

# GXRLS IN STEM



ARTWORK: ELLA MAJD '22 (SFS)

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**GXRLS IN STEM WAS CREATED TO BRING TOGETHER STUDENTS WHO IDENTIFY AS FEMALE OR NON-BINARY ACROSS DC AND INSPIRE US TO PURSUE OUR INTERESTS IN STEM. WE PUBLISH IN THE WINTER AND SPRING.**

***WE ARE DEDICATING THIS ISSUE TO EVERYBODY ON THE FRONTLINES ON THE PANDEMIC. YOU ARE OUR HEROES.***

# GROWING STRONG

Your friendly neighborhood gxrls are back at it again with another issue of Gxrls in STEM magazine! In the time since our last issue, our community of gxrls has spread its roots, sprouting beyond the paper to lead workshops and connect with younger gxrls. And now, in this latest issue, we look at the inspiring role gxrls have played in health, medicine, and disease.

Did you know that one in three working women is an essential worker? As gxrls, we have a whole legacy of women pumping the oxygen vital to maintain our public health and our economy. A whole legacy of women uprooting gender barriers and tilling the soil so that we can grow. Nurturing your passion in often male-dominated STEM fields can be tough, but in the words of Dr. Kidest Assegued, a physician who kindly gave us her time, "BLOCK THE NOISE and pursue your dream."

We recognize that the times we live in are unexpected and frightening. In the midst of the COVID-19 pandemic, we want you to know that we are with you. Alone we can bake, we can bike, we can binge, but together, we can make our community bloom in even the strangest of circumstances. Even a global pandemic will not stop us, as we are distributing this issue of Gxrls in STEM online in order to safely share the personal stories and latest developments from gxrls at Sidwell Friends and Georgetown Day School. We hope that this magazine will bring you comfort and a sense of connection to your fellow gxrls, no matter how far apart we may be. And if you ever need any support, our family of gxrls will always be there for you. We grow stronger together.

Best,  
Layla Dawit and Avani Ahuja

# SPOTLIGHT TOPIC:

## Breakthroughs in Medicine

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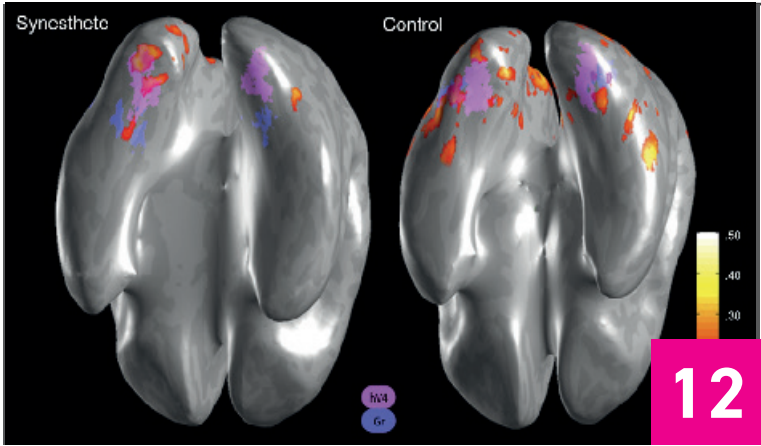
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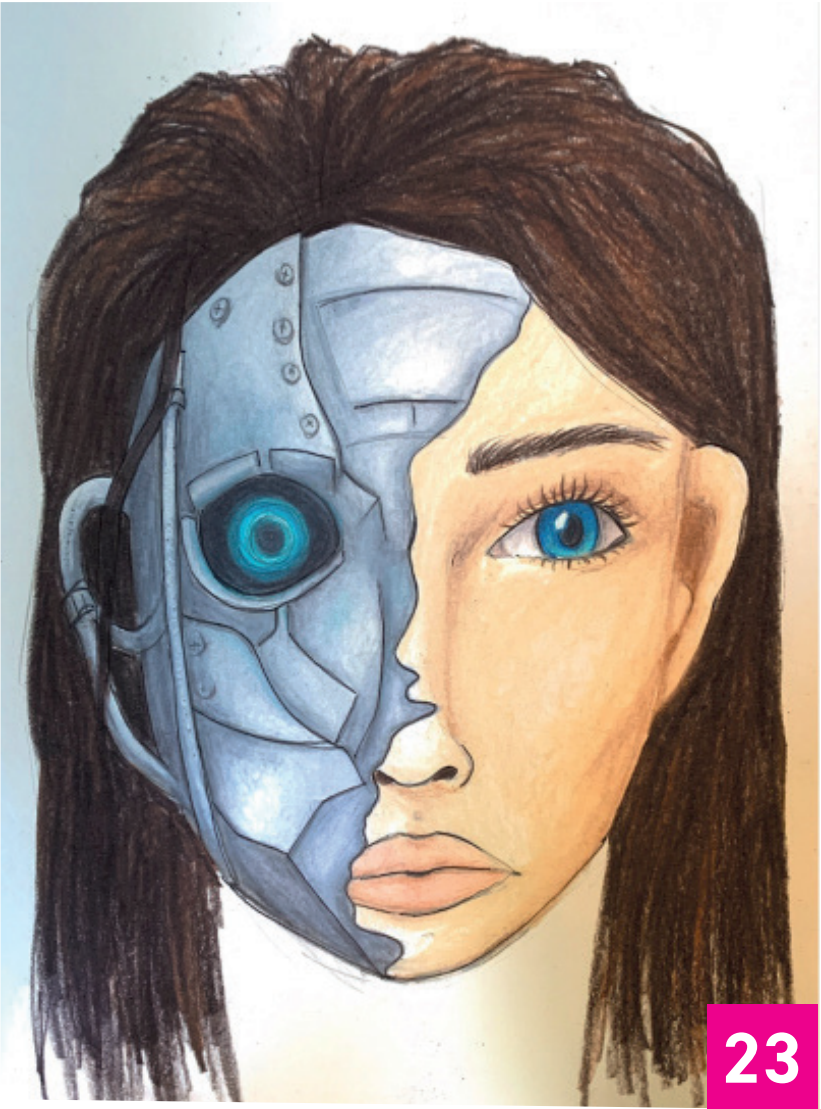
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# The Heroes of the Night's Watch: A Tribute to Health Officials Working During the COVID-19 Pandemic

Layla Dawit '22 (SFS)

**A**s the COVID-19 pandemic worsens, doctors and nurses stand on the front lines risking their lives to protect us. Imagine that. I use hand sanitizer every time I step out of the house to ride my bike or walk my dog. I've seen people wearing masks and gloves while nervously purchasing groceries. Yet our health officials go to work each day, wading through the front lines of the battle they refuse to turn their backs on. Each sickbed they visit poses a threat, but they take that risk.

Doctors and nurses lift up our communities while burdened themselves by shortages of protective gear and the weight of the constant threat of contracting the virus and infecting their families. Over 100 doctors have already died from COVID-19 across the world, and as more and more health officials contract the virus, they pose a greater risk to their loved ones. Dr. Stephen Anderson from Washington state sums up this sentiment through his report to the New York Times, in which he complains, "I am sort of a pariah in my family. I am dipping myself into the swamp every day."

The cloud of fear this virus brings hangs low over the families of local health officials as well. I spoke with Dr. Kidest Assegued, a physician at Kaiser Permanente. Assegued works in virtual medicine, meaning that she interacts with patients online from her home. Yet she spoke of a colleague who lives in a rented apartment for fear of going home and infecting his newborn and ten-year-old children, as well as another friend who isolates herself in a separate room from the rest of her family.

Even while health officials face barrages of threats to themselves and their loved ones, Assegued says that for doctors, "our ultimate reward is a healed patient." These heroes selflessly sacrifice their security and peace of mind for the chance to save people they may have never met. Even retired doctors have answered the call. In New York City, in one day, 1000 retired doctors and nurses answered Mayor de Blasio's request to help their community one last time. In the words of Laura Carstensen, founding doctor of the Stanford Center on Longevity, "think of older people as the cavalry coming over the hill." Not for fame or rewards, these shields protecting our communities felt a calling to lend their arms to the growing bulwark of health officials providing their skills out of pure selflessness.

## The Process

In the face of risk and uncertainty, what really

goes on behind hospital walls? While the virus has yet no cure, hospitalized patients are still treated for their symptoms and provided with breathing support. According to Assegued, patients call in to her hospital before visiting, where virtual practitioners such as herself provide medical advice as well as emotional support.

Only in life-threatening cases are patients admitted into Assegued's hospital, where they are immediately separated into tents based on whether they show symptoms of an upper-respiratory illness or another serious condition, such as a heart attack, without symptoms of COVID-19. After this split, coronavirus patients are kept in the Intensive Care Unit, or ICU, without any contact with their loved ones.

While patients are kept in isolation for safety purposes, this separation can bring anxiety to many families. Assegued explained that one of her patients, an older woman in a decades long marriage, could not see her husband because he was COVID-19 positive in an ICU and had developed pneumonia. In these cases, Assegued and other doctors play an important psychological role for patients and their families, "making sure they don't fall apart," as she puts it.

## Testing

Yet health officials suffer from a lack of high-demand supplies such as testing kits. Assegued explains that among doctors, "the viciousness of the virus and the uncertainty of our abilities to fight back is robbing our confidence." She shared with me that ordered tests must go through a difficult chain of approval. Assegued is



Artwork: Layla Dawit '22 (SFS)

frustrated "as a treating physician, the inability to order [tests] as we see has caused a delay in intervention."

This issue has struck hospitals nationwide, as organizations across the country, including the Association of State and Territorial Health Officials, the Association of Public Health Laboratories, and the Council of State and Territorial Epidemiologists documented "widescale shortages of laboratory supplies and reagents." The situation varies from state to state, with one of the most extreme responses so far in New York. A lack of resources led New York City's Department of Health and Mental Hygiene to issue a statewide order that "COVID-19 testing is only indicated for HOSPITALIZED PATIENTS." According to this statement, as of March 20th, on the front lines in New York, not only would suspected cases be denied testing, but doctors and first responders would not even be afforded testing after interacting with infected patients.

In the midst of all of these challenges to doctors and nurses, they still return each day to their duties, donning and doffing their masks, respirators, goggles, gloves, and gowns to slow the spread of the virus and protect families across the country. They are, to quote George R.R. Martin, "the fire that burns against the cold, the light that brings the dawn, the horn that wakes the sleepers, the shield that guards" each of us.

**To all of the health officials carrying the torch for the next generation of gxrls through your example of selflessness in a time of anxiety and calm in the midst of a storm, thank you so much. We look up to you.**

# Period-Tracking Apps: Wolves in Sheep's Clothing?

Carmen Gitchell '22 (GDS) and Joya Breinholt '22 (GDS)



ARTWORK: ANNABEL WILLIAMS '22 (GDS)

**If you ask a AFAB (assigned female at birth) student at GDS or SFS if they themselves or somebody they know uses an app to track their period, there's a big chance that they'll say yes. On the surface level, period-tracking apps are exactly what they sound like: apps in which you input data about your menstrual cycle to receive predictions as to when your next period will be. Many of these apps go above and beyond and allow you to record all aspects of your life, from how much you slept to the last time you had sex. And there is a wide variety of apps to choose from, with over one thousand available on the iOS App Store. Additionally, non-male students in our schools are not the only ones using these apps; according to Bloomberg, over 100 million women now use their phones to track their periods.**

Period-tracking apps have also become increasingly popular among teenagers. They are now the second-most popular health app among teenage women. Many of these apps market specifically to teenagers, with bright colors and simple, user-friendly layouts. It's understandable why period-tracking apps have become so popular. They are on your phone and give you a quick and easy way to

track your period. Tracking your period can be challenging without a lot of experience, and these apps do it for you. Also, many users feel that these apps are more discreet, with many having options to lock them with a passcode. It is clear why period-tracking apps have recently become extremely popular among AFAB, particularly adolescent AFAB: they promise convenience, accuracy, and privacy. However, upon a closer look, it is clear that there are many valid and underrepresented concerns with these apps, from their medical accuracy to the developers behind them to data privacy.

## The Issues

One persisting concern with period-tracking apps is who actually developed them. In many cases, male executives have been the leading developers. For example, Glow, a period-tracking app that made \$23 million in 2013 alone, was created by five men, including Max Levchin, the co-founder of PayPal. Additionally, despite being branded as healthcare technology, in one report, the Columbia University Medical Center wrote that 95% of free period-tracking apps do not "cite medical literature or health professional involvement." It is clear that the innovators behind most period tracking apps were not health care

professionals. It is clear that the innovators behind most period-tracking apps are not doctors or women empowered by the femtech revolution; instead, they are male executives seeking a business opportunity.

Knowing who made these apps, it makes sense that they wouldn't be medically accurate. Period-tracking apps also don't have regulations from any organization saying that they have to be medically accurate to be classified as "healthcare technology." The University of Washington conducted a study of nearly 700 users and concluded that they "didn't feel like the apps were very good at supporting their particular needs or preferences."

Because many of these apps were not developed by healthcare professionals, they do not understand the intricacies of menstruation. For example, if you had a stressful week or did not get much sleep, your app might not understand how that would affect your menstrual cycle. Some apps do not even have the option to input birth control, which can make your period more irregular or halt it altogether.

The lack of accuracy is even apparent on an anecdotal level. For instance, one sophomore at GDS said of their app: "It's usually in the same window, but almost always a day or two off". Even when an app has options for you to input relevant data, those options are often hidden as "in-app purchases." Many apps also operate on a cisgender, heteronormative standard, assuming that all users are cisgender women who are in relationships with cisgender men, which reduces its accuracy and usefulness for any groups beyond that.

While many users use these apps to track their periods, it is clear that the main focus of many of these apps is fertility. Apps such as Flo will tell you how fertile you are at different points of your cycle, even if you are not using the app in the "fertility mode." Glow often asks you to take fertility and ovulation tests and reminds users that they are in their fertile years and therefore shouldn't drink alcohol because it lessens the chance of pregnancy. Many users are solely trying

*"Because many of these apps were not developed by healthcare professionals, they do not understand the intricacies of menstruation."*



their period, but there is still no way to turn off the fertility functions.

Despite being branded as period-tracking apps, the main purpose of many is fertility. Making the apps main purpose actually fertility allows for more advertising to be done, which makes the apps more money. Many users who are not using it solely to get pregnant not only cannot turn off fertility functions but don't have good enough tracking of their period because many symptoms of a menstrual cycle and birth control are not taken into consideration, which limits the accuracy of the way most people are trying to use the apps.

Perhaps the most troubling concern of period-tracking apps is privacy. In an age of rapid technological advancement, data privacy is a major concern in nearly all fields. Health data is particularly sensitive for many people. While most period-tracking apps outline privacy

policies, the content of these policies is concerning. One charity, Privacy International, uncovered evidence that many period-tracking apps, like Maya and MIA Fem, shared sensitive user data with Facebook, which has had its own privacy issues in the past. Even more popular apps, like Clue, Flo, and Eve, admit that they share user data with third parties, specifically advertising and analytics companies like AppsFlyer. While these companies claim they only share basic demographic data with third parties, their privacy policies never state that they will not share data about your health in the future. The sad reality is that consumers cannot trust most apps not to share their private health data with third parties.

Period-tracking apps have become very popular because they are convenient and seem discrete. However, they are rarely medically accurate, are often developed by men, and are a massive

violation of privacy. Concerningly, many of the apps are marketed to teenagers are violation of privacy and are becoming ingrained in the lives of young AFAB. While an increase in menstrual resources is certainly a positive change, concerns of privacy and accuracy outweigh any benefits. Overall, the many issues with period-tracking apps, from their lack of accuracy to privacy concerns, are an example of how so-called "femtech" apps have little benefits for women when women are not represented in the fields that develop them.

To avoid these issues, paper tracking and digital calendars are viable options. If users still want to continue using an app, one alternative is Spot On. Spot On is an app developed by Planned Parenthood, a legitimate health organization, and it has an extensive privacy policy. Unlike many apps, it provides users the option to track their birth control rather than their fertility.

# The Stigma Around Girls in Nutrition

Natalie Keating '21 (SFS)

**I first became interested in nutrition during the summer following 9th grade. I had always wanted to become a vegetarian, but my mother worried that I wouldn't be able to maintain a healthy diet with the absence of meat as a protein. To cope with her insecurity around letting me go vegetarian, I began researching nutrition. I started reading books and listening to podcasts, trying to absorb as much knowledge as I could about how I could eat and sustain my health while cutting out meat. At first, it all seemed so clear: your diet should be a majority of vegetables, excess sugar can lead to cancer, and omega-3 can help your cognitive function. Yet I started to dig deeper into my research and found contradicting information: one book would explain how meat was crucial to one's diet, while the other would recommend eating entirely plant-based foods. I was stimulated by the opposing data and impassioned to find out more about the science around food and which information to trust.**

However, as I began to change my diet to reflect my research, I faced increased pressure and questioning about diet culture and the stigma surrounding it. Diet culture is the fixation on weight as the sole representation of one's health, wellbeing, and moral value. While I was attempting to eat healthy to maintain a strong immune system and have energy throughout my day, magazines and influencers on Instagram were targeting diets as



Photo: Alden Zhang '22 (SFS)

something I should be following to achieve a certain weight.

My friends began to notice that I was changing my diet and being cautious as to what I ate, and they worried that I had fallen into an eating disorder in which I was focused on limiting consumption as a means of losing weight. What started as an intellectual journey to learn about food as medicine for my body became a "problem" in the eyes of my peers. I stopped talking about what I was learning about nutrition and tried to convince everyone that I was certainly not struggling with any eating disorder. It was true. I wasn't. I was simply

passionate about the field of study and wanted to learn all I could.

What I've come to realize now is that diet culture is an epidemic in the country and around the world, perpetuated by misleading social media posts, constant false advertising, and the objectification of women's bodies. However, women's nutritional awareness to maintain health has also been stigmatized as something automatically in accordance with a desire to change their physical appearances, as if women cannot simply be interested in nutrition because they find the science of it stimulating.



# The Larger Fight: How Gxrls in STEM is Combating Gender Inequality

Madeleine Popofsky '22 (GDS)

**A**s a society, we tend to shy away from problems as massive as gender inequality. Even today – with women holding positions of power in both the public and private sector – policymakers’s proposals to address persistent obstacles women confront and improve how women are portrayed still gain little traction.

This leaves it to women and nonbinary people from all walks of life to stand up for ourselves and effect real change from the bottom up. As a magazine devoted to making gxrls in STEM heard and showcasing their accomplishments, we try to make gxrl’s voices heard, but it is hard to do this when the magazine is only distributed as of now in two high schools. We need to take more direct action as well – and what better way to effect change than by educating the next generation?

Sophomore Avani Ahuja, senior Tayae Rogers, sophomore Julie Steele, sophomore Lyra Gemmill-Nexon, sophomore Phoebe Braun, sophomore Sophie Zinn, and I put together a workshop intended to educate and capture the interests of middle schoolers about how women in STEM are portrayed in the media. The presentation began with an explanation of the magazine, and then quickly dove into the shocking statistics about how women in STEM are portrayed and represented in the media; for example, for every 15 male characters shown in STEM fields in children’s media, there is only one woman portrayed in a STEM profession. We explained how children’s media is so vital to a gxrl’s future, and encouraged the students to reflect on the importance of having a role model.

We then showed the middle schoolers some examples of gxrls in STEM as portrayed by the media. The clips were not labeled as positive or negative portrayals since it is vital to have the students form their own opinions and learn to think critically about the messages surrounding them. The first clip was an ad for IBM Watson’s “Hack a Hair Dryer” campaign, which encouraged women to make science their own by using a hairdryer to do science experiments.

The second was the “Innovator’s Ad” created by Best Buy, which features several inventors describing their contributions to current technology and ends with Best Buy employees showing off the products. The third was an ad called “Science, It’s a Girl Thing,” released by the European Commission in June 2012 in order to encourage women to join science fields.

While the creators of these ads may not have intended to perpetuate gender stereotypes, the middle schoolers determined that that was the



ARTWORK: MADELEINE POPOFSKY '22 (GDS)

result. After being asked to critically evaluate these ads, the students were able to recognize the problems and issues with their content.

The first clip encouraged women to limit their science to interaction with household appliances while leaving “real” science to men. The second clip only showed white men as inventors while the only women represented were store employees. The third clip only served to sexualize women in science with images of models striking poses in high heels and makeup.

Fortunately, the world isn’t all bad when it comes to the representation of women in science. After the negative clips, we showed the students some positive examples, including how Shuri, the sister of the main character in the movie “Black Panther” is portrayed as intelligent and operates high-tech gadgets and medical equipment.

We next organized an engineering challenge to encourage interest and show that anyone can enter these fields. We told the students the

*“As a society, we tend to shy away from problems as massive as gender inequality.”*

story of Emily Roebling, the unknown, unofficial chief engineer of the Brooklyn Bridge. Then, we split them into groups of four, gave them duct tape and cardboard, and asked them to build a bridge that could carry as much weight as possible.

We will not eradicate the problems of sexism and the gender gap in STEM by simply teaching a bunch of middle schoolers about stereotypes and inequality. However, with each young gxrl who learns that they have the option to become a scientist, engineer, mathematician, or whatever they want to be, that gap will shrink. Maybe, one day, it will disappear entirely.

Until then, we keep fighting.



# Vaccines: How are They Developed and Why Does It Take So Long?

Sarah Murad '22 (SFS)

**M**ost people are aware of what vaccines are and how they work: they contain weakened parts of the disease itself, which can be used to train the immune system to develop an immunity to the disease. This, in theory, seems relatively simple, and thus, a process that should not take a long time to finish. So, then, why can it take anywhere from six months to over a decade to develop a successful vaccine?

There are essentially six stages to the development of vaccines: the exploratory stage, the preclinical stage, the clinical development stage, the regulatory review and approval stage, the manufacturing stage, and the quality control stage.

The exploratory stage begins with the identification of the disease for which scientists want to create a vaccine. With laboratory research, scientists then look to find what an effective vaccine would contain - for example, virus-like particles, weakened viruses, bacteria, or bacterial toxins, and other substances. In cases like the annual influenza, this step includes the collection of international data on circulating influenza strains by the World Health Organization (WHO). Using this data, the WHO can discern which strains would be most relevant to include in that year's flu vaccination. Moreover, during pandemics, this step would also encompass identifying and analyzing the pandemic virus or bacteria.

The pre-clinical stage often involves animal testing to indicate the expected efficacy, safety, and general immune response induced by the vaccine. Scientists also gain an idea of what a safe dosage might be and what a secure method of administering the vaccine is. During this stage, the vaccine is often changed and adapted to increase its effectiveness. Sometimes scientists will attempt to infect their test subject with the pathogen to examine the success of their vaccine, a practice called a "challenge study."

The next stage, the clinical development stage, comprises three phases of testing, titled Phase I, Phase II, and Phase III. However, before commencing this part of the procedure, a sponsor for the vaccine will submit an Investigational New Drug (IND) application to the US Food and Drug Administration (FDA). An IND will include a description of the vaccine, the method of manufacture and testing, a summary of the lab reports, and the proposed study. Once approved - the FDA can take up to 30 days to approve an application - the three phases of testing start.



ARTWORK: ELLA MAJD '22 (SFS)

Phase I, or initial human studies, are performed with a group of small and closely monitored adult test subjects - even if the vaccine is targeted towards children - with the aim of determining safety and type of immune response elicited by the vaccine. The Phase I group may also undergo a challenge study. Phase II is conducted with a far larger collection of subjects, usually belonging to the group most likely to contract the disease, and endeavors to determine the dosage, as well as safety and method of delivery. Finally, Phase III involves thousands of people and tests the vaccine against a placebo. Phase III determines rare side effects and provides the necessary data and documentation for licensing the vaccine.

Should the vaccine prove efficient, safe, and effective, the next stage, regulatory review and approval, starts, and the developer will send a Biologics Licensing Application (BLA) to the FDA, which is followed by inspections, testing, a risk/benefit assessment, and decisions about proper informative labeling for the product conducted by the FDA. Further optional Phase IV trials may be conducted after the distribution of the vaccine to continue monitoring its success.

*"Sometimes scientists will attempt to infect their test subject with the pathogen to examine the success of their vaccine."*

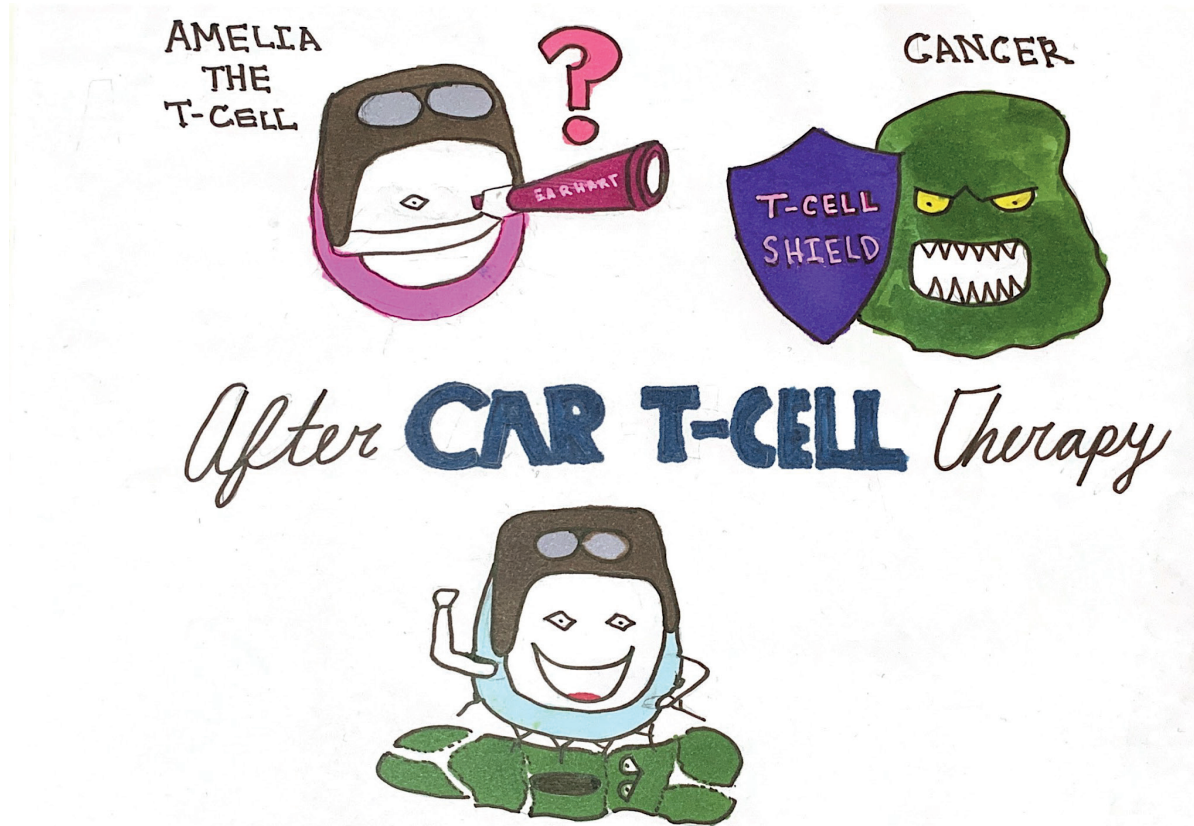
Finally, manufacturers, once they obtain approval from the FDA, begin to produce the vaccine. Depending on the method, it can take months to mass-produce vaccines and make them available to the public. For example, the influenza vaccine is injected into and incubated inside of hens' eggs for several days, allowing the vaccine virus to multiply. The virus is harvested, purified, and killed to produce the antigen, or the active element in the vaccine, and the entire process takes about two weeks and is repeated until enough vaccine is produced. The whole time, the FDA continues to oversee the production and effects of the vaccine.

In short, the process of developing a vaccine is a long one. Much of the procedure is spent conducting tests with the vaccine, both on humans and animals, to ensure safety and effectiveness of it. Additionally, should the vaccine cause harmful side effects, or simply not prevent the pathogen with enough efficiency, scientists have to start the process over from the beginning to come up with a new, different method.

Furthermore, the vaccine and place of manufacture have to undergo extensive government inspections and testing before they can even begin to produce the vaccine, and they have to continue to uphold those standards throughout their distribution of the drug. The process of creating a vaccine is undoubtedly lengthy, but rewarding, in that it guarantees a secure and effective path to immunization.

# CAR T-cell Therapy: A Hope for the Future

## Avani Ahuja '22 (GDS)



ARTWORK: AVANI AHUJA '22 (GDS)

**C**ancer is the second leading cause of death in the world, killing over 20,000 people every day all over the world. The typical assortment of cancer treatments includes surgery, chemotherapy, and radiation therapy. While effective in many cases, these treatments are limited, especially for recurring cases of blood cancers such as acute lymphoblastic leukemia (ALL), the most common type of cancer in children. More than 80% of ALL cases are treated with intensive chemotherapy, but if the cancer re-emerges after a stem cell transplant or chemotherapy, treatment options are nearly nonexistent.

But now, just within the past few years, a new treatment for cancer has had unprecedented success in curing patients with ALL and other blood cancers. With the potential to save countless lives, it has grabbed the attention of pharmaceutical companies all over the world.

### "A Living Drug"

Generally called immunotherapy, this new treatment has emerged as the "Fifth Pillar" of cancer treatment. Immunotherapy treatments generally involve modifying the immune system to recognize and attack cancer cells. In particular, Chimeric Antigen Receptor T-cell therapy (CAR T-cell therapy) has emerged at the forefront of the field, presenting a new option for patients with recurring cases of ALL.

CAR T-cell therapy is a form of Adoptive Cell Transfer (ACT), an immunotherapy approach that uses a patient's own immune cells to treat their cancer. After retrieving immune cells and performing certain modifications, scientists insert these immune cells back into a patient's body, strengthening the immune system and enabling it to successfully attack and destroy tumors. One of the problems with cancer is that it escapes detection by the immune system. With CAR T-cell therapy, scientists are able to overcome this barrier by altering a patient's immune cells so that they recognize and specifically target the desired tumor.

*"One of the problems with cancer is that it escapes detection by the immune system. With CAR T-cell therapy, scientists are able to overcome this barrier by altering a patient's immune cells so that they recognize and specifically target the desired tumor."*

### The Process

CAR T-cell therapy relies on the power of T cells, immune cells that orchestrate the immune response and kill cells that are infected by pathogens. After first extracting T cells from a patient's blood, scientists genetically engineer them to produce chimeric antigen receptors (CARs) on their surface. These artificial receptors, which consist of fragments of synthetic antibodies, allow T cells to recognize and attach to a specific protein, or antigen, that is expressed on the surface of tumor cells. The collected T cells are then amplified in the laboratory.

The final step in CAR T-cell therapy is introducing the engineered CAR T cells into the patient, which is preceded by a dose of chemotherapy. The body has protective mechanisms against the entry of foreign entities, so scientists have to weaken the immune system through chemotherapy (which has its own drawbacks) so that the body will not reject the engineered T cells. In ideal circumstances, the engineered cells would replicate in the patient's body and, with help from the CAR, detect and kill cancer cells that host the antigen on their surface.

### Side Effects

CAR T-cell therapy, like all cancer therapies, is accompanied by a variety of side effects. One of the most common side effects is cytokine



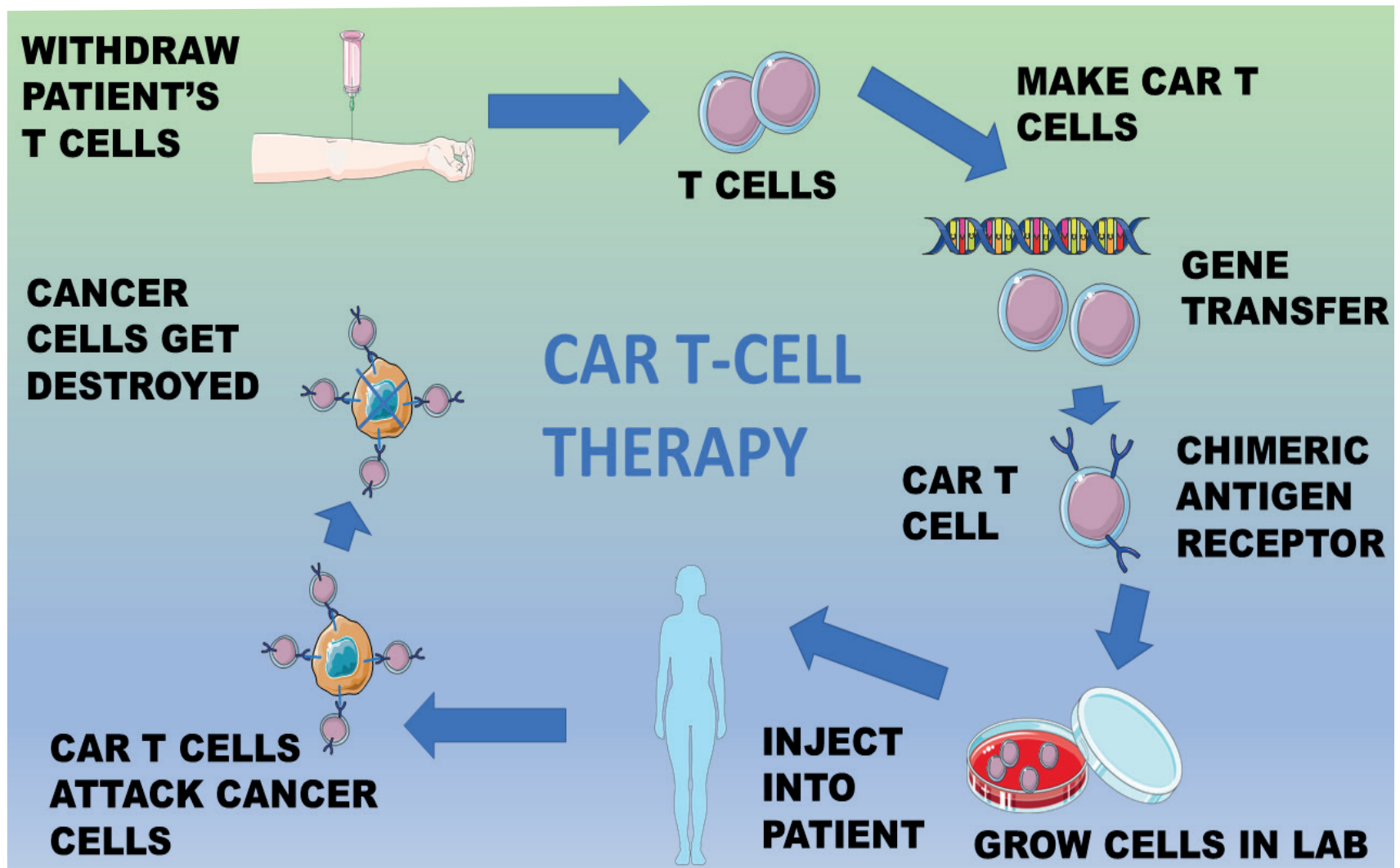


DIAGRAM: AVANI AHUJA '22 (GDS)

release syndrome (CRS). As part of an effective immune response, T cells release cytokines, chemical messengers that help direct the immune response. In the case of CRS, T cells are overstimulated due to an imbalance of cytokines in the bloodstream, leading to dangerously high fevers and steep drops in blood pressure, weakening and harming the patient.

Fortunately, a research team noticed several years ago that patients experiencing severe CRS all had particularly high levels of IL-6, a cytokine that is secreted by T cells in response to inflammation. Using this information, they turned to therapies that are approved to treat inflammatory conditions such as juvenile arthritis, which blocks IL-6 activity.

Swelling in the brain, or cerebral edema, is another serious and potentially fatal side effect of CAR T-cell therapy and has been seen in some larger trials. However, the problem appears to be limited, with the leaders of other trials of CAR T-cell therapies reporting no such instances. Other neurotoxicities, such as confusion or seizure-like activity, have been seen in most CAR T-cell therapy trials, but the problem is short-lived and reversible in nearly all patients.

#### Limitations

CAR T cells have had limited success in solid tumors so far. As opposed to liquid tumors such

***"CAR T-cell therapy relies on the power of T cells, immune cells that orchestrate the immune response and kill cells that are infected by pathogens."***

as lymphomas or leukemias, tumor antigens in solid tumors likely reside inside the tumor cells rather than on the surface, which helps them evade the detection of CARs. In addition, these tumors are surrounded by microenvironments designed to prevent an effective immune response. As a first step toward addressing this issue, scientists are creating a "super T cell" or an "armored" CAR T cell to overcome the immune-suppressing environment of many advanced solid tumors.

#### Future Directions

The next direction for this therapy is to create CAR T-cell therapies that use immune cells collected from healthy donors, not just from patients. Currently, therapies are customized for each patient, so the hope is that scientists can eventually create cheaper therapies that work

universally. Researchers are also exploring ways to mitigate side effects such as CRS by developing CAR T cells with molecular "off switches." They are also exploring more precise methods of editing T cells, using gene-editing technologies such as CRISPR/Cas9.

CAR T-cell therapy had largely been restricted to small clinical trials, but in 2017, two CAR T-cell therapies were approved by the FDA, providing a new chance at life for many terminally ill patients.

***"In 2017, two CAR T-cell therapies were approved by the FDA, providing a new chance at life for many terminally ill patients."***

CAR T-cell therapy is an example of the incredible progress that scientists can make within just a few years; if we could come this far in such a short amount of time, maybe a complete cure for cancer isn't too far into our future.

# Seeing Isn't Always Believing: Synesthesia and Prosopagnosia

Madeleine Popofsky '22 (GDS)

Imagine living in a world where each letter you see has a corresponding color. Or that each sound you hear has an associated texture. Or maybe the note F tastes like mustard. You can't explain it. This is reality for people with synesthesia. Now, imagine that when your friend gets a haircut, you can no longer recognize them. Or that you have trouble distinguishing your parents from a scarf. Or that you can't identify yourself in the mirror. Welcome to prosopagnosia.

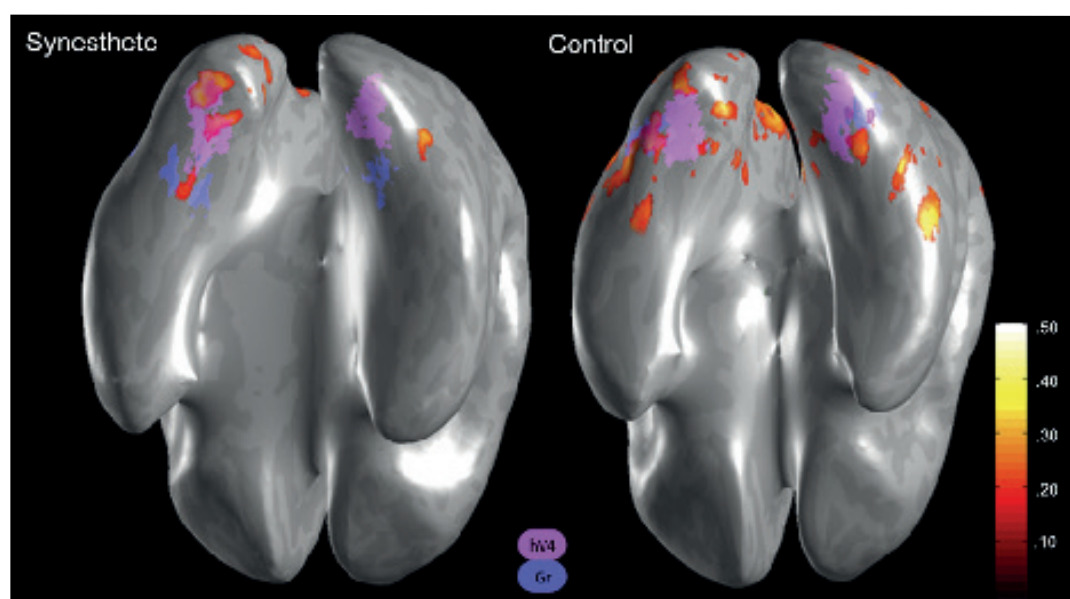
Synesthesia and prosopagnosia challenge our assumptions about the relationship between senses and reality. Are you sensing things around you that aren't there? Are there things other people can sense that you can't? We cannot definitively answer these questions. However, by talking with people who perceive the world differently from us, and by making strides within the field of neuroscience, we can learn more about the wonders and horrors occurring in the minds of those around us. Or, maybe even in ourselves.

## Synesthesia

Synesthesia is defined as a union between different senses. There are over 70 different types of synesthesia, reflecting virtually every combination of the senses. One of the more common types is Grapheme-Color synesthesia, which is when a person associates colors with letters. Some less common types involve tasting words or touching sounds.

People with synesthesia have consistent associations throughout their lives. For a certain individual with Grapheme-Color synesthesia, for example, the letter "K" would always be dark blue. However, different synesthetes do not necessarily have the same associations; one person can see the letter "T" as purple while another could see it as blue. Experiencing such correlations between senses leads to a completely different perception of the world. Most people with synesthesia are not aware of it, as it is normal to them. However, it is estimated that between two to four percent of the world's population has synesthesia in some form.

While people describing these symptoms used to be considered crazy, modern research has proven that synesthesia is real. Experiments that asked Graphemes-Color synesthetes to associate a color with a particular letter found that the colors were consistent over 90% of the time, meaning that an individual synesthete was consultant in the color they associated.



*The light purple color represents the hv4 region, while the dark purple represents the grapheme-sensing region of the brain. The level of activation is shown by the red to white scale on the right. There is an activation of the grapheme-area in both brains, but the hv4 region is activated only in the brain of the synesthete.*

In addition, scientists modified the standard Stroop paradigm, a test in which subjects are asked to name the color of a word that is describing a different color (for example, the word "red" presented in green ink) for Grapheme-Color synesthetes. In this "synesthetic Stroop," synesthetes were presented with certain characters that were sometimes presented in the "correct" color for that synesthete and sometimes not. The synesthetes were then asked to name the color of the character. The study found that reaction times for when the color matched the synesthete's internal association were much higher than when they did not, showing that synesthesia is automatic and not voluntary.

Although synesthesia is undoubtedly real, its cause is disputed and research is ongoing. Lack of pruning, a process that occurs during adolescence and involves the removal of synapses, the spaces that allow two neurons to communicate, provides one origin theory.

Failure to remove these synapses increases connections between areas of the brain, which is what synesthetes experience. Supporting this hypothesis, data from fMRI scans of the brain reveal activation of the grapheme-processing area of the brain for both synesthetes and a control group, but the hv4 area is only activated for synesthetes, suggesting a connection in synesthetes between the two brain areas. Graphemes are the smallest unit of a language, such as letters, while hv4 is an area of the brain responsible for visual perception, especially color. This connection between brain areas that process colors and letters can explain the experiences of Grapheme-Color synesthetes.

Synesthesia has been linked to many other abilities and conditions, including enhanced memory due to a heightened ability to associate different objects and sights, smells, or feelings with each other. On the other hand, scientists are also exploring a connection between synesthesia and autism because 20% of people with autism have synesthesia, but the cause of the link is still unknown. A strong correlation also exists with the arts, with synesthesia being linked with creativity. Many famous artists and painters have or are suspected to have had synesthesia of some sort, including Vincent Van Gogh and Lady Gaga.

*"Synesthesia and prosopagnosia challenge our assumptions about the relationship between senses and reality."*



### Prosopagnosia

Prosopagnosia is the impairment of the ability to recognize faces. This condition can range from a small difficulty in remembering features to an inability to tell apart a family member and everyday objects. This seems strange because we are primed by both childhood and evolution to recognize faces even when they aren't there – we see faces in objects from rock formations to pieces of toast to even the headlights and grille of a car. Evolutionarily, an ability to recognize faces has allowed humans to be more social and to easily identify potential allies and enemies.

Prior to the 21st century, scientists believed that only people with severe head injuries could develop this condition. However, in "developmental" prosopagnosia, prosopagnosia can occur without brain injury. Scientists estimate that two percent of the population experiences prosopagnosia of some kind. While people with this condition face impairment in recognizing faces, studies have shown no correlation between prosopagnosia and general impairment of memory or word recognition.

One extreme early example of prosopagnosia is described in Oliver Sacks's book *The Man Who Mistook His Wife for a Hat*. As the title might suggest, this man's case was so severe that he attempted to grab his wife's head, thinking it was his hat. The patient, Dr. P, was also asked to comment on a TV show and "what was [most] striking was that he failed to identify the expressions on [the actress's] face or her partner's, though in the course of a single torrid scene these passed from sultry yearning

through passion, surprise, disgust, and fury to a melting reconciliation." He was not even able to identify the sex of the actors on screen, and his commentary on the show was completely devoid of human description.

There are many different areas of the brain that, when damaged or not functioning, could lead to prosopagnosia. There are four main areas of the brain responsible for processing faces: the fusiform face area (FFA), occipital face area (OFA), the posterior portion of the superior temporal sulcus, and another system including the anterior temporal face area. Humans primarily use the right sides of these areas when identifying faces.

Acquired prosopagnosia is normally caused by lesions in the brain, and despite having a perfectly functioning OFA or FFA, people could still develop prosopagnosia due to a lesion in another area associated with facial recognition such as the anterior temporal face area. This leads to the conclusion that prosopagnosia is not a single disorder but instead a family of different disorders that lead to the same issue. Some more recent research points to an area corresponding to the FFA that is on the left side of the brain instead of the right as the culprit. While the case described above is very severe, many people live their entire lives with this condition in a milder form and never know it.

The underlying causes of prosopagnosia are unknown, although the condition can be inherited. While there is no known cure, most people with this condition can go about their daily lives and use other markers, such as hair length or clothing items, to recognize people.

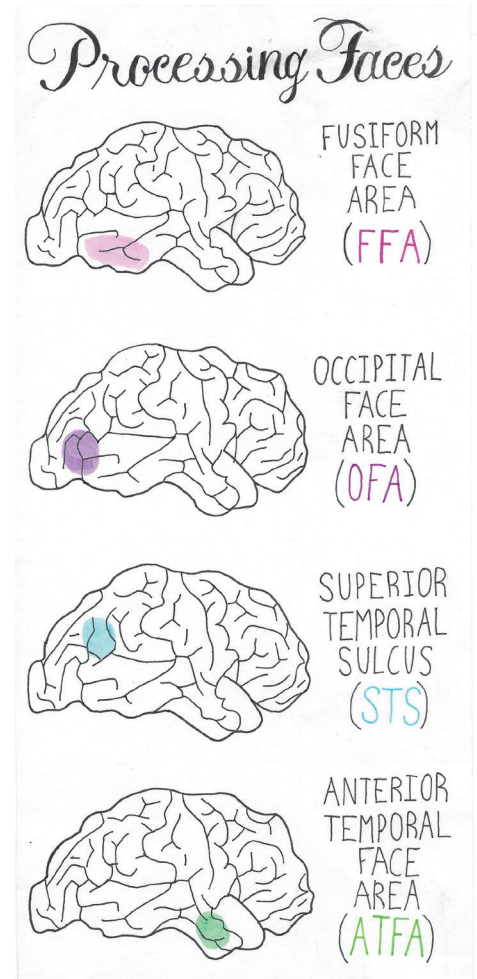


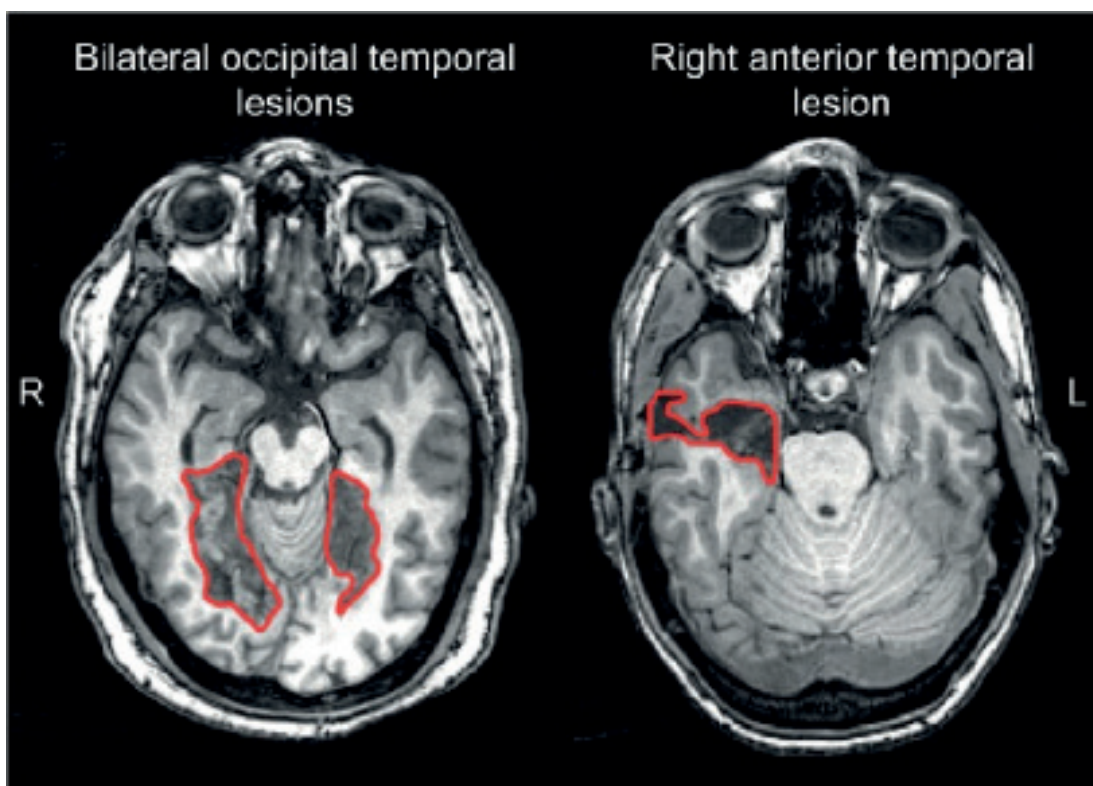
DIAGRAM: MADELEINE POPOFSKY '22 (GDS)

### What is Reality?

Synesthesia and prosopagnosia both result in perceiving the world differently. Although these very distinct neurological conditions seem strange, they have more in common than you might think. They can enrich lives, such as provide people with synesthesia with an extraordinary creative ability or a beautiful way to look at the world or give people with prosopagnosia increased confidence in crowds and with strangers. However, both of these conditions can also result in difficulties, from bullying and ostracizing to low self-esteem and even offending family and friends.

What these people perceive is all they have ever known, yet we do not consider it to be real. Still, those of us without these conditions are not perceiving the same world either. Colors aren't definite or real. Neither are sounds, smells, or anything else we perceive. Two people can see an apple as red and yet be seeing different colors. A dog would see that same apple as a yellowish-grey. A mantis shrimp, which has 12 color receptors, would see it as an entirely different color. Everything we think is real is just a creation of our minds.

**So, what is reality?  
Only you can decide.**



Examples of lesions that lead to prosopagnosia. The approximate lesions are outlined in red.





*Dr. Maya Das holds an M.S. in Epidemiology from the University of Maryland Baltimore, a J.D. from the University of Wisconsin Law School, and an M.D. from the University of Wisconsin-Madison School of Medicine and Public Health. She currently works in clinical development at Heliconia, LLC, as well as serving on the faculty of the University of Maryland Medical School.*



# Interview with Epidemiologist Dr. Maya Das

Celia Johnson '22 (GDS)

**Johnson:** Can you tell me a little bit about what you do?

**Dr. Das:** Right now I'm a consultant for drug device and digital health companies. I do clinical development consulting, so I help them get drugs through the FDA process and onto the market. I primarily work with small and midsize companies. Right now I'm not actually functioning as an epidemiologist, but I have a master's in epidemiology.

**J:** What drew you to epidemiology?

**D:** For me, it's the idea of being able to help populations as opposed to individual patients. I love numbers and I think it was a good mix of being able to look at numbers from a larger perspective (and I have a background in law) so one of the good things about being on the epidemiology side is the tie-in with the public policy and the regulatory side as well and being able to use numbers to inform your decision making in terms of how to approach a regulatory and public policy issue.

**J:** Did the epidemiological community have a sense that a pandemic like COVID-19 was on the horizon?

**D:** I think there has been a sense. Over the course of the past oh-so-many years there have been multiple potential pandemic-like viruses or other agents that develop, like SARS. We talked a lot about this in 2009 during the swine flu. Even with Ebola or Zika more recently, we've definitely been through that process of preparing for something that could be like [our current situation], at least in the epidemiological community. Although because this is an area where science and public policy intersect, there are definitely different approaches and separations within the community itself.

**J:** What could the United States and the world at large have done to be better prepared?

**D:** I think that's a loaded question because obviously hindsight is 20/20. However, one of the first things when you're doing an epidemiology investigation is identification of cases. I think it's important to identify what the hazard actually is, how much exposure is required for infection, and then characterise that risk. And then communicating that widely and in an appropriate fashion so that folks can prepare for it.

I think, again hindsight 20/20, that there are definitely things that could have been done on the identification side. I think when this was identified, we probably should have been a bit better at making sure we had the diagnostic

capabilities to identify patients with the virus and making sure patients who suspect they have the virus actually get tested. It's also important to not be too strict with your case definition. You know, part of epidemiology is defining who should be included and I think initially, in the US, we were too narrow in defining who our cases actually were.

Being that this is a virus that we've never encountered before it's not like there's going to be a vaccine or medication or a treatment that's ready to go. Some of the basics you do need to do, such as having protective equipment that's available such as masks and gloves. The capacity issue, in terms of ventilators and hospital beds, is something that I think we talk about a lot, but it's one thing to talk and another to put it into practice.

**J:** What is most concerning about the spread of COVID-19?

**D:** I think what's most concerning is the fact that it can spread in patients that either have a very mild form or are asymptomatic. I think that it makes it extremely difficult to control. When people feel healthy it's very difficult to keep them inside and indoors and away from people. Humans by nature are social, so it's difficult for us to have to be sitting inside with just our immediate family. That's one of the biggest challenges with COVID-19. At least with SARS it appears that you were only infectious when you were symptomatic, but in this case that's not true.

**J:** What has the epidemiological community been working on?

**D:** At least from my perspective, I think right now they're really just trying to understand what needs to happen before you can start opening things up safely. That's really a big key, trying to figure that piece of it out. You're seeing different states and the federal government coming up with different paradigms in terms of how that might happen. For example, in Maryland you've heard [Governor] Hogan talk about how he wants to see fourteen days of continuous decline in hospitalizations. And that's his sign that things can start opening up more. You're also seeing different states take different approaches.

**J:** Do you think the number of hospitalizations is a prudent standard for establishing a timeframe to reopen the country?

**D:** I think it's one of those things where we haven't been in this situation before, so

it makes it difficult to know exactly what you should do. But I do think it's a prudent approach. There is definitely a risk of opening up too soon, especially when you take people who have been indoors for so long and let them go outside. There's that fear that comes that you're actually going to see some major spikes if you don't open up with a more gradual, thought-through process.

**J:** Why do you think people are protesting against these social distancing measures?

**D:** I think that's where politics meets policy. There are political reasons why that's happening, which are not related to the actual pandemic itself, but apart from that I think it also comes from the fact that we've been in this situation for six, seven weeks now and people are looking to get back to work. They're looking to get back to as it was before.

Unfortunately, unless there is a vaccine or a treatment that works quite well for patients that do end up with more severe cases of COVID-19, I don't think that we're going back to normal. We're going back to a situation where we have to maintain social distancing to some extent. If we do start opening up, you're still going to see uses of masks and gloves and things like that. Until we get to a vaccine, we're not going to get to a point where things are normal.

**J:** What are the most effective ways to prevent virus spread?

**D:** It goes back to the simple rules: wash your hands for 20 seconds, keep your hands away from your face, keep your distance from other people, cough into your elbow, stay home when you're sick. It's the standard practices that we all have.

Additionally, I think that as we start opening things up, you're going to start seeing the idea of people wearing masks permeating into other situations, like work. There have been some discussions even in airports, where flight attendants have come out saying that they wanted people to have access to masks and gloves. Not just necessarily cloth masks, but also masks that have actual filter protection, whether that be surgical masks or N-95 masks. Cloth masks are good at helping

you not pass it to another person, but they're not as good as filtering the things that come from other people.

**J:** We have seen three coronavirus outbreaks in the 21st century: SARS, MERS, and now COVID-19. Is there reason to believe that it is only a matter of time before we see another one?

**D:** Coronaviruses are with us all the time. What we call the common cold is a coronavirus. It is always possible that another virus, coronavirus or not, might cause another pandemic type-situation. Going forward, hopefully we've learned the things we need to do from a public health and a public policy perspective to make sure that when we suspect that there's a potential [pandemic] we can react early. There's no going back, we can only go forward. If you can't control it early on, you're stuck in mitigation and mitigation isn't as good as containment.

**J:** What do you predict will be the permanent social effects, if any, on the population?

**D:** I think that's really hard to know. I wish I had a crystal ball and could tell you, but I do think that, as anything that is transformative as a society, the effects of it will linger. In terms of how we interact, it's probably going to take a while before people are comfortable going to the movie theater, for example. There's absolutely going to be changes in the way we go to restaurants, bars, places where you're packed in. Even after all this clears, people are going to be nervous in those kinds of situations.

I also think people are going to rethink their roommate situations, because obviously your roommate might not be someone you're best friends with. Their approach to this might be different than yours, and how do you deal with that? So maybe these are the kinds of discussions that you'll have when you talk

to your roommate that you've never even thought about before.

**J:** Everything right now seems uncertain, but what is one thing that we should be hopeful about?

**D:** For those of us who have been fortunate to stay healthy through all of this, I think there's a lot of things to be hopeful about. This is a temporary time, and while I hate to say that this is something that we're all going through together, because I think different people are feeling it at different levels of intensity, I do think that when we make it through to the end of it, we'll have learned something from it and when a similar situation presents itself we'll have that knowledge and experience.

**J:** Thank you so much for speaking with me.

**D:** You're welcome. Good luck!

# Crossing Norway for a Cure

Aliza Lubitz '21 (GDS)



PHOTOS: TIA PIZIALI '21 (GDS)

**O**n February 21st, 2020, Alison Reynolds left her Northwest Washington, DC home to ski across the backcountry of Norway in hopes of raising money to fund research on phenylketonuria (PKU). Her daughter Tia Piziali, a junior at GDS, has been afflicted with the disorder since birth.

PKU, a rare inherited disorder, is caused by a defect in the gene that helps create phenylalanine hydroxylase, an enzyme needed to convert the essential amino acid phenylalanine (phe) to tyrosine. Those afflicted with the disease have increased levels of the amino acid in the blood. To manage the condition, individuals must follow an extremely restrictive diet, limiting consumption of phenylalanine (which is found in all proteins and some artificial sweeteners) and consuming

a phe-free amino acid formula four times a day to meet individual protein needs. If the disease is unmanaged, irreversible brain damage can ensue.

This past fall, Piziali began using the novel enzyme therapy Palzyniq, a phenylalanine-metabolizing enzyme, to help treat her PKU. She injected the drug daily into her stomach and for the first time was able to try foods like shrimp, beans, and bacon (her favorite).

BioMarin Pharmaceutical, the maker of the drug, received the Food and Drug Administration's (FDA) long sought approval for the distribution of the drug in 2018. However, the FDA required the drug to be dispensed with a black box warning label, as about 9% of patients treated with the drug during initial clinical trials suffered

anaphylaxis. That, together with the drug's average cost of 192,000 dollars per patient, has limited the number of patients with access to the drug and derailed analysts' hopes for a rousing introduction of the drug to the PKU community.

Both Reynolds and Piziali have voiced their desires for a decrease in drug costs, an oral form of the drug, and further recognition and awareness of this rare, mostly-unknown condition. After training for more than a year, Reynolds skied 125 miles, pulling an 80 pound sled, sleeping in tents at night, and at constant risk of contracting frostbite and hypothermia to help make these hopes a reality. She also stopped in Steinkjer, Norway the hometown of Norwegian physician and biochemist Ivar Asbjørn Følling, who first discovered and named the disease in 1934.

Reynolds and Piziali have been invited to raise further public awareness on the disorder on multiple national talk shows and television programs, including NBC's Today Show. These opportunities have aided Reynolds in raising an astounding one million dollars for research on the disease; this amount is more than twice her original goal and she's not going to stop fundraising now.

Fundraising is an important way to catalyze the development of new drugs to treat specific disorders, but it is not the only way. Now more than ever, in the midst of the COVID-19 pandemic, it is necessary to take inspiration from Reynolds and contribute to the halting of the spread of the coronavirus. We can help actualize this objective by social distancing and staying at home. Our contribution in this manner can provide hope for infected individuals and their families, and potentially save lives.



# Spooky Action Over Long Distances: A New Breakthrough in Quantum Computing

Lyra Gemmill-Nexon '22 (GDS)

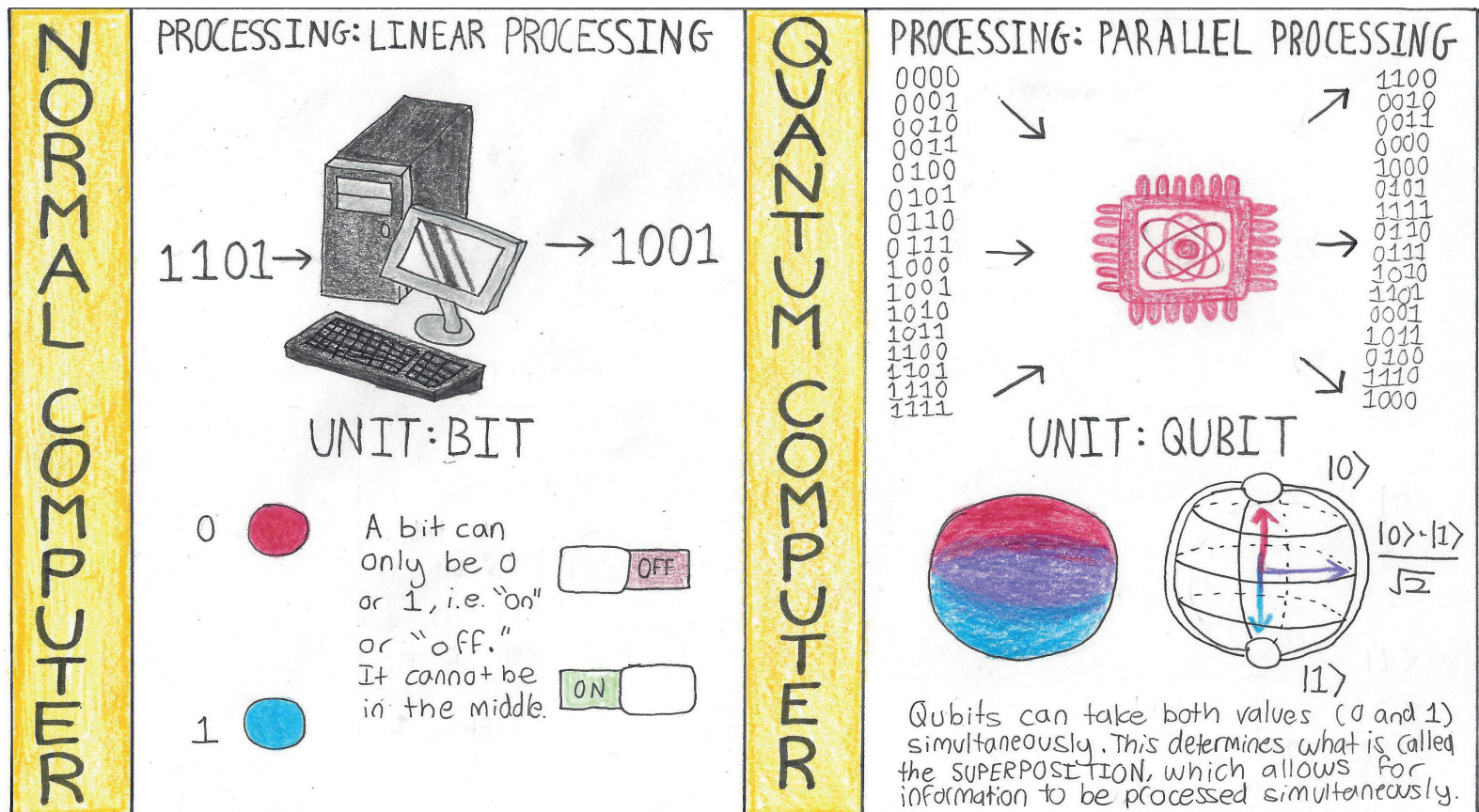


DIAGRAM: MADELEINE POPOFSKY '22 (GDS)

**T**he quantum world is markedly different from the macro, observable world that we experience every day, which is to say that it doesn't really make sense. In quantum mechanics, observation can change the very nature of systems, and particles behave in ways that violate Einstein's laws of relativity. This is called entanglement, a relationship between two particles that would seem to defy the classic laws of physics. Einstein himself decried it as "spooky action at a distance," testimony to its strange, counter-intuitive nature.

Breakthroughs in quantum entanglement usually pertain to increasing the distance over which individual particles (usually photons) are entangled. However impressive these experiments are, for quantum computing or a quantum internet (a network of quantum computers integrated over great distances, similar to the classical internet) to succeed, a key component remains missing: the ability to store quantum information. This requires the entanglement of "quantum memory," the quantum equivalent of classic computer memory.

Just last month, researchers at the University

succeeded in entangling quantum memory across an astounding 50 kilometers. While certainly not yet enough to facilitate a quantum world wide web, the study, published in Nature, is an important step towards functional quantum networks.

Perhaps most importantly, the research team touts a relatively new method to improve the reliability of larger-scale entanglement across great distances. Instead of simply attempting to entangle photons over further and further distances, they utilized a system wherein cooled rubidium atoms acting as nodes were

*"Just last month, researchers at the University of Science and Technology of China (USTC) succeeded in entangling quantum memory across an astounding 50 kilometers."*

entangled with photons. These photons could then travel between nodes and be measured with as little interference as possible. This is important, because if the entangled system is disturbed, the information will be lost.

But why does this all matter? Quantum computing would theoretically allow for much more powerful computers, as instead of running on a system of bits (binary digits one and zero), they use qubits. Qubits can be measured not just as on or off, but by their quantum state and superposition. This would give quantum computers an edge in tasks such as decryption, conducting searches, and solving equations—areas where having more variables to work with would make them both faster and more efficient than classical computers.

The future of quantum computing remains in question, as it has for decades, and as it probably will for some time to come. It remains to be seen if widespread quantum computers or a quantum internet are even possible, but experiments like that of the USTC researchers are constantly improving quantum technology and bringing us ever closer to a reality where that is the case.

# WXMEN IN STEM

Maya Landweber '22 (GDS)

**< 1/3**

of female students pursue  
higher education in science  
and engineering fields  
(2020)

white men constitute almost

**half**

of scientists and engineers employed in  
science and engineering positions  
(2015)

**29.3%**

of researchers  
worldwide are womxn  
(2019)

fewer than

**2 in 10**

science and engineering  
employees in the US are  
womxn of color  
(2015)

for every 1\$  
earned by a man  
in STEM, a  
womxn in STEM  
earns

**86¢**  
(2009)

over

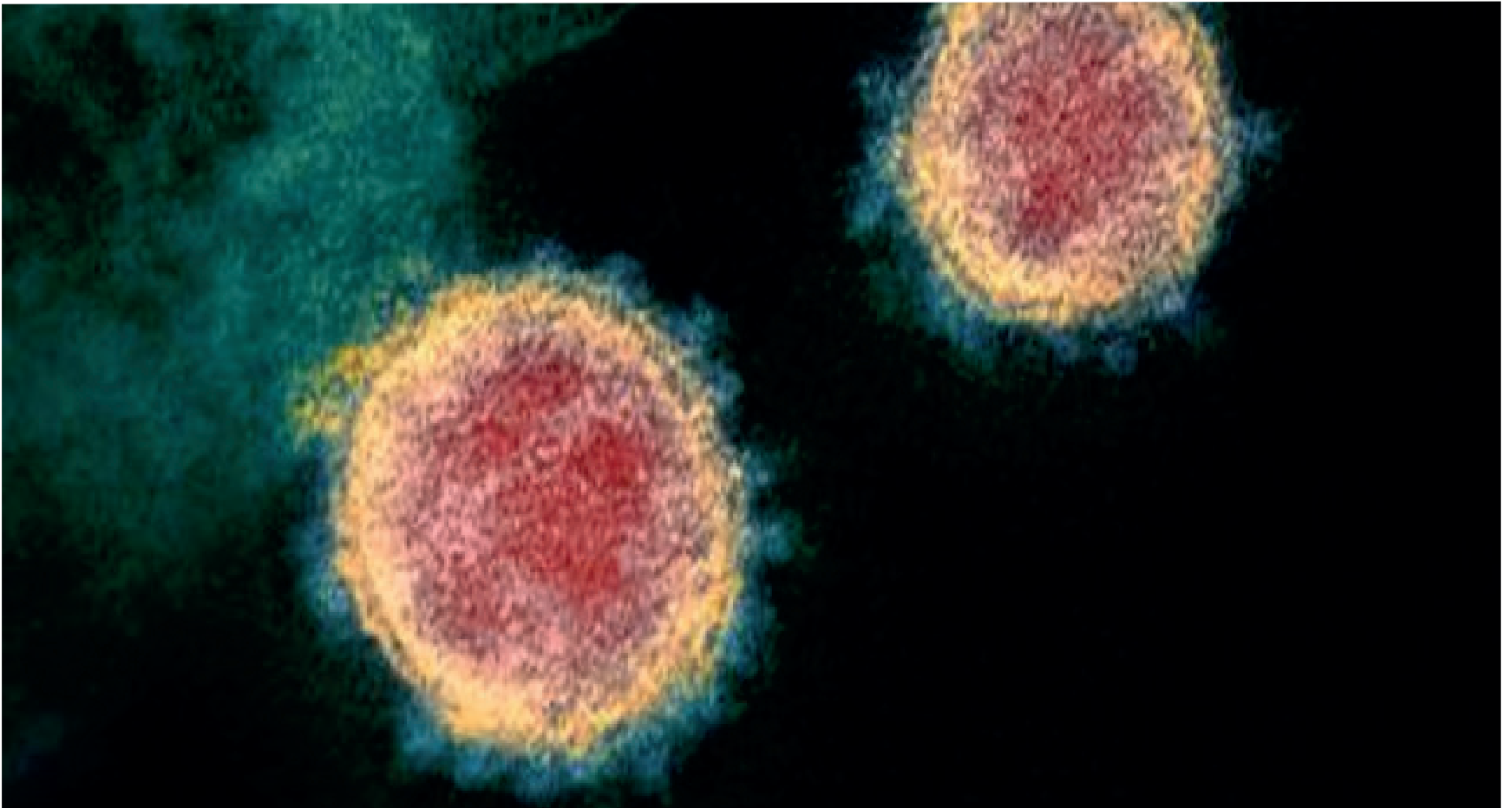
**50%**

of science and engineering doctoral  
degrees awarded in 2017 in the US  
were to womxn



# Treatment Options for COVID-19: Does an Effective Drug Already Exist?

Nora O'Connor'22 (GDS)



*Remdesivir has the capability to destroy COVID-19*

**F**or the past few months, COVID-19 (more commonly referred to as coronavirus), has dominated all news sources and affected countless lives. The disease, which originated in Wuhan China in December of 2019, and rapidly spread to many other countries, including the US, has no vaccine. The race to create one is on and scientists are progressing at a rapid pace. However, what if effective treatments for COVID-19 already exist?

Antivirals are a type of drug used for treating viral infections. They work through many different methods. Some are only useful against one specific virus and some can be used more universally. Most antivirals do not completely eradicate a virus but instead inhibit it, reducing symptoms and infectivity.

Some studies have suggested that antivirals already in existence could be an effective prevention or treatment method for COVID-19.

An in vitro study showed that both chloroquine and remdesivir were effective in decreasing the viral load of COVID-19. Cells were infected with the novel coronavirus and then treated with varying doses of different drugs with antiviral properties. Then both the viral yield and the cytotoxicity (the measure of how toxic the drugs were to the cell) were measured. Both remdesivir and chloroquine showed a relatively low level of cytotoxicity and also inhibited the virus.

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*"Some studies have suggested that antivirals already in existence could be an effective prevention or treatment method for COVID-19."*

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Chloroquine was used in multiple clinical trials, and while some showed positive results, there also appeared to be side effects. Irregular heart rhythms were observed in some patients in Brazil and this has discouraged many doctors from using chloroquine as a treatment for COVID-19.

Although a vaccine may appear to be the only option to many Americans, alternative treatment methods should be explored. Antiviral therapies could be used in tandem with a vaccine or be used as an initial preventive treatment until a vaccine is developed. In dealing with this virus, we should use all the resources available in order to lessen the negative impacts it will have upon our society. Antiviral treatments can be used to treat people already infected with the virus, and possibly even be taken as a preventive measure by people at high risk of infection, like doctors and nurses or families with members who are infected.

# Henrietta Lacks and the Ethics of Medical Breakthroughs

Celia Johnson '22 (GDS)

**W**hen Henrietta Lacks died on October 4, 1951, she could not have conceived what her legacy would become. Lacks, only 31, was battling an aggressive form of cervical cancer. Johns Hopkins Hospital, the only hospital in the area that saw African-American patients, treated her. Her doctor, George Gey, harvested both a healthy and a cancerous sample of tissue from her cervix. When he studied her cells, what he saw amazed him; while other cell lines had died off quickly, only reproducing a few times before dying off, Lacks's cells replicated at an incredible rate.

Today, we understand that her cells had two important mutations created by the human papillomavirus (HPV). The first mutation caused the accelerated division rate observed by Gey and the second created an enzyme called telomerase. Telomeres are structures at the end of chromosomes that prevent chromosomes from fraying. Normally, the total loss of telomeres through many cycles of cell division causes cells to stop dividing after a certain amount of time. However, when Lacks's cells divide, telomerase activates, rebuilding the telomeres and ensuring that her cells can theoretically divide forever.

As the world's first immortal cell culture, Henrietta Lacks's cell line (known as HeLa), revolutionized the study of diseases. Her cells have been used to develop treatments for diseases such as herpes, leukemia, and polio, as well as for studying cloning and in vitro fertilization. Scientists estimate that if every HeLa cell ever grown was put end-to-end, they would wrap around the Earth at least three times (which is especially impressive considering the average skin cell is only 30 micrometers long).

However, while HeLa cells had extraordinary consequences for the healthcare industry, there is also another, hidden side to this story. Henrietta Lacks did not consent to having her cells mass-reproduced. Medical consent was not an established practice in the 1950s., and no one informed Lacks's family of the existence of HeLa cells until more than 20 years after her death. This failure to communicate was not a simple oversight. In the 1970s, when the press came close to finding out her identity, Gey told them that her name was Helen Lane in an attempt to throw the press off her trail.

This desire to conceal her identity stemmed not only from Lacks's lack of consent but also from the monetization of HeLa cells. While Gey initially gave HeLa cells to his colleagues for

free, the demand surrounding them became so great that scientists began charging for her cells. Her cells were the first commercialized biological material, launching a multi-billion dollar industry. Even today, one can buy a vial of HeLa cells online for \$250. If Lacks's identity were discovered, it would collapse the industry and raise ethical questions about years of scientific developments as well as ending future research opportunities.

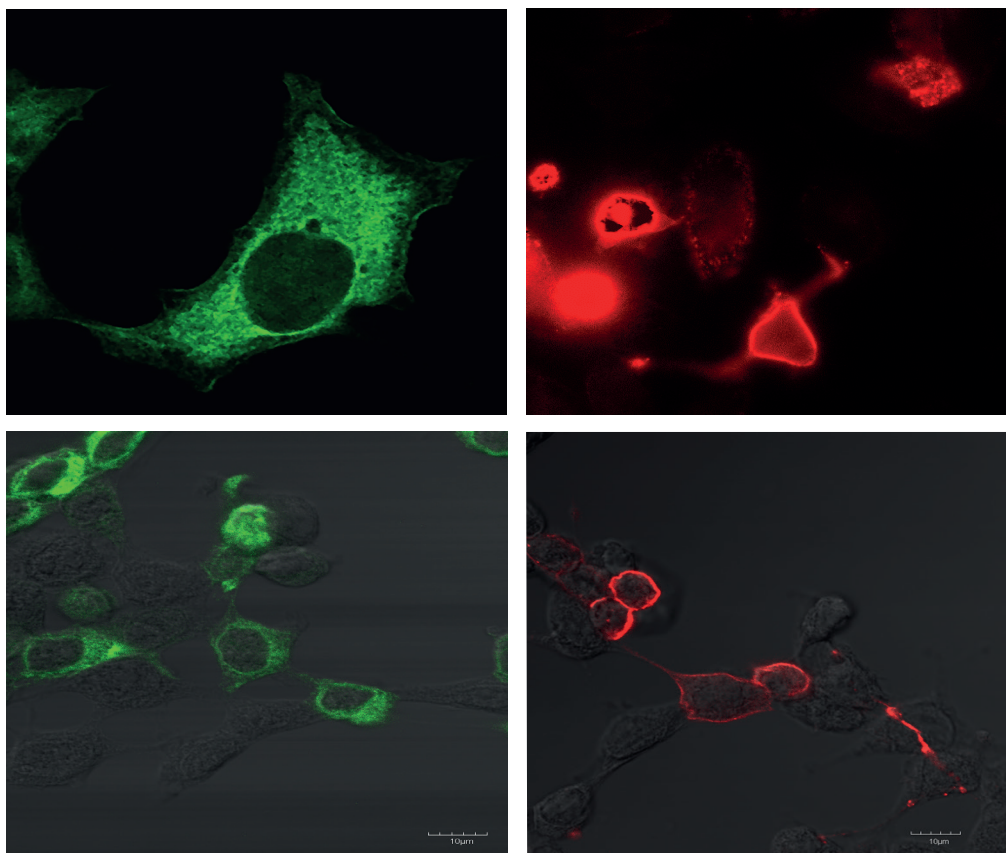
***"The desire to conceal her identity stemmed not only from Lacks's lack of consent but also from the monetization of HeLa cells."***

In the mid-1970s, scientists discovered that HeLa cells could travel on air particles and had contaminated many other cell cultures. In an attempt to figure out which cells belonged to the HeLa line, scientists contacted the family to get a similar genetic sample. When Lacks's family found out why they were being contacted, they were understandably upset. There was a whole industry surrounding their relative and they had received no notice or compensation. Some of her family members launched a campaign to receive part of the profits, while others simply wanted to learn more about

the surprising legacy of their relative.

Since then, the medical industry has taken steps toward giving the Lacks family more say in decisions made surrounding the cell line, such as the 2013 decision by the National Institutes of Health to allow two members of the Lacks family to review applications for the use of HeLa cells. However, research has continued on HeLa cells without the consent of Lacks's family due to the widespread proliferation of her cell line. For example, in 2013, scientists sequenced the genome of a HeLa cell and published their results on the internet, exposing Lacks's DNA to the public without the permission of her family.

Ultimately, the story of Henrietta Lacks is one that explores issues of medical consent and privacy. Rebecca Skloot, the author of the award-winning book *The Immortal Life of Henrietta Lacks*, argues that rather than a story with one good side and one bad one, Lacks's story is a nuanced one that shows that "sometimes[,] even with the best of intentions[,] things go wrong." On one hand, Lacks's cells have saved millions of lives. On the other, Lacks and many other patients at that time never consented to being experimented with. Today's scientists should remember that although it can be easy in science to reduce humans down to their component parts, it is important to see the human behind every biological sample.



CONFOCAL IMAGES OF HELA CELLS, PHOTOS: HENRY OHMAN



# Expected Economic Impact of the Coronavirus

Emma Dower '22 (SFS)

**C**ovid-19, more commonly known as the Coronavirus, has impacted the world tremendously over the last few months. It affected animals at first, but it has now become a pandemic, putting countries around the world into a state of crisis. However, the virus poses a threat not only to public health but also to the state of the economy.

On Wednesday, March 11, the DOW dropped 1,464.94 points, which put it into bear territory. Bear territory means that it dropped by 20% or more, becoming the biggest economic fallout since 2009. The S&P was just short of bear territory, dropping 500 points and 19.2% from February 19th. As of March 12, the DOW was at 21,200.53 points, and the last time it fell this low was June of 2017. This low point result stems from investors not wanting to put their money into an uncertain economy.

At present, the high-risk companies are those which either depend on large congregations of people, or ones reliant on Chinese and Italian factories and production facilities. Car companies, Apple, and general medicine are examples of businesses all experiencing decreasing amounts of products to sell. This disturbance in revenue stability worries investors and causes the stock market to fall.

The disease poses a larger threat to the older generations, which particularly influences mature economies. As a result, economy analysts expect a global economic recession.

The fear surrounding Covid-19 will also impact the economy. Goolsbee from The New York Times explains that "when people pull back from interacting with others because of their fear of disease, the things they stop doing will frequently affect much bigger industries in the United States." People will stop going places, lowering luxury spending habits on which the US economy relies on heavily. An average of 11 million United States residents per year

*"At present, the high-risk companies are those which either depend on large congregations of people, or ones reliant on Chinese and Italian factories and production facilities."*

go on cruises, a number which will decrease enormously due to the close proximity and subsequent risk inherent with such a venture.

In addition, the American people spend 19 billion dollars each year on gym activity, which will decrease with quarantine and fear of the virus. People will stop going to the doctor or dentist unless absolutely necessary.

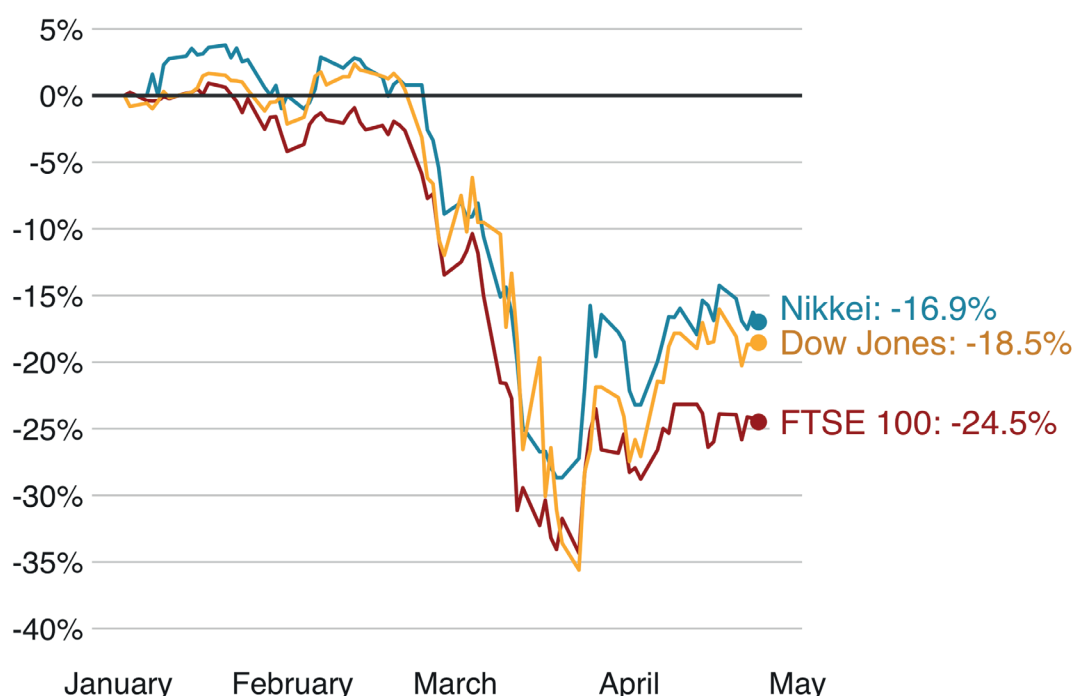
Gad Levanon, the vice president at The Conference Board where he heads the Labor Markets Institute, predicts two possible economic outcomes. First, the disease fades away after April. The "luxury" spending markets will slow down and take a hit, which will affect roughly 7% of the US GDP if there is a 10% drop over a 3 month period (a conservative estimate). This will affect the total GDP by .7%, which is significant because it normally grows only .5% per quarter. However, by early summer, the economy will bounce back and may even go into a rebound.

The second possibility is less optimistic, reflecting what may happen if the disease continues after April. The economy could enter a full recession but will be dependent on the health officials and policymakers' reactions. Businesses are expected to begin to lay off employees, but government subsidies will be hard to come by because the interest rate will be close to 0%. This affects the federal reserve's ability to make tax payroll cuts.

While the near future does not look promising, these are all suspicions. The many uncertainties of the nature of the virus make it hard to predict what is to come. Be cautious, but not extreme, as drastic measures taken by investors is what led the DOW to plummet. The Coronavirus has led to a precarious economic state in the short term. While the long term implications remain to be seen, the underlying fundamental elements of the economy remain strong, giving reason to be optimistic.

*"The Coronavirus has led to a precarious economic state in the short term. While the long term implications remain to be seen, the underlying fundamental elements of the economy remain strong, giving reason to be optimistic."*

## The impact of coronavirus on stock markets since the start of the outbreak



Source: Bloomberg, 24 April 2020, 11:00 GMT

BBC

# The Ethics of Somatic and Germline Gene Editing

Lucie Johnson '23 (GDS)

Imagine being able to select the intelligence, athletic ability, musical talent and more for your future child. Although this may seem dystopian, this future is not so far-fetched and it is all made possible by gene editing. Gene editing, also known as genome editing, involves adding, removing, or altering segments of DNA. Scientists use gene editing to study the mechanisms of different diseases by modifying the DNA of animals, such as mice or zebrafish. This technique has enabled scientists to treat diseases like cystic fibrosis or diabetes in humans.

There are multiple technologies used for gene editing, one of the most recent and promising being CRISPR-Cas9 (clustered regularly interspaced short palindromic repeats and CRISPR associated protein 9). In addition to being both more precise and efficient than other technologies, CRISPR-Cas9 is also cheaper to use.

## The Mechanism

This form of gene editing was adapted from a gene editing system that naturally occurs in bacteria. Bacteria obtain small sections of DNA from invading viruses and use them to make segments of DNA called CRISPR arrays. These arrays allow the bacteria to recognize a virus and repel future attacks. Using its CRISPR arrays, the bacteria is able to produce segments of RNA called CRISPR RNA (crRNA). The crRNA segments along with tracrRNA (trans-activating crRNA) bind to the enzyme Cas9 and guide it to the area of DNA that is complementary to the crRNA. At that location on the DNA, the Cas9 will cut both strands of the double helix.

The CRISPR-Cas9 technology works in a similar way in the lab, but without the invading virus and CRISPR arrays. Scientists produce a small segment of RNA called guide-RNA (sgRNA) that binds to a target sequence of DNA. The segment of RNA also binds to the Cas9 enzyme, which makes the double stranded cuts in the target genomic DNA sequence. The cellular repair machinery then tries to repair the segments of DNA.

There are two methods the cells may use to repair the DNA. One involves "gluing" the cut DNA back together, a method called "non-homologous end joining" (NHEJ). However, this method often causes errors such as the accidental insertions or deletions of nucleotides. This results in a frame-shift error

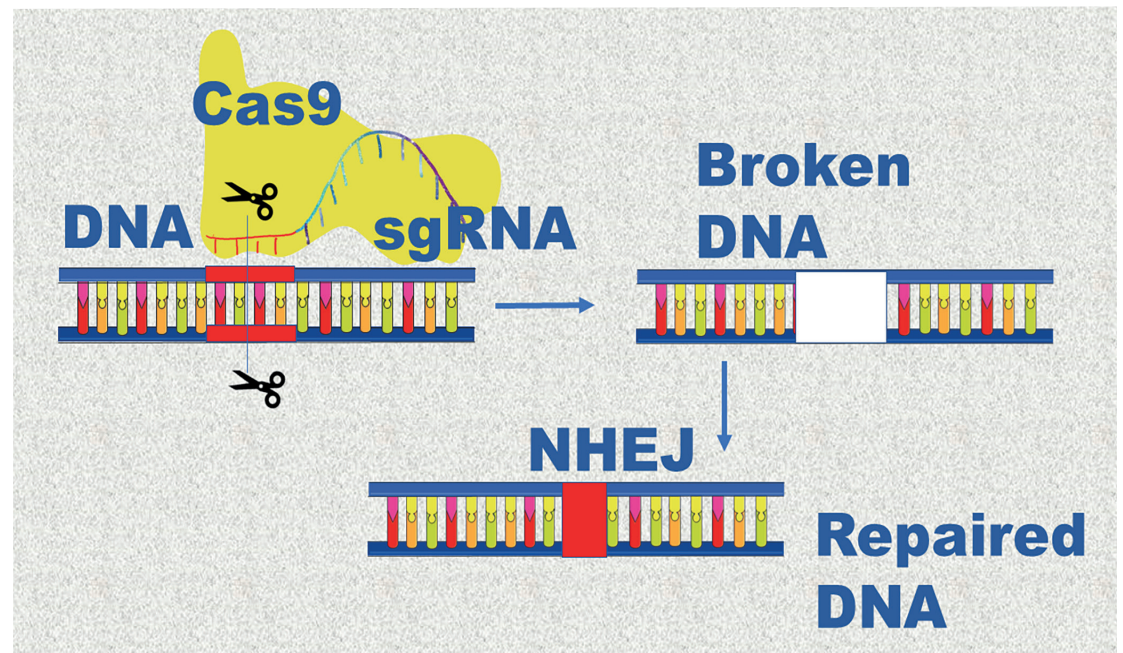


DIAGRAM: AVANI AHUJA '22 (GDS)

in genomic DNA and a mutated or inactive translated protein. The second method is the one used by scientists to edit genomes. To repair the cuts, the cell fills the gap with a sequence of nucleotides copied from a short DNA template strand. In order to correct mutations or edit genes, scientists and researchers simply supply the DNA template strand.

In humans, gene editing can either be somatic and germline. Somatic gene editing refers to modifications in human somatic cells, which are all body cells other than reproductive cells (gametes) or cells that produce the gametes. When somatic cells are edited, the modifications made are not inheritable. Germline gene editing refers to modifications in gametes, the cells that lead to them, or embryos. The editing done in gametes will be inherited by future generations.

*"The editing done in gametes will be inherited by future generations."*

Both somatic and germline gene editing have raised concerns. The only issue with somatic gene editing is the possibility of unintended consequences, as the technology is relatively new. Because somatic cell gene editing is confined to a specific area and is not inheritable, the risks are fewer than those of gene editing in gametes or embryos.

However, with germline gene editing, many

ethical issues arise concerning consent and the distinction between therapy and genetic enhancement. Because the risks of germline therapy are relatively unknown, many scientists and researchers are worried about parents giving truly informed consent. In addition, it is impossible to get informed consent from the embryo and future generations. As a result, many argue that gene editing in human embryos is too dangerous and "ethically unacceptable," and multiple countries have banned germline gene editing.

At the moment, germline gene editing is being proposed as a therapy to cure genetic diseases before children are born. However, as Marcy Dornovsky, the executive director of the Center for Genetics and Society in Berkeley, California, said, "How do you draw a clear, meaningful line between therapy and enhancement?" From therapeutic genetic modifications, it's a slippery slope to non-therapeutic enhancement and "designer babies." This practice would also deepen inequalities, creating a gap between those who could afford it and those who couldn't. Embryos being modified merely for the purpose of enhancement could potentially create social classes based on gene editing.

Although there are many arguments against germline gene editing, some also argue that it is unethical not to research the possibilities that it offers. According to bioethicist Julian Savulescu, "To intentionally refrain from engaging in life-saving research is to be morally responsible for the foreseeable, avoidable deaths of those who could have been benefited."



# Bioprinting

Grace Zhao '22 (SFS)

**W**hen we imagine robots, we always imagine a cyborg, made up of all metal with glowing eyes, but what if tomorrow's robots didn't look any different from us?

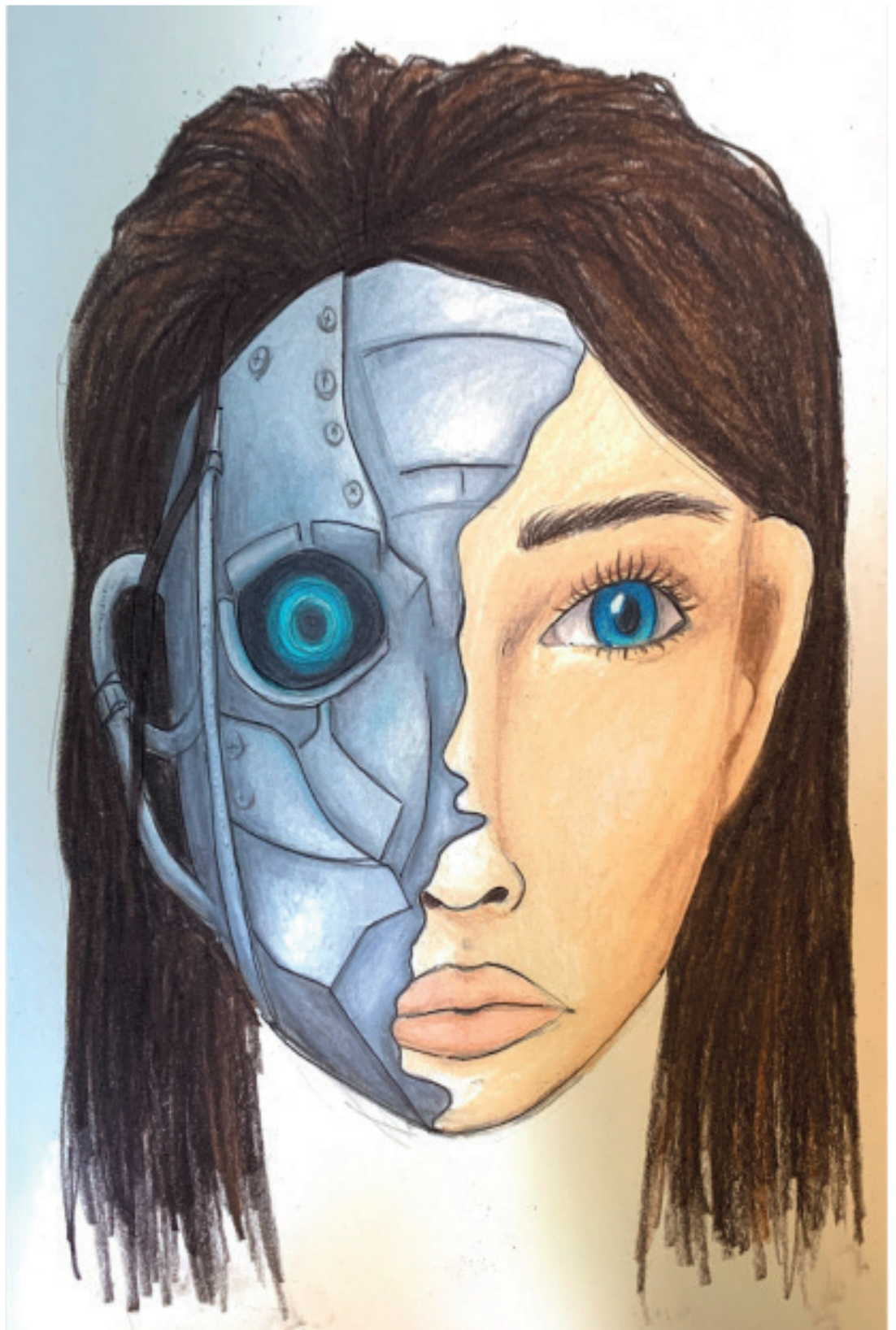
Someday, a human being may step out of a 3D printer. More than just a wax figure, more than just identical in looks – it would be completely functional: moving, thinking and growing, with muscles and organs like ours. If the idea scares you, there is no need to worry, and you'll be happy to hear that this concept is still far from reality. Experts have not yet achieved anything close to an entire living, breathing person. But if the idea sounds cool, bioprinting might interest you. Scientists and physicians have already begun to construct muscles and tissues from human cells. Still working on parts of the whole, they are making steady progress, fine-tuning the smaller and simpler pieces.

In the biological world, 3D printing was limited to "static non-living constructs" before the study of bioprinting began. Upon the discovery that cells were capable of being extruded like ink, biologists realized that they could engineer living matter just like its inanimate counterparts. Since then, scientists have developed a formula for bioink.

Cells (usually stem cells) are mixed in a nutrient gel, which contains growth factors to simulate cell divisions as well as polymers, which help the cells form the shapes required. Ejected layer by layer onto a mold, the organ is carefully constructed. The mold consists of biodegradable plastic, which deteriorates when the organ is finished and ready for use. Today, scientists at the Wake Forest Institute for Regenerative Medicine have already printed and utilized a variety of different organs, including "skin, urethras, cartilage, bladders, muscles, kidney, and vaginal organs."

Still, there is a long way to go before these manufactured organs are offered for common medical practice. As with all new products,

*"Upon the discovery that cells were capable of being extruded like ink, biologists realized that they could engineer living matter just like its inanimate counterparts."*



ARTWORK: ELLA MAJD '22 (SFS)

When it does become publicly available, bioprinting can be employed in a variety of ways. One major implementation would be in organ transplants. Currently, the need for organs profoundly exceeds the number of donors, which are the only source.

Imagine if those waiting for transplants could have organs custom-made. Using the stem cells of the patients, a new organ could be printed, no longer requiring a donor and increasing availability. Not to mention that these organs would already be a "match" for the person it was printed for, therefore reducing the chance of rejection, and possibly saving a life.

Another possible application of bioprinting would be for those in need of skin grafts. Skin grafts are procedures in which surgeons transfer skin from one area of the body to another.

The German company BASF has developed a

unique approach for this task: to first scan the wound, then, using a person's own skin cells as a spray, applying directly onto the patient. Similarly to transplanting bioprinted organs, here, using the patient's cells, the rate of rejection will also be reduced. However, as skin is surprisingly complicated, scientists have not yet mastered this technique.

Bioprinting can also positively impact those with sensory disabilities. New possibilities lie ahead in artificial ears, composed of metal receptors embedded in skin cells, and photoreceptor eyes, which scientists are currently experimenting with. That also raises questions: what are the limits? Are supersensory capabilities in our future?

Furthermore, pharmaceutical companies too have invested in bioprinting technologies. They are hoping to practice drug tests on human



tissues, replacing the rats and other lab animals in use today. Not only would this satisfy animal rights activists, but it would also improve accuracy in testing medications for humans. With so many applications, bioprinting is a valuable resource that is being explored by many.

Major manufacturing companies, like L'Oréal and Procter & Gamble, are working alongside physicians and scientists to contribute to advances in the bioprinting field. And research

companies like Organovo, which specialize in tissues, have already begun using kidney and liver tissues for drug testing. Bioprinting opens new doors in several fields.

Though we're still working on small pieces (organs with up to two cell types and simple structure), scientists believe that our printed future could become reality. Martin Birchall of the University College London, called it "the goose that really does lay golden eggs." Also,

more complicated organs have just begun trials. For example, bioengineers have created a silicon heart with limited functionality. Most of us take our hearts for granted, and never realize what it has to endure: "physiological stresses[...]physical forces such as shear stress and pressure as well as biological stressors including presence of toxins, enzymes and non-physiological pH" must all be taken into account. Research must be developed, prices lowered, the process must be made quicker and easier before bioprinting will reach you.

## Teen Stress

### Brooke Bao '22 (SFS)



ARTWORK: VIRGINIA HEINSEN '20 (GDS)

**T**eens today face many pressures of a changing society, pressures which their parents did not experience or felt less strongly in their time. Although the teenage years are famous for bringing academic pressure and social pressure, among others, the reported stress levels of today's teens are far higher than those of previous generations.

The journal *Psychology Today* reports that, "the average high school kid today has the same level of anxiety as the average psychiatric patient in the early 1950's," and a poll by the

American Psychological Association (APA) found that since 2013, teens report stress levels even higher than those of adults during the school year. Moreover, in the APA's 2018 survey, only 45% of Gen Z respondents reported "excellent or very good mental health," the lowest percentage of any age group. These results are disheartening, yet the first step to helping alleviate stress in teenagers is to understand the underlying problem. What is causing teen stress?

It is important to begin by debunking the myths. The most popular scapegoat of the media and

parents for teen stress is social media.

However, according to Diana Divecha, a writer for *Developmental Science*, a Canadian study of nearly 1,700 teenagers over the course of six years showed that social media did not lead to depression in girls or boys. In fact, social media served as an effect of depression rather than its cause, as the study proved that depression in middle school is linked with increased future use of social media (in girls only).

In a survey taken by nearly 36,000 teens across the country, the primary cause for teen stress was relationships (27.22%), followed by teachers (24.55%), parents (13.46%), college (9.47%), and friends (4.21%). Moreover, Divecha found that teens are more stressed than adults about the current state of our nation in issues such as rising suicide rates, climate change, immigration issues, and sexual harassment. For instance, three out of every four teens surveyed by the APA reported that they were stressed about gun violence.

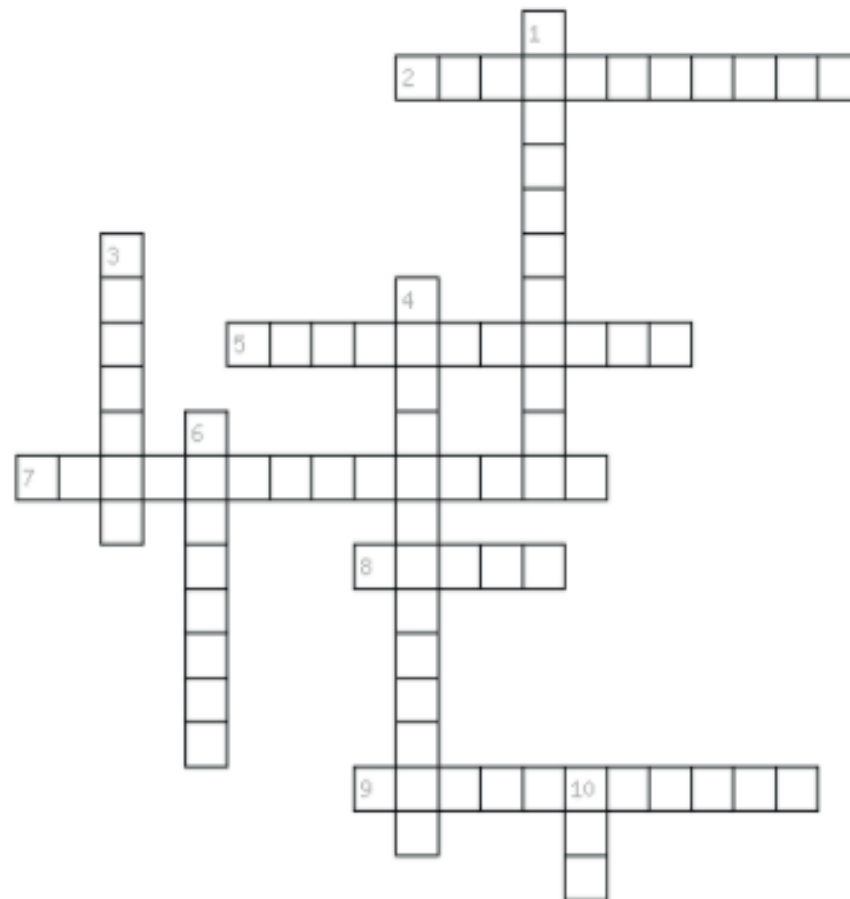
Although more than half of teens reported that stress had very little to no impact on their physical and mental health, stress in teens has been directly linked to a decline in physical and mental health: teens may lose sleep, skip meals, or eat more to deal with stress. And from personal experience, the effects of stress have been normalized by our generation.

How many times have you complained to your friends about how little sleep you got the previous night or how stressed you are for an upcoming test? In spite of these issues, more than half of teens reported that stress had very little to no impact on their physical and mental health, and according to the APA's Stress in America survey, 42% of teens said that they were not learning to cope with stress and did not know if they were doing so correctly.

Though there has been an increase in education and focus on mental health in recent times, teens still have trouble identifying the effects of stress as well as coping with and managing them. In an era of rising pressure and the normalization of stress, educators and parents need to raise awareness about our divergence from the expected levels of stress to begin helping teens alleviate their symptoms.



# CROSSWORD



Down

1. Machines which take over the function of the lungs when patients cannot breathe

3. Body cells other than reproductive cells

4. The impairment of the ability to recognize faces

6. Gene editing relating to modifications in gametes

10. A rare inherited disorder resulting in increased levels of the amino acid phenylalanine

Across

2. A union between different senses

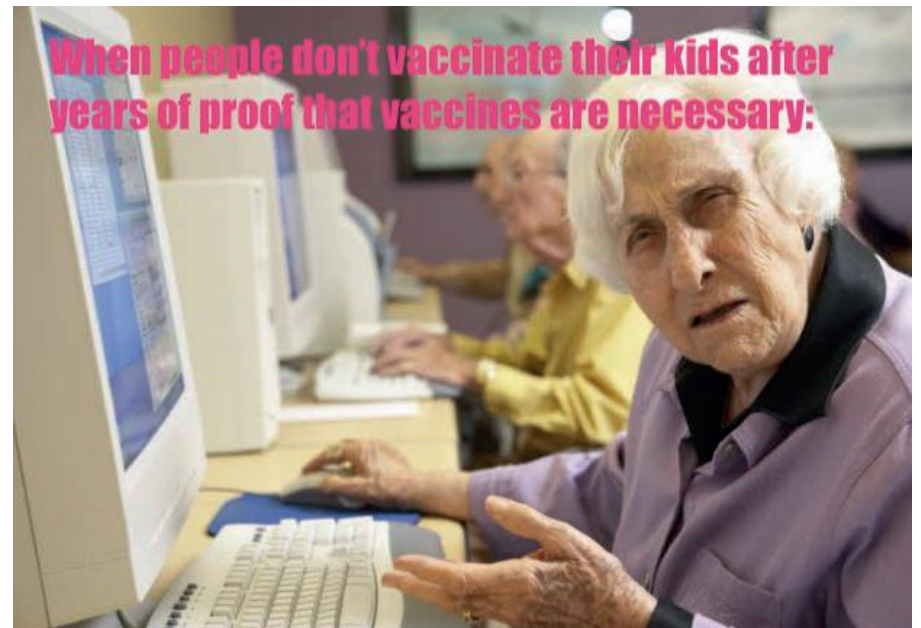
5. 3D printing human tissues

7. Someone who studies disease control

8. Woman whose cells are the source of the HeLa line

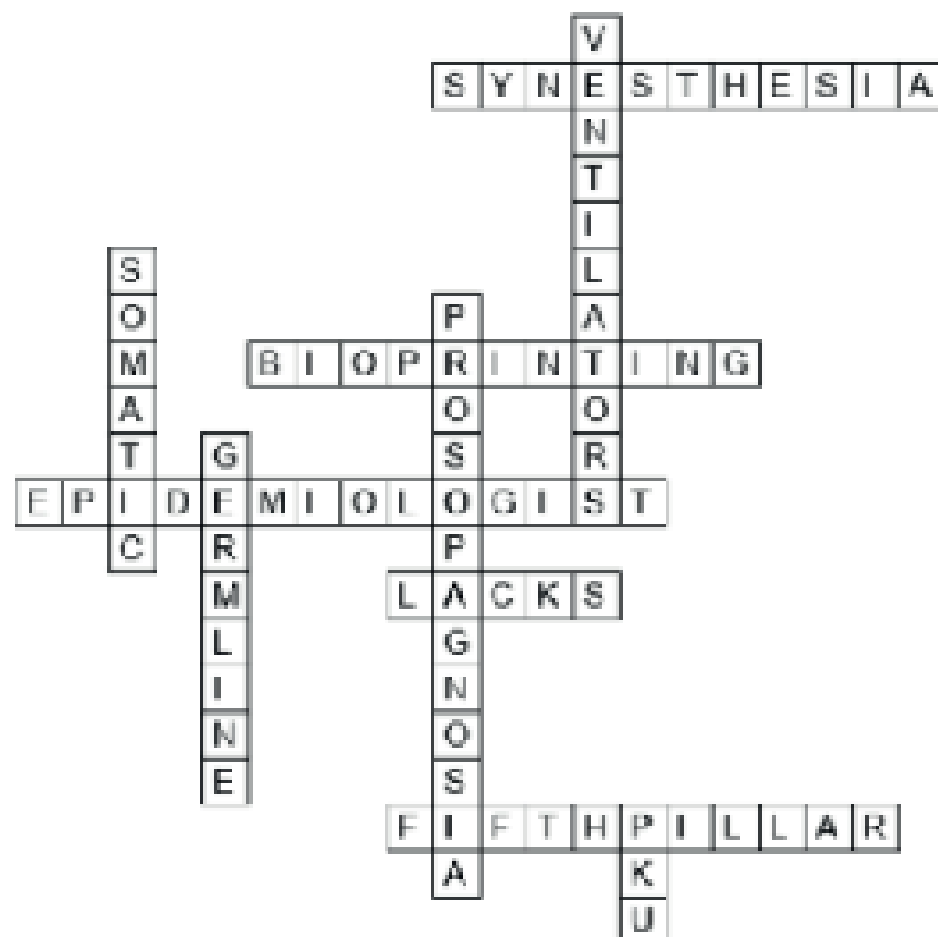
9. Architectural role of CAR T-Cell therapy? (two words)

# SCIENCE MEMES





# CROSSWORD SOLUTION!



## Down

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## Across

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9. Architectural role of CAR T-Cell therapy? (two words)

# COVID-19 RESOURCES

## 1. All In Challenge

**Website:** <https://www.fanatics.com/all-in-challenge/x-12589906+z-9713580-3838082054>

**Webpage description:**

"Fanatics is ALL IN to help eliminate food insecurity during these challenging times. More than ever before, families will struggle to provide food as tens of millions are out of work, kids are out of school, many are at risk of losing their income, and our most vulnerable are self-isolating.

100% of proceeds are going to these great charities: Meals on Wheels, No Kid Hungry, America's food fund, Feeding America, World Central Kitchen"

## 2. CDC Foundation

**Website:** <https://give.cdcfoundation.org/give/269833/#!/donation/checkout>

**Webpage description:**

"The CDC Foundation's Emergency Response Fund enables CDC to strengthen critical global health security needs and respond immediately to public health emergencies such as the current novel coronavirus (COVID-19). Your gift allows CDC to better prepare for and respond to crisis situations by providing flexibility to meet both immediate and planned needs that would not otherwise be readily available."

## 3. AmeriCares

**Website:** <https://www.americares.org/emergency-program/coronavirus-global-health-emergency/>

**Webpage description:**

"AmeriCares is using every resource to fight the COVID-19 pandemic from critical supplies to education, training and other support for our staff and partners here at home and around the world. We are focused on frontline health workers, keeping them safe so they can continue to do life-saving work on behalf of patients with COVID-19 and those in need of care for other essential health services and life-threatening conditions."

## 4. World Central Kitchen

**Website:** <https://donate.wck.org/give/236738/#!/donation/checkout>

**Webpage description:**

"WCK is working across America to safely distribute individually packaged, fresh meals in communities that need support – for children and families to pick up and take home, as well as delivery to seniors who cannot venture outside. WCK is now active in dozens of cities providing nearly 200,000 fresh meals every day."

## LOCAL RESOURCES:

### 1. Martha's Table

**Website:** <https://marthastable.networkforgood.com/projects/95536-martha-s-table-martha-s-table-expanded-programs-covid-19>

During the COVID-19 outbreak Martha's table is doubling down on our mission to support strong children, strong families and strong communities

### 2. The Capital Area Food Bank

**Website:** <https://www.capitalareafoodbank.org/donate/>

**Webpage description:**

"Everyone deserves good food today and a bright future tomorrow. We work with 450+ nonprofit partners across the region. Together, we provide more than 30 million meals every year."

### 3. GDS initiatives

3D printing faceshields : Jonah Doctor Loeb '20: [jdoctorloeb20@gds.org](mailto:jdoctorloeb20@gds.org) and Margaret Tilmes '20: [mtilmes20@gds.org](mailto:mtilmes20@gds.org)

### 4. SFS initiatives

1. 3D printing faceshields : Ian Palk '20: [ipalk20@sidwell.edu](mailto:ipalk20@sidwell.edu), Kamran Rowhani '21: [krowhani21@sidwell.edu](mailto:krowhani21@sidwell.edu), Luke Primis '20: [lprimis20@sidwell.edu](mailto:lprimis20@sidwell.edu)

2. Sewing masks for healthcare workers-SFS initiative led by Mia Palk '23: [mpalk23@sidwell.edu](mailto:mpalk23@sidwell.edu)



## References by Article

**Dr. Kidest Assegued. (n.d.). [Personal communication].**

**Robertson, C., & Gebeloff, R. (2020, April 18). How Millions of Women Became the Most Essential Workers in America. New York Times. <https://www.nytimes.com/2020/04/18/us/coronavirus-women-essential-workers.html>**

### **A Tribute to Health Officials Working During the COVID-19 Pandemic**

Baird, R. (2020, March 24). Why Widespread Coronavirus Testing Isn't Coming Anytime Soon. The New Yorker. <https://www.newyorker.com/news/news-desk/why-widespread-coronavirus-testing-isnt-coming-anytime-soon>

Coronavirus disease 2019 (COVID-19). (n.d.). <https://www.mayoclinic.org/diseases-conditions/coronavirus/diagnosis-treatment/drc-20479976>

Coronavirus: How are patients treated? (2020, January 30). BBC News. <https://www.bbc.com/news/world-asia-china-51295415>

Coronavirus: The young doctors being asked to play god. (2020, April 2). BBC News. <https://www.bbc.com/news/world-us-canada-52137160>

Coronavirus: What are ventilators and why are they important? (2020, April 7). BBC News. <https://www.bbc.com/news/health-52036948>

Kim, S. (2020, April 3). OVER 100 DOCTORS AND NURSES HAVE DIED COMBATING CORONAVIRUS ACROSS THE WORLD. Newsweek. <https://www.newsweek.com/coronavirus-deaths-infections-doctors-nurses-healthcare-workers-medical-staff-1496056>

Q&A on coronaviruses (COVID-19). (2020, April 8). World Health Organization. <https://www.who.int/news-room/q-a-detail/q-a-coronaviruses#:~:text=symptoms>

Weise, K. (2020, March 16). Doctors Fear Bringing Coronavirus Home: 'I Am Sort of a Pariah in My Family.' New York Times. <https://www.nytimes.com/2020/03/16/us/coronavirus-doctors-nurses.html>

### **Period-Tracking Apps: Wolves in Sheep's Clothing?**

After years of neglect, femtech is getting substantial investment. (n.d.). Financial Times. Retrieved from <https://www.ft.com/content/125cfea-69c9-11ea-a6ac-9122541af204>

Bradley, S., & Bacharach, E. (2019, September 20). The 11 Best Period Tracker Apps, According To Ob-Gyns. Women's Health. Retrieved from <https://www.womenshealthmag.com/health/g26787041/best-period-tracking-apps/>

Kresge, N., Khrennikov, I., & Ramli, D. (2019, January 24). Period-Tracking Apps Are Monetizing Women's Extremely Personal Data. Bloomberg Business Week. Retrieved from <https://www.bloomberg.com/news/articles/2019-01-24/how-period-tracking-apps-are-monetizing-women-s-extremely-personal-data>

Langston, J. (2017, May 2). Period tracking apps failing users in basic ways, study finds. UW News. Retrieved from <https://www.washington.edu/news/2017/05/02/period-tracking-apps-failing-users-in-basic-ways-study-finds/>

Morgan, J. (2019, December 17). Using A Period Tracking App? This Is Where All Your Personal Info Goes. Retrieved March 26, 2020, from Refinery29 website: <https://www.refinery29.com/en-gb/period-tracking-apps-personal-data>

Olen, H. (2019, October 21). Missouri didn't track Planned Parenthood patients' periods to protect women. It was to control them. The Washington Post. Retrieved from <https://www.washingtonpost.com/opinions/2019/10/31/missouri-didnt-track-planned-parenthood-patients-periods-protect-women-it-was-control-them/>

Rosato, D. (2020, January 28). What Your Period Tracker App Knows About You. Consumer Reports. Retrieved from <https://www.consumerreports.org/health-privacy/what-your-period-tracker-app-knows-about-you/>

Sara, M. (2016, April 18). We Tried 8 Period Tracking Apps — Here's How They Held Up. Bust. Retrieved from <https://bust.com/living/16150-which-period-tracking-app-is-right-for-you.html>

Singer, N. (n.d.). Period-Tracking Apps Say You May Have a Disorder. What if They're Wrong? The New York Times. Retrieved from <https://www.nytimes.com/2019/10/27/technology/personaltech/health-apps-hormonal-disorder-pcos.html>

### **The Larger Fight: How Gxrls in STEM is Combating Gender Inequality**

The Lyda Hill Foundation & The Geena Davis Institute on Gender in Media. (n.d). Portray her: Representations of women STEM characters in the media. Retrieved from <https://seejane.org/wp-content/uploads/portray-her-executive-summary.pdf>

### **Vaccines: How are they Developed and Why Does it Take So Long?**

Vaccine development, testing, and regulation. (2008, January 17). Retrieved March 12, 2020, from The History of Vaccines website: <https://www.historyofvaccines.org/content/articles/vaccine-development-testing-and-regulation>

Vaccine product approval process. (2018, January 30). Retrieved March 12, 2020, from U.S. Food and Drug Administration website: <https://www.fda.gov/vaccines-blood-biologics/development-approval-process-cber/vaccine-product-approval-process>

### **CAR-T Cell Therapy: Hope for the Future**

Paddock, C. (2007). Cancer Kills Over 20 Thousand People A Day Says Global Report. Retrieved May 18, 2020, from <https://www.medicalnewstoday.com/articles/92062#1>

Cancer now leading cause of death in high-income countries - while heart disease burden persists in low-income and middle-income countries. (2019, September 3). Retrieved from <https://www.sciencedaily.com/releases/2019/09/190903084037.htm>

CAR T Cells: Engineering Patients' Immune Cells to Treat Their Cancers. (2019, July 30). Retrieved May 18, 2020, from <https://www.cancer.gov/about-cancer/treatment/research/car-t-cells>

### **Seeing isn't always believing: Synesthesia and Prosopagnasia**

Bate, S. (n.d.). Information about prosopagnasia. Retrieved March 9, 2020, from Centre for Face Processing Disorders website: <https://prosopagnosiaresearch.org/index/information>

Cafasso, J. (2018, January 3). What is synaptic pruning? (K. R. Gill, Ed.). Retrieved March 9, 2020, from Healthline website: <https://www.healthline.com/health/synaptic-pruning>

Corrow, S. L., Dalrymple, K. A., & Barton, J. J. S. (2016). Prosopagnasia: Current perspectives. *Eye Brain*, 2016(8), 165-175. <https://doi.org/10.2147/EB.S92838>

Hubbard, E. M. (2005). Neurocognitive mechanisms of synesthesia. *Neuron*, 48(3), 509-520. <https://doi.org/10.1016/j.neuron.2005.10.012>

Palmeri, T. J., Blake, R. B., & Marois, R. (2006, September 11). What is synesthesia? Retrieved March 9, 2020, from Scientific American website: <https://www.scientificamerican.com/article/what-is-synesthesia/>

Robson, D. (2014, July 29). Neuroscience: Why do we see faces in everyday objects? Retrieved March 9, 2020, from BBC website: <https://www.bbc.com/future/article/20140730-why-do-we-see-faces-in-objects>

Sacks, O. (1998). *The man who mistook his wife for a hat: And other clinical tales*. New York, NY: Simon & Schuster.

Taggart, E. (2019, March 1). 5 synesthesia artists who paint their multi-sensory experiences. Retrieved March 9, 2020, from My Modern Met website: <https://mymodernmet.com/synesthesia-art/>

University of Copenhagen. (2020, February 18). Brain coordinates for face blindness identified. Retrieved March 9, 2020, from Neuroscience News website: <https://neurosciencenews.com/face-blindness-brain-15728/>

Van Leeuwen, T. M., van Peterson, E., Burghoorn, F., Dingemanse, M., & van Lier, R. (2019). Autistic traits in synaesthesia: Atypical sensory sensitivity and enhanced perception of details. *Philosophical Transactions of the Royal Society B*, 374(1787). <https://doi.org/10.1098/rstb.2019.0024>

### **Spooky action over long distances: A new breakthrough in Quantum Computing**

Conover, E. (2020, February 12). Scientists entangled quantum memories linked over long distances. *Science News*. Retrieved from <https://www.sciencenews.org/article/scientists-entangled-quantum-memories-linked-over-long-distances>

Nield, D. (2020, February). Chinese scientists just entangled quantum memories over 50 km. *Sciencealert*. Retrieved from <https://www.sciencealert.com/scientists-demonstrate-quantum-memory-entanglement-over-more-than-50-km>

Yu, Y., Ma, F., Luo, X. et al. Entanglement of two quantum memories via fibres over dozens of kilometres. *Nature* 578, 240–245 (2020). <https://doi.org/10.1038/s41586-020-1976-7>

### **Treatment Options for COVID-19: Does an effective treatment already exist?**

AOCD. (n.d.). CHLOROQUINE. Retrieved March 18, 2020, from American Osteopathic College of Dermatology website: <https://www.aocd.org/page/Chloroquine>

Christian A. Devaux, Jean-Marc Rolain, Philippe Colson, Didier Raoult, New insights on the antiviral effects of chloroquine against coronavirus: what to expect for COVID-19?, *International Journal of Antimicrobial Agents*, 2020, 105938, ISSN 0924-8579, <https://doi.org/10.1016/j.ijantimicag.2020.105938>.



FDA. (2019, October 28). Development & Approval Process | Drugs. Retrieved March 18, 2020, from U.S. Food & Drug Administration website: <https://www.fda.gov/drugs/development-approval-process-drugs#top>

French researcher posts successful COVID-19 drug trial. (2020, March 17). The Connexion. Retrieved from <https://www.connexionfrance.com/French-news/French-researcher-in-Marseille-posts-successful-COVID-19-coronavirus-drug-trial-results>

Khan, A. (2020, March 12). Why will it take so long to make a coronavirus vaccine that can prevent COVID-19? Los Angeles Times. Retrieved from <https://www.latimes.com/science/story/2020-03-12/why-does-it-take-so-long-to-make-a-coronavirus-vaccine>

National Institute of Health. (2020, April 29). NIH clinical trial shows Remdesivir accelerates recovery from advanced COVID-19. Retrieved May 3, 2020, from <https://www.nih.gov/news-events/news-releases/nih-clinical-trial-shows-remdesivir-accelerates-recovery-advanced-covid-19>

Picower Institute for Medical Research. (n.d.). Chloroquine: Mechanism of drug action and resistance in Plasmodium falciparum. PubMed. [https://doi.org/10.1016/0163-7258\(93\)90056-j](https://doi.org/10.1016/0163-7258(93)90056-j)

Remdesivir for Potential Treatment of Covid-19. (2020). Retrieved from <https://www.clinicaltrialsarena.com/projects/remdesivir/>

Todaro, J., Rigano, G. (2020, March 13). An Effective Treatment for Coronavirus (COVID-19). <https://docs.google.com/document/d/e/2PACX-1vTi-g18ftNZUMRAj2SwRPodtscFio7bJ7GdNgbJAGbdfF67WuRJB3ZsidgpIdB2eocFHAVjIL-7deJ7/pub>

Wang, M., Cao, R., Zhang, L. et al. Remdesivir and chloroquine effectively inhibit the recently emerged novel coronavirus (2019-nCoV) in vitro. Cell Res 30, 269–271 (2020). <https://doi.org/10.1038/s41422-020-0282-0>

Thomas, K., & Sheikh, K. (2020, April 12). Small Chloroquine Study Halted Over Risk of Fatal Heart Complications. New York Times. Retrieved from <https://www.nytimes.com/2020/04/12/health/chloroquine-coronavirus-trump.html>

### Henrietta Lacks and the Ethics of Medical Breakthroughs

Brown, D. L. (2018, June 25). Can the 'immortal cells' of Henrietta Lacks sue for their own rights? The Washington Post. Retrieved from <https://www.washingtonpost.com/news/retropolis/wp/2018/06/25/can-the-immortal-cells-of-henrietta-lacks-sue-for-their-own-rights/>

Cell Size and Scale. (n.d.). Retrieved March 18, 2020, from Learn.Genetics website: <https://learn.genetics.utah.edu/content/cells/scale/>

Fresh Air. (2010, February 2). 'Henrietta Lacks': A Donor's Immortal Legacy. Retrieved from NPR website: <https://www.npr.org/2010/02/02/123232331/henrietta-lacks-a-donors-immortal-legacy>

The Legacy of Henrietta Lacks. (n.d.). Retrieved March 18, 2020, from Johns Hopkins Medicine website: <https://www.hopkinsmedicine.org/henrietalacks/upholding-the-highest-bioethical-standards.html>

Ronson, J. (2017, May 18). The Science Behind Henrietta Lack's Immortal Cells. Retrieved from Inverse website: <https://www.inverse.com/article/31538-henrietta-lacks-immortal-cells-cervical-cancer>

Skloot, R. (2010, January 22). Henrietta Lacks' 'Immortal' Cells (Interview by S. Zielinski) [Transcript]. Retrieved from Smithsonian Magazine website: <https://www.smithsonianmag.com/science-nature/henrietta-lacks-immortal-cells-6421299>

Talk of the Nation. (2010, December 13). 'Immortal' Cells Of Henrietta Lacks Live On In Labs. Retrieved from NPR website:

### Expected Economic Impact of the Coronavirus

Connerly, B. (2020, March 10). Rolling recessions are the likely economic impact of new Coronavirus And COVID-19. Forbes Magazine. Retrieved from <https://www.forbes.com/sites/billconerly/2020/03/10/rolling-recessions-are-the-likely-economic-impact-of-new-coronavirus-and-covid-19/#36f835081320Bi>

DOW closes in a bear market [chart]. (2020). Retrieved from <https://www.cnn.com/business/live-news/stock-market-news-today-031120/index.html>

Goolsbee, A. (2020, March 6). Why the Coronavirus could threaten the U.S. Economy even more than China's. New York Times. Retrieved from <https://www.nytimes.com/2020/03/06/business/coronavirus-economy-us-china.html>

Levanon, G. (2020, March 10). Two economic scenarios for the impact of coronavirus on the US. CNN. Retrieved from <https://www.cnn.com/2020/03/10/perspectives/economy-recession-coronavirus/index.html>

Menton, J. (2020, March 11). Dow drops into bear territory for the first time since the financial crisis, as investors fret over coronavirus. USA Today. Retrieved from <https://www.usatoday.com/story/money/2020/03/11/dow-tumbles-coronavirus-woes-counter-hope-fiscal-steps/5019349002/>

### The Ethics of Somatic and Germline Gene Editing

Cavaliere, G. (n.d.). The Ethics of Human Genome Editing. Retrieved from <https://www.who.int/ethics/topics/human-genome-editing/WHO-Commissioned-Ethics-paper-March19.pdf>

Krause, K. W. (2016, May-June). CRISPR-Cas9: not just another scientific revolution: poised to transform the world as we know it, a new gene-editing system has bioethicists wringing their hands, physicians champing at the bit, and researchers dueling with demons. *Skeptical Inquirer*, 40(3), 24+. Retrieved from [https://link.gale.com/apps/doc/A451149081/GPS?u=georgetown\\_dhs&sid=GPS&xid=6d6356ae](https://link.gale.com/apps/doc/A451149081/GPS?u=georgetown_dhs&sid=GPS&xid=6d6356ae)

NIH Image Gallery. (2018, May 10). Crispr Cas9 [Photograph]. Retrieved from <https://www.flickr.com/photos/nihgov/41124064215>

Saey, T. H. (2015, May 30). Editing human germline cells debated: new techniques for modifying genes raise ethical questions. *Science News*, 187(11), 16+. Retrieved from [https://link.gale.com/apps/doc/A416301739/SCIC?u=georgetown\\_dhs&sid=SCIC&xid=5b25c42b](https://link.gale.com/apps/doc/A416301739/SCIC?u=georgetown_dhs&sid=SCIC&xid=5b25c42b)

Vidyasagar, A. (2018, April 21). What is CRISPR? Retrieved April 1, 2020, from <https://www.livescience.com/58790-crispr-explained.html>

What are the Ethical Concerns of Genome Editing. (2017, August 3). Retrieved March 11, 2020, from National Human Genome Research Institute website: <https://www.genome.gov/about-genomics/policy-issues/Genome-Editing/ethical-concerns>

What are Genome Editing and CRISPR-Cas9? (2020, March 3). Retrieved March 11, 2020, from NIH U.S. National Library of Medicine website: <https://ghr.nlm.nih.gov/primer/genomicresearch/genomeediting>, [wakehealth.edu/Research/Institutes-and-Centers/Wake-Forest-Institute-for-Regenerative-Medicine](http://wakehealth.edu/Research/Institutes-and-Centers/Wake-Forest-Institute-for-Regenerative-Medicine)

### Bioprinting

Berg, J., Hiller, T., Kissner, M. S., Qazi, T. H., Duda, G. N., Hocke, A. C., Hippenstiel, S., Elomaa, L., Weinhart, M., Fahrenson, C., & Kurreck, J. (2018). Optimization of cell-laden bioinks for 3D bioprinting and efficient infection with influenza A virus. *Scientific Reports*, 8(1), 1–13. <https://doi.org/10.1038/s41598-018-31880-x>

Gallagher, J. (2014, April 11). Doctors implant lab-grown vagina. *BBC News*. <https://www.bbc.com/news/health-26885335>

Gallagher, J. (2016, February 16). Doctors 3D-print “living” body parts. *BBC News*. <https://www.bbc.com/news/health-35581454>

Heilweil, R. (2018, November 28). It's Alive! Eyes and Ears 3D-Printed From Human Flesh Could One Day Boost Our Senses. *Wired*. <https://www.wired.com/story/3d-printed-flesh-body-parts/>

Murphy, S. V., & Atala, A. (2014). 3D bioprinting of tissues and organs. *Nature Biotechnology*, 32(8), 773–785. <https://doi.org/10.1038/nbt.2958>

Murphy, S. V., De Coppi, P., & Atala, A. (2019). Opportunities and challenges of translational 3D bioprinting. *Nature Biomedical Engineering*, 1–11. <https://doi.org/10.1038/s41551-019-0471-7>

Ong, C. S., Yesantharao, P., Huang, C. Y., Mattson, G., Boktor, J., Fukunishi, T., Zhang, H., & Hibino, N. (2018). 3D bioprinting using stem cells. *Pediatric Research*, 83(1), 223–231. <https://doi.org/10.1038/pr.2017.252>

Researchers Are Now Creating Body Parts Using 3D Printing. (2018, February 27). *CELLINK*. <https://cellink.com/researchers-now-creating-body-parts-using-3d-printing/>

Stang, D. (2017, May 30). Skin Graft. *Healthline*. <https://www.healthline.com/health/skin-graft>

The Editors of the Economist. (2018, March 7). Here's How 3D Printers Are Making Human Body Parts. *Reader's Digest*. <https://www.rd.com/health/healthcare/3d-printer-body-parts/>

Wake Forest Institute for Regenerative Medicine (WFIRM). (n.d.). Wake Forest School of Medicine. Retrieved March 10, 2020, from <https://school>.

### Teen Stress

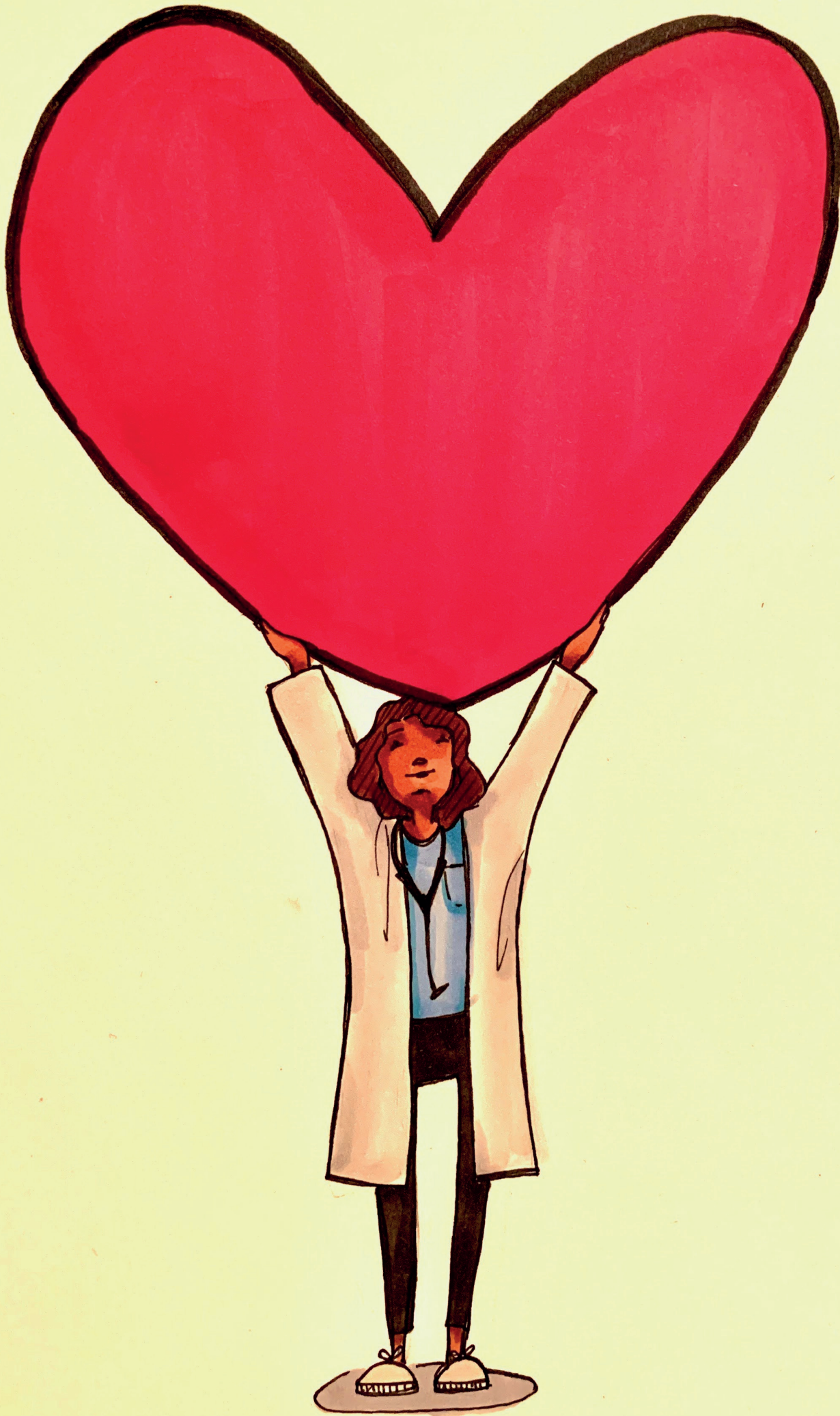
Bethune, S. (2014). Teen Stress Rivals That of Adults. *American Psychological Association*. <https://www.apa.org/monitor/2014/04/teen-stress>

Collins, J. (n.d.). 45% of Teens Say They're Stressed “All the Time,” Turn to Online Resources and Apps for Help Says Poll on Stress and Mental Health. *Globe Newswire*. <http://www.globenewswire.com/news-release/2018/02/21/1372739/0/en/45-of-Teens-Say-They-re-Stressed-All-the-Time-Turn-to-Online-Resources-and-Apps-for-Help-Says-Poll-on-Stress-and-Mental-Health.html>

Divecha, D. (2019, May 9). Our Teens Are More Stressed Than Ever: Why, and What Can You Do About It? *Developmental Science*. <https://www.developmentalscience.com/blog/2019/5/7/our-teens-are-more-stressed-than-ever>

Leahy, R. (2008). How Big a Problem is Anxiety? *Psychology Today*. <https://www.psychologytoday.com/us/blog/anxiety-files/200804/how-big-problem-is-anxiety>





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