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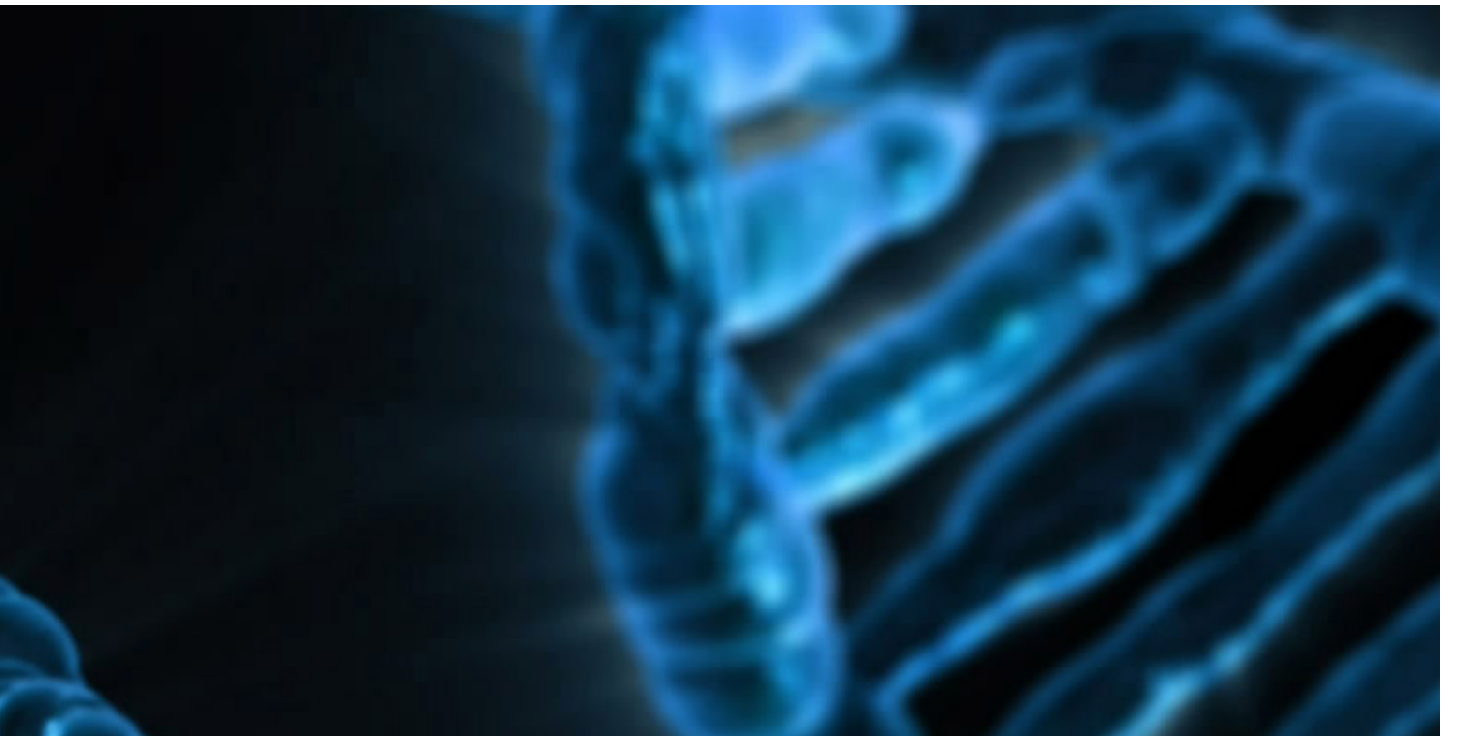

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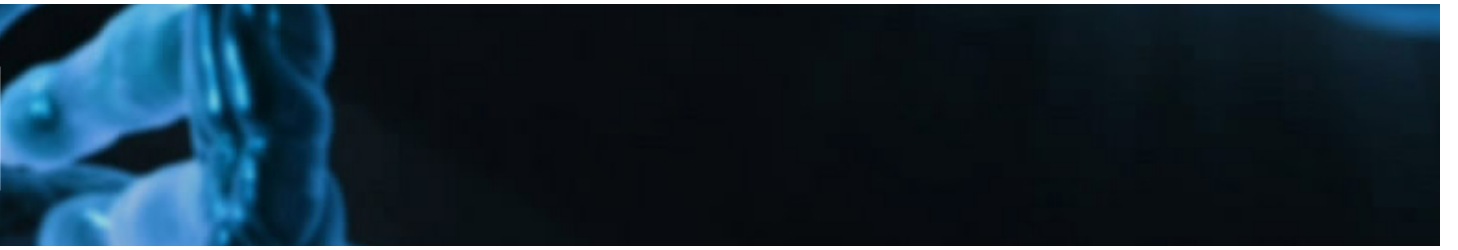

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LETTERS FROM

Dear Reader,

Welcome to the Fall 2019 print issue of the Columbia Science Review. I am excited to introduce you to this issue which is full of topics that have intrigued our writers, and invite you to enjoy the student crafted illustrations accompanying each article. It has been a wonderful semester of investigation and discovery. I also invite you to read our online publication, with new articles available every week on our refurbished website found at columbiasciencereview.com.

In this issue, our writers unravel theories behind diabetes as a beneficial component of human evolution, illuminate the inconsistencies and inherent flaws amongst popularized, at-home genetic testing services, and discuss the prevalence of sexual harassment in academia. They also detail the contributions of the financial industry to climate change, as well as the ethics of improving longevity and preventing neurodegenerative decline. I hope that you also enjoy the series of cocktail articles which aim to pique your interest and offer you an array of curious content in a short, accessible format.

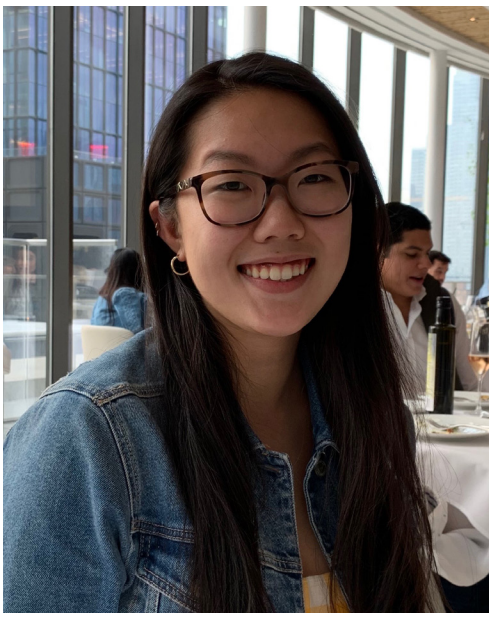
Having completed the first part of my term as Editor-in-Chief, I would like to express my gratitude and appreciation for the effort and commitment demonstrated by all members of the Columbia Science Review. I look forward to continuing to forge relationships with, as well as learn from, the editors, writers, illustrators, and layout staff that continue to improve this publication and fulfill our goal for excellence.

I wish you a marvelous New Year and hope that it is full of wonder, passion, and discovery.

Cordially,

Alice Sardarian
Editor-in-Chief

Dear Reader,



Hello and welcome to the Fall 2019 issue of the Columbia Science Review! Our writers, editors, illustrators, and layout editors have worked very hard to produce the issue before you. As you flip through, you'll find articles on a variety of topics, ranging from a theory for the development of diabetes to the role that financial institutions play in climate change.

As a discipline, science has unfortunately gained a bit of a reputation for being rote and obscure, difficult to understand and even more difficult to study. I hope that as you read through this issue, you will find that its articles strive to instead highlight how exciting and accessible science can be.

This issue is particularly important because, as you may notice, many of its articles highlight the social impact of science, be it the ethics of a cognitive enhancement drug, facial recognition software, or DNA testing. After all, science does not exist in a vacuum; rather, it is inextricably tied to almost every facet of our lives. This issue serves as a reminder to not only appreciate scientific advancements and discoveries, but also to examine how this knowledge is applied to and influences society.

I sincerely enjoyed working on this issue, and I hope you enjoy these articles just as much as I did. Happy reading!

All the best,

Sarah Ho
Managing Editor

THE EDITORS

All Cocktail Article Illustrations by Emily Wang

IN THE AGE OF FACIAL RECOGNITION, ANONYMITY IS OBSOLETE

Written by Rachel Powell

When you're walking through a crowded, vibrant, fast-paced city, it's easy to feel a sense of anonymity—you're one of so many, you're blending in, you're basically invisible. However, thanks to increasingly advanced facial recognition technology, you're actually far from being under the radar.

Today, as a direct result of advancements in artificial intelligence, facial-recognition software is more powerful and accurate than it was only a few years ago. Cloud computing, a way to store and access data over the internet, enables companies to analyze immense amounts of data in a cost-effective manner [1]. There have also been significant strides made in deep learning, which is a method of analyzing patterns that mimics the human brain [1].

In the past, facial-recognition software was primarily used by law enforcement agencies to identify faces captured on surveillance footage [2]. While this practice is still in place and is expanding, private companies are now able to use facial recognition as a type of added security. In 2018, Madison Square Garden stated that it installed facial-recognition technology to identify people as they arrive in the arena [3]. Individuals can also purchase facial-recognition software packages for use on their personal computers and home security systems [2].

Social media also allows companies to collect personal data. Facebook's research suggests that DeepFace, Facebook's facial recognition system, has reached an accuracy level of 97.35% on the Labeled Faces in the Wild dataset, which includes images of people in everyday locations and poses [4]. Because people upload their own photos to social media and tag themselves and others, Facebook, Google, and other large tech companies now have extensive collections of photos containing people's faces [1].

As facial-recognition technology becomes more accurate, widespread, and accessible, concerns about personal privacy and racial biases are rising exponentially. In response, some American cities, including San Francisco and Oakland, have passed legislation that prohibit government agencies from using this technology [2]. Other cities, such as New York City and Cambridge, have proposed similar bans [5]. These debates will continue to gain momentum as facial-recognition technology evolves, shaping the way we see our personal privacy, whether we are uploading photos to social media or simply walking down a city street.

HOW GOOD IS PLANT-BASED MEAT FOR YOU AND YOUR PLANET?

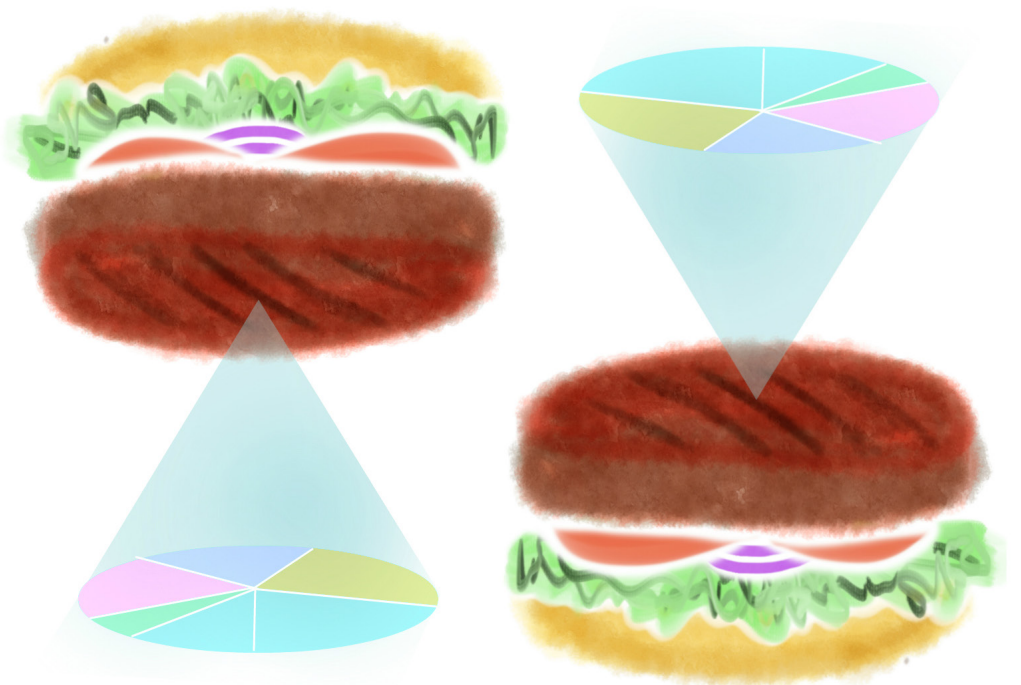
Written by Enoch Jiang

The meteoric rise of products like Beyond Meat and Impossible Foods in recent years has propelled plant-based meats to a serious position in the American dietary consciousness [1]. The societal atmosphere is apt for meat alternatives' sudden surge in popularity: consumers are increasingly interested in sustainable consumption and plant-based meats that provide a massive decrease in environmental impact from animal meat across the board. Knowing that your burger requires 87% less water to produce than a beef burger is undoubtedly a good feeling [2].

Importantly, plant-based meat also tastes good to those who still desire the rich, juicy chew of a traditional burger patty. Specifically, Impossible Foods has utilized heme (the compound that gives beef its red quality) to help emulate beef's tasty qualities [3]. Heme engages neurobiology to make its host food attractive, emitting hundreds of odorant molecules that the olfactory system transduces into enjoyable perceptions [4]. Similarly, heme is full of amino acids, which activate the taste receptors for umami on the tongue [5]. Taken together, these components make for a remarkable experience that has been rewarded by a spike in popularity, investments, and sales [1].

Although one might assume that plant-based meat is healthier than its animal analog (the word "plant" is in the name!), a comparison of a Beyond or Impossible Burger with a beef burger yields cautionary results. By volume, both plant-based products clock in with slightly more calories, similar levels of saturated fat, and a dramatic increase in sodium (about 300 milligrams more per 4-ounce serving) when compared to beef burgers [2]. This last phenomenon of high sodium content is not unique to plant-based burger patties: vegan products across the aisle are loaded with sodium, possibly to stand in for the lack of animal fat that would otherwise provide more flavor [6].

All this nutritional discussion is not meant to cast plant-based meat as a villain; its overall benefits toward animal ethics and environmental sustainability are still substantial gains over the animal meat for which it substitutes. Plant-based meat is, however, far from a health product, and should not be treated as such. At its heart, this new meat aims to provide the consumer with a tasty, flavorful experience—and we haven't quite figured out yet how to stimulate the taste buds without keeping the indulgent nutrients. Until then, enjoy your Impossible Burger responsibly!



COCKTAIL ARTICLES

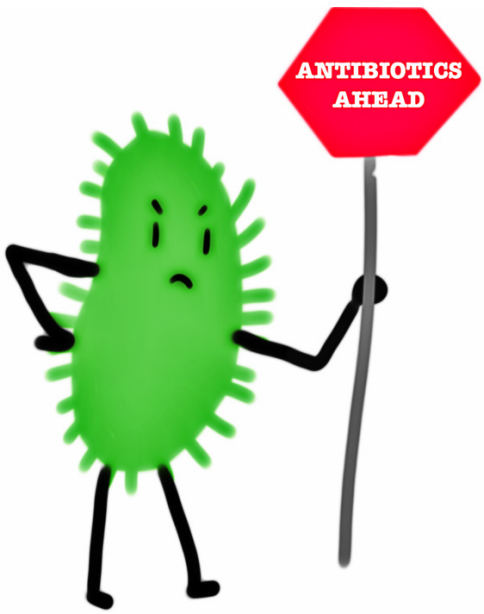
BACTERIAL WARNING SIGNALS: A KEY TO COMBATING ANTIBIOTIC RESISTANCE?

Written by Sarah Ho

These days, if you have pneumonia, strep throat, or even an infected piercing, a quick visit to the doctor and a subsequent antibiotic prescription will often solve your problem within a week or so.

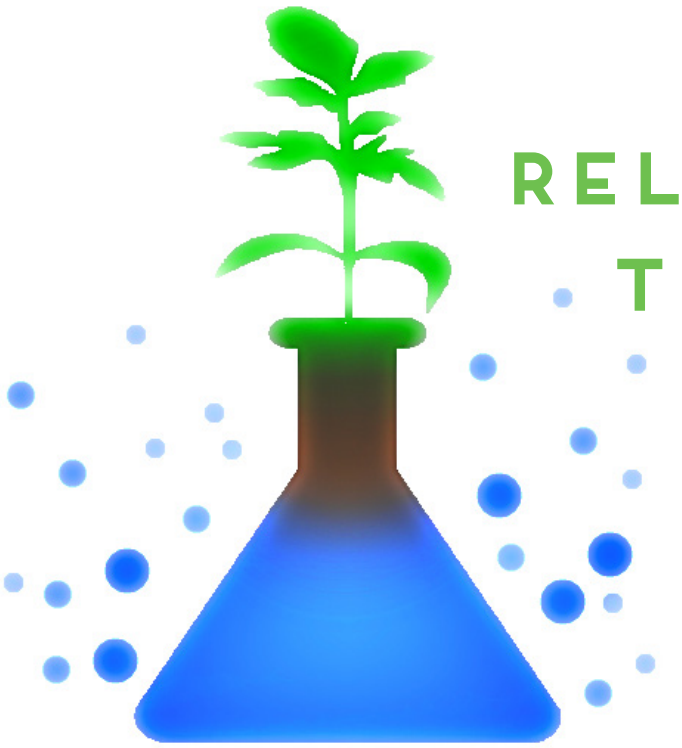
Antibiotics, which can be used to fight bacterial infections ranging from mild to life-threatening, function by killing or slowing the growth of the strain of bacteria in question [1]. This can be achieved by attacking the bacterial wall or by interfering with reproduction or protein production [1]. Unfortunately, antibacterial resistance can occur when some of the targeted bacteria have mutations that allow them to survive the effects of the antibiotic. With all of the "normal" bacteria killed by the antibiotic, the resistant bacteria is free to multiply, spreading the infection. Antibiotic-resistant strains of bacteria can spread from organism to organism, and those who are infected with antibiotic-resistant bacteria are much harder to treat—diseases such as pneumonia and tuberculosis are becoming more dangerous for this reason [2].

The development of antibiotic resistance is accelerating due in part to the misuse of prescriptions, leading to higher medical costs and higher mortality rates [2]. Moreover, medication that is developed to target strains of bacteria that are resistant to existing antibiotics will itself induce strains of bacteria that are resistant to both kinds of treatment, meaning that one day, common diseases that were once easily treated with antibiotics might be more difficult to treat due to the high prevalence of antibiotic-resistant strains.



Luckily, researchers at the University of Copenhagen and the University of California Irvine may have just discovered a key mechanism by which bacteria can become resistant to antibiotics [3]. The research groups studied Pseudomonas aeruginosa, a bacterium which often infects the lungs of people with cystic fibrosis, and found that these bacteria send out "warning signals" when attacked by antibiotics or bacteriophages (viruses that attack bacteria) [4]. In response to this warning, other bacteria will simply avoid the area with the antibiotic or bacteriophage, ensuring the overall survival of the population of bacteria [4]. The discovery of this mechanism is very promising because future drugs and treatment can target this "warning signal," preventing it from being sent or received [4]. With more research and treatments being developed to specifically circumvent antibiotic resistance, hopefully, we can ensure that bacterial conditions and diseases continue to be treatable.

HYDROPONICS



RELIC OF THE PAST OR WAY OF THE FUTURE?

Written by Linghao Kong

According to the World Bank, only about a third of Earth's landmass is usable for agriculture [1]. With rising sea levels increasing the soil salinity and reducing crop yield and with population growth necessitating more food production, agricultural innovation is needed now more than ever [2][3]. However, rather than a completely new method of farming, an ancient technique is growing more appealing: hydroponics.

At its core, hydroponics is a system of growing plants in a nutrient solution instead of in soil [4]. Its roots trace back thousands of years to the likes of the Hanging Gardens of Babylon and the floating gardens of both ancient China and the Aztecs [5].

Compared to traditional soil-based farming, hydroponics offers many advantages. Because plants do not need to expend as much energy searching for nutrients in soil, that energy is diverted instead to producing a larger crop yield [6]. Hydroponics can also be utilized in areas with otherwise non-arable land, since the self-contained system does not rely upon soil quality. Because of these and other advantages, hydroponics has successfully been used to provide food for Pan-Am Airways staff during refueling stops on a remote Pacific island and for soldiers during World War II [5]. Despite this, hydroponics has yet to overcome traditional agricultural practices—it constitutes less than one percent of total agricultural U.S. revenue [7, 8]. Why is that?

One factor is cost: the cost of beginning a hydroponics farm includes all of the plumbing and air systems associated with hydroponics [9]. Furthermore, electricity is needed to circulate the nutrient solution and to light and heat the crops—consequently, electrical costs are substantially greater for hydroponics than for traditional farming [9]. Additionally, a greater understanding of the biochemistry of farming is necessary because more control is in the hands of the farmer [9]. Factors like these prevent hydroponics in its current state from successfully competing with traditional farming on the large scale.

Despite these shortcomings, the stage may be set for an increase in such water-based farming. As consumers become increasingly concerned with how their food is sourced, and innovation from companies such as Freight Farms provides easier access into hydroponics, it may be just enough to launch this ancient technique firmly into the modern era [9].

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DNA TESTING:

THE HIDDEN TRUTH BEHIND "DISCOVERING YOURSELF"

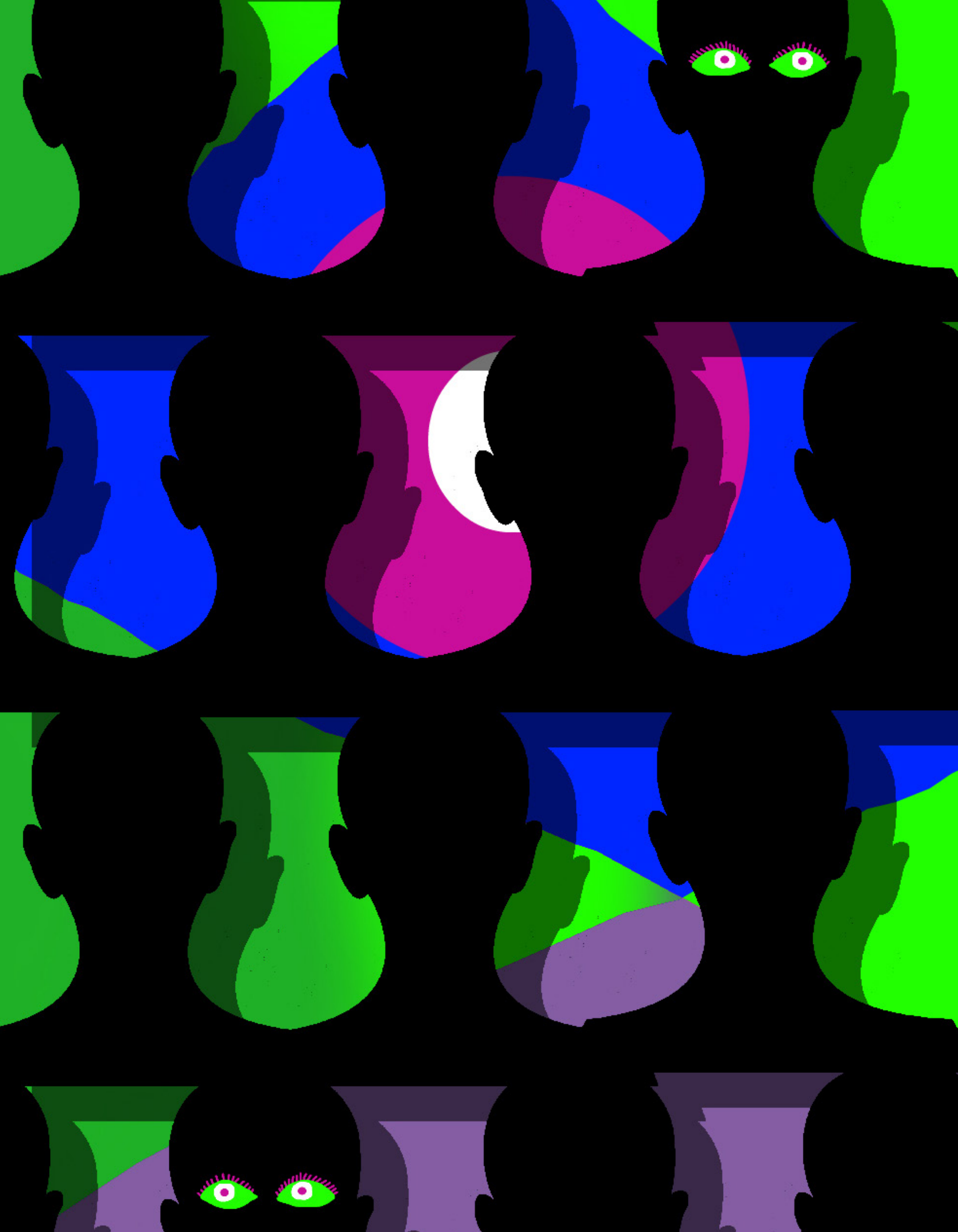
Written by Georgia Gonzalez
Illustrated by Emily Wang

DNA testing used to be a concern limited only to researchers and doctors looking for signs of genetic diseases. Now, anyone can order a kit online and do it from home. For as little as $99, companies like Ancestry.com and 23andMe allow consumers to send in a sample of their saliva and in return receive information on their genetic makeup, including predispositions for certain diseases and ethnic heritage estimates. These tests are wildly popular, with millions of people having bought the Ancestry.com kit alone. For those wishing to "seek their roots" or uncover family mysteries, these tests seemingly provide an insight into the truth.

However, these diagnostic tests open up a whole array of ethical and social dilemmas. There are privacxy problems associated with giving your DNA to a company that could sell it without your knowledge, as well as the drama that could ensue from unexpected results [1][2]. An issue that deserves more attention, though, are the racial and social implications of these tests and their assumptions. The methodologies behind the scientific processes of the tests are marred by dodgy statistics and limited public information. There are also social dangers to the interpretation of ethnic results given to customers, which may end up perpetuating socially constructed racialization. Considering genetic makeup as a hugely significant part of one's identity begs questions about how we choose to value ethnicity and how it relates to our understanding of ourselves. So, before you buy one of these kits, make sure you're informed of its social and ethical implications.

So how do these tests work? In principle, DNA tests work by comparing your DNA to others from around the world to see how similar they are. The more similar, the closer the connection between you and that group, thus, the more "ethnically similar" you may be. For example, if your DNA is similar to that of those from Ireland, then "Irish" will come up as one of your ethnicities. It's important to note that ethnicity is defined by a group of people sharing a common cultural or national origin, whereas race refers more to the physical characteristics of a person, yet both are misleadingly thought to have genetic markers.

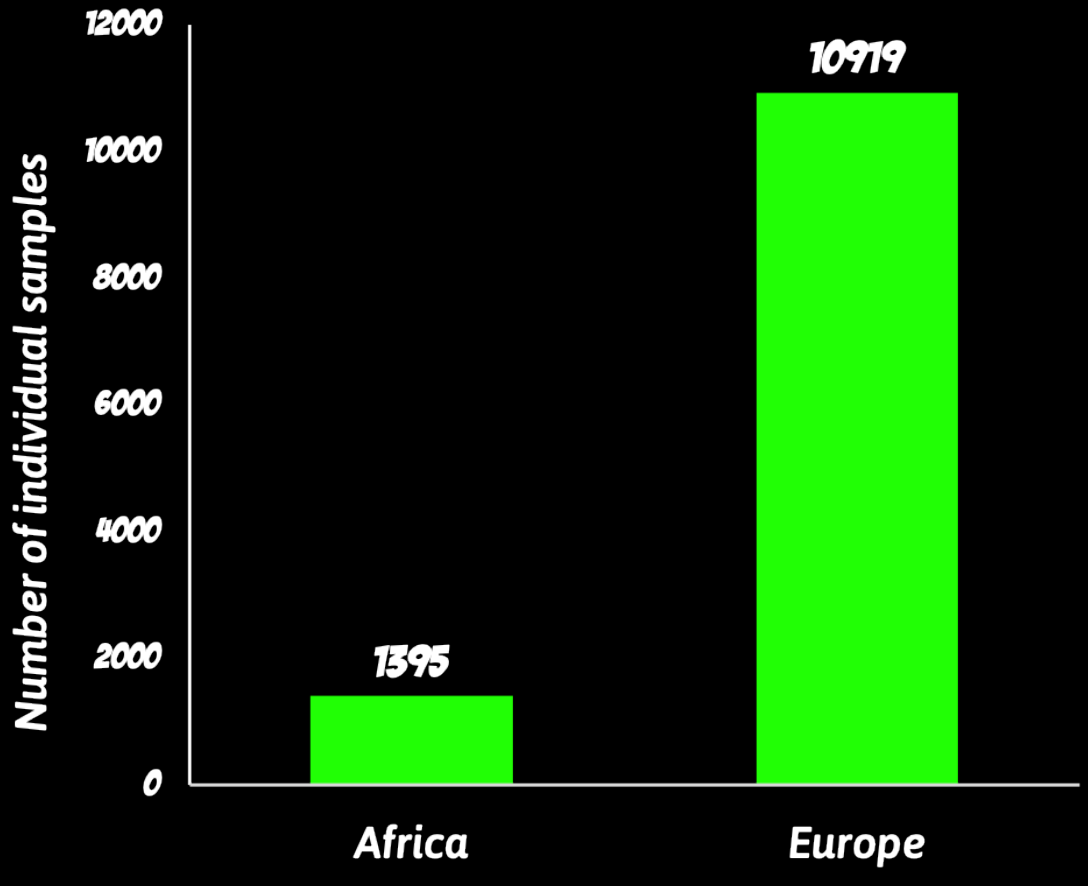
Enter the "reference panel," the people to which these companies compare your DNA. This is a DNA database from individuals with "known origins" [3] that companies use as a baseline for comparison. According to Ancestry.com, "under perfect conditions, the panel would be created using samples from people who lived hundreds of years ago."[3] This is due to the fact that DNA markers from specific regions have morphed and changed over hundreds of years, making the DNA of humans today different from that of the past. As gathering DNA from people alive during past times is not possible, they have settled for using DNA from currently living people who have strong ties to a region. Inherently, this method is already flawed, given that its ideal is impossible, so instead it settles for a less accurate technique, requiring gross assumptions.



Probing deeper into this mysterious panel of people with "known origins" reveals that the literature lacks specifics. Ancestry.com claims that the reference panel contains only individuals with a "long family history in a particular region," yet the length of time is never discussed, nor is the method with which these people can verify these claims. Further, the company claims that knowing where recent ancestors are from serves as a proxy for deeper ancestral ties. This claim, however, can easily be disputed for many populations, which have historically travelled and mixed with others through diaspora, imperialism, or more insidious methods. Ancestry states that "by definition the individuals in our reference panel each have 100% of a single ethnicity" [3]. This statement carries an implicit assumption that one can even be "100%" of a single ethnicity, despite the fluid movement and mixing of humankind over the hundred thousands of years that roamed the planet. This claim then seems strange and, when viewed from a historical lens, not possible. Even the goal of quantifying that movement into clearcut percentages is misguided, perpetuating the myth of ethnic purity and oversimplifying a complex history. What Ancestry.com means by being 100% of an ethnicity is never discussed, and frankly, it is dangerous to claim that anyone is a 100% of anything, given how this rhetoric has been historically used in arguments for eugenics and ethnic cleansing. All of these shortcomings cast doubt into the accuracy of the reference panel itself and further complicates the idea of being able to have a strong genetic basis for ethnic identity.

Investigating where Ancestry.com obtains the reference panel data reveals some interesting disparities. The panel uses the data of around 16,000 individuals spanning across 43 geographic regions to predict customers' ethnicities. However, the regions are not equally represented, neither in depth nor in size. Sixteen European regions are represented, which account for 66% of the

ANCENTRY.COM'S AFRICAN & EUROPEAN DNA SAMPLES



total sample, whereas only nine African regions are represented, accounting for only 8% of the total sample size [3]. According to this reference panel data, the fine genetic difference between those of Swedish or Finnish descent can be discerned, but the data puts others into broad and unclear categories such as "African Hunter-Gatherer" or "Central-Northern Asia." This clear Eurocentric skew means that the accuracy for those of non-European descent is compromised. Unfortunately, this kind of bias in data is not uncommon, but it should be clear to consumers before they decide to place their trust in the product. The lack of diversity in the data is worrying and shows that these companies may not actually be committed to caring about the most accurate results for everyone, but more so catering to a particular client base.

This reference panel is in fact part of an Ancestry.com major update, prior to which only 3000 samples were included [4]. Upon the update, many customers saw their ethnicity estimates shift dramatically, demonstrating how volatile the ethnicity estimates currently are and how inadequate the dataset still is. Given that the reference panel and its predictions are clearly still in flux, the authority of the "ethnicity estimates" may not be as strong as some may think. The fact that a supposedly fixed biological standard is changing so much proves that these diagnostic methods are deeply limited and that ethnicity is a far more complex concept than it is marketed as.

In terms of understanding the mechanisms behind the statistical methods of ethnicity estimates, we're left in the dark. Much of the methods and algorithms used are kept secret in order to maintain the integrity and value of the companies. However, this privacy means that the methodology cannot be validated by the scientific community. The beauty of the peer review process is that it advances valid science and can quickly discredit and critique science that is not up to standard. Without this, we cannot be certain of how scientifically accurate the methods of DNA testing companies are. This casts further doubt into the validity and consequently, the truth behind ethnicity estimates.

Between the shaky science and unreviewed methods these companies use to make a profit, we must ask about the implications of these kinds of tests and whether or not they are worth it. The popularity of these tests prove a deep societal interest in self-discovery,

> ***"The goal of quantifying that movement into clearcut percentages is misguided, perpetuating the myth of ethnic purity and oversimplifying a complex history."***

but there are dangerous implications of conducting this within genetic parameters.

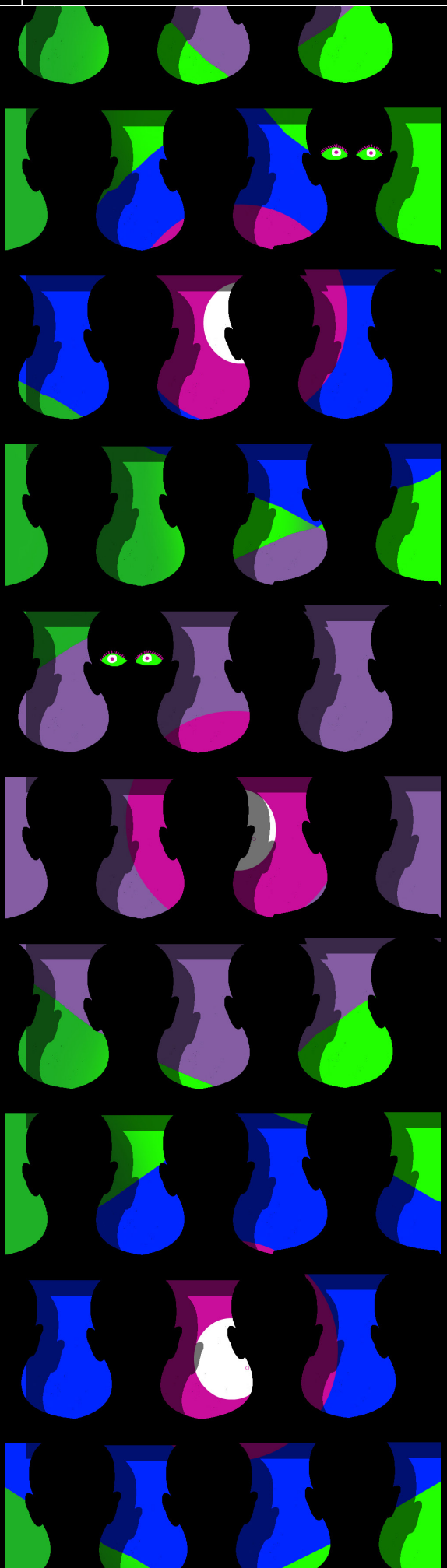
Although ethnic identity is a far more nuanced concept than just purely biological, tests like this strengthens the idea that it is a genetic phenomenon only and encourage people to see ethnic makeup as a static aspect of themselves rather than evolving and varied. Then, when you take into account how weak these ethnicity estimates may be, this strengthening is a falsified notion. Many of the reaction videos to receiving genetic results include people being shocked to discover parts of their family history or lineage are different from what they expected. This "revelation" of genetics, however, shouldn't come as a surprise. People have always mixed and travelled. The boxing of individuals into neat ethnic percentages is a fallacy. We do a disservice to ourselves when thinking of our backgrounds as being so homogeneous and categorised when the reality of humanity is far more complex and non-binary.

These tests are often marketed to vulnerable diaspora groups such as African Americans, who oftentimes have been denied the privilege of access to family history. They promise an insight into who you are, and at times, that may help in the struggle of grappling with your history. Family history is often what helps construct identity. It can inform who you are and how you think of yourself. When faced with an empty void of knowledge in this department as many people are, a quick solution may be to turn to these tests. Moreso though, knowing the vague area that your ancestors were from just sheds light on the insignificance of geographical answers to the giant questions of culture and identity. These tests offer a band-aid for a gaping wound, but they aren't the whole answer. What truly matters most often are the stories and shared expression

and culture one can get from family or ethnic group. Genetics can't help in that department, yet the marketing insinuates it does just that, promising to connect the consumer to hidden parts themselves.

The ethnicity estimates also trigger the question of personal identification after these tests. Some people take these tests and go on to claim an ethnicity (see Elizabeth Warren's Native American ancestry [5]) that others feel is superficial and disrespectful. These tests encourage a biological basis behind ethnic identification, which in fact is part of a far more nuanced picture. DNA companies encourage and facilitate the measurement of connections to identities using biology only, when this connection should instead be measured through family and history.

So when you see friends and family absorbed in the adverts, take the time to engage in dialogue. Educate yourself and others about the science behind the tests. Ask if they really want to give both valuable personal information and a cheque to a company that might sell it on and mislead you. And really ask yourself, "What am I trying to discover about myself?" The answer is probably not going to be found in DNA results.



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SUGARY SECRETS

uncovering diabetes

Written by Allison Lin
Illustrated by Aeja Rosette

Diabetes, one of the most common chronic diseases, is estimated to affect 170 million people in the world, a number expected to double by 2030 [1]. Diabetes disrupts the normal function of insulin, a pancreatic hormone that helps transport glucose into cells and maintain blood sugar levels. Without it, blood glucose concentrations build to dangerously high levels, while cells are starved of their source of energy. This can lead to rapid dehydration, coma, and in extreme cases, death [2]. Long-term consequences of diabetes can also include blindness, heart disease, and stroke, among other complications.

The disease is most commonly categorized into two major types, Type 1 and Type 2. Type 1 is largely believed to be an autoimmune disease, where the body's immune system recognizes normal cells—in this case, pancreatic cells responsible for insulin production—as foreign invaders and attacks them. No pancreatic cells means no insulin, which means no natural regulation of blood glucose. Patients can be treated with either a surgically-implanted insulin pump, or more commonly, daily self-administered insulin injections. On the other hand, in Type 2 diabetes, the body still produces insulin, but at a lower or otherwise abnormal rate, so the conversion of blood sugar by other organs is drastically impaired [2]. Type 2 diabetics don't need an insulin pump or daily injections; it typically can be controlled through a rigorous exercise routine, careful diet, and intermittent blood sugar monitoring.

Today, although the general population views diabetes as a terrible and incurable disease accompanied by numerous symptoms, more and more physician scientists are pushing forward a new theory: diabetes may not have actually always been all that bad. Dr. Sharon Moalem, an expert in evolutionary medicine at the Mount Sinai School of Medicine in New York, is one of the primary advocates of this little-known theory. His thought-provoking stance claims that diabetes could have evolved for us, not against us.

> Diabetes could have evolved for us, not against us.

Diabetes, especially Type 1 (also referred to as juvenile diabetes) is highly prevalent in people with significant Northern European ancestry. Finland has the world's highest level of Type 1 Diabetes, with Sweden, the United Kingdom, and Norway following close behind. However, it's rarely seen in people of Asian, Hispanic, or African descent [1].

When something as debilitating as diabetes, a disease with known genetic risks, occurs mainly in certain geographic populations, it's time to take notice of this unusual trend. In other words, we need to examine further evidence.

For Dr. Moalem and other researchers, this issue was worth deeper investigation. Before the 1960's, Swedish scientists discovered large traces of a wildflower called the Dryas, known to only bloom in severe cold climates, in mud layers dating back to 12,000 years ago: these traces served as evidence of an ancient thousand-year cold spell, aptly named the "Younger Dryas." The wildflower was initially known to only bloom in the Arctic, so when it was discovered in a lake bottom in Sweden, scientists deduced that there must have been a long period of cold that interrupted the warmth that had followed the last "true" ice age. When Professor Dave Fultz began building a model of atmospheric gases in the late 1950's at the University of Chicago, more and more evidence supporting the existence of a Younger Dryas came into contemporary worldview [3].

Scientists were initially skeptical that such a massive shift in climate occurred over mere centuries, so they began searching for more hard evidence. Thankfully, in the 1980's, ice cores from northern Greenland revealed definitive proof of a cold spell—the Younger Dryas—12,000 years ago. The United States' 1989 expedition to drill through the 2-mile ice sheet of Greenland gave us even further evidence of this weather conundrum and solidified the existence of the Younger Dryas [3].

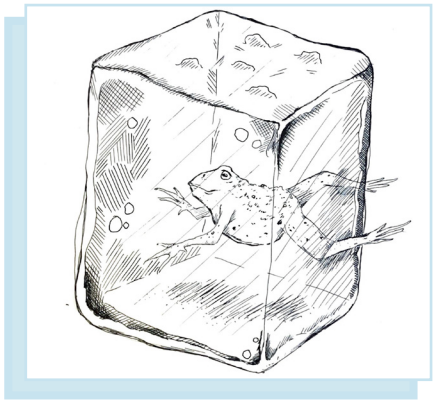
Sandra Blakeshee, a leading advocate of the theory of juvenile diabetes as an adaptation, wrote in a 2005 paper in the *New York Times* that Northern Europeans had to battle "an ice age [that] arrived virtually overnight." At the time of the Younger Dryas, humans, through natural selection, had no choice but to find ways of protecting themselves against the violent climate change in Northern Europe [4].

While pursuing this hypothesis, scientists have investigated the phenomenon of cold diuresis (the urge to urinate when cold) and other similar biological processes in the natural world. For example, wood frogs have a remarkable biological ability to freeze themselves during the harsh winter cold and revive in the spring. In the 1990's, a Canadian biochemist named Ken Storey collaborated with colleagues to examine this special ability of wood frogs. Storey had been studying these animals since the early 1980's and observed that frogs freeze and thaw themselves by pooling their internal water in their abdomen and secreting large amounts of glucose into the bloodstream. When they freeze, their major organs are essentially resting on ice, slowing metabolism and reducing bacteria growth [5].

At Carleton University in Ottawa, Storey published a paper on how glycogen in the frogs' liver is converted into glucose, increasing their blood sugar levels. The glucose molecules then bind to intracellular water, lowering the freezing point of body water and making it incapable for ice formation. Otherwise, if the frogs' intracellular water froze, it would have expanded and killed the frogs [6]. That's fauna for you.

Outside the animal kingdom, a similar phenomenon exists in flora. Four hundred years ago, a frugal German winemaker discovered that his fields were hit by a sudden frost. Deciding to

make something rather than nothing, he harvested the grapes anyways, and discovered icewine by accident. This icewine was insanely sweet, and became an instant hit, with a 18-28 rating on the "sugar scale" of wine. The grapes



dumped a majority of their internal water, making themselves much tinier than normal. This makes sense: the less water, the fewer ice crystals form come the first frost. But why the sugar? That was a question that stumped scientists for years before they tied it in with other prevailing anomalies of nature. Sugar is a natural antifreeze—adding it increases solute concentration inside the cell, which prevents the freezing of water molecules, effectively lowering the freezing point of water. Now the grape withstands much colder temperatures without freezing. And vintzers can make a nice profit as well [3].

Now let's bring the conversation back to the subject at hand: humanity. These discoveries have helped scientists develop a reasonable theory for why juvenile diabetes developed. The disease actually helped survival, at least in the beginning. By forcing people to expel excess water in the body through urination and reduce insulin levels, diabetes caused the body to amass large sugar quantities, which may have helped early humans survive the challenges brought on by the Younger Dryas.

Dr. Clive Gamble, who works as a professor of geography and is an expert on ancient human migration at the University of London, said that this theory helped support a large and still growing amount of evidence that proposed Europeans as descendants of hunters with a tolerance to cold climates and not farmers from warm ones [4]. Thanks to Gamble, Dr. Moalem, Blakeshee, and numerous others, more individuals are beginning to accept this rising theory. Diabetes could have helped early humans thrive in the frigid environments of the Younger Dryas, and could have evolved with a beneficiary intent—to heal, not to harm. It may have been a salvation in the past, but is certainly devastating in the present. What can you say? Evolution's not perfect.

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INVESTING IN OUR CLI

Written by Alena Zhang
Illustrated by Emily Wang

Imagine that you are sitting in Hungarian Bakery, pretending to complete your readings. Next to you are two Columbia students, a recent graduate, the other searching for a job. They are talking shop, and shop means investment management.

"What do you do at BlackRock?" one asks the other.

The other responds, "I work in the energy and resources sector." That's the sector that invests in Shell, Exxon Mobil, BP, and Chevron.

Then she adds, "But don't worry, I love the environment." Well, she says not to worry, so you go back to your readings.

Or not. Granted, the recent deluge of environmental science in the news is climate-change centric, with omens of sea-level rise, destructive hurricanes, and vanishing species. Nothing here seems related to finance. It's all about greenhouse gases: since the early 2000's, the international scientific body has come to a consensus that the increased concentrations of greenhouse gases in the atmosphere shifts the balance of radiant energy being absorbed by the Earth [1]. The news tells us that the problem is climate change. The aggressors? Greenhouse gases. And the solution? Why, *decrease* greenhouse gases, of course.

A 2019 *New York Times* article bears the headline "Scientists Urge Stronger Paris Agreement Pledges to Curb Climate Change." The Paris Agreement is, of course, a pledge to curb specifically greenhouse gas emissions [2]. This simple formula has hardly varied since 1975. A *Times* article from that very year titled "Scientists Ask Why World Climate Is Changing" suggests that the answer to climate change is—drumroll, please—the introduction of large amounts of carbon dioxide into the atmosphere [3].

Given such news coverage of the state of the environment, you are practically excused from having to pay attention to the girl working in the energy sector at BlackRock. After all, what does the mysterious stock exchange have to do with the nitty-gritty particles of carbon dioxide implicated in climate change?

In fact, environmental destruction has enjoyed a long marriage with finance, stretching all the way back to the nineteenth century. We're understandably preoccupied with the future: the Paris Agreement frets anxiously over 2030, the date by which mitigation targets are meant to be reached, for the sake and safety of the earth. But with our eyes set on the future, facts of history tend to slip us by—specifically, the facts that remind us just how lucrative it is to put carbon dioxide into the air. It's not without

reason that the Rockefeller name is borne on buildings everywhere. John D. Rockefeller, the richest person in all of world history, founded the Standard Oil Company in 1870 [4]. After Standard Oil was deemed an illegal monopoly and broken up, its wealthy descendents Chevron and ExxonMobil took up the ancestral sword and shield. (We remember ExxonMobil particularly for its 1989 Exxon Valdez oil spill, which spilled 10.8 million gallons of crude oil in Alaskan waters.) The profit made by these companies is shared among its shareholders and investors—many of whom happen to be financial institutions.

It may not need to be stated that BlackRock is among good company here. In 2018, for example, JPMorgan invested 70 billion dollars into fossil fuels; Bank of America, 34 billion; Morgan Stanley, 19 billion; the list goes on [5]. Columbia University's endowment, for reference, is not quite 11 billion dollars.

The burning of fossil fuels draws a simple connection between finance and greenhouse-gas-driven climate change. The full relationship between finance and environmental degradation, however, is more complex. Today there is a polygamous marriage between dollars, fossil fuels, greenhouse-gas driven climate change, and land-use. Such a contrived relationship is difficult to pin down, but you—you who refuses to go back to your readings—ought to try.

Let's return to BlackRock as an example (though we could look at Capital Group, Vanguard, or any number of other financial institutions). With over six trillion dollars in assets, BlackRock is among the top three shareholders in 25 of the world's largest deforestation-risk companies, and its investment in these companies is only increasing [6]. Take the Brazilian meatpacking group JBS. BlackRock has 58.1 million shares in JBS, which is today the world's largest meat processing company and owns extensions of Tyson Foods as well as Cargill Inc [7]. This year, JBS was accused by the Bureau of Investigative Journalism of purchasing cattle from farms involved in up to 300 square kilometers of deforestation risk per year [8]. On a separate investigation, JBS was also linked to cattle ranchers who use fires to clear land in the Amazon rainforest [9].

For the same reason that environmentalists on campus have been exhorting you to stop eating beef, for God's sake, climate change scientists are beginning to pay attention to the devastating effects of deforestation for cattle ranching: land-use change is as powerful an agent in climate change as the burning of fossil fuels we've come to detest.

A 2019 report by the Intergovernmental Panel on Climate Change (IPCC) states that 23 percent of all human-caused greenhouse gas emissions can be attributed to agriculture, forestry, and other types of land use. (In comparison, the energy supply sector, what we associate with the burning of fossil fuels, is responsible for 35 percent.) When looking at the Least Developed Countries category in this report, the greenhouse gas emissions associated with land use amount to a stunning 90 percent of total greenhouse gas emissions [10]. A significant portion of these emissions results from forest fires and biomass burning; the largest portion results from deforestation and agricultural emissions from livestock [11]. It just so happens that cattle ranching is, according to the Yale School of Forestry, the largest driver of deforestation in the Amazon, accounting for 80 percent of deforestation [12]. And we've seen our fair share of forest fires in the Amazon too: as of September, the number of fire outbreaks in the Amazon rainforest has reached more than 74,000 in 2019, representing an 84 percent increase from last year [13]. It almost doesn't bear repeating that financial institutions like BlackRock rely on these fires for profit.

Yes, the drivers of climate change are complex. The IPCC reports on a litany of factors in global climate change, from transportation to buildings to industry to waste to, of course, land use [14]. Every claim made by the IPCC reports is accompanied by a declaration of a level of certainty: "very high confidence," for example, or "limited evidence, medium agreement." Hardly, if ever, is there an incontrovertible

There is a polygamous marriage between dollars, fossil fuels, greenhouse-gas driven climate change, and land-use.

statement in their reports. Yet there seems to be rather convincing evidence suggesting that to understand the drivers of climate change, it's not just important to pay attention to our diets and reliances and habits, but to notice what's enabling all these facets of our lifestyles. Past our plates, past our shopping at Costco, past the distribution centers at Tyson Foods, past the offices of JBS, past the loggers in the Amazon, there is a company like BlackRock, funneling money into making all of this possible. And reaping the rewards, too.

No matter your year or your major, you've heard of these companies. JPMorgan, Goldman Sachs, fill in the blank, their names spare no one, not even in a place like Hungarian. It's worth mentioning that for those among us who are pursuing careers in banking and private equity firms, the connection between them is far from abstract. A recent *Nature Climate Change* journal article states that climate change will increase the frequency of banking crises by an estimated, and stunning, 26-248 percent [15]. The drivers of climate change are manifold, but its victims are, too, universal. No matter where you stand in it, it turns out we're all implicated in the messy web of climate change, and maybe we should all worry and act, today.

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OF ALL HUMAN-CAUSED GREENHOUSE GAS EMISSIONS...

23%

due to land use (agriculture, forestry, etc.)

35%

due to energy supply sector

OF GAS EMISSIONS DUE TO LEAST DEVELOPED COUNTRIES...

90%

due to land use

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Sexual Harassment in Academia

Violence Against women is Stymying Scientific Discovery

CONTENT NOTICE

Please note that pages 26-28 contain discussion of sexual harassment and related topics.

Written by Liza Casella
Illustrated by Emily Wang

"The museum's investigation into allegations concerning Neil deGrass Tyson is complete. Based on the results of the investigation, Dr. Tyson remains an employee and director of the Hayden Planetarium. Because this is a confidential personnel matter, there will be no further statements by the museum."

This statement concluded the American Museum of Natural History's investigation into Neil deGrass Tyson, which centered around Tchiya El Amet's accusation that while she was a graduate student working under Dr. Tyson at the University of Texas Austin in 1984, Tyson invited her to his apartment, drugged her, and raped her. Amet told this story in a 2014 blog post, citing the incident as the reason she left her graduate program and the reason that "there is one less black female galactic astronomer on this planet" [1].

According to a 2003 study surveying various occupations and workplaces, the reported prevalence of sexual harassment in academia (58%) is second only to that of the military (69%) [2]. Another study found that 20% of female students in the sciences at the University of Texas campuses reported harassment from faculty or staff [3]. Yet another found that 43% of graduate students at Pennsylvania State University reported having experienced harassment [4]. Women of color were found to experience more harassment than white women and half reported feeling unsafe because of their gender. As staggering as these numbers are, these statistics are nonetheless likely underestimates because finding the actual prevalence of sexual harassment and/or sexual violence, in any setting, is notoriously difficult. Hesitance to report for fear of incurring negative consequences or provoking repercussions, power imbalances in institutional structures, and a lack of clarity in the definition of sexual harassment all contribute to it being under-reported [5].

Despite the large variation in these numbers, it is nevertheless abundantly clear that sexual harassment is pervasive in academia. Graduate students were found to be particularly vulnerable; this is due in part to the length of graduate programs, the small communities within scientific disciplines, and the hierarchical structure of higher education. In other words, graduate students' careers are strongly dependent on a small number of faculty members and advisors, meaning that sexual harassment can have a particularly detrimental effect on their futures.

According to RAINN (the Rape, Abuse, and Incest National Network), 23.1% of women in college have experienced sexual assault. A study which specifically looked at the rates of sexual assault among students at Columbia and Barnard found that 28.1% of students had experienced sexual assault [6]. It also found that first-years were the most likely to experience sexual violence—21% of first-years reported experiencing unwanted sexual contact. Among seniors, 36.4% reported experiencing unwanted sexual contact, which suggests that the risk is cumulative. The rates were higher than average among queer students, gender-noncomforming students, and low-income students, as well as students who participate in Greek life.

Dating and sexual violence is also prevelant among high school students. A study by JAMA Pediatrics that surveyed high school students to determine the prevalence of dating violence among American high school students found that 20.9% of female students experienced some form of dating violence in the 12-month period before they were given the survey [7].

There is a myriad of evidence suggesting that women who have experienced sexual violence are more likely to develop depression, anxiety,

substance abuse, eating disorders, and other mental health problems [8]. It is unsurprising that further statistics demonstrate that mental health problems can then go on to have negative effects on academic performance. One study found that college students who experience mental health problems have GPAs that on average are 0.2-0.3 points lower by the end of their freshman year than their peers without the same mental health conditions [9]. A study focusing on sexual victimization and academic performance found that women who experienced sexual violence as teenagers were more likely to finish high school with a GPA below 2.5 and to earn a lower GPA during their first year of college as compared to women who did not report experiencing sexual violence [10]. Women who reported being sexually assaulted during their first semester of college (when sexual violence is most likely to occur) also had statistically significantly lower GPAs than women who did not.

One's GPA matters most in STEM fields, with applicants to colleges, graduate, and medical schools being evaluated heavily on their academic performance. The link between sexual violence and a lower GPA by the end of high school means that women who were assaulted as teenagers are less likely to be admitted to top-tier colleges, which admit students on the basis of test scores and GPA. While the college admission system is fraught with problems, it is objectively true that students at elite institutions have more access to professional opportunities; thus, survivors of sexual assault are less likely to have access to these resources. Women who are assaulted while in college also face academic difficulties due to subsequent mental health conditions, thus making academic success more difficult and statistically causing lower GPA's. This affects the likelihood of getting admitted to graduate and medical school, which can hinder their career success. While graduate programs try to accommodate extenuating circumstances, it is not always easy or even possible for one to elaborate on, or let alone disclose, their trauma in an application.

Moreover, experiencing sexual violence can impede academic success beyond high school and college, especially in STEM fields. Statistically, sexual harassment occurs more frequently in STEM fields than in the humanities [11]. While men and women earn degrees in equal measure in some STEM fields such as biological sciences, agricultural sciences, and medicine, many other fields are still very male-dominated. For instance, in 2018, men were awarded approximately 80% of all physics, computer science, and engineering degrees. Furthermore, even despite earning the same percentage of degrees in biology and medicine, women remain vastly underrepresented on the faculty level. These male-dominated environments contribute to a culture in academia wherein sexual harassment is more common and women are less likely to report it to their collegues or superiors.

Once women enter into graduate school or faculty positions in STEM fields at academic institutions, they have a disturbingly high likelihood of being subject to sexual harassment from faculty at their institution, especially in highly male-dominated fields [4]. All of these factors converge to stymie women's career success in STEM fields. One could make the argument that it is not lack of funding or government regulations or the bureaucracy that is the greatest factor in stymying scientific research, but instead the prevalence of sexual harassment and sexual violence that women in STEM fields experience.

MAKING THESE CHANGES WILL NOT ONLY HELP WOMEN TO SUCCEED PROFESSIONALLY, BUT IT WILL ACCELERATE THE PACE OF SCIENTIFIC DISCOVERIES BY NOT HOLDING SCIENTISTS BACK

So how can society work to fix this? Studies have shown that effective sexual assault prevention programs at universities are professional-facilitated, workshop-based, and offered multiple times throughout a student's time in college [12]. They should include a wide range of content including information about rape culture, healthy dating behaviors, alcohol and drug safety, and bystander intervention. Such programs should also be provided to high school students and to faculty and administrators at institutions of higher education. Dismantling the hierarchical structure of higher education and implementing ways for students and faculty to report sexual harassment without fear of negative reprocussions would also serve to lessen the incidence of sexual harassment.

Universities should also take more action

when faculty are accused of sexual harassment or violence. The American Association for the Advancement of Science and the American Astronomical Society recently approved new codes of conduct to make it easier for people to report sexual harassment at annual meetings and explicitly forbids retaliation. An article in the Journal of Academic Medicine suggests that, in addition to following the lead of the AAAS and AAS, institutions should implement zero-tolerance policies for such behavior at universities [13]. Lessening the emphasis on GPA and making it easier for students with mental health conditions to apply to graduate programs and access resources to help them succeed academically would also make a positive difference.

While it may be an impossible task to completely put an end to sexual assault and violence in academia, there are steps institutions can take to prevent future occurrences. Making these changes will not only help women to succeed professionally, but it will accelerate the pace of scientific discoveries by not holding scientists back.

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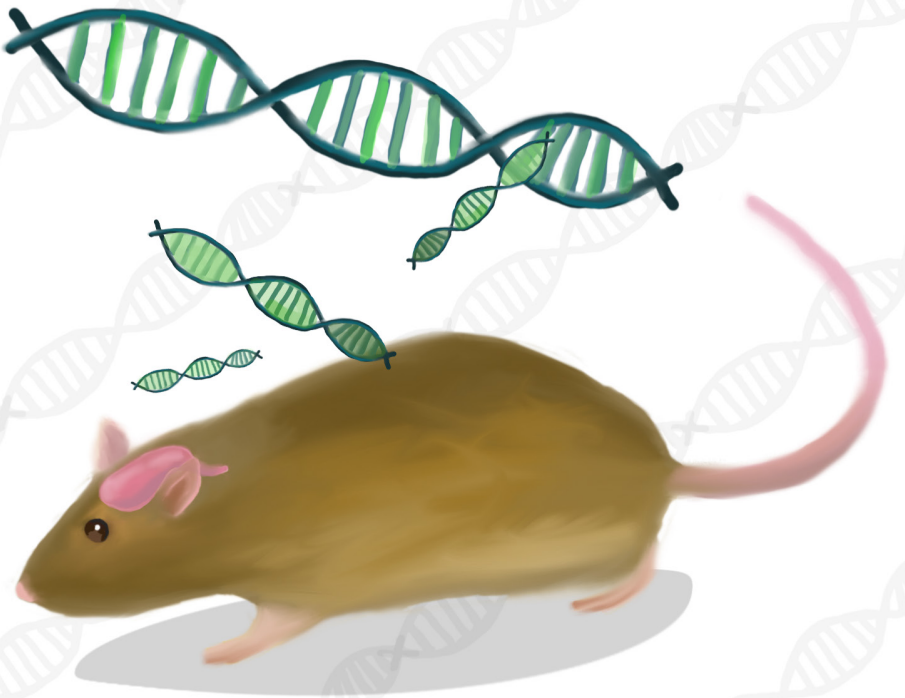


the pill spun by the fates

The Ethics of Developing an "Immortality Elixir"

Written by Ashley Sun & Sirena Khanna // Illustrated by Sirena Khanna

It is the year 2500. Artificial intelligence servants, mind-reading goggles, and renewable fuel are some of the hottest items on the biotechnology market. A new product that supposedly cures aging was just released by the burgeoning company ImMortality. This company made its name with products like an age-reversing facial cream and an anti-Parkinson's pill, which launched the company into the top three most-profitable firms worldwide. Their new drug, called the Kuro, was named after Dr. Makoto Kuro-o, who discovered the genetic basis of immortality in the klotho gene in 1997. After many generations of researchers and billions of dollars in funding, the Kuro was created. The top-secret recipe of molecular and chemical agents was successfully tested in non-sentient human clones, who were cured of all age-related problems and were assumed to be immortal. Due to the well-publicized success of the Kuro, the drug has become more famously known as the "immortality elixir."

While this version of the future may seem fantastical, it is not entirely impossible. In 1997, Dr. Makoto Kuro-o, a Japanese cardiologist, was studying high blood pressure in mice when he inadvertently shut down the klotho gene during his experiments. He noticed that his mice started to die much more quickly than usual. After discovering the gene responsible, he named it klotho in honor of the Fate who spun the thread of life in Greek mythology.

When overexpressed, the klotho gene is associated with enhanced cognition, and when disrupted, the klotho gene is associated with accelerated aging phenotypes. According to Professor Dena Dubal from University of California, San Francisco, who has conducted extensive research on Klotho, the enzyme encoded by the klotho gene, a higher abundance of Klotho protects mice from Alzheimer's-related cognitive decline. In her 2015 experiment, she overexpressed a single allele of a genetic variant of klotho, KL-VS, which promotes longevity. Mice with increased Klotho serum levels due to this allele's overexpression performed significantly better in contextual memory and spatial learning tests than did controls. Furthermore, elevating Klotho levels in mice carrying mutations for early-onset Alzheimer's reduced their premature mortality, cognitive deficits, and other Alzheimer's-related dysfunctionalities.

The exact neurobiological role of Klotho is unknown, but it most likely activates

neural networks by binding to excitatory receptors on neurons. This receptor-binding interaction causes neurons to fire, which in turn creates a cascade of signals that spread through neural networks. Dr. Dubal discovered that certain excitatory glutamate receptors in the hippocampus and cortex are especially stimulated by Klotho to enhance cognition. Further experiments showed that synaptic plasticity was directly increased because of Klotho elevation. These results were startling, to say the least, and in recent years, other researchers have followed in Dr.Dubal's footsteps to demonstrate Klotho's neuroprotective and neuroenhancing effects.

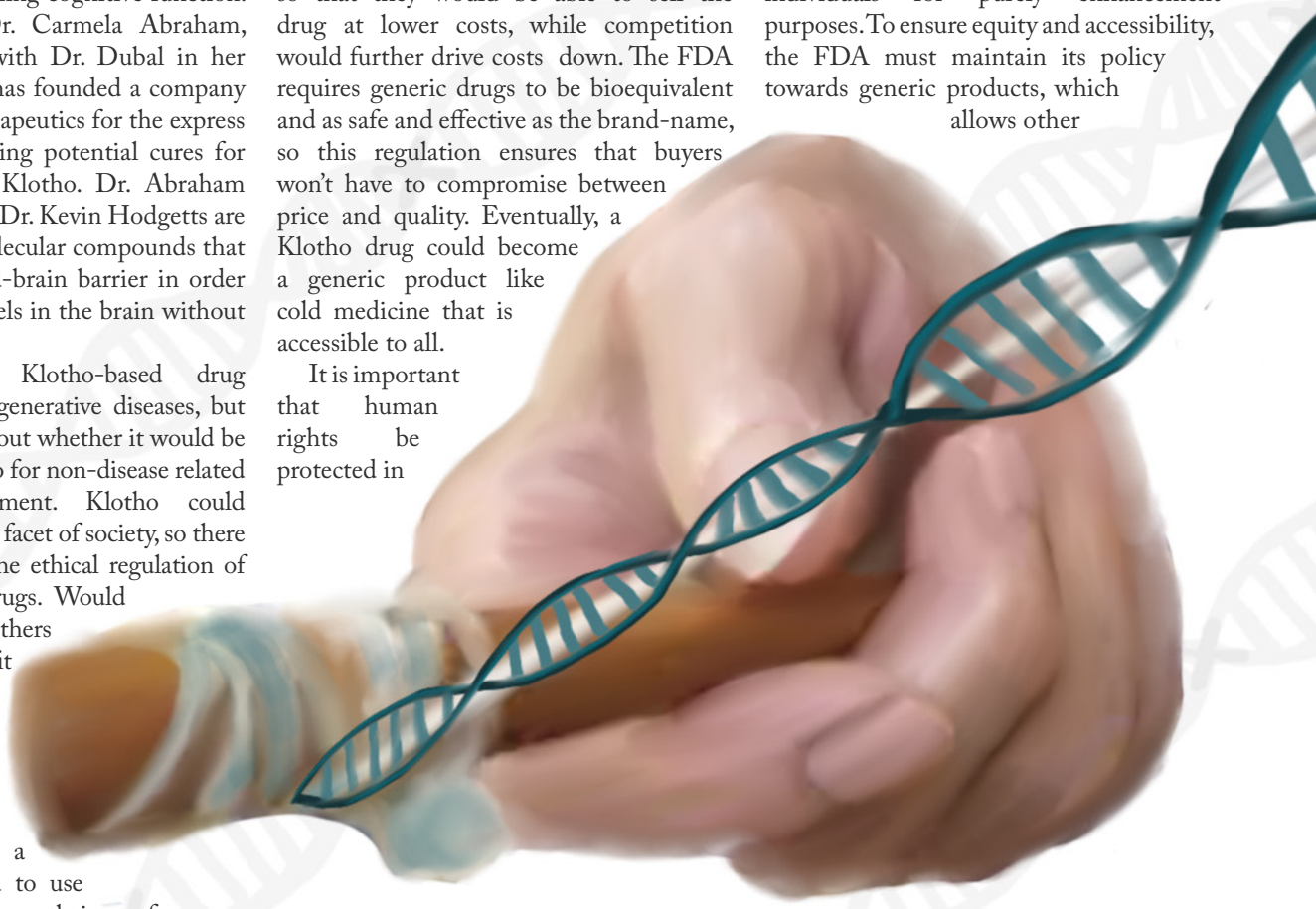
Scientists and researchers are now trying to develop uses for Klotho based on these early findings. Preliminary results show that Klotho can have both a therapeutic and enhancing effect on cognition. The main focus in the field right now is in developing Klotho-based therapies for diseases that show signs of declining cognitive function. One researcher, Dr. Carmela Abraham, who collaborated with Dr. Dubal in her early experiments, has founded a company called Klogene Therapeutics for the express purpose of developing potential cures for Alzheimer's using Klotho. Dr. Abraham and her co-founder Dr. Kevin Hodgetts are designing small molecular compounds that can cross the blood-brain barrier in order to boost Klotho levels in the brain without toxic effects.

Developing a Klotho-based drug could cure neurodegenerative diseases, but questions remain about whether it would be ethical to use Klotho for non-disease related cognitive enhancement. Klotho could change almost every facet of society, so there is a dire need for the ethical regulation of Klotho-elevating drugs. Would it be fair to allow others who would benefit from cognitive enhancement to take the drug for non-therapeutic reasons? For example, should a surgeon be allowed to use the drug to enhance their performance during surgery? Should college or high school students be allowed to use it for standardized tests? Other stimulants that have similar but less significant impacts on intellectual capability, such as prescribed amphetamines or even coffee, are accepted in society. Unlike amphetamines and caffeine, however, Klotho is naturally encoded and produced in humans. Moreover, its effects on longevity necessitate that it must be treated as more than just a cognitive enhancer.

The question of who would get to use a Klotho-based drug also begs socioeconomic consideration. Widespread demand and corporate greed could drive up prices far beyond what would be considered equitable and accessible for all. This would further stratify socioeconomic access to drugs. Equal access to Klotho can be resolved by allowing patents and the exclusive right to sell a drug to expire, a solution that the Food and Drug Administration (FDA) currently employs in the biopharmaceutical market. Once a patent expires, other manufacturers can apply to make and sell generic versions of the product that have the same active ingredient. These companies would forego the startup cost of research and testing, so that they would be able to sell the drug at lower costs, while competition would further drive costs down. The FDA requires generic drugs to be bioequivalent and as safe and effective as the brand-name, so this regulation ensures that buyers won't have to compromise between price and quality. Eventually, a Klotho drug could become a generic product like cold medicine that is accessible to all.

It is important that human rights be protected in conjunction with the regulation of Klotho-enhancing drugs in order to avoid exacerbating socioeconomic inequality. People might have to take a Klotho drug to survive in an increasingly competitive society, so workloads could increase dramatically, and vulnerable populations in society would be exposed to further inequalities. In addition, increasing average lifespans would require reassessing policies like retirement benefits and health insurance plans. Indeed, if a population is immortal, retirement becomes a perplexing conundrum. Could anyone ever retire or would humans be sentenced to an endless lifetime of work with brief, intermittent sabbaticals? Although achieving immortality is not yet practical, the ramifications of a Klotho drug must be kept in mind as social and economic policies change.

Eventually, enough might be known about Klotho to approve its use in healthy individuals for purely enhancement purposes. To ensure equity and accessibility, the FDA must maintain its policy towards generic products, which allows other



manufacturers to sell products with the same active ingredient for cheaper prices. Furthermore, a societal level, action can be taken to create policies that do not discriminate or punish people who do not use a Klotho-enhancing drug. Ultimately, it should be an option whether or not to use the drug, but this decision should be personal rather than socially enforced.

One day, a generic Klotho beverage might be available as a menu item at your local coffee shop. Just as coffee transformed the world centuries ago, the cognitive and longevity benefits of Klotho may one day increase the productivity and stamina of the worldwide population.

At best, a potential drug like the Kuro would help us maximize our potential.

Ethical regulation is necessary to ensure safety and equity since there are many dangers of cognitive enhancement drug usage in an overly competitive society. As we approach superhuman abilities, it is important to keep in mind the Greek etymology of the klotho gene. The thread of life is ever so delicate, so having the power to spin the thread is a significant bioethical responsibility and burden that scientists, clinicians, and policy makers should heed.

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