye, when she didn't have the shield of centimeters and qualitative observations to protect her, the damage from the moss appeared much grimmer. Her hand had gone black, making the flesh look charred. The moss had eaten away at much of her fat and muscle, leaving an exposed web of bones and tendons. Dark veins ran up her blackened forearm. Rootlike, they spread past her shoulder, beginning to travel across her back and up her neck. To Daze, they were a promise that the moss would spread. The daily progress was not visible, but over the months it had crept up her arm, claiming more of her flesh as its own.

As it stood, Daze had to collect her own samples. If the odd forms of new plant life could bring Daze's demise, she hoped they could also provide a cure. As the moss grew slowly, she researched. So far, the moss was winning the arms race. Still, Daze grabbed her field bag and headed out into the ruinous New Miami. Although the sun now hung low in the sky, the thick, humid air ensured that it was still uncomfortably hot. She wandered for almost an hour looking for new plant life. Every once in a while, she would stop by a large vine crawling up a building, or a suspiciously vibrant patch of lichen, and compare the specimen to drawings in her notebook. There was hardly half an hour of good sunlight left in the day when Daze came upon a dead raccoon. While neoflora was thriving, mammals did not fare well in the overgrown wreckage of New Miami. By instinct or impulse, Daze approached the corpse. It was wound with thin vines, the green standing out against dark fur and the dried blood that matted it. The flesh had begun to deteriorate, leaving the raccoon's pale ribs open to the air. Those too were engulfed in the grasping tendrils of the vines. Daze could tell the corpse had been there for some time. One eye had melted away to only a socket, bursting with vines from the raccoon's skull, searching for the light. However, the other was still milky, staring blankly back up at her. Given the state of the flesh, the eye should have been long rotten in the humid heat. Daze wondered if the vines were expediting the decomposition of the flesh, or if something was slowing the rotting the eye. She crouched down, taking out her field notebook to try to identify the vines. Daze was not a botanist by any stretch, but this was clearly a plant she'd never encountered before. She quickly sketched it, hoping some daylight would travel by. The drawing was crude, but she could make a better one when she got back to the lab.

Replacing the notebook in her bag, Daze retrieved a capped tube, scalpel, and pen. She quickly scribbled the date and a specimen number on the tube, before uncapping it and gently scraping the vines from the corpse. As she pressed the blade into the vine, the whole raccoon jerked. Daze jumped back, scalpel still in hand. She watched in horror as the raccoon rolled onto its stomach. There were several wet popping noises - it took Daze a moment to identify the source of the strange sound. While the raccoon's limbs laid limp on the ground, each of its little ribs splayed out, pulling away from its body with little cracks and pops. It then propped itself up on its now dislodged ribs, the vines pulling at the sun-bleached bone like the strings of a marionette. With surprising swiftness, it scuttled away, the little ribs carrying it like the legs of a centipede. The whole time the head lolled, dragged along as if it were good for nothing at all.

Daze continued to stare long after it had scurried away. The blankly staring eye haunted her. If the raccoon were still alive, puppeteered by the vines, that would explain the state of the eye. She shuttered, then steadied her breath. Were it not for the oncoming threat of the setting sun, she would have stood there much longer. Eventually, Daze was forced to make her way back, trudging after what remained of the raccoon.



This brilliant piece was illustrated by Roger Ort. It highlights the extinct Falls-of-the-Ohio scrufpea (*Orbexlium stipulatum*). *The scurfpea was last seen in 1881 and is presumed extinct.*

Exctinct Species Native to Ohio Word Search

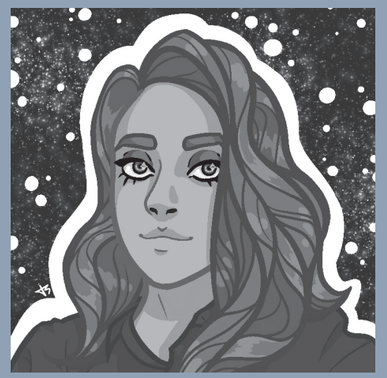
E	U	P	M	O	E	L	D	R	Q	I	P	A	H	L	A	R	F	A	E
C	A	A	X	S	G	Y	T	K	H	E	A	T	H	H	E	N	E	U	H
T	V	S	J	I	A	P	C	X	H	B	R	S	O	K	P	X	N	H	N
J	W	S	T	M	B	P	K	I	U	L	G	B	C	Y	E	I	T	S	B
G	F	E	M	E	Y	R	Q	Y	N	U	C	U	S	P	A	Y	H	C	I
D	M	N	S	B	R	G	E	W	K	E	S	G	I	P	S	W	I	X	G
E	I	G	E	B	I	N	S	J	M	P	Z	C	C	R	X	J	S	S	L
R	S	E	C	C	D	J	E	N	I	I	R	A	N	G	N	N	M	L	E
M	O	R	L	Q	B	G	I	L	J	K	M	Q	I	C	J	Y	I	P	A
M	N	P	Y	H	G	J	E	T	K	E	D	K	F	Y	G	M	A	L	F
P	G	I	D	U	Q	R	L	R	K	C	X	M	K	M	E	K	A	C	S
S	E	G	H	N	A	E	R	F	Z	M	R	J	C	X	R	M	M	M	C
H	A	E	T	H	R	H	K	Y	R	G	K	K	A	Z	H	J	E	P	U
C	A	O	G	L	F	S	W	R	Y	P	I	F	L	Q	K	K	R	N	R
L	U	N	J	Z	D	K	Q	B	G	O	H	D	B	G	X	F	I	L	F
D	V	P	B	V	B	I	D	E	D	S	A	B	W	R	X	D	C	T	P
D	E	E	P	W	A	T	E	R	C	I	S	C	O	H	S	B	A	U	E
Z	K	A	U	I	S	L	K	G	P	Q	R	J	D	M	C	J	N	L	A
B	W	V	T	B	K	O	W	U	A	E	H	L	L	O	I	V	A	M	M
C	A	R	O	L	I	N	A	P	A	R	A	K	E	E	T	N	A	A	D

Eastern Elk Carolina Parakeet Blackfin Cisco Deepwater Cisco
Harelip Sucker Bigleaf Scurfpea Thismia Americana
Passenger Pigeon Heath Hen Blue Pike

Congratulations to our Seniors!

Monica Dix
Writer, Layout Editor

Neil Ruthen
Writer



Jack Bens
Artist

Katherine Karson
Artist

Della Copes-Finke
Artist

Steven Mentzer
Artist, Art Coordinator, Graphic Deisgner

Kirsten Heuring
Writer, Content Editor, Layout Editor, Copy Editor

... and all the graduating students who have contributed to *The Synapse*

We thank the Class of 2020 for all their hard work and dedication!

...at Oberlin

Pictured from left to right, back to front: Zoë Martin del Campo, Steven Mentzer, Athina Apazidis, Rebecca Fenselau, Emma Larson, Yue Yu, Evelyn Morrison, Miranda Marnik-Said, Victoria Fisher

...at Denison

Pictured from left to right: Casey Pearce, Kileigh Ford, Elizabeth Toigo, Delaney McRitchie

/syn . apse/ noun : the point at which a nervous impulse passes from one neuron to another.
The Synapse is an undergraduate science magazine that serves as a relay point for science-related information with a threefold objective. First, we aim to stimulate interest in the sciences by exposing students to its global relevance and contributions. Second, we work to bridge the gap between the scientific and artistic disciplines by offering students a medium through which to share their passions, creativity, and ideas. Third, we strive to facilitate collaboration between undergraduate institutions across the country, especially within the natural science departments.